Toward natural asset management in the

City of Charlottetown

Prince Edward Island

Summary of inventory results and implications
April 2021

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Municipal Natural Assets Initiative

M NAI .CA
Making Nature Count
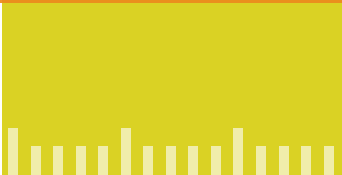
Invest in Nature

The Municipal Natural Assets Initiative (MNAI) is a Canadian not-for-profit that is changing the way municipalities deliver everyday services - increasing the quality and resilience of infrastructure at lower costs and reduced risk. The MNAI team provides scientific, economic and municipal expertise to support and guide local governments in identifying, valuing and accounting for natural assets in their financial planning and asset management programs, and developing leading-edge, sustainable and climate-resilient infrastructure.

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1 Purpose

This document summarizes the results of a project to develop a natural asset inventory in the City of Charlottetown and documents steps the local government can take to proceed to a full natural asset management initiative.

2 Introduction

What are municipal natural assets

The term *municipal natural assets* refers to the stock of natural resources or ecosystems that a municipality, regional district, or other form of local government could rely upon or manage for the sustainable provision of one or more local government services[1].

Why manage natural assets

A growing number of local governments recognize that it is as important to understand, measure, manage and account for natural assets as it is for engineered ones. Doing so can enable local governments to provide *core* services such as stormwater management, water filtration, and protection from flooding and erosion, as well as *additional* services such as those related to recreation, health and culture. Outcomes of what is becoming known as *municipal natural asset management* can include cost-effective and reliable delivery of services, support for climate change adaptation and mitigation, and enhanced biodiversity.

How to manage natural assets

There are numerous ways for local governments to manage natural assets. The Municipal Natural Assets Initiative (MNAI) uses methodologies and tools rooted in standard asset management, and provides a range of advisory services to help local governments implement them. MNAI has developed the methods and tools with significant investments, piloting, refinement, peer review, and documentation of lessons in multiple Canadian provinces. MNAI's mission is to make natural asset management a mainstream practice across Canada, and in support of this, for local governments to accept and use the methodologies and tools in standard ways across the country.

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1   *mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf*

What is a natural asset inventory

Inventories provide details on the type of natural assets a local government relies upon[2], their condition, and the risks they face. As depicted in Figure 1 and explained in detail in the Annex, a natural asset inventory is the first component of the Assessment phase. The Assessment phase, in turn, is the first of three phases of a full natural asset management project. By itself, an inventory will not give a sense of asset value, but is an essential first step in the full natural asset management project.
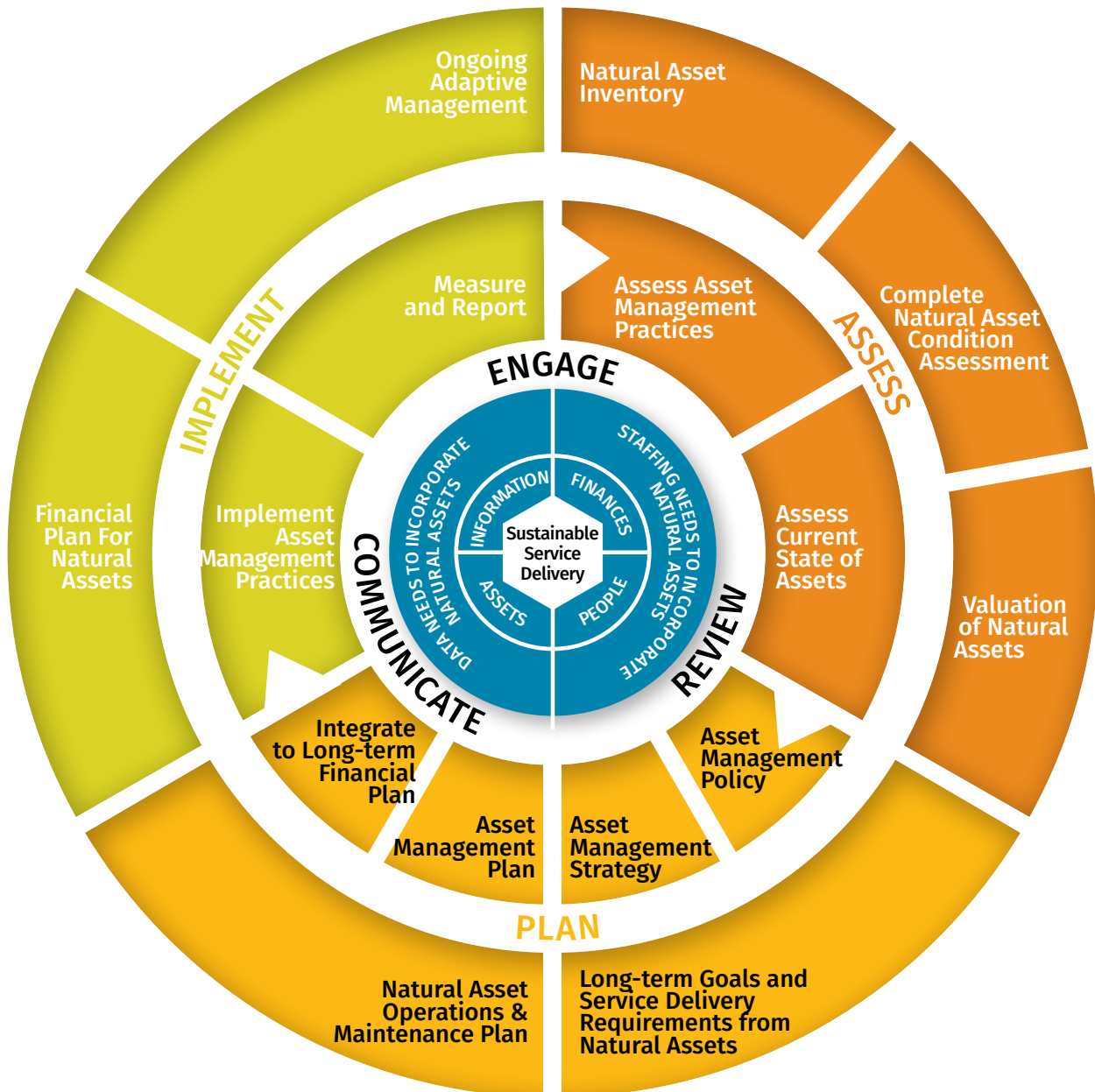

