City of Maple Ridge

GREEN INFRASTRUCTURE REVIEW

MAPLE RIDGE
British Columbia

Contents

Green Infrastructure Background

What is green infrastructure?

GREEN INFRASTRUCTURE refers to the natural vegetation, soils, and bioengineered solutions that collectively provide a broad array of products and services for healthy living. Natural areas such as forests, wetlands and floodplains, and engineered systems like green roofs and rain gardens conserve natural resources and mitigate negative environmental effects, benefiting both people and wildlife. When green infrastructure is connected as part of a larger framework, a green infrastructure network is created.

– Metro Vancouver, Connecting the Dots, 2014

Top: traffic bulge, CCbync Dylan Passmore; middle: bioswale, CCbyncnd Thomas Le Ngo; bottom: permeable paving, CCbyncsa Travis Estell.

Why is green infrastructure important?

Municipalities use green infrastructure to manage stormwater, increase the livability, vibrancy and health of urban spaces, maintain wildlife habitat, and create resilience to climate change.

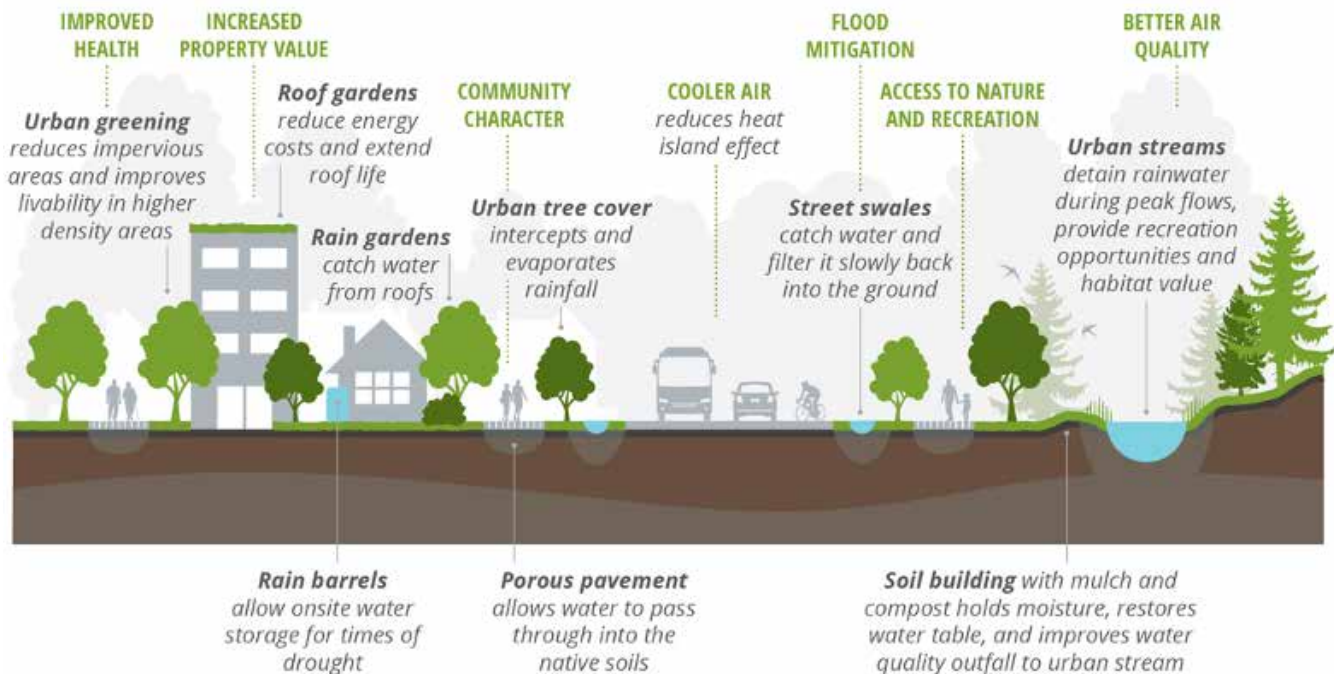## CLIMATE CHANGE RESILIENCE AND STORMWATER MANAGEMENT

Conventional drainage and water treatment systems are designed to move urban stormwater away from the built environment. Green infrastructure reduces and treats stormwater at its source and has been shown to be a cost-effective, resilient approach to managing wet weather impacts, both as support to grey infrastructure or as a stand-alone system. In particular for higher density, urban areas, green infrastructure can effectively minimize the volume of water flowing into municipal systems while reducing the risk of flooding and improving the water quality of run off, maintaining the health of receiving streams and waterbodies (Asadian et al., 2009; Berland et al. 2017). Research shows that **green infrastructure often yields higher net environmental and economic benefits than grey infrastructure**, especially in light of climate change (Vineyard et al., 2015; Daigneault et al., 2016). For example, in a typical grey urban watershed, unfiltered stormwater quickly runs off impermeable surfaces and into streams, which can overflow, making the area less habitable. In a green urban watershed, stormwater is retained, absorbed, stored, and filtered before entering a stream, leading to less flooding and more habitable areas. These ecosystem services are key to supporting community resilience to climate change (manage shorelines, reduce flood risk, mitigate temperature highs, etc.) (Green et al., 2016; Barron et al., 2019).

HEALTH AND SOCIAL BENEFITS

At the same time, communities are also looking for solutions to address the social and environmental factors that negatively impact the health and well-being of residents, especially those most impacted by poor health outcomes. Promoting health and improving health equity can reduce health care costs and improves the health and well-being of residents (Oregon Green Infrastructure and Health Care Guide, 2018).

A focus on developing a "green network", including both urban and natural areas, **improves residents' wellness through increased opportunities for physical activity, better mental wellness with time spent in green space, more aesthetically**

IMPROVED HEALTH

INCREASED PROPERTY VALUE

Urban greening reduces impervious areas and improves livability in higher density areas

Roof gardens reduce energy costs and extend roof life

Rain gardens catch water from roofs

COMMUNITY CHARACTER

Urban tree cover intercepts and evaporates rainfall

COOLER AIR reduces heat island effect

FLOOD MITIGATION

ACCESS TO NATURE AND RECREATION

Street swales catch water and filter it slowly back into the ground

BETTER AIR QUALITY

Urban streams detain rainwater during peak flows, provide recreation opportunities and habitat value

Rain barrels allow onsite water storage for times of drought

Porous pavement allows water to pass through into the native soils

Soil building with mulch and compost holds moisture, restores water table, and improves water quality outfall to urban stream

pleasing neighbourhoods and improved air quality (Van den Berg, 2010). Another proven health benefit of green infrastructure is a reduction of the urban heat island effect in more dense urban areas, which reduces the impact of heat on human health (e.g., through tree canopy shading) (Edmondson et al., 2016; Shisegar, 2014). Promoting health equity through green infrastructure projects in underserved communities offers possible opportunities for engagement, learning, strengthening relationships, new partnerships, and improvements to the look, feel and health of the community (Braveman et al., 2017; Jenerette et al., 2011).

ECONOMIC BENEFITS

Along with health benefits, green infrastructure adds to the "look and feel" of the built environment. Green neighbourhoods become more attractive places to live and green infrastructure in retail or commercial areas are transformed to interesting destinations. This in turn, can increase visitor and resident traffic. Communities worldwide have benefited from the economic value of green infrastructure. **It can serve as a way to regenerate neighbourhoods, increase property values**

and capture economic activity (Kramer, 2014; Space, 2005; Wolf, 2016).

GREEN INFRASTRUCTURE LEVERAGES TAX DOLLARS TO DELIVER MULTIPLE BENEFITS AND AMENITIES

Green infrastructure offers co-benefits, in that, a green infrastructure project will fulfill more than one priority area. For instance, a municipality may undertake street upgrades (e.g., new corner bulges, sidewalk improvements) in an urban commercial area and then include street swales to manage stormwater runoff. This effectively manages stormwater during typical rain events and holds back water runoff in large rain events, thereby **reducing the need for the City to further increase the capacity of the municipal stormwater system** (a much larger and costly undertaking). The process of doing this creates a more aesthetically pleasing streetscape (e.g., planted swale) that builds character of the commercial area, contributes to the health and well-being of residents, and in the process, **attracts residents and visitors generating additional economic activity of small businesses in the area.**

Green Infrastructure Opportunities

Green infrastructure includes a range of opportunities for municipalities. These can range from natural to bio-engineered solutions.

NATURAL GREEN INFRASTRUCTURE

Natural green infrastructure generally includes a municipalities existing natural assets, such as natural open spaces, forests, streams and watercourses, riparian areas, etc. as well as formal park spaces, greenspaces, and/or other green elements within a City, such as street tree canopy, greenways, etc. These areas provide "eco-system services" to the City such as water purification, air quality, space for recreation, and climate impacts mitigation. Several municipalities in B.C., for example, Gibsons and the District of West Vancouver have not only built an inventory of assets and developed protection for natural assets and have begun to include these within the City's annual financial planning and reporting.

BIO-ENGINEERED GREEN INFRASTRUCTURE

Bio-engineered solutions are the built infrastructure that incorporates living or "green" elements (such as a bio-retention pond or rainwater gardens). These are elements that are specifically designed to mimic natural systems (for example, permeable paving) to achieve the benefits these systems provide. These solutions are integrated into existing features of the built environment, including buildings, streets, parking lots, and other landscaped areas. Such options are increasingly used and especially beneficial for managing stormwater within new development and redevelopment/infill situations where density is desired and offsite mitigation is not possible.

At a City-wide scale, green infrastructure includes a range of projects from natural to more bio-engineered solutions. The diagram shows some of the most common green infrastructure opportunities available to municipalities (below).

Figure courtesy of Metro Vancouver – Connecting the Dots, 2014

Green Infrastructure Comparative Review

What is happening at the regional level?

Metro Vancouver's current Regional Growth Strategy, Metro 2040*, does not include specific green infrastructure requirements for municipalities. However, Metro 2040 does require municipalities to do the following which relate directly to green infrastructure:*

- Adopt Regional Context Statements that:

  – include land use policies to support the protection of and, where appropriate, buffer Conservation and Recreation areas that are consistent with the supply of high-quality drinking water, environmental conservation, recreation, education, commercial uses, tourism, cultural amenities, and agriculture

  – identify land development and transportation strategies and policies and/or programs that reduce energy consumption and greenhouse gas emissions, and improve air quality from land use and transportation infrastructure;

- Indicate how ecologically important areas and natural features will be managed;

- Develop and manage municipal components of the Metro Vancouver Regional Recreation Greenway Network and connect community trails, bikeways, and greenways to the Regional Recreation Greenway Network where appropriate;

- Implement land use policies and development control strategies which support integrated storm water management and water conservation objectives; and,

- Coordinate priority actions to address vulnerabilities to climate change (e.g., flooding and sea level rise) including implementation and funding strategies.

Metro Vancouver provides guidance on developing the regional green infrastructure network in the report entitled *'Connecting the Dots'* (2014). This guide describes the breadth of green infrastructure types, notes the benefits, and justifies initial and ongoing costs associated with green infrastructure. The guide also demonstrates how municipalities are successfully implementing green infrastructure across various land uses and scales and supports the development of other green infrastructure-promoting policies.

Metro Vancouver's *Climate 2050 Strategic Framework* states that green infrastructure will play a key role in supporting communities across the region in mitigating, adapting to, and preparing for climate change.

As a member municipality, the City of Maple Ridge sits on multiple Metro Vancouver Committees, including Climate Action, Regional Planning, and Water. As a member of these committees, Maple Ridge provides advice and recommendations on policies, bylaws, plans, programs, budgets and issues related to the Air Quality and Climate Change service, the Environmental Planning function, Metro Vancouver's Regional Planning service, and water management within Regional Planning.

What is happening in Maple Ridge?

The City of Maple Ridge is well positioned to benefit from a green infrastructure management strategy. There are a number of existing intiatives and work of which the City can effectively build on.

Context

From 2016 to 2017, the City of Maple Ridge saw a 3.4% increase in growth, followed by an increase of 2.5% in 2018 and 0.6% in 2019. Currently, the City of Maple Ridge's population is estimated at just over 91,000 residents, with a projected growth to 132,000 by 2040. Continued growth increases development pressure and the need to accommodate more housing and amenities to serve residents. With new growth and development, can be fragmentation of landscape and impacts on ecological health. With infill and densification, development needs to address livability, human health, and wellbeing. These cumulative impacts, along with global influences and issues such as resiliency to acute events and climate change, are increasing concerns about storm events, flooding, drought, etc. While the City is already taking steps to address these challenges, green infrastructure offers opportunities to further strengthen and enhance this work, achieving multiple benefits and efficiencies.

Core Regulatory and Policy Drivers

Green infrastructure can support Maple Ridge in achieving many of the City's strategic priorities and objectives. For example, green infrastructure promotes safety and wellness, supports place-making, protects natural assets, greens neighbourhoods, offers job opportunities, and increases environmental education opportunities and awareness.

Primary regulatory and policy drivers in Maple Ridge that green infrastructure supports include:

• Council's Strategic Priorities;

• Maple Ridge Official Community Plan objectives, and;

• Maple Ridge Environmental Management Strategy priorities.

Current Green Infrastructure Related Works

The City of Maple Ridge does not currently maintain a specific strategy for green infrastructure or policy that outlines and supports a green infrastructure network. However, listed here, are a number of assets and ongoing initiatives happening in the City related to green infrastructure and that could easily become the building blocks for a green infrastructure strategy and/or a green infrastructure network. These initiatives are sorted into those that focus on the protection of natural features and spaces (green), greenfield development (blue), and urban infill (dark blue/purple).

CITY-WIDE INITIATIVES

NATURAL FEATURES	
	Conservation Land Acquisition Partnerships with Metro Vancouver, the City, and landowners working together to set aside priority conservation lands for significant natural areas and assets (Blaney Bog, Codd Island Wetlands, North Alouette Greenway, Kanaka Creek Regional Park).
	Community Ecosystem Restoration Initiatives – Municipal reforestation program replanting over 100,000 trees on public lands where dead, dying trees, or sparsely vegetated areas occur.
	Municipal Invasive and Noxious Weed Management Program
	Support for local stewardship groups that are involved with various programs related to enhancement, restoration, protection, and outreach related to green spaces – e.g., environmental stewardship, adopt a park, bear aware, school programs, tree replanting programs.

GREENFIELD DEVELOPMENT	
	Natural Features Development Permit Infill Guidelines and Zoning Bylaw Protection of steep slope areas, natural hazard areas, and hillside areas for all new development via Development Permits.
	Watercourse Protection Bylaw (2006) and the Subdivision and Development Servicing Bylaw (2019) requirements for developers to provide on-site source controls for stormwater management, erosion control, and water quality control on all new developments.
	Watercourse Protection Regulations (SPR) and Watercourse Protection DP Guidelines to provide larger riparian protective buffers and enhancement restoration opportunities across the municipality through new development.
	Street Tree Planting Program along municipal road ROW areas through new development applications and servicing requirements.
	OCP Land Use Planning Policy and Natural Features Section, Area Plans (Silver Valley), Town Centre/Transit Corridor Areas and Smart Growth Strategies emphasizing ecological planning-based approach and smart growth approach for new area plans.
	Tree Protection and Management Bylaw emphasizing requirements for tree canopy cover performance targets, retention plans, and replacement strategies.

URBAN INFILL	
	Pilot studies related to innovative methods for the inventory of municipal trees and evaluation of benefits/services/losses associated with urban forests using iTree software in collaboration with BCIT, UBC, and SFU.
	Recent and ongoing updates for urban infill areas - Form and Character DP Guidelines with consideration for more sustainable practices, in addition to Town Centre Visioning exercise.

There are also other department lead initiatives that relate to green infrastructure. These initiatives span a gradient from nature-based (green) to engineered (purple) solutions.

DEPARTMENT SPECIFIC INITIATIVES

NATURE-BASED

Municipal Parks Management Plan to ensure appropriate active park areas at various scales and locations across the community including municipal wide network of community greenway trail corridors

Municipal Integrated Stormwater Management Plans for different watershed areas

Pending Step Code for Building Dept. and energy conservation best practices

Corporate Sustainability program for energy conservation and GHG reduction

Support for Downtown beautification program for Chamber of Commerce/ Business Improvement Program

Sorting existing green infrastructure-related initiatives in Maple Ridge emphasizes that the City has taken opportunities to capture the benefits of green infrastructure through environmental conservation and some greenfield development but has committed less tools and management to address green infrastructure through urban infill. As green infrastrcuture often serves many objectives, a cross department collaboration may be required to achieve effective implementation and maximize those benefits that green infrastructure offers.

While the City has much to build from, the following list outlines some existing challenges associated with the implementation of green infrastructure.

CHALLENGES

- Inventory, monitoring and evaluation of existing assets (in order to assign value)

- Need for established metrics for valuation of natural assets and performance

- Need to establish green infrastructure targets for on site water, energy, access to green space and servicing requirements (i.e. stormwater), in particular with new and/or higher density development

- Understanding existing financial opportunities, and budget allocation

- Understanding future impacts of not incorporating green infrastructure with new development - and its cost to residents in the long-term

- Ensuring that green infrstructure maximizes benefits to the development community and future residents/taxpayers

- Understanding lifecycle and maintenance costs of physical infrastructure and green infrastructure

- Addressing gaps in industry and in-house knowledge, skills, abilities and resources

- Coordination of departments prioritization and public/private sector

Such challenges must be taken into account within a green infrastructure management strategy.

What are other municipalities doing?

A number of municipalities in the lower mainland and throughout North America have developed specific strategies and plans for green infrastructure.

Below is a comparison of different municipalities' approaches to green infrastructure. Case studies for some of these muncipalities and strategies are provided (*starting on page18*).

Common tools that municipalities use to promote green infrastructure include green infrastructure-specific frameworks, regulations to shape developments, incentives to encourage private green infrastructure development, documenting and analyzing the benefits of existing natural features, and educating and engaging with the public. Green infrastructure-leading municipalities typically use a combination of these tools.
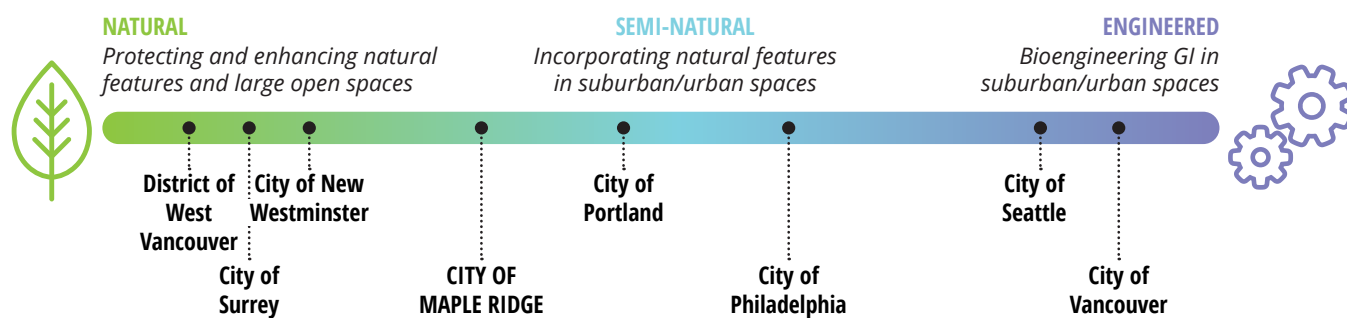
FIGURE: *Comparison of green infrastructure focus areas within other municipalities in the region and North America and whether there was a public engagement component. Note: Table shows where municipalities maintain specific strategies and management plans.*

MUNICIPALITIES & STRATEGIES	GREEN INFRASTRUCTURE - FOCUS AREAS				
	Natural Assets Valuation	Bio-Diversity & Conservation	Urban Forestry & Management	Stormwater/ Rainwater	Education/Awareness & Public and Stakeholder Engagement with GI
Town of Gibsons	✔				✔
City of Vancouver*		✔	✔	✔	✔
District of West Vancouver	✔				
City of New Westminster*		✔	✔		✔
City of Surrey*		✔	✔	✔	✔
City of Seattle			✔	✔	✔
City of Portland			✔	✔	✔
City of Philadelphia				✔	✔

* Municipalities interviewed as case studies for this report for additional information.

Types of green infrastructure cover a broad gradient from maintaining natural features (e.g. natural open spaces) to bioengineering (e.g. green roofs). Different municipalities focus on implementing different types of green infrastructure depending on their context. For instance, the District of West Vancouver has many natural spaces and focuses on natural assets, while the City of Vancouver is highly developed and focused on engineered solutions. Currently, the City of Maple Ridge has focused on projects that are classified as natural green infrastructure (e.g. parks) and semi-natural green infrastructure (e.g. street trees). To date, Maple Ridge has focused less on green infrastructure types that are suitable for densifying, developed areas.

FIGURE: *Gradient of the types of green infrastructure other municipalities are implementing and where Maple Ridge currently sits on the gradient.*

NATURAL
Protecting and enhancing natural features and large open spaces

SEMI-NATURAL
Incorporating natural features in suburban/urban spaces

ENGINEERED
Bioengineering GI in suburban/urban spaces

District of West Vancouver

City of New Westminster

City of Surrey

CITY OF MAPLE RIDGE

City of Portland

City of Philadelphia

City of Seattle

City of Vancouver

District of West Vancouver - West Vancouver Natural Capital Study

APPROACH: Not outlined specifically as a green infrastructure strategy, but initiated in 2019 and lead by the director of Financial Services, this study was to create an initial high level inventory of natural capital. The intent was to better inform decision making (land use, development, etc.) raise public awareness, start the conversation, and anticipate challenges for additional green infrastructure in the District.

FRAMEWORK FOR THE STUDY: Assets were identified, mapped, and defined in categories including the resulting eco-system services offered by each – forests (water filtration, clear air, carbon sequestration), waterways (stormwater management, habitat), foreshore (erosion control, recreation), parks and open spaces (carbon sequestration, recreation/well-being).

HIGHLIGHTS:
- When the District began the work, there were no bylaws or policies directly related to the valuation of natural assets, however, the District did have many bylaws which contained provisions to protect natural features.

- The District is beginning with natural assets and engaging staff to develop the process and have set up an advisory panel to guide the study.

- This study focuses on the development of methods to value the assets and their service value offered. Valuation methods include: avoided cost, contingent value, hedonic pricing, opportunity cost, travel cost, replacement cost, and production.

- The study also outlines issues and implications and focus areas for each asset.

- Valuation of natural assets will be included in the District's financial planning asset management, financial reporting, and captial budgeting processes and decisions.

SUMMARY OF ASSET VALUES OUTLINED IN THE DISTRICT OF WEST VANCOUVER, 2019 PRELIMINARY INVENTORY

Natural Capital Asset Class	High Estimate annual service	High Estimate Asset
Upper Forest	$37,197	$1,239,911
Urban Forest	$18,200	$606,662
Total waterways (including riparian buffer)	$17,218	$573,935
Total Foreshore	$16,487	$549,539
Total Grasslands	$487	$16,237
Total Carbon Storage - forest, soils	n/a	$228,842
TOTAL		$3,215,175

KEY LESSONS FOR MAPLE RIDGE
- *Frame the approach - natural assets have the capacity to provide better services, at lower cost, and over longer period than constructured assets, with little or no replacement cost, and may even appreciate, rather than depreciate, over time. Maintainance costs can be lower, and they provide aesthetic values for residents too.*
- *Ensure there is good data. Create an inventory and map of natural assets with areas and service values.*
- *Involve Finance department (as lead or co-leads to the work).*
- *Natural assets are not constrained by municipal boundaries.*
- *Development pressure creates conflicts of use, look for ways to place value on natural assets in the process.*

City of Vancouver - Vancouver Rain City Strategy

RAIN CITY STRATEGY

APPROACH: Rain Water Management, base of the goals of Resilience, Water Quality and Liveability

MEASURABLE OBJECTIVES: Remove pollutants from water and air, reduce water entering pipes, harvest and reuse water, increase total green space, increase managed impermeable area, mitigate urban heat island effect

IMPLEMENTATION: The Rain City Strategy sets out a framework for green infrastructure which includes a set of directions and action plans specific to priority areas and across different departments within the City.

PROJECTS AND INITIATIVE AREAS: Streets, Parks, New Development (high to low density)

HIGHLIGHTS:
* The Strategy includes quantitative targets and design standards:
  – To capture (infiltrate, evapotranspiration, and/or reuse) and clean (treat) a minimum of 90% of Vancouver's average annual rainfall volume (long term);
  – To manage urban rainwater runoff from 40% of impervious areas in the city by 2050 (30% of this total would be achieved by including rainwater management, where feasible, as a standard practice in new capital projects in the public realm and through regulation for new developments in the private realm; the remaining 10% of the total would be achieved through targeted retrofits in the public and private realm);
  – Capture (infiltrate, evapotranspirate, or reuse) and clean 48mm of rainwater per day in – streets and public spaces, civic facilities, and parks (already adopted);
  – Capture and clean 48mm of rainwater per day in private property (adopted for private sites by 2022); and,
  – The design standard is applied at the project, site or district scale whenever rainwater management objectives are included as part of a project scope.

* The Strategy divides the City up by urban watersheds, using watershed mapping and analysis of the following key aspects as the foundation for prioritization of projects and needs for each area.
  – Urban heat
  – Combined sewer overflows
  – Sea-level rise vulnerability
  – Highly impervious areas
  – High pollutant load areas
  – Tree canopy

* Includes cost-benefit analysis

* Initial start-up funding of $70 million for several programs within the action plans has been identified within existing 2019-2022 Capital Plan and operating budgets.
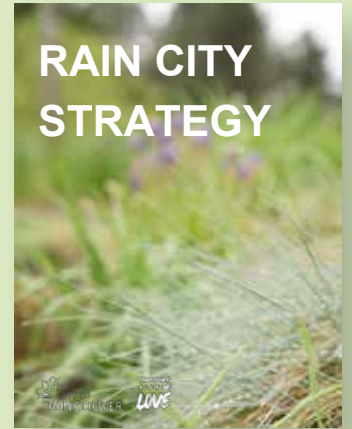
KEY LESSONS FOR MAPLE RIDGE
* *Determine financial mechanisms to help support operations and maintenance of existing green infrastructure assets, such as integration in street redevelopments (e.g. drainage design), use of Utility Development Cost Levys to fund new assets, or incorporate green infrastructure features as part of new developments (e.g. boulevard restoration).*
* *Determine what department 'owns' green infrastructure assets and financial responsibility.*
* *Identify where green infrastructure can complement existing systems, help diversify drainage infrastructure and help save costs overall.*

City of Surrey – Biodiversity Conservation Strategy

APPROACH: Biodiversity Conservation

GOALS: Conserve nature in the urban environment, reduce the City's ecological footprint, embrace economic, social, and cultural benefits

OBJECTIVES: Protect critical habitat features, enhance habitat connectivity, maximize the size of core natural areas, improve habitat quality, research, education and public awareness, regulations, community action, maximize ecosystem services.

IMPLEMENTATION: As part of the City's land use and development, the strategy aims to conserve as much habitat as possible to support biodiversity within the rapidly growing city. The Green Infrastructure Network connects habitat hubs, corridors, and urban green infrastructure across the city and was planned in 2011 based on wildlife behaviour, development, greenways, protected areas, and cost/benefit analysis.

PROJECTS AND INITIATIVE AREAS: Parks, Agricultural Land Reserve, riparian and shore areas, yards, streets

HIGHLIGHTS:
- The City created a full time position (an RPBio) to implement the strategy.

- The Strategy includes an in-depth study of habitat types and availability in the city, local species, and species biodiversity rankings. One tool used for this study was i-Tree.

- The Strategy identifies different management areas based on land classification and outlines applicable objectives, opportunities, and constraints of each area.

- The Strategy includes 20 management goals with criteria and measurable low to optimal indicators. Example optimal indicators include:
  – Increase biodiversity in built-up areas: the population of native bird species is >20% above baseline.
  – Increase public awareness of value of biodiversity: >300 visits per year; neighbourhood awareness of management issues and management actions in natural areas.

- The City is now looking to create a green infrastructure network tax to pay for green infrastructure components that aren't able to be captured in other ways (such as cash in leiu) and are exploring the idea of a stand alone development cost charge to be housed through parks.

- The City has also developed and piloted a green infrastructure network stewardship program for Agricultural Land Reserve lands (partnering with those groups already working with the agricultural community).

- The City includes biodiversity objectives within RFPs and leases of land.

KEY LESSONS FOR MAPLE RIDGE
- *Take a cross-departmental approach and ownership.*
- *Support the work with appropriate staff time and resources.*
- *Different green infrastructure tools are appropriate for the objectives, opportunities, and constraints of different areas.*
- *Consider implementing green infrastructure at different scales that form a network throughout the city.*
- *Develop measurable criteria to monitor change.*

City of New Westminster - Urban Forest Management Strategy

APPROACH: Urban Forest, Public Awareness and Education

FRAMEWORK FOR THE STRATEGY: Includes a vision, set of objectives, and goals. The Strategy doesn't specifically discuss green infrastructure although urban forestry is a tool/strategy to green infrastructure.

HIGHLIGHTS:
- The City took a leading role to develop an extensive public awareness program that included easily accessible graphic based information for the public and development community that identified how/what they can do to assist the strategy implementation.

- An emphasis was placed on internal department meetings and workshops (including those across the organization - i.e. operations staff, managers, etc.) were employed to overcome key challenges in the process

- Foundation mapping was undertaken to calculate the urban forest cover and include current statistics and measures on the urban forest with comparison to best practices and recommended targets for tree cover in other urban areas. This helped shape the story and value to the strategy.

- Compiled case studies for comparison to other municipalities in the Lower Mainland.

- The strategy identified a comprehensive set of 40 actions to reverse the current documented trend and provided measurable targets to increase the tree canopy cover from 18% to a target of 27%.
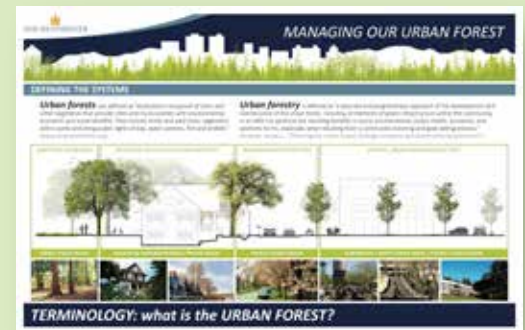
This equates to an additional 8,500 trees planted on public lands and 3,300 trees planted on private lands in order to meet the targets set out.

- As a result, updates were made to the OCP, tree bylaw, and a tree removal permit program established.

- An additional 7 new staff positions were created to implement various aspects of the management plan. An Arborist Technician - to lead the plan, two bylaw arborists within the buildings department, two climbing arborists, one auxillary position and a natural areas practioner.

- Working with the development community - a level of flexibility was built into the bylaw, allowing staff working with individual applicants to identify creative solutions that meet objectives of the strategy.

KEY LESSONS FOR MAPLE RIDGE
- *Community leadership with public/stakeholder awareness and education is a key step.*
- *Building ownership across departments and throughout the organization (including operations and those "on the ground") is required for successful implementation (i.e. department workshops).*
- *Support the strategy with the resources, staff, budgets.*
- *Ensure a good data set (to best explain the value) , develop an inventory of what the City already has and set measureable targets.*

City of Philadelphia – Green City, Clean Waters

APPROACH: Stormwater management

GOALS: Improvement of stream quality; aesthetics and recreation; preservation and enhancement of healthy living resources; improvement of wet weather water quality and quantity.

OBJECTIVES: Implement green infrastructure on public land, develop requirements and incentives for green infrastructure on private property, a large-scale street tree program, access to recreation along the waterfront, preserve open space, convert vacant land to open space or responsible development, restore streams, meet water quality standards.
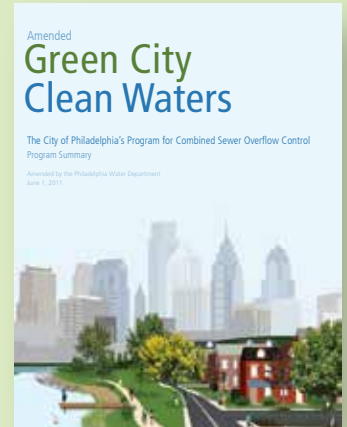
IMPLEMENTATION: The Philadelphia Water Department developed a 25-year plan to improve the health of the Cities watercourses and beautify neighbourhoods primarily through a land-based approach, which includes implementing opportunities such as rain increasing permeable surfaces, storage practices, green roofs, swales and increasing tree canopy. The plan is based on an analysis of the trade-offs between conventional "grey" infrastructure and green infrastructure, including affordability, scalability, meeting policy goals, public support, the provision of economic, social, and environmental benefits, and benefit accrual method.

PROJECTS AND INITIATIVE AREAS: Green streets, schools, public facilities, parking, open space, industry/business/commerce/institutions, alleys/driveways/walkways, and homes.

HIGHLIGHTS:
- The City of Philadelphia will invest $2billion over the next 25 years to implement green infrastructure citywide.

- Over the first five years Philadelphia's green infrastructure industry grew rapidly, the public invested in green infrastructure, the majority of projects focused in low-income neighborhoods, and that green infrastructure features increased housing values by approximately 10%.

- *A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds* (a 2009 assessment that informed the 2011 plan), found:
  - Increasing Low Impact Development, which includes GI, by 50% would result in a $2.85 billion net benefit (traditional grey infrastructure would result in a $0.12 billion net benefit).
  - GI can serve as a tool in poverty reduction by increasing access to jobs that require no prior experience.
  - GI enhances recreation, improves community quality of life, and reduces excessive heat.
  - GI improves air quality, saves energy, offsets climate change, and restores ecosystems.

- The plan includes watershed plans with specific implementation commitments.

Amended
Green City
Clean Waters

The City of Philadelphia's Program for Combined Sewer Overflow Control
Program Summary

Amended by the Philadelphia Water Department
June 1, 2011

KEY LESSONS FOR MAPLE RIDGE
- *Trade-offs between green and grey infrastructure must include, public support, the provision of economic, social, and environmental benefits, and benefit accrual method.*
- *Green infrastructure is multifaceted with many co-benefits, while grey infrastructure is often linear, focusing on one benefit.*
- *Investment in green infrastructure results in good returns for the City in the long term.*

City of Seattle – Green Stormwater Infrastructure in Seattle Implementation Strategy

APPROACH: Stormwater Management

GOALS: Manage 400 million gallons of stormwater annually

OBJECTIVES: Community benefits, climate change preparedness and mitigation, environmental equity, green economy access, tree canopy restoration.

IMPLEMENTATION: The Strategy targets retrofitting impervious surfaces to manage stormwater and deliver other community benefits. A Stormwater Code, which is administered by the Seattle Department of Construction and inspections and Seattle Public Utilities, guides retrofits on both public and private property.

PROJECTS AND INITIATIVE AREAS: Streets, parks, retrofits on private property

HIGHLIGHTS:

- Green infrastructure opportunities are guided by four funding types: required by Stormwater Code, utility-led and funded, utility incentivized, and non-utility-led.

- The Strategy includes detailed capital and ongoing maintenance and operations costing information, supporting detailed estimated budgets for projects over a five-year period.

- Efficiency is a key consideration in the strategy. Stormwater management green infrastructure tools are categorized by space efficiency, including strategies that manage run-off from impervious areas that are larger, equal to, and smaller than the green

infrastructure tool, emphasizing different solutions that are appropriate for different urban areas. The strategy also calculates the capital and ongoing costs of green infrastructure tools per gallon managed (e.g. bioretention has a capital cost of $0.50 - 1.30 USD and ongoing costs of $0.01 USD per gallon managed and street trees have a capital cost of $2.78 USD and ongoing cost of $0.76 USD per gallon managed).

KEY LESSONS FOR MAPLE RIDGE
- *The merits of incorporating* green infrastructure *in stormwater management are well documented.*
- *Some* green infrastructure *tools can be implemented by the public, while other strategies are best led by the City.*
- *Some* green infrastructure *tools are more spatially efficient than others.*
- *Some tools are have higher capital costs, while other tools have higher maintenance and operation costs.*
- Green infrastructure *tools are adaptable to fit different areas of the city.*

Green Infrastructure Area Analysis

Town Centre
Lougheed Transit Corridor
Silver Valley Area

Green Infrastructure Analysis

Purpose

A high level analysis of three different case study areas in the City was conducted to identify broad green infrastructure opportunities and challenges.

Methodology

The following three case study areas were reviewed (see map, page 27):

- Town Centre (urban infill),

- Lougheed Transit Corridor (redevelopment and infill along a corridor), and;

- Silver Valley area (greenfield and natural areas).

The following attributes were mapped within each area to identify green infrastructure challenges and opportunities:

- natural areas & tree canopy (e.g., tree cover, rivers and wetlands, riparian areas, green space and natural areas),

- existing drainage infrastructure (drainage, sewer, roads), and;

- impervious surface area.

Challenges and opportunities were assessed in each area to examine potential city-wide and area specific strategies, tools, and potential for green infrastructure services.

Data was sourced from the City of Maple Ridge and Metro Vancouver's Open Data Catalogue. Where applicable, it was noted where the City may need to acquire missing or additional data for future reference and improved understanding of green infrastructure potential.

The key findings and lessons learned from this exercise are intended to inform a City-wide approach to green infrastructure.

How to Read the Maps

Each attribute mapped provides information for assessing green infrastructure potential within each area. In turn, these aspects also address many of Council's Strategic Priorities - building healthy, safe and resilience communities, supporting growth, and natural environment. Below is a description of each map, why the attributes assessed are important to creating a green infrastructure network, how these attributes can provide services to the City and how they address the City and Council's priorities.

MAP: NATURAL AREAS & TREE CANOPY

Natural areas include undeveloped municipal owned and privately held lands, watercourses, riparian areas and wetlands, City parks and tree canopy (street trees, within parks, etc.). These areas provide a number of green infrastructure services. They soak up and contain stormwater reducing the risk of flood hazards. Parks and trees provide cooling shade and along streets help to slow traffic while also providing recreation space and refuge for residents and wildlife in urban areas. Trees also reduce and slow stormwater by intercepting precipitation in their leaves and branches, contribute to better air quality and carbon sequestration/GHG offsets. Natural assets also contribute to a healthier and more atractive community, compliment drainage systems, and result in cost savings for the City. At it's base, these elements provide the foundation of a healthy green infrstructure network.

Mapping natural assets can help the City to identify lands that provide these valuable ecosystem services, target areas that would benefit from additional green space or green infrastructure features, link and network green areas, and assess and set tree canopy goals to restore some of the benefits of trees that were lost when the areas were developed.

MAP: DRAINAGE

The drainage map provides an indication of the existing grey infrastrucuture and stormwater system and identifies where stormwater is discharged into nearby water bodies. This is important as stormwater runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape. Higher flows resulting from heavy rains can also cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Identifying these areas on the map may help target where green infrastructure can assist or complement the existing engineered system, supporting the health and safety of residents, climate change preparedness and potential cost savings or compliments to future infrastructure needs.

MAP: IMPERVIOUS SURFACE

Highly impervious areas typically correspond with increasing "urban areas" or key transportation corridors and include elements such as wide streets, parking lots or industrial areas that do not allow water to infiltrate into the ground. These areas require planned infrastructure systems to capture and redirect stormwater. Where impervious surfaces are very high, 60-100% impervious surface, these tend to be at a higher risk for flooding with large storm events. It is in these areas where the addition of green infrastructure elements may help compliment conventional pipe systems so that stormwater is less likely to overwhelm the system.
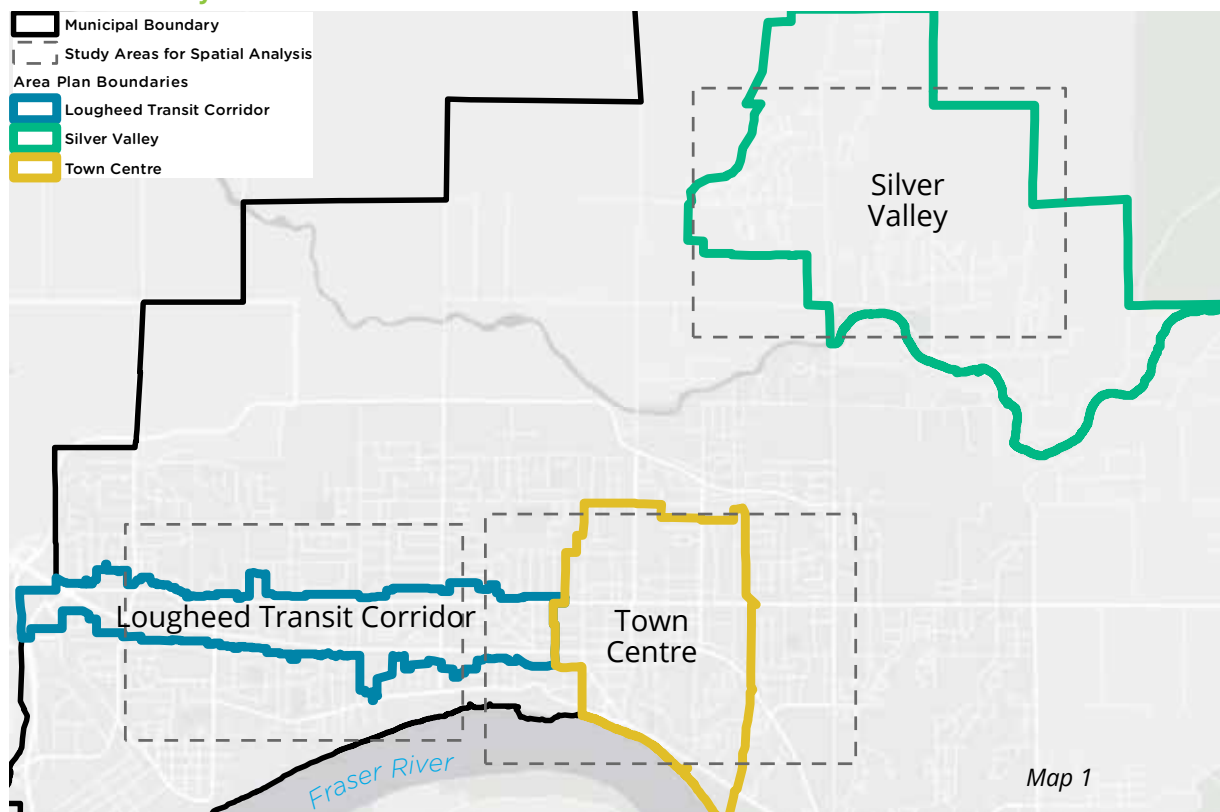
Further to stormwater concerns, highly impervious areas often look more "barren" and are also typically warmer than their surroundings, a phenomenon known as the "urban heat island effect". This is due to the sun's heat captured on paved surfaces creating pockets of intense heat where there is a lack of street trees, parks, and other green elements to offset the sun's rays. These areas are also often correlated with poor air quality ratings (exhaust from vehicles is retained in heat pockets) and are increasingly being mapped or acknowledged as an issue of "health equity" for residents who live in these areas.

As a result, high levels of imperviousness (60-100%) negatively affects the look and feel of an area, the health and well-being of residents, indicate where drainage may overwhelm infrastructure, the natural water balance and soil systems.

Understanding the spatial distribution of impervious surfaces helps the City identify areas where green infrastructure approaches, such as swales, tree cells, bio-filtration, green roofs, etc., could help counteract the negative impacts of impervious areas on drainage, thereby improving the City's resilience, as well as addressing residents health equity (creating healthy urban spaces), and improving the look, feel and vibrancy of urban spaces at the same time (resultant economic benefits, etc.).
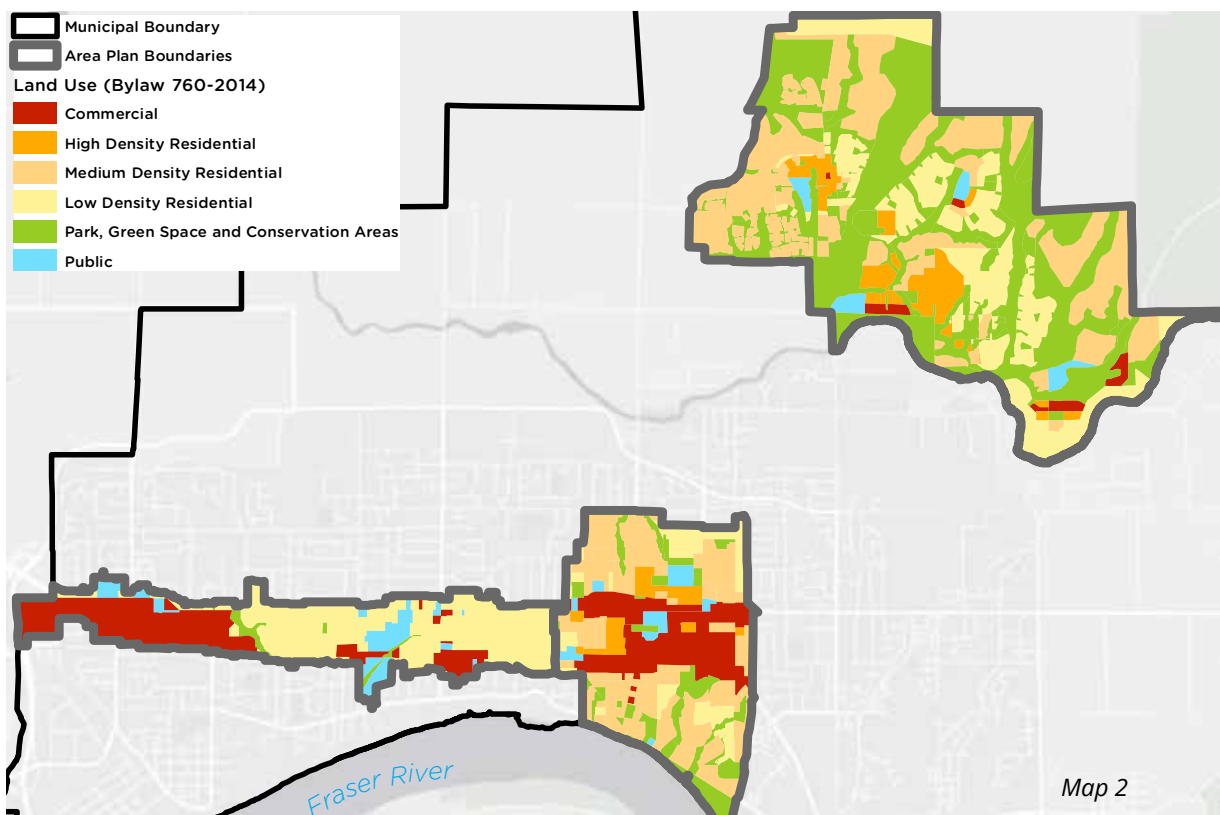
Case Study Area Overview

Legend:
- Municipal Boundary
- Study Areas for Spatial Analysis
- Area Plan Boundaries
  - Lougheed Transit Corridor
  - Silver Valley
  - Town Centre

Silver Valley

Lougheed Transit Corridor

Town Centre

Fraser River

Map 1

Land Use Overview

Legend:
- Municipal Boundary
- Area Plan Boundaries
- Land Use (Bylaw 760-2014)
  - Commercial
  - High Density Residential
  - Medium Density Residential
  - Low Density Residential
  - Park, Green Space and Conservation Areas
  - Public

Fraser River

Map 2

FIGURE: *Overview of study areas for green nfrastructure analyis (Map 1). Overview of the different types of land use within each study area (Map 2).*

TOWN CENTRE

Bounded by 124th Avenue to the north, 221st Street on the west, Burnett Street to the east, and the Fraser River to the south, this area is the commercial heart of Maple Ridge, encompassing the central business district (between Lougheed Highway and Dewdney Trunk Rd.), municipal offices, various historic locations, and a West Coast Express station.

The Town Centre is intended to support an attractive and vibrant business community and is also designated as a priority area for future development and increased residential density, and as a 'Regional City Centre' for densification and public transit. The 2014 Town Centre Area Plan, drawing from an earlier Smart Growth on the Ground, positions the Town Centre as a pedestrian oriented, liveable community with thriving business. It includes green infrastructure principles and objectives such as protecting natural features, rainwater management, green buildings, green roofs, green streets, and access to nature (i.e. community gardens, community open space & park areas, etc.).

At present, there many active businesses, in particular along a portion of 224th street, with larger sidewalks and parking. Outside of 224th but adjacent to it, there are more businesses and some residential uses, however, less street trees, open parking lots and some vacant lots. There are several active applications for mixed use and/or higher density residential development within and around 224th street within the Town Centre.

Existing Assets and Challenges
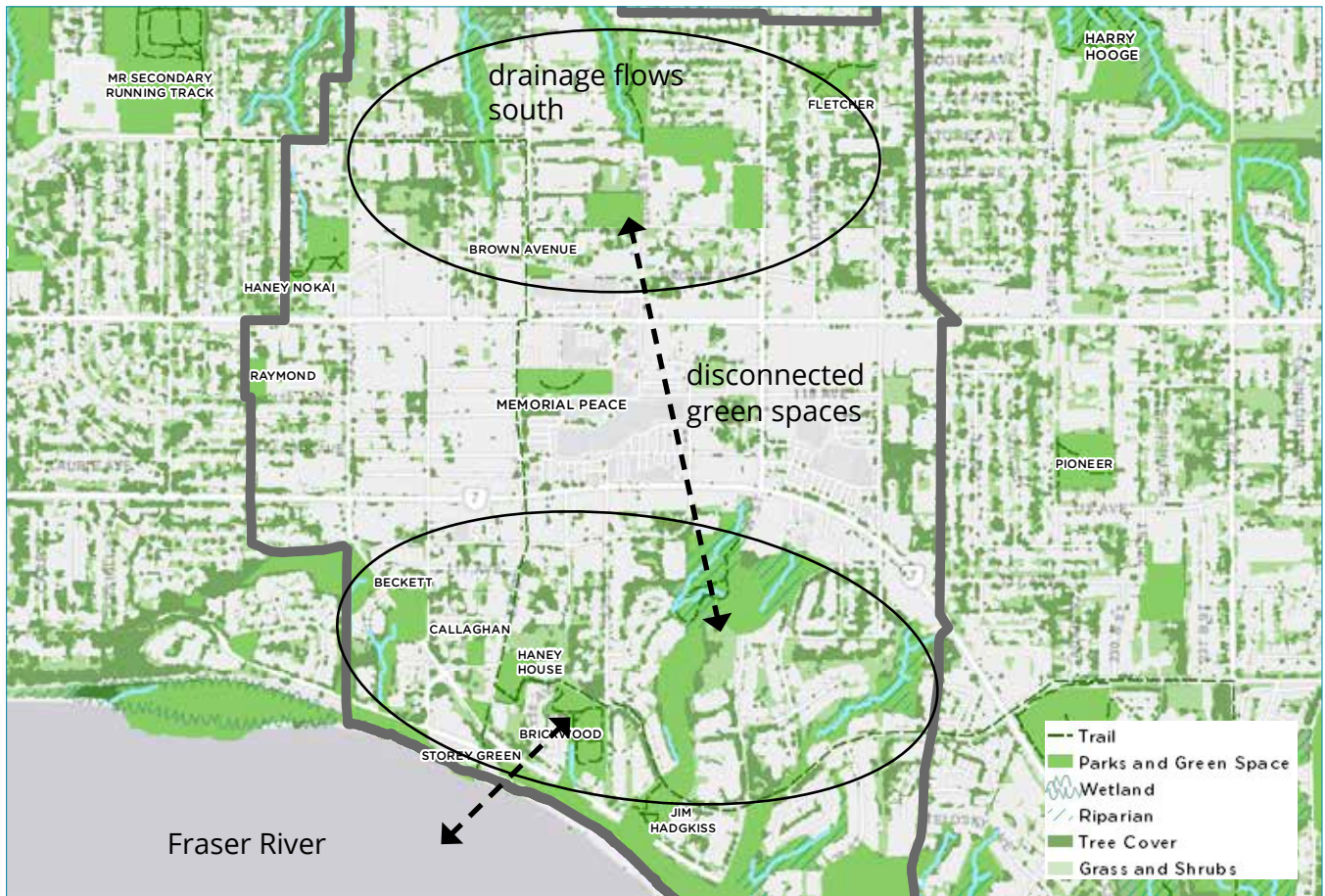
NATURAL AREAS AND PARKS

There are a number of greenspaces surrounding the Town Centre, located to the north and southern areas within the Town Centre Area Plan boundaries. These areas are not well-connected through the central core area with landscaping, continuous street tree canopy, and/or watercourses and riparian areas (see below).

Several streams and wetlands exist and flow south from the Alouette River, however, these stop at the north end of the Town Centre. Natural drainage to these watercourses is discontinued at the surface to those areas further south, adjacent and on to drainage points along the Fraser River due to urban development.

40% tree canopy is a recommended best practice target
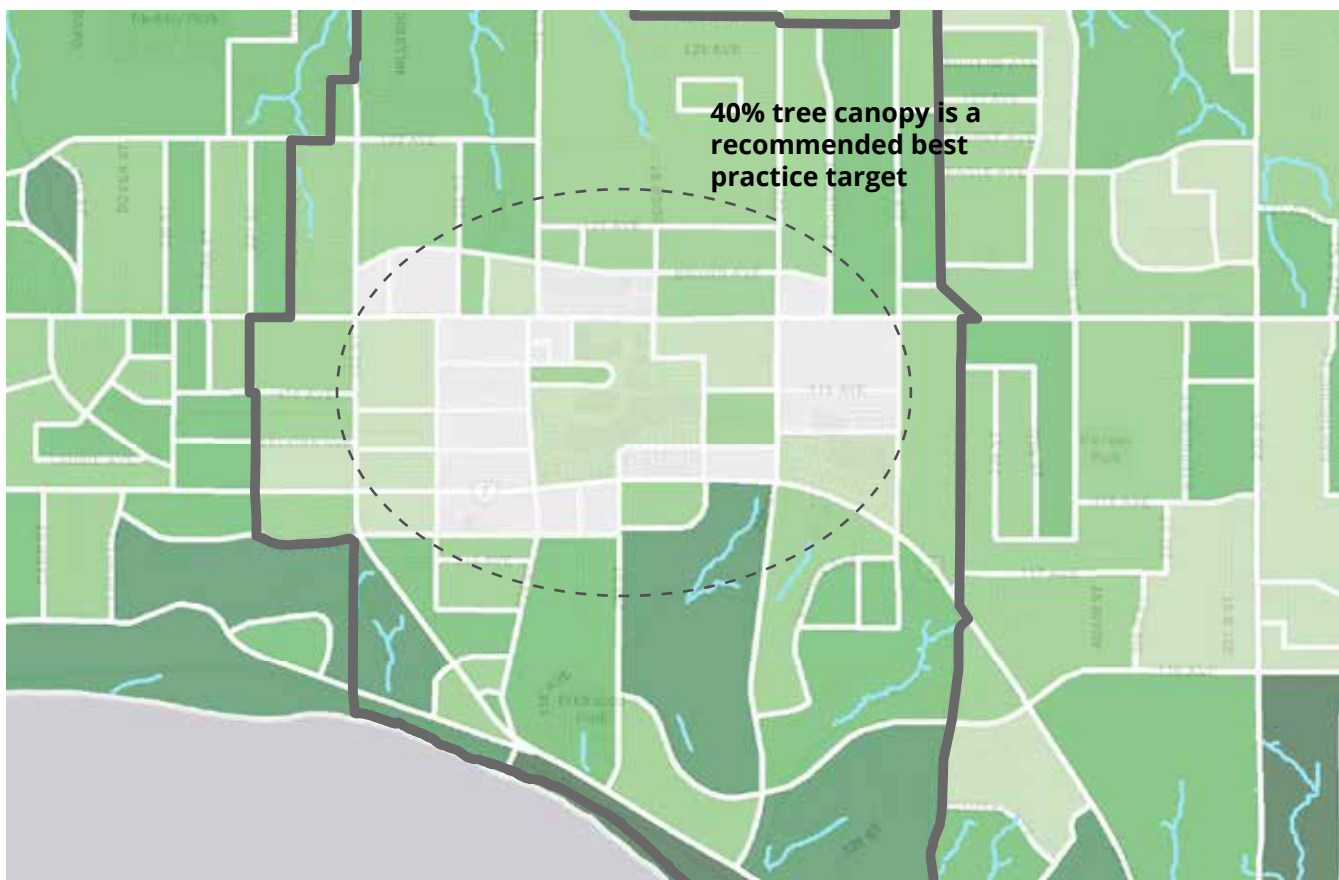
TREE CANOPY

The Town Centre area features significantly less street tree canopy (0-15% by block), particularly in its innermost core, compared to surrounding residential areas (as a comparison, the North American average is 27%). Major corridors including Dewdney Trunk Road and Lougheed Highway maintain less tree cover, grass, shrubs and greenspace than shown in areas outside the Town Centre core area with the exception of 224th which shows on the map as a more "green" street due to increased street tree cover.

Aerial photo showing the central core of the Town Centre where tree canopy is reduced.

Tree Cover	Shrub, Herb, Grass	Building	Pavement	Other
17%	29%	24%	30%	

Example of assessing tree canopy to show relative % coverage and absolute (ha) coverage of tree cover, shrub/herb/grass, buildings, and pavement within each of the City's area plans. This information is benefical to prioritize, measure and set tree cover targets.

DRAINAGE

There are two primary drainage basins within the Town Centre. Several key drainage outfalls flow from the Town Centre into nearby wetlands and watercourses within each drainage basin.

Two culverts are located in the southeastern area of the Town Centre, one on 227th Street, and one on Brown Ave. Outfalls are scattered throughout, adjacent to various streams. One detention pond is located in the southeast corner of the study area.

Some riparian and wetland areas just outside the Town Centre are not protected within park or protected areas.

Impervious Surface per Block (%)
- 0% - 19.99%
- 20% - 39.99%
- 40% - 59.99%
- 60% - 79.99%
- 80% - 100%
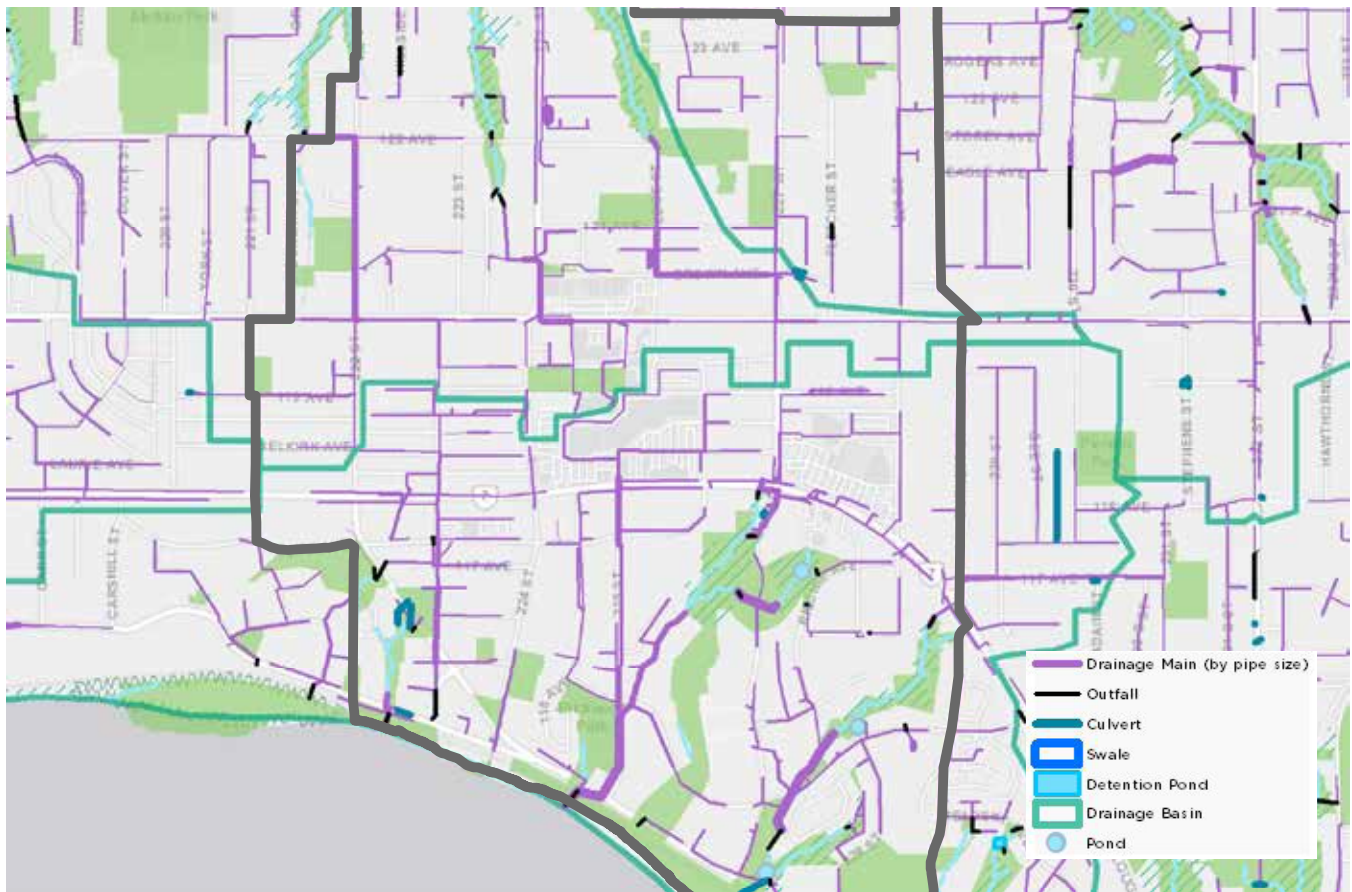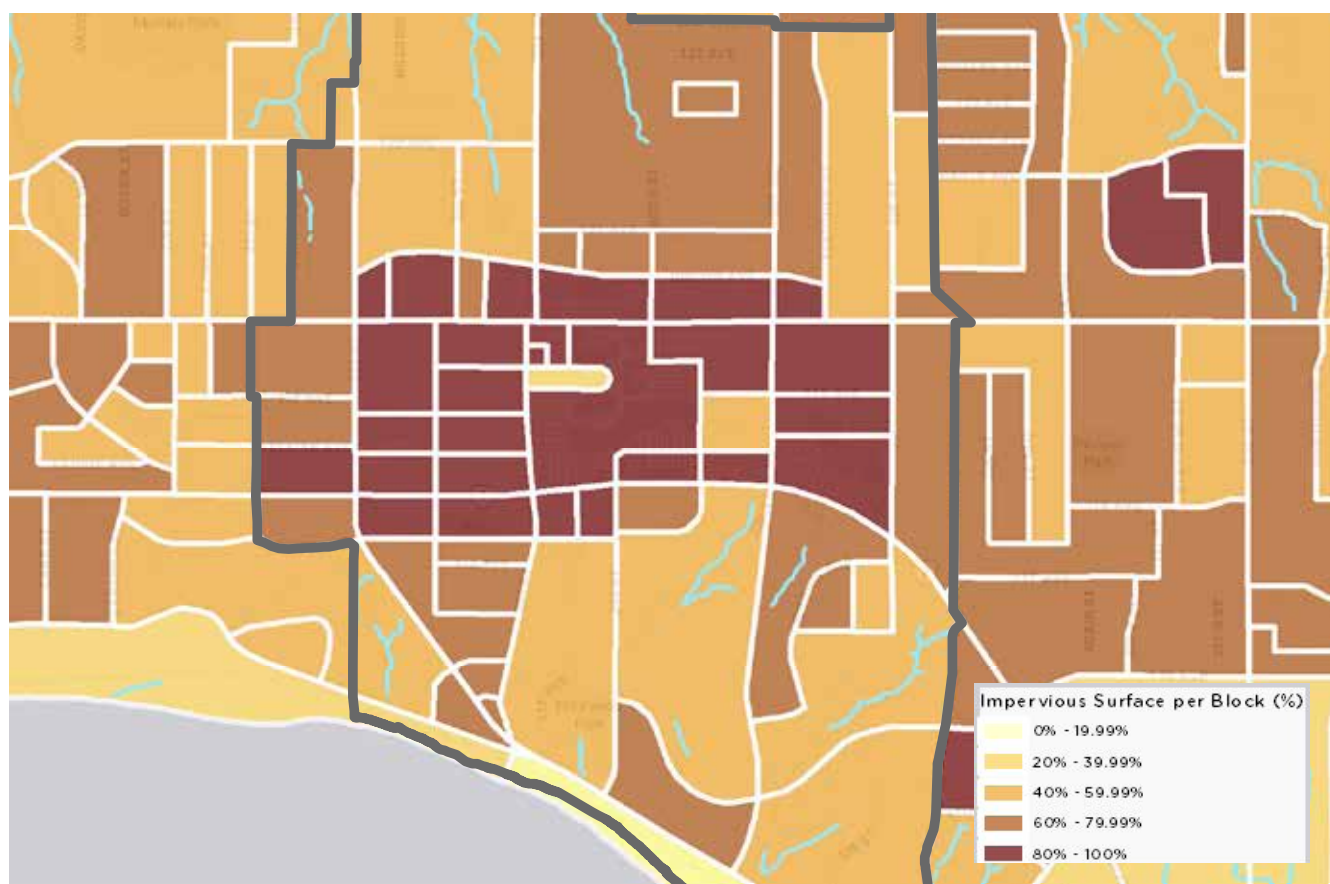
IMPERVIOUS SURFACE

The Town Centre core area maintains an 80-100% impervious surface area with the exception of a park space and several vacant lot areas. Town Centre areas to the north and south show a 40-80% impervious surface per block due to trees.

The impervious areas typically correspond with flooding risk during major rain events, due to pavement runoff that is not captured or overwhelmed storm water catchment systems. These same areas are also highly susceptable to an urban heat island effect and poor air quality. Areas of highest imperviousness contain no surface watercourses.

Green Infrastructure Opportunities for Town Centre Areas

STREETS AND PARKING

- Extend the connectivity of larger greenspaces from outside the Town Centre Area into and through the Town Centre as green streets and recreation corridors (greenway - pedestrian focused street, bikeways, trails). Starting first with major corridors and primary shopping/retail streets, or with redevelopment as it occurs or when street upgrades are undertaken.

- Increasing tree canopy cover overall (with a target of 30-40% coverage - the recommended best practice) for all streets or a targeted street tree program that focuses on major corridors and key retail shopping streets and areas as a first step. This could include incentive programs for business owners and residents to add to landscaping and/or steward existing street trees.

- With redevelopment infill in urban areas:

  - Incorporate bioretention planters and soil cells for street trees.

  - Incorporate permeable paving along sidewalks, pathways, at building entrances, in resident courtyards, parklets or smaller surface parking areas.

- Encourage rain gardens and bioswales at corner bulges, round-abouts, in street medians and along parking lot perimeters.

PARKS AND GREENSPACES

- Incorporate additional parklets, courtyards, and business-related outdoor patio spaces, as opportunities arise.

- Identify urban streams to daylight (where applicable).

- Acquire or protect identified riparian/wetland areas currently outside of park spaces.

- Identify park design opportunities for absorbant landscaping which could be incorporated along pathways, childrens' play areas, or seating areas, such as:

  - water/rain gardens and water features;

  - additional planted/natural areas within existing Town Centre park spaces.

SITES AND BUILDINGS

- Encourage local businesses to incorporate bioretention planters, hanging baskets, and outdoor green patio spaces and front seating areas. This could include developing programs for standard planter boxes and parking space green parklet.

- Encourage and/or incentivize green roof systems for new buildings with redevelopment.

- Encourage and potentially incentive green walls for new buildings.

- Replace some parking spaces with planters or landscaping along parking lot perimeters.

- Continue to incorporate greenspace into new residential or mixed use buildings at ground level.

Lougheed Transit Corridor map (City of Maple Ridge)
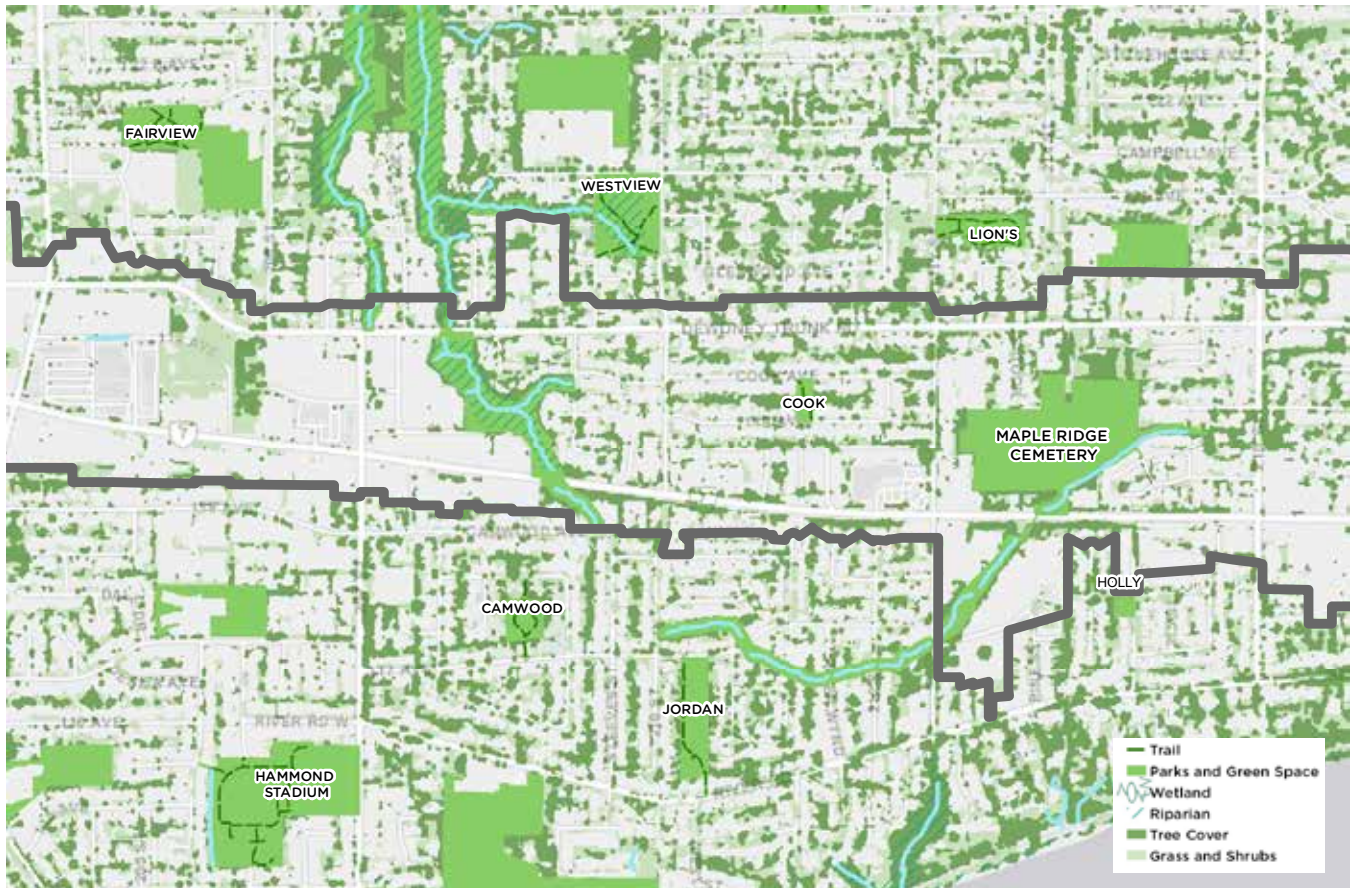
LOUGHEED TRANSIT CORRIDOR AREA

The Lougheed (LTC) area is bisected by Highway 7 (Lougheed Highway) and Dewdney Trunk Rd., both major roads running east-west. It is a mix of commercial areas, urban residential, low and medium density multi-family neighbourhoods, as well as community facilities including a hospital, cemetery, and school. There is not much park space in the Lougheed Transit Corridor and limited protected areas around streams.

Recently, the City has undertaken the Lougheed Transit Corridor Study and developed early concepts for its future development. This concept envisions an urban environment with a focus on the pedestrian and integration of green spaces. Two primary mixed-use nodes were identified at rapid bus stop locations, and four north-south 'high streets' intersect with the West Ridge Greenway running in an east-west orientation. Employment and light industrial land uses were included to reflect a desire to increase local jobs and regional demand for employment lands. With this, a greater range of housing tenure and options were targeted between Dewdney Trunk Road and Lougheed Highway.

Residential infill development, through detached garden suites, secondary suites, duplexes, triplexes and subdivisions in neighbourhoods to the north and south of the study area was outlined to create a transit supportive density as well as a customer base and node for 'high street' retail stores and services within each precinct.

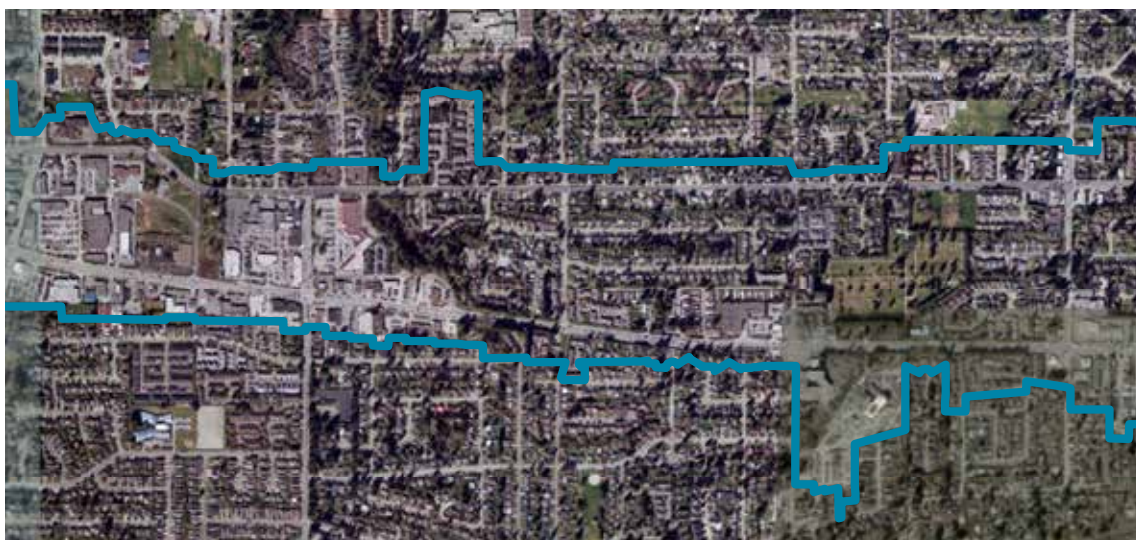# Existing Assets and Constraints
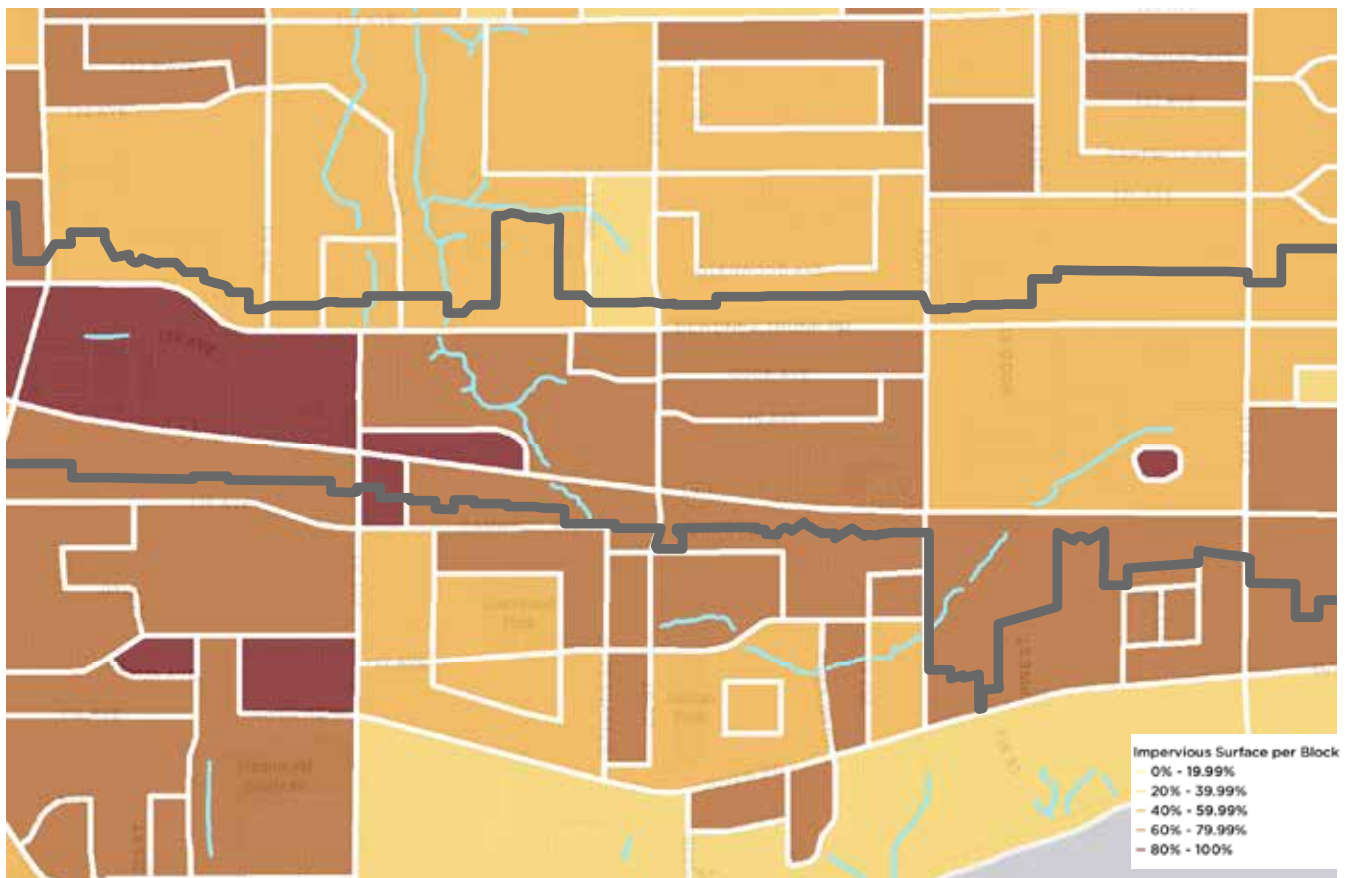

NATURAL AREAS AND PARKS

There are several watercourses running through the Lougheed Transit Corridor area that host important riparian areas and wetlands. These watercourses are not fully contained within protected park spaces. However, there are a number of parks and greenspaces (i.e. school parks) in the area. There are no defined linear greenways or trails that connect these spaces as a larger network, but these are identified in the LTC concept plan.
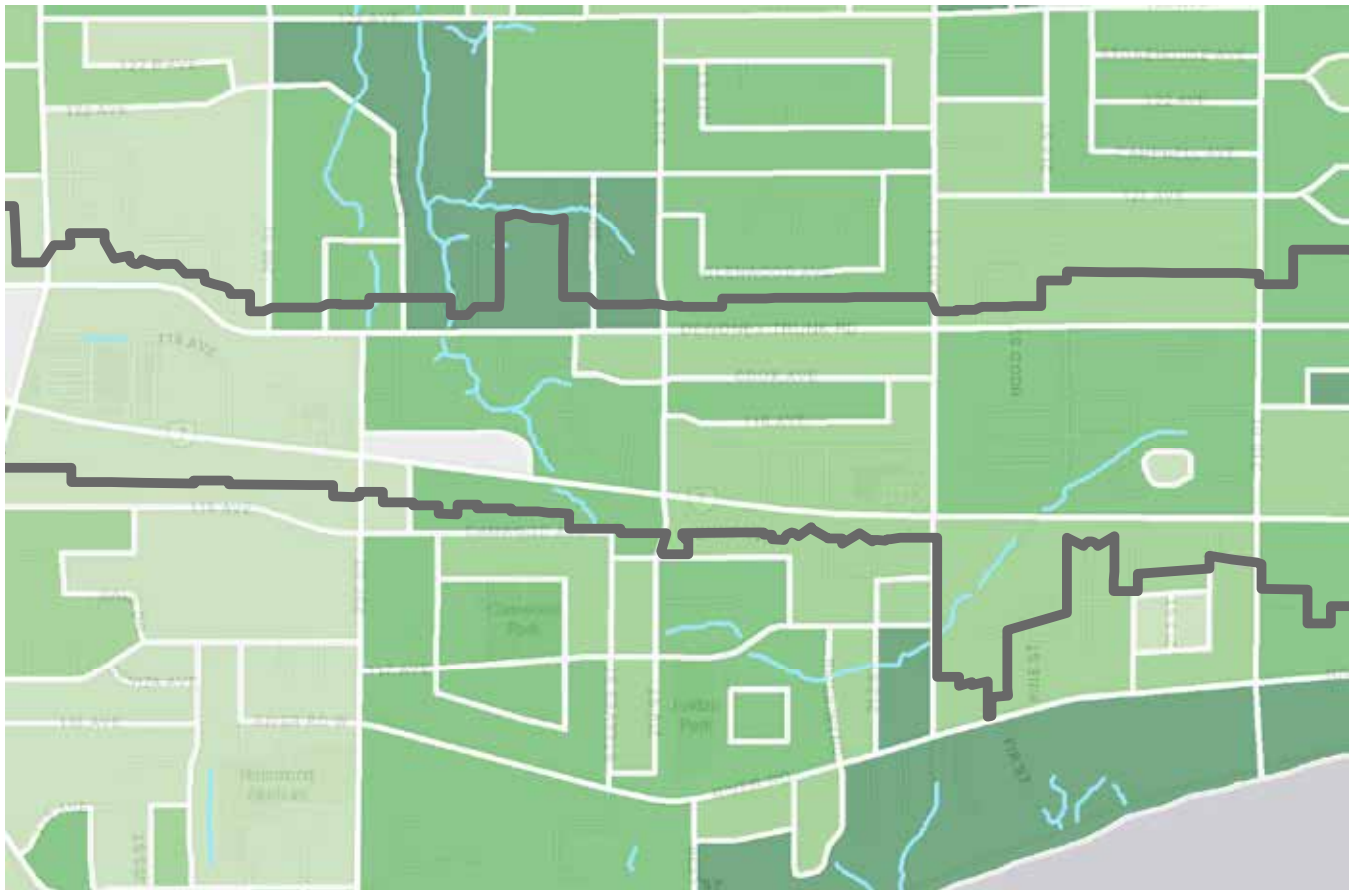
TREE CANOPY

The average tree canopy per block along the two major corridors of Dewdney Trunk Rd. and Lougheed Highway is variable within surrounding residential areas. The lowest tree canopy is within the planned 203rd St. precinct (5-15%). Tree canopy in areas directly along the corridors is noticably minimal in most areas (see air photo, below).

DRAINAGE

Lougheed Transit Corridor exists within two drainage basins. The largest drainage mains (by pipe size) are along the two main corridors - Dewdney Trunk Rd. and Lougheed Highway. There is one primary watercourse within this area with several culverts, outfalls, and one swale. Most of the outfalls are connected to a waterway.

IMPERVIOUS SURFACE

Areas directly between Lougheed Highway and Dwedney Truck Road and directly south of Lougheed Highway maintain 60 - 80% impervious surface with some areas reaching higher, such as the commercial zone with the planned 203rd St. precinct.

The surrounding residential areas are slightly lower at 40-60% impervious surface, with the lowest impervious surface areas occuring along the Fraser River, outside the Lougheed Transit Corridor area.

Green Infrastructure Opportunities for Lougheed Transit Corridor

STREETS AND PARKING

- Targeting additional street tree canopy and planted medians along Lougheed Corridor with new planned development nodes.

- Creating a linear greenway route (for walking and cycling) along the Lougheed Corridor that incorporates bioretention drainage features within it.

- Incorporating permeable paving along sidewalks, bike paths or trails, building entrances, courtyards, in parklets or smaller parking areas.

- Including rain gardens and bioswales at corner bulges (bioretention bulges), round-abouts, and in street medians and along parking lot perimeters within new development.

PARKS AND GREENSPACES

- Encouraging and partnering with nearby schools for greening initiatives to support greater connectivity of spaces.

- Identifying potential new trail networks or extensions to link smaller green spaces to larger park spaces.

- Additional park acquisition or policy development that supports existing protection measures and adds to the enhancement of natural assets along watercourses and riparian or wetland areas.

- Identify opportunities for rain gardens within park spaces, in particular where outfalls are located

SITES AND BUILDINGS

- Encouraging and potentially incentivizing green walls and green roof systems for new buildings with redevelopment.

- Outline landscape requirements within parking lot perimeters.

- Incorporate additional greenspace into new residential or mixed use buildings at ground level, with emphasis on identified key development nodes within the Lougheed Transit Corridor concept.

SILVER VALLEY

Located north of the Alouette River, Silver Valley maintains forested areas and has ample access to parks and trails, in proximity to nearby Malcolm Knapp Research Forest and Golden Ears Park, as well as still undeveloped greenspace.

The Silver Valley Area Plan provides for growth within the neighbourhood while putting the environment first. The plan encourages infrastructure and development that protects and promotes the area's natural assets.

Development is designed within neighbourhood clusters. Medium to high density is concentrated around pedestrian-oriented commercial areas and community amenities including a school.

Stormwater management is a key feature of the Plan. This includes accommodating and treating storm water at/near the source wherever possible through maximizing permeable areas and minimizing storm water collection, unpaved, shared driveways and narrow paved lanes to housing clusters to minimize paved areas, as well as utilizing rain and grey water collection systems where feasible for irrigation within private lots.

Existing Assets and Constraints
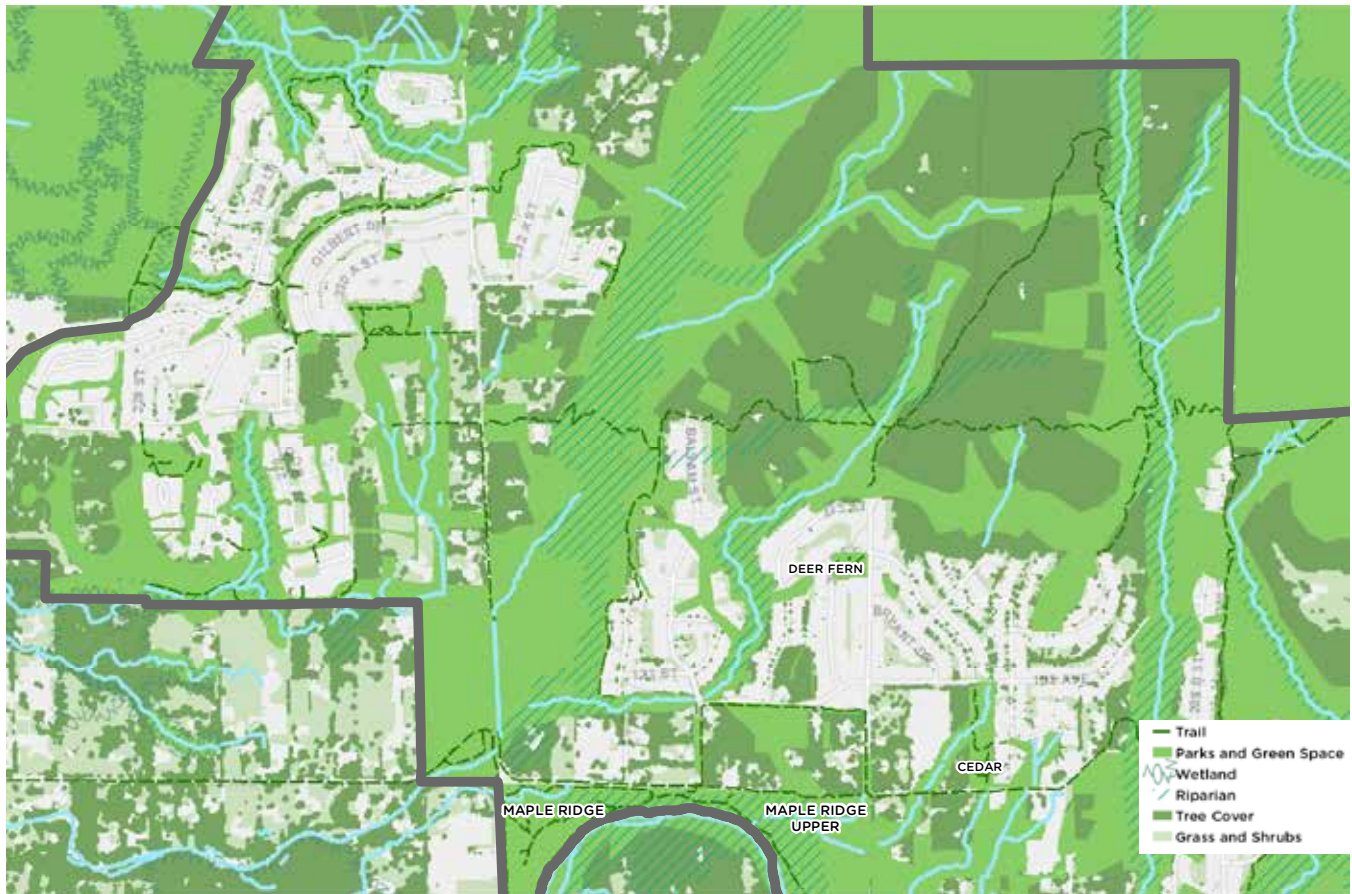

NATURAL AREAS AND PARKS

There are large natural areas, including ecologically rich wetlands and riparian areas within Silver Valley. Some of these areas are municipal owned lands. These natural areas provide benefits to the City, such stormwater management, improved water quality within the watershed, improved air quality, and recreation opportunities for residents. The clustering of residential development enables strong connectivity between existing green spaces throughout the neighbourhood. While growth is anticipated for this area, the Silver Valley Area Plan states a desire to protect and preserve the area's natural assets.
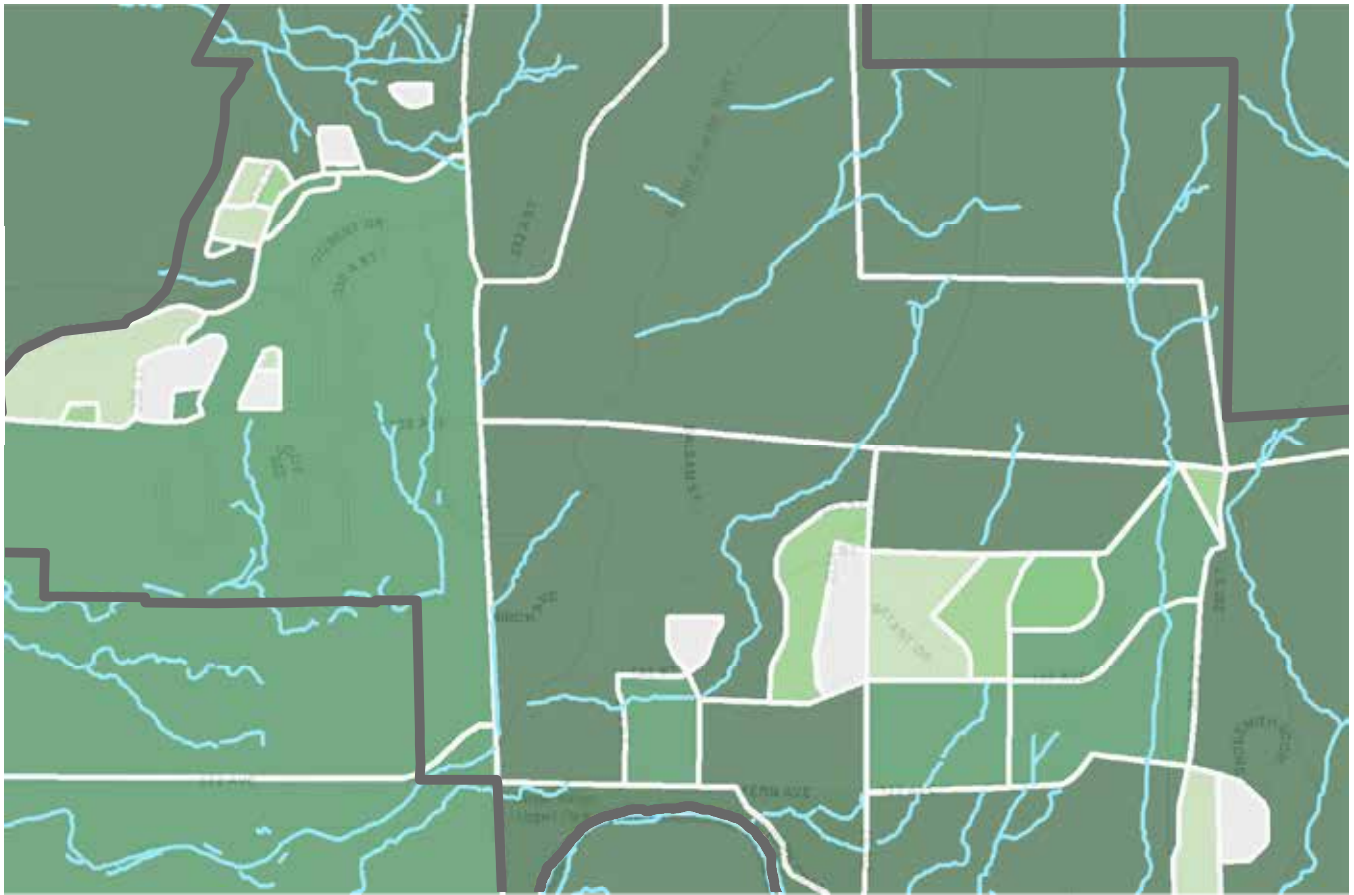
TREE CANOPY

Silver Valley is characterized by widespread tree cover (the majority >25% average cover), densely forested hillsides, and natural areas. These elements, along with the many waterways, provide rich salmon habitat and wildlife corridors, as well as ample trails and access to large nearby parks (e.g., Golden Ears, Knapp Research Forest).
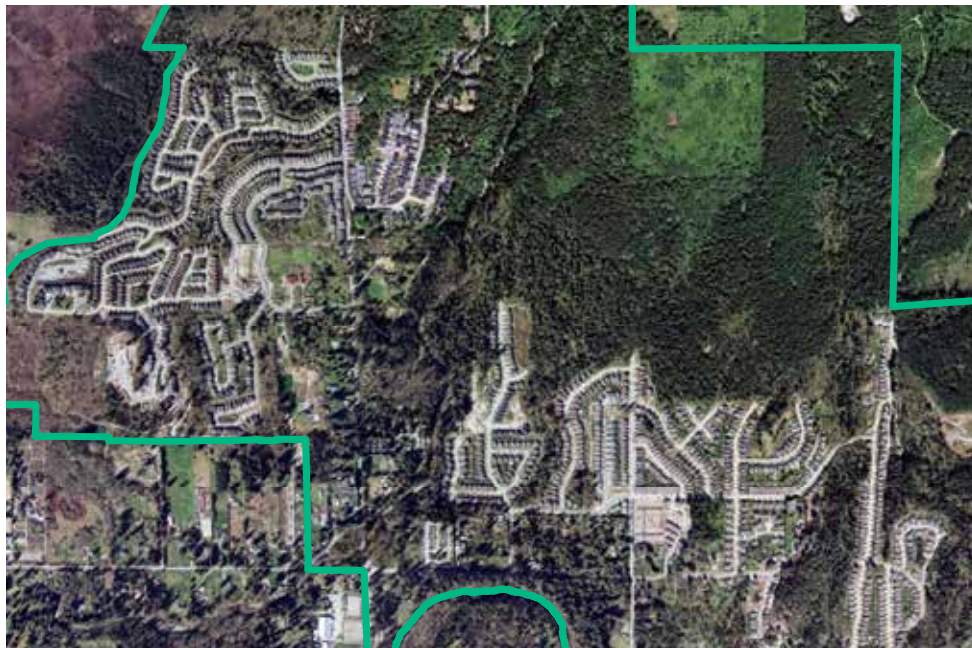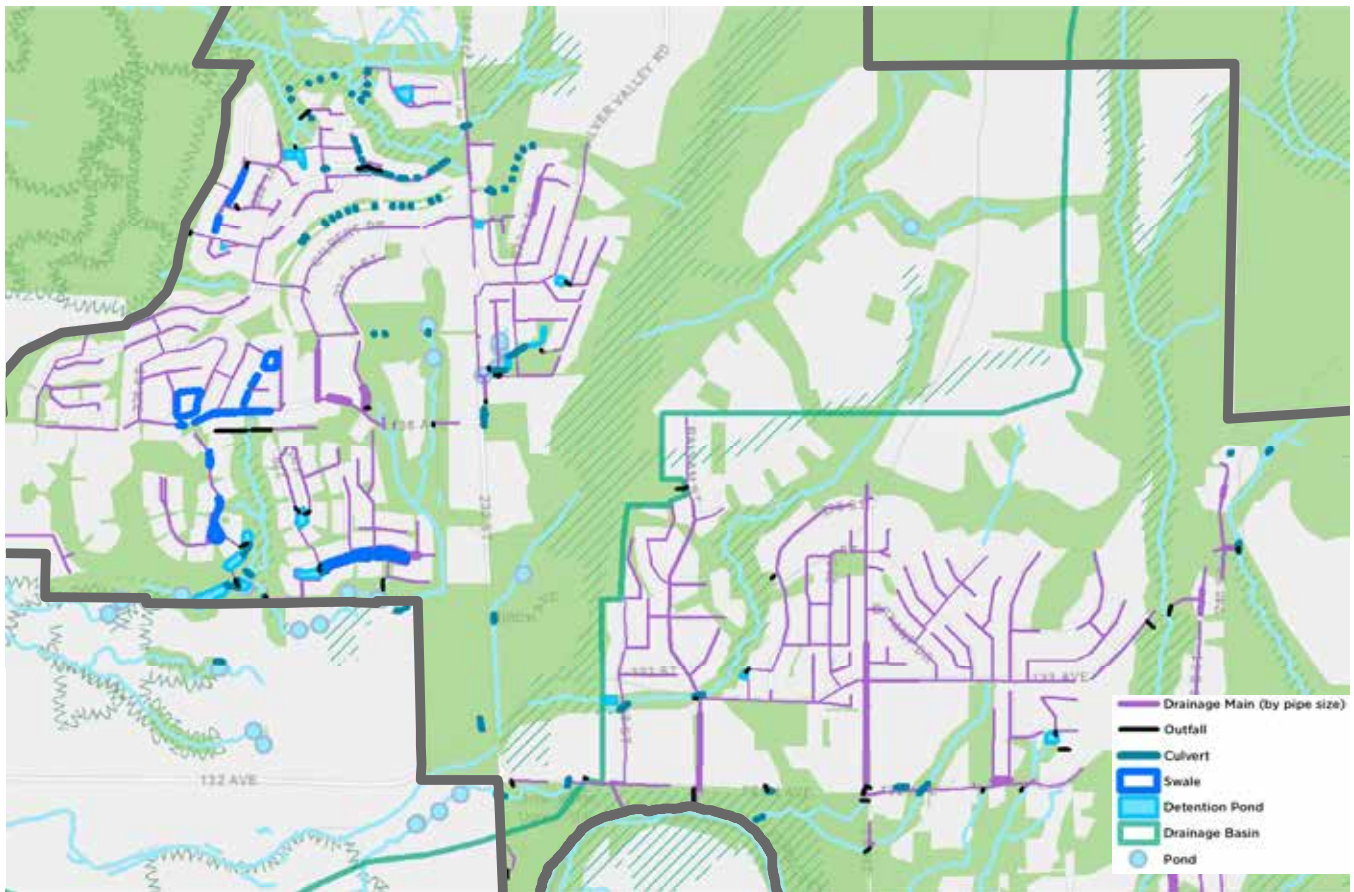
DRAINAGE

Silver Valley includes two drainage basins. Within these, there are many watercourses, riparian and wetland areas. There are several outfalls to riparian areas, local watercourses and various culverts. Existing green infrastructure within the neighbourhood, includes detention ponds that help collect and direct rain water and runoff and a linear roadside rain garden for stormwater management.

Impervious Surface per Block
- 0% - 19.99%
- 20% - 39.99%
- 40% - 59.99%
- 60% - 79.99%
- 80% - 100%
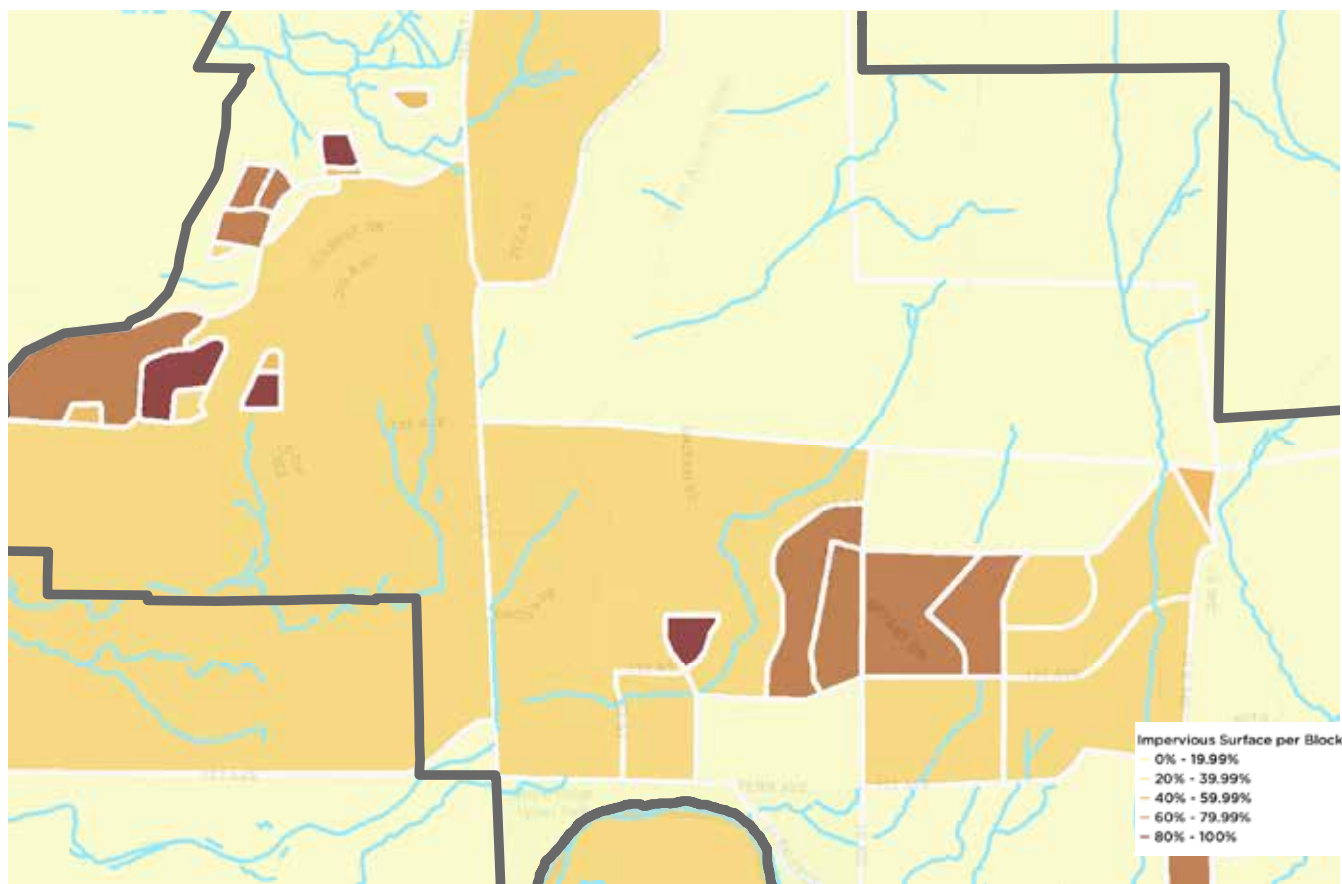
IMPERVIOUS SURFACE

As a highly forested area, the Silver Valley neighbouhood maintains the most pervious surface area of all three case studies. The majority of this study area is 0-20%, some 20-40% in lower density residential areas areas, and pockets of higher imperviousness around clusters of residential and commercial development. Isolated areas of 80-100% imperviousness are located within densely clustered residential development. The Silver Valley Area Plan includes an objective to limit imperviousness to 15% of the total Silver Valley area.

Green Infrastructure Opportunities for Silver Valley Area

STREETS AND PARKING

- Exploring alternative options for maintenance costs of bioretention street swales for residents.

- Look to incorporate additional bioretention street swales in any future development, as per current standards for development in Silver Valley.

PARKS AND GREENSPACES

- Inventory and valuation of existing natural area assets to both the neighbourhood and to the City overall.

- Identify additional opportunities for rain gardens within neighbourhood park spaces and at drainage outfalls.

SITES AND BUILDINGS

- Encourage on-site, low impact development strategies within existing residential lots and new development, including rain gardens, downspout disconnect programs for landscape watering and cisterns/rain barrel programs.

- Incorporate absorbent landscapes in parks or entire yards, permeable pavement and on site swales or a soakaway pit or trench. A soakaway is similar to a swale but typically dug deeper (a hole or trench) and without landscape elements. The hole is filled with drain rock and strategically placed in areas to collect rainwater.

Summary of Green Infrastructure Analysis in Case Study Areas

The following is a summary of key challenges and opportunities based on the three case study areas:

Challenges:

- There is low tree canopy and high impervious surface in urban areas - and therefore at risk of increased run-off, flooding, and urban heat island effect.

- There are fragmented or disconnected green spaces, watercourses and wetland/riparian areas in urban areas.

- Existing natural assets are not well defined and therefore the benefits (stormwater management, air quality, recreation opportunities, healthy ecosystems, etc.) these areas offer to residents and the City are less understood.
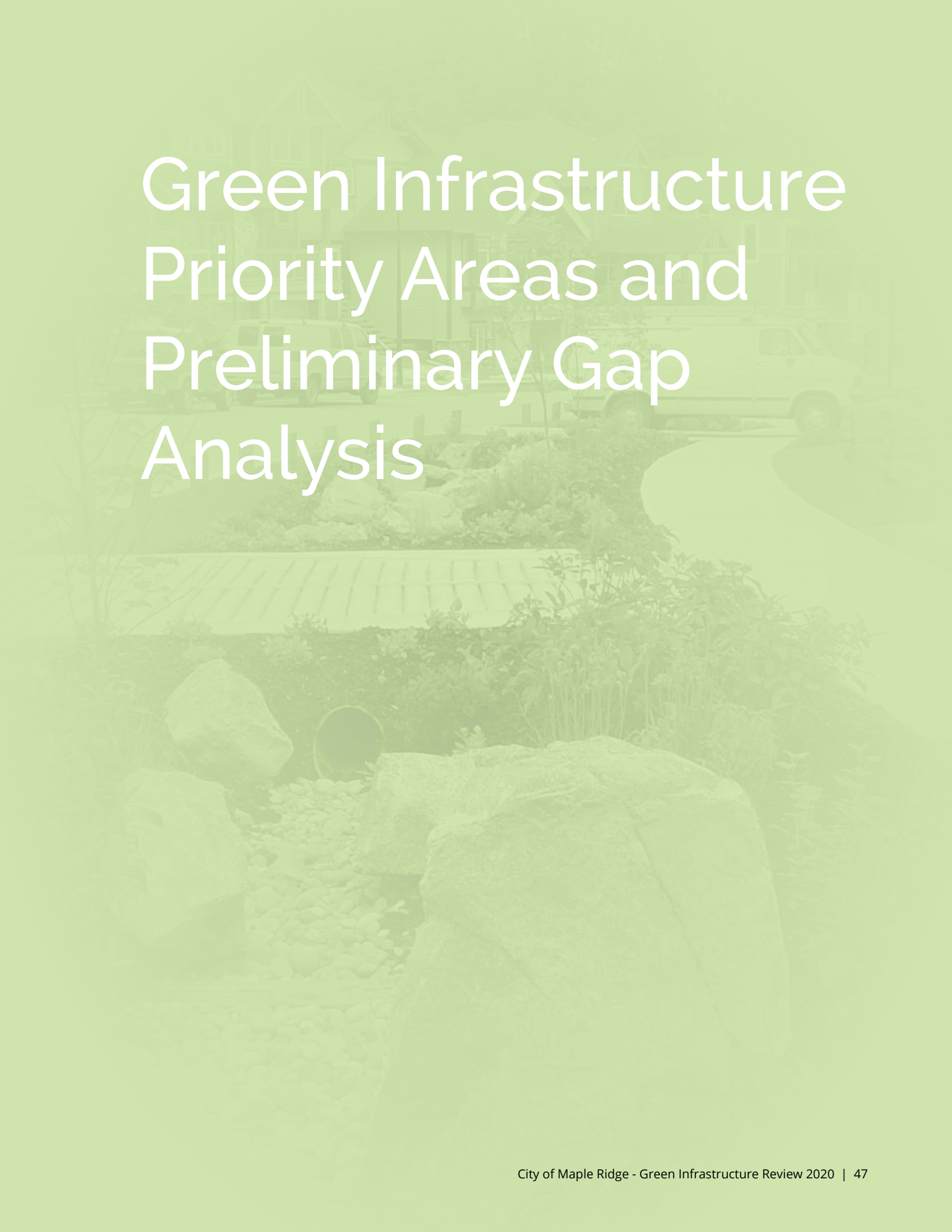
Opportunities:

- Urban infill and redevelopment areas (Town Centre and Lougheed Transit Corridor) offer the most opportunities to integrate green infrastructure within the City within all categories identified (streets, parking, sites, buildings, etc.).

- Areas where there are existing natural assets provide good opportunities to maximize eco-system services to the City (such as Silver Valley).

- Areas where there are existing natural assets and new greenfield development, such as Silver Valley, provide opportunities to integrate existing and supporting green infrastructure within the new development (as opposed to a traditional clearing and sub-division development).

- Development of a larger green infrastructure network would identify critical ecosystem areas and better connect the many parks, natural areas and other greenspaces the City maintains. A green infrastructure network would also document and expand the City's recreational network connections and help track eco-system health.

- Existing parks and greenspaces offer good opportunities to achieve multiple objectives, for example, recreation and stormwater management.

- Programs, initiatives and user fees that motivate homeowners to reduce on site runoff within private lands would further improve and add to the City's green infrastructure system.

Green Infrastructure Priority Areas and Preliminary Gap Analysis

Priority Areas

Based on the background review and summary of the analysis in the three case study areas, the following potential directions have been identified for the City.

Priority areas for green infrastructure in Maple Ridge:

1 Inventory, mapping, assessment and valuation of existing natural assets as City services to determine protection measures and the best land use, in particular, for City-owned properties.

- Mapping a green infrastructure network (using existing and collection of new data).

- Protection of critical areas and prioritize where green infrastructure is needed.

- Acquisition of additional lands for protection.

- Restoration and stewarship of existing protected natural areas.

- Regulatory controls to control point source/non-point source pollution from outside sources that flow into protected ecosystems.

2 Green infrastructure in new development.

- Urban infill and redevelopment - incorporate green infrastructure into new projects and those currently in planning stages, specifically within the Town Centre & Lougheed Transit Corridor areas.

- Review policy for lot assembly to ensure green infrastructure targets can be met in redevelopment areas.

- New greenfield development - incorporate green infrastructure requirements within area plans.

- Implement programs, incentives and user fees for private residential lots.

3 Parks and street trees - incorporate broader green infrastructure objectives into park design such as stormwater management services and increase tree canopy within the City.

- With new park design (rain gardens, pollinator gardens, etc.), recreation spaces and other greenspaces (i.e. within school grounds, neighbourhood parks, etc.).

To support these three priority areas, the following additional directions have been identified. Through internal engagement, these can be further detailed.

- Incorporate green infrastructure into business planning and annual budgets.

- Account for the value of natural assets/capital.

- Develop green infrastructure outreach, education and awareness initiatives, targeting the development community, public and other stakeholders, including urban greening programs and initiatives with each priority area.

- Further connect and develop partnerships with neighbouring and supporting governments and local groups (Metro Vancouver, First Nations, UBC Malcom Knapp Research Forest, Alouette River Management Society, etc.) to:

  - Work with surrounding jurisdictions to protect important areas.

  - Share data and align with regional government green infrastructure intiatives.

  - Green infrastructure design charrette to demonstrate green infrastructure in action and conduct cost-benefit assessments.

- Work with local groups on stewardship and restoration of critical sites.
- Internal City requirements:
  - Access available grant funding programs.
  - Internal training and staff resources.

Table. Summary of identified priority areas for the City of Maple Ridge

PRIORITY AREAS:	1	2	3
	Inventory, Mapping and Valuation of Natural Assets	New Development - Infill and Greenfield	Parks & Streets
SUPPORTED BY:	• Business Planning and Annual Budgets • Staff Resources and Training • Connections and Partnerships with Neighbouring Jurisdictions • Engagement and Outreach, Education and Awareness for Stakeholders and Residents		

Municipal Tools & Resources

Municipalities are in a unique position to support green infrastructure. With this, the City has a number of tools available for implementation. The following table outlines the potential tools available and provides an evaluation of where the City could explore further action to best utilize these tools in supporting the priority areas identified. This information is for discussion and is based on information gathered through the green infrastructure review and staff input.

Mechanism	Tools	CMR Potential Focus Areas
Land use planning & legal mechanisms	Official Community Plan Development Permit Areas Design guidelines & standards (i.e. low impact development, etc.) Development Checklists Area Plans Zoning Other Bylaws - Sub-division control bylaw, tree bylaw, Development Cost Charge Bylaw Covenants and easements (i.e. for private land natural asset protection) Local Area Service Agreements and alternatives to LAS	Ensure that development prioritizes and makes better use of existing assets on the land Review land assembly of smaller lots within infill areas to ensure green infrastructure opportunities can be maximized Amendment to the Development Cost Charges Bylaw (DCC Bylaw) to fund natural asset restoration & enhancement, where the project meets the requirements of a capital cost supporting an eligible service, and where the restoration and enhancement will directly or indirectly service the development in which the charge is imposed (as opposed to applying to engineering assets only)
Management planning, use of targets or key indicators	Management Plans (Integrated Stormwater Management Plans, Environmental Management System, etc.) Development/redevelopment run-off volume control targets or targets for rainfall management	Document the risks associated with changes or damages to natural assets

Community - based incentive programs, projects and municipal initiatives	Pilot or demonstration projects	Identify new programs and initiatives for private residential lots - such as:
	Rebates to home owners (one time payment) to install low impact development strategies on their lot	• that focus on stormwater management
	Community initiatives - i.e. offering discounted nursery trees to residents	• those that promote stewardship of natural assets
	Market based tools - i.e. quantity based offsets and trading systems of green infrastructure benefits (i.e. obtain credits for reduced runoff - to be implemented with a stormwater user fee system)	• increase tree canopy cover in areas that have been identified as deficient
		Tax incentives/tax credits or Payments for Ecosystem Services (PES) in exchange for protection or improved management and stewardship of natural assets
	Residential household levy - i.e. to install green infrastructure assets, to build a land acquisition fund and purchase land for regional parks and trails that residents utilize	
	Stormwater user fees (based on the stormwater the site generates, an economic incentive for developers or property owners to improve performance)	
Development Application and Process	Development Process Incentives	Reduction or refund in DCCs for developments which include green infrastructure
	Density Bonus	
	Development Cost Charge (DCCs) reductions	CAC policy amendment that includes qualifying green infrastructure assets
	Cash in lieu (parks)	Public - private partnerships for design, construction and management of projects that integrate green infrastructure
	Green Infrastructure Network tax	
	Community Amenity Contribution Policy	
	Development Agreements	Accelerated approvals processes, density bonus for developments that integrate green infrastructure or retention and use of natural assets / eco-system services
	Public - Private Partnerships	

Financial Planning and Asset Management	Municipal Asset Management Policy Municpal Finance Planning Annual Financial Statements Capital Investments - Asset Assessment & Life-Cycle Planning	Create a municipal asset management policy to include specific obligations to operate, maintain and replace natural assets alongside traditional capital assets. Integrate natural asset management into municipal finance planning (although it may not be included fully in financial reporting), including long term financial plans (20 years+) Recognize natural assets in the notes section of annual financial statements and other documents and the need to manage them in conjunction with engineered assets - Note that Infrastructure Canada has begun to broaden the way it defines eligibility as tangible capital assets to include natural assets and green infrastructure, so that natural assets can be included within public sector financial statements Assess options to preserve, maintain, or enhance existing natural assets and the services they provide, before proposing new built assets Compare the life-cycle costs of natural and engineered assets before making capital investment decisions
Other municipal resources	GIS data sets/inventory Staff Resources Staff Training Infrastructure funding opportunities (Provincial and Federal governments)	Gather / acquire additional data to support green infrastructure network mapping. Identify new staff positions and training needs required to support green infrastructure components. Seek Provincial and Federal funding opportunities.

Potential Funding Programs

The following list outlines the current local infrastructure grant programs from the Province of BC as of January 2021.

- Covid-19 Resilience Infrastructure Stream (CVRIS) - Increase resilience/adaptation (up-coming deadline)

- Investing in Canada Infrastructure Program - Green Infrastructure Focus Area

- CleanBC Communities Fund

- Community, Culture, and Recreation Fund - resident access to, and quality of, cultural, recreational and community spaces

- Green Infrastructure—Environmental Quality program

- Community Economic Recovery Infrastructure Program (CERIP)

- Infrastructure Planning Grant Program

Next Steps

This background report provides a general assessment of key opportunities and priority areas for green infrastructure within the City of Maple Ridge based on current information available and input from staff. Next steps in the development of a green infrastructure strategy will be to:

1. Review identified green infrastructure priority areas (as outlined in this report) with City departments and staff.

2. Further identify the specific actions and resources required.

3. Further engage and review with Council, Environmental Advisory Committee, staff and external stakeholders to review strategy areas and actions.

4. Compile a final Green Infrastructure Strategy document as a roadmap for future green infrastructure assets in the City.

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