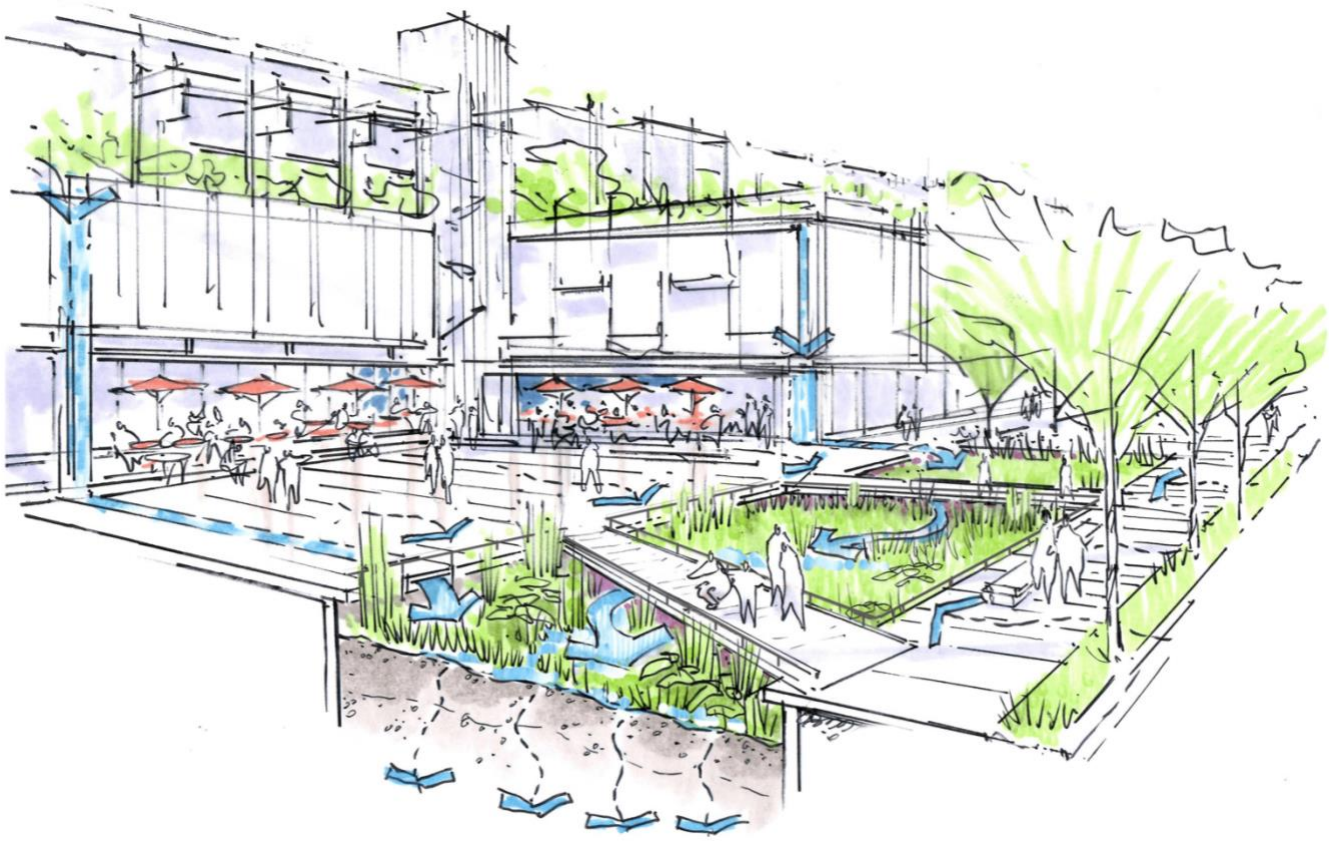

Photo: City of Vancouver, 2019

EXPLORING OPPORTUNITIES & CHALLENGES ASSOCIATED WITH MANAGING RAINWATER FROM PRIVATE PROPERTIES IN THE PUBLIC REALM

Alternate compliance mechanisms for private realm rainwater management

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1. INTRODUCTION + PROBLEM STATEMENT

The City of Vancouver's recently adopted Rain City Strategy is an ambitious program for reimagining how the city manages rainwater over the coming three decades. With growing concerns over limited combined sewer capacity, reduced local water quality, ageing infrastructure, and climate impacts set to bring an increase in extreme rain events, the Rain City Strategy seeks to better manage rainwater at the source, by mimicking the natural hydrological cycle and capturing and treating rainwater where it lands using green rainwater infrastructure (GRI) (City of Vancouver, 2019). To achieve this objective, the Strategy identifies rainwater management targets and associated design standards spanning both public and private lands across the city. It is also necessary for public and private lands to manage the majority of rainwater falling on their sites *within their own respective areas*.

Although the Rain City Strategy intends for private lands to manage a large proportion of the rainwater falling on site, there may be instances where private sites struggle to meet the city's rainwater management targets. In some limited cases it may not be possible to manage all or a majority of the rainwater falling on a particular site using on-site GRI practices, due to particular site characteristics limiting possible (and perhaps cost-effective) solutions. This may include site characteristic variables (e.g. soil permeability, slope, water table level, groundwater contamination), city policy variables (e.g. required setbacks for infiltration, adherence to other social policy objectives), and/or form, character and massing variables (e.g. roof type/slope, underground parking). To ensure that the City is able to meet the Rain City Strategy's GRI implementation targets, opportunities need to be considered that enable these sites to meet rainwater management targets in other ways. This includes managing rainwater from private sites using GRI on public lands within, for example, adjacent streets, laneways, boulevards, plazas and other spaces, as part of a neighbourhood or 'district scale' system, a pay-in-lieu or rainwater management credit trading system, or other alternatives. Broadly, these are referred to as '**alternate compliance mechanisms**' in this report.

Transferring rainwater from private lands into the public realm raises a number of questions and issues on topics that include finance, equity, legal implications, and risk management. It also requires consideration of the roles and responsibilities between public and private entities. In seeking to explore alternate compliance mechanisms for the private realm, some of the key topics and questions that require consideration include:

1. **Alternate Compliance Mechanism**: What might be an appropriate alternative compliance mechanism, or mechanisms, for the City of Vancouver? For example: Can private rainwater be managed by GRI in the adjacent public right of way? Are In-Lieu Fees most appropriate? Or would shared, District Scale solutions provide a pathway forward? What does this mean for the location of GRI between the private and public realm?
2. **Trigger Mechanism**: What are the circumstances or conditions under which the City of Vancouver would allow a private site to make use of an alternate compliance mechanism for rainwater management (i.e. what is the threshold or trigger mechanism)? How would this fit into and/or adjust the existing development review process, and review/approval of Rainwater Management Plans?
3. **Division of Operation & Maintenance Responsibility:** Who would be responsible for the construction, operation and maintenance of the GRI between public and private parties? What mechanisms (e.g. legal) might need to be in place to ensure clarity in responsibility for the long-term functioning of assets?

4. **Division of Ownership & Responsibility**: What are the policy and/or legal implications of managing rainwater offsite? What policies, bylaws or regulations would need to be addressed to enable certain alternate compliance mechanisms in a City of Vancouver context? How can risk be managed to protect public and private assets from unintended consequence (i.e. who is responsible for asset ownership, maintenance, inspection, cost, etc.)?
5. **Cost:** How does cost get apportioned between public and private parties? Depending on the type of alternate compliance mechanism, who pays for the construction, operation and maintenance of new GRI assets? Or, what might the appropriate cost for an In-Lieu Fee?
6. **Equity:** How does the City of Vancouver ensure that alternate compliance mechanisms are applied equitably across the private realm? How do these approaches intersect with, for example, affordability, drainage level of service, and green space area?

These broad questions help to form the basis of this report. Various municipal approaches for alternate compliance with rainwater management in the private realm, including In-Lieu Fees, GRI in the public right-of-way for private rainwater, and rainwater credit trading systems, are explored and discussed using the aforementioned questions as a guiding framework. The City of Vancouver's current context for rainwater management in the private realm is also investigated using these questions as a means for understanding where there may be existing challenges and/or opportunities for enabling alternate compliance mechanisms with rainwater management targets in the private realm.

Ultimately, the objective is to provide recommendations on policy options and next steps for considering alternate compliance mechanisms in Vancouver. A program of this nature would help to advance action towards achieving the rainwater management targets and design standards currently required in the Zoning and Development Bylaw and anticipated from ongoing implementation of the Rain City Strategy.

2. BACKGROUND

Understanding the City of Vancouver's existing context for rainwater management in the private realm, including the overarching policy framework and development review and approval process, is an important starting point for this work. This offers a lens through which to explore policy options from other leading municipalities and a means of identifying critical touchpoints for new approaches and tools. The following sections provide a brief summary of key contextual information for rainwater management in Vancouver, as well as possible implications and considerations for the City of Vancouver should they choose to move forward with exploring alternate compliance approaches.

2.1. CITY OF VANCOUVER'S RAINWATER MANAGEMENT CONTEXT

The City of Vancouver's Rain City Strategy (approved by Council in November 2019) affirms an aspirational target to capture and treat 90% of Vancouver's average annual rainfall, close to where it lands. The strategy also identifies an implementation target for capturing and cleaning rainwater from 40% of Vancouver's impervious areas citywide using green rainwater infrastructure by 2050. It is estimated that 30% of this total would be achieved by including rainwater management as a standard practice in new capital projects in the public realm and for new developments in the private realm (RCS, 2019) – highlighting the importance of participation from the private realm.

Currently, projects in the private realm which meet the threshold for rainwater management must meet the City's existing design standard of capturing rainwater from a minimum of the first 24mm of rainwater per day, in

addition to cleaning (treating) rainwater from a minimum of the first 48mm of rainfall per day (RCS, 2019). The Rain City Strategy proposes an update to these design standards which will be adopted city-wide to include the private realm by 2022. The updated design standard will require private sites to capture and clean rainwater from a minimum of the first 48mm of rainfall per day, in addition to meeting required peak flow release rates. The 48mm capture and clean standards are already in effect for city-owned properties, parks and the public realm.

While the Rain City Strategy affirms these rainwater targets and design standards, there exists a broader policy and regulatory framework guiding rainwater management in Vancouver (Figure 1). Furthermore, there are only a few City-wide rainwater regulatory requirements approved by Council to implement these targets and design standards through either the rezoning or the development review processes. Firstly, at the time of rezoning, rainwater design standards and infrastructure can be required subject to the **Rezoning Policy for Sustainable Large Developments** or the **Green Buildings Policy for Rezoning**. If the site does not need to be rezoned, development permit applicants will be required to comply with the existing **Zoning and Development Bylaw (Section 3.3)** rainwater design standards if the development site does not have adequate drainage. In effect, these policies require that the following applications comply with the Zoning and Development Bylaw (Section 3.3):

- Rezoning Applications
- Development Permit Applications (currently applied in the Cambie Corridor only)

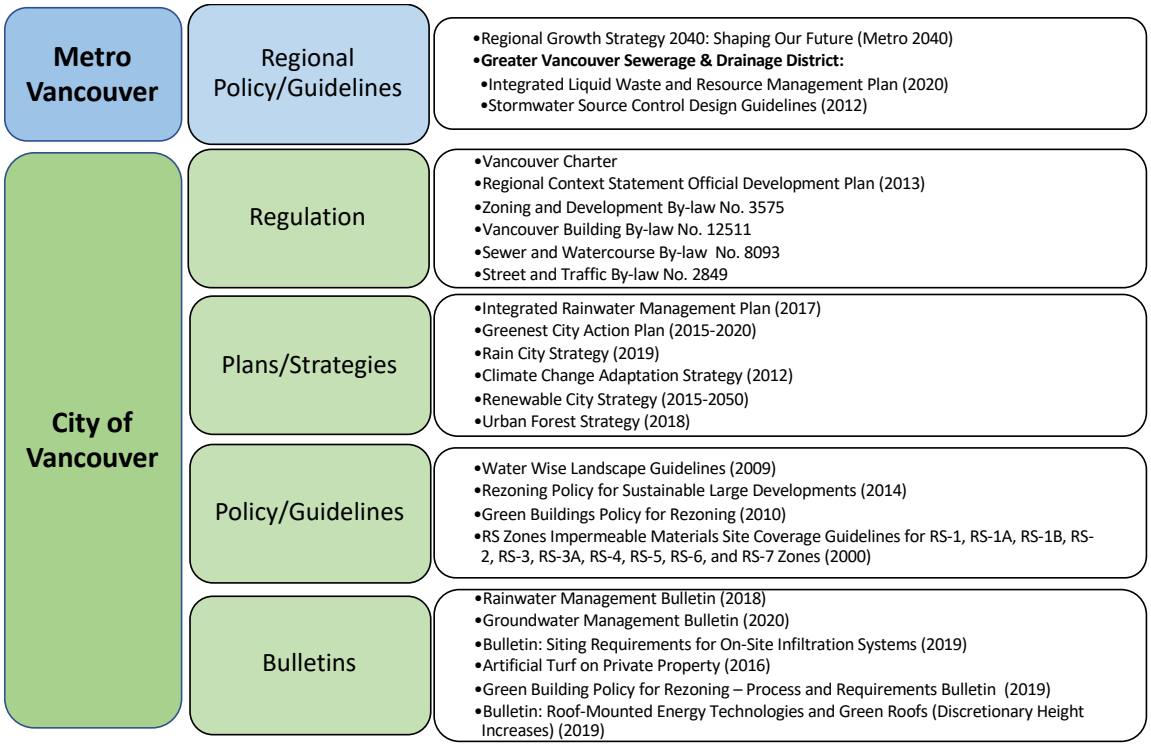

Figure 1.*Policy and regulatory framework surrounding rainwater management on private sites in Vancouver*[1]*.*

[1] This diagram focuses primarily on the bylaws, policies and documents that are deemed to be of most relevance for the discussion of transferring rainwater from the private to the public realm. However, it is recognized that there are numerous other policy documents which guide development in Vancouver, which may ultimately also have implications for rainwater management.

Through these two mechanisms, applicants are required to submit a Rainwater Management Plan (RMP) as part of their rezoning or development permit application. The Green Buildings Policy for Rezoning and the Rezoning Policy for Sustainable Large Developments – each of which are triggered through the rezoning process and refer to the standards in the Zoning and Development Bylaw and the supplementary Rainwater Management Bulletin (RMB) - also trigger the submittal of an RMP. It should be noted that the Green Building Rezoning Policy does offer two pathways (A and B) for applications, each with a distinct set of submission requirements. Pathway 'A' for the 'Net Zero Emissions Buildings Requirements' does not currently require submission of a Rainwater Management Plan (City of Vancouver, 2017).

The Zoning and Development Bylaw (Section 3.3) establishes the requirements for sites to meet the 24mm/day (retain), 48mm/day (treat), and post-development peak flow (release) rainwater management design standards (City of Vancouver *By-law 3575,* 2019). Sites must keep their peak flow release rate (m3/s) at less than or equal to the value under pre-development conditions. The **Rainwater Management Bulletin** was created to offer guidance on the interpretation and implementation of these requirements. Importantly, the RMB also establishes a 'Tier' system whereby there is an established hierarchy of preferred rainwater management solutions (City of Vancouver, 2018). The applicant must prioritize methods of rainwater capture according to the following three Tiers, beginning with Tier 1. Justification must be provided for using Tiers 2 and 3 and are reviewed at the discretion of the City.

- **Tier 1:** Use volume reducing green infrastructure practices. Acceptable practices include but are not limited to: infiltration into in-situ soil, rainwater harvesting and re-use, and green roofs.
- **Tier 2**: Use non-infiltrating landscapes. For example, rainwater can be directed to absorbent landscape on slab, closed bottom planter boxes, and lined bioretention systems.
- **Tier 3:** Use detention in combination with a water quality treatment practice as a last resort.

Rainwater Management Plans must demonstrate how a site will meet the rainwater design standards established in the Zoning and Development Bylaw (Section 3.3), using Tier 1-3 solutions identified in the RMB. RMPs are reviewed by City staff and may be adjusted throughout the Development Review Process (Figure 2) and are generally finalized and approved at the Building Permit stage. All GRI solutions implemented within the private realm remain the responsibility of the landowner for post-occupancy operations & maintenance, replacement and/or renewal.