Figure 1: *The Asset Management Process. MNAI has adapted this for use with natural assets.*

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2   Note that many local governments rely on services from natural assets they do not own.

3 Local government context

3.1. General
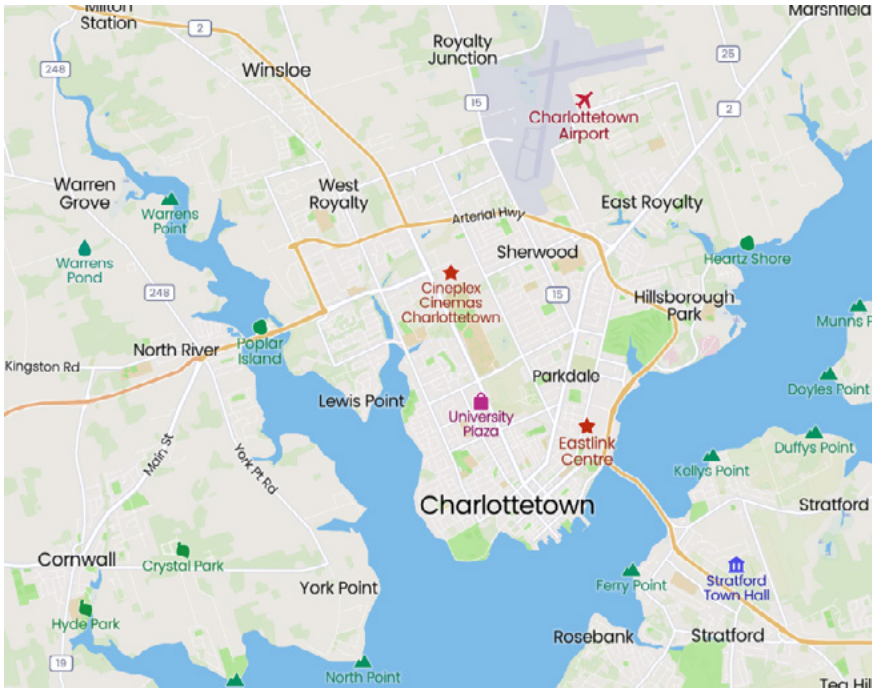
Figure 2: City of Charlottetown.

The City of Charlottetown[3] (population ~40,500) is the capital and largest city of Prince Edward Island and the seat of Queens County. As a waterfront city, it is facing climate change impacts such as rising water levels, increased flood risk, increased intensity of storms, and frequent droughts. Services such as flood management and water quality improvements are high priority concerns due to growing impermeable surfaces in urban areas.

Charlottetown has four main interests in natural asset management. First, the natural asset inventory will provide valuable baseline information that can be referenced across departments to provide Council, senior management and staff a better understanding of natural assets within the municipal boundaries and/or upon which the community relies. Second, consolidated inventory data will improve decision-making as Charlottetown must currently rely on assumptions or incomplete details of natural assets. Third, Charlottetown wishes to better understand - and demonstrate the interconnections between - development, infrastructure planning, land-use decisions, and natural assets. They anticipate this will provide evidence of the value of natural assets' services and inform and justify their protection and restoration. In this context, the project would link to Charlottetown's Official Plan (OP), Parks Master Plan (PMP), Integrated Community Sustainability Plan (ICSP), and the Victoria Park Master Plan. The OP articulates policies that protect defined natural areas and includes a future land use map that outlines environmental open space, recreational lands, trail buffers and greenspace connectors.

