Green Infrastructure Project-Based Examples

The following section includes examples from other municipalities in the Lower Mainland and across North America. These examples are classified within four key categories that reflect the primary benefits of green infrastructure. Examples include key highlights and outline specific strategies, tools, policies and lessons learned. Where available, specific information on costing and return on green infrastructure in the short and long term is included.

Community Safety and Resilience

Green infrastructure offers a number of opportunities to build resiliency to climate change, manage risk with respect to drought, storm events, air quality, temperature, wildfire, flooding and mitigate the impacts associated with conventional versus green urban development.

MUNICIPALITY:	City of Surrey, BC
PROJECT:	Coastal Flood Adaptation Strategy – Mud Bay Foreshore Enhancements
TYPE:	Semi-natural, engineered solutions
DATE:	2018 - present
APPROACH:	Testing a variety of green infrastructure

The City of Surrey Living Dike works will create flood mitigation and ecosystem services for up to 100 m of shoreline adjacent to the Mud Bay Park and include interpretive information. Building on work led by numerous partners, an innovative, nature-based solution will be implemented at two locations in Boundary Bay to mitigate coastal squeeze damages and coastal flood risk associated with climate change. The "Living Dike" concept will be used to enhance habitat and other ecological, cultural, and aesthetic values of intertidal and nearshore areas while providing flood regulation services. Since the project is in a complex and dynamic environment, the foreshore enhancements will be implemented using an adaptive management approach: establishing different kinds of green infrastructure and observing performance to inform later phases of implementation.

- This flood control method offers several co-benefits including greater food security and wetlands for birds, fish, and clams.
- Surrey's Coastal Flood Adaptation Strategy is funded by a $76.6M federal fund awarded under the Disaster Mitigation and Adaptation Fund. It is estimated that the foreshore enhancements will cost between $500k and $10m (not including the sediment augmentations $50m to $100m).
- A large-scale project, the foreshore enhancements are seeking an exemption from BC's Environmental Assessment process because project focuses on habitat enhancement and seeks consensus with Indigenous governments, with benefits far outweighing consequences.

MORE INFORMATION:

- https://www.surrey.ca/city-services/30811.aspx
- https://www.surrey.ca/files/CFASFinalReportNov2019.pdf

MUNICIPALITY:	City of Cuyahoga Falls, Ohio
PROJECT:	Rain Garden Reserve
TYPE:	Human made
DATE:	**2004**
APPROACH:	Replace properties in hazardous areas with green infrastructure

After suffering through two 500-year storm events in 2003 and 2004 that caused millions of dollars in property damage and having been declared a federal disaster zone twice in a two-year period, the City of Cuyahoga Falls started looking at new, cost-effective solutions for stormwater management. Using Federal Emergency Management Agency flood buyout funds, the City acquired four flood-damaged properties and demolished the houses to preserve the lots and as open space and create the mid-block 24,000-square-foot Rain Garden Reserve. The park has three rain gardens and an overflow pipe for peak rain events, which drains 3.17 acres at the lowest point on the block.

- The cost for the project was $107,000 in Federal Emergency Management Agency funds and $50,000 in donated materials, and the effort was supported by community organizations, residents, and local businesses. Ongoing maintenance is performed by the City and has minimal costs of approximately $700 per year, mainly for mulch and the removal of invasive plants.
- The garden is a neighborhood amenity with pervious walking paths, solar lighting bollards, and year-round visual interest.
- School groups visit to learn about plants.
- It has served as a model for large-scale rain gardens that the City has begun to see included in private developments.

MORE INFORMATION:

- http://nrcsolutions.org/cuyahoga-falls-ohio/
- https://epa.ohio.gov/Portals/41/storm_workshop/retrofit/Cuyahoga%20Falls%20Rain%20GardenReserve%20Flyer.pdf

Economic Vitality and Cost Savings with Growth and Development

Green infrastructure has many short-term and long-term benefits and cost savings to communities overall. The following project examples provide a look at potential financial tools available to support green infrastructure, cost savings from green vs. grey infrastructure, and how natural capital inventory & evaluation is used.

MUNICIPALITY:	City of Baton Rouge, Louisiana
PROJECT:	Episcopal High School bioswales and rain garden
TYPE:	Human made
DATE:	2008
APPROACH:	Green infrastructure at educational facilities

For many years, Episcopal High School in Baton Rouge, Louisiana, was troubled with severe flooding in the school's quadrangle because of an inadequate and aging drainage system. In 2008, BROWN+DANOS landdesign, Inc. designed bioswales and a rain garden for the five-acre space to capture one inch of rainfall and slow down the impact to the storm drain system. Since implementation, the school has not experienced any flooding. Their park lands handled over 9.95 billion gallons of water during the 2016 great flood.

- The school uses the rain garden as part of their environmental curriculum.
- Green infrastructure saved the school over $400k. Estimates for re-piping the site were approximately $500,000, while the green infrastructure cost about $110,000 for design and construction.

MORE INFORMATION:

- https://www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/Banking%20on%20Green%20HighRes.pdf
- https://www.asla.org/uploadedFiles/CMS/Advocacy/Federal_Government_Affairs/Stormwater_Case_Studies/Stormwater%20Case%20459%20Episcopal%20High%20School%20Stormwater%20Rain%20Garden,%20Baton%20Rouge,%20LA.pdf

MUNICIPALITY:	City of Toronto, Ontario
PROJECT:	Every Tree Counts: A Portrait of Toronto's Urban Forest
TYPE:	Semi-natural
DATE:	2010-present
APPROACH:	Document and assess green infrastructure to inform targets, measures, and management

Tree canopy studies of this kind are an important part of the adaptive management cycle for Urban Forestry. They allow City staff to work with reliable data to adjust program activities that reflect the changing nature of the urban forest and evolving management issues. The City of Toronto assessed the City's urban tree canopy in 2010 and again in 2018, which involved field study, data analysis using the i-Tree Eco model, integration of City street tree data, and manual assessment of land and forest cover change. The assessment collected important data about ecological services, land use and changing urban cover, tree size effects, forecasting future conditions, and significant pests impacts.

- Community benefits from the urban forest include energy savings through warming/cooling effects of trees, storm water attenuation, local climate modification, provision of wildlife habitat, air quality improvements, noise reductions, increased property values in treed commercial and residential areas, and psychological and health benefits for Toronto residents.
- The i-Tree Eco model (formerly known as the Urban Forest Effects or UFORE model) developed by the USDA Forest Service was a key component of this study. To complement the information derived through i-Tree Eco, the study used spatial analysis tools combined with City mapping data as well as City street tree data to develop a detailed description of urban forest composition, structure, function, and distribution.
- The urban tree canopy is a vital City asset with an estimated structural value of $7 billion in Toronto.
- Over the last decade, the City has invested $605.6 million in Toronto's urban forest, a steady annual increase from 2008 to 2018.
- Toronto's urban forest provides the equivalent of at least $60 million in ecological services each year. The benefits derived from the urban forest significantly exceed the annual cost of management.

MORE INFORMATION:

- https://www.itreetools.org/documents/349/Toronto_Every_Tree_Counts.pdf
- https://www.toronto.ca/legdocs/mmis/2020/ie/bgrd/backgroundfile-141364.pdf

MUNICIPALITY:	City of Port Moody, BC
PROJECT:	Newport Village
TYPE:	Semi-natural and human made
DATE:	1993-2004
APPROACH:	Aesthetic: green infrastructure attracts customers

Newport Village is a dense, suburban, master-planned green field neighbourhood developed by Bosa Development. It is a mixed-use, pedestrian-oriented development with residential, retail, and commercial space. The public realm includes wide sidewalks, street trees, unit pavers, outdoor seating areas, and green space. Outdoor areas provides eyes on the street and trees provide a buffer between pedestrians and traffic, promoting safety of residents and visitors. Attractive green spaces also draw retail customers and increase access to nature for residents.

- Newport Village has a high representation of young families.
- Newport Village is connected to other neighborhoods by a pedestrian network, an interlinked system of trails, streets, sidewalks, green spaces, and rest areas.
- Planners and architects tour Newport Village to learn from the development's success.

MORE INFORMATION:

- https://www.coquitlam.ca/docs/default-source/community-planning-documents/Commercial_and_Housing_Choices_Tour_Booklet.pdf
- https://www.portmoody.ca/en/Business-and-Development/resources/Documents/Official-Community-Plan.pdf

MUNICIPALITY:	City of Burnaby, BC
PROJECT:	UniverCity
TYPE:	Natural, semi-natural, and human made
DATE:	1995-present
APPROACH:	A variety of green infrastructure contribute to an attractive community

Adjacent to Simon Fraser University's Burnaby Mountain campus, UniverCity is a complete community consisting of multiple sustainable, mixed-use neighbourhoods with shops, services, a grocery store, educational facilities, and access to nature. Atop a forested mountain, UniverCity has several environmental considerations, such as watercourses, significant trees, and wildlife habitat. To meet environmental standards, UniverCity has setbacks from watercourses, street trees, native species landscaping, parkland preservation, rain gardens, and rooftop gardens, which are green infrastructure that offer services including water retention and filtration, habitat preservation, recreational opportunities, and forested aesthetics for the mountaintop community.

- UniverCity residents are surveyed about their experience every two to three years. According to the most recent survey, over 90% of residents are aware of sustainability features in the community and would recommend living there to their friends.
- Planning and development of UniverCity is overseen by SFU Community Corporation. Although the land is under SFU ownership, fully serviced and subdivided parcels are available to developers through 99-year lease agreements.
- Each development site is required to infiltrate and detain rainwater to specified standards, and to monitor and report how the systems are functioning for at least two years.
- On private property, significant trees identified for retention, greenways and riparian corridors are protected by covenants held by SFU Community Trust and/or the City of Burnaby.
- As UniverCity continues to develop, the community continues to implement current green technologies and principles and supports research about affordable sustainable development.

MORE INFORMATION:

- http://univercity.ca/planning-development/
- https://www.sfu.ca/content/dam/sfu/fs/files/Stormwater%20Management%20Strategy.pdf
- http://univercity.ca/wp-content/uploads/2019/03/B972-UniverCity-Community-Survey-REPORT-Mar-8.pdf

Community Health, Social Vitality, and Wellbeing

Green infrastructure, especially engineered solutions in urban areas provide increased livability. Connectivity and access to green space, and design that includes ecosystem features and green design contribute to vibrant cities, neighborhoods, and sites (i.e. "City Green" or "Smart Growth on Ground" Green Design Principles and Best Practices). This is especially important in a time when communities are looking at upstream, or preventive, solutions to address the social and environmental factors that negatively impact health, especially for communities most impacted by poor health outcomes.

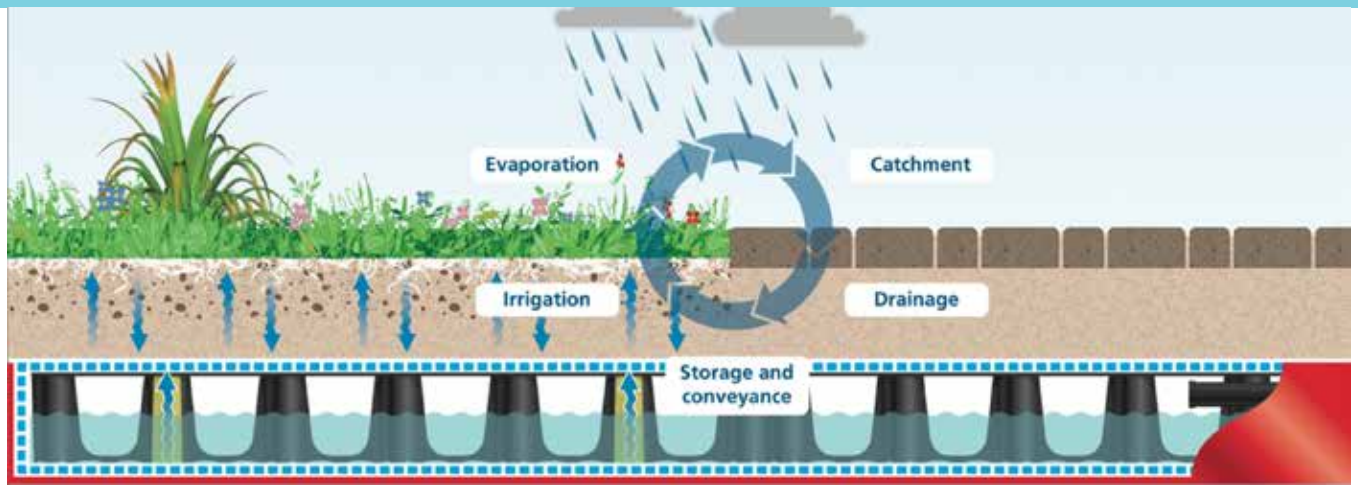
MUNICIPALITY:	City of Seattle, Washington
PROJECT:	Barton Roadside Rain Gardens
TYPE:	Human made
DATE:	2016
APPROACH:	Incentivize residents to implement green infrastructure

Fifteen blocks of rain gardens were completed in the Barton neighbourhood in 2016. The project was coordinated by King County's Wastewater Treatment Division. This area was chosen because it contributes significantly to the overflow problem and have planting strips that can accommodate a green infrastructure retrofit. Residents were encouraged to voluntarily install rain gardens or cisterns. At the time of construction, RainWise rebates were available to cover up to 100% of the installation cost. Since this pilot project, 93 roadside bioretention facilities have been built in the Sunrise Heights and Westwood neighborhoods.

- Co-benefits of the neighborhood rain gardens include traffic calming, improved streetscape aesthetics, reduces heat island, reduction in energy use to pump stormwater, preserved pipe capacity/climate resilience, carbon sequestration through composted soils, recharged groundwater, and educational value.
- The Barton rain gardens project was covered by a $22,099 RainWise rebate.
- The estimated cost per gallon of water managed for Bioretention Green Infrastructure is approximately $0.50 to $1.30 USD of capital investments and $0.009 to $0.012 USD for operations and maintenance.

MORE INFORMATION:

- https://www.seattle.gov/Documents/Departments/OSE/GSI_Strategy_Nov_2015.pdf
- https://www.kingcounty.gov/~/media/depts/dnrp/wtd/capital-projects/COMPLETED/BartonCSO/docs/1710_BartonCSOnews.ashx?la=en



MUNICIPALITY: City of Amsterdam, North Holland

PROJECT: Marineterrein – Navy Yard Blue-Green Roof

TYPE: Human made

DATE: 2015

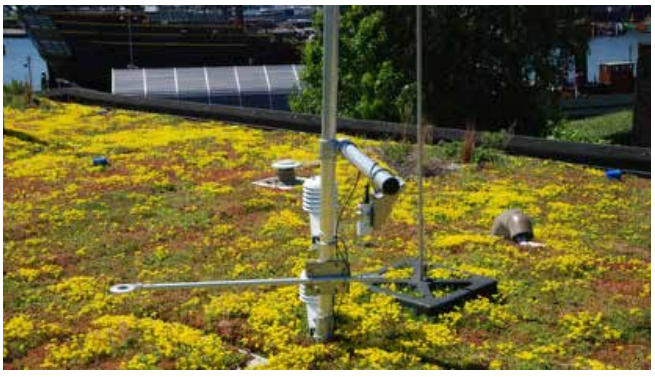
APPROACH: Innovate a specific type of green infrastructure

Marineterrein (Navy Yard) is a historic 13-hectare area close to the Central Station in Amsterdam. Since 2015, the area has been gradually opening up to the public and will be transformed into a future-proof city quarter. The roof of Building 002 has been retrofitted with a blue-green roof system that captures and stores rainwater. The roof system, Smartroof 2.0, consists of an 85 mm thick hollow drainage layer located directly under the planted soil layer that provides rainwater storage. This hollow drainage layer is comprised of lightweight recycled plastic drainage units called permavoid units that are fitted with special fibre cylinders. The fibre cylinders utilize capillary action to transport water to the upper soil layer to naturally irrigate the plants without the use of pumps, hoses, valves or energy.

- The project aims at demonstrating and scientifically validating function and value of the combination of *Blue* (rainwater catchment, storage and reuse) and *Green* (biodiverse) roofs for resilient and climate adaptive cities, not for the future, but for today.
- Smartroof 2.0 is an important international research roof.
- Benefits of the roof include plant evaporation that is equal to that of normal forests and fields, energy efficiency, cooling and reducing rainwater in sewers.
- 42 different types of insects were found on the new roof in just 24 hours.
- The project was partly funded by the Top Consortia for Knowledge and Innovation of the Ministry of Economic Affairs and Climate.
- According to another company based out of Amsterdam, De Dokdokters, living roofs may cost between $50 and $250 CAD/$m^2$ to install.

MORE INFORMATION:

- https://openheritage.eu/wp-content/uploads/2018/11/15_Open-Heritage_Amsterdam_Observatory-Case.pdf
- https://en.projectsmartroof.nl/
- https://www.marineterrein.nl/en/project/project-smartroof-2-0/
- https://www.marineterrein.nl/en/smart-roof-2-0/



Ecological Health

Green infrastructure is the foundation of maintaining healthy eco-systems and bio-diversity in urban, semi-urban and rural areas. Benefits are recorded at the bio-regional level, the City, within watersheds, neighborhoods, streets, and at the site level. Maintaining healthy eco-systems also benefits food gardens and pollinator species, creates green corridors for wildlife, and allows access to green space for citizens.

MUNICIPALITY:	City of Vancouver, BC
PROJECT:	Hinge Park Engineered Wetland
TYPE:	Semi-natural
DATE:	**2010**
APPROACH:	Restore natural areas

The land along South East False Creek and Hinge Park are formerly marine estuarine wetlands but was later contaminated by industrial uses. The wetland is lined in order to cap the contaminated soil and protect surface water and vegetation and a daylighted storm sewer collects the majority of rainwater runoff from streets on the west side of the site and treats it by filtering it through vegetation in the Hinge Park wetland. The engineered wetland has songbird houses and places where kids can climb on rocks and poke around in the mud. Storm water is used to irrigate and supply water for the sites features. Bridges and stepping stones are placed to stimulate creative play even while they satisfy visual and functional values. Wildlife habitat, natural play and aesthetic values are interwoven in the design fabric.

- The remediation of the previously contaminated site supports a notable increase in biodiversity, including bald eagles and herring.
- The park is a popular natural and green oasis in the City, increasing people's access to green space.
- The park had a $6 million CAD budget.

MORE INFORMATION:

- http://courses.be.uw.edu/SDMasterStudio/wp-content/themes/gehl-studio/downloads/Autumn2011/A11_SEFalseCreek_HingePark.pdf
- https://sustain.ubc.ca/sites/default/files/2017-36_Lessons%20Learned%20-%20Rainwater%20Mgmt%20Strategies%20in%20OV_Luker.pdf

MUNICIPALITY:	City of Surrey, BC
PROJECT:	Green Infrastructure Network
TYPE:	Natural
DATE:	2011 - present

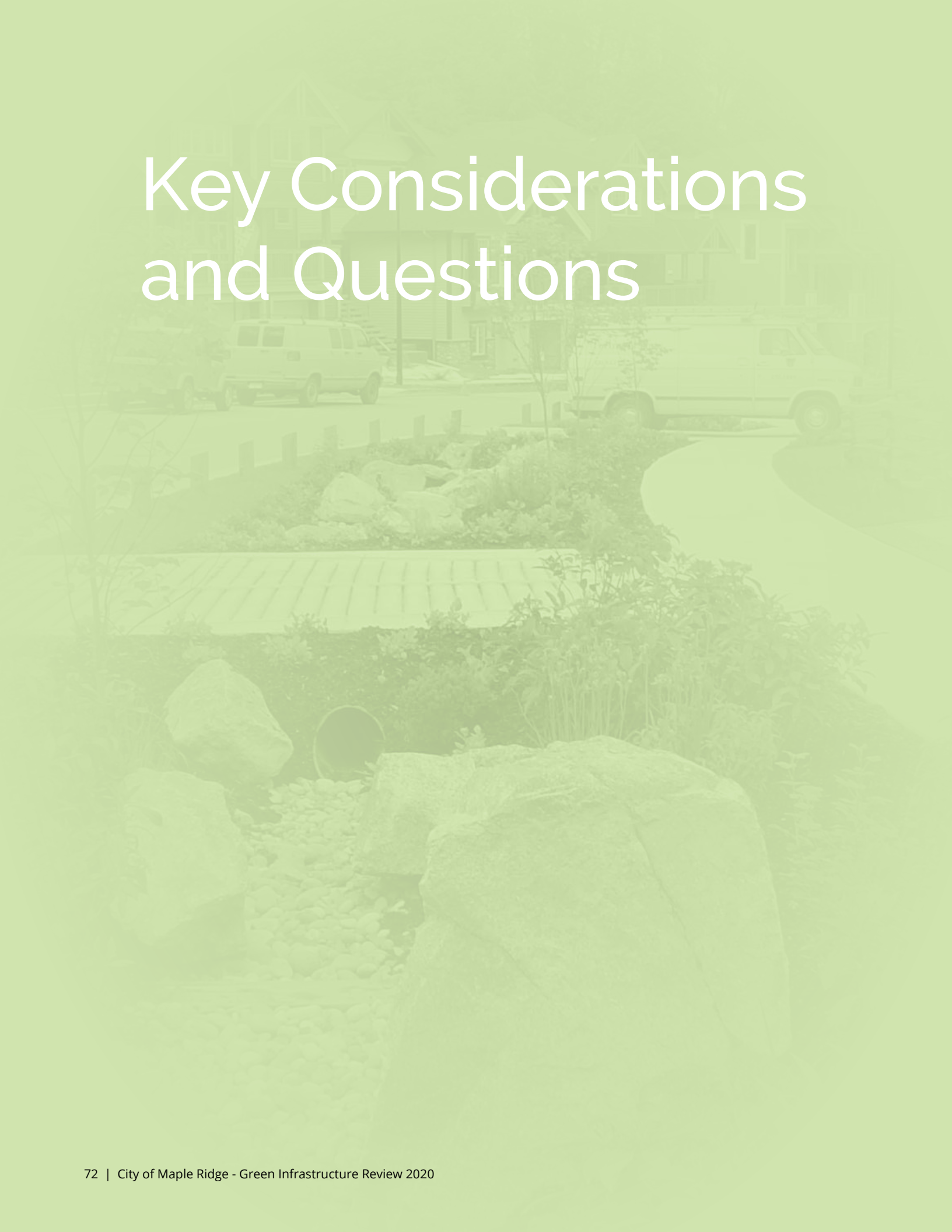
Surrey is connected by a Green Infrastructure Network ("GIN"). The GIN is approximately 3900 hectares of interconnected natural areas, green corridors, and open space that conserves ecosystems and functions, while providing benefits to both wildlife and people. The GIN identifies the pieces of the habitat puzzle necessary to maintain biodiversity values across the City, including backyards, boulevards and urban forests to wetlands, rivers, and shorelines. Approximately 6,675 hectares of the GIN is already secured through direct land dedication (e.g. parks) or other land use planning tools. For the GIN to achieve its intended benefits, a remaining 1,216 hectares will need to be protected or acquired.

- The GIN evolved out of Surrey's 2011 Ecosystem Management Study and the BCS' Habitat Suitability map. Maintaining the GIN ensures the City can conserve diverse ecosystems and the services they provide for the long-term, which in turn benefits wildlife and people alike.
- GIN used GIS mapping to identify ESAs, ecosystem features, and green spaces within the City. This study also analyzed the relationships and spaces between these assets with the intent to create a GI network of 'hubs, corridors and sites', and its relationship to the larger regional network.
- The BCS also supports and builds on other existing City policies, including the Official Community Plan, the Sustainability Charter, Climate Adaptation Strategy and Parks, Recreation and Culture Strategic Plan.
- The GIN uses direct land dedication with some funding acquired through DCCs, park dedication, and provincial ALR lands (on-farm conservation leases and stewardship activities).
- The GIN includes monitoring based on a list of indicator species, engagement of residents, businesses, staff and visitors to add biodiversity observations using online tools, and partnering with local organizations as stewards of greenspaces.
- The GIN is supported by OCP policies and complementary protections, such as an Environmental Development Permit Area (DPA) designation.

MORE INFORMATION:

- https://www.surrey.ca/city-services/11565.aspx
- https://www.surrey.ca/files/BCS_GIN_Map_8X11.pdf
- https://www.vaughan.ca/services/business/urban_design/General%20Documents/VMC%20Streetscape%20and%20Open%20Space%20Plan%20-%20May%202018-reduced.pdf

Key Considerations and Questions



Below is a list of questions that will be helpful to work through as the City of Maple Ridge undertakes its own process towards incorporating more green infrastructure into future development and planning.

- What information do we need to help us move forward, establish important baselines, performance targets and objectives, measure or monitor successes/losses, benefits and costs?
- Are there efforts that we can take in the short term that can have multiple co-benefits for each of these categories with reasonable start-up costs and benefits?
- Are there opportunities for working with "low hanging fruit" in our community in terms of existing or potential available resources, initiatives, and information?
- Are there certain areas that we cannot afford to neglect because of potential/pending impacts or costs to the community?
- What are the potential challenges, opportunities or possible co-benefits, and implications for the City, for various departments, developers, citizens?