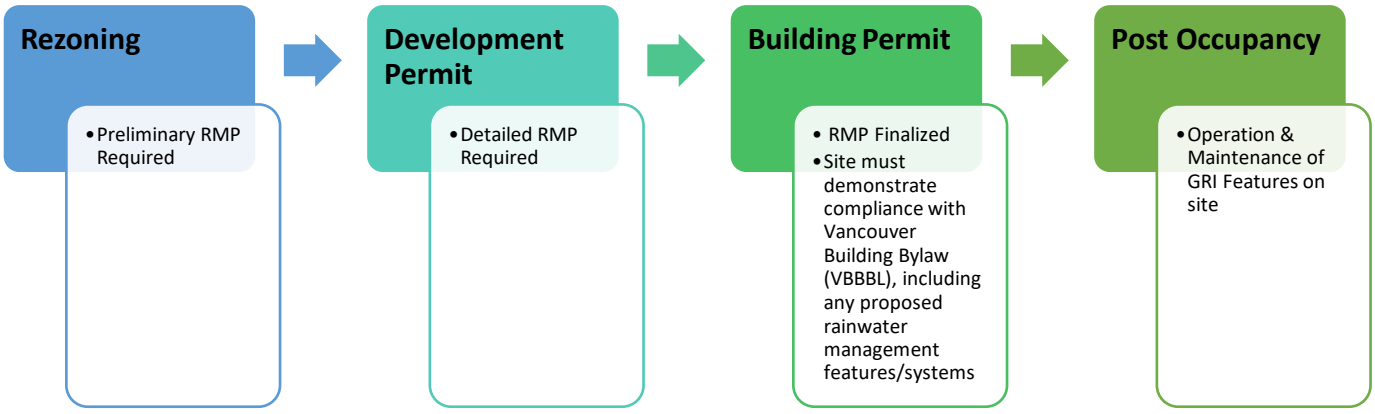

***Figure 2**. Summary of key Rainwater Management Plan steps through Vancouver's Development Review Process*

2.2. IMPLICATIONS FOR ALTERNATIVE COMPLIANCE IN THE PRIVATE REALM

2.2.1. *ESTABLISHING THRESHOLDS FOR ALTERNATIVE COMPLIANCE*

While the intent is for private lands to manage a large proportion of rainwater falling on their site using GRI (Tier 1), there are known barriers and challenges in achieving these rainwater targets. Many projects report struggling to meet the 24mm target. Sites that do achieve the existing design standard are often doing so using detention tanks (Tier 3) rather than preferred green rainwater infrastructure solutions (Tier 1 & 2). Lastly, there remain challenges through the operation and maintenance stage with GRI on private sites, which may limit the long-term performance of GRI assets.

Appendix 1 offers a broad overview of some of the known, existing challenges for implementing green rainwater infrastructure on private sites, which were gathered through interviews with City staff and reviews of academic and policy literature. It should be noted that many of these challenges are not unique to the City of Vancouver (Brears, 2019; Burgess *et al*., 2019; O'Neill & Cairns, 2016). Importantly, many of the existing challenges may be feasible to overcome through, for example, clarifying approval processes, providing private-realm GRI capacity-building and education opportunities or establishing design guidelines, which demonstrate feasible GRI solutions for various building typologies. Many of these are identified as critical implementation actions in the Rain City Strategy. However, some challenges remain genuine barriers and there is currently no defined process in place within the City of Vancouver to enable alternate compliance for these sites.

Differentiating between 'perceived' and 'actual' barriers to GRI implementation in the private realm remains a critical step for establishing the criteria or thresholds for considering alternative compliance for onsite rainwater management.

2.2.2. *POLICY, REGULATORY AND LEGAL IMPLICATIONS*

In seeking to identify possible solutions for managing private rainwater in the public realm, it is important to identify the policy, regulatory and legal implications surrounding rainwater and storm water in Vancouver. Although rainwater has been the primary terminology used in this report, many policies such as the Vancouver Building Bylaw refer instead to the term 'storm water'. The **Vancouver Building Bylaw** (or **VBBL**) offers the following definition for clarification (City of Vancouver By-law *12511,* 2019):

> **Storm water** means water that is discharged from a surface as a result of rainfall or snowfall.

The factors listed below are critical considerations in seeking to pursue rainwater transfer from the private to the public realm; they underpin important conversations surrounding risk, liability and legal frameworks for various policy options or tools that may be considered. More detail regarding each factor can be found in Appendix 2.

1. **Constraints for Rainwater Transfer from the Private to the Public Realm**: There are provisions within the City of Vancouver's **Sewer and Watercourse Bylaw** (City of Vancouver By-law 8093*,* 2019), the **Vancouver Building Bylaw** (City of Vancouver By-law 12511*,* 2019) and **Street and Traffic Bylaw** (City of Vancouver By-law 2849, 2020) which may have implications for drainage, and storm water management across private and public parcel boundaries.

2. **Constraints for Rainwater Transfer between Private Sites**: As a general principle, infrastructure and buildings cannot cross property lines. The VBBL states that storm water cannot discharge upon or impact other properties (City of Vancouver By-law 12511, 2019).

There are implications for the location of GRI, ownership of assets and responsibility for operation and maintenance.

Any alternate compliance approach which involves transfer of rainwater into the public right-of-way, or shared systems in which rainwater crosses across private parcels, would thus need to consider and comply with these provisions; seek to make appropriate amendments to these provisions; or alternately, establish appropriate legal agreements as an alternate means of meeting the spirit of these provisions.

2.2.3. *FINANCIAL/COST IMPLICATIONS*

As Vancouver continues to grow, there are increased demands on sewer, drainage and water services. A key issue is how to:

- maintain existing grey infrastructure to accommodate i) extreme storm events for current and future development, and ii) impacts from climate change, and
- construct/maintain new GRI to i) free up capacity in existing grey infrastructure, and ii) accommodate small and intermediate storm events for current and future development, while maintaining a level of service for those who live and work in Vancouver.

City-wide, there are contributions from both public and private entities to construct and maintain both grey and green drainage assets. At a high level (not exhaustive), existing private-realm contributions for drainage services and GRI include:

- Development Cost Levies: This includes contributions towards a Citywide Utility Development Cost Levy, which can be applied towards constructing, replacing, altering or expanding facilities for drainage, and remains a major source of the City's capital funding for GRI. As a limitation, this funding source cannot be used for operation and maintenance.
- On-Site Rainwater Management Costs: On-site GRI assets implemented as a means of meeting on-site rainwater management targets are the responsibility of the private landowner. This includes design, construction, operation and maintenance, renewal and replacement.
- Off-site GRI: In some cases, there may be developer-delivered GRI in the public ROW. These assets are designed and constructed by the private landowner, but ultimately become City-owned and maintained assets following acceptance after a minimum 2-year warranty period.
- Utility Fees: Post-construction, private landowners are responsible for paying ongoing City utility fees. A small portion of these fees may be dedicated to fund replacement, renewal and operations of GRI.

More details on how GRI is funded in the City of Vancouver can be found in Appendix 3.

When considering alternate compliance mechanisms, there remain questions as to who would be responsible for the cost of design, construction, operation, maintenance, renewal and replacement of GRI assets delivered offsite. If there are district scale solutions implemented, how are those costs apportioned between the various parties who benefit from the rainwater management benefits delivered by a shared

asset? Similarly, if an In-Lieu Fee approach is taken, how is that cost structured such to reflect the full lifecycle cost of the GRI asset delivered in the public realm (construction, operation, maintenance, monitoring).

3. METHOD

The purpose of this study is to assess policy options, approaches and tools from other jurisdictions for managing rainwater from the private realm in the public realm (alternate compliance), and to draw key insights, lessons learned and recommendations for the City of Vancouver. To achieve this, this study included secondary research of existing academic literature, policy reports, and government documents including guidelines, standards, bylaws, policies, and reports from the City of Vancouver and other jurisdictions, alongside primary research including informal interviews with city staff and a qualitative survey distributed to select municipalities.

Firstly, a review of Vancouver's existing policy and regulatory framework for rainwater management was conducted. This included a review of existing guidelines, standards, policies, reports and by-laws as well as informal interviews with City staff across the Planning, Urban Design and Sustainability and Engineering Services Departments.

Secondly, a cursory mapping exercise of the City's development review process was undertaken. Steps 1 and 2 helped to identify relevant policy documents for review; opportunities, challenges and gaps in the existing review process for Rainwater Management Plans; and also helped to inform an initial list of municipalities to research.

Thirdly, an initial scan of municipalities was conducted to identify potentially relevant rainwater management policies, tools and approaches. Municipalities were initially identified based on staff recommendations, known rainwater management policies/plans, cities with comparable climate and rainfall patterns, and municipalities identified through the initial literature review. Municipalities were also limited to a Canadian and USA geographic boundary.

Collection and review of secondary data on various regulatory agencies' websites was completed to identify relevant cases that could offer insights for the issue at hand. An initial list of 11 municipalities was developed (Figure 3) and a qualitative, open-ended question online survey was sent to key staff at each municipality detailing key questions regarding the policy/program in place for managing rainwater from private sites in the public realm (see Appendix 4 for survey questions). Contact information was retrieved through direct phone calls to municipalities, staff listed in the Green Infrastructure Leadership Exchange, and contacts listed in online resources. In some cases, an informal interview was conducted in lieu of completing the survey. In total, 8 responses were received, which reflects a 74% response rate.

TOP 11 MUNICIPALITIES

1. **City of North Vancouver, B.C.**
2. New Westminster, B.C.
3. Philadelphia, PA, USA
4. **Portland, OR, USA**
5. Seattle, WA, USA
6. San Francisco, CA, USA
7. St. Paul, MN, USA
8. City of Victoria (Dockside Green Development), B.C.
9. University of British Columbia, B.C.
10. UniverCity (Simon Fraser University in Burnaby), B.C.
11. **Washington, D.C., USA**

Figure 3 *Initial list of eleven municipalities identified and top 3 selected for case studies (in bold)*

These municipalities were then assessed and ranked based on the following criteria:

1. Data availability
2. Rainwater management policy/tool (alternate compliance mechanism: type (financial, offsite transfer, etc.), comprehensiveness of approach, insights offered for Vancouver)
3. Relevance/applicability to Vancouver (regulatory framework, population, development patterns, climate+ rainfall)

From the initial list of 11 cities, the top 3 cities were selected for this report (Figure 3). Additional information gathering from these 3 cities was completed on an as-needed basis, including follow up interviews with some city staff.

3.1. FRAMEWORK APPLIED TO THIS STUDY

For the purposes of reviewing and assessing the various cases in this report, a public/private management spectrum was developed in order to emphasize where the particular tool or approach fell with regards to management of private rainwater in the public realm or private realm, respectively.

As emphasized in the introduction of this report, transferring rainwater from the private realm to the public realm raises a number of key questions. The factors listed below are intended to act as key indicators for these broad questions and roughly characterize the overall division of responsibilities between the public and private realms. These factors, and the overall framework, are provided below in Figure 4.

Factors

GRI Location: where to physically locate GRI (and corresponding policy trigger)

O&M: who should undertake operation and maintenance

Liability: who accepts responsibility/liability

Costs: how costs are apportioned.

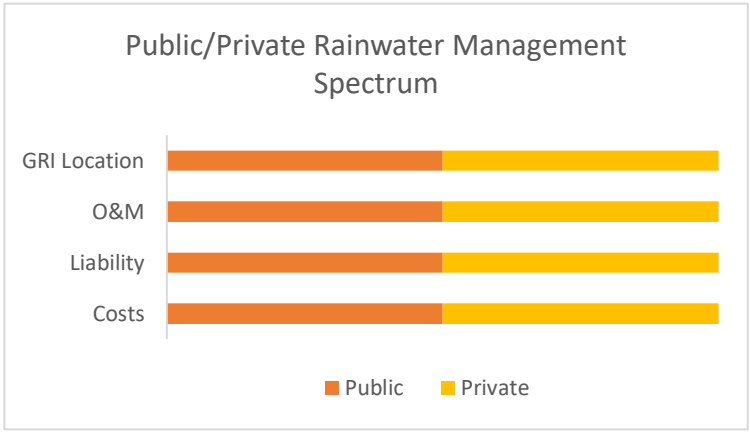

Figure 4 *Public/Private rainwater management framework for assessing case studies, considering GRI Location, Operations & Maintenance (O&M), Liability and Cost.*

4. FINDINGS

Eleven cities that have programs or innovative developments in place for private/public-realm rainwater management were identified through initial research and sent a survey as part of this study. These municipalities include: The City of North Vancouver, New Westminster, Philadelphia, Portland, Seattle, San Francisco, St. Paul, Victoria (Dockside Green Development), University of British Columbia, UniverCity (Simon Fraser University in Burnaby), and Washington, D.C. Eight cities completed the survey, which provided additional insights to preliminary research findings. A broad summary of findings is provided below under the topics of Regulatory Mechanisms, Financial Mechanisms, Incentives, Offsite Transfer Mechanisms, and District-Scale Solutions. These broad summary findings are followed by more detailed findings of selected case studies for the following jurisdictions: 1. City of Portland, Oregon; 2: Washington, D.C.; and 3. City of North Vancouver, British Columbia.

Various approaches are used across these municipalities to manage rainwater volume and quality in the private realm, to encourage or require GRI on private sites, and to enable alternate compliance mechanisms to on-site rainwater management when necessary. With each approach comes a different breakdown of responsibility between the public and the private realm.

Regulatory Mechanisms*: Regulatory mechanisms are requirements established by municipalities to require developments over a certain size threshold to meet specific rainwater volume and/or quality targets.* Rainwater management volume and quality regulations are a tool that is applied across most municipalities, including City of Vancouver. Regulatory requirements vary in terms of volume and quality thresholds/triggers for rainwater management. Communities which demonstrated success appear to have very clear regulatory guidelines, application processes, design guidelines for green rainwater infrastructure practices, and long-term operation and maintenance requirements for private-realm rainwater assets. Regulatory mechanisms are also used as a tool to prioritize the use of GRI on private sites as a means of meeting rainwater targets.

Financial Mechanisms*: Financial mechanisms offer an alternate compliance pathway for sites that are unable to meet on-site rainwater management requirements, by payment of some form of monetary fee.* Financial mechanisms can include off-site or In-Lieu Fees, or in the case of Washington D.C., a stormwater credit trading program. Typically, offsite or In-Lieu Fees are accompanied by a process for determining when a site is permitted to make use of this alternate compliance provision. In the case of Washington, D.C., the credit trading program offers flexibility for private sites to meet some of their stormwater requirements offsite through purchase of stormwater credits, generated through other regulated or voluntary GRI projects in the District. Often, off-site or in-lieu -site fees support delivery of GRI projects in the public realm.

Incentives: *Incentive programs provide a means of encouraging community uptake of GRI on private property, including new or existing development.* This can include discounts on utility fees, as is the case in Washington D.C.'s RiverSmart program or waiving of infiltration requirements with installation of 'EcoRoofs', as is the case in Portland, Oregon. Victoria's Rainwater Rewards Program uses financial incentives (rebates and credits) instead of regulatory mechanisms to encourage the uptake and retrofit of Green Infrastructure on private sites (City of Victoria, n.d.).

Offsite Transfer Mechanisms*: Offsite transfer mechanisms permit the management of private realm rainwater in the public right of way.* As discussed in the case study of North Vancouver, rainwater can be transferred and managed by GRI practices within the adjacent public right of way. Success with this approach requires there to be sufficient space in the ROW, and appropriate policies in place permitting transfer of rainwater from a private site to the public realm prior to connection to the sewer and drainage system. Legal agreements may be in place to determine responsibility of assets between private and public entities.

District-Scale Solutions*:* There was interest in exploring District-Scale solutions, which are large, shared facilities that manage rainwater from multiple private properties or from both public and private properties within a defined boundary. This can include any GRI tool, in isolation or combination, such as rainwater harvesting and reuse, treatment and/or other volume and release control facilities. District scale-solutions may be most applicable at the master planning or rezoning stage of development. Often, strong legal agreements such as covenants are used to clarify roles & responsibilities for shared infrastructure.

District Solutions for Multiple Private Properties – Dockside Green Development, Victoria, B.C.
Dockside Green, a developer-led initiative in the City of Victoria, captures, treats and reuses rainwater (as well as stormwater, greywater and blackwater) from an entire development site, including residential and mixed-use

development. The site's Master Development Agreement (MDA), signed between the City of Victoria and the developers, was the main function enabling the City of Victoria to approve this development as many of the systems and approaches did not confirm to existing stormwater bylaws and policies. The MDA made explicit the responsibilities and contributions each party would be expected to uphold, including for ownership, operation, maintenance and cost of stormwater assets. The project began as a single, consolidated brownfield site.

