SUSTAINABLE FREDERICTON COMMUNITY PLAN

ENVS 4003 Capstone Seminar
Environment & Society
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ABOUT THIS PROJECT

The authors of this report are graduating students from the Environment and Society program at St. Thomas University. At the end of four years of study, they know well the immense challenges that climate change, mass extinctions and widespread chemical pollution are presenting.

In their final Capstone course, we flipped the script to envision the future we want and how we get there. Our focus was to explore new ways of organizing our collective lives that would build towards sustainability.

This is a huge topic, of course, with myriad potential starting points and end points. To make it manageable, we concentrated on a very tangible aspect of our lives – the city we live in. *Sustainable Fredericton: A Community Plan* is the product of our work together as a class.

Most communities with a local government have an overarching plan guiding their decisions and actions. Generally developed with participation of the public, community plans represent the vision, goals and direction for a municipality over, say, a decade. While it is common now for community plans to invoke sustainability as one of their goals, most do not fully articulate a definition of sustainability to guide their development goals. Consequently, they fall short of what a truly sustainable community would entail.

In this class project, Emma, Tyler, Dhruv, Jenna and Kayla researched best practices in sustainable community development to construct a plan that reflects their vision of a sustainable Fredericton. Their direction was to think outside the box – to not be constrained by what is, but to imagine what could be. Having a vision of a community we want is the first step to achieving it; without a vision, we won't get there.

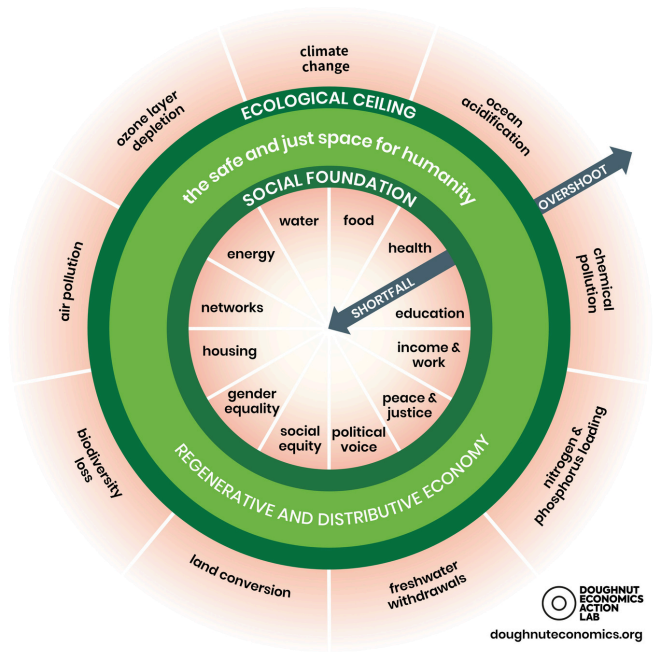
This project begins with a statement of vision, values and principles underpinning the idea of sustainability. This is drawn from class readings, student writing and hours of very rich classroom discussion. It represents the sustainability lens through which the students view what the community of Fredericton can be.

Subsequent sections are written by individual students.

Professor Janice Harvey
Environment & Society

VISION, VALUES, PRINCIPLES, GOALS

Our collective vision is of a world in which all people and species can flourish over time within the self-renewing and self-regulating systems of the living planet Earth. Ecological economist Kate Raworth's metaphor of the doughnut provides a model which helps us envision what this is. The inner edge of the doughnut represents the social floor below which nobody should fall. The outer edge of the doughnut is the ecological ceiling above which Earth systems start to destabilize. Planning and regulating economic and social activity to stay within the doughnut provides everyone with the means for a fulfilling life, without breaching the hard limits of the nine natural systems that make life on Earth possible. The goal must be to create a society that sits within "the safe and just space for humanity." This is the essence of sustainability.



DEFINING COMMUNITY SUSTAINABILITY

The most basic meaning of sustainability is the ability of a system to persist indefinitely. This definition has three elements: systems, persistence and future time.

Sustainability begins where we live - in actual communities with names, boundaries, distinct natural and cultural features, and many assets. A community is a system, made up of many nested systems. Communities are embedded in larger ecological and societal systems. Community sustainability emerges from the sustainability of all these parts, small and large.

For a system to persist, it must 'function well,' as economist Amartya Sen put it. All its constituent parts are healthy and working symbiotically, allowing the system to flourish and regenerate itself over time. How long over time must we be concerned for system persistence? We can draw on Indigenous teachings for a guidepost: decisions today should be made with the next seven generations in mind. Doing the math, that's from 200 to 300 years into the future, depending on how we define a generation. In other words, we need to stretch out minds out to the Year 2225 and beyond.

VALUES

This understanding of sustainability is grounded in a set of values that encompass all aspects of community. It is first and foremost a geographic community, defined by the ecology and physical features of the region where we live, in our case, the Wolastoq watershed.

Ecologist and ethicist Aldo Leopold called the soils, waters, plants, and animals of a place the 'land community.' Indigenous teachings call these our relatives, and as such they are to be treated with respect. We are sustained by gifts of the land, and we respond in kind with gratitude. Leopold called for a 'land ethic' in which the role of 'Homo sapiens changes from conqueror of the land-community to plain member and citizen of it.' This is our first level of responsibility: to live in a way that allows the land community to flourish. Leopold gave us this benchmark to judge our actions:

"A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise."

This place is also an Indigenous community, whose ancestors lived for millennia in deep relationship with the land according to original principles of sustainability. Our responsibility as treaty people is to seek understanding of the colonialist relations that shape this community, and to reconcile with the Indigenous peoples of this region the unjust systems of power that have resulted.

It is a multicultural community, where people from diverse origins now gather to forge a life together. We embrace and make room for this diversity, ensuring that everyone is included in our quest for mutual flourishing.

While we live in a specific land-community, we are also members of a global community. This is not a rhetorical statement. Through global supply chains, much of the energy and material that make up our everyday consumption comes from other communities, near and far. Our consumption patterns affect their land, water, air and quality of life. Our obligation is to minimize and ideally eliminate the damage our consumption does to others.

It is at the community level that we have the greatest responsibility and the best opportunity to shape our world. Beyond the here and now, this responsibility extends to generations not yet born. It is up to us to leave them a place to live in which they too can flourish.

This is the goal of sustainability: to ensure that all members of the community – human and non-human, present and future – can flourish.

PRINCIPLES AND GOALS FOR COMMUNITY PLANNING

Three overarching principles are the foundation of sustainable communities: ecological health, fairness and mutual responsibility for achieving both.

Planning for sustainable communities is guided by a set of principles. Principles are statements of both values and knowledge. Values reflect how we wish to live together in community. Knowledge includes what we understand about the Earth systems that support us and how they can be sustained. A set of principles provides the lens through which decisions can be evaluated: Does this proposal, decision or action support the principles of the plan? The answer should be yes.

KNOWLEDGE-BASED PRINCIPLES

- Because the Earth is finite, there are biological and physical limits to the growth of human communities.
- All members of the community – humans and non-humans alike – live in reciprocal, interdependent relationships.
- Personal, community and ecological wellbeing are interconnected.
- Human interactions with Nature are regenerative – they restore and enhance ecological processes.
- Energy and food systems are renewable.
- Economies and materials use are circular.

VALUES-BASED PRINCIPLES

- All members of the community have responsibility for the present and future integrity of the community as a whole.
- Colonial systems are dismantled and Indigenous rights are recognized and upheld.
- Every community member shares in the life of the community and has something of value to contribute to it.
- Progress is measured by ecological, material, physical, spiritual, and cultural wellbeing, not quantitative economic growth or "more."

GOALS FOR SUSTAINABLE COMMUNITIES

"A sustainable city is a vibrant human settlement that provides ample opportunities, in harmony with the natural environment, to create dignified lives for all citizens."

In the book, *Can a City be Sustainable?*, the Worldwatch Institute identifies several goals for sustainable communities that align with the above principles.

Sustainable community planning should support these goals:

- Reduced, circulating, and clean flows of materials
- A prominent place for Nature
- Compact and connected patterns of development
- Creative place-making
- Centres of well-being
- People-centred development
- Participatory governance

SUSTAINABLE LAND USE

TYLER DUPUIS

BUILDING A SUSTAINABLE FREDERICTON

Cities are living ecosystems that must evolve to meet the challenges of today. City planners understood this in the 20th century, when they introduced land use policies as a means of addressing economic, social and environmental challenges in urban spaces.

It is imperative that Fredericton become a sustainable community in the face of increasing growth, urban sprawl, climate change, ecological degradation, and peripheral dependence. To create a sustainable Fredericton, we can reimagine its zoning bylaws, adopt integrative land use strategies and promote peri-urban agriculture.

A sustainable Fredericton would adopt land uses that encourage more mixed-use neighborhoods, urban rewilding, conservation and preservation, and peri-urban land uses.

PARTICIPATORY GOVERNANCE

A sustainable community has land use decision-making bodies that are inclusive and socially just. Planning advisory committees need to broaden public outreach and engagement with the community. This could be achieved by implementing neighborhood councils or citizen assemblies that provide feedback to a planning advisory committee.

In addition to inclusive planning advisory committees, citizen assemblies and neighborhood councils are ideal mechanisms to encourage citizen engagement and feedback.

REIMAGINING LAND USE

Land use policies determine how land is allocated, developed, and used, and are reflected in municipal bylaws, zoning, and municipal plans. Conventional land use policies oriented to continuous growth have allowed for urban sprawl, environmental degradation, and soul-less cities that lack character and alternatives for sustainable living.

Sustainable land use policies are oriented towards meeting the present and future needs of communities by balancing both human and ecological factors. Sustainable land use policies increase resilience, self-reliance, and community building, addressing issues like climate change, food insecurity, urban sprawl, and habitat loss.

ZONING FOR THE FUTURE

Sustainable land use balances present and future needs for people and the environment. This means reimagining zoning bylaws to be more integrative and centered around people. Zoning for sustainability focuses on balancing purpose, density, and community decision-making. This is achieved using mixed-use zones and growth boundaries.

DESIGNATION AND PURPOSE

Traditional zoning designations have resulted in segregated communities that "bunch" land uses to certain areas (see Ex. 1). Sustainable land use optimizes efficiency by placing commerce and services close to residential areas. Thus, rather than having commercial zones that result in inefficient "commerce streets", adopting mixed-use zones would combine different designations to allow for multi-purpose neighborhoods. For example, a mixed-use zone could have restaurants and retail space mixed with offices or apartments in the same development or neighborhood (see Ex. 2).

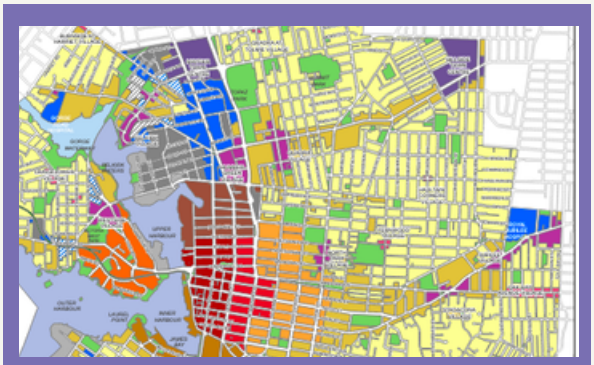
REIMAGINING ZONING IN FREDERICTON

Currently, Fredericton bylaw Z-5 fits the definition of exclusionary zoning. As a result, city zoning limits and "bunches" land uses to certain areas. This unsustainable practice causes environmental and social problems for residents and the community. Sustainable Fredericton will amend this bylaw to include more mixed-use zones that combine different land use designations. The West 5 neighbourhood in London, Ontario will serve as a model. This would integrate residential and commercial neighborhoods to promote mixed-use development.

WHAT IS ZONING

Zoning policies regulate how land is used in different areas of a town.

Created by municipal governments, zoning ensures that development matches community goals and vision.



Ex.1: exclusionary zoning that segregates, limits, and "bunches" land use to certain designations.

Ex.2: mixed-use neighborhood that has retail, residential (e.g. senior living, apartments, single-unit) and services.

THE "WEST 5": MIXED USE ZONING IN LONDON ONTARIO

The West 5 is a 28-hectare mixed-use community in London, Ontario with 2,000 residential units and up to 400,000 square feet of commercial and retail space. Once completed, the West 5 will have a mix of housing, work, and recreational spaces, along with green space, car-streets, and pedestrian walkways.

DENSITY OVER SPRAWL

Conventional urban planning in North America focused on car-dependent single unit housing has resulted in what is known as urban sprawl. This is associated with negative environmental, economic, and community impacts including air pollution, traffic congestion in cities, loss of farmland, higher energy costs, social segregation and fewer services for residents.

Sustainable communities prioritize higher-density developments in mixed-use zones to avoid urban sprawl. Proven strategies include urban growth boundaries (UGBs). Growth boundaries contain urban development within a set boundary, limiting growth and urban sprawl to promote sustainable development and densification. The benefits of UGBs include protecting nature and arable land, reduced infrastructure costs, and promoting compact land use for walkable cities.

Fredericton's current municipal plan has a designated urban growth boundary within which new development is to be contained. It is only in place, however, for a set number of years, after which the rural lands outside the UGB can be developed.

Making this UGB permanent will ensure that the city protects the rural features of the periphery, including the potential to expand local food production to increase food security.

Fredericton's urban growth boundary is shown here in green. Sustainable Fredericton will make the growth boundaries permanent, preserving the goals and values of the UGB into the future.

LAND USE FOR PRESERVATION AND CONSERVATION

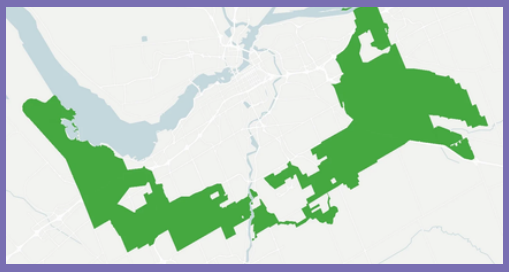
Sustainable communities use land use policies as a means of preserving and protecting vital ecosystems and their natural functions. These incluse establishing greenbelts and urban rewilding projects.

GREENBELTS AND NATURAL BUFFER ZONES

Greenbelts and buffer zones are land use designations that aim to protect undeveloped land near urban areas. As such, they can also be used as a means for avoiding urban sprawl by preserving natural areas and farmland.

URBAN REWILDING

Urban rewilding focuses on restoring ecosystems and ecological services in urban areas. For instance, rewilding policies could have a goal of increasing carbon sinks in the city as a climate change mitigation strategy. Strategies include land repurchasing policies, greening vacant lots, and developing micro rewilding plans in existing parks and open spaces.



In 1950, Ottawa created a 203.5 km² greenbelt that contains green space, forests, and wetlands. It acts as a natural barrier between the dense urban center and the rural farms located in the city's periphery. Because of its lush wetlands, the greenbelt increases biodiversity by providing habitat for migratory birds and diverse species.

"THE THREE RETURNS": URBAN REWILDING IN XICHANG CHINA

The city of Xichang, China formulated a "three returns project" which aimed to return ponds, fields, and houses to the Qionghai River Basin. The urban rewilding project has proven successful. Water, soil, and air quality have improved, and biodiversity in the Qionghai River Basin has increased, attracting fauna and 15 new bird species to the region.

INTEGRATIVE ECOZONES

Sustainable communities adopt integrative, holistic, and interactive land use policies that recognize the interconnections between people, ecosystems, and species. Recognizing ecological connectivity, integrative ecozones respect the interconnected relationships between different species and ecosystems. Considered holistic and interactive, this approach is a sustainable alternative to traditional environmentally protected areas. The principle behind integrative ecozones is the integration of horizontal and vertical ecosystem elements. Protections extend beyond a singular ecosystem to include other vital elements that are necessary to sustain present and future ecological needs.

The non-profit Nashwaak River Watershed Association is leading a long-term integrative ecozone restoration project. In partnership with the City of Fredericton, they are restoring the silver maple forest in the Nashwaak River floodplain to form a greenway from Marysville to where the river meets the Wolastoq in Barker's Point. A Sustainable Fredericton plan will include similar restoration work along the Wolastoq proper within the city limits.

Satelite image of the Nashwaak River which flows through the northeast section of the City of Fredericton. A major floodplain restoration project is underway along its banks, integrating water and land ecosystems. From the NWPA website: https://www.nashwaakwatershed.ca/.

GREENING FREDERICTON

Fredericton is located within the ecozone formed by the Wolastoq River and its tributaries such as the Nashwaak River.

Fredericton is known for its access to abundant nature. This includes forests, wetlands, and the Wolastoq River. Fredericton has a very high density urban tree canopy and a robust plan for increasing this. There are many benefits to urban tree cover, including providing beauty, shade and decreasing the urban heat sink effect. They do not, however, increase biodiversity. Sustainable Fredericton will complete a comprehensive biodiversity audit of the city region and quantify the benefits that healthy ecosystems provide. The goal of land use policy is to maintain and increase biodiversity within the city.

The non-profit Nature Trust of NB manages two City-owned properties in Fredericton: the 8-hectare Hyla Nature Preserve in the northeast of the city (above) and the 16-hectare Ferris Street Forest and Wetland Preserve in the northwest of the city.

LAND USE FOR LOCAL FOOD SECURITY

North American cities have become dependent on the globalized industrial food system, which has led to food insecurity and ecological degradation. Urban agriculture is an effort to reverse these trends. Urban agriculture involves cultivating, processing, and distributing food within urban areas. Sustainable land use policies are critical for encouraging the expansion of urban food systems.

Sustainable Fredericton will adopt land use policies that encourage food security through local food production.

URBAN AND PERI-URBAN AGRICULTURE

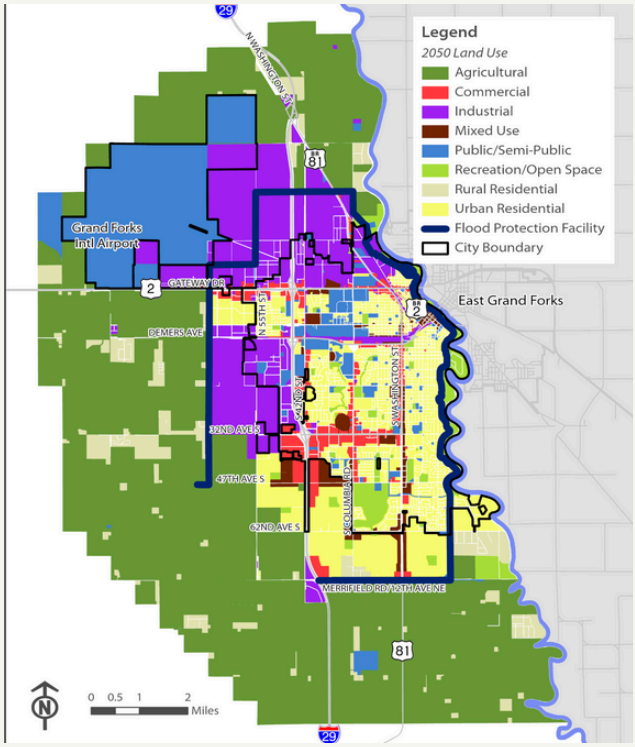
Land use policies influence the type of farming activities that are permitted and where they should be located. Urban food systems are located in developed urban areas, including residential, commercial and recreational zones. These include rooftop gardens, community gardens, and back-and front-yard gardens in neighbourhoods. Vertical farms are located inside commercial or industrial buildings.

Peri-urban agriculture is located on the edges of urban areas where development is less intensive. Here, production systems can be larger, including community-supported agriculture operations and market gardening. Urban farmers' markets provide distribution centres connecting food producers and customers.

To protect public health and water quality, urban and peri-urban food production must be organic, grown without synthetic pesticides and fertilizers. These are associated with human health problems and fish kills and algal blooms in aquatic systems.

HEALTHY, LOCAL FOOD FOR ALL

Locally grown food provides social, economic and environmental benefits to communities.



Grand Forks, Michigan has zoned the periphery region of the city as agricultural to encourage food production within the city boundaries.

BACKYARD ANIMAL HUSBANDRY

Backyard animal husbandry bylaws allow for certain farm animals in urban areas. Less common than growing fruits and vegetables, raising animals is also an important source of food and fertilizer. The most common backyard animals are chickens. Some communities allow other animals well-suited for urban areas. For example, the City of Galway, Ireland allows for pigs, goats, and Dexter cows. Some policies include commercial properties for businesses and restaurants. Sustainable animal husbandry policies must minimize environmental impacts and ensure biosecurity and animal welfare.

Backyard Dexter cows in Galway City, Ireland.

Originally a 80-hectare dairy farm in Devon on Fredericton's north side, Hayes Farm is a project of the nonprofit NB Community Harvest Gardens. The farm mandate is to create an inclusive, educational space where everyone, regardless of background or experience, can come together to grow food, grow minds, and grow community. From the website: https://www.nbchg.org/hayes-farm/

Backyard chicken coops on private property.

GROWING FOOD IN FREDERICTON

Sustainable Fredericton will increase food security, protect biodiversity, and mitigate climate change by adopting an urban food policy. Mixed use zones will allow rooftop and vertical farms. Land will be made available in each neighbourhood to establish community gardens.

The peri-urban area outside the urban growth boundary will be prioritized for food production. The City will acquire unused arable land within its boundaries and make it available for free to new food producers.

Currently, zoning bylaw Z-5 requires residents to pay a one-time fee of $250 for a variance application, to have up to three hens on their property. This fee will be removed. The by-law will also allow other livestock in certain neighborhoods with larger individual lot sizes.

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TRANSPORTATION & MOBILITY

EMMA FACKENTHALL

THE CHALLENGE

Fredericton is a deeply car-centric community. In order to meet climate change emissions reduction targets and achieve a carbon-neutral economy, we need to drastically change the way we navigate the world. In developed countries, transportation remains one of the leading sources of greenhouse gas emissions.

According to *Can a City Be Sustainable?*, the World Health Organization reports that each year urban air pollution causes 1.3 million deaths, sedentary lifestyles are serious killers causing 3.2 million deaths, and traffic-related injuries are responsible for 1.3 million deaths. All of these risks are exacerbated in deeply car-reliant systems; thus, it is imperative we reduce car dependency and even establish car deterrence through many landscape changes and policies.

5.8M

GLOBAL DEATHS PER YEAR ARE TIED TO OUR OVERRELIANCE ON VEHICLES

While many might hope or suspect that adequate change to meet emissions targets will hold electric vehicles (EVs) at the forefront, this is an unsustainable dream. EVs play their part in our sustainable future, but overreliance on EVs could exacerbate unsustainable mining in southern countries and would do nothing to relieve the congestion and gridlock issues cities all around the world, including Fredericton, face to this day.

Car-dependency is polluting, land-consuming, and dangerous for human and wildlife.

MEASURING SUCCESS

When envisioning a Sustainable Fredericton, improving transportation and mobility is a top priority. Implementing sustainable mobility infrastructure will contribute to five of the seven goals for sustainable communities:

- Including a prominent place for nature
- Favouring compact and well-connected patterns of development
- Engaging in creative placemaking
- Creating centres of well-being
- Building environments in favour of the citizens, human and non-human alike

VEHICULAR DETERRENCE

Employing strategies that deter vehicle use is the key to designing a sustainable mobility system in Fredericton.

To deter cars as a primary method of transportation, we will expand public transportation. This will include increased public transportation service from North Core to South Core, from uptown to downtown, and from residential areas to mixed-node centres.

For those who commute from more rural neighbourhoods or beyond city limits, cars will most likely remain a necessity. However, this fleet of commuter vehicles will transition from combustion engines to plug-in hybrids or Zero Emission Vehicles (ZEVs).

Sustainable Fredericton will develop a multi-modal system for commuting in the form of Park & Ride services. Commuters will drive part of their commute, and then switch to active or public transportation modes to get to their destination.

PARK & RIDE: MARYSVILLE PLACE

For out-of-town commuters commuting from the North end of the Marysville bypass, Marysville Place offers an expansive parking lot suitable for a Park & Ride strategy.
Utilizing this method will greatly reduce morning and afternoon gridlock on the Princess Margaret Bridge.

Verne Equinox

ROAD-SLIMMING: LANCASTER, CA

John Massengale

This revitalization project is a stellar example of road dieting - refurbishing a dying five-lane street into a vibrant, flourishing alley that limits car mobility and embraces the pedestrian experience. Fredericton can embrace this strategy in moderately dense areas.

John Massengale

Surrounding Fredericton's core will favour road slimming, limiting vehicle traffic and making active transportation safer and more effective.

To preserve valuable ecosystems and reduce outward sprawl, parking will first be considered underground or behind buildings. Any new parking garages will be built near public transportation stops on the city outskirts, enforcing the Park & Ride method.

CAR-FREE CORE POLICIES

Already compact areas will forgo cars entirely. Downtown Fredericton is ideal for maximizing active transportation. In the city centre, pedestrian-only and separate cycling pathways are prioritized.

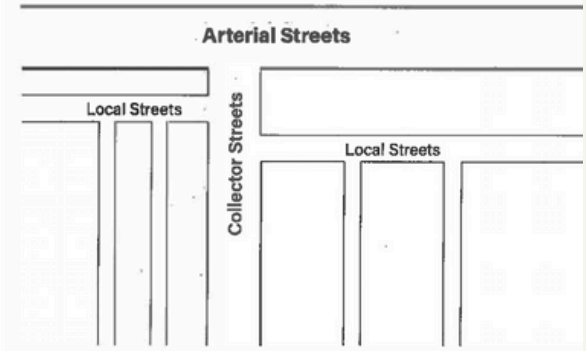
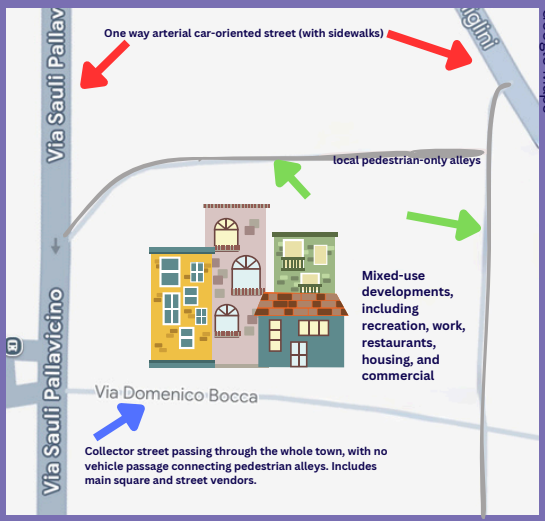


FIGURE 7.3. Street Hierarchy (Source: Yuono, "Street Network, Transportation, and Transit Oriented Development," adapted.)

Towards Sustainable Communities

Local streets will be pedestrian-based in city cores. Collector streets will encourage a sustainable mix of pedestrian and cycling mobility. Larger arterial streets offer a slim road for vehicles and public transportation and offer active mobility pathways buffered from the car road.

CASE STUDY: CITY OF ARENZANO



Google Maps

A mix of active transportation and vehicle infrastructure, streets in Arenzano, Italy funnel traffic efficiently. Larger mixed car and pedestrian streets filter into wide-laned piazzas that only allow active transportation methods, which then trickle into smaller pedestrian-only lanes.

"CASH FOR CAR" INCENTIVES

In 2022, the government of France launched a program offering 4,000 Euros to exchange cars for e-bikes or alternative transportation methods. while investing in bicycle-safe lanes. The subsidy favours low-income families - higher-income families receive a smaller amount. The policy goal was to reduce car dependency and traffic congestion in cities.

"HOY NO CIRCULA!"

The "Hoy No Circula" (Today You Don't Drive) policy in Mexico City is designed to reduce air pollution by limiting the number of vehicles on the streets based on their license plate numbers. Exemptions are made for hybrid and electric vehicles, public transportation, motorcycles, and vehicles driven by disabled persons.

MILAN AREA C

Area C is Milan's restricted traffic zone in the historic city center, designed to reduce congestion and pollution. Most vehicles must pay a cngestion fee to enter Area C. The standard charge is five euros a day for gas and diesel cars. EVs, hybrid, low-emission cars, emergency vehicles and disabled persons are exempt.

Area C Milano

RE-ZONING FOR MOBILITY

Re-zoning for sustainable mobility contributes to the third, fourth, and fifth goals of sustainable city:

- Favouring compact and well-connected patterns of development
- Engaging in creative placemaking
- Building environments in favour of the citizens, human and non-human alike

15-MINUTE CITY

As discussed in the land use section, the goal of sustainable land use is to build intricate and dense cities. This includes building up rather than spreading, and utilizing current infrastructure to avoid suburban sprawls. In denser cities, transportation is more efficient in terms of energy, time, and land use. The "15-minute city" principle plans for mixed use neighbourhoods where travel to and from work and accessing basic services takes no longer than 15-minutes per trip.

Image credit: weforum.org

REVITALIZATION OF COMMERCIAL CORRIDORS

To prioritize well-connected patterns of development in Fredericton, current commercial corridors will be redesigned. Transforming car-centric commercial corridors to mixed-use nodes will support small businesses, reduce greenhouse gas emissions, and contribute to the health of Fredericonians. Those corridors needing attention include: Two Nations Crossing, Main Street, Prospect Street, Bishop Drive, and Knowledge Park Drive.

CASE IN POINT: PROSPECT STREET

CBRE

Fredericton's Prospect Street is wide and deeply car-centric. Navigating this area is best by vehicle.

Sargent Town Planning

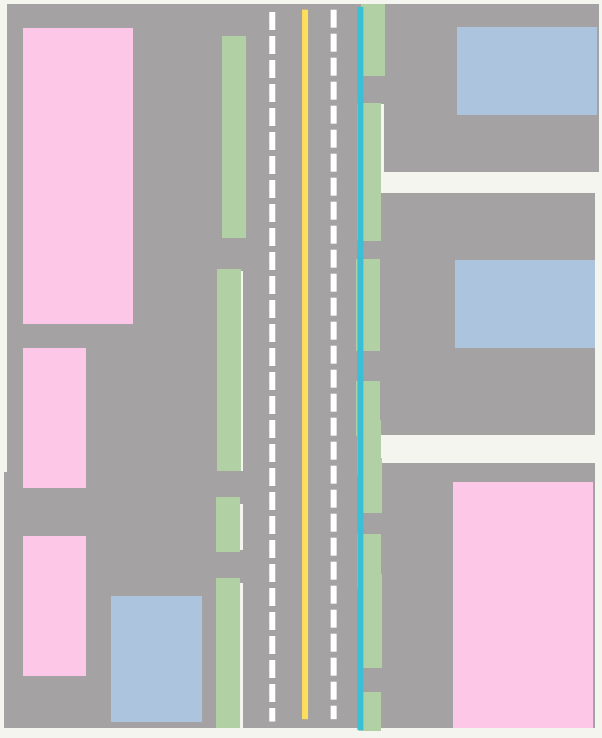
A denser, mixed-use, walkable streetscape that embraces nature and human traffic makes spaces more welcoming to all life.

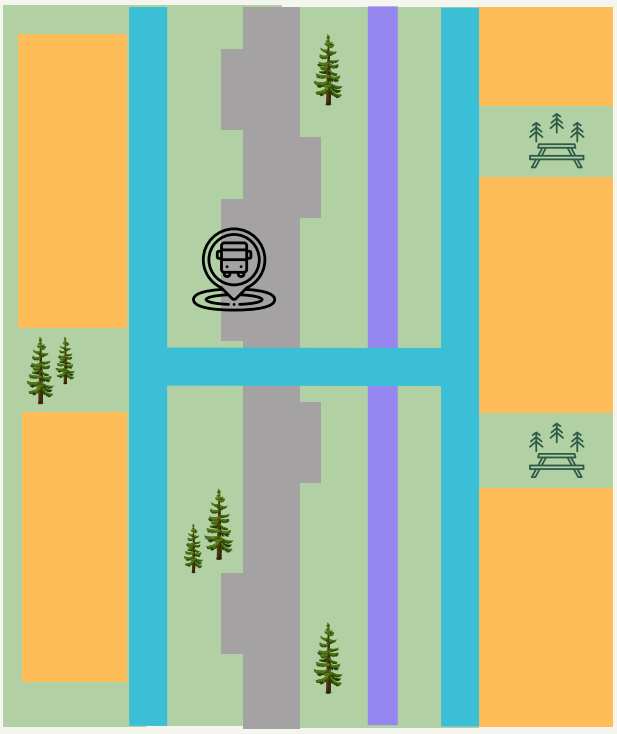
REDESIGNING PROSPECT STREET

To reduce Fredericton's ecological footprint, our city's transition to more active transportation and mobility will use infrastructure. Instead of building new neighbourhoods and roads, why not add more stories and turn roads into walkways? Here is an example of how we could reimagine the heavily car-centric layout of Prospect Street.

THE CURRENT DAY LAYOUT is deeply fragmented and facilitates the driver. There is little ecological habitat and green space is mostly lawns. Rush hour and the multiple drive-through restaurants cause gridlock. Aesthetically, the pedestrian experience is poor, with multiple intersections, sidewalks close to the roads, and parking lots at the front of the stores.

A SUSTAINABLE LAYOUT has accessible storefronts to pedestrians first and segregated lanes for walking, cycling, and driving traffic. There is ample green space, which benefits the mixed-use developments in the area, as residents have commercial resources, green space, residences, offices, and access to public transportation all within their "node" of Fredericton. If vehicular travel is needed, the bus stop near the street centre offers timely travel to other centres in town.





Diane Cook

ACTIVE TRANSPORTATION

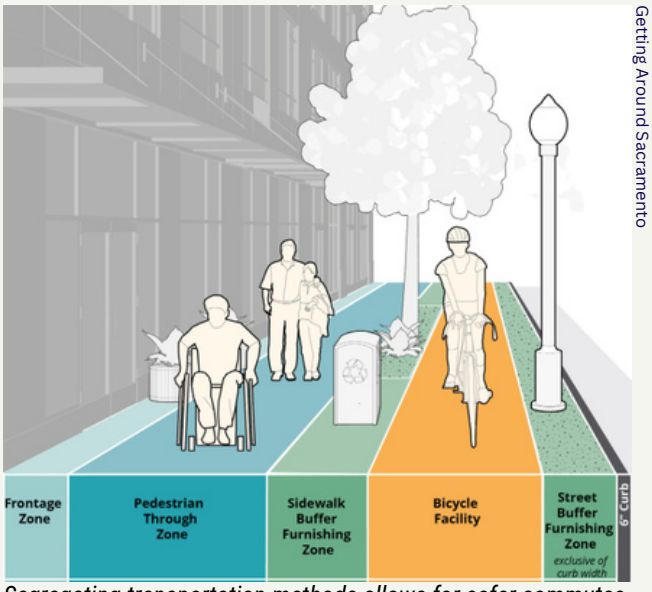
Effective active transportation is the most essential component of a sustainable city plan. Enforcing and creatively making space for active transportation will improve the mental and physical well-being of all Fredericktonians while reducing our emissions footprint.

TRAVEL BY FOOT

The most inexpensive transportation method is by foot. However, many are deterred from walking due to unsafe sidewalks and deterrents built into the environment. Improving the pedestrian experience will be done in a multitude of ways including:

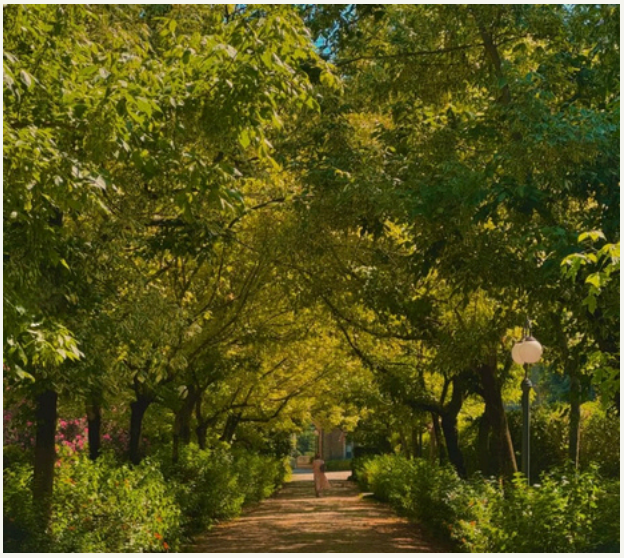
- Adding benches and removing hostile architecture meant to deter people from congregating in public spaces.
- Using native flower beds or plots to buffer walkways from the street.
- Planting trees to cover walkways, improving shade in the sunnier seasons.
- Create spacious and easy to snowplow walkways that allow for all mobility levels (wheelchairs, walkers, strollers).
- Design storefronts to be pedestrian friendly with colourful murals, big windows, and easily accessible right off the walkway.
- Add Crime Prevention Through Environmental Design (CPTED) practices, like increased lighting.

New York City's Highline (right) is an ecologically vibrant and buffered walkway for the pedestrian experience. Creating walkways similar to this one in denser areas of Fredericton keeps the balance between effective circulation and a place for nature.



Getting Around Sacramento

Segregating transportation methods allows for safer commutes and the opportunity to incorporate greenery, improving air quality in denser cities and the overall commuting experience.



Emma Fackenthall

A wide walkway with tree cover, shrubbery, and lighting. The pedestrian is enticed to commute by foot.

TRAVEL BY WHEELS

Travelling by wheels is the next most inexpensive and environmentally-friendly transportation method after walking. It can include:

- Bicycles, e-bikes
- Skateboards
- Hoverboards
- Rollerblades
- Scooters
- Pedal crawlers
- Rickshaws

To improve travel by wheels, Fredericton will improve infrastructure geared towards wheeled travel methods, including:

- Adding city bike-sharing programs
- Building bike/scooter lockers
- Segregating and buffering transportation systems including exclusive bike lanes
- Improving storage on public transit by adding more bike racks

Jean-Claude Taliana

Bixi city bikes in Montreal are an example of city-wide bike sharing. Well-planned placement of charging centres and staffing responsible for redistribution in hotspots is of utmost importance to this method of commuting.

CASE STUDY: BIKE BUSES

Bicycling

Bike buses are a safe and healthy way for children to commute to school. The town of Anatole, France launched "the S'Cool bus" in 2017. The large tandem bicycle with electric assist could also be a way for adults to travel through cities, especially since "Party Bikes," also known as pedal crawlers, are quite popular for recreational use.

Pedal Crawlers

Party bikes will be used as third spaces, where people can gather to travel but also socialize and move their bodies.

CYCLE RICKSHAW SERVICES

Cycle rickshaws like the one pictured above are sustainable ways for less mobile people to get around. Rickshaws will be called to your apartment complex to pick you up, unlike bus stops that typically require some walking. For elderly and disabled citizens needing shorter-distance travel, cycle rickshaw services offer short distance mobility.

TRAVEL BY WATER

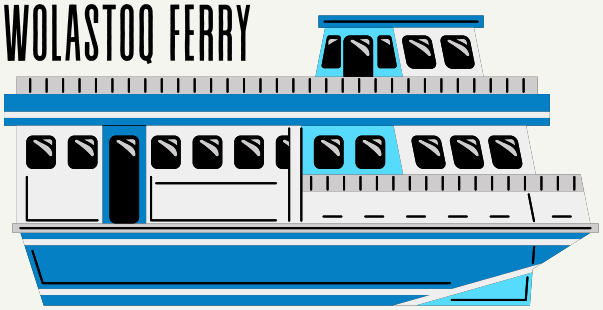
Conservation Council

Fredericton's two cores, north and south, are divided by the Wolastoq. This river is currently navigated by two vehicle bridges and one pedestrian bridge near the city centres. During morning and afternoon rush hours, there is significant congestion on these bridges, giving rise to demands for a third bridge.

AquaBound

Active transportation by water during the warm months will relieve some congestion and make mobility more interesting. "Canuting" is a term that describes canoeing as a commuting method. Traversing the Wolastoq by canoe, kayak and SUP is entirely viable. Implementing these travel methods will be similar to bike-sharing. Docks and canoes/kayaks will be available near cores so citizens can easily alternate from one commuting method to another.

WOLASTOQ FERRY



An electric ferry until river freeze-up will relieve traffic on the bridges on the Wolastoq. Requiring less infrastructure than the construction of a new bridge, the ferry will equally benefit Fredericton's disabled population as it will accommodate cycle rickshaws, golf carts, and electric strollers.

CASE STUDY: MV AMPERE

MV Ampere

MV Ampere, the world's first electric battery-powered ferry, operates between Lavik and Oppedal in Norway. Launched in 2015, the ferry has demonstrated a 95 percent drop in emissions compared to fuel ferries. How much congestion will be reduced on Fredericton's bridges when the city employs a similar transportation method for active and park & ride commuters?

PUBLIC TRANSPORTATION

Public transportation facilitates longer journeys and makes inner-city mobility accessible to all. Investing in connected public transportation will meet three of our goals for measuring success by

- Favouring compact and well-connected patterns of development
- Engaging in creative placemaking
- Building environments in favour of the citizens, human and non-human alike

Dublin' s light rail delivers city-wide net-zero journeys.

LIGHT RAIL

Building a light rail system to connect outlying communities to the inner city is a more sustainable solution than increasing electric bus fleets. Light rails offer higher passenger capacity and lower emissions per passenger mile. Trains have fewer acceleration events than buses and have much lower rolling resistance. A light rail system must include:

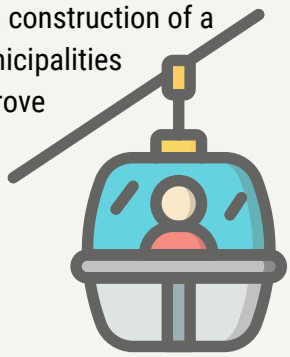
- Shorter intervals for each stop
- Priority over private vehicles
- Ample space for wheelchairs & strollers
- Ample bike racks for bikes & scooters
- Low step-up for those with mobility issues
- Easy connection to alternative transportation systems (i.e. park & ride lots, kayaking & canoe docks, city bike drop-offs, etc.)

CASE STUDY: THE VILLAGES

The Villages is a Florida retirement community comprised of mixed-node and residential areas all accessible through electric golf carts or microcars. the slower speeds and smaller energy consumption of these carts allow for more sustainable transport for inner-city travel. Like Fredericton's current Para Transit, for elderly and mobility-challenged residents,the carts will be driven by city employees who assist passengers in entering and exiting the carts. Microcars and carts will be modified for travel in all seasons.

REGENT STREET FUNICULAR

Active transportation in Fredericton can be daunting due to the city's large hill with an approximate 130-metre incline between downtown and uptown. One solution is construction of a funicular system. Many municipalities have built funiculars to improve mobility in environments with strong inclines.



CASE STUDY: FUNICULAIRES DE LYON

French Views

Lyon, France, has a funicular system with two lines on the Fourvière Hill. This city has many important historical landmarks and parks situated on the hill's plateau. The funiculars connect straight to the metro station in Vieux Lyon, allowing for easy multi-modal commutes. More importantly, the 130-metre incline to the hill's plateau is accessible for those with mobility challenges.

MOBILITY FOR ALL

When transitioning to a sustainable transportation and mobility system, it is important to keep in mind that everyone has different types of mobility needs. This is why multi-modal approaches are essential. Each transportation service can cater to different demands.

In regions where citizens use active transportation modes, populations are more healthy. Even as people age, they remain relatively self-reliant and mobile. While inclusivity is essential, the transition to better active transportation for all will reduce overall dependence on private vehicles.

To create a sustainable Fredericton, we will create safe, inclusive, sustainable, and compact systems of living and commuting. Ensuring we do so will create better lives for all.

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GREEN SPACES, TRAILS & PARKS

DHRUV MANISH

WHAT ARE GREEN SPACES?

Green spaces are small and large areas within a municipality that are not built up or paved. These include natural areas, open space, engineered green spaces, sometimes called green infrastructure.

TYPES OF URBAN GREEN SPACES

There are various types of urban green spaces, which can be roughly divided into two categories: public green spaces and private green spaces. Public green spaces include urban parks, conservation areas, greenways, trails, urban and rural forests, street trees, community gardens, shorelines and ravines. These are important urban public spaces and provide residents with places for leisure and entertainment.

Private and institutional green spaces include gardens, green roofs, green walls, cemeteries, golf courses, school grounds, and other outdoor spaces. Although these green spaces are small in scale, they play an important role in improving urban microclimate and increasing biodiversity.

In August 2021, Parks Canada launched the National Urban Parks program. Conserving nature, connecting people with nature, and advancing reconciliation with Indigenous peoples are the core objectives of the National Urban Parks program. The program will build on the success of the Rouge National Urban Park in Toronto, Ontario. Parks Canada is exploring the creation of national urban parks in several cities: Halifax, Nova Scotia; Windsor, Ontario; Winnipeg, Manitoba; the Saskatoon region, Saskatchewan; the Edmonton region, Alberta; and the Victoria region, British Columbia. Early discussions have also been held in Montreal, Quebec.

Nearly 72 percent of Canada's population lives in urban areas. As urban sprawl claims crucial habitat for wildlife and devastates biodiversity, it also diminishes our opportunities to connect with and learn about local nature. It is critical for the upcoming generations to maintain these connections and bestowing them with natural skills and know-how about our natural surroundings is considered important to Canadians.

- According to reports from 2021, 91percent of all Canadians have easy access to parks and green spaces, with 85 percent claiming that they visit these parks often.
- These include parks, conservation areas, greenways, trails, urban and rural forests, street trees, community gardens, school grounds, shorelines, and ravines.
- There are 37 national parks and 11 national park reserves in Canada, representing 31 of Canada's 39 terrestrial natural regions.

ROUGE NATIONAL URBAN PARK

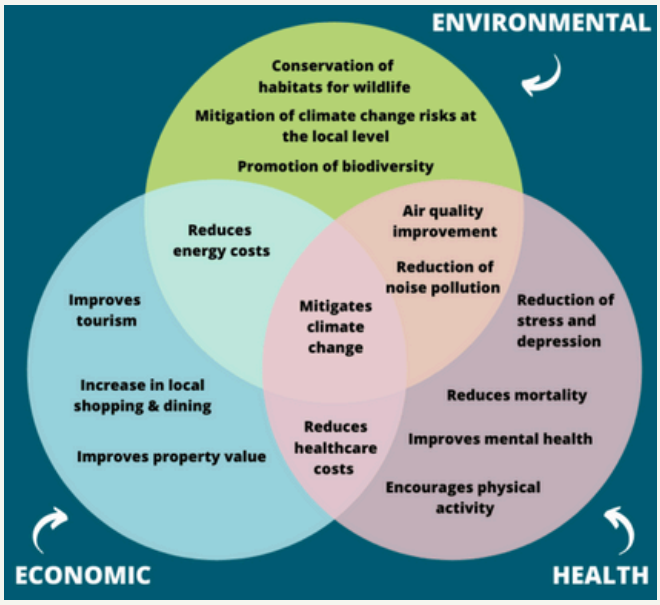
The Rouge National Urban Park is located in the Greater Toronto Area. Within one hour's drive of 20 percent of Canada's entire population and accessible by public transit, the park provides unparalleled opportunities for visitors to experience the area's natural, cultural and agricultural heritage, while protecting the habitat of thousands of local plant and animal species.

WHY ARE GREEN SPACES IMPORTANT?

City parks and green spaces are important because they provide many benefits to people, the environment, and the economy. They are crucial for both environmental and human well-being, offering benefits like improved air and water quality, reduced urban heat island effects, and enhanced mental and physical health. They also support biodiversity and provide opportunities for recreation and stress reduction.

Studies show that municipal green spaces help mitigate two societal challenges, climate change and chronic diseases. The reduction of anxiety, obesity and cardiovascular disease, has been associated with the presence of and access to green space. Green spaces have also been shown to reduce flooding, improve air quality and provide cooling and shade.

Research shows that quality of life is higher for people living close to parks compared to those who have no green spaces nearby. Vulnerable groups, including people living on low income, racialized groups, older adults, and children have been found to experience the most benefits from green space. In particular, children living close to well-maintained parks with playgrounds are healthier than those who do not have this access. The health of vulnerable groups has been shown to benefit from fairly small increases in nearby green space density.



According to Parks Canada, an urban national park system will have economic and health benefits, and contribute to national conservation targets and biodiversity objectives. Urban national parks will also champion First Nation, Inuit, and Métis leadership and stewardship, honouring commitments to the Truth and Reconciliation Commission Calls to Action and the United Nations Declaration on the Rights of Indigenous Peoples.

National urban parks will create more opportunities for people to connect with and learn about nature in welcoming spaces. Grounded in accessibility and inclusion, improved access to natural and cultural heritage will provide equitable opportunities for people to benefit from time spent in nature.

PARKS AND GREEN SPACES IN FREDERICTON

Fredericton has 138 green spaces, totaling 900+ hectares of open space for public use. These include municipal parks, playgrounds, skateboard parks, courts and playing fields. There are six community gardens and urban farms. Ten percent of land area allocated to parks. Forty-five percent of park land is in a natural state, while 55 percent is actively managed. Operating municipal parks costs $58 per resident per year.

The Green Space Index, a unique data tool designed to track and analyse green space provision across Great Britain, recommends that there should be 2.4 hectares (ha) of accessible green space for every 1,000 persons living in an area. Fredericton, with 1362 ha of land, has 21.6 ha of parks and green spaces per 1000 population, more than 20 times the standard. On a hectare-per-person basis, Fredericton has the second highest density of green space in Canada.

Fredericton's tree canopy consisting of 21,000 street trees of many species and ages earned the city the Forest Capital of Canada recognition in 2023. The City of Fredericton's Parks and Trees Division works to preserve the tree canopy by:

- Planting new trees, including species better adapted to a changing climate
- Treating and removing trees afflicted by the Emerald ash borer and Dutch elm disease
- Partnering with community groups on large scale tree planting efforts
- Reducing lawn mowing and restoring key areas to their natural state to strengthen pollinator populations

The City is undertaking several key measures to conserve and grow community's greenspaces. This includes increasing zoning requirements for green spaces and mandates for development that would result in a more ecologically balanced community.

The City is also developing an inventory of natural assets, including wetlands, forests, parks, and water-side regions to verify that they continue to provide their many environmental benefits to the city and its residents. The City will also acquire and conserve floodplain and water-side properties.

SUSTAINABLE FREDERICTON: NEXT STEPS

Fredericton has a strong network of parks and trails but there is room for improvement. Many regions have transitioned to green and clean energy parks with solar panels and water wells that are replenished by natural aquifers. In Sustainable Fredericton, all park infrastructure will be off-grid powered by solar energy.

Fredericton's Killarney Lake Park

URBAN GREENING

Sustainable Fredericton will green every available space. Urban greening mitigates the effects of climate change, significantly reducing urban temperatures, reducing energy consumption, and improving the well-being of city dwellers.

Urban greening creates new ecological habitats, encouraging a greater variety of biodiversity in these environments. It is also a strategy for urban food production.

Image by StockSnap from Pixabay

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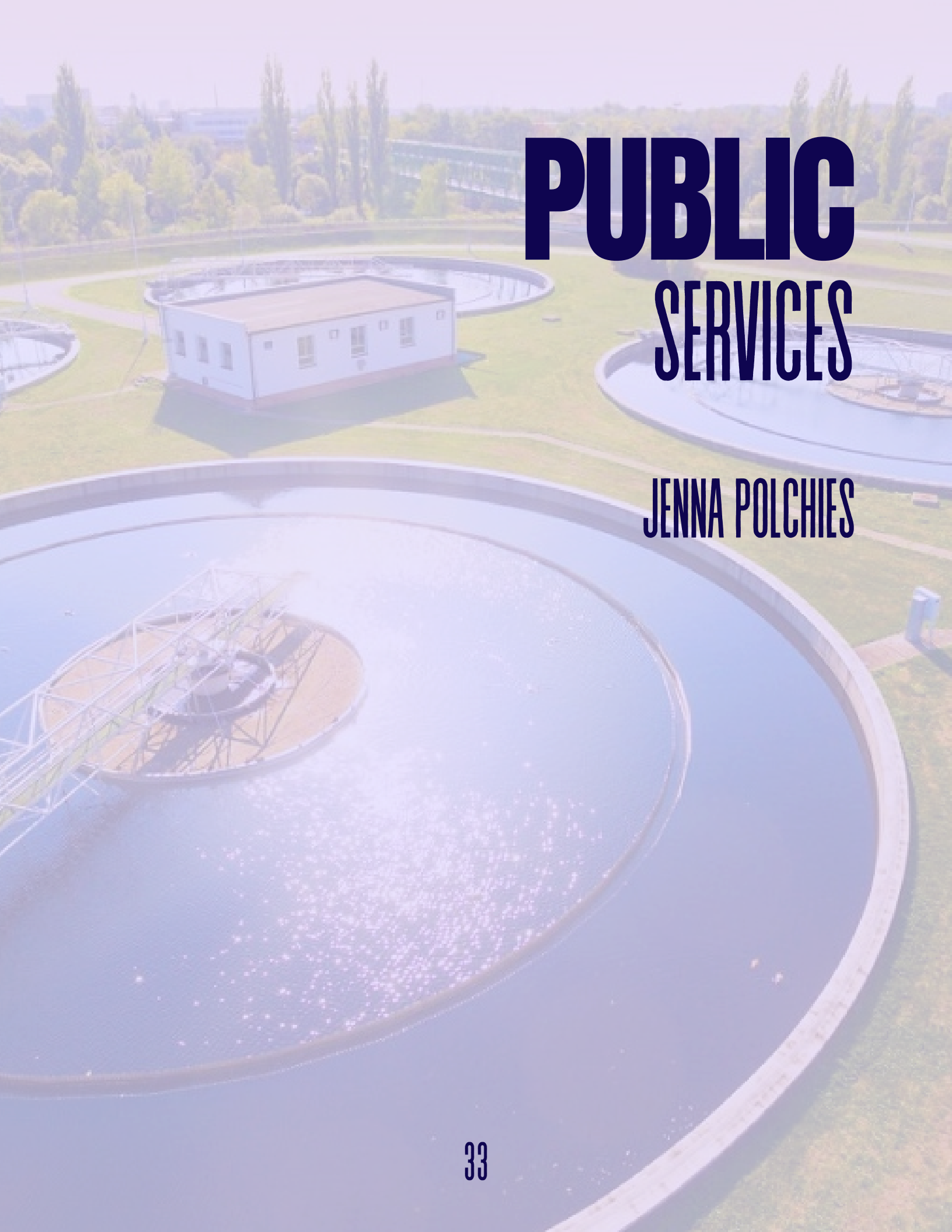
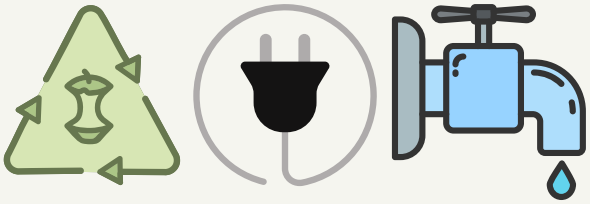


PUBLIC SERVICES

JENNA POLCHIES

PUBLIC SERVICES

The public services within a city provide a critical role in sustainability efforts, from critical infrastructure such as effective water treatment to the material flows of consumption, metabolization, and waste. Public services are necessary to maintain a high quality of life and the safety of all residents. The vision for these services is that in addition to serving all citizens, they will work in sync with the Earth's natural systems.



MEASURING SUCCESS

A sustainable future for Fredericton requires that we design our municipal services to meet the needs of citizens while ensuring that our systems enable us to remain within ecological boundaries. To measure the success of these public services, we can look at the goals for a sustainable community outlined in *Can a City Be Sustainable?* Several of these are important for public services.

- Reduced, circulating, and clean flows of materials
- A prominent place for nature
- Compact, connected patterns of development
- Centers of well-being
- People-centered development
- Participatory governance

"BUSINESS AS USUAL"

ENERGY

From Fredericton's 2019 energy and emissions inventory, residents and businesses consumed over 8.4 million Gigajoules of energy, leading to 58,200 tonnes of carbon emissions (TCO2e).

WATER

A centralized water system coupled with an ever-increasing demand on water supply, natural resources are strained. A vital priority for public services is to ensure citizens have access to clean water, that sewage is removed, and stormwater is managed efficiently.

WASTE

The traditional linear use-and-discard flow of materials is not working: Fredericton's 2024 waste audit found that 60% of landfilled material could be diverted through reuse, recycling or composting. Almost 50% is compostable material.

USING NATURAL PROCESSES: ECOLOGICAL DESIGN

Sustainable public services require transitioning from conventional centralized systems to smaller scale, decentralized systems that are designed to work with nature. Ecological design means following the principles of ecosystem cycles to design water, waste and energy systems. An effective ecological design will emulate natural ecosystems to meet the needs of citizens while maintaining ecological integrity. For instance, water recycling and reuse is beneficial to increase resiliency and adaptability of our municipal water system.

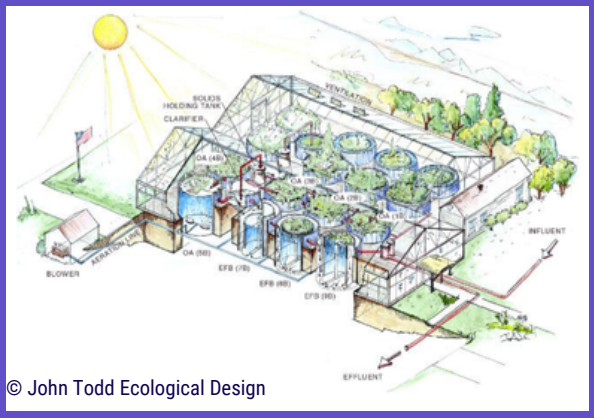
THE TRUE COST OF WATER

- Municipalities face challenges of water scarcity and the vulnerability of centralized water supply and treatment systems. These centralized systems may not be able to meet future challenges if the city continues to grow.
- In Fredericton, renewing the 100-year-old pipes would cost the city $23.3 million, but it is not reflected in the $2.70 per litre average household price.

BEST PRACTICES: ECO MACHINES FOR WASTEWATER TREATMENT

A prime example of a decentralized ecological wastewater system is John Todd's Eco-Machine. These ecologically engineered systems treat wastewater using vegetation, nutrient and hydrological cycles. Sustainable Fredericton will implement systems that follow natural processes to treat wastewater.

CASE STUDY: SOUTH BURLINGTON MUNICIPAL ECO MACHINE



© John Todd Ecological Design

In South Burlington, Vermont, 80,000 gallons of sewage is diverted from the city's conventional wastewater treatment plan to the Eco Machine. Eco Machines replace mechanical and chemical processes with *life* - bacteria and plants. Removing pathogens biologically requires a proper amount of retention time and exposure to an oxygen-rich environment for the organisms that feed on biochemical oxygen demand. An Eco Machine for wastewater treatment is not only a beautiful and prominent place for nature, but it has been used as a educational center, resembles a garden center, and produces papyrus.

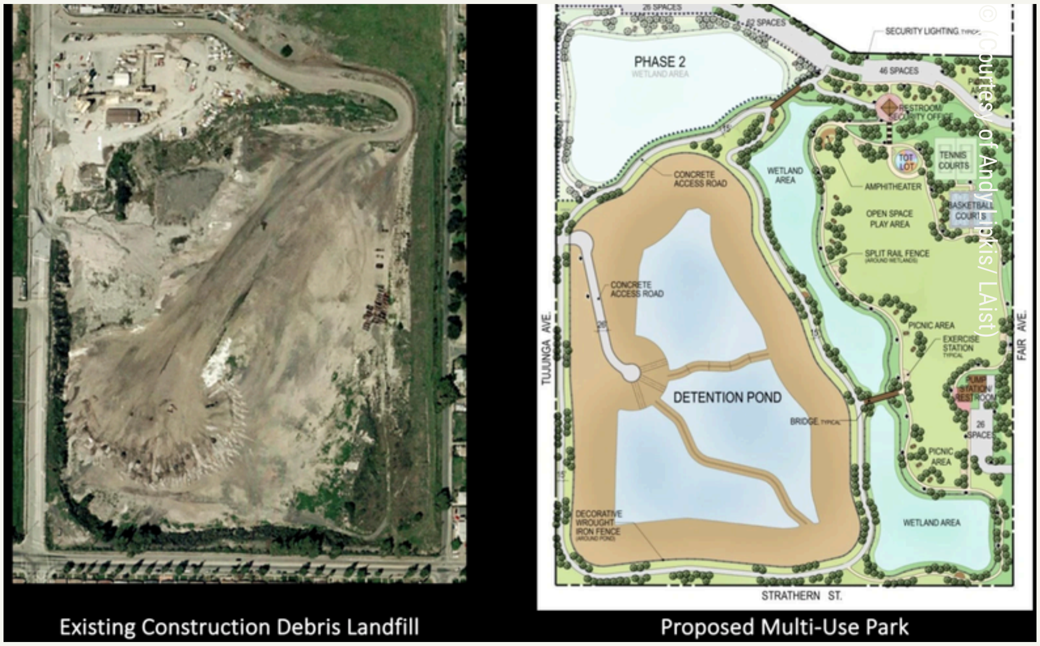
DECENTRALIZED MUNICIPAL WASTEWATER SERVICES

BEST PRACTICES: RAINWATER /STORMWATER HARVESTING

Sustainable Fredericton will collect rainwater to minimize the drawdown on the aquifer that supplies our drinking water. Harvesting rainwater can alleviate the burden on drainage systems and reduce the effects of flooding, erosion, and water pollution. Garden-like drainage systems will be put in place to increase their aesthetics.

The common uses of captured rain/stormwater are to flush toilets and for irrigation. At the household level, water intake piping will be modified to include rainwater, which will be priced lower than potable water. Benefits of stormwater harvesting at the regional level include habitat maintenance, recreational uses, and aquifer recharge.

The Rory M. Shaw Wetlands Park Project in Sun Valley neighborhood of Los Angeles will contain a 21-acre detention pond to hold runoff from the upstream tributary. The stormwater then runs through a wetland to naturally remove pollutants. The wetland will host various plants and animal species. The treated stormwater will be pumped into infiltration basins for groundwater recharge at the final stage.

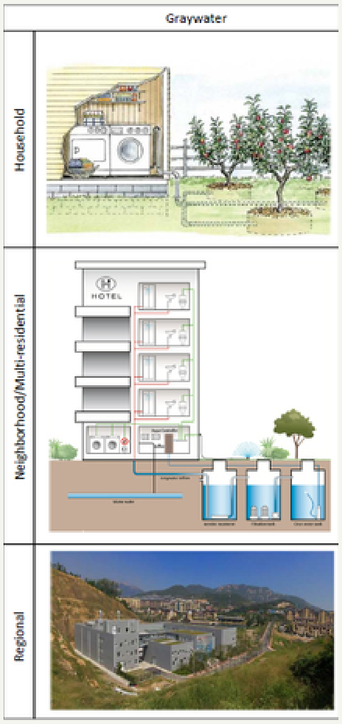


Existing Construction Debris Landfill

Proposed Multi-Use Park

GREYWATER SYSTEMS

Greywater is waste water from uses such as laundry, bathing and dishwashing. Greywater systems replace potable water for uses such as watering garden and maintaining parks foliage, as well as toilet flushing at household, city and neighborhood scales. Heat from graywater can be captured through heat exchange systems and used for heating potable water or improving the efficiency of absorption heat pumps.



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MUNICIPAL WASTE

ZERO WASTE SYSTEMS

The traditional linear use-and-discard flow of materials is unsustainable and environmentally harmful. Organic waste in landfills is a major source of methane, a greenhouse gas that traps 82.5 times as much heat as CO2 over a 20-year timespan. Almost half of the waste going to the Fredericton landfill is organic material. Significant amounts of CO2 are released through the transport of waste.

© European Parliament

Zero waste systems are being implemented in over 550 municipalities around the world. Zero waste means designing product life cycles so that all products are repurposed and the waste from their production is cycled to other uses. This is known as the circular economy.

Gone are the days of recycling as a superficial fix for a throw-away culture. Sustainable Fredericton will require waste avoidance and a reuse and repair culture emerges. We will curb waste production at the source, incentivizing a conserver rather than consumer culture.

An Amsterdam-based electronic company, Fairphone, designed the first smartphone using a circular supply chain. While it is a small step in the right direction, the vision for Fredericton's future would be for all products to be redesigned so they last several cycles of use: Repair, reuse, recovery.

WASTE REDUCTION AT THE SOURCE

Several laws need to be introduced at provincial and municipal levels to reduce waste at the source and to hold companies accountable for the products they produce. At the provincial level:

- **Eco-taxes:** Eco-taxes deter wasteful practices by including the full cost of the product lifecycle.
- **Mandatory "take-back" regulations:** These hold manufacturers responsible for their products until the end of their life cycle, thus incentivizing better quality products and more sustainable practices.
- **Bans on single-use packaging:** Fredericton will lobby for bans on items such as single-use items, unnecessary packaging and organic waste.
- **Right to repair law:** This allows people to repair products without returning to the manufacturer.

At the municipal level:

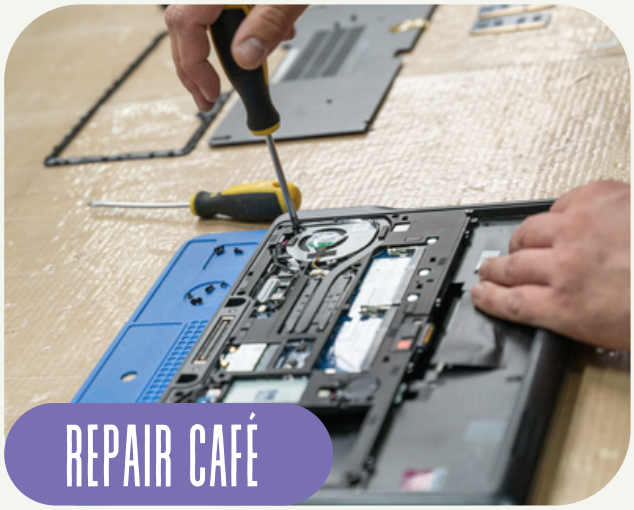
- **Pay-as-you-throw fees:** There will be variable pricing on trash collection such as volume-based waste fees.

MUNICIPAL WASTE

REUSE AND REPAIR

An important component in achieving a zero-waste system is reusing and repairing materials and products. The government's role in this is to provide subsidies to repair and second-hand shops.

Reverse Garbage is a non-profit organization established in 1975 originally to divert waste from landfills and reuse materials in schools. They accept a broad range of materials to repurpose.



The Repair Café is a non-profit organization that teaches repair skills, promotes more repairable products, changes people's mindsets about reuse and strives for sustainability at the local level.

SOURCE SEPARATION: ORGANIC WASTE

A good source separation strategy is vital to organic waste management and achieving high quality compost. Organic waste represents the largest portion of the solid waste stream; one-third of all food produced is wasted. When prevention is not available, food recovery and composting are the priority.

- **Food rescue:** Redistribution programs to help people and communities in need.
- **Home composting and small-scale decentralized composting:** (See *Case Study: The City of Partizánske*)
- **Animal feed:** Using food waste for animal feed is a substitute for resource -intensive feed crops. However, precautions are necessary to avoid potential disease transmission.

CASE STUDY: THE CITY OF PARTIZÁNSKE

The city of Partizánske, Slovakia worked with citizens to develop a Home Composting Development Programme. The program targets biowaste from kitchen food and garden waste in individual households and multi-apartment buildings. With a population of around 21,000, 95% of households living in single-family houses now compost at home. That is a decrease of 36% of mixed waste per capita since 2018. The total reduction across the municipality is 18% since 2018. Such programs offer optimistic potential to eliminate bio-waste from entering landfills.

DECARBONIZING ENERGY

Fredericton's energy and emissions inventory revealed that households and businesses consumed over 8.4 million gigajoules of energy, leading to 582,00 tonnes of carbon emissions (TCO2e). If energy consumption continues to rise with an increase in population, urbanization, and wealth, Fredericton's energy consumption is expected to increase to 743,00 tonnes by 2050. The fundamental aspect of transitioning to a 100 percent renewable Fredericton is to decrease our energy consumption to compliment efficiency gains mentioned in the previous section.

Sustainable Fredericton depends upon decarbonizing the energy system. This refers to transitioning away from fossil fuels as energy sources. Burning oil, coal and fossil (natural gas) for mobility, heat and electricity is the primary source of carbon dioxide and other greenhouse gases which cause dangerous climate change.

Decarbonizing means transitioning to renewable energy, including solar, wind and water. Although a 100% renewable Fredericton meets our overall vision of a sustainable city, there must be some caution with the terms "renewable" and "decarbonizing." Some energy sources that are considered renewable are not necessarily impact free. For example, hydropower projects can permanently alter river ecosystems. Similarly, nuclear power is considered "carbon-free" yet produces dangerous wastes with adverse consequences.

ENERGY EFFICIENCY

Decarbonizing Fredericton involves maximizing energy efficiency and switching electricity production and heating and cooling systems to be run on renewable energy. In doing so, Fredericton will benefit from increased resiliency and self-sufficiency.

A large proportion of current energy use is wasted, so the first step in the transition is making sure that energy waste is minimized. Improving energy efficiency is ideal because large efficiency gains produce energy-cost savings, expand employment, and have health and environmental benefits.

RETROFITS

According to *Can a City Be Sustainable?* existing buildings account for approximately one-third of global energy consumption. Retrofitting buildings to minimize energy use is essential. "Deep" energy retrofits use whole building approaches and integrative design.

57%

According to Fredericton's energy and emissions inventory, most of the city's greenhouse gas emissions come from heating, cooling, and powering buildings.

ENERGY: BUILDINGS

Some best practices of deep energy retrofits include:

- Improved building envelopes: This reduces heating and cooling demand by upgrading roof insulation, adding wall insulation, and minimizing outdoor air infiltration by sealing the building envelope.
- Heat pumps for heating systems: In combination with deep retrofits which reduced energy demand, high efficiency heat pumps replace conventional heating systems.
- Management of plug loads and lighting controls: In an integrative design, energy savings can be achieved by efficient lighting and management of electrical demand from plug loads. Automatic low-power state or schedule timer control devices are a few strategies for management.

With targeted financial incentives, rooftop solar photovoltaic panels can be a cost-efficient retrofit for low-income, multi-family properties. Once installed, the cost of electricity is lower than from conventional sources.

To facilitate the green energy transition, Sustainable Fredericton will:

- work with provincial and federal governments to put together comprehensive financial packages to support household and business efficiency retrofits.
- Implement a building code that requires new buildings to be designed to achieve zero or near-zero emissions.

NEW BUILDINGS: PASSIVHAUS

Passivhaus is a standard and methodology for low energy buildings developed in Germany. These buildings use 75% percent less energy than similar conventional houses. They eliminate the need for space heating and cooling through designing for super insulation, firm airtightness, and removing thermal bridges. These buildings also design for passive solar gain, mechanical ventilation and heat recovery systems.

Paasivhaus building are heated by the residents and waste heat from appliances and cooled by strategic shade, nighttime purging of heat and cross ventilation. This design is a prime model for how new construction can be built.

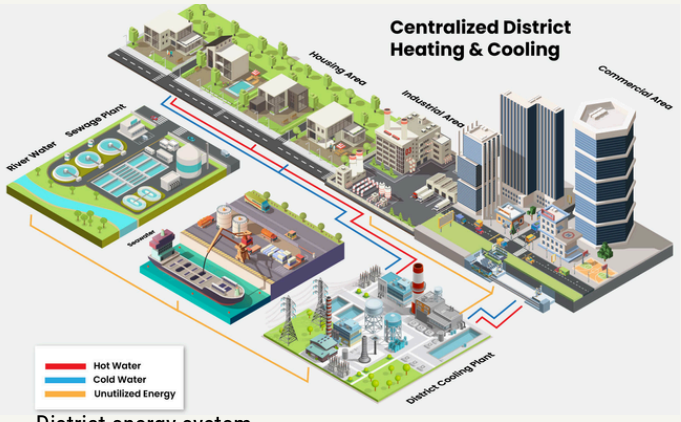
DECENTRALIZING ENERGY

In Fredericton's renewable city, electrical utilities are municipally owned, allowing local decisions about supply and distribution. To address social equity concerns, Fredericton will implement solar power purchase agreements where the homeowner only purchases the electricity produced, not the photovoltaic (solar panels) themselves.

Electricity purchasing cooperatives will be formed and community solar gardens will be established. Community solar gardens work by customers subscribing to a solar network and each subscriber's utility bill is credited by their share.

HEATING & COOLING

For healing and cooling, a district energy system, or mixed grid system, in combination with isolated residential systems are the most viable. Isolated residential systems would consist of rooftop solar photovoltaic panels, solar water heating, ground source (geothermal) heat pumps, and grid-connected or off grid renewable energy systems. A district energy system sends steam, hot water, or chilled water through pipes to interconnected buildings. Copenhagen is a leading city in district heating system with the world’s largest district heating network.



District energy system

SUSTAINABLE PUBLIC SERVICES

Transforming Fredericton public services to meet the needs of all citizens while remaining in harmony with natural systems is no simple feat. Having a decentralized water system, a zero-waste system, and decarbonizing the energy system are huge but necessary changes. Instead of large centralized systems to provide water and energy, and remove waste, decentralized and community-focused systems will be necessary to restrain our overconsumption of these resources. Public services are meant to serve the people. Fredericton's public services will allow nature to flourish along side its citizens.

Most of Copenhagen’s electricity supply comes from onshore and offshore wind energy, as well as biomass, and solar energy.

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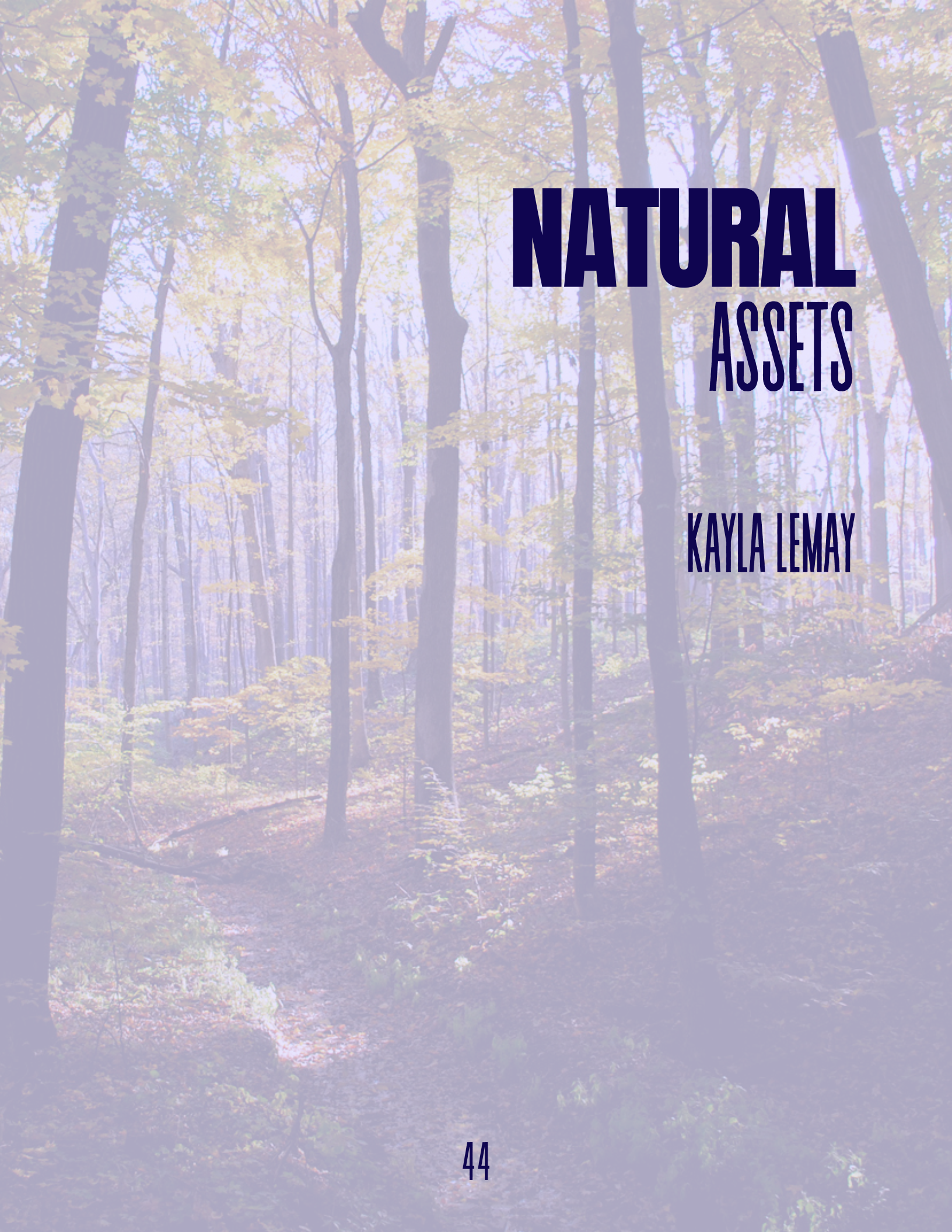

NATURAL ASSETS

KAYLA LEMAY

NATURAL ASSETS

Natural assets are physical and non-physical elements that when grouped together form an ecoregion. Every region has its unique groupings of natural assets that are determined through millennia of geological and human history. Air quality, water quality, topography, biodiversity, watersheds and climate types are all considered natural assets. These provide us and the natural world with important services that make life possible.

There can be many assets in a single city. For instance, Charlottetown, PEI conducted a Natural Asset Inventory and registered over 1,719 assets throughout the region. These consist of agricultural land, marshes, rivers, forests, grasslands and more.

FREDERICTON'S NATURAL ASSETS

Fredericton is located in the Grand Lake Lowlands ecoregion. The lowlands act as flood plains that fluctuate with the tides of the Bay of Fundy as well as northern snow melt.

Rivers. The Wolastoq River is the predominant natural asset that fuels Fredericton's way of life. It is a hotspot for migrating waterfowl and wildlife, as well as a source of fertility for the region's precious arable land. The Nashwaak River flows into the Wolastoq. Its calmer flow supports fish nurseries, rare plants/ trees, and amphibians such as the Gray Tree Frog. It forms many wetlands found on the North side such as the Hyla Nature Preserve.

- **Climate.** The river valley creates the conditions for a temperate climate of warm summers and milder winters. This climate type is suitable for agriculture and benefits the rich arable lands on the periphery of the city.
- **Forests and biodiversity.** Fredericton boasts a slice of primeval forest found right in the center of the city. Odell Park is home to over 120 species of birds, 30 species of mammals, and is home to ancient hemlock tree stands. Some of the trees are over 400 years old and form the park's microclimate. Park management is limited to trail maintenance in order to preserve the ancient ecosystem. At the southern edge of the city, the UNB woodlot harbors peatbogs, brooks, endangered Acadian forest stands and a plethora of biodiversity completely different from that of the rivers and hemlock forest.
- **Air and water quality.** The dense old growth forests within and on the boundaries of the city allows for improved air quality and water quality due to their filtration focused ecosystem services.
- **Aquifer.** The city's source of drinking water is a naturally occurring aquifer. All potable water that is used by the city is provided by this underground reservoir. It is covered by a natural layer of thick clay that prevents the permeation of harmful substances into the water supply.

WHY THEY MATTER

Natural assets form ecosystems. These are living systems that create the conditions for survival of all species including humans. They are the source of the cycles of nature that renew material growth and recharge nutrients.They are defense mechanisms that ensure smooth sailing during inclement times.

The Nashwaak and Wolastoq rivers retain a snaking pattern that mitigates flooding and maintains calm currents. The rivers provide essential nutrients to the land that is needed to fertilize local farmland. Trees in Odell Park and the 21,000 trees that line our streets keep the city cool, the air fresh and the wind at bay. Being embedded within the ecosystems formed by these natural elements increases Fredericton's resiliency. By keeping these natural assets unimpaired we can ensure the surrounding ecosystems and their services remain healthy. Ensuring the health of these assets generates a healthier community.

Biodiversity is key to ecological resilience. Bugs, birds, mammals, plants and fish keep materials, nutrients and energy cycling in an ecosystem. They provide services such as breaking down waste, pest control and enriching the area with their presence.

Odell Park, Fredericton

PROTECTING BIODIVERSITY

- **Wildlife corridors. I**n order to maintain biodiversity within the city, new plantings of native flowers and trees will be required as part of any new development. The strategic placing of these patches will connect and create a wildlife corridor. Wildlife corridors will ensure uninterrupted natural movements of birds, insects and animals through the city. The corridors provide habitat and protection for animals within a city. It will also bring the public closer to nature and create important human nature connections.
- **Bird habitat.** Cities are home to over 20 percent of the world's bird populations, which have been in decline for 50 years. This is due to habitat loss from agriculture, clearcut forests and urban sprawl, disease, window strikes, and introduced predators. Fredericton harbours a population of endangered Chimney Swifts that could benefit from integrated urban habitats. Solutions such as bird brick/nesting bricks can be used to provide nesting habitat within the heart of cities.
- **Invasive species.** Tourism, recreation and cross-border trade risk introducing non-endemic species that could upset ecosystems and displace local species. To protect the integrity of our natural assets, invasive species need to be monitored and removed when possible. Maintaining close partnerships with local NGO,s such as NB Invasives helps educate the public and mobilize action when threats arrive.
- **Urban forestry.** We will manage Fredericton's forests to withstand and adapt to climate change, invasive species, and urban growth. This includes collecting, storing and planting seeds for the future.

RE-NATURALIZING RIVERFRONTS

CASE STUDY: LIVING ALSTER HAMBURG, GERMANY

Like Fredericton, Hamburg is nestled along a river called the Norderelbe. In order to preserve river health and sustain habitat for biodiversity, in 2012 the City began the Living Alster project which continues today. The project goal is to restore the river and its branching streams to their near natural state.

They installed bee hotels, fish ladders, gravel depots for fish to lay eggs, with further biodiversity supporting structures planned. Since implementation, the freshwater ecosystem has greatly improved. More species are present, biodiversity loss is at a minimum, and ecological connectivity is greater than ever across the city.

PROTECTING BIODIVERSITY

- **Protect old growth.** Fredericton benefits from its dense urban tree canopy. Continuing to protect and preserve them is important. Rather than cut down old growth trees in the way of a project, we will integrate them into the design of the proposed development.
- **Intentionally unmanaged areas.** These can manifest in small pockets throughout the city such as industrial or abandoned lots. Letting the wilderness take over these areas with a little bit of help can make a big difference in city biodiversity.
- **Pesticide-free city.** Pesticides are toxic chemicals designed to kill certain plants and insects. They poison soil, contaminate water, harm non-target species, and affect human health. Sustainable Fredericton will ban chemical pesticide use throughout the city. This will protect biodiversity, water and air quality, and eliminate any accidental human/pet contact to harmful chemicals. Natural weed and insect control are integral to an ecologically sound community.

Credit: Nature Trust of New Brunswick

DARK SKY COMMUNITIES - WORLDWIDE

Light pollution is inevitable within cities. It disrupts migrating bird patterns and disrupts the circadian rhythm of trees who have been unlucky to find themselves in the path of a lamppost. There are ways to solve this and many communities around the world are taking action.

There are over 160,000 square kilometres of designated dark sky reserves all over the world. Some of these reserves are in communities of similar size to Fredericton. Communities have achieved Dark Sky status by retrofitting their lighting to Dark Sky approved street lights. This means the lights themselves are warmer on the colour spectrum to minimize natural rhythm disturbances. Municipal bylaws and codes can set outdoor lighting requirements and establish no light hours/zones.

RIVERS, STREAMS, & WETLANDS

No Development Zones. Establishing no-development zones along waterways allows for the naturally occurring yearly floods to carry on with minimal impacts. Maintaining the meandering shape of rivers allows flood waters to slow down and spread to river bends that contains the water into a single area.

Preserving wetlands offers the same benefits during flood season and they also serve as filters for pollutants in the flood water. Peat bogs located within the UNB Woodlot act as carbon sinks and have the ability to filter out harmful substances such as pesticides due to its high carbon content. Disturbing this ecosystem leads to carbon to be released into the atmosphere and restored peat lands take hundreds of years to start sequestering carbon again.

AQUIFER PROTECTION

- **Preserve Water.** Conscious water use is integral to preserving aquifer water levels. Rain water collection and gray water systems will ensure potable water from the aquifer is not being used to flush waste.
- **Decrease Soil Contamination.** Pollutants from cars, salt and other road based activities pose a risk to the aquifer if they penetrate the clay layer or end up in the river. Water collected into storm drains should have a level of treatment in order to lessen the chemicals and pollutants in the water.
- **Naturalize yards and parks.** Non-native ornamentals such as grasses use more water than native plants who have evolved to survive the area's climate. Replacing them can allow more water to pass through the soil into the aquifer. It also eliminates the need to water plants more frequently.

ARABLE LAND PRESERVATION

Recognize agricultural areas as natural assets. Fredericton's nutrient rich arable land has formed over hundreds of years. Yearly flood cycles, animal migration and unique geographical history has led to Fredericton having highly productive land ideal for food production. Protecting farming areas through soil and water stewardship is critical for long term food security and rural economies. We will preserve these areas from urban sprawl. Dense building practices within the city core can help reduce the threat of development creeping onto arable land.

Adopt regenerative agricultural practices. In recent years, the traditional method of tilling soil for planting preparation has been proven to strip the topsoil of organic matter necessary for food production. Tilling perpetuates erosion as well. In order to maintain soil health season after season, Sustainable Fredericton will support the transition to regenerative growing practices. Planting cover crops after harvests keeps soil in place, adds nutrients to the soil and preserves organic matter.

Hayes Farrm: Regenerative food production in Fredericton. Photo: Hannah Moore.

AIR QUALITY

Air pollution control. Fredericton's largest sources of greenhouse gas emissions and air pollutants are commercial buildings, residential buildings and personal/business vehicles. Pesticide applications in in residential neighbourhoods also affect air quality. Retrofitting buildings, improving public transit, moving to green energy, and banning chemical pesticides are all actions that can limit air pollution within the city. Maintaining tree canopies and setting aside land for protected forest areas will ensure the city's air quality is maintained.

ECONOMICAL ECOLOGY

Monetary value is being assigned to the ecological services that natural assets provide to human communities. Maintaining the functions of rivers, marshes, tree canopies and more ends up saving communities billions of dollars a year.

Hamilton, Ontario has analyzed the ecosystem services the Grindstone Creek Watershed provides to the city through its natural functions. The 91-sq km area has saved the city an estimated $2 billion in stormwater management and roughly $34 million in other services such as erosion control and carbon sequestration. These numbers represent the money the city did not have to spend in repairing, updating and building infrastructure due to the natural assets functioning normally. Degrading these assets would cost more to the city than it would protect them.

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CONCLUSION: THE CHANGING CLIMATE

PREPARING FOR UNCERTAINTY: SUSTAINABILITY PLANNING

Bill Thorpe Walking Bridge, Fredericton. Photo: https://joeyisatraveler.com/best-things-to-do-in-fredericton-nb/

As climate change progresses, the future is uncertain. Climate modeling suggests that by 2050 New Brunswick can expect temperature increased of from two-to-four degrees C above average in summer and between one-to-six degrees C above average in the winter season. Yearly precipitation will increase and inland summer droughts will be more common. Unseasonal weather events such as storms or early and late frosts will become more intense, upsetting plantings and harvests. Summer droughts will mean lower river levels that can lead to low oxygen levels for aquatic species, more frequent toxic algal blooms, a dry Nashwaak River and depleting aquifer. Certain tree species will struggle, and food production will change. Summer heat waves will become more frequent, making outdoor work and recreation difficult, and uncooled indoor spaces dangerous for vulnerable people.

Building sustainability into every aspect of the city infrastructure, services, and natural asset management is the best protection against a changing climate. That is what this plan for Sustainable Fredericton is all about. It is a plan for living within the “doughnut” - the safe and just operating space for humanity; a society that stays within ecological boundaries while ensuring that everyone can live a fulfilling life.

Transitioning to low-carbon transportation and energy systems, increasing local food security, expanding green spaces and protecting water supplies are central to reducing our ecological footprint and building community resilience against climate disruption.

While these transitions are necessary, protecting Fredericton’s natural assets is at the heart of community resilience. While healthy ecosystems are not all we need, we cannot do without them. This is the foundation on which Sustainable Fredericton is built. We know there are ecological limits to urban growth. Containing the community’s demands on these natural assets is our ultimate responsibility.