Fraser Basin Council

METRO VANCOUVER & VICTORIA, BC

Showcasing Successful Green Stormwater Infrastructure – Lessons from Implementation

MAY 2016

INSIDE

Fraser Basin Council

Acknowledgements

This case study report is part of a larger research project undertaken by the Fraser Basin Council to identify key challenges and opportunities to implementing Green Stormwater Infrastructure in BC communities. Support for this research project was provided by the Environment Canada Science Horizons Internship Program, Sitka Foundation, Keurig Canada and Salmon-Safe BC.

Valuable information to support this research was collected during numerous interviews with municipal and regional government staff along with water management practitioners, urban design professionals and related community groups. We gratefully acknowledge their contributions, which were essential to identifying success factors and challenges encountered in planning, implementing and maintaining green stormwater infrastructure. Additional documentation, including stormwater management plans, environmental policies and neighbourhood plans provided further details to inform the case study research.

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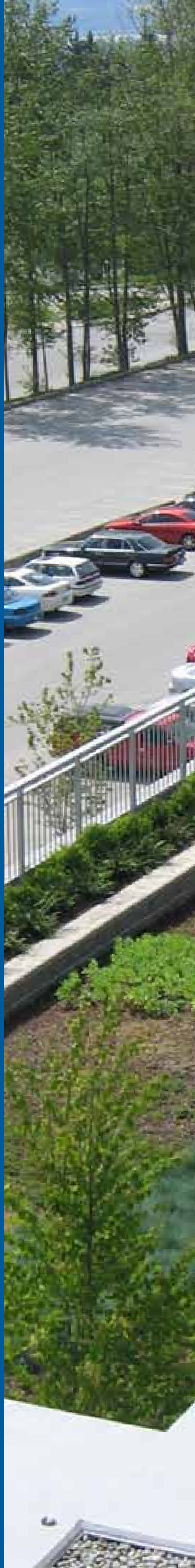
Insert Left: Rain garden at Sunshine Hills Elementary, North Delta, BC.
Photo credit: Corporation of Delta

Insert Right: Green roof at MEC Head Office Vancouver, BC.
Photo credit: Fraser Basin Council



1.0 Introduction & Highlights

Throughout the 20th century, urban design and development practices have relied on “grey” stormwater infrastructure. This management approach conveys stormwater, generated from rain falling on impervious surfaces, away from urban areas as quickly as possible with a network of curbs, gutters and underground pipe systems - often discharging directly into nearby watercourses. Although this traditional pipe-and-convey approach to stormwater management has protected urban property from surface flooding during rain events, it has led to a range of unintended, yet significant impacts to receiving watercourses - including water pollution, stream-bank erosion and loss of fish habitat[1,2].

Green stormwater infrastructure (GSI) is an alternative approach to stormwater management that includes a network of decentralized infrastructure to capture, detain and infiltrate rainwater as close as possible to where it falls. In this way, GSI decreases the amount of surface runoff generated from rainfall events within urban areas. GSI includes a range of features such as bioswales, rain gardens, green roofs, pervious paving and infiltration trenches. By capturing and infiltrating rainfall, GSI slows and reduces stormwater entering the traditional piped system while also removing pollutants. As such, GSI has proven to be an appropriate tool to improve water quality and stream health in urban watercourses[3, 4].

In addition to these benefits, GSI has been identified as a method of increasing the resilience of urban communities to climate change. Moving into the 21st century, communities in BC’s South Coast are expected to face an increase in the frequency and intensity of winter storms[5,6]. Such a trend increases in the risk of flooding from overwhelmed, aging urban drainage systems and receiving stream channels. If GSI is implemented across the urban watershed, the cumulative reduction of stormwater entering the piped drainage system can reduce the burden on receiving streams and aging storm sewer systems – thereby reducing the risk of flooding and increasing the resilience of communities to the impacts of a changing climate[7].

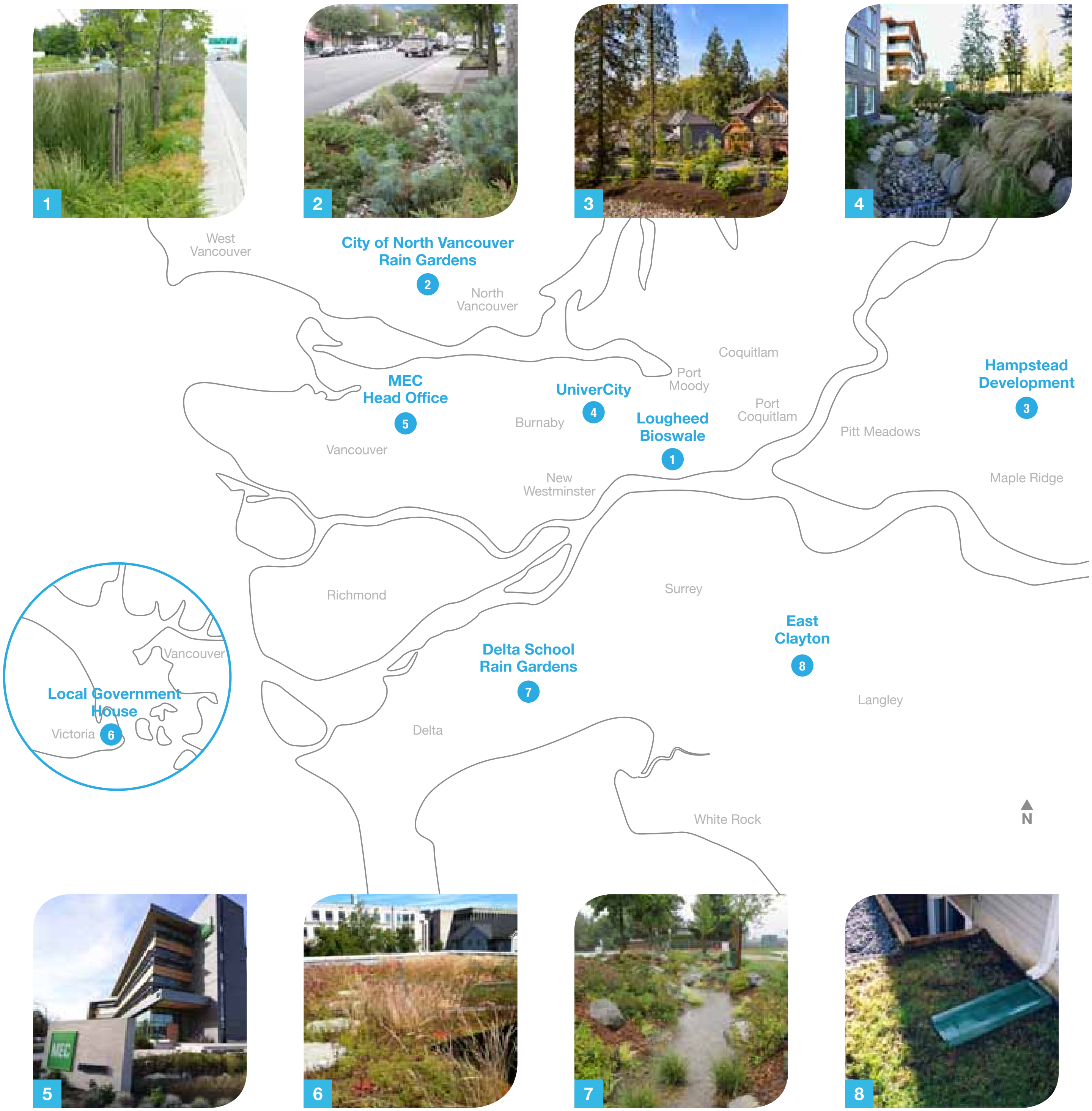
When appropriately designed and maintained, GSI effectively manages rainwater at various scales, from individual properties to streetscapes, and entire neighbourhoods[8]. This report profiles the successful implementation of green stormwater infrastructure across three urban land use types:

- **Streetscapes,**
- **Residential Communities, and**
- **Institutional Sites**

While there are many examples of successfully implemented GSI projects within BC communities, this report emphasizes the local context by profiling examples primarily from Metro Vancouver. Case studies were selected based on the availability of information related to project design, implementation and maintenance and, where possible, monitoring data. Selected case studies were verified during an interview with the project manager, planner, or engineer involved in GSI design and implementation.

Map Showing GSI Case Study Locations

Metro Vancouver and Victoria, BC.



Photos: 1 – Lougheed Bioswale, Coquitlam | 2 – Rain Garden Network, North Vancouver | 3 – Hampstead Development, Maple Ridge
4 – UniverCity, Burnaby | 5 – MEC Head Office, Vancouver | 6 – Local Government House, Victoria (shown on inset map)
7 – Delta School Rain Garden Network, Delta | 8 – East Clayton, Surrey

The research identified the following aspects – or enabling factors - that are needed to expand the implementation of GSI, and support the transition to a more comprehensive GSI network in our urban communities:

- Maintaining and strengthening municipal leadership and commitment to GSI.
- Building public awareness and support for the broad benefits of GSI.
- Establishing effective development requirements and bylaws to incentivize GSI across different land use types.
- Clearly defining ownership and maintenance responsibilities for green stormwater infrastructure

In addition to the enabling factors outlined above, it is important to note that each case study example profiled in this report had at least one, if not multiple, GSI champions within the staff team or the planning-design team. The role of these champions in facilitating the inclusion of GSI to improve environmental and broader community outcomes is an important factor in the successful implementation of GSI. Another observation is that, while the ecological, social and financial benefits of GSI are well documented; there are few incentives in place that encourage or reward property developers to go beyond the industry standard or baseline regulatory requirements for stormwater management. Incentive programs, including rebates, fast-tracking, and third party certifications, will help support compliance with existing bylaws and regulations while mainstreaming the use of GSI across private and public sites, resulting in improved water management and better environmental outcomes.

Each case-study includes the following details:

- **Snapshot** – Summary information including land use type, location, type of development, GSI features and their key benefits.
- **Description** – An outline of the project location and highlights.
- **Driving Force** – Key enabling factors, including policies, tools, partnerships and incentives that led to the inclusion of GSI within project planning, design and implementation.
- **GSI Features & Benefits** – An overview of the GSI features and beneficial outcomes.
- **Maintenance & Responsibility** – Overview of specific maintenance considerations including responsible groups and management challenges if any were identified.

By showcasing successful examples of GSI in the BC context and identifying key factors that strengthen and enable GSI implementation, this case study report confirms that GSI is a viable alternative to traditional stormwater management practices. We hope the examples showcased here inspire further, and more consistent, implementation of GSI to address stormwater challenges in communities across BC.

Completed rain garden captures and infiltrates runoff from nearby impervious surfaces, Brook Elementary, North Delta, BC.

Photo credit: Corporation of Delta

Juvenile Coho salmon

Photo credit: USFWS Paul Kaiser, CC Flickr, under Attribution 2.0 license

Enhancing Water Quality

Research from Washington State University tested the effectiveness of soil-based GSI in removing toxins and pollutants from highway runoff. The study found that nearly all of the juvenile Coho salmon survived when exposed to stormwater collected from a densely used four - lane highway when the runoff was filtered through an amended soil, similar to that used within a rain garden or swale. On the other hand, 100% of the juvenile Coho exposed to the untreated stormwater died in less than 12hrs[11].

2.0 Green Stormwater Infrastructure in Streetscapes

GSI is becoming more common within streetscapes across Metro Vancouver and other regions of BC as municipalities recognize the multiple benefits of using green infrastructure to manage stormwater in public spaces and rights of way. Municipalities recognize that GSI improves public space by enhancing urban biodiversity, improving streetscape aesthetics and helping to increase community resilience to the impacts of climate change. Including GSI in streetscapes is particularly beneficial as sidewalks and streets are significant generators of stormwater runoff and, in many communities, cover 30% of the urban landscape[9]. Stormwater flowing across these highly impervious surfaces transports contaminants including hydrocarbons, metals and sediment- all of which can have significant negative impacts of water quality and stream health[10]. GSI in streetscapes can effectively capture and filter contaminated stormwater runoff while improving roadside aesthetic and supporting biodiversity within urban spaces.

Clearly defining GSI ownership and maintenance responsibility helps ensure the long term functioning and success of these features. Commonly, municipal bylaws assign maintenance responsibilities of boulevard space fronting private property to the property owner. However, GSI can require a different type of maintenance than periodic boulevard mowing or weeding. To address this, alternate approaches -such as local service area agreements - have been used to better secure long-term maintenance of GSI fronting private property. Additionally, clearly defining the optimal division of maintenance responsibilities between local government departments is equally important. This is particularly true when GSI includes landscape features, often the responsibility of parks departments, as well as rainwater management functions, often the responsibility of engineering or drainage departments.

The following case studies demonstrate the benefits of GSI within streetscapes and highlight how municipalities are enhancing their communities by implementing GSI within this land-use type.

Roads designed with curb-cuts allow stormwater runoff to enter a rain garden and slowly infiltrate into the soil.

Photo credit: Flickr CC by Center for Neighbourhood Technology under an Attribution-ShareALike 2.0 license (https://creativecommons.org/licenses/by-sa/2.0/legalcode)

2.1 Streetscapes: Lougheed Highway Bioswale, Coquitlam, BC

Using GSI to manage contaminated runoff from a busy arterial corridor

Description

A linear 400m x 4m vegetated swale installed in the median strip along a central portion of the Lougheed Highway collects and treats stormwater runoff from approximately 4000m^2 of impervious road surface.

Driving Force

The City of Coquitlam's Rainwater Management requirements for City streets and roadways informed the design and construction of the bioswale, with an overarching goal to protect water quality in surrounding watercourses. Additionally, the construction of the bioswale was used as a pilot project to test the effectiveness of engineered soils in infiltrating and removing pollutants from highway runoff. The City of Coquitlam's Integrated Stormwater Management Plans set out specific requirements and expectations for rainwater management on public and private property.

GSI Overview & Benefits

The bioswale includes trees, shrubs, perennials and engineered soils to filter pollutants and improve the quality of water discharged into Como Creek. The bioswale protects fish habitat in nearby waterways and enhances roadway aesthetic along a busy transportation corridor. In order to manage rainfall from large storm events, the swale includes an overflow connected to the storm sewer network. A 2013 water quality monitoring assessment evaluated the effectiveness of the bioswale and identified significant improvements in water quality, with pollutant reductions ranging from 75-90%. (Table 1 below).

Maintenance & Responsibility

The City's Operations Department cleans hard infrastructure in the bioswale, such as catchbasins and lawnbasins, annually, while the Parks Department services the bioswale three times a year to maintain vegetation and landscaped features[12].

Pollutant	Reduction
Nitrate	92%
Zinc	83%
Copper	81%
Nitrogen (Organic)	86%
Total Kjeldahl Nitrogen (TKN)	77%
Total Suspended Solids	89%

Table 1. Percent reduction in key urban stormwater pollutants in bioswale effluent relative to roadway runoff[13].

Snapshot

Land Use Type: Streetscape

Location: Coquitlam, BC

Type of Development: Retrofit

GSI Features: Vegetated bioswale

GSI Benefits: Improves water quality in Como Creek, enhances roadway aesthetic.

Photos (Top) | Vegetated bioswale in median of Lougheed Highway, Coquitlam, BC. (Bottom) Water Quality testing at the Lougheed Hwy bioswale.

Photo credit City of Coquitlam, BC

2.2 Streetscapes: Rain Garden Network, City of North Vancouver, BC

Rain gardens bring multiple benefits to streetscapes and public spaces

Description

The City of North Vancouver is creating a rain garden network in streetscapes and rights of way throughout major transportation corridors and side streets. The City has constructed approximately 50 rain gardens in a number of public spaces, including the intersection of Keith Road and 13th Street and in bus bulges along the Lonsdale corridor. These gardens enhance the aesthetic value within streetscapes while capturing and infiltrating stormwater runoff from impermeable surfaces, including sidewalks and roads.

Driving Force

A guiding principle for the City of North Vancouver is to ensure that rainwater is managed on site across both public and private lands. This is implemented through development requirements that make rainwater management with GSI a standard for streetscape re-development[14].

Rain gardens are included within capital projects such as major transportation upgrades and streetscape improvements[15] and the City is preparing Integrated Stormwater Management Plans for creeks within the City. These plans will identify current and potential opportunities for expanding the use of GSI, including rain gardens to manage rainfall.

GSI Overview & Benefits

In addition to slowing and infiltrating surface runoff, the rain garden network also improves safety for pedestrians on the busy Lonsdale corridor by reducing crossing distances at bus bulges[16]. Water that infiltrates into the rain gardens supports growth and survival of street trees, which also contribute to the GSI network by intercepting and evaporating rainfall[17]. To complement rainwater management on public lands and meet infiltration and water quality objectives on private property, the City has established development guidelines that require on-site GSI for all new development. In addition, water volume and quality monitoring programs are required for larger new developments, providing valuable data to the City to inform effectiveness of GSI features and future rainwater management policies[18].

Maintenance & Responsibility

Maintenance requirements vary with the design and sizing of each rain garden. To better manage maintenance efforts with existing resource, the City adjusts the extent of vegetation depending on location. More vegetated rain gardens, which are more maintenance intensive, are installed in higher profile, publicly accessed areas while un-vegetated rain gardens are installed in less publicly accessed locations. The City has found that ensuring proper design and siting prior to construction minimizes maintenance requirements as rain gardens that are incorrectly sized – i.e. too small for their catchment areas – require a significantly higher level of maintenance to ensure their effectiveness[19].

Snapshot

Land Use Type: Streetscape

Location: City of North Vancouver, BC

Type of Development: Retrofit

GSI Features: Rain gardens

GSI Benefits: Reduces roadway flooding, improves water quality and fish habitat in North Vancouver streams, improves pedestrian safety by narrowing crossing distance

Photos: (Top) Vegetated and (Bottom) un-vegetated rain gardens in streetscapes, City of North Vancouver.

Photo Credit: City of North Vancouver, BC

3.0 Green Stormwater Infrastructure in Residential Communities

Like many large urban centers, Metro Vancouver's population is growing, and an additional 1 million residents are expected to be living in the region by 2040[20]. Population growth leads to an expansion of housing, including single-family homes as well as multi-family units like townhouses and apartments. In general, growth in housing increases the area of impervious surface as there are more rooftops, driveways and streets – all of which can generate a significant amount of stormwater runoff. As our communities grow, GSI will be essential to managing stormwater in a way that minimizes the impacts of urban growth on watercourses in the region.

In Metro Vancouver, residential land use represents approximately 35% of the urban land area[21]. By incorporating GSI to better infiltrate rainwater where it falls, municipalities and residential developers can significantly reduce the stormwater burden on existing grey infrastructure while also improving conditions in urban streams and receiving waters.

There are challenges facing the effectiveness and implementation of GSI, especially within smaller land parcels often dedicated to single-family housing. Size constraints and conflicts with the building code - such as minimum front and side lot setbacks - have been identified as barriers to integrating GSI on residential properties. In addition, the large surface area often required by above-ground GSI features, such as raingardens or swales, may make them less attractive options to property developers, who generally seek to maximize the buildable area. Some municipalities have addressed this by working collaboratively with developers to allow the use of boulevards and rights of way in GSI construction[22].

The following case studies provide three examples from the Metro Vancouver region that demonstrate the effective design and implementation of green stormwater infrastructure within residential development.

Rain garden in a multi-family residential community infiltrates and cleans stormwater collected from surrounding impermeable surfaces.

Photo credit: A Greenwood

3.1 Mixed-Use Residential: East Clayton Community, Surrey, BC

Pioneering GSI in high density community development

Description

The community of East Clayton, located in northeast Surrey, is home to approximately 13,000 residents[23]. The East Clayton Neighbourhood Plan, approved by the City of Surrey in 2000, has received numerous awards for its innovative approach to sustainable community planning. The Plan integrates a compact neighbourhood layout that includes a GSI network designed to mimic natural drainage patterns. The East Clayton community includes a variety of residential, commercial, recreational and educational land uses across approximately 200 hectares[24].

Driving Force

The City of Surrey recognized the need and opportunity to implement new approaches to urban development servicing in order to reduce the environmental impact of increased urban density and the associated impervious surfaces. The planning and successful construction of the East Clayton Community clearly demonstrated that GSI can protect watershed health and prevent downstream flooding within a high-density development. As such, lessons learned from the East Clayton Community have resulted in a more progressive urban design based on an understanding of the land-water connection and the importance of protecting urban watercourses with innovation in the built environment[25, 26].

GSI Overview & Benefits

The GSI measures incorporated at East Clayton manage rainwater at both the individual property and neighbourhood scales. Systems such as dry wells, infiltration trenches and disconnected downspouts are used at the property scale. In the road right of ways, curb-cuts allow street runoff to reach roadside infiltration trenches. At the neighbourhood scale, bioretention ponds capture and filter runoff from larger rain events before discharging slowly into local streams and watercourses. Other GSI features incorporated across the site include[27]:

- Topsoil depth of 300mm to increase infiltration capacity, support plant growth and reduce irrigation demand.
- Narrowed streets and driveways to reduce impermeable surface area.
- Paving stones as an alternative to asphalt to increase permeability and reduce runoff.

Although the East Clayton community was developed more than a decade ago, the GSI features continue to function well to meet the stormwater management goal of capturing and infiltrating 90% of annual rainfall across the site. A decade of monitoring in North Creek, which receives stormwater discharged from the East Clayton detention ponds, shows that the GSI measures have effectively reduced peak flows in winter while helping to sustain minimum summer streamflow by increasing groundwater reserves during the wet season[28, 29].

Maintenance & Responsibility

Initially 75% of the GSI features implemented at East Clayton did not perform to the intended design, largely due to a lack of proper maintenance or regular inspection following rain events. However, improving maintenance management and designing more underground GSI features – such as infiltration trenches and dry wells - increased the success rate to almost 100%. This experience further illustrates the importance of proper maintenance to ensure the long-term effectiveness of GSI[30].

Snapshot

Land Use Type: Mixed-use Residential and Streetscapes

Location: Surrey, BC

Type of Development: New mixed-use community development

GSI Features: Bioretention ponds, roadside swales, permeable pavement, rain garden, dry wells

GSI Benefits: Enhances community livability and aesthetic, protects water quality and fish habitat in the Nicomekl and Serpentine Rivers.

Photos: GSI features at East Clayton Community, Surrey, BC including (Top) lawn basin for underground infiltration tank and (Bottom) bioretention pond vegetation filters runoff before it is slowly released into nearby watercourse.

Photo credit: (Top) Kerr Wood Leidal Associates, Ltd. (Bottom) City of Surrey

3.2 Residential: Hampstead Development, Maple Ridge, BC

GSI supports habitat conservation and improves stormwater management

Description

The Hampstead development includes 84 single-family lots and 6 duplex-style units located in Silver Valley, northeast Maple Ridge[21]. The forested hillsides host a network of creeks and streams and offer some of the highest quality salmon habitat in the Lower Mainland[31]. In order to protect riparian habitat and to prevent erosion and sediment from entering the watercourses, the development design condensed housing units into groups on slopes less than 20%, ensuring steeper slopes remained forested. Housing clusters are surrounded by open space and connect to the community by single local roads. The clustered design protects sensitive natural areas, providing wildlife corridors while also minimizing site-grading requirements[32].

Driving Force

Numerous municipal policies promoted GSI implementation at Hampstead, including:

- The Silver Valley Area Plan, which outlines stormwater management goals, such as limiting total impervious area to 15% and maintaining pre-development hydrology[33].
- The Watercourse Protection Bylaw, which requires stormwater management plans for all new development sites to demonstrate how GSI will manage rainfall events of varying sizes. GSI designs are required to comply with provincial[34], regional[35] and municipal stormwater requirements[36].
- Streamside Protection Regulations, which, given Hampstead's proximity to sensitive forested and aquatic ecosystems, prioritized the protection of habitat and riparian environments[37].

GSI Overview & Benefits

Over 30% of the site is dedicated as open park space, with runoff from impermeable surfaces minimized through[38]:

- Clustering housing units on low gradient slopes to protect adjacent sensitive natural areas.
- Parkettes incorporated into frontage of housing units as infiltration zones that also provide habitat.

Runoff generated by impermeable surfaces is captured, infiltrated and treated by:

- Rockpits on individual properties
- Rain gardens
- Permeable paving where possible
- Enhanced topsoil amendments (minimum 300mm)
- Roadside bioswales
- Central bioretention ponds in parkettes fronting housing units

Maintenance & Responsibility

A Local Area Service Agreement requires Hampstead residents to pay annual dues for GSI maintenance, which is performed by the municipality and private contractors. This service agreement has been applied within other communities across Maple Ridge for 5-6 years with increasing effectiveness. A key lesson learned is that clear communication with residents about the purpose of the annual dues is essential to ensuring success and maintaining ongoing support[39].

Snapshot

Land Use Type: Residential and Streetscapes

Location: Maple Ridge, BC

Type of Development: New Development

GSI Features: Bioretention ponds, protected natural landscapes, rock pits, rain gardens, top soil, roadside bioswales, permeable paving

GSI Benefits: Protects fish habitat and stream health, enhances neighbourhood aesthetic, preserves habitat in sensitive ecosystems

Photos: (Top) Parkettes fronting residences and (Bottom) condensed housing cluster layout at Hampstead Development, Maple Ridge, BC.

Photo Credit: Portrait Homes

3.3 Mixed-Use Residential: UniverCity Community Development, Burnaby, BC

Integrated stormwater management at the community level

Description

The mixed-use UniverCity community, located on Simon Fraser University property on Burnaby Mountain, is positioned within the ecologically sensitive Brunette Basin. In order to accommodate an expected 10,000 residents within 160 acres, UniverCity applied sustainable urban design principles within a high-density residential community to minimize environmental impacts on the surrounding watercourses and sensitive ecosystems[40, 41].

Driving Force

Stormwater runoff from Simon Fraser University drains to Eagle and Stoney Creeks near the headwaters of the Brunette Basin, which provides important habitat for many species of native fish including salmon. Given the environmental impact of past development in the Basin's headwaters, the UniverCity community was designed to minimize further impact and to improve the existing hydrological conditions. As part of the effort to restore pre-development hydrology in surrounding watercourses, the natural forested conditions were used as the baseline to determine targets for runoff quality, volume and peak flow rates[42].

GSI Overview & Benefits

The UniverCity development guidelines require GSI to be implemented at the individual lot, streetscape and neighbourhood scale. At the site level, below-ground cisterns capture runoff from impermeable surfaces such as roofs, driveways and paved walkways. The cisterns release water into bioswales and infiltration trenches along streets. These filter and infiltrate water as it is conveyed into one of three vegetated detention ponds. The ponds detain and filter runoff at the neighbourhood scale, which is then released into tributaries at pre-development rates. In addition, permeable paving is used in all parking bays[43].

Six monitoring stations provide data to evaluate the effectiveness of GSI features and inform an adaptive management program. In response to elevated peak runoff rates from the detention ponds, development standards have been updated to enhance on-site infiltration using landscaped areas. Long-term water quality monitoring demonstrates that a decentralized network of GSI applied at various scales can meet or exceed water quality guidelines for contaminants including nutrients, metals and hydrocarbons [44].

> *"The system mimics nature by returning nearly 100% of stormwater to the ground instead of diverting large amounts into conventional drainage pipes or storm sewers. Our objective is to create pre-development water conditions, so that a salmon swimming in a stream at the bottom of Burnaby Mountain would have no clue that a thriving urban community exists at the top."*
>
> Director, Development, SFU Community Trust.

Snapshot

Land Use Type: Residential, Commercial and Streetscapes

Location: Simon Fraser University, Burnaby, BC

Type of Development: Re-development (65%) and new development (35%)

GSI Features: Rainwater detention in underground cisterns, rain gardens, roadside bioswales, infiltration trenches/ galleries, permeable paving, bioretention ponds

GSI Benefits: Protects stream health and fish habitat in Brunette Basin, enhances neighbourhood aesthetic and access to green space.

Photos: (Top) Green roof and (Bottom) infiltration trench construction and UniverCity Community Development, Burnaby, BC.

Photo Credit: SFU Community Trust

Maintenance & Responsibility

Landscaped GSI features on individual lots are maintained according to strata landscaping protocols. Rights of way are serviced by the City of Burnaby, with City crews maintaining vegetation in swales on an annual basis. In order to maintain capacity and effectiveness, stormwater ponds are drained every 4 years for sediment trap cleaning and vegetation control[45].

Photo: Stormwater bioretention pond at UniverCity Community Development, Burnaby, BC.

Photo Credit: SFU Community Trust

Rain garden on an institutional property captures and infiltrates runoff from adjacent parking lot and other impervious surfaces.

Photo Credit: A. Greenwood

4.0 Green Stormwater Infrastructure on Institutional Sites

Institutional sites provide a diverse range of services and activities for public, private and corporate users. Examples of institutional sites include university campuses, libraries, hospitals and public schools along with publicly owned land that may be leased for private or commercial use.

Institutional sites, which represent approximately 5% of Metro Vancouver's urban land area[46], and often cover a relatively large area that includes landscaped areas, buildings, vehicle access, parking and other hard infrastructure. As institutional sites are often accessed frequently by members of the public, they present a unique opportunity to raise the profile of GSI and enhance urban aesthetics while improving stormwater management. As with other land-use types, incorporating various GSI features to manage rainwater onsite helps to reduce burden on traditional stormwater infrastructure, leading to potential future cost savings, as aging grey infrastructure may avoid replacement with larger pipes.

4.1 Institutional: Delta School Rain Garden Program, Delta, BC

GSI helping to cultivate the next generation of environmental stewards

Description

To capture and infiltrate stormwater from impervious surfaces on school property, the Corporation of Delta has worked collaboratively with local community groups and the School District to install rain gardens in 12 of 14 elementary schools in North Delta. The Municipality designs and constructs the gardens and the school community assists with the planting, offering students a sense of ownership, responsibility and pride for their school rain garden. Rain gardens will be installed at the remaining two schools in 2016[47].

Driving Force

The local Cougar Creek Streamkeepers group was the initial driving force behind Delta's school rain garden program - catalyzing the first rain garden as a pilot project at Cougar Canyon Elementary School in 2006. This rain garden extends the length of the school parking lot and allowed for the decommissioning of two storm sewers. The program's continued success is built upon a lasting partnership between Delta's Engineering Department, the Delta School District and local streamkeepers. Recognizing the importance of improved stormwater infrastructure to water quality and fish habitat, the Pacific Salmon Foundation has provided funding assistance for many of the school rain gardens.

GSI Overview & Benefits

Each rain garden collects, infiltrates and cleans stormwater runoff generated from impervious surfaces, such as school parking lots and driveways. This improves water quality and reduces peak flow in local streams during periods of heavy rainfall and storm events. In some cases, school curriculum has been developed to include the school rain gardens as an outdoor classroom for lessons in science and environmental stewardship. Interactive lessons engage students with nature and improve their understanding of the connection between land use and the health of surrounding watercourses. The rain gardens have also enhanced the landscape aesthetics of school grounds and along public rights of way, while fostering community involvement and education.

Maintenance & Responsibility

Once the municipality completes construction, the rain gardens are maintained by local streamkeeping groups.

Snapshot

Land Use Type: Institutional on public land

Location: Delta, BC

Type of Development: Retrofit

GSI Features: Rain garden

GSI Benefits: Captures and infiltrates stormwater runoff to improve water quality and stream health, provides science education opportunities for students.

Photos: (Top) Completed rain garden at Brooke Elementary, Delta, BC. (Bottom) Before and after rain garden at Chalmers Elementary School, North Delta.

Photo Credit: (Top) Corporation of Delta (Bottom) D. Jones

4.2 Institutional: Mountain Equipment Co-op Head Office, Vancouver, BC

Integrating innovation in building and landscape design

Description

The Mountain Equipment Co-op (MEC) Head Office, completed in 2014, is located on a former industrial site on the edge of Vancouver's False Creek Flats industrial area. The site includes a number of GSI features to manage rainwater on site and recently became the first urban site in BC to achieve Salmon-Safe certification.

Driving Force

MEC prides itself on its commitment to sustainability and progressive Corporate Social Responsibility mandate. Maintaining this leadership role was an important driver behind the site's energy efficiency and water-centric design. The landscape architecture team included well renowned experts in GSI and regenerative landscape design, ensuring water quality protection with various GSI features and reduced water demand with rainwater harvesting.

GSI Overview & Benefits

A network of landscape features work together to reduce stormwater runoff, enhance water quality and minimize water leaving the site. Rainwater is captured from the "blue-roof", which covers about ½ the building footprint. This rainwater is stored in a 35, 000L underground cistern and is reused for non-potable purposes including toilet flushing and irrigation of the green-roof, which covers the remaining rooftop area and is accessible to MEC staff. Rainwater harvesting significantly reduces non-potable water use by nearly 55%, while landscaping with drought-tolerant native plants reduces irrigation requirements.

Stormwater from the parking lot is directed into a central bioswale, which filters pollutants and reduces the volume of water entering the storm sewer system. All landscaping is managed without the use of synthetic fertilizers or herbicides, helping to protect the quality of water leaving the site.

Maintenance & Responsibility

A private landscape contractor maintains the GSI features at MEC Head Office. As this is a relatively new facility, there have been few requirements for maintenance of the GSI features, other than seasonal vegetation maintenance. To date the GSI features are functioning as designed.

In 2015, MEC Head Office became the first urban site in BC to achieve "Salmon-Safe" certification. Salmon-Safe is a site specific certification program that requires improved water quality and environmental benefits from urban development.

Photos: (Top) MEC HEad Office Building in Vancouver, BC. (Left) Wall signage posted at the front entrance recognizes the MEC Head Office as a Salmon-Safe certified site.

Photo Credit: (Top) Fraser Basin Council (Bottom) V. Oviedo

Snapshot

Land Use Type: Institutional on private land

Location: City of Vancouver, BC

Type of Development: Re-development

GSI Features: Rain water harvesting and re-use, rain garden, green roof and bioswale

GSI Benefits: Reduces on-site water use and dependence on municipal water supply, reduces stormwater volume and improves quality of runoff leaving site.

Photos: (Top) Stormwater captured from the green roof and adjacent impervious surfaces is infiltrated within the roadside bioswale. (Bottom) Central vegetated bioswale captures runoff from parking lot surface at MEC Head Office in Vancouver, BC.

Photo Credit: (Top) R. Sharp. (Bottom) Fraser Basin Council

4.3 Institutional: Local Government House, Victoria, BC

Incorporating GSI designs from the outset

Description

Local Government House in Victoria BC, constructed on the site of a former parking lot, is home to the Union of BC Municipalities. The building was designed to LEED gold standards and includes an integrated network of green stormwater infrastructure among other progressive green building features.

Driving Force

The land for the Local Government House was gifted by the Province of British Columbia with the condition that the constructed building seek LEED certification. As a result, LEED standards for energy efficiency and onsite management of stormwater where incorporated into the initial planning and design stages, which helped to ensure they were streamlined into the construction process[48].

GSI Overview & Benefits

A network of above and below-ground GSI features work together to reduce stormwater volume, improve water quality and reduce on-site water consumption.

The green roof is equipped with a substrate designed to absorb and infiltrate rainfall and planted with drought-tolerant species. Any rainwater that is not absorbed by the green-roof is directed to below-ground cisterns and is stored for landscape irrigation during the summer months. The cisterns were designed with sufficient capacity to meet all irrigation needs for the site, significantly reducing potable water demand. Low-flow fixtures and appliances inside the building further reduce demand on the municipal water supply.

A rain garden captures and infiltrates overflow from the underground cisterns, along with stormwater from the building sump, and any excess runoff from the permeable pavers along the driveway and walkway. Finally, redundancy is built into the system so that any rainwater volume that exceeds the combined capacity of the green-roof, cisterns and rain garden is diverted to the municipal stormwater sewer[49].

Maintenance & Responsibility

The maintenance of GSI within the Local Government House site is contracted to a local landscaping company and no significant maintenance challenges have been reported.

Snapshot

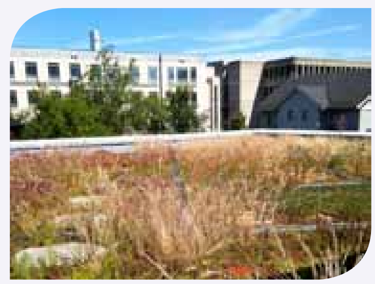
Land Use Type: Institutional on public land

Location: City of Victoria, BC

Type of Development: Re-development

GSI Features: Rain water harvesting and re-use, rain garden, permeable paving

GSI Benefits: reduces quantity and improves quality of runoff reaching storm sewers, reduces on-site water use and dependence on municipal water supply.



Photos: (Top) Green roof and (Bottom) underground cisterns at UBCM Local Government House in Victoria, BC.

Photo Credit: Local Government House, UBCM

5.0 Towards a Comprehensive GSI Network: Lessons from Implementation

The BC case studies profiled in this report clearly demonstrate that GSI has been effectively applied across different land-use types to manage rainfall, improve water quality and reduce or eliminate stormwater run-off while enhancing overall environmental health. The examples included here offer insight into how GSI has been successfully planned, constructed and maintained at different scales and across different land use types. It was found that, although there is general acceptance of GSI as an effective way to manage rainwater, a number of enabling factors are required to get beyond GSI “pilot-projects” and support the creation of a more comprehensive GSI network. These enabling factors include:

Stream restoration project helps improve runnoff water quality before entering Burrard Inlet while providing valuable urban habitat and green space, Creekway Park, Vancouver, BC.

Photo credit: S. Primeau

Maintain and strengthen municipal leadership & commitment to GSI

Municipalities have tremendous influence on the built environment and how it affects or enhances surrounding watercourses and the broader community. Because municipalities are largely responsible for land use planning and stormwater management in urban communities they have shown leadership in by implementing GSI technologies at various scales and continuing to require higher development standards for on-site infiltration and stormwater management. While it was not a main focus of this research, the development and implementation of Integrated Stormwater Management Plans presents a significant opportunity for Metro Vancouver’s member municipalities to strengthen their leadership role in GSI implementation. Setting infiltration targets, maximum impervious areas objectives, guidelines for new development and including GSI within streetscape development or upgrades are just a few examples that local governments are using to expand GSI throughout their municipalities.

Build public awareness & support for the broad benefits of GSI

While local government action is important, public awareness and understanding is also a key element to broaden the acceptance and implementation of GSI at various scales. In many instances, urban development and streetscape design is informed and enhanced by public participation in the planning process.

Therefore, an increased public understanding and support for the multiple benefits that GSI offers is a key step in ensuring the built environment – on both public and private land - includes innovative stormwater management practices. In addition, public involvement in planning, planting and maintaining GSI features is an effective way to increase support and educate the community more broadly about the benefits of GSI and the connections between land use and watershed health.

Rain garden at Sunshine Hills Elementary, North Delta, BC

Photo credit: Corporation of Delta

Establish effective development requirements and bylaws to incentivize GSI across different land use types

Stormwater bylaws and development standards that clearly define infiltration and stormwater retention goals along with the suite of GSI measures to meet these goals are essential to improving stormwater management at the site and community scale. These can be strengthened by incentives or rebate programs, such as building permit fast-tracking, fee reductions and density bonusing for designs that meet or exceed on-site rainwater retention and infiltration goals. Encouraging third party certification that prioritizes innovative water management, such as Salmon-Safe or Sustainable SITES certifications, demonstrates compliance with stormwater management best practices and raises public awareness of actions that improve water quality and protect watershed health.

Clearly define GSI ownership and maintenance responsibilities

The case study research confirmed the importance of clearly defining the roles and responsibilities of site-owners, operators, contractors and municipalities at an early stage in the GSI planning process to ensure proper maintenance and functioning of GSI features. In many cases, collaborative partnerships create ongoing benefits and ensure multiple groups take an active role in sustaining GSI features.

With ongoing leadership and support for the implementation of GSI to manage stormwater in a more holistic way, communities across Metro Vancouver and other regions of BC will continue to benefit from improved environmental health, enhanced community livability and greater resilience to the impacts of climate change.

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