District Solutions for Public and Private Properties – St. Paul, MN, USA
The City of St. Paul is working towards establishing Stormwater Management Districts, in which public and private stormwater across an established district is managed by a shared stormwater facility. Properties within a 'Stormwater Management District' have unique stormwater connection charges, which are pooled in a separate fund for the ongoing O&M of that particular District's stormwater facilities. This approach is supported through a city-wide ordinance, which grants the City the ability to establish Stormwater Management Districts for large redevelopment sites, and a Master Development Agreement is also signed between the City and the landowner.

Other examples include UniverCity and University of British Columbia in B.C.'s lower mainland. UniverCity development guidelines require GRI to be implemented at the individual lot, streetscape and neighbourhood scale. Each development has a registered covenant requiring the developer and lease holder to implement and maintain the stormwater management system. University of British Columbia relies on Community Detention Facilities as a result of private sites often being unable to meet retention and detention requirements due to space constraints. Construction of community detention facilities has allowed new developments to be more economically feasible while achieving the desired levels of detention.

Cities, including Seattle, are working through similar questions as the City of Vancouver to identify appropriate steps forward to enable off-site or alternate compliance with existing private-site rainwater regulations. While limited follow-up data was available for the Cities of San Francisco and Philadelphia, they appear to have extensive programs in place including modified compliance programs which enables qualifying sites to have adjusted performance requirements (San Francisco) and facilitation of Stormwater Management Enhancement Districts (Philadelphia). Further investigation may be warranted.

In order to explore these themes in more detail, in addition to those listed in the introduction of this report (e.g. cost, operations & maintenance, risk) the three cities selected for in-depth research were: 1. City of Portland, Oregon; 2: Washington, D.C.; and 3. City of North Vancouver, British Columbia. Each case study is described in further detail below, and a snapshot of the City of Vancouver is also provided for reference purposes.

<table>
<tr><th colspan="2">CITY OF VANCOUVER – REFERENCE COMMUNITY SNAPSHOT</th></tr>
<tr><td> 
</td><td>POPULATION: 675,218

AVERAGE ANNUAL RAINFALL: 127 cm (50")

RAINWATER DESIGN STANDARD: Capture rainwater from a minimum of the first 24mm of rainwater per day and clean (treat) rainwater from a minimum of the first 48mm of rainfall per day (<u>private realm</u>). Sites must keep their peak flow release rate (m3/s) at less than or equal to the value under pre-development conditions

Rain City Strategy Updated Target: Capture and Clean a minimum of the first 48mm of rainfall per day (<u>private realm</u>).</td></tr>
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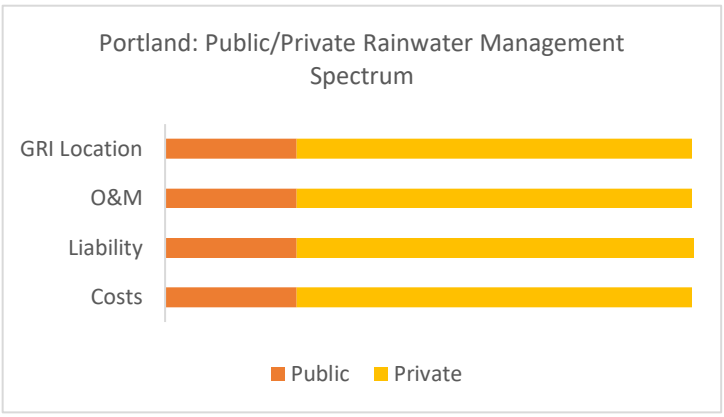
5. CASE STUDY: PORTLAND, OREGON

Offsite Fee Process for Regulated Sites

COMMUNITY SNAPSHOT



***POPULATION**: 654,741 (US Census Bureau, 2019b)*

***AVERAGE ANNUAL RAINFALL**: 94 cm (37") (City of Portland, 2020)*

***RAINWATER DESIGN STANDARD:** 86mm (3.4") of rainfall over 24 hours (10-year design storm)*

***APPROACH**: The City of Portland [Portland] is a longstanding municipal leader in stormwater management and green infrastructure implementation. Portland has established a runoff retention standard with a priority for green infrastructure implementation, which applies to new and redevelopment projects involving as little as 500 square feet of impervious area. Stormwater must be infiltrated onsite to the maximum extent feasible, before any flows are discharged offsite. When complete onsite infiltration is not feasible, decisions regarding the degree of onsite infiltration and the discharge location (when complete onsite infiltration is not feasible) are based on a defined stormwater hierarchy. The hierarchy ranks discharge systems by levels in order of preference (Level 1 is the preferred solution), where Level 1 is full onsite infiltration, Level 2 is offsite discharge to a storm sewer and Level 3 is offsite discharge to a combined sewer. While most development projects can meet the majority of stormwater management requirements onsite, occasionally they cannot due to technical reasons. In these cases, sites can submit an application through a Special Circumstances Process, which may enable those sites to pay an offsite management fee if approved. Offsite fees go towards a grant program that funds construction of green infrastructure projects, called % for Green.*

5.1. LOCATION, POPULATION, CLIMATE

The City of Portland is located in western Oregon, USA at the confluence of two of the nation's major river systems, the Columbia and the Willamette (City of Portland, 2020d). All of Portland's five local sub-watersheds are part of the larger Columbia Basin. Native salmon, steelhead and other fish and wildlife species are found within Portland's urban boundary and migrate beyond through the Willamette and Columbia River Basins (City of Portland, 2020d). The City is home to 654,741 people (US Census Bureau, 2019), and has an average annual rainfall of 94 cm (37 inches) (City of Portland, 2020h).

5.2. HOW THE SUBJECT CITY MEETS THE SELECTION CRITERIA

Data Availability: The City of Portland has accessible municipal reports and policy documents available online; completed our open-ended survey; and provided added insight during a follow up interview.

Approach: The City of Portland is a recognized leader in stormwater management and green infrastructure. Their long-standing stormwater management program – developed in the 1990s - takes a multi-faceted approach to stormwater management, combining regulation with incentive programs, education and community-driven greening in the public right of way (WERF, 2009; NRDC, 2013).

Relevance: Portland is found in a similar climate region to Vancouver and faces many of the challenges of managing stormwater within a dense urban environment. There are comparable drivers for stormwater management, including reducing CSOs and protecting water quality, although there are differing regulatory environments.

Portland was identified as a top municipality based on data availability; being in a similar climate region to Vancouver; and the comprehensive nature of their private stormwater program and process and thresholds for offsite compliance. From the municipalities assessed, it was deemed to have the most relevant and applicable lessons learned for Vancouver.

5.3. OVERARCHING RAINWATER MANAGEMENT OBJECTIVES

The City of Portland maintains two types of sewerage infrastructure: a combined sewer system and a separate municipal storm sewer system, which discharges to area waterways (NRDC, 2013). As with many cities, a key driver for Portland's stormwater strategies is a history of pollution and a desire to repair local ecosystems, in combination with regulatory requirements set by state and federal governments. One concern is the city's combined sewer system, which is subject to periodic overflows (CSOs).

In 1972, Congress passed the Clean Water Act, which "prohibits discharge of pollutants into waters of the United States unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit" (City of Portland, 2016). The City of Portland maintains two types of NPDES permits: a stormwater (MS4) permit and a wastewater treatment plant permit, which includes the combined sewer collection system (City of Portland, 2016). Compliance with the NPDES MS4 permit requires Portland to establish a stormwater management program, including controls on post-development stormwater runoff (City of Portland, 2016). Portland's citywide Stormwater Management Manual (SWMM) includes stormwater water quality and quantity design standards, focusing on low-impact development practices, stormwater management facilities and maintenance and operations best practices (City of Portland, 2016). To address CSOs, the City of Portland has pursued both major grey infrastructure capacity projects and lot-level green infrastructure to manage volume. The Big Pipe Project, completed in 2011, resulted in a 94% reduction in combined sewer overflows (CSOs) to the Willamette River and a 99% reduction to the Columbia Slough. The project detains stormwater from both private and public sites. Ongoing efforts to reduce CSOs include removing volume from the system through infiltration, and installation of regional stormwater facilities in priority areas.

The City uses the Stormwater Management Manual (SWMM) to protect both watershed resources and infrastructure investments citywide. The SWMM guides development and improvement projects across the City of Portland, ultimately contributing to the important long-term goals of:

- "Protecting watershed health by requiring infiltration wherever feasible, to mimic pre-development hydrologic conditions.

- Protecting groundwater resources by removing pollutants from stormwater before discharging it into the ground.
- Protecting streams and rivers by providing water quality treatment and flow control for stormwater before discharging it to surface water.
- Minimizing long-term costs to the City for treating stormwater through public wastewater treatment plants.
- Protecting the capacity of downstream infrastructure.
- Minimizing sewer overflows and basement sewer backups" (City of Portland, 2020b).

5.4. RATIONALE FOR MANAGING PRIVATE RAINWATER ON PUBLIC LANDS

Special circumstances on a proposed site may make it impractical to meet the stormwater management requirements to the standards specified in the SWMM. Payment of an In-Lieu Fee may be requested when it is considered technically infeasible to install stormwater management facilities for all or part of a site. For example, this may include sites with low infiltration rates, steep slopes or landslide hazards.

5.5. POLICY AND REGULATION FRAMEWORK DESCRIPTION (AND TRIGGER MECHANISM)

In Portland, projects that develop or redevelop over 500 square feet of impervious surface are required to comply with stormwater management requirements for the new or redeveloped impervious area at the site (City of Portland, 2016). Stormwater must be infiltrated onsite to the maximum extent practicable before any flows can be discharged offsite. Full on-site infiltration would meet the design standard of 86mm of rainfall over 24 hours. Portland's SWMM provides details on Design Approaches and Site Evaluation to characterize the ability of the site to meet said infiltration standards using various stormwater facility types. If complete infiltration of Portland's 10-year design storm (86 mm (3.4") of rainfall over 24 hours) cannot be accomplished onsite, an offsite discharge location must be identified (City of Portland, 2016) – either a storm-only (separated) or a combined sewer. Flow control standards vary, depending on the point of discharge (separated or combined sewer). Discharge to a separated storm system requires meeting pollution reduction and flow control requirements, whereas in the combined sewer system flow control is critical for protecting sewer capacity and preventing sewer backups and street flooding (City of Portland, 2020g). The base standard must be sufficient to maintain peak flow rates at their predevelopment levels for the 2-year, 5-year, and 10-year, 24 hour design storms (City of Portland, 2016).

Decisions regarding the degree of onsite infiltration and the discharge location (when complete onsite infiltration is not feasible) are based on an infiltration and discharge hierarchy, which is outlined in detail in the city's SWMM and briefly described below.

The Infiltration and Discharge Hierarchy ranks discharge systems by levels in order of preference. The highest technically feasible level must be used, unless otherwise directed by Portland's Bureau of Environmental Services (BES). It is the responsibility of the project designer to justify moving from one level to the next, based on technical issues or competing requirements. All cases are subject to BES review and approval and are evaluated on a site-by-site basis.

- **Level 1:** Full Onsite Infiltration - required to the maximum extent practicable for sites with design infiltration rates of 2 in/hr (51 mm/hr) or more, unless site constraints prevent infiltration, or the site qualifies for an Ecoroof exception. If full onsite infiltration is not practicable, offsite discharge is allowed (Level 2 or 3) (City of Portland, 2020g).

- **Level 2:** Offsite Discharge to a Storm System - water quality treatment, and flow control are required (City of Portland, 2020g).
- **Level 3**: Offsite Discharge to a Combined System - flow control is required. Flow control management is required to mimic pre-development hydrologic conditions and to preserve system capacity. Pre-development conditions are based on an undeveloped site rather than current conditions at the site (City of Portland, 2020g).

For Level 1, the term 'maximum extent practicable' means complete infiltration of Portland's 10-year design storm (86 mm (3.4") of rainfall over 24 hours). Typically, sites that have a 2"/hr infiltration rate or greater are required, and are able, to meet this infiltration requirement. If a site is below the 2"/hr infiltration rate, is a lot line to lot line development, or is in an area with landslide concerns, then there is greater willingness on the part of The City to permit a shift to Level 2/3. There may be additional special circumstances considered by City of Portland in addition to those listed here.

The City's Ecoroof Policy is now embedded as a zoning code requirement in the central city, which requires that 60% of roof area on a new building be an 'Ecoroof' (City of Portland, 2020c). As part of the updates to the Stormwater Management Manual, sites which trigger and meet the Ecoroof Policy will not be required to evaluate onsite infiltration for the building area. Ground level impervious areas that allow sufficient space to install an infiltration facility (e.g. surface parking lot) may still need to investigate infiltration for those impervious areas. Sites must still meet all relevant flow control requirements. Guidance on Ecoroof requirements as they pertain to the Stormwater Management Manual (stormwater volume and quality requirements) are summarized in an online guidance document.

Portland's SWMM includes a detailed chapter on 'Stormwater Facility and Conveyance Design', which provides the information needed to select and design stormwater management facilities and conveyance features that meet the requirements established in the manual (City of Portland, 2016). These technical design guidelines support private sites in implementing solutions to meet the regulatory requirements.

5.6. SPECIAL CIRCUMSTANCES – OFFSITE STORMWATER MANAGEMENT FEE

Special circumstances on a proposed site may make it technically unfeasible to meet the stormwater management requirements to the standards specified in the SWMM. Portland's BES manages a **Special Circumstances Process** to review requests either to meet stormwater management requirements in alternative ways or to pay an **Offsite Stormwater Management Fee** in lieu of building a stormwater facility as part of the project.

A project designer can request to pay an Offsite Stormwater Management Fee instead of building a stormwater management facility (on-site) for some or all of the stormwater management requirements for the project by submitting a Special Circumstances Request. Typically, sites will have exhausted all options available through Levels 1-3 prior to requesting to pay an offsite fee. BES manages a Special Circumstances process, in which applications for Special Circumstances are reviewed by a Committee. According to City of Portland staff, the vast majority of private development that applies to pay the offsite fee is only doing it for a portion of their site area on which they are unable to manage stormwater. Furthermore, the use of the Special Circumstances Process is not a regular occurrence (as noted by staff, it is usually only 1-2 applications per month). The City will prioritize and require infiltration to the maximum extent possible before approving payment of an off-site fee. A copy of the Special Circumstances Form is available online.

The Offsite Stormwater Management Fee charged for a project **is per square foot of unmanaged impervious area** and is calculated based on the average construction costs for the City to install stormwater management facilities through retrofitting impervious area (City of Portland, 2020g). In other words, the fee is calculated based on the City's standard retrofit cost for an existing impermeable area in the public realm. Currently, the Offsite Stormwater Management Fee is $54.11/m^2 CAD ($39.38/m^2 USD, $3.70/square foot USD) (City of Portland 2019). The methodology and the rate are published and adopted through BES's annual budget process and are listed with the current fiscal year's Sewer and Drainage Rates and Charges (City of Portland, 2020e). Special Circumstances requests that are submitted following permit issuance are charged a Post-Permit Issuance Offsite Stormwater Management Fee of $108.17/m^2 CAD ($79.65/m^2 USD, $7.40/square foot USD) (City of Portland, 2019). This Fee is charged as a penalty on sites that complete their development but fail to leave space for a stormwater facility or construct a facility that is unable to perform as required. It is rare (approx. 1-2 times per year) that this fee is applied.

Currently, the offsite fees are used to fund Portland's **% for Green** program. This program "supports construction of green street facilities in the City of Portland that manage stormwater, enhance livability, and provide other environmental benefits" (City of Portland, 2020a). Grants are available for "green street facility projects" on either private property or in the public ROW but must treat stormwater from the public ROW (City of Portland, 2020a). The % for Green program is part of a broader Green Streets Program, which aims to implement GRI practices in streets, rights-of-way and boulevards across Portland. These facilities become public (City-owned) infrastructure (City of Portland, 2020i).

5.7. OPERATION AND MAINTENANCE (AND PERFORMANCE) REQUIREMENTS

To support the stormwater requirements for private sites, the City of Portland also has clear guidelines embedded in the SWMM for Operations and Maintenance (O&M). Broadly, it is stated that all "stormwater management facilities, conveyance features and related components implemented or protected as per the SWMM must be operated and maintained in a way that preserves intended functionality" (City of Portland, 2016, p.1-46). The O&M submittal requirements vary based on the design approach and location of the facility (i.e. located on private or public property or in the public right-of-way) (City of Portland, 2016). O&M plans may include monitoring of infiltration/flow-through rates, identification of visual indicators of diminished performance and corrective actions and listing of regular maintenance requirements.

5.7.1. *O&M REQUIREMENTS FOR THE PUBLIC RIGHT OF WAY*

Stormwater facilities constructed in the public ROW or in a public easement adjacent to a development site are the responsibility of the permittee until the City (BES) accepts and assumes ownership following the completion of a 2-year warranty period (City of Portland, 2016). Note that these facilities, though developer delivered, manage stormwater from the public realm only.

In the case of public easements, BES owns the public stormwater facility following acceptance, but the property owner will continue to maintain the surface of the easement itself including any associated features such any additional landscaping, fencing or access ways (City of Portland, 2016). A signed maintenance agreement designates maintenance responsibility and is approved by BES.

Ongoing O&M costs for green infrastructure are generally approached and calculated on a $/square foot of facility basis. Long term O&M funding is supported through the City's operating funds.

5.7.2. *O&M REQUIREMENTS FOR PRIVATE PROPERTIES*

Stormwater facilities and conveyance features on property (parcels or tax lots either privately or publicly owned) are the responsibility of the property owner (City of Portland, 2016). It is required that property owners submit O&M information for all stormwater management facilities, conveyance features and impervious area reduction techniques to the City for approval (City of Portland, 2016). The SWMM provides an established 'Operations and Maintenance Form' for private stormwater management facilities, alongside best management practices for O&M of various facility types. Additionally, there are specific provisions for shared systems, including:

- Where "multiple properties share one onsite private stormwater system, the property owner(s) for each property must record and file the O&M submittal" (City of Portland, 2016, p.1-46). This recognizes that there is joint ownership and equal responsibility for the O&M of the stormwater system serving the multiple properties and property owners.
- Where "a property served by an onsite private stormwater system is subsequently divided, a new O&M submittal must be approved at the time of BES review and recorded for each newly created parcel and/or tax lot that was previously part of the original parcel or tax lot" (City of Portland, 2016, p.1-46). This ensures long-term responsibility for the asset is maintained.

O&M of a stormwater facility or conveyance feature is documented through an inspection and maintenance log, submitted to the City of Portland. The logs must document deficiencies and corrective actions taken to keep structural and vegetative components in good working order. A log-sheet, and Best Management Practices for various stormwater facilities are provided by The City of Portland in the SWMM (found in Section 3.1).

5.7.3. *MAINTENANCE INSPECTION PROGRAM*

The City of Portland has a program to inspect stormwater facilities that have been installed on private property and provide property owners with the technical assistance they need to ensure that SMFs are functioning as intended (City of Portland, 2020f). This means that BES staff inspect sites to ensure that stormwater management facilities are operating in compliance with the recorded O&M submittal (City of Portland, 2016). BES provides post-construction inspections of stormwater facilities and drainage reserves on private property. In general, inspectors strive to work with site owners and operators to ensure the proper O&M of stormwater facilities. However, if technical assistance does not yield tangible O&M improvements, BES has the ability to take enforcement action, issue a code violation, and/or levy civil penalties (City of Portland, 2016).

5.8. FUNDING MECHANISMS

The City of Portland's Green Infrastructure work is covered through BES Operating Fees and Stormwater Fees included on Utility Bills.

The % for Green program is funded in part through the Offsite Management Fee collected through the Special Circumstances Process on private development in Portland. There is an additional 'one percent for green' fund within the City of Portland, which is directed towards the broader 'Green Streets' program. This fund comes from one percent of construction costs for any "City of Portland funded development, redevelopment or enhancement project, that does not trigger the Stormwater Manual but requires a street opening permit or occurs in the right of way" (City of Portland, 2007, p.1).

5.9. RISK MANAGEMENT MECHANISMS

The majority of responsibility rests with the private landowner, for ongoing onsite asset ownership, operation and maintenance. Mechanisms in place that enable BES staff to ensure deficiencies with private stormwater facilities are addressed support the long-term functioning of these facilities.

GRI projects delivered in the ROW become City-owned assets, after City approval is granted following a 2-year maintenance warranty period. Green streets projects delivered offsite through the % for Green program (funded in part through the Offsite Management Fees) ultimately become city-owned assets (City of Portland, 2020i).

5.10. IMPLEMENTATION CHALLENGES AND SOLUTIONS

Overall, the City of Portland prefers onsite management of stormwater on private property. However, the municipality recognizes that sometimes implementation on a particular site is infeasible and there needs to be an alternative approach. This is achieved through the Special Circumstances Process and Offsite Management Fee. Additionally, the City has system needs that need to be addressed and cannot wait for an entire basin to redevelop. In these instances, sometimes regional facilities are considered.

The success of the City of Portland stormwater program is due to 20 years of trial and error in the realm of green infrastructure. Portland has approached stormwater management with a willingness to experiment with green infrastructure initiatives; an adaptive management approach; and an openness to tailor solutions to the needs of specific watersheds across the city (NRDC, 2016). The strong regulatory context necessitating action on stormwater remains a large driver for their overall program.

City of Portland Staff Quote:
"We have required stormwater management on private property since 1999. 20 years later, it is just part of the cost of development."

5.11. CASE STUDY SUMMARY

CRITERIA	CHALLENGES AND BENEFITS
Overall Ease of Implementation	• Regulation, combined with off-site compliance fees, incentive programs and education work in tandem to produce successful outcomes. • Portland's comprehensive program is the result of 20 years of program and policy development. • Success is contingent upon a clear and strong regulatory framework being in place, which can take time and effort to establish. • Portland's Stormwater Management Manual is a comprehensive document, which provides regulatory requirements, operations and maintenance requirements and facility selection, sizing and design guidelines. • Relatively low threshold to comply with stormwater regulations (500 sq. ft) captures most types of development in the city (including single family).
GRI Location	• Private realm implements GRI on site to meet stormwater design standards. • Developers may deliver GRI in the public ROW during construction (for public realm stormwater only). These projects ultimately become city-owned assets. • Offsite Fees are allocated to Green Streets projects in the public realm, which become city-owned assets. Green Streets projects may be delivered by the City or community groups who apply through the % for Green Fund.

Division of O&M Responsibilities	• Private sites are responsible for O&M of GRI assets in the private realm. Sites are required to submit an O&M Form, detailing maintenance activities, and the responsible party for carrying out and paying for said activities. • Private sites are responsible for O&M of GRI assets delivered in the public realm until the City (BES) accepts and assumes ownership and maintenance responsibility following the completion of a 2-year warranty period.
Division of Ownership & Responsibility	• The City rests responsibility for private rainwater management with the private realm, requiring sites to meet infiltration targets to the maximum extent practicable. • Private-realm GRI practices remain the responsibility of the private landowner. • Projects delivered in the public realm are ultimately owned & maintained by the City.
Cost	• Private sites must construct, operate and maintain all assets installed on site. • Private sites may pay an Offsite Compliance Fees, which supports a grant program for GRI delivery across the city. • Private sites may construct GRI assets in the public realm and maintain them for 2 years after which The City assumes ownership and cost responsibilities.
Pay In-Lieu Fee	• Offsite Stormwater Management Fee = $54.11/$m^2$ CAD ($39.38/$m^2$USD, $3.70/square foot USD) per unmanaged impervious area on site. • Post-Permit Issuance Offsite Stormwater Management Fee (i.e., 'late fee') = $108.17/$m^2$ CAD ($79.65/$m^2$ USD, $7.40/square foot USD).
Equity	• Alternative compliance mechanisms are embedded into the overall process, recognizing specific site constraints that may preclude a site from meeting the established regulatory requirements. • % for Green program provides grant funding for GRI projects across the city. • Net benefits from policy for all utility ratepayers. • Net environmental benefit through delivery of GI.

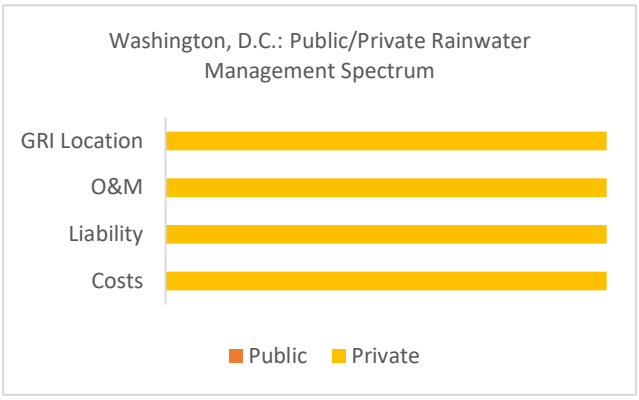
5.12. LIST OF APPLICABLE BYLAWS + AGREEMENTS

- 2016 Stormwater Management Manual
- Proposed 2020 Stormwater Management Manual
- Special Circumstances Form
- Operations and Maintenance Form/Agreement

6. CASE STUDY: WASHINGTON, D.C.

Stormwater Credit Trading Program

COMMUNITY SNAPSHOT



***POPULATION**: 705,749* (United Stated Census Bureau, 2019a)

***AVERAGE ANNUAL RAINFALL**: 101 cm (40")* (US Climate Data, 2020)

***RAINWATER DESIGN STANDARD:** 30mm from a rain event (90th percentile rain event).*

***APPROACH**: Driven by regulatory requirements established through the District's MS4 Permit and being located along one of the most polluted waterways in America (the Anacostia River), Washington, D.C. [the District] has taken a leadership role in stormwater management and green infrastructure over the past decade. The District has developed a comprehensive program that supports green infrastructure, including their innovative Stormwater Retention Credit (SRC) Program, a RiverSmart program which provides financial incentives for GI at many levels, Stormwater Fees and other policy tools such as Green Building requirements. The Stormwater Retention Credit (SRC) Program enables stormwater compliance flexibility for regulated projects (new and redevelopment), while at the same time providing incentives to private landowners throughout the District to incorporate or retrofit green infrastructure projects. Annually, about 13-15% of regulated projects opt to meet a portion of their retention volume offsite, which has resulted in a significant increase in GI retrofits throughout the District. As of June 2020, DOEE staff stated that through the SRC Program over 20 acres of GI retrofits have occurred.*

6.1. LOCATION, POPULATION, CLIMATE

Washington D.C., formally known as the District of Columbia [the District], is the capital of the United States of America (USA). The District is located on the border of Maryland and Virginia in north-eastern USA. The main waterways are the Potomac and Anacostia Rivers and Rock Creek, but the District is also part of the broader Chesapeake Bay Watershed (Department of Energy and the Environment (DOEE), n.d.-d). The Anacostia River is one of the most polluted rivers in America, with billions of gallons of untreated stormwater and combined sewer overflows being discharged to this and other surrounding waterbodies on a yearly basis (O'Neill & Cairns, 2016). The District is urbanized with 43% of land area covered with impervious surface (O'Neill & Cairns, 2016). One third of the district is serviced by combined sewer systems, while the remaining two thirds are serviced through

separated systems (O'Neill & Cairns, 2016). Washington, D.C. is home to 705,749 people, and has an average annual rainfall of 101 cm (40 inches) (US Climate Data, 2020).

6.2. HOW THE SUBJECT CITY MEETS THE SELECTION CRITERIA

Data Availability: The SRC program is well documented, providing access to resources for case study development. Staff from Washington, D.C.'s Department of Energy and Environment also completed our survey.

Approach: Washington D.C. pioneered a stormwater credit trading approach for the management of stormwater on private sites, through the development of their Stormwater Retention Credit (SRC) Program. In addition to a comprehensive suite of policy, incentive and regulatory tools supporting stormwater management and green infrastructure, the SRC Program was designed to enable flexibility in regulatory compliance among private development within the District.

While it may not be the immediate next step for the City of Vancouver, this case is highlighted as a possible aspirational program. It emphasizes the role of private development for the construction, operation and maintenance of GRI and establishes mechanisms for covering lifecycle costs of GI. Furthermore, the model enables flexibility for sites recognizing competing site interests or limited space which may impact the feasibility of GRI uptake. Lastly, it encourages GRI projects elsewhere across the municipality, enabling wider spread of benefits of GRI across a municipality.

Relevance: In Washington, D.C., development is a key driver for meeting stormwater and green infrastructure objectives. The District has a mixed combined and separated sewer system and reducing CSOs and addressing water quality remain key drivers for their program. With 43% impervious are District-wide, a dense urban business core, and comparable population and rainfall patterns, Washington, D.C. offers a suitable case study for Vancouver.

6.3. OVERARCHING RAINWATER MANAGEMENT OBJECTIVES

In Washington, there are two distinct entities responsible for stormwater management: DC Water and the Department of Energy and Environment (DOEE) (O'Neill & Cairns, 2016). DOEE is the District authority on environmental and energy issues and is primarily responsible for the Municipal Separate Storm Sewer System (MS4). DC Water is a separate legal entity, with responsibility for water distribution wastewater collection and treatment, and addressing combined sewer overflows (O'Neill & Cairns, 2016). While separate entities, both have a shared interest in managing stormwater for the benefit of all District residents (O'Neill & Cairns, 2016). Overarching District goals are to restore health to local waterbodies and to ensure fishable and swimmable rivers through the implementation of green infrastructure.

Stormwater management is guided by the District's National Pollution Discharge Elimination System (NPDES) Permit, which is also referred to as the Municipal Separate Storm Sewer System (MS4) Permit (Department of Energy and Environment (DOEE), n.d.-b). This Federal permit, administered by the Environmental Protection Agency (EPA), requires the District to control its stormwater quality and quantity entering local waterbodies (Department of Energy and Environment (DOEE), n.d.-c).

The District, through the DOEE, has innovative and environmentally protective stormwater management regulations that require stormwater management through the use of green infrastructure (GI) on projects that trigger the regulations. Presently, the District's requirements for stormwater management go beyond the requirements established in the MS4 permit.

The District's stormwater regulations (2013 Stormwater Rule) adopted a progressive retention standard requiring the installation of GI on major development projects. The 2013 Stormwater Rule is the largest driver towards achieving GI implementation across the District.

Large development and redevelopment projects, both private and public, are required to manage post-construction stormwater runoff. This requirement can be achieved through a combination of on-site and off-site GI such as green roofs, rain gardens, cisterns, and permeable pavement.

The District has developed a comprehensive program throughout the city that supports green infrastructure at many levels, including their Stormwater Credit Trading Program, the RiverSmart program which provides financial incentives for GI at many levels, Stormwater Fees and other policy tools such as Green Building requirements (O'Neill & Cairns, 2016).

6.4. RATIONALE FOR MANAGING PRIVATE RAINWATER ON PUBLIC LANDS

The main impetus for developing the stormwater retention credit (SRC) program was to enable compliance flexibility for regulated projects, while at the same time providing incentives to private landowners throughout the District to incorporate or retrofit green infrastructure projects. The SRC program allows sites to meet a portion of their requirement offsite, by purchasing SRCs (generated by voluntarily installed stormwater retention capacity). As a result, the program leverages private funding to install GI in areas where it is needed most. The option for sites to meet a portion of their requirement on-site but then being free to go off-site provides that flexibility and leverages private funding and removes the disproportionate burden of certain sites for achieving stormwater regulations.

Th SRC Trading Program was established with the adoption of the regulations as a way to incentivize voluntary GI to be built all across the District and therefore enhances the environmental benefit of the District's stormwater regulations.

Each development project may have site constraints (utilities, drainage, slope, existing site conditions, etc.) or opportunity costs involved that make the flexibility to comply with a portion of their onsite requirement offsite a cost-effective option. This mechanism demonstrates a recognition that there may be competing interests for site space (e.g. Green roof versus rooftop patio) and that in some cases there can be added permitting, review and maintenance costs for having GI on site.

6.5. POLICY AND REGULATION FRAMEWORK DESCRIPTION (AND TRIGGER MECHANISM)

Stormwater management requirements are triggered if new or re-development meets the definition of either a 'major land disturbing activity' or a 'major substantial improvement activity', or both (Center for Watershed Protection (CWP), 2020). Major land disturbing activities, defined as projects disturbing 5,000 square feet or more, must retain the volume of stormwater created by a 30mm (1.2") rain event (the 90th percentile rainfall event for the District). According to the Stormwater Guidebook, this stormwater retention volume can be "managed through runoff prevention (e.g., conservation of pervious cover or reforestation), runoff reduction (e.g., infiltration or water reuse), and runoff treatment (e.g., plant/soil filter systems or permeable pavement)" (CWP, 2020, p.1). Major substantial improvement activities must retain the first 20 mm (0.8") of rain from a storm event. These activities include the "renovation of or addition to a structure that exceeds the following cost and size thresholds:

- Cost of project ≥ 50% of pre-project assessed value of structure.

- Combined footprint of structure(s) exceeding cost threshold and any land disturbance ≥ 5,000 SF" (Department of Energy and Environment, 2013).

Regulated projects have the option to meet a portion of their retention requirement (or all, depending on the location) offsite through the purchase of Stormwater Retention Credits, or through payment of an In-Lieu Fee. Projects in the combined sewer system that drain to large storage tunnels have the option to meet 100% of their requirements offsite. Projects in the MS4 area, or that do not drain to these tunnels, must retain at least 50% of the required stormwater volume on site. These sites can meet the remaining 50% by purchasing SRCs or paying the In-Lieu Fee.

DOEE staff identified that this system encourages developers to consider the specific needs of their project and determine when the use of offsite retention is cost effective. The offsite compliance flexibility allows each specific development project to decide if a mixture of on and offsite retention is cost effective for the project.

Annually, about 13-15% of regulated projects opt to meet a portion of their retention volume offsite. This has resulted in a significant increase in GI retrofits throughout the District. As of June 2020, DOEE staff stated that through the SRC Program, including projects that have been constructed or are in permitting, over 20 acres of GI retrofits have occurred.

According to a recent report on Washington's SRC Program, there were 660 transactions through the Program between 2014 and 2019, at an average market price of $1.82 USD ($2.40 CAD) per SRC (Odefey *et al*., 2019). Each SRC represents 1 gallon (3.8L) of GI retention capacity for 1 year. Using the average cost of an SRC of $2.40/gallon (CAD), we can calculate the equivalent costs of an SRC based on m^3 and m^2. An equivalent SRC cost would be $634.08 CAD/$m^3$ or $19.33 CAD/$m^2$ of GI retention capacity. Additionally, the average market price for a credit has dropped from $2.27 USD to $1.77 USD ($3.08 CAD to $2.40 CAD) in this time frame, which compares favorably with DOEE's established payment in lieu cost ($3.61 USD as of 2017) and on-site management costs for real estate re/development projects (Odefey *et al.,* 2019).

6.6. HOW DOES THE SRC PROGRAM WORK?

Regulated projects can meet stormwater requirements in two ways: (1) by installing GI on site or (2) by buying SRCs to pay someone else to install GI elsewhere.

SRCs can be generated through any voluntary GI project, which includes GI retrofits or exceeding stormwater requirements on a regulated private site. However, there are several factors which influence the value and cost-effectiveness of a particular SRC-generating project:

- GI projects that manage runoff from large impervious areas (roofs, parking lots, etc.)
- GI projects in areas of a site that are not needed for other uses
- GI projects within the MS4. These projects are most beneficial to District waterbodies, and thus they are referred to as 'high impact SRCs'. These SRCs will be eligible for the DOEE's 'SRC Price Lock Program' (Department of Energy and Environment (DOEE), n.d.-a).

Projects that wish to purchase SRCs must first meet on site requirements based on their project location, as described above. The remaining stormwater that will be met using offsite SRCs is called an Off-Site Retention Volume (Offv) obligation. Offv obligations must be satisfied annually to sell on the market to regulated projects (Department of Energy and Environment (DOEE), n.d.-a). Credits may be purchased from projects located

anywhere within the District (i.e., there are no sub-watershed or catchment trading boundaries) (Odefey *et al.*, 2019).

Prices for SRCs are negotiated between buyers and sellers, and the SRC market price fluctuates with supply and demand. All SRC trading prices are published by the DOEE in the SRC and Offv Registry (Department of Energy and Environment (DOEE), n.d.-a). Through the SRC Price Lock Program, eligible SRC generators have the option to sell SRCs to the DOEE at fixed prices, which offers certainty about the revenue from an SRC-generating project. The DOEE's In-Lieu Fee effectively acts as a price ceiling for the SRC trading market, and SRCs are unlikely to sell for more than the In-Lieu Fee price. DOEE adjusts this price annually for inflation (Department of Energy and Environment (DOEE), n.d.-a). In order to facilitate SRC market participation, DOEE has a template contract and financial return calculator.

SRC sales and trades are tracked by the DOEE through its **Stormwater Database**, while information about available SRCs and prior transactions is available on the SRC and Offv Registry. When an SRC sale takes place, the seller submits an *Application to Transfer SRC Ownership* through the Stormwater Database. According to DOEE staff, SRCs are tracked including the gallon amount, how many years they have been used to meet a site requirement, where the SRCs were generated (sewershed and watershed), and where the SRCs were used (sewershed and watershed). All of this information can be searched for, measured, and tracked in the database and the SRC information is reported on every fiscal year. The database is also used for the regulated plan submittal and review process, including tracking plan review comments and maintenance inspections.

Each SRC represents 1 gallon (3.8L) of GI retention capacity for 1 year, and DOEE will certify up to 3 years' worth of SRCs at one time. If a project triggers the regulatory requirements, it is a legal obligation for the site to manage the required stormwater volume in perpetuity. This applies to projects with and without off-site compliance. If a site chooses some or all on site compliance, they are required to maintain the GI and get inspections in perpetuity. Alternatively, if a site opts for some offsite compliance, they are required to meet that offsite compliance on an annual basis, in perpetuity.

6.7. OPERATION AND MAINTENANCE (AND PERFORMANCE) REQUIREMENTS

Projects that want to generate and certify SRCs must submit a Stormwater Management Plan to District plan reviewers. This is the same rigorous process that regulated projects go through. Once the plan is approved and construction begins, inspectors make periodic inspections along with a final inspection once construction is complete. Assuming there are no GI maintenance issues, the project can apply to certify their SRCs. This application is reviewed by SRC program administrators.

If a project triggers the requirements, it is a legal obligation for the site to maintain the stormwater facility in perpetuity. This obligation is established through a legal covenant applied to the land on which the GI was installed, which is binding on current and future owners of a property. A copy of the covenant is found in the Stormwater Management Guidebook on page 307 (CWP, 2020). This is the case for projects with and without off-site compliance. If a site chooses some or all on-site compliance, they are required to maintain the GRI and get inspections in perpetuity. If a site opts to have some or all off-site compliance, they are also required to meet that on an annual basis in perpetuity. If any site does not comply, the District may take legal action.

SRC-generators are responsible for maintaining the GI practices. In order for SRC-eligible sites to certify SRCs, they are required to submit a maintenance contract, with their certification application, that covers the certification period (maximum of 3 years per cycle).

6.8. FUNDING MECHANISMS

The ongoing cost of this program is largely funded through private investment. A project that generates voluntary SRCs can sell them to developers of regulated projects that choose to meet a portion of their retention offsite. This leverages the pace of development as a funding mechanism for voluntary GI implementation.

Sites with SRC-generating GI can also qualify for Washington D.C.'s RiverSmart Rewards program, which provides discounts on DOEE's Stormwater Fee and DC Water's Impervious Area Charge Department of Energy and Environment (DOEE), n.d.-c). This financial incentive helps to encourage uptake of GI practices across the District.

The administration of the SRC program involves 6 District staff who work on the SRC Program, translated to 3 full-time employees. These staff supporting all aspects of Stormwater Management Plan reviews and oversee the maintenance and administration of the SRC program (e.g. manage stormwater database, report on program outcomes). Staff have a variety of expertise, including environmental engineering, LEED certification, environmental policy, and green infrastructure maintenance.

6.9. RISK MANAGEMENT MECHANISMS

The responsibility for construction, operation, maintenance and cost lies primarily with private sites. The District's Stormwater Database, and ongoing monitoring, certification and enforcement mechanisms, led by DOEE staff, ensure the long-term functioning of GI assets to ensure ongoing compliance with stormwater regulations.

6.10. IMPLEMENTATION CHALLENGES AND SOLUTIONS

In 2010, the District had attempted to adopt a regulated retention standard (1.2" or 30mm) for all new and re-developments which faced a lot of criticism, as there was question as to who should pay for necessary retrofits to achieve compliance city-wide (C40 Cities, 2014). As a result, during the development of the 2013 Stormwater Rule, significant stakeholder engagement was completed in order to understand the perspectives of a wide array of stakeholders. This process informed the ultimate development of the SRC program. This program allows the district to meet the overall regulatory requirements and retention standards while providing compliance flexibility for the development community to meet stormwater management requirements off-site when on-site controls may not be feasible or may be deemed too costly.

According to DOEE staff, it took over 2 years for the SRC program to be developed and implemented, including the drafting of potential rules, stakeholder engagement, and the publication of the final rule. Following the implementation of the SRC program, ongoing investment was required to get the 'market' up and running.

Investing in significant and meaningful stakeholder engagement was and remains crucial to the overall program. DOEE continues to engage in outreach efforts with the development community to inform developers of the compliance flexibility that is available through the program.

6.11. CASE STUDY SUMMARY

CRITERIA	CHALLENGES AND BENEFITS
Overall Ease of Implementation	• Credit trading programs can be complex systems to establish. It requires considerable time and possible up-front investment to get the new market up and running. Working through the design process and political buy-in necessary to success requires extensive community and stakeholder outreach, commitment and creativity. • Strong regulatory framework is required for ensuring some compliance in priority areas of the city. • The success and function of stormwater credit trading is in large part dependent on a location having a vibrant development economy.
GRI Location	• Green Infrastructure assets are delivered in the private realm. • Regulated projects can choose to meet some or all of their stormwater requirements on site, through implementing Green Infrastructure practices on site. Alternatively, they can purchase Stormwater Retention Credits to meet stormwater requirements offsite. • Stormwater Retention Credit generating projects come from voluntary Green Infrastructure practices delivered on other private sites across the District.
Division of O&M Responsibilities	• It is the responsibility of a private site to operate & maintain their Green Infrastructure assets in perpetuity. • Sites that wish to generate Stormwater Retention Credits are required to submit a maintenance contract to the District, along with their application. • Ongoing monitoring and oversight of the Stormwater Retention Credit program, including application review, database management and ongoing inspections, is the responsibility of the District.
Division of Ownership & Responsibility	• Ownership and responsibility of GI assets lies with the private landowner. This obligation is established through a legal covenant applied to the land on which the GI was installed. • Sites which purchase Stormwater Retention Credits for offsite compliance must purchase said credits in perpetuity.
Cost	• Private sites are responsible for the cost to construct, operate and maintain GRI assets delivered on-site. • Off-site compliance must be met in perpetuity, by purchasing SRC credits on an annual basis. • Developers have the opportunity to determine to what extent including Green Infrastructure practices is cost-effective for their site.

In-Lieu Fee	• Washington, D.C.'s In-Lieu Fee is $3.61 USD/ 1 gallon of GI retention capacity for 1 year (in lieu fee acts as a price 'cap' for Stormwater Retention Credits).
	  ○ Equivalent cost = $38.98 CAD/$m^2$
	• Average Stormwater Retention Credit cost in 2019 is $1.77 USD/1 gallon of GI retention capacity for 1 year ($2.40 CAD) – prorated based on impervious area managed offsite.
	  ○ Equivalent cost = $19.33 CAD/$m^2$ of GI retention capacity or $634.08 CAD/$m^3$

Equity	• Stormwater credit trading provides a flexible approach to compliance with stormwater requirements. Accounts for site constraints and cost barriers for many developments in overall program design. • Encourages uptake of green infrastructure projects in areas where development may not be a primary driver for regulatory compliance. This approach incentivizes voluntary GI projects which enables greater and more broad-scale implementation of GI, improving more neighborhoods. • Net benefits from policy for all utility ratepayers. • Net environmental benefit through delivery of GI.

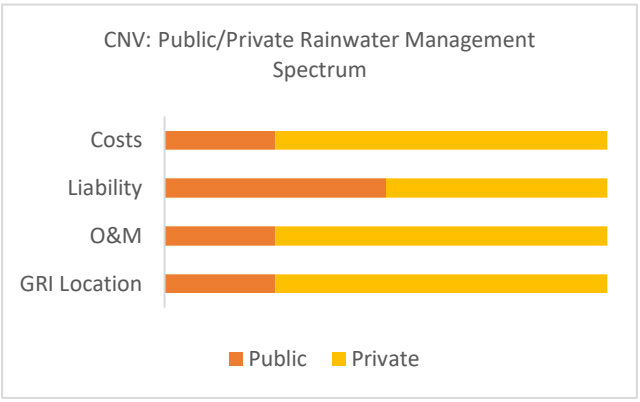
6.12. LIST OF APPLICABLE BYLAWS + AGREEMENTS

- Declaration of Covenants for a Stormwater Management Facility
- District of Columbia's Stormwater Management Guidebook

7. CASE STUDY: NORTH VANCOUVER, BRITISH COLUMBIA

Managing rainwater from the private realm in GRI assets in the adjacent public ROW

COMMUNITY SNAPSHOT



***POPULATION**: 52,898* (Statistics Canada, 2017)

***AVERAGE ANNUAL RAINFALL**: 177 cm (70")* (City of North Vancouver, 2020d)

***RAINWATER DESIGN STANDARD:** 56mm of precipitation over 24 hours (90% capture target).*

***APPROACH**: In support of their Integrated Stormwater Management Plan, The City of North Vancouver has established stormwater management requirements that apply to all new and re-developments. CNV's preferred approach for stormwater management on private properties is capture and infiltration. For three-unit and larger developments, CNV allows source controls to be implemented in the road right-of-way (ROW) (known as a "contributed asset") that manage rainwater from the adjacent private site. Some maintenance of the contributed assets remains with the private landowner, while the City ultimately assumes ownership, as stipulated by an overall 'Servicing Agreement' signed between The City and the Landowner. In the event that no rainwater source controls can be achieved/rainwater management targets cannot be met on a private property, the CNV allows for alternate compliance through a fee-in-lieu program. This fee is applied and dedicated to stormwater management projects in the public ROW.*

7.1. LOCATION, POPULATION, CLIMATE

The City of North Vancouver (CNV) is found in the Lower Mainland of British Columbia, with the steep North Shore Mountains bordering the area to the north and Burrard Inlet to the south. Streams and creeks are a defining feature within the CNV, and as such stormwater management has been an integral part of the CNV's city building efforts. The majority of the CNV is within the Mosquito Creek watershed, with major tributaries including Wagg Creek, Thain Creek and Mission Creek (City of North Vancouver (CNV), 2016a), and also is within the boundaries of Mackay Creek watershed, and Lynn Creek watershed (and tributary Keith Creek) (CNV, 2016a).

All watersheds in the City are shared with the District of North Vancouver, and in some cases the Squamish Nation and Port of Vancouver (Metro Vancouver, 2019). These creeks ultimately drain to Burrard Inlet. The area receives an average of 177cm (70") of precipitation annually (CNV, DATE). As of 2017, the CNV has a population of 52,898 (Statistics Canada, 2017).

7.2. HOW THE SUBJECT CITY MEETS THE SELECTION CRITERIA

Data Availability: The City of North Vancouver's has sufficient information available online, completed the open-ended survey, and were available for a follow up interview.

Approach: The City of North Vancouver offers a regional example of private rainwater being managed by GI assets in the adjacent public right-of-way (ROW). Assets built in the ROW, known as 'contributed assets', support long-term rainwater management objectives while offering developers greater flexibility in complying with on-site rainwater management requirements. Additionally, the City allows payment of an 'in-lieu-fee' recognizing where it is infeasible for sites to meet existing rainwater objectives. This case study also offers insights for managing rainwater from the private realm directly in the adjacent ROW, including overall policy approach and compliance with building code/site servicing standards.

Relevance: The CNV is guided by the same regional stormwater regulations as the City of Vancouver, bears climatic similarities and may provide key lessons learned from a regional development community perspective. Although the CNV receives greater annual rainfall, and their development types and patterns may trend towards more single-family and residential development than Vancouver, there remain key insights applicable to Vancouver's context.

7.3. OVERARCHING RAINWATER MANAGEMENT OBJECTIVES

The City of North Vancouver has a city-wide Integrated Stormwater Management Plan (ISMP), which was developed in support of Metro Vancouver's Regional Integrated Liquid Waste and Resource Management Plan (ILWRMP). Once a heavily forested area, the community has undergone several decades of development which has resulted in a city-wide impervious area total of 55% (CNV, 2016a). This community growth has had a detrimental impact on the health of local streams. A new wave of redevelopment is now occurring, generally resulting in greater impervious areas as a result of more intensive land uses (CNV, 2016a). While the CNV has a separated sewer system, a key challenge will be to ensure that this system has adequate capacity to account for increasing precipitation as result of climate change (Metro Vancouver, 2019). Some areas in the city remain un-serviced by a storm sewer. The ISMP is thus focused on the protection of receiving waters, the health of local streams, and prolonging capacity of existing grey infrastructure.

As part of a commitment to meeting the ILWRMP, the CNV has been continually updating and implementing design guidelines to encourage on-site rainwater management (Metro Vancouver, 2019). Through the ISMP, the City has adopted a source control target of up to 70% (43mm) of the peak annual average daily rainfall (City of North Vancouver, 2020e). To achieve this, CNV has established requirements for stormwater management on all new developments.

7.4. RATIONALE FOR MANAGING PRIVATE RAINWATER ON PUBLIC LANDS

CNV's preferred approach for stormwater management on private properties is capture and infiltration. However, in some cases it may not be possible or practical to achieve this due to "high groundwater conditions, poor soil infiltration, presence of bedrock or proximity to steep ravine slopes" (CNV, 2020a).

For three-unit and larger developments, CNV allows source controls to be implemented in the road right-of-way (ROW) for managing private realm rainwater (known as a "contributed asset") (CNV, 2020b). This can include construction of below-grade soil cells, rain gardens, detention tanks or bioswales along the frontage to manage both rainfall volume and water quality (CNV, 2020b).

In the event that stormwater management targets cannot be met (or no rainwater source controls can be achieved) on a private property (for all development types), the CNV allows for alternate compliance through payment of an In-Lieu Fee. This fee is ultimately applied to CNV-delivered stormwater management projects in the public ROW (CNV, 2020a). An In-Lieu Fee is only considered if and when no other viable options exist (CNV, 2020a). As stated by city staff, this option is not highly encouraged and is not frequently used.

The In-Lieu Fee is set at "$30 per square metre of premises lot area or at cost to provide works on public property" (City of North Vancouver *By-law No. 6746*, 2019). The fee was structured such that it should only be considered as a final option; ideally, the inclusion of source control practices is more cost-effective than payment of the In-Lieu Fee. City staff noted that it would be possible to prorate this fee based on area should a site partially meet rainwater management requirements.

7.5. POLICY AND REGULATION FRAMEWORK DESCRIPTION (AND TRIGGER MECHANISM)

All new developments and redevelopments within the CNV (including single family, duplexes, triplexes and any larger developments) are required to prepare and submit a stormwater management plan (CNV, 2020c). Current guidelines for development within the CNV are based on a 90% annual capture for 'high density sites' (town homes and larger) and 75% annual capture for single family sites and duplex (CNV, 2016a). The 90% capture target equates to 56mm of precipitation over 24 hours. Additionally, the CNV has established a discharge criteria goal of 0.25L/s/ha, which is applied to all public and private sites (CNV, 2020b). As per the City of North Vancouver's 'Stormwater Management Guide for Three Units or More' (City of North Vancouver (CNV), 2014), "stormwater source controls shall consume (i.e. not release to the receiving water) 56 mm of rain over a 24 hour period from all impervious building surfaces (e.g. roofs, decks, etc.)" (p.2). Additionally, acceptable stormwater source controls include:

- "deeper infiltration facilities (e.g. rock pits, dry wells, underground chambers);
- street side infiltration and treatment facilities (e.g. silva cells or equivalent);
- shallower infiltration facilities (e.g. raingardens, bioswales);
- absorbent landscaped areas;
- intensive and extensive green roofs; and
- rainwater harvesting (also subject to Building Code and Vancouver Coastal Health guidelines)" (CNV, 2014, p.1).

Presently, the CNV's Subdivision and Development Control Bylaw requires all new impervious surfaces from private developments to be managed by a source control (CNV, 2016a). Additional provisions require that new road frontage shall include water quality-based source controls.

Requirements for private site stormwater management differ based on development type:

- For **single family and duplex development applications**, CNV provides standard designs that achieve the required 56mm/24 hours. The City also accepts individualized designs prepared by engineers. The preferred option is infiltration, but in circumstances where that is not feasible, alternate approaches or payment of an In-Lieu Fee is acceptable.

- For **three-unit developments or larger**, it is a requirement in the Subdivision and Development Control By-law that Stormwater Management Plans be designed and approved by a certified Engineer (CNV, 2020b). All runoff volume originating from new impervious surfaces must be mitigated through on-site source controls and any drainage collected along the development frontage must also be managed for water quality and volume, to meet the 90% capture target (56mm/24 hours) (CNV, 2020b). For these development types, the CNV also permits use of source controls in the newly constructed ROW to manage rainwater from the private site ("contributed asset"). Assets in the ROW are owned by the City but remain the responsibility of the private property owner in perpetuity. CNV offers a provision for In-Lieu Fees for sites that have site constraints that cannot be overcome.

The City of North Vancouver noted that the ROW provision was created for three-unit developments or larger because as a City requirement, these development types were already replacing the property frontage. Allowing source controls to be placed in the ROW during the time of development created greater flexibility for developers to meet on-site rainwater objectives and supported the CNV's overarching stormwater management goals.

There are no clear trigger mechanisms for In-Lieu Fee. Rather, sites are assessed on a case-by-case basis and city staff will work to include source controls to the maximum extent feasible. Considerations for payment of an In-Lieu Fee include but may not be limited to "high groundwater conditions, poor soil infiltration, presence of bedrock or proximity to steep ravine slopes" (CNV, 2020a).

The policy currently exempts infill laneway houses, as an affordability concern for current residents.

7.6. OPERATION AND MAINTENANCE (AND PERFORMANCE) REQUIREMENTS

The CNV's Subdivision and Development Bylaw states that all private realm stormwater initiatives shall be maintained by the property owner in perpetuity (City of North Vancouver (CNV) *By-law 8014*, 2013). In cases where rainwater from private sites is being managed by infrastructure on public lands, the City ultimately assumes ownership of the asset, but some maintenance responsibility lies with the private owner. This division of ownership and responsibility is outlined by a Servicing Agreement ('Schedule B' of the Subdivision and Development Control Bylaw) between the CNV and the private landowner. Ultimately, the asset is City-owned and thus any major long-term renewal or replacement costs rest with the City.

New developments with a floor space ratio (FSR) of 1.0 or greater are required to provide performance monitoring of stormwater source controls during the first two years post-implementation as part of the new development's Stormwater Management Plan (City of North Vancouver (CNV), 2016b). The specifics of the monitoring requirements are outlined in the CNV's *Monitoring and Reporting Guidelines for Stormwater Source Controls (CNV, 2016b).* These monitoring and reporting guidelines specify flow monitoring approaches, and reporting requirements for the flow rate and water quality of assets. This ensures that stormwater source controls are performing as designed, and in the long term the data provides critical information that can inform improved design and design efficiencies (CNV, 2016b).

Long term inspection and monitoring of assets in the ROW is the City of North Vancouver's responsibility, typically carried out by existing City operations.

There is currently no mechanism for tracking and enforcing operation and maintenance on private sites.

7.7. FUNDING MECHANISMS

The City of North Vancouver funds stormwater source control works through the drainage utility. Typically, the City may invest $200,000 to $300,000 annually to source controls in the public ROW. Contributed assets remain a much larger value, reflecting the importance of this mechanism for implementing stormwater source controls across the CNV.

When applied, In-Lieu Fees are charged at "$30 per square metre of premises lot area or at cost to provide works on public property" (City of North Vancouver *By-law No. 6746*, 2019). In-Lieu Fees that are collected are lumped into the city's overall capital budget for stormwater source control projects.

In the event of re-development or major infrastructure works in the public realm which impacted contributed assets in the ROW, it was noted that the CNV would likely take on that cost and responsibility.

Long term inspection, operation and maintenance costs are currently lumped, but are tracked by asset once the business process is complete.

The City currently has five development technicians that screen and review applications for development, including Stormwater Management Plans. However, complex applications or issues may be reviewed by the Manager of Engineering Design.

7.8. RISK MANAGEMENT MECHANISMS

Contributed source control assets in the public ROW are viewed by CNV as another engineered solution, comparable to the grey sewer system. In this way, rainwater from private sites moving to a source control in the ROW via a pipe is an engineering responsibility subject to design, review and approvals by certified engineers. The offsite compliance provisions are included in the City of North Vancouver *Sewerage and Drainage Facility Bylaw No. 6746 (2019)*:

> ***Section 701.3:*** *Stormwater Management Facilities located on private property, as required by the Subdivision and Development Control Bylaw, shall be the responsibility of the Owners to maintain and ensure good functioning order. Should the Owner be unable to construct Stormwater Management Facilities on private property, the Owner may request, subject to review and approval by the Engineer, to install the facilities on public property or pay a Fee in lieu of constructing the works as outlined in Schedule "A" of this Bylaw.*

Additionally, the Servicing Agreement creates clear responsibilities between public and private entities regarding the long-term ownership and maintenance of assets in the ROW.

Provisions in the *Monitoring and Reporting Guidelines for Stormwater Source Controls* (CNV, 2016b) require that sites with an FSR ratio of 1.0 or greater monitor and report on the condition of source controls that are installed as part of a new development. These requirements are in place for the duration of the maintenance period (typically two years) (CNV, 2016b). This ensures that source controls are functioning as designed and provide the benefits intended. In the long term, monitoring data also may inform improvements to the design and design efficiency of source controls (CNV, 2016b).

7.9. IMPLEMENTATION CHALLENGES AND SOLUTIONS

The initial policy for utilizing contributed infrastructure in the public ROW to manage rainwater from private sites was brought forward in 2010. During the first four years of implementation, the policy was limited to large sites. From 2014 to 2016, the policy was extended to have universal application to all sites. This process involved

developing more rigorous policy documents, guidelines and practice around applications review. For the last five years, work has continued to advance operations, maintenance, tracking and continued improvement on business process.

A key lesson has been around the appearance (aesthetic maintenance) of contributed assets, which has remained the largest issue to date. Performance or facility failures has been less of an issue.

Some key challenges with implementing the program included:

- Internal challenges with alignment to building regulations: CNV's Sewerage and Drainage Bylaw now contains language to support the delivery of source controls in the public ROW. Development of a servicing agreement helped ensure clarity with regards to requirements between the City and the landowner.
- Developing a common understanding with the development community: CNV continues to address this through development of design guidelines and providing iterative learning opportunities with development designers.

Through the survey, it was noted that for smaller sites (detached homes), the CNV has provided typical/standardized (available at cnv.org/drainage) solutions which offer clear and consistent guidance for developers. For larger sites, the guidelines provided by CNV have helped but there still remains a need for continued capacity building within the development engineering community as to stormwater management requirements and solutions.

7.10. CASE STUDY SUMMARY

CRITERIA	CHALLENGES AND BENEFITS
Overall Ease of Implementation	• Ten years of policy evolution. Started small and then extended policy to include more development types. • There continues to be a need for ongoing capacity building with the development community as to stormwater requirements and solutions, particularly for larger sites.
GRI Location	• Stormwater source controls are delivered across the private and public realm. Projects which trigger stormwater requirements can manage stormwater with source controls on site or in the adjacent public right of way (ROW). • Projects that cannot meet on-site requirements can pay an In-Lieu Fee. These funds are lumped into the City's overall capital stormwater source control program, supporting delivery of stormwater source controls in the public realm. • Challenges do occur with implementing source controls in the public ROW where there can be competing interests in these spaces. City will accept cash-in-lieu if ROW solutions are not feasible.
Division of O&M Responsibilities	• Operation and maintenance of all stormwater source controls delivered in the private realm are the responsibility of the private landowner. • Stormwater source controls in the public right of way which manage rainwater from private sites are owned by the City, but some maintenance responsibility lies with the private owner. • A Servicing Agreement ensures clarity of responsibility for operation and maintenance of source control assets on public and private property. • Sites with an FSR of 1.0 or greater are required to monitor and report on the condition of private-realm source control practices, as per the CNV's *Monitoring and Reporting Guidelines for Stormwater Source Controls.*

Division of Ownership & Responsibility	• Source control practices in the private realm are owned and are the responsibility of the private landowner. • Contributed source control practices in the public ROW that manage rainwater from the private realm become City-owned assets following acceptance. Some maintenance responsibility remains with the private realm, but long-term renewal and replacement cost remains with the City. • A Servicing Agreement ensures clarity of responsibility for operation and maintenance of source control assets on public and private property.
Cost	• Construction, operation & maintenance costs primarily borne by private sites. • Private sites pay for the construction, O&M and in some cases monitoring of private-site stormwater source control assets. • Private sites pay for the construction and some maintenance of contributed source control assets in the adjacent public ROW. • Long-term, the city assumes ownership of contributed assets, including long-term replacement or renewal costs. • In-Lieu Fee paid by the private realm supports long-term capital delivery of stormwater source controls in the public realm.
In-Lieu Fee	• $30 per square metre of premise lot area or at cost to provide works on public property (fee applies to total site area; may be prorated at the discretion of City of North Vancouver).
Equity	• Policy applies to all new builds but exempts infill laneway developments to balance need for additional housing options and affordability for current residents. • Net benefits from policy for all utility ratepayers. • Net environmental benefit through delivery of GI.

7.11. LIST OF APPLICABLE BYLAWS + AGREEMENTS

- Servicing Agreement (‘Schedule B’ of the Subdivision and Development Control Bylaw)
- Monitoring and Reporting Guidelines for Stormwater Source Controls
- Integrated Stormwater Management Plan

8. CASE STUDY: COMPARISON TABLE

Contextual Information

	VANCOUVER	PORTLAND	WASHINGTON, D.C.	CITY OF NORTH VANCOUVER
LOCATION	Southwest coast of Canada	Pacific northwest of the USA	Northeast coast of the USA	Southwest Coast of Canada
POPULATION	675,218	654,741	705,749	52,898
AVERAGE ANNUAL RAINFALL	127 cm (50”)	94 cm (34”)	101 cm (40”)	177 cm (70”)
INFRASTRUCTURE TYPE	Mix: Combined and Separated Sewer System	Mix: Combined and Separated Sewer System	Mix: Combined and Separated Sewer System	Separated Sewer System
AUTHORITY	City of Vancouver	City of Portland, Bureau of Environmental Services	Department of Energy and Environment (DOEE); DC Water	City of North Vancouver
KEY DRIVERS FOR SW MANAGEMENT	CSO; Water quality; Infrastructure capacity	CSO; MS4 permit compliance (surface water quality); Groundwater quality; System capacity	MS4 permit compliance; CSO; Water quality	Protection of local streams and receiving waters; extend capacity of grey infrastructure.

Policy Information

	VANCOUVER	PORTLAND	WASHINGTON, D.C.	CITY OF NORTH VANCOUVER
PRIVATE SITE RAINWATER MANAGEMENT TARGETS	Current Target: Capture rainwater from a minimum of the first 24mm of rainwater per day and clean (treat) rainwater from a minimum of the first 48mm of rainfall per day *Rain City Strategy Updated Target: Capture and Clean a minimum of the first 48mm of rainfall per day* Sites must keep their peak flow release rate (m3/sec) less than or	Maximum infiltration on-site (ideal to achieve full infiltration of 10-year design storm (86mm (3.4”) of rainfall over 24 hours) Flow control standards vary, depending on the point of discharge. The base standard must be sufficient to maintain peak flow rates at their predevelopment levels for the 2-year, 5-year, and 10-year, 24 hour design storms	Major Land Disturbing Activities must retain the first 30mm/1.2” from a rain event (90th percentile rain event). Major substantial improvement activities must retain the first 2cm/0.8” of rain from a storm event Regulated projects have the option to meet a portion of their retention requirement offsite: • Up to 100% off-site compliance in CSO areas	90% capture target (56mm of precipitation over 24 hours) Discharge criteria goal of 0.5L/s/ha

	equal to pre-development conditions		Max 50% offsite compliance in MS4 areas	
WHO HAS TO COMPLY WITH PRIVATE SITE RAINWATER TARGETS	***New and Re-Development*** Rainwater Management Plan Required for all Rezoning Applications and Development Permits	***New and Re-Development*** Compliance with Stormwater Management Requirements required for projects that develop or redevelop over 46.5 m^2 (500 square feet).	***New and Re-Development*** Major Land Disturbing Activity = ≥465 m^2 (5,000 square feet) Major substantial improvement activities = Renovation of or addition to a structure that exceeds the following cost and size thresholds: • Cost of project ≥ 50% of pre-project assessed value of structure. Combined footprint of structure(s) exceeding cost threshold and any land disturbance ≥ 5,000 SF.	***New and Re-Development*** All new and re-development within CNV must submit a Stormwater Management Plan.
CURRENT PERFORMANCE	Many sites may struggle to meet 24mm targets using preferred GRI solutions. Assessment in progress.	Majority of rainwater targets met on site. From staff: "800-1000 applications reviewed annually, with 1-2/month making use of off-site fee."	Annually, about 13-15% of regulated projects opt to meet a portion of their retention volume offsite	Unknown
ALTERNATE COMPLIANCE APPROACH	N/A	Special Circumstances Process for Off-Site Fee	Stormwater Credit Trading Program	Developer Contributed GRI in Public ROW for Private Rainwater **and** In-Lieu Fee
GRI LOCATION	Spectrum[2]: PRIVATE GRI required on all private sites as condition of rezoning/development approval	Spectrum: PRIVATE (some public) GRI required on all private sites as condition of development approval. Off-site compliance fee funds GRI delivery on other public or private sites across the city,	Spectrum: PRIVATE GRI projects are delivered in the private realm. Stormwater Credits available for purchase are generated through other private-realm GRI projects.	Spectrum: PRIVATE + PUBLIC Priority is for GRI to be delivered on site, but rainwater from private sites can be managed by GRI in public ROW.

[2] The 'Spectrum' label is used to broadly characterize and summarize the division of responsibility between public/private for various components in this table (e.g. cost, O&M) or the location of GRI assets (e.g. GRI location). Labels include 'PRIVATE' (private responsibility/located in private realm), 'PUBLIC' (public responsibility/located in public realm), 'PRIVATE (some public)' (predominantly private with some public responsibility/location) and 'PUBLIC (some private)' (predominantly public with some private responsibility/location).

		provided they manage rainwater from public ROW		
DIVISION OF OPERATION & MAINTENANCE RESPONSIBILITIES	Spectrum: PRIVATE Private sites responsible for O&M of all on-site GRI.	Spectrum: PRIVATE (some public) Property owners submit O&M information for all stormwater management facilities, conveyance features and impervious area reduction techniques installed on-site to the City for approval, using the 'Operations and Maintenance Form'. City responsible for long-term O&M of stormwater assets in the ROW.	Spectrum: PRIVATE Private sites are responsible for O&M of stormwater facilities in perpetuity. This is established through a legal covenant which applies to the land. SRC Purchasers are required to purchase credits in perpetuity, covering the offsite stormwater volume.	Spectrum: PRIVATE + PUBLIC Private sites are responsible for O&M of GRI assets in the private realm. Private sites retain some maintenance responsibility for contributed assets in the ROW, as described in a 'Servicing Agreement'.
MONITORING	Spectrum: PUBLIC (some private) Operating Permit Program for Alternate Water Systems (e.g. water reuse systems) tracks permitted systems and establishes monitoring and reporting requirements for private sites.	Spectrum: PRIVATE + PUBLIC City of Portland oversees a Maintenance Inspection Program for private site stormwater management features. Responsibility of the private site to ensure proper functioning of stormwater assets.	Spectrum: PRIVATE + PUBLIC A Stormwater Database tracks all SRCs including the gallon amount, how many years they have been used to meet a site requirement, where the SRCs were generated (sewershed and watershed), and where the SRCs were used (sewershed and watershed). All of this information can be searched for, measured, and tracked in the database and the SRC information is reported on every fiscal year.	Spectrum: PRIVATE + PUBLIC Sites with an FSR greater or equal to 1.0 must monitor and report on the performance of the asset for 2 years.
DIVISION OF OWNERSHIP & RESPONSIBILITY	Spectrum: PRIVATE Private realm responsible for onsite GRI assets.	Spectrum: PRIVATE (some public) Operation and Maintenance Form outlines responsibility of private landowner to maintain private assets in good working order. As a priority, rainwater is managed on private sites.	Spectrum: PRIVATE Legal covenants applied to private sites on which stormwater facilities installed - establishes obligation for the site to maintain the stormwater facility in perpetuity (regardless of owner)	Spectrum: PRIVATE + PUBLIC Servicing Agreements established between landowners and The City define ownership and O&M responsibilities for stormwater source controls contributed in the ROW

COST	Spectrum: PRIVATE Private site pays for ongoing O&M, renewal and replacement of GRI practices on their property to meet regulatory targets.	Spectrum: PRIVATE (some public) Private site pays for ongoing O&M, renewal and replacement of GRI practices on their property to meet regulatory targets. Offsite Fees fund GRI delivery + management of rainwater within the ROW by the City.	Spectrum: PRIVATE Developers can determine what is cost effective for their project, provided they meet minimum regulatory requirements Leverages the pace of development to fund program RiverSmart program is additional incentive for GRI implementation which discounts stormwater utility fees	Spectrum: PRIVATE (some public) Private site pays for ongoing O&M, renewal and replacement of GRI practices on their property to meet regulatory targets. Offsite Fees are added to citywide capital stormwater source control budget program.
PAY IN-LIEU FEE (if applicable)	N/A - Vancouver does not currently have a pay In-Lieu Fee program.	Offsite Stormwater Management Fee = **$54.11/m² CAD** • Per unmanaged area of impervious surface • One-time fee	Average Stormwater Retention Credit (SRC) Cost = **$19.33/m² CAD** *In Lieu Fee = $38.98/m² CAD* • Per GRI retention capacity purchased offsite • Annual fee • In-Lieu Fee acts as 'price ceiling' for SRC	In-Lieu Fee = **$30/m² CAD** • Per total lot area (may be prorated at discretion of the City) • One-time fee
EQUITY	Net benefits from policy for all utility ratepayers through on-site rainwater management Net environmental benefit through delivery of GI.	Alternate compliance mechanisms in place, recognizing specific site constraints. Offsite Fees provide grant funding for voluntary GRI projects across the city Net benefits from policy for all utility ratepayers Net environmental benefit through delivery of GI.	Accounts for site constraints and cost barriers for many developments in overall program design. Approach incentivizes voluntary GRI projects. Enables greater and more broad-scale implementation of GI, improving more neighborhoods. Net benefits from policy for all utility ratepayers Net environmental benefit through delivery of GI.	Exempts infill laneway developments to balance need for additional housing options and affordability for current residents In-Lieu Fees support GRI delivery across the city Net benefits from policy for all utility ratepayers Net environmental benefit through delivery of GI.

9. RECOMMENDATIONS + CONCLUSION

The regulation and encouragement of onsite management of rainwater falling on private sites is common across the majority of municipalities reviewed in this study, as is the inclusion of some form of alternate compliance mechanism for private sites. While each may differ with regards to design standard, type of regulated sites, or alternate compliance mechanisms, what municipalities with successful private realm rainwater programs have in common are **strong regulatory frameworks**; clear **guidelines and processes** for private sites; enabling **flexibility through alternate compliance;** supporting a **combination of approaches** including regulatory, incentives and education; and a **long term** investment in rainwater management. These themes provide insight into some of the key questions established at the outset of this report:

Alternate compliance enables flexibility for sites that have specific constraints

The cases of Portland, City of North Vancouver (CNV) and Washington, D.C. demonstrate **means of enabling flexibility in compliance** for private sites, recognizing that there may be specific constraints for particular sites that limit their ability to meet rainwater requirements. However, as demonstrated by Portland and CNV, the primary objective remains to ensure that private sites manage the majority of their rainwater on site (or in the adjacent public realm). Although investigating the rationale (and associated supporting studies) that guided development of these municipalities' approaches was beyond the scope of this report, their current requirements for rainwater management are grounded in **strong policy framework**s **and guidelines** for applicants initiating new projects in the private realm.

Trigger Mechanisms

Understanding the specific circumstances or conditions under which the City of Vancouver would allow a private site to make use of an alternate compliance mechanism for rainwater management was a central question in this report. What was determined through the review of the case studies is that the thresholds for alternate compliance are not always specifically defined or may not be an exact 'trigger'. Rather, they may consider a range of known limitations that are specific to a particular municipality and require review and consideration on a site-by-site basis. Understanding what the particular challenges or constraints are, or opportunities for use of the ROW, for private sites within a municipality is an important step towards creating a means for evaluating alternate mechanism applications from private sites. The review process for alternate compliance pathways may need to recognize that different private sites have different (and sometimes unique) challenges.

Division of responsibilities between public + private realm

In each case, a key to success is the inclusion of **clear agreement mechanisms** (e.g. legal agreements, covenants) when responsibility lies with the private realm. These mechanisms may define responsibility for asset ownership, maintenance, operation, and/or performance monitoring to ensure that they continue to perform and function as designed and will provide the rainwater quality and quantity benefits intended in the long run. These agreements also define responsibility in cases where there are assets in the public ROW managing private rainwater.

Developing a program is a long-term effort

A final key insight is that comprehensive **rainwater management programs and alternative compliance approaches are not built overnight**. For many municipalities, their programs or approaches are based on over a decade of policy evolution, investment in GRI and engagement with the private realm. Furthermore, many of these **programs are comprehensive**, incorporating regulatory, education and incentive approaches. The City of Vancouver, while a leader in many respects, remains early in this process with the recent adoption of the Rain

City Strategy. Achieving success will require continued research, engagement with private industry, capacity building and long-term visioning.

From the review of private realm rainwater management approaches in Portland, City of North Vancouver, and Washington, D.C., the following are recommended for consideration by the City of Vancouver as next steps towards developing an alternate compliance approach for private sites:

1. Define the particular conditions or characteristics of private sites under which City of Vancouver would consider permitting alternate compliance mechanisms.

Identifying the actual barriers for particular sites for achieving rainwater management design standards remains a critical action from which to build an alternate compliance approach. This includes identifying known site characteristic variables (e.g. infiltration potential due to high groundwater table, contamination presence, and/or steep slopes, etc.) and policy variables (e.g. form and character of buildings, infiltration setbacks, which may limit green roof and infiltration opportunities). This assessment may also consider coordination with other City priorities, including affordability, or alignment with other GRI strategies such as with Portland's green roof synergy. Furthermore, this review may identify certain development types where use of the adjacent ROW for offsite compliance would be a feasible pathway.

There may also be an identification of the types of sites that should be excluded from alternate compliance. For example, it could be a requirement through the Rezoning Policy for Large Sustainable Sites that rainwater design targets are met through GRI solely on site, aligning with this policy's commitment to demonstrate leadership in sustainable design on these types of larger sites.

It should be noted that concurrent to this report, work is underway to better characterize the feasibility of various GRI tools, in isolation or combination, to meet the Zoning and Development Bylaw (Section 3.3) design standards across a range of building-site typologies in the private realm. This 'Pathways Study' will also investigate the associated costs, co-benefits, barriers to implementation, and solutions to said barriers. This will establish a foundation for which to establish new or improved rainwater management policies for the City that will, in turn, achieve the goals of the Rain City Strategy in a fair and consistent manner. The results from this study will be a critical building block from which to advance this particular discussion. Other critical ongoing studies that will help to advance conversations about rainwater management in the private realm include the Citywide Groundwater Management Strategy, the Foundation/infiltration (5-metre setback) study, the Green Roof Barriers Study and the GRI Financing Study.

2. Initiate an internal policy review for enabling transfer of private realm rainwater into GRI in the public ROW as an alternate compliance mechanism

One key approach examined in this study is managing private rainwater in GRI in the public ROW. This may be a feasible option for certain development types, and in places where there is sufficient capacity within the ROW for these systems. For example, in the City of North Vancouver it was observed that developments comprised of three townhomes or larger were already doing work within the adjacent public ROW. This paved the way for allowing these development types to utilize the ROW to help meet on-site rainwater management targets. Vancouver has several notable large development projects on the horizon which may serve as ideal pilot sites for an approach of this nature.

This approach may raise questions regarding compliance with the Vancouver Building By-law, Street and Traffic Bylaw, and/ or the Sewer and Watercourse By-law whereby there are specifications and limitations regarding the transfer of rainwater across public/private boundaries, including the requirement for each parcel to have a separate rainwater connection to the public storm/combined sewerage system. There are also specific definitions pertaining to what constitutes a storm/sanitary sewerage system. A key question may pertain to whether GRI is or can be considered part of the 'storm sewer system', alongside the grey infrastructure system.

As a next step for this approach, it would be necessary to initiate an internal policy review to understand:

1. How GRI in the public ROW might meet the overall spirit of the City's by-laws and codes as they're currently written, or;
2. What changes to existing by-laws and codes may be needed to better enable this approach across the City?

As with CNV, a formal legal agreement ('Servicing Agreement') between the City and the landowner may be a critical component to the success of this approach, as it defines the roles and responsibilities for the GRI asset in the ROW for asset ownership, operation and maintenance, monitoring and replacement and renewal.

3. Initiate internal review of In-Lieu Fee approach

A second key alternate compliance approach examined in this study is In-Lieu Fees. As with GRI in the public ROW, In-Lieu fees may offer a feasible solution for the City of Vancouver. While both In-Lieu Fees and GRI in the public ROW may be applied independently, they can also be used in combination (through a sequential or cascading approach) as in the case of the City of North Vancouver.

As a next step towards better understanding this approach, a study should be undertaken to review the various costing methodologies for establishing an In-Lieu Fee. Some considerations for this approach include:

- Does the fee consider the full lifecycle cost of GRI assets (e.g. construction, operation, maintenance, performance monitoring, renewal and replacement)? Is it a one-time fee, or an ongoing fee as in the case of Washington's SRC program?
- Is the cost high enough to serve as an incentive to prioritize on-site options?
- Is the cost equitable for sites that face physical or financial barriers for achieving rainwater management targets?
- How are the monies collected from the fee utilized? For example:
    - Fees may need to support delivery of GRI offsite to manage the equivalent area of rainwater not managed on-site.
    - Fees could support a retrofit program on private sites.
    - Fees could support advancing public realm GRI objectives in strategic areas (e.g. watershed/system need) or to advance Vancouver's GRI equity objectives (e.g. neighbourhoods with less green space). For example, the City of Portland's % for Green Program (funded in part by In-Lieu Fees) provides grants for GRI projects in the public ROW. Their selection criteria for grant recipients contains a number of equity and social objectives (e.g. Create diverse employment opportunities; provide community benefits; foster community involvement).
    - Assess opportunities to incorporate O&M funding for new GRI delivered through this program.

4. Identify how an alternate compliance process would fit into overall RMP review process

Embedding an alternate compliance process within Vancouver's overall development review and RMP review process will require commitment early in the process to understand and define what is feasible on a particular site, including maximizing on-site GRI as a priority. For the City, this requires clear communication of rainwater management design standards, preferred approaches, and conditions under which alternate compliance would be considered.

The City has the ability to require particular commitments during the rezoning phase, which may serve as an opportunity to ensure that the overarching rainwater design standards will be adhered to throughout the development review process. As a 'Condition of Rezoning' the applicant could sign an agreement to meet the required rainwater management design standards, prioritizing on-site options but recognizing the opportunities to utilize the ROW or pay and in-lieu fee.

Some considerations for including In-Lieu Fees and GRI in the ROW include:

1. **Prioritize on-site rainwater management options.** The results from the forthcoming 'Pathways Study' will assist The City in characterizing the feasibility of various GRI tools in the private realm to meet the City's rainwater design standards. This information will help with the review of Rainwater Management Plans to ensure sites are considering GRI to the maximum extent possible on site before considering alternate compliance options. If meeting the design targets on-site is not feasible, then consideration of step 2 (below) could occur.

2. **Permit applicants to consider the use of the adjacent ROW for managing some private realm rainwater using GRI.** When submitting a Rainwater Management Plan, an applicant could submit a strong rationale for needing off-site space to meet on-site requirements and also identify an area/areas within the adjacent public ROW on which they wish to install GRI for managing a portion of the site's rainwater. This would be reviewed by City staff (Committee or otherwise) to ensure:
    a. the rationale is sound (i.e. on-site options are not feasible);
    b. the approach helps to meet a site's compliance with rainwater design standards; and
    c. there is no interference with other objectives in the ROW areas in question.

    The expectations regarding ownership, maintenance, renewal and replacement, and monitoring of these assets would need to be made clear to the applicant at the outset of the process. This may require additional language in the Rainwater Management Bulletin to identify this as an option for sites as well as the use of formalized legal agreements to clarify roles and responsibilities for assets in the ROW.

3. **Formalize the In-Lieu Fee request process.** As is the case in Portland, a formalized process exists for an applicant to request to pay an offsite fee. This process might be considered a 'final' option for sites that have exhausted all on-site and off-site (adjacent ROW) options for meeting rainwater design standards (i.e. steps 1 and 2 listed above).
    a. Create a standard form or template for applicants to submit their request. Applicants may need to include detailed site descriptions, what rainwater management solutions have been included to date, and a robust justification for requesting to pay the in-lieu fee.
    b. Establish a Committee for reviewing In-Lieu Fee requests. This could include key staff across the City of Vancouver's Engineering and Planning departments.

c. In-Lieu Fee requests could be submitted alongside a Rainwater Management Plan up until it is finalized (BP stage). This recognizes that development designs mature and are modified as they make their way through the review process.
d. An additional mechanism to ensure adherence to a site's Rainwater Management Plan could include a tiered approach to In-Lieu Fees, whereby the In-Lieu Fee is greater should any additional rainwater need to be managed off-site following approval of the RMP and alternate compliance form. This mirrors the process in Portland, though it was noted that they do not often make use of this fee.

5. Support development applicants with additional resources for GRI in the private realm

As part of the ongoing implementation of the Rain City Strategy, actions to support the private realm with on-site rainwater management and GRI are needed. Some strategies used by other municipalities include:

Clarifying City processes for applicants who are required to submit a Rainwater Management Plan

- Establish templates or guidance documents for submitting Rainwater Management Plans
- Include standard design guidelines for GRI on various site typologies as part of rainwater management resources

Generating momentum in the private realm

- Showcase success stories and create community champions
- Identify possible synergies with other GRI programs or City priorities. Incentive programs (e.g. Washington's RiverSmart program) could be used to encourage sites that go above and beyond with GRI on site, or to support advancement of other GRI priority areas (for example, Portland's Green Roof program).

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APPENDIX A

Implementation Challenges for GRI in the Private Realm

Implementation Barriers for GRI on Private Sites (table adapted from Brears, 2019)		
Barrier	**Type**	**Description**
Financial	Perceived cost-effectiveness of GRI	The numerous benefits of GRI are well known; yet there remains difficulty in quantifying the soft benefits. Consequently, short-term cost-benefit analysis often favours grey infrastructure, and there is a perception that GRI is more expensive than traditional grey solutions. There remains a gap as well in identifying on which sites GRI is financially feasible as well as the relative financial feasibility of individual GRI types.
	Perceived higher risk	For many private developers, GRI is relatively new; thus, the lack of historical data may increase the perceived risk associated with GRI projects.
Regulatory	Lack of clarify in rainwater management requirements + approval process	Although design standard requirements are relatively straightforward, there remains uncertainty by applicants as to what the process entails, and what information is required at what stage.
	Competing site/policy requirements	Overlapping and at times competing requirements on site creates confusion for both applicants and plan reviewers. Some policies, for example, necessitate maximizing floor area and buildable footprint, thereby limiting infiltration potential. Other policies require particular architectural forms or compete for rooftop space.
Infrastructural	Site and building characteristics and constraints	Site constraints and/or competing interests in the private realm may be such that meeting rainwater design standards and/or implementing GRI is infeasible. For example, infiltration solutions may be severely constrained by site characteristics such as small lot sizes coupled with the VBBL 5m foundation setbacks, a high groundwater level, or an unacceptable risk of mobilizing groundwater contaminants. Building constraints (e.g. roof type/slope) may also limit GRI options. See endnote for additional detail [i].
	Poor construction and maintenance	Lack of proper construction and/ or maintenance can result in GRI being less effective, or even failing, over time. Constraints may include insufficient minimum design standards, construction standards, maintenance standards, resources and/or knowledge capacity for constructing and maintaining GRI.

**Please see References in main body of the report*

APPENDIX A

Implementation Challenges for GRI in the Private Realm

	Limited monitoring + enforcement	The City currently has limited capacity for monitoring and enforcing GRI on private sites. This may result in private assets not performing to standards as a result of poor maintenance, or even being abandoned.
Awareness, Knowledge, and Critical Capacity	Lack of knowledge of GRI benefits	The call to action for private sites to implement GRI in new/re-development sites requires sufficient capacity building endeavours. There remains an industry-wide knowledge gap of the benefits of GRI.
	Lack of knowledge of GRI design solutions	There are limited guidance documents provided by the City for how to design, construct, maintain, operate, and monitor GRI assets over their anticipated life cycles. This is an existing knowledge gap within industry.
	Shortage of Trained Professionals	It is suspected there is an insufficient number of firms with the design, construction, maintenance, operation, and monitoring expertise to enable necessary expansion of current policies to other building typologies across the City. There is a need to focus on industry outreach and education, to raise capacity for GRI installations in the private realm.

[i] Space constraints and competing interests may be present in both the public and the private realm. Those in the public realm may pose barriers to some private realm alternate compliance options, such as transfer of rainwater into GRI in the public ROW. Some of the challenges highlighted for GRI implementation in both the public and private realms are summarized below:

- **Space constraints and competing interests in the public realm:** There is already limited space in the public realm for GRI. If seeking to manage private rainwater in the public realm using GRI, it means that those assets need to be bigger in order to handle the volume of both public and private rainwater. With limited space to do this, it would require rethinking of public space planning, which could lead to the need to reconcile other public realm planning objectives (or may also lead to solutions that provide innovative, multifunctional spaces).
- **Space constraints and competing interests in the private realm:** Development occurring in the private realm is also subject to many competing interests and space constraints that may limit possible rainwater management solutions, particularly in dense urban development sites. For example, maximizing floor space on below market rentals and zero lot line development may limit space for GRI solutions. Parking requirements and below ground parking solutions, coupled with required 5-metre setbacks for infiltration facilities from building foundations and high groundwater tables also pose challenges for GRI implementation. Additional open space and play area provisions set by the City may also be seen as having competing interests with rainwater management, for example, with the use of roof space. Although the purpose here is to identify possible challenges for GRI implementation, it is important to also acknowledge that reconciling competing policy interests in the private realm may ultimately lead to innovative, multifunctional solutions.

APPENDIX B

Policy, Regulatory and Legal Implications for Rainwater/Storm Water Management in and Across the Private and Public Realm

In seeking to identify possible solutions for managing private rainwater in the public realm, it is important to identify the policy, regulatory and legal implications surrounding rainwater and storm water in Vancouver. Although rainwater has been the primary terminology used in this report, many policies such as the Vancouver Building Bylaw refer instead to the term 'storm water'. The Vancouver Building Bylaw offers the following definition for clarification (City of Vancouver By-law 12511*,* 2019):

> **Storm water** means water that is discharged from a surface as a result of rainfall or snowfall.

The factors listed below are critical considerations in seeking to pursue rainwater transfer from the private to the public realm; they underpin important conversations surrounding risk, liability and legal frameworks for various policy options or tools that may be considered.

- **Constraints for Rainwater Transfer from the Private to the Public Realm**:
    - Sewer and Watercourse Bylaw: Vancouver's Sewer and Watercourse Bylaw stipulates that every separate parcel of land must connect to the public sewer system (where available) via an individual connection (See 2.3, 2.5, City of Vancouver By-law 8093, 2019). It can be assumed then that all storm water not managed on site will be transferred into the publicly owned grey infrastructure system through this connection. At the moment, transferring storm water into anything other than the public sewer (i.e. to GRI in the public realm) may thus require a legal agreement or adjustments to the Sewer and Watercourse Bylaw itself.
    - Vancouver Building Bylaw: The Vancouver Building Bylaw contains several important code provisions that may have implications for drainage and storm water management across parcel boundaries. For example, Book II, Division B, Article 2.4.2.4 states that "all roof and paved areas shall drain to a storm drainage system" except where "storm water conservation measures are employed and storm water does not discharge upon or impact other lands or sites". Book I, Division B, Article A-5.7.1.2.(2) provides acceptable solutions for drainage, and states that water directed away from a building should be drained to "a municipal drainage system, drainage ditch, swale or other acceptable water management means" (p.5-168).
    - Street and Traffic Bylaw: This bylaw contains provisions regarding the flow of water into the street. Item 71I states that water from a property adjacent to a street must not allow water to flow from said property on to a street (City of Vancouver By-law 2849, 2020).
- **Constraints for Rainwater Transfer between Private Sites**: As a general principle, infrastructure and buildings cannot cross property lines. The VBBL states that storm water cannot discharge upon or impact other properties. However, this does not preclude transfer of rainwater between properties under certain circumstances (see POP OUT BOX: TELUS GARDEN).

POP OUT: TELUS GARDEN (Telus Garden, 2020; staff communication)

The Telus Garden development, located at the corner of West Georgia and Richards Street is a mixed-used office tower redevelopment in Vancouver, BC. The 500,000 square foot project boasts two office towers and takes up an entire city block in the heart of downtown Vancouver and was one of the city's first LEED Platinum certified office towers. This project is an example of where rainwater was permitted to cross private property lines. Rainwater from one building is transferred across a lane for use in an adjacent building. Keys to success in this case:

- The multiple private properties in question were owned by a singular owner (Telus). Where different property owners are involved, there would be a need for a formal legal agreement.
- This specific configuration conforms to other applicable VBBL requirements.
- Telus purchased a portion of the lane separating the buildings.

APPENDIX C

How does the City of Vancouver Fund Rainwater Services?

The City of Vancouver has two main budgets: Operating and Capital.

Operating: This annual budget covers all required costs and expenditures needed for the continued operation of the city. It is largely funded through property taxes and utility fees (75%) and user fees such as parking fees, permits and recreation programs (25%) (City of Vancouver, 2020a). Water utility fees in Vancouver include an annual flat rate and a metered rate for sewer and water. The operating budget is used primarily for the sewer and drainage infrastructure network and not for GRI.

Capital: The capital budget is set primarily to maintain facilities and infrastructure, direct money to areas of Council priority, and optimize amenities for citizens and customers. The capital plan and budget come from city contributions, development contributions and partner contributions (City of Vancouver, 2020a). 22% of the 2019-22 capital budget is allocated to the One Water Program ($616 million) which includes funding for potable water, sewerage and drainage and green infrastructure (City of Vancouver, 2020a). Of that, the total GRI budget is $1.1 million for renewal; $53 million for new GRI construction; and $8 million for operation and maintenance (City of Vancouver, 2020a).

City contributions, including property tax and utility fees, are used to fund replacement and renewal, as well as operations and capital maintenance. Only 12% of the total $62 million GRI capital budget in the 2019-22 capital plan is from city contributions.

The primary mechanism for GRI funding through the capital budget is through Development Cost Levies (DCLs). DCLs are “fees collected from developers to help fund the cost of growth-related infrastructure” (City of Vancouver, n.d.(b), p.1). GRI is currently funded through DCLs as they can be applied towards constructing, replacing, altering or expanding facilities for drainage. A new Citywide Utilities DCL was approved by Council on July 11, 2018 to address the need for upgraded water, sewer and drainage infrastructure. This new Citywide utilities DCL applies to new developments on a square foot basis and is in addition to the existing Citywide DCL which will continue to pay for other services such as parks, childcare facilities, affordable housing and transportation projects related to growth (City of Vancouver, 2020b). The Utility DCL rates are calculated based on various residential, non-residential and cultural, institutional and social categories/uses (City of Vancouver *By-law No. 12183,* n.d.). However, there are limitations with this funding source with regards to long term operation and maintenance.

In this way, much of the current GRI funding is necessarily linked to growth. Large-scale GRI or Blue-Green Systems at the larger planning stages can be established in a community plan, but the implementation of that plan through development can be patchwork. Since DCLs come from development, and if development slows down or does not advance equally, there can be implementation challenges.

APPENDIX D

Public/Private Rainwater Management Survey

INTRODUCTION AND CONTEXT

As part of the recently adopted Rain City Strategy, the City of Vancouver is currently embarking on an ambitious approach that treats rainwater (stormwater) as a valuable resource and mimics the natural hydrologic cycle by capturing and treating rainwater where it lands using decentralized 'green' rainwater/stormwater infrastructure (GRI/GSI), rainwater design standards, and targets that span both public lands and private lands across the city. Although the intent is for private lands to manage a large proportion of the rainwater falling on their site, this may not always be possible due to particular site characteristics. Other opportunities need to be considered, and one option is to manage rainwater from these private sites using GRI on public lands, typically within adjacent streets, laneways, boulevards, plazas and other spaces or as part of a neighborhood or 'district scale' system.

Transferring rainwater from private lands to the public realm raises financial, equity, and legal issues such as what is the threshold (or policy trigger) for considering such transfer, who is responsible for the construction, operation, and maintenance of the GRI, how should responsibility and costs be apportioned between parties, and how should risk be managed to protect public and private assets from unintended consequences.

Your municipality is recognized as a leader in innovative rainwater management. We are interested to understand your insights on your general approach to rainwater management and, in particular, on the specific rainwater private/public transfer issues stated above.

Findings from this survey may be profiled in a report that will be made available publicly through the University of British Columbia's Sustainability Scholars Project Library and internally through the City of Vancouver Greenest City Scholar (GCS) Project Library. By completing this survey, you consent to the information being provided being used and shared as described above.

DRIVERS + TARGETS

1. What are the main drivers necessitating rainwater management in your jurisdiction? (e.g. CSO, environment, regulatory, cost, other)

2. Describe your city's overarching rainwater management objectives and/or targets. Please be sure to describe:
    a. How do your policies apply to private sites?
    b. Are the targets (both overall and on private sites) currently being met?

PUBLIC/PRIVATE RAINWATER PROGRAM

3. We are interested in learning more about your municipality's program for managing private site rainwater on public lands (henceforth referred to as "program"). Please answer the following questions to the best of your ability. What were the key drivers for the creation of this program?

4. Describe the key challenges faced by private sites in meeting rainwater targets/implementing green infrastructure prior to implementation of this program?

5. How has this program addressed these challenges?

6. Describe the program in detail. How does your program work? Please be sure to cover:

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Public/Private Rainwater Management Survey

   a. Trigger Mechanisms/Thresholds for considering offsite compliance (e.g. management of stormwater landing on private sites in the public realm; in-lieu fees; offsite green infrastructure implementation, etc.)
   b. What types of development is captured by your program? Include reference to any variations between (a) land uses/densities and to (b) new development versus existing stock/retrofits.
   c. Include any relevant links to program information

7. What were the key philosophies around risk to public and private assets, and public vs private responsibilities, when shaping this program? Describe how this influenced the program design and delivery.

8. What is the governance structure surrounding this program? Who is involved and in what capacity? (e.g. from application review, construction, operation/maintenance, performance monitoring). Please be sure to cover:
   1. Number of staff required internally to support the program.
   2. What (if any) external supports help to manage your program?
   3. What types of expertise are required?

9. What tools are provided to support the program? (e.g. website, minimum design standards, guidelines, and other application, process, informational, or educational tools). Please provide links where available.

10. How is this program funded? What is the annual budget?

11. What types of legal agreements are in place for shared private/public infrastructure? (e.g. district-scale green infrastructure that manages rainwater from both private and public sites)

MONITORING + OUTCOMES

12. How does your program address the long-term operation, maintenance and monitoring of green infrastructure assets? Please be sure to describe the following:
    a. Who is responsible?
    b. Who pays?
    c. How do you assess the lifecycle cost of your assets?

13. How do you measure and track key outcomes? (e.g. volume of stormwater managed, maintenance logs, etc.) Please consider how outcomes are measured and tracked from application review, construction, operation/maintenance, to performance monitoring.

CHALLENGES + LESSONS LEARNED

14. What challenges did you have in implementing your program? How did you overcome those challenges? What challenges remain? What would you have done differently?

15. What advice would you have to a municipality currently grappling with the public/private rainwater management issue? Would you recommend the approach that you have taken, or would you suggest an alternative?

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Public/Private Rainwater Management Survey

TIMEFRAME

16. How long did it take to develop and implement the program? Please be sure to describe any key phases in program development (e.g. establishing application processes, training/education, regulatory/policy work, design guidelines, maintenance/monitoring protocols). Or, alternatively, please provide a link to this information and page(s) where this information is located.

PRIVATE INDUSTRY + KNOWLEDGE CAPACITY

17. How has private industry responded to this program?

18. What was the knowledge capacity of the private industry before this program was in place? Now? Please describe.
19. What specific capacity-building initiatives were/are part of this program?

EQUITY

20. How does this framework address equity issues in your community? (e.g. Addressing issues of affordability; access to green space; level of service; neighbourhood resiliency)

OTHER RESOURCES

21. Do you have any other resources or examples that we should be looking at? (e.g. other municipalities, links, contact information, final thoughts)