Fourth, the inventory could support and guide future partnerships to increase capacity and devote resources to preserve and protect natural assets in areas with the most need and value. Charlottetown already has partnerships with local watershed groups with a keen interest in the inventory, and the data would support and strengthen these and other collaborations.

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3   *Retrieved March 4, 2021 from* mapcarta.com/Charlottetown

Charlottetown has identified nature as a theme in the ICSP, which includes riparian zone health assessment, reforestation projects, woodland inventory, and a street tree inventory. Charlottetown has a street and park tree inventory that it uses regularly to guide tree care and planting; a similar summary for forested natural areas would support the Urban Forest Management. Climate change drives changes to landscape with loss of some plant species and introduction of new species, so invasive species is another concern. Additional priorities include air quality improvements, temperature regulation, and physical and mental health services that natural assets provide to residents.

3.2. Asset management readiness assessment

As part of inventory development, MNAI helps local governments determine their overall state of asset management maturity. To do this, MNAI has adapted the Federation of Canadian Municipalities (FCM)'s asset management readiness assessment tool[4] to help local governments measure their progress on both asset management and natural asset management in four competency areas, with each area describing outcomes based on five levels of progress or maturity.

The completed assessment will, in turn, help the local government prioritize actions that will increase its effectiveness in managing all assets, including natural ones.

Based on assessment results, Charlottetown is at a very early stage of adopting asset management, either working on level one or having achieved level one in most outcome areas. In some areas, it is further ahead on natural asset management than for its engineered assets, particularly in relation to its inventory and management plan for its street trees and urban forest in parks. Charlottetown conducts a yearly pond study with support from Holland College to monitor its ponds and lakes and establish baseline data, and monitors for Dutch Elm Disease and Emerald Ash Borer. Baseline data and monitoring of other natural assets are limited.

Charlottetown does not yet have a formal asset management program in place, nor a policy or roadmap. However, management has recognized the importance of moving forward on natural asset management. Charlottetown created a manager position responsible for reviewing departmental information and preliminary asset lists but has not developed formal expectations and objectives for asset management.

Charlottetown recognizes the need for interdepartmental collaboration to ensure all aspects of natural assets are considered in decision-making and are included in the development of asset management plans and policies, and there is good cross-functional collaboration in other teams and committees. Overall, Charlottetown still budgets primarily based on historical values and short-term needs guided by Council and management.

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4   See *fcm.ca/sites/default/files/documents/resources/tool/asset-management-readiness-scale-mamp.pdf* for details

Charlottetown has been reporting its tangible capital assets but does not yet have a single inventory of engineered assets. There are also data gaps related to asset groups such as stormwater assets and sidewalks related to age, condition, and current replacement value. Charlottetown has limited performance information and metrics for its assets, but does have ongoing water quality data and a tree inventory that includes health assessments and ecosystem services and financial benefits. The street and park tree inventory calculates the value of tree benefits (greenhouse gas avoided, energy reductions, air quality benefits based on current and evolving tree data).

4 Natural asset inventory

4.1. Inventory overview

MNAI's natural asset inventories have two main components, or ways, to express natural asset information: an asset registry (which is a tabular representation of the data) and an online dashboard. MNAI provided the registry to Charlottetown in an Excel file and the dashboard as a website address. Information on the condition of the assets is a subset of the inventory and is depicted in both the registry and dashboard.

4.2. Inventory data

To establish the inventory, MNAI used the most recently available annual crop inventory data produced by Agriculture and Agri-Food Canada (AAFC) as baseline for land use / land cover[5]. MNAI then combined this spatial data with data the municipality provided on wetlands and water bodies to establish a comprehensive depiction of natural assets. Table 1 describes the data sources used to develop the inventory and condition assessment.

TABLE 1: DATA SOURCES SUMMARY		
DATA	**SOURCE**	**PURPOSE**
Corporate Landuse Inventory 2010	The Government of Prince Edward Island	Used in combination with annual crop inventory to create base natural asset inventory
Annual Crop Inventory 2020	Agriculture and Agri-Food Canada (AAFC)	Used in combination with corporate landuse inventory to create base natural asset inventory
municipal_boundaries	The Government of Prince Edward Island	Used for determining study area and clip datasets to study area
Wetlands2000_modified	The Government of Prince Edward Island	Used in combination with annual crop inventory and corporate landuse inventory to create base natural asset inventory

5   [1] For more information on AAFC annual crop inventory, see: Annual Crop Inventory - Open Government Portal (*canada.ca*)

