A Scan of Natural Infrastructure Approaches

Bright Spots from the City of Nelson, Halifax Regional Municipality, and EPCOR

IISD REPORT

IISD | Natural Infrastructure for Water Solutions

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Natural Infrastructure for Water Solutions

Natural Infrastructure for Water Solutions (NIWS) is a 5-year initiative (2022 to 2026) led by IISD to scale up natural infrastructure across the Canadian prairies (Manitoba, Saskatchewan, and Alberta). The NIWS initiative aims for natural infrastructure to be well-understood, adopted, financed, and enabled by policy.

While science and policy are the foundation for this work, IISD is also taking a systems view—looking for opportunities and creative approaches to achieve real impact across the region, working with a network of champions, partners, and decision-makers.

A Scan of Natural Infrastructure Approaches: Bright Spots from the City of Nelson, Halifax Regional Municipality, and EPCOR

March 2024

Written by Ashley Rawluk and Josée Méthot

Photo: iStock

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- City of Nelson: Cecilia Jacques and Natalie Andrijancic
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- EPCOR: Mathew Langford

Indigenous Lands and Cultures

The region we refer to as the Canadian Prairies is home to an incredible diversity of Indigenous cultures. Indigenous Peoples of the Prairie region are rightsholders with robust knowledge and close connection to their traditional lands and with jurisdiction over their territories.

The region of focus for IISD's Natural Infrastructure for Water Solutions (NIWS) initiative spans the traditional lands of over 200 Indigenous territories and homelands across the provinces we call Alberta, Saskatchewan, and Manitoba—including the Indigenous territories of the Cree, Assiniboine, Salteaux, Lakota, Dakota, Anishinaabe, Ojibwe, Oji-Cree, Blackfoot, Nakota Sioux, Iroquois Tsuut'ina, Stoney Nakoda, and the homeland of the Métis Nation. Water is life, and we have the responsibility to listen to and learn from the knowledge held by those who have lived here since time immemorial.

At IISD's NIWS, we uphold the agency and autonomy of Indigenous Peoples, supporting their efforts to revitalize and engage with their heritage across traditional, contemporary, and future contexts. We offer respect to those who have long lived with and stewarded lands and waters across the Prairies and recognize the ongoing leadership of First Nations and Métis communities.

We encourage everyone to visit native-land.ca to learn more about traditional lands and treaties across the Prairies.

Executive Summary

Local governments are responsible for delivering day-to-day services that their residents require, such as drinking water, wastewater treatment, stormwater management, flood protection, and rural drainage. These services are typically delivered with traditional grey infrastructure like dams, pipes, storm drains, and water treatment facilities. However, there is growing interest in natural infrastructure to enhance the delivery of these services, particularly with the growing threat of climate change. Local governments possess significant management and regulatory responsibility, making them well placed to be significant drivers in furthering natural infrastructure strategies.

While natural infrastructure is not yet considered mainstream, several jurisdictions across Canada are currently paving the way and successfully implementing natural infrastructure to help deliver municipal services. This review identifies bright spots—effective and positive examples of policy change—from three jurisdictions: the City of Nelson, Halifax Regional Municipality, and EPCOR. Each represents illustrative models for natural infrastructure implementation in various administrative, jurisdictional, and geographic contexts.

This review shows that successfully implementing natural infrastructure requires a multipronged approach that is best embedded within policies, plans, and programs, while leveraging collaboration to guide practical implementation. Some key bright spots that can illuminate paths forward for other communities include

- leveraging local bylaws to support implementation;
- embedding natural infrastructure across multiple levels of policy and planning for better delivery of natural infrastructure on the ground;
- taking a hybrid approach that combines natural infrastructure and grey infrastructure to reduce risk and improve service delivery in the face of climate change;
- collaborating with other departments to help normalize and scale up natural infrastructure for service delivery.

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Abbreviations and Acronyms

HGNP	Halifax Green Network Plan
HRM	Halifax Regional Municipality
IISD	International Institute for Sustainable Development
LID	low-impact development
Nelson	City of Nelson
NIWS	Natural Infrastructure for Water Solutions
OCP	Official Community Plan
SIRP	Stormwater Integrated Resource Plan

Glossary

Asset management	The process of "inventorying a community's existing assets, determining the current state of those assets, and preparing and implementing a plan to maintain or replace those assets" (Municipal Natural Assets Initiative, 2018, p. 4).
Benefits	The range of outcomes (economic, social, environmental, and cultural) provided by solutions to meet infrastructure outcomes. Co-benefits are the multiple secondary benefits of solutions, such as improved biodiversity, carbon sequestration and storage, enhanced well-being, and opportunities for recreational activities (Horizon Advisors, 2019).
Grey infrastructure	Human-made structures, such as dams, roads, ditches, pipes, water treatment facilities, storm drains, and bridges, that are often (but not exclusively) constructed from materials such as concrete and steel. Grey infrastructure is typically intended to meet targeted infrastructure outcomes (Canadian Council of Ministers of the Environment, 2021).
Hybrid infrastructure	The use of natural infrastructure to complement or augment grey infrastructure to achieve more resilient infrastructure outcomes (Canadian Council of Ministers of the Environment, 2021).
Low-impact development	Practices typically used in urban stormwater management by applying or mimicking natural processes (e.g., increasing the infiltration of stormwater into the soil) to manage runoff as close to its source as possible (Canadian Council of Ministers of the Environment, 2021). Examples of low-impact development include rain gardens, bioswales, soil cells, permeable pavement, and rainwater harvesting.
Natural infrastructure	Conserved, restored, or engineered ecosystems that provide specific infrastructure outcomes, such as flood protection, as well as a variety of co-benefits that support the environment, the economy, and community well-being (Infrastructure Canada, 2018).
Natural assets (also called "natural capital" assets)	"Ecosystems or ecosystem components considered in terms of their value to society, particularly for the benefits they provide, such as water purification or flood mitigation. These assets can be assessed and managed to ensure ongoing infrastructure outcomes and other benefits to people through the ecosystem services they provide" (Horizon Advisors, 2019).

1.0 Purpose and Approach

As local governments and communities across Canada grapple with the need to provide reliable water infrastructure services in the face of climate change and an increasing funding gap (Méthot et al., 2023), natural infrastructure is increasingly being seen as an affordable and effective infrastructure option at local scales.

This review presents an overview of approaches to natural infrastructure implementation in three jurisdictions: a mid-sized municipality in British Columbia, a regional municipality in Nova Scotia, and a municipally controlled utility provider in Alberta. Many studies have examined the challenges of natural infrastructure implementation at local scales: these include limited financial and staff resources, fragmented responsibilities across jurisdictions, and a preference for "proven" grey infrastructure (Cairns & Hallsworth, 2021; Méthot et al., 2023; United States Environmental Protection Agency, 2023). This review seeks to identify "bright spots," i.e., effective and positive examples of change, focused on the policy and planning context that shapes implementation efforts.

Specifically, this review looks at natural infrastructure bright spots from the City of Nelson in British Columbia, Halifax Regional Municipality (HRM) in Nova Scotia, and EPCOR in Edmonton, Alberta.

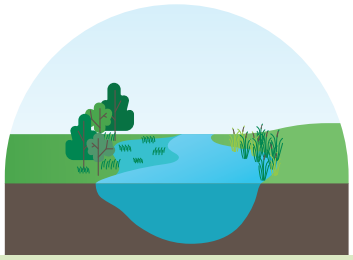
Taken together, the review explores various approaches that can inform the development and implementation of natural infrastructure in different contexts, with an emphasis on the delivery of water services (potable water, stormwater, and wastewater) and the integration of water management into other planning efforts, like policy plans, open space plans, and capital improvement plans. While the jurisdictions use varying terms (e.g., "green infrastructure," "natural assets," or "low-impact development" [LID]), this scan considers them synonymous with natural infrastructure. The Natural Infrastructure Framework: Key Concepts, Definitions and Terms (Canadian Council of Ministers of the Environment, 2021) includes helpful definitions for further differentiation.

2.0 Natural Infrastructure at the Local Level

As the impacts of a changing climate become more apparent, with drought, floods, and other climate hazards growing increasingly frequent and more devastating, local governments and service providers are seeking practical solutions to mitigate these risks and support sustainable, climate-resilient communities. Natural infrastructure is defined as a way to plan and work with nature to meet our infrastructure needs. It uses conserved, restored, or engineered ecosystems to deliver targeted infrastructure services, such as flood protection or water treatment, while also providing a variety of social, economic, and environmental co-benefits (Méthot & Rawluk, 2023). Natural infrastructure can be a conserved ecosystem, a restored ecosystem, or even a nature-based engineered feature (Figure 1).

Natural infrastructure alone will not meet all municipal and watershed needs for water services. However, a hybrid infrastructure approach, where natural infrastructure is integrated to complement grey infrastructure, can achieve more resilient and effective infrastructure outcomes.

Figure 1. Description and examples of natural infrastructure—conserved, restored, and engineered ecosystems



Conserved Ecosystems

Conserving existing natural ecosystems to prevent their loss and/or optimizing their function to enhance infrastructure outcomes

Examples

Wetland, grassland, floodplain, and forest conservation, riparian buffers, and urban tree canopy

Restored Ecosystems

Restoring or enhancing degraded ecosystems to deliver infrastructure outcomes

Examples

Wetland, grassland, floodplain, and forest restoration, riparian buffers, and urban tree canopy

Engineered Ecosystems

Engineering and constructing new ecosystems that incorporate ecosystem features to deliver infrastructure outcomes

Examples

Constructed wetlands, water retention sites, floating treatment wetlands, soil cells, green roofs, and bioswales

Source: Authors' diagram.

The current implementation of natural infrastructure is characterized by slow rates of adoption and a patchwork of projects in Canada (Anderson & Gough, 2022; Eyzaguirre et al., 2023) and across the Canadian Prairies region (Méthot et al., 2023). While there are some leading examples, a targeted effort is needed to better equip local governments with the information, capacity, funding, and support required to support meaningful implementation of natural infrastructure. This report is part of IISD's Natural Infrastructure for Water Solutions (NIWS) initiative (Box 1) and offers preliminary insights in leading approaches applied in jurisdictions across Canada that will inform more targeted work in the Canadian Prairies region.

Box 1. Natural Infrastructure for Water Solutions

"Taking natural infrastructure from novel to normal."

NIWS is a 5-year initiative (2022 to 2026) led by IISD to help scale up natural infrastructure for cleaner water and more resilient communities across the Canadian Prairies region. Working with partners, including the Natural Assets Initiative, NIWS aims for natural infrastructure to be backed by evidence, adopted at local scales, financed, and enabled by policy.

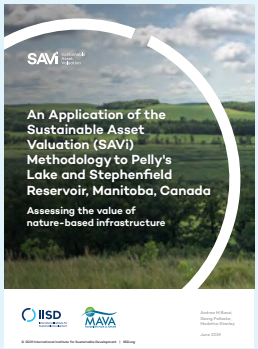
IISD's expertise has contributed to the growing momentum behind natural infrastructure in Canada and internationally. Through the NIWS initiative and affiliated efforts—including IISD's Nature-Based Infrastructure Global Resource Centre and Nature for Climate Adaptation Initiative—IISD and partners will build upon the illustrative work below to help scale natural infrastructure for water solutions, informed by the priorities and needs of key partners and communities across the Prairies.

Examining the current implementation of natural infrastructure and suggested paths to scale.

READ

Identifying drivers for the funding and financing of natural infrastructure.

READ



Assessing the value of natural infrastructure in Canada and internationally using the SAVi methodology.

READ

Advancing the climate resilience of Canadian infrastructure, including water infrastructure.

READ

2.1 The Water Infrastructure Needs of Local Governments

Local governments own and manage over 60% of Canadian infrastructure assets (Federation of Canadian Municipalities, 2023), including water infrastructure that delivers day-to-day services that residents need, like drinking water, wastewater treatment, stormwater management, flood protection, and rural drainage. While grey infrastructure, which includes human-made structures like dams, pipes, storm drains, and water treatment facilities, is the default approach to delivering water infrastructure services, natural infrastructure can also contribute to meeting these needs.

Local governments also manage other infrastructure, like transportation networks, roads, and waste management, that influences surface water and groundwater. They oversee land-use planning, development planning, and parks and green area planning within their boundaries, where there are clear opportunities to incorporate natural infrastructure into infrastructure decision making at the local level. Finally, local governments also influence decisions regarding privately owned land, where homeowners are encouraged to install LID, like rain gardens, or urban developers are required to construct naturalized stormwater ponds to capture stormwater in new subdivisions. With this breadth of management and regulatory responsibility, local governments are well placed to be significant drivers in furthering natural infrastructure strategies on the ground. Multiple strategies are needed to help boost natural infrastructure adoption at local scales related to policies, statutory and non-statutory plans (Box 2), best practices, funding sources, and economic performance.

Box 2. Statutory and non-statutory plans

Local governments often use two types of plans: statutory and non-statutory plans (City of Edmonton, n.d.). Although each jurisdiction will have a specific definition, these plans may be understood as follows:

1. Statutory plans are adopted by the local council as legal documents, requiring a particular number of readings at a public hearing. Types of statutory plans include regional plans, area structure plans, and municipal development plans.
2. Non-statutory plans are guidance documents and are also adopted by the local council. These types of plans are also developed with public consultation, evidence, and best practices, providing guidance for decision making. Types of non-statutory plans include design guidelines, planning strategies, and implementation plans. Climate change action plans are a common example.

2.2 Bright Spots

The term "bright spots" is an academic concept to identify outliers that perform substantially better than expected (Bennett et al., 2016; Cinner et al., 2016). The bright spots approach may help identify new and actionable strategies while promoting optimism among those working to make change (Cvitanovic & Hobday, 2018). In this scan, the bright spots approach helps to highlight key strategies that support natural infrastructure implementation in different jurisdictions.

In the following case studies, we highlight bright spots in three jurisdictions, with a focus on how natural infrastructure is being supported or implemented to deliver water infrastructure services related to drinking water, stormwater, wastewater, flood protection, or similar services.

Bright spots help to highlight effective and positive examples of change.

3.0 City of Nelson

3.1 Overview

About the City of Nelson

Nelson is a small urban municipality of 11,106 people with an area of 12 km^2 (Statistics Canada, 2022) in the Regional District of Central Kootenay, an administrative district in southeastern British Columbia. It is in the traditional territory of the Ktunaxa, the Syilx, and the Sinixt peoples (City of Nelson, 2022). Nelson lies on the West Arm of Kootenay Lake in the Kootenay River watershed (Watersheds BC, 2022). The primary water source for the city is Five Mile Creek, which empties into Kootenay Lake to the city's northeast (City of Nelson, n.d.-b).

What is a city in British Columbia?

British Columbia's Local Government Act designates a community with more than 5,000 people as a city (Government of British Columbia, 2015).

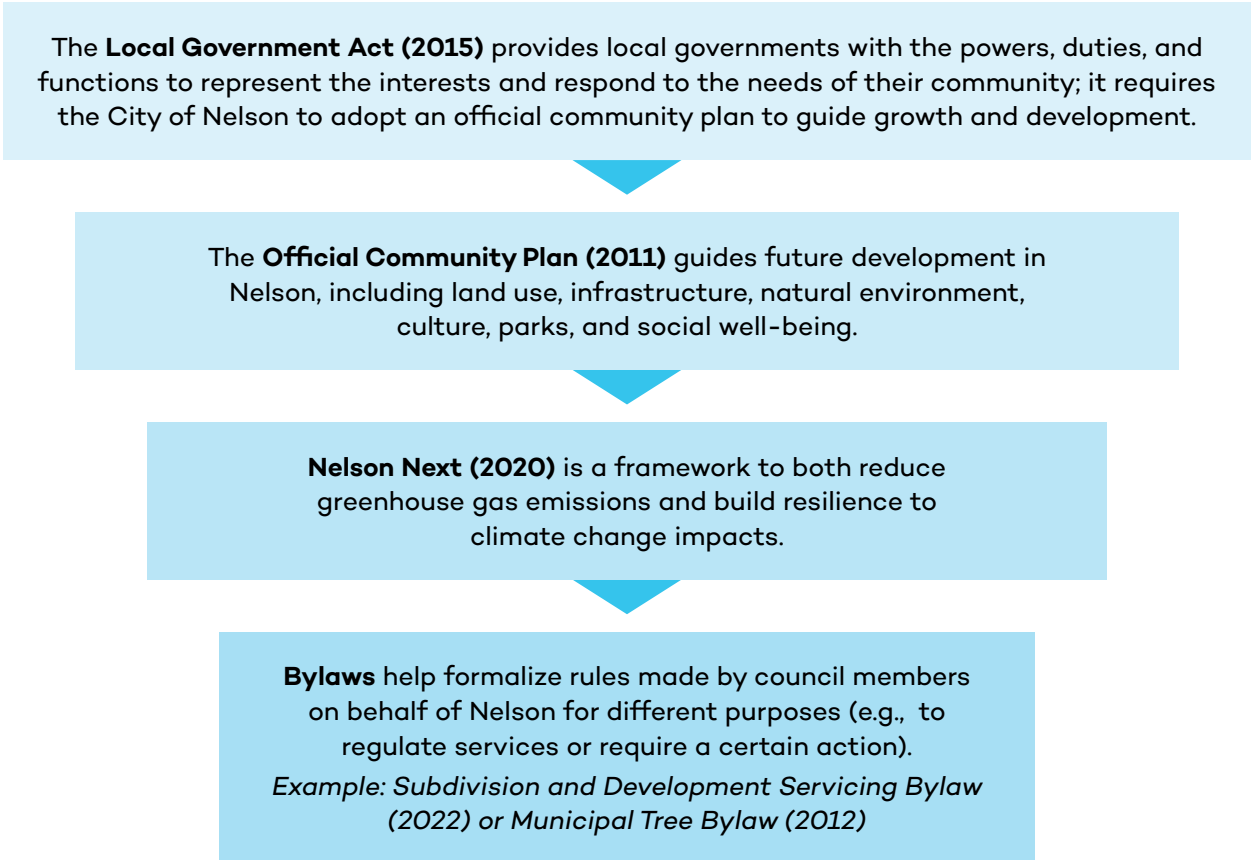
Why the City of Nelson?

As a small urban municipality, Nelson has local bylaws that support water-related natural infrastructure strategies, also supported by high-level planning policy (Figure 2). While Nelson uses terms like "green infrastructure," "green technologies," and "LID," there are no specific definitions for these terms or specific references to natural infrastructure in the planning documents or bylaws reviewed.

Policy and Planning Mechanisms Supporting Natural Infrastructure

Nelson has a hierarchy of policy and planning mechanisms to guide growth across the region (Figure 2).

Figure 2. The City of Nelson's hierarchy of planning documents reviewed in this report



Source: Authors' diagram.

Official Community Plan

Development in Nelson is guided by the Official Community Plan (OCP) (City of Nelson, 2013), adopted by bylaw and prepared in accordance with the requirements of British Columbia's Local Government Act. Nelson is initiating an update to the OCP, anticipated to take 2 years, spanning 2023 to early 2025 (City of Nelson, n.d.-b).

Nelson's OCP provides direction on specific natural infrastructure strategies that support implementation at a bylaw level. For example, the OCP suggests that street trees should consist of native species that are appropriate to the area and strategically placed "to help regulate climate, control stormwater, cleanse air and water, and provide habitat" (City of Nelson, 2013, p. 53). The OCP also requires stormwater runoff from commercial developments to be treated using low-impact treatment measures, including bioswales, rain gardens, engineered treatment units, and constructed wetlands before emptying into the stormwater system.

Nelson Next

Nelson recently released a comprehensive climate change action plan called Nelson Next, which has a coordinated, collaborative, and evidence-based approach to both prepare for the anticipated impacts of climate change (adaptation) and reduce carbon emissions (mitigation) (City of Nelson, 2020). Nelson Next identifies seven aspirational goals to guide the city's efforts on climate action, including Aspiration Four, where "Nelson's natural ecosystems and the services they provide us are healthy, abundant, and diverse" (City of Nelson, 2020, pg. 47). Aspiration Four recognizes the co-benefits of natural ecosystems and how green infrastructure contributes to a reduction of carbon emissions. To help meet this Aspiration, the city suggests a variety green infrastructure approaches and mechanisms, including

- performing a natural asset inventory;
- developing and implementing an Urban Forest and Biodiversity Master Plan;
- looking into converting a public area into a "Water Square," or tiered water collection pool, that also provides arts and recreation space;
- exploring green infrastructure opportunities for city-owned buildings and piloting a green roof demonstration site on a community building;
- formalizing existing biodiversity corridors and developing and connecting additional ones;
- providing incentives for landowners to maintain and protect trees of a particular age and size on their land;
- developing a Green Roof and Walls bylaw or incentive.

Nelson Next also has a strong framework to implement and evaluate the city's progress, with an in-depth plan update scheduled for 2025.

Bylaws

Nelson's bylaws are notable in providing direction on natural infrastructure implementation. The Subdivision and Development Servicing Bylaw supports the goals and objectives of Nelson's OCP with enforceable design standards and a noteworthy strategy to providing infrastructure services in an urban environment using natural infrastructure approaches[1] (City of Nelson, 2013). The bylaw specifies lot stormwater detention requirements, indicated as storage rates and maximum allowable release rates, and lists "dry detention ponds, rain gardens, and swales" as possible storage alternatives for meeting the stormwater requirements (City of Nelson, 2011, p. 60). This policy encourages the use of natural infrastructure strategies for onsite stormwater management as property owners and developers attempt to satisfy the bylaw requirements.

Nelson's Municipal Tree Bylaw, enacted in 2012 in accordance with the Tree Management Plan, helps to ensure the protection of the city's trees. This bylaw sets clear rules for the pruning,

[1] Note, the term "natural infrastructure" is not specifically used but suggests approaches that the review considers as natural infrastructure.

planting, and removal of trees on public property, such as prohibiting the destruction of trees unless the city has deemed it necessary and establishing financial penalties (up to CAD 10,000) for noncompliance (City of Nelson, 2012). Although this bylaw does not provide guidance or requirements for the installation of new trees, the conservation of existing trees helps ensure the long-term viability of this type of natural infrastructure.

Example of Natural Infrastructure in Nelson

Nelson's urban forests and tree canopy are a complex and crucial part of the city's identity and natural landscape (Figure 3). Nelson has long recognized the value of the community's trees in the OCP, Tree Management Plan, and Municipal Tree Bylaw. However, Nelson Next prioritized the need to update current plans and policies by developing and implementing an Urban Forest and Biodiversity Master Plan. To kickstart this effort, Neweduk et al. (2023) completed an assessment of Nelson's current planning environment, social and political context, and existing engagement strategies to assess the existing approach to urban forestry. The report examines case studies of current best practices as Nelson begins to update its approach and plan for urban forestry to acknowledge, value, and manage it as a natural asset.

Figure 3. Nelson's urban tree canopy

Source: Joy McAdams.

3.2 Bright Spot in the City of Nelson

Smaller municipalities can successfully implement natural infrastructure, and local bylaws are critical.

Nelson has been successful in developing and implementing policy and bylaws that support the implementation of natural infrastructure in land development, doing so with a smaller planning department and the guidance of a limited number of comprehensive planning documents, as compared to large urban centres.

Strong bylaws further stand out as an enabling factor that supports natural infrastructure. For example, the design standards in Nelson's Subdivision and Development Servicing Bylaw clarify and facilitate the application of natural infrastructure approaches, including rain gardens, bioretention swales, and constructed wetlands, as best management practices for water quality control to "be considered and implemented where practical" (City of Nelson, 2011, p. 67). These types of natural infrastructure further complete Nelson's OCP, which suggests that communities' resiliency is dependent on their "ability to continue to build local, green infrastructure that uses resources thriftily and efficiently" (City of Nelson, 2013, p. 8), suggesting sustainable design features like LID to treat stormwater prior to its entering the stormwater system, emphasizing the use, retention, and restoration of native vegetation, planting trees, increasing the depth of topsoil, using permeable paving surfaces, and installing naturalized ponds, bioswales, or rain gardens to capture rainwater (City of Nelson, 2013).

4.0 Halifax Regional Municipality

4.1 Overview

About the Halifax Regional Municipality

HRM is a regional municipality in Nova Scotia. It includes four municipalities that amalgamated in 1996: the City of Halifax, the City of Dartmouth, the Town of Bedford, and Halifax County (HRM, 2022). HRM is the capital of Nova Scotia, with 480,582 residents, approximately 49% of Nova Scotia's population, and an area of almost 5,500 km^2 (HRM, 2023a). HRM is a unique blend of both suburban and rural areas, with a concentrated urban mix spanning over 200 communities.

HRM is located on the ancestral and traditional lands of the Mi'kmaq people, with three Mi'kmaw Nation communities having reserve lands within the region (Acadia, Sipekne'katik, and Millbrook) (HRM, n.d.-a).

What is a regional municipality in Nova Scotia?

In the context of HRM, a regional municipality is a single level of government that provides municipal services to its urban, suburban, and rural communities across a continuous region. The regional municipality shares elected leaders, administration, and financial resources, as well as its common vision for residential, commercial, and industrial growth and environmental sustainability (HRM, 2023a).

Municipal water, wastewater, and stormwater services are provided across HRM by the Halifax Regional Water Commission (Halifax Water). Halifax Water is an autonomous, self-financed utility owned by HRM and operates on a cost-of-service basis (Halifax Water, 2020).

Why the Halifax Regional Municipality?

HRM takes a comprehensive, regional approach to its planning policies, placing it in a strong position to actually build natural infrastructure solutions on the ground. The entire suite of planning documents explicitly uses terms like "green infrastructure" and "natural assets"[2] and is well cross-referenced, with primary planning documents guiding lower-level plans, which, in turn, support the implementation of the objectives of the various strategies.

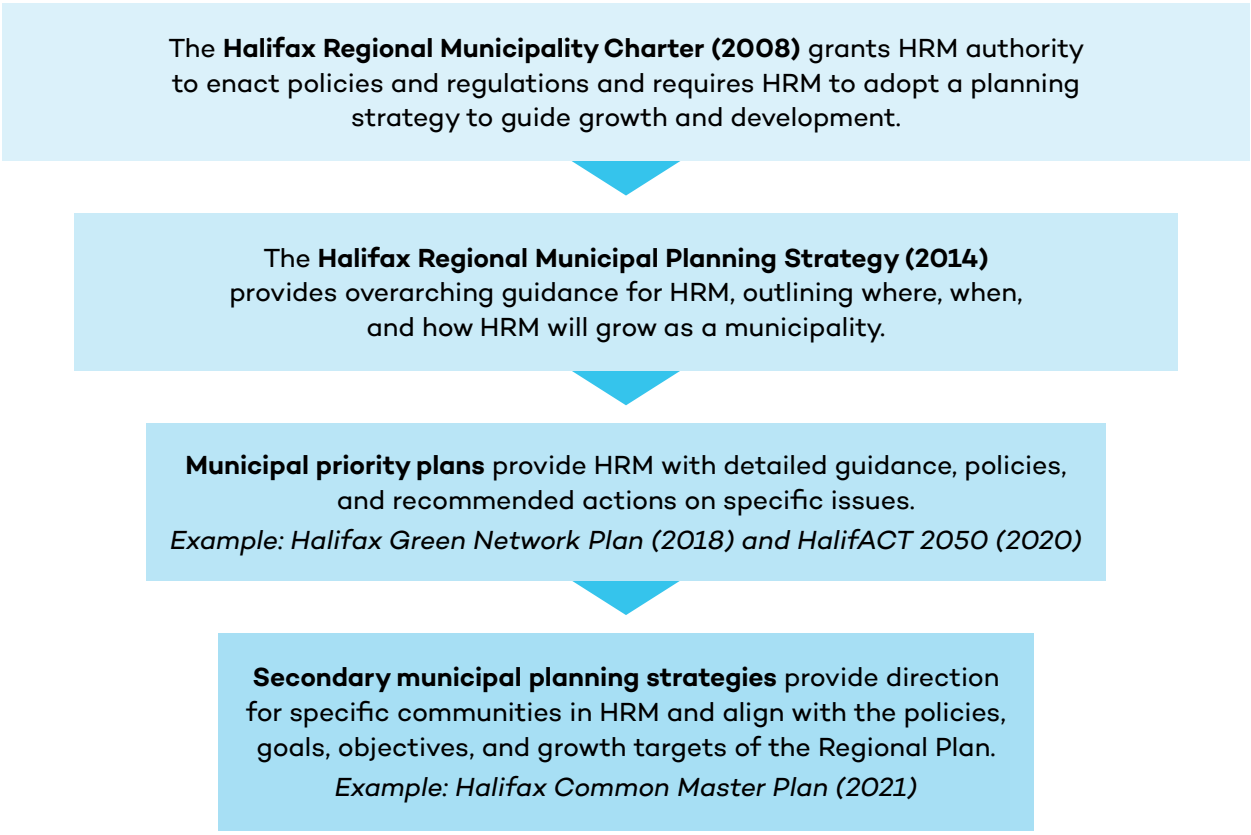
[2] Green infrastructure is defined by HRM as "a network of natural and semi-natural engineered landscape elements designed to provide products and services such as stormwater management, water filtration and improved air quality" (HRM, 2018, p. 100). Natural assets are defined by HRM as "natural resources (finite or renewable) and ecosystems that provide direct or indirect benefits to the economy, our society, and the world around us" (HRM, 2020, p. 43).

Additionally, HRM recognizes that existing bylaws may require amendments to support natural infrastructure implementation, as well as to protect water sources, guided by its planning policies.

Policy and Planning Mechanisms Supporting Natural Infrastructure

HRM has a hierarchy of planning policies to guide growth across the region (Figure 4).

Figure 4. Halifax Regional Municipality's hierarchy of planning documents reviewed in this report



Source: Authors' diagram.

Halifax Regional Municipality Charter

The Halifax Regional Municipality Charter grants HRM the municipal authority and tools to enact policies and regulations, requiring that it adopt a planning strategy to guide growth and development in the region (Province of Nova Scotia, 2022).

Halifax Regional Municipal Planning Strategy

Most recently updated in 2014, the Halifax Regional Municipal Planning Strategy (also called the Regional Plan), has provided the overarching guidance (HRM, 2014), outlining "where, when, and how" HRM will grow as a municipality. The Regional Plan strives to conserve natural ecosystems by implementing development practices that curb harmful impacts on water, land, and air. The Regional Plan suggests developing an integrated system of natural areas, parks, trails, and corridors, outlining policies to protect water supplies, wetlands, and riparian buffer zones with designated park and conservation zones (HRM, 2014).

Box 3. Updating the Regional Plan

As of fall 2023, the Regional Plan is currently under review. The Draft Regional Plan is an update of the existing plan, with a rewrite of each chapter (Shape your City Halifax, n.d.), and the incorporation of recently developed priority plans. The Draft Regional Plan is proposed to further strengthen HRM's prioritization of natural infrastructure, with approaches that will direct future urban development to existing urbanized areas to protect natural spaces, develop a natural asset framework, and identify private and public lands that perform important environmental services for the Open Space and Natural Resource Designation (HRM, 2023a).

The 2014 Regional Plan acknowledges natural infrastructure as a necessary means of addressing climate change and delivering municipal water services and includes the following principles (HRM, 2014, p. 3):

- "Preserves and promote sustainability of cultural, historical, and natural assets";
- "Manages development to make the most effective use of land, energy, infrastructure, public services, and facilities, and foster healthy lifestyles"; and
- "Ensures opportunities for the protection of open space, wilderness, natural beauty, and sensitive environmental areas."

Additionally, the Regional Plan requires that secondary planning designs include consideration for "community-scale or site-level green infrastructure" (HRM, 2014, p. 114).

Municipal Priority Plans: Halifax Green Network Plan and HalifACT

Municipal Priority Plans provide HRM with detailed guidance, policies, and actions on specific issues, setting the long-term direction for municipal decisions and investments and incorporating the desires of residents, stakeholders, and the regional council (Shape Your City Halifax, n.d.). Since the last Regional Plan was reviewed in 2014, HRM has adopted some Priority Plans that will be incorporated into the updated Regional Plan, including the Halifax Green Network Plan (HGNP) and HalifACT.

The HGNP, adopted in 2018 as a framework to amend the Regional Plan and secondary planning strategies, provides design direction to preserve and manage open space. It includes objectives specific to natural infrastructure, such as the following (HRM, 2018):

- maintaining ecologically and culturally important lands
- promoting sustainable usage of natural resources and economically important open spaces
- identifying and planning for lands that are well suited for parks and corridors
- recognizing the ecological functions of riparian areas, wetlands, and urban forests as being critical to ensuring and managing water quality and quantity as climate patterns change.

The HGNP also includes actions for HRM to work with Halifax Water and Nova Scotia Environment to promote natural infrastructure, like naturalized stormwater ponds, as the preferred approach to stormwater management and to develop specification documents to promote natural infrastructure development on private property (HRM, 2018).

HalifACT, adopted in 2020, is HRM's long-term climate action plan to reduce emissions and help communities adapt to climate change. HalifACT incorporates natural infrastructure in its actions for Decarbonized and Resilient Infrastructure, highlighting that it is a core component of stormwater management, particularly in preparation for future climate conditions and risks (HRM, 2020). There is also a specific objective to "protect, restore, maintain, and expand natural areas and green infrastructure assets" (HRM, 2020, p. 40).

Secondary Municipal Planning Strategies

HRM has 21 community plan areas, each with its own set of land-use bylaws and policies specific to its area. The Regional Plan is the overarching planning document that guides growth across all of HRM, while the Secondary Municipal Planning Strategies provide detailed guidance to further the goals of the Regional Plan at the community and neighbourhood level (HRM, 2019). Secondary Municipal Planning Strategies and land-use bylaws, either in the development of new plans or the amendment of existing plans, must align with the policies, goals, objectives, and growth targets of the Regional Plan. Secondary Municipal Planning Strategies are also supported by municipal priority plans, like the HGNP and HalifACT.

A review of two Secondary Municipal Planning Strategies[3] demonstrates that natural infrastructure is included in these secondary documents as directed by the Regional Plan. The Regional Centre Secondary Municipal Planning Strategy outlines policy requirements to "incorporate naturalization and green infrastructure in parkland maintenance" (HRM, 2019, p. 208). The Halifax Common Master Plan makes natural infrastructure a key consideration and identifies the Halifax Common to have "large-scale urban green spaces can provide an exciting testing ground for low-impact green infrastructure that will be critical to helping the municipality

[3] Additional Secondary Municipal Planning Strategies exist but were not reviewed in this scan.

meet its sustainability goals and build resilience to an uncertain future" (HTFC Planning & Design, UPLAND, Planning & Design, & CoLab, 2021, p. 94).

Example of Natural Infrastructure in the Halifax Regional Municipality

In Eastern Passage, a suburban community within HRM, there is grey infrastructure like riprap and hard armour installed along Shore Road to mitigate against frequent storms. However, severe erosion, road washouts, and road closures happen regardless. As severe storms are expected to increase with climate change, HRM needs a new approach to avoid costly repairs and frequent closures of a key access route. The Building with Nature project is one solution. In alignment with the HGNP and HalifACT, HRM will implement natural infrastructure along a 555-metre section of Shore Road, which includes the restoration of the cobble beach with native vegetation and a breakwater, as well as a raised permeable waterfront trail with native vegetation and rain gardens (Figure 5; HRM, n.d.-b). The natural infrastructure will dissipate the waves and reduce erosion, improve the quality of stormwater runoff, increase green space and public access to nature, and enhance habitat connectivity.

The project is estimated to cost CAD 5 million, with 60% funded by the federal Natural Infrastructure Fund and the remainder funded by HRM through HalifACT (HRM, 2023b). Planning and public engagement are underway, with construction anticipated to begin in 2024 (HRM, n.d.-b).

Figure 5. Shore Road, before the Building With Nature Project

Source: Suzanne Rent/Halifax Examiner.

4.2 Bright Spot in the Halifax Regional Municipality

HRM embeds natural infrastructure across multiple levels of policy and planning.

HRM's comprehensive regional-level and area-specific policy and planning mechanisms that specifically use "green infrastructure" and "natural assets" put the regional municipality in a strong policy position to deliver natural infrastructure on the ground. The Regional Plan's vision and objectives guide the lower-level plans, such as municipal priority plans and secondary municipal planning strategies, which in turn support the implementation of the policies and objectives of the planning strategy.

The Regional Plan acknowledges natural infrastructure as a necessary means to address climate change and deliver municipal water services (HRM, 2014), also requiring secondary municipal planning strategies to consider "community-scale or site-level green infrastructure" (HRM, 2014, p. 114). This emphasis on natural infrastructure continues in the HGNP and HalifACT. The Building with Nature Project for Shore Road is a great example where municipal priority plans guide the on-the-ground implementation of natural infrastructure. Additionally, HalifACT recognizes that existing bylaws may require amendments to protect, restore, and expand natural areas and green infrastructure in support of infrastructure services and increased adaptative capacity (HRM, 2020). To further support the implementation of natural infrastructure, HRM is currently working on developing engineering design standards for specific green infrastructure for inclusion in municipal design standards and specifications (H. Langille, personal communication, September 5, 2023).

Natural infrastructure strategies are explicitly named in the Regional Centre Secondary Municipal Planning Strategy (HRM, 2021), providing an example of how lower-level plans interlock with the higher-order objectives of the Regional Plan. This strategy mandates that the design of landscapes and facilities incorporate natural infrastructure, such as pervious surfaces and added vegetation (HRM, 2021, p. 96).

Even while clear direction is provided through the Regional Plan and subsequent policies and planning mechanisms, there remains a gap between the design and implementation of natural infrastructure. While the planning mechanisms and the upcoming design standards and specifications are useful, capacity shortages may limit HRM's ability to use natural infrastructure to its maximum potential.

5.0 EPCOR

5.1 Overview

About EPCOR

EPCOR is a municipal controlled corporation, with the City of Edmonton as the sole shareholder. EPCOR builds, owns, and operates electrical, natural gas, and water transmission and distribution networks, water and wastewater treatment facilities, sanitary and stormwater systems, and infrastructure in Canada (British Columbia, Alberta, Saskatchewan, and Ontario) and the United States (Arizona, New Mexico, and Texas) (EPCOR, n.d.-a). The wastewater and stormwater collection components of EPCOR's utility mix were transferred from the City of Edmonton in 2017. EPCOR now provides wastewater and stormwater servicing for almost 1 million residents in Edmonton, carrying wastewater from homes and businesses and stormwater from streets and properties. Additionally, EPCOR provides bulk water sales for more than 90 communities and counties in the Edmonton Metropolitan Region (EPCOR, n.d.-a.).

What is a municipal controlled corporation in Alberta?

Regulated by the Municipal Government Act, a municipal controlled corporation is a separate, for-profit entity that is controlled by a municipality(s) to provide a regional municipal service or facility. A municipal controlled corporation can hire staff, administer payrolls, own property, and raise capital independent of the municipalities involved (Government of Alberta, n.d.).

EPCOR has facilities within Amiskwaciwâskahikan (meaning Beaver Hills House), the Cree name for the Edmonton area. Their water treatment facilities are located along the banks of the North Saskatchewan River on Treaty 6 territory, a sacred gathering place on the traditional lands of the Blackfoot, the Cree, the Dene, the Nakota Sioux, the Saulteaux, and the Métis (EPCOR, n.d.-b.). As of 2021, EPCOR had engagement and participation with over 80% of the Indigenous communities that it works with (EPCOR, n.d.-b.).

Why EPCOR?

EPCOR is committed to mitigating flood risk by ensuring the safe movement of stormwater through a multipronged approach that combines comprehensive plans and committed funding with design standards and collaborative implementation for prioritized types of LID.[4] EPCOR uses a mix of distributed storage infrastructure, including LID, to slow the rate of stormwater entering the sewer system, reducing demand on the stormwater system, both on public land and with private landowners in areas that have a high risk of flooding (Mathew Langford, personal communication). EPCOR implements LID as a tool to reduce flood risk while also taking advantage of co-benefits, including improved water quality, greenhouse gas mitigation, reduced urban heat island effects, climate change adaptation, community beautification, and air quality improvements (Credit Valley Conservation, 2021). To date, EPCOR has standardized the design and construction of five types of LID and is continually analyzing alternative options for future implementation:

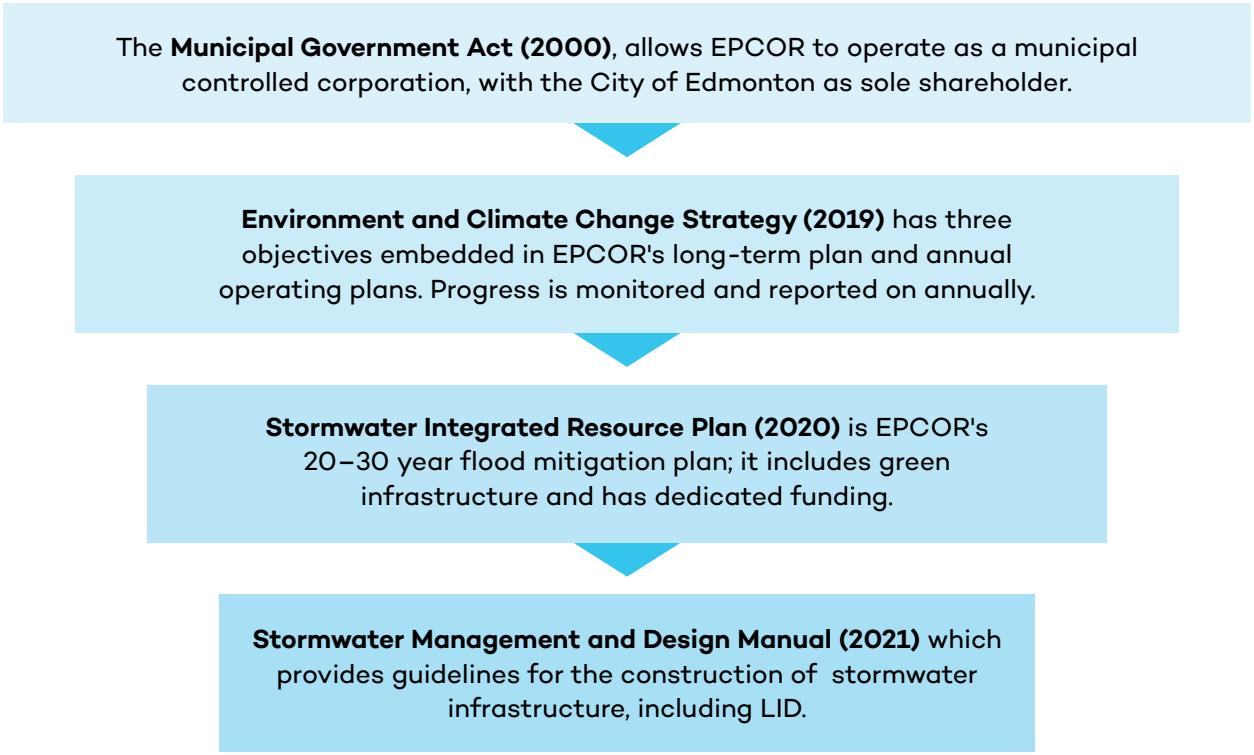
- bioretention or rain gardens
- bioretention basins
- box planters
- soil cells
- absorbent landscaping.

What Are the Policy and Planning Mechanisms Supporting Natural Infrastructure?

EPCOR is guided by a hierarchy of policy and planning mechanisms that prioritize and guide the implementation of natural infrastructure across the region (Figure 6).

[4] EPCOR defines LID as "a type of stormwater management facility that incorporates plants, engineered soils and natural processes to capture stormwater runoff close to its source. Stormwater enters the LID and flows into the engineered soil layer with the ability to capture, and filter stormwater. Specially selected plants then absorb the water, or it evaporates. Any excess water that isn't used by the plants and soils drains into the stormwater system" (EPCOR, n.d.-c.).

Figure 6. EPCOR's hierarchy of planning documents reviewed in this report



Source: Authors' diagram.

The Municipal Government Act

The Municipally Controlled Corporations Regulation, under the Municipal Government Act (2000), allows EPCOR to build, own, and operate electrical, natural gas, and water infrastructure and services. The City of Edmonton is the sole shareholder, and EPCOR is a separate, for-profit entity with its own staff, property, facilities, and administrative structure.

Environment and Climate Change Strategy

The Environment and Climate Change Strategy (2019) has three objectives (EPCOR, n.d.-d.):

- Reduce EPCOR's environmental footprint.
- Improve the resilience of EPCOR's infrastructure.
- Support communities and clients to reduce their environmental footprint and increase resilience.

These objectives are implemented in EPCOR's projects, supported by the integration into their long-term plan and annual operating plans, guided by climate change projections for the region. Progress is monitored and reported on annually.

Stormwater Integrated Resource Plan

Edmonton, like other prairie cities, frequently experiences flooding from spring snowmelt and heavy rainfalls, impacting homes, businesses, and essential services. To mitigate flooding from stormwater, EPCOR launched the Stormwater Integrated Resource Plan (SIRP), a 20–30-year, CAD 1.6 billion system-wide plan (EPCOR, n.d.-e.), where about half of the funding is dedicated to LID and dry ponds[5] (Credit Valley Conservation, 2021).

SIRP was developed in alignment with the Climate Resilient Edmonton Adaptation Strategy and Action Plan (Ancel, 2021), determining actions based on a detailed analysis of the vulnerability to flooding across more than 1,300 drainage sub-basins in Edmonton and further refined with public input (ECPOR, n.d.-e). The goals of SIRP (EPCOR, n.d.-f) are to

- **slow** the entry of stormwater into the existing drainage system by retaining or detaining it in small storage infrastructure or LID (rain gardens, bioretention basins, box planters, and tree soil cells) and holding it in dry ponds;
- **move** excess water by increasing the capacity of the drainage system;
- **secure** individual properties that are at greater risk of sewer backups, overland flooding, and river flooding;
- **predict** the movement of stormwater with smart sensors and technologies for data collection and automated control;
- **respond** quickly to flood emergencies in coordination with the City of Edmonton Office of Emergency Management.

By combining natural infrastructure with grey infrastructure, in a hybrid infrastructure approach, and identifying regions at greatest risk, EPCOR can build greater climate resilience, save money, and see results more quickly than taking a grey infrastructure approach alone. Prioritizing slowing stormwater with LID and dry ponds costs less than moving stormwater with sewer separation and pipe upgrades. Thus, SIRP slows stormwater where it is possible and moves stormwater when it is the only option (Credit Valley Conservation, 2021).

SIRP is an award-winning approach to flood mitigation. It received national recognition as a Clean50 Top Project Award in 2021 and was ranked first (alongside Toronto and Regina) by the Intact Centre on Climate Adaptation among 16 municipalities for their flood mitigation plans (ECPOR, n.d.-e).

As of 2022 and with a portion funded through SIRP, several LID and dry pond projects have been built or are under construction (EPCOR, 2023); six dry ponds are built or are in

[5] Dry ponds are one solution that EPCOR is using as part of its holistic approach to mitigate flooding in Edmonton. A dry pond is a low area within the landscape that can be used for recreation but acts as a surge pond for excess water during storms and floods, removing it from the sewer network (EPCOR, 2023). In addition to flood mitigation, dry ponds are a key feature within in the community, providing greenspace for soccer fields, pathways, tobogganing hills, or naturalized wildlife habitat (EPCOR, 2023).

various phases of development (31 are planned in total), and 73 greened hectares[6] (including bioretention, soil cells, box planters, and small underground storage tanks) have been installed in about 20 locations across Edmonton.

Stormwater Management and Design Manual

EPCOR has developed the *Stormwater Management and Design Manual*, which is Volume 3-02 of the City of Edmonton's Design and Construction Standards, and provides guidelines for the construction of stormwater infrastructure, including LIDs. In addition to design guidance for bioretention (or rain gardens), bioretention basins, box planters, soil cells, and absorbent landscaping, the manual details considerations around site planning, piping and infrastructure, cold climate consideration, vegetation, drawings, construction, soil, and testing (EPCOR, 2022). This additional information is key to the success and function of each LID installation.

There is an advantage to incorporating the *Stormwater Management and Design Manual* in the City of Edmonton's Design and Construction Standards. This helps to ensure that all infrastructure in the City of Edmonton is built to a consistent standard, providing a useful resource if parties beyond EPCOR build LID. Some guidance around suggested species of vegetation for LID is also provided in the Landscape section (Volume 5) of the Design and Construction Standards. The Landscape section (Volume 5) is managed by the City of Edmonton and suggests referencing Volume 3 for additional information (City of Edmonton, 2022).

Example of Natural Infrastructure led by EPCOR

The Old Strathcona Back Street Plaza transformed two former parking lots in an Old Strathcona alley into pedestrian plazas with picnic tables, landscaping, and bike racks (Figure 7). In addition to being an inviting place for visitors as they participate in local programs or shop at the Farmers' Market and local businesses, EPCOR and the City of Edmonton's Building Great Neighbourhoods partnered to implement LID in the design and construction of the upgrade to better manage stormwater. Soil cells were installed below the plaza, which promotes healthy trees by providing loose soil and ample room for root development, while designed to retain a 1:2-year storm event, capturing and storing stormwater to water the trees and reduce the volume of water directed to the stormwater system (City of Edmonton, 2023).

Developed in alignment with SIRP, the Back Street Plaza project received a grant from the Green Municipal Fund for incorporating green infrastructure and received a 2023 Edmonton Urban Design Award of Excellence for Sustainable Urbanism (City of Edmonton, 2023). Early monitoring results show the removal of total suspended solids (79.5%), total phosphorus (69.9%), and total dissolved phosphorus (76.9%) (City of Edmonton, 2023).

[6] Greened hectares are determined by the water volume captured during any storm events (EPCOR, 2023), where 1 greened hectare = 150 m^3 of stormwater managed with LID and small storage tanks during regular rainfall events (Mathew Langford, personal communication).

Figure 7. The Old Strathcona Back Street Plaza, incorporating LID in its redesign

Source: EPCOR.

5.2 Bright Spot With EPCOR

Taking a hybrid approach with natural infrastructure and grey infrastructure provides better outcomes in the face of climate change.

EPCOR cannot provide all its stormwater management services with natural infrastructure alone. However, SIRP takes an integrated approach, combining both natural and conventional strategies to support more resilient infrastructure systems, especially when considering the more unpredictable and extreme weather events that are anticipated with climate change. The integration of LID and dry ponds will reduce pressure on grey stormwater infrastructure while saving money. SIRP will cost CAD 1.6 billion over 30 years, with approximately 59% (CAD 940 million) dedicated to LID and dry ponds. Additionally, the SIRP strategy is coupled with programs to enhance the monitoring network, operational plans to plan for and respond in the event of emergencies, and homeowner education programs to enhance flood resilience at the lot level. The City of Edmonton's previous plan, which exclusively used grey infrastructure, was

estimated to cost between CAD 2.2 billion and CAD 4.6 billion over 80 years and has been less effective at reducing flood risk (Credit Valley Conservation, 2021).

Collaboration With the City of Edmonton

EPCOR is collaborating with the City of Edmonton to share the cost, operation, and maintenance of implementing natural infrastructure.

This will help normalize natural infrastructure by increasing knowledge of the practices, building more LID across the region, and growing the pool of professionals with relevant natural infrastructure experience. Examples of collaboration include the following (Credit Valley Conservation, 2021):

- sharing information with the Climate Change Adaptation Initiative to identify natural infrastructure options for stormwater, that also provide adaptation co-benefits;
- working with relevant departments to design and build LID, such as soil cells, where EPCOR builds the cell and provides the soil, while the City of Edmonton's Urban Forestry department selects, supplies, and maintains the trees, helping to ensure function and success of the soil cell;
- building LID for non-priority sub-basins in conjunction with the City of Edmonton's Building Great Neighbourhoods Programs, an initiative to reconstruct and upgrade existing neighbourhoods and roads, coordinating capital investment to further reduce flood risk (like the Old Strathcona Back Street Plaza);
- operating a planned educational program for both EPCOR and City of Edmonton staff to learn about these facilities and their maintenance requirements as EPCOR is responsible for maintaining the LID features. It will also include four demonstration sites that showcase bioretention or rain gardens, bioretention basins, box planters, and soil cells;
- collaborating with the Alberta Low Impact Development Partnership, as well as its research partners at the University's of Alberta and Calgary, to understand research needs and advance research and development for the design, implementation, and monitoring of natural infrastructure in the Canadian Prairies.

6.0 Conclusion

This review of Nelson, HRM, and EPCOR demonstrates that a key avenue for jurisdictions to implement natural infrastructure in Canada is to take multipronged approaches along with embedding it within policies, plans, and programs. These leading-edge lessons can inform workable models for different municipal structures, whether it is a smaller municipality like Nelson, a regional municipality like HRM, or a municipal controlled corporation like EPCOR. While there is no one-size-fits-all approach to natural infrastructure implementation, these jurisdictions have found solutions that enable meaningful progress on the ground. Some key bright spots that can illuminate paths forward for other communities include

- leverage local bylaws to support implementation;
- embed natural infrastructure across multiple levels of policy and planning for better delivery of natural infrastructure on the ground;
- take a hybrid approach that combines natural infrastructure and grey infrastructure to reduce risk and improve service delivery in the face of climate change;
- collaborate with other departments to help normalize and scale up natural infrastructure for service delivery.

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