TABLE 1: DATA SOURCES SUMMARY

DATA	SOURCE	PURPOSE
ChTownHydronetwork	The Government of Prince Edward Island	Used to indicate which assets have creek/river flowing through them, and attributes of those features
City_Streets	The Government of Prince Edward Island	Used to estimate road density and perform road density condition assessment
PEI LIDAR WATERSHED BOUNDARIES 2008	The Government of Prince Edward Island	Used to assign assets to their corresponding watershed
Lidar_ct	The Government of Prince Edward Island	Used to interpolate to 5 m DEM and assign mean elevation value to assets
Parks_region	The Government of Prince Edward Island	Used to determine number of parks within an asset, and to assign the area of asset overlapping with parks and corresponding park names
City_OWNED_Property	The Government of Prince Edward Island	Used to determine assets owned by City of Charlottetown
Charlottetown Public and Joint Owned Trees Dec 8, 2020	The Government of Prince Edward Island	Used in static map to depict trees in urban area
Soils	The Government of Prince Edward Island	Used to assign assets a minority and majority drainage type
Trails	The Government of Prince Edward Island	Used to determine length of trail in assets
Sub_catchments__ within_Charlottetown_ Muncipality	The Government of Prince Edward Island	Used to assign assets to corresponding watershed and sub watershed

The inventory project defined a total of 1,719 individual assets, covering 1,363 hectares (ha) of the municipal area, as noted in Table 2. The majority of this area was agriculture and forests. Note that Charlottetown had an assessment of their tree canopy completed using the iTree software application. The iTree assessment revealed that, taken together, trees and shrubs constitute 22 per cent of the total cover in Charlottetown. This number is not directly comparable to the number below for forests, given differences in land cover classifications and what is included in each (e.g., the forest category below does not account for street trees).

TABLE 2: SUMMARY OF NATURAL ASSETS BY TYPE

NATURAL ASSET TYPE	NUMBER OF ASSETS	TOTAL AREA (HA)	AVERAGE ASSET AREA (HA)
Agriculture	425	871	2.05
Forest	777	351	0.45
Grassland	13	0.61	0.05
Shrubland	137	10	0.07
Water	16	31	1.96
Wetland	350	98	0.28
	1,718	**1,363**	**0.79**

4.3.   Asset registry

Each asset within the inventory has a unique identification number that allows individual assets to be selected, analyzed, and the corresponding data manipulated as required. For example, changes in condition can be noted for individual assets. Information on each asset is housed in an asset registry. Table 3 is an excerpt from Charlottetown's registry showing natural asset characteristics and details.

Charlottetown Natural Asset Inventory

| | | | | Summary | Asset Registry | Condition | Decomposition |

Natural Asset Registry

Asset ID	Asset Type	Asset Area (ha)	Sub Asset Area (ha)	Subcatchment	Watershed	Corporate Lancover Subclass	Majority Drain Type	City Owned (ha)	Mean Elevation (m)	Trail Length (km)	Internal Forest%	Road Density Score	Relative Size Score	Permeability Score	Adjacent Land Use Score	Total Score
FOR-525	Forest	5.47	5.47	Winter River1184	Winter River	Eastern Larch	Well	0.00	44.20	0.00	50	10	10	10	9	51
FOR-592	Forest	5.09	5.09	Winter River1184	Winter River	White Spruce	Well	0.00	40.07	0.00	31	10	10	10	10	48
FOR-683	Forest	5.99	5.99	Winter River1184	Winter River	Red Maple	Well	0.00	41.82	0.00	24	10	10	10	9	45
FOR-698	Forest	2.52	2.52	Winter River1184	Winter River	Alder	Imperfect	0.00	39.36	0.00	10	10	5	10	9	36
FOR-650	Forest	1.66	1.66	Winter River1184	Winter River	Red Maple	Well	0.00	39.77	0.00	8	10	5	10	10	37
FOR-649	Forest	1.48	1.48	Winter River1183	Winter River	Red Maple	Well	0.00	42.98	0.00	7	10	5	10	9	36
FOR-685	Forest	2.73	2.73	Winter River1183	Winter River	Red Maple	Well	0.00	42.71	0.00	6	10	5	10	8	35
FOR-533	Forest	1.73	1.73	Wrights Creek1459	Wrights Creek	White spruce	Well	1.65	19.66	0.14	5	5	5	10	8	29
FOR-686	Forest	1.67	1.67	Winter River1184	Winter River	Red Maple	Well	0.00	41.27	0.00	5	10	5	10	10	36
FOR-520	Forest	1.49	1.49	North River1403	North River	Red Spruce	Mod Well	0.00	15.88	0.00	4	1	5	10	9	26
FOR-560	Forest	2.26	2.26	Winter River1183	Winter River	Balsam Fir	Well	0.00	42.14	0.00	4	10	5	10	8	34
FOR-590	Forest	5.92	5.92	Winter River1184	Winter River	Eastern Larch	Poor	0.00	38.82	0.00	3	10	10	10	8	39
FOR-537	Forest	9.10	1.14	Wrights Creek1456	Wrights Creek	White Spruce	Rapid	9.10	5.29	0.01	2	1		10	8	19
FOR-537	Forest	9.10	7.97	Wrights Creek1459	Wrights Creek	White Spruce	Rapid	9.10	5.29	0.01	2	1		10	8	19
FOR-591	Forest	2.21	2.21	Winter River1184	Winter River	Black Spruce	Poor	0.00	38.25	0.00	2	10	5	10	10	35
FOR-545	Forest	4.12	0.08	Wrights Creek1454	Wrights Creek	White Spruce	Well	0.01	12.36	0.00	1	1	10	10	8	29
FOR-545	Forest	4.12	4.04	Wrights Creek1458	Wrights Creek	White Spruce	Well	0.01	12.36	0.00	1	1	10	10	8	29
FOR-556	Forest	0.74	0.74	Winter River1184	Winter River	Balsam Fir	Well	0.00	35.14	0.00	1	10	10	10	8	38
FOR-615	Forest	0.98	0.98	Winter River1184	Winter River	Eastern Larch	Well	0.00	48.13	0.00	1	10	5	10	9	34
FOR-648	Forest	2.60	2.60	Winter River1184	Winter River	Red Maple	Poor	0.00	35.31	0.00	1	10	5	10	10	35
AGR-10	Agriculture	0.13	0.13	Hornes Creek 21452	Hornes Creek_2	Trees	Well	0.00	48.44	0.00	0	1	1	5	7	14
AGR-100	Agriculture	0.07	0.07	Wrights Creek1459	Wrights Creek	Trees	Rapid	0.00	4.64	0.00	0	10	1	5	7	23
AGR-102	Agriculture	0.01	0.00	North River2312	North River	Unknown	Well	0.00	42.22	0.00	0	10	5	5	6	26
AGR-102	Agriculture	0.01	0.01	North River2313	North River	Unknown	Well	0.00	42.22	0.00	0	10	5	5	6	26
AGR-1022	Agriculture	0.58	0.16	Hornes Creek_21452	Hornes Creek_2		Well	0.25	26.93	0.00	0	1	10	5	6	22
AGR-1022	Agriculture	0.58	0.42	Wrights Creek1459	Wrights Creek		Well	0.25	26.93	0.00	0	1	10	5	6	22
AGR-1024	Agriculture	0.02	0.02	Wrights Creek1456	Wrights Creek		Well	0.00	36.86	0.00	0	1	1	5	6	13
AGR-1029	Agriculture	0.95	0.95	Wrights Creek1456	Wrights Creek		Well	0.00	31.67	0.00	0	5	1	5	4	15
AGR-103	Agriculture	0.47	0.27	North River2312	North River	Trees	Well	0.00	48.13	0.00	0	10	1	5	6	22
AGR-103	Agriculture	0.47	0.20	North River2313	North River	Trees	Well	0.00	48.13	0.00	0	10	1	5	6	22
AGR-1038	Agriculture	0.00	0.00	Winter River1183	Winter River		Poor	0.00	41.83	0.00	0	10	1	5	6	22
AGR-104	Agriculture	9.87	9.87	Winter River1183	Winter River	Grain	Well	0.00	45.25	0.00	0	10	10	5	7	32
AGR-1050	Agriculture	2.58	0.01	Wrights Creek1405	Wrights Creek		Well	0.00	38.78	0.00	0	1	1	5	5	12

4.4. Online dashboard

Inventories may provide more insights when characterized visually in a dashboard, which enables users to explore different aspects of the data. For instance, natural asset information can be quickly summarized by watershed area, or, if users want to dive into the specifics of forest assets, they can quickly filter the data to focus on that particular asset. Figure 3 is a screen shot from the dashboard that MNAI provided to Charlottetown. The full version can be accessed at *go.greenanalytics.ca/Charlottetown*.
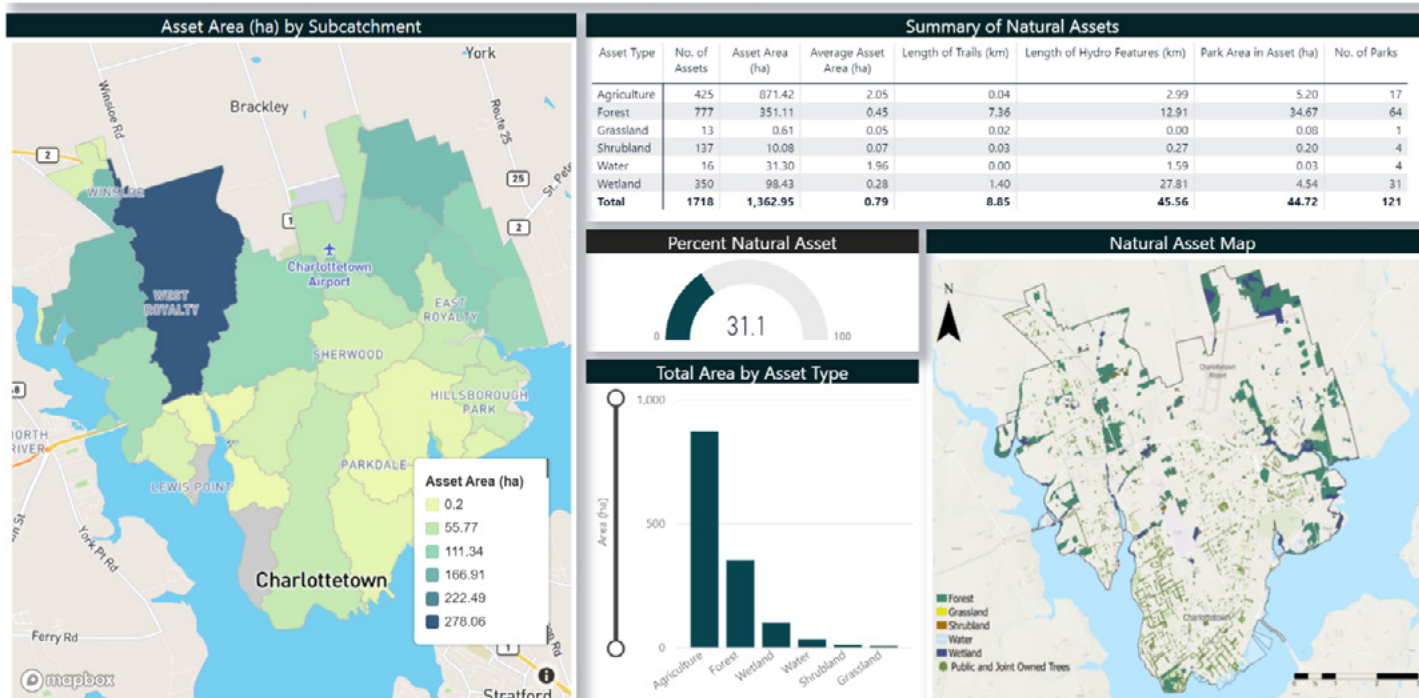
Figure 3: *Screenshot of main inventory summary*

4.5. Condition of natural assets

Documenting the condition of natural assets is a key aspect of natural asset inventories. A natural asset condition assessment provides an understanding of both the ecological health of natural assets, and the ability of natural assets to provide services. This, in turn, can support the effective management of natural assets, be reflected in the registry and the dashboard, and updated over time.

MNAI completed a desktop-based condition assessment and built it into the inventory to provide an initial understanding of the status of the natural assets for Charlottetown. Table 4 summarizes the condition assessment steps and indicators.

TABLE 4: CONDITION ASSESSMENT APPROACH AND INDICATORS		
Indicator	**Description & Methods for Quantification**	**Data used to Quantify Indicator**
Relative asset size	For each natural and semi-natural asset type, total area is calculated and a rank is assigned to the assets within each class based on its percentile score. Natural assets within the top third of the ranking (e.g., the largest assets within a class) received a 3, those within the middle third of the ranking received a 2, and those within the bottom third of the ranking received a 1.	Natural asset inventory

TABLE 4: CONDITION ASSESSMENT APPROACH AND INDICATORS

Indicator	Description & Methods for Quantification	Data used to Quantify Indicator
Road density	Measures the density of the roads in and around the assets according to high density (assets with more than 2km or roads per square km), medium density (assets with between 1km and 2km of roads per square km) and low density (assets with less than 1km of roads per square km).	Natural asset inventory plus spatial representations of roads
Surface permeability	The permeability of surfaces is ranked on a scale of nil to high depending on the type of landcover present. Urban areas, roads and industrial areas are ranked as nil. Assets within impervious surfaces are assigned as low permeability. Agriculture and shrublands are ranked as medium. Wetlands, waterbodies and forests are ranked as high.	Natural asset inventory, spatial representations of land uses and roads, as well as the Global Man-made Impervious Surfaces Dataset from NASA *data.nasa.gov/dataset/ Global-Man-made-Impervious-Surface-GMIS-Dataset-Fr/dkf4-4bi3*
Adjacent land use (nearest neighbours)	Considers the distance to, and the nature of, the area surrounding natural assets. Intense land uses (e.g., airports) in close proximity to natural assets result in a poor rating, while distant land uses that are less intense (e.g., agriculture) result in a good rating.	Natural asset inventory plus spatial representation of land use as well as intensity rankings of land uses

Once conditions were allocated to each asset, an overall score was derived for the project area. The maximum possible score for an asset was 40, based on a possible 10 points for each of 4 categories:

- Road density as low (10), medium (5) or high (1).
- Surface permeability rated as high (10), medium (5), low (1), or nil (0).
- Adjacent intensive land use (0 for intense land uses, otherwise 10).
- Relative asset size where the largest 3rd areas receive 10, 5 for middle 3rd, and 1 point for the lowest 3rd.

The total condition score was then converted into a rating scale:

- **Good -** assets with a score of 30 or higher
- **Fair -** assets with a score between 20 to 29
- **Poor -** assets with a score between 10 to 19
- **Very Poor -** assets with a score lower than 10

Figure 4 demonstrates the results of the condition assessment as presented in the inventory dashboard.

Charlottetown Natural Asset Inventory   Summary | Asset Registry | Condition | Decomposition

Natural Asset Condition Scores

The maximum total condition score for an asset is 40, and is based on a possible 10 points across 4 condition categories:
(I) Surface Permeability: High(10), medium(5), low(1)
(II) Adjacent Land Use: From 0-10. Where no adjacent land use = 10, surrounded by intensive land use = 0
(III) Road Density: Uses a 1 km² hexagonal tessellation. Low(1) where asset is in area where road density is > 2 km/km², medium(5) when between 1 and 2 km/km², or high(10) when < 1km/km²
(IV) Relative Asset Size: Largest 3rd of assets within each asset type are rated as high (10), middle 3rd are rated as medium (5), and lowest third are rated as low (1)
The total condition score is then converted into a **condition rating: Good:** Total condition score >30, **Fair:** Total condition score >20, **Poor:** Total condition score >10, **Very Poor:** Total condition score <= 10
Note: an interior forest area and condition rating are also calculated but not included in the overall rating as they apply only to forested areas.
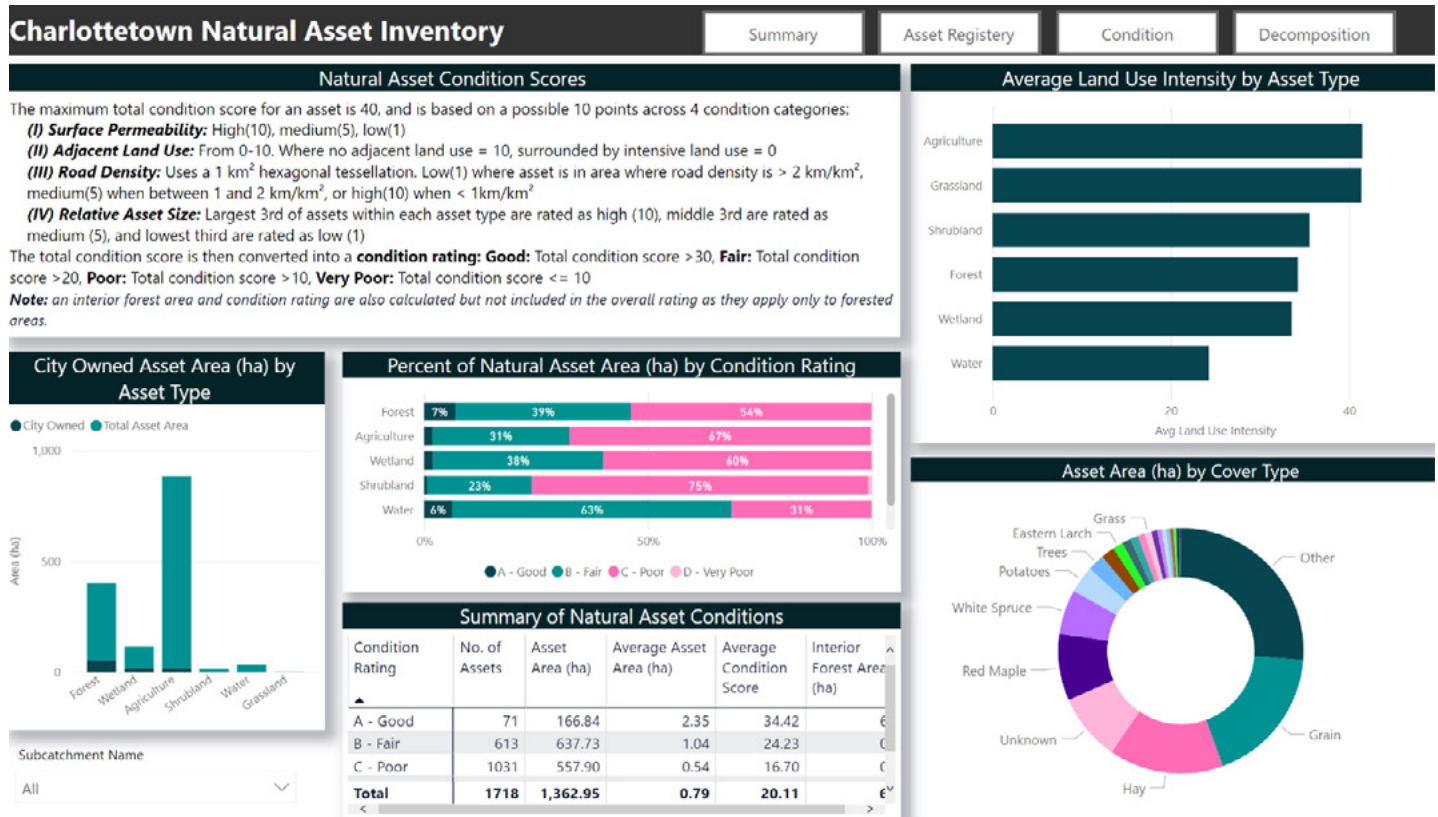
Figure 4: Screenshot of condition assessment results

Overall, about 167 ha (or 12 per cent) of natural assets were assessed in good condition and 638 ha (or 47 per cent) were assessed in fair condition.

Forest, wetland and water assets that rated poor were due to road density and asset size. Table 5 summarizes condition ratings and Figure 6 summarizes condition by natural asset type.

TABLE 5: SUMMARY OF NATURAL ASSET CONDITION RATINGS

Condition Rating	Number of Assets	Total Area (ha)	Average Total Score	Average Condition Score
Good	71	167	2.35	34.42
Fair	613	638	1.04	24.23
Poor	1,031	558	0.54	16.70
Very Poor	3	.5	0.16	10.00
Total	1,718	1,363	0.79	20.11

Percent of Natural Asset Area (ha) by Condition Rating

Asset	A - Good	B - Fair	C - Poor
Forest	7%	39%	54%
Agriculture		31%	67%
Wetland		38%	60%
Shrubland		23%	75%
Water	6%	63%	31%

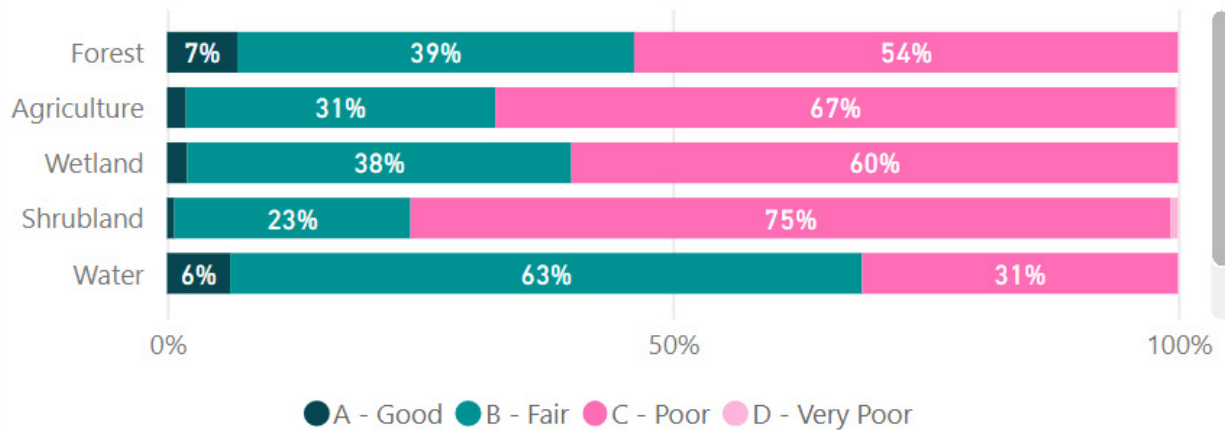Legend: ● A - Good ● B - Fair ● C - Poor ● D - Very Poor

Figure 5: Summary of condition rating by natural asset type

4.6. Maintaining the inventory

Inventories are not static. Both the registry and the dashboard can be expanded as new information becomes available. For example, asset condition might improve as a result of restoration efforts, or new studies may add insights on the condition of the assets. New data can be reflected in the asset registry and subsequently in the online dashboard as it becomes available. Furthermore, the level of desired detail may evolve as asset management readiness increases, or as areas of natural asset management focus emerge. However, inventories should grow in detail and sophistication only insofar as they remain aligned with the capacity of the communities to maintain them, and the uses to which they will be put. Their evolution and development should be a function of the monitoring, reporting and lessons of the asset management cycle and be driven by the imperative of ensuring sustainable, cost-effective delivery of services to the community, which is the core of asset management.

5 Risk identification

5.1. Risk identification tool overview

Identifying risks facing natural assets can help local governments prioritize their management of natural assets. To this end, MNAI provides local governments with a tool entitled *Risk Identification Process in the Development of Natural Asset Inventories* and guidance in self-administering it.

Risk management is a four-stage process that includes risk identification, analysis of probability and consequence, development of risk mitigation strategies, and control and documentation. The use of the risk identification tool informs the first and second stages of risk management through the identification of top risks to natural assets and their associated services, and a high-level analysis of impacts and consequences.

Risk types relevant to natural asset management typically include:

- **Service risk:** the risk of an asset failure that directly affects service delivery.
- **Strategic risk:** the risk of an event occurring that impacts the ability to achieve organizational goals.
- **Operations and maintenance risk:** risks related to poor asset controls and oversight, which can lead to poor record-keeping and poor monitoring of asset.
- **Financial risk:** risks related to the financial capacity of Charlottetown to maintain municipal services.
- **Political risk:** risks related to the nature of municipal politics.

5.2. Using the risk identification tool

Using the risk tool, Charlottetown considered possible risks that the loss of natural asset functions could pose to engineered infrastructure, personal health and safety, and private property, including:

- Overuse of trails/dumping
- Flooding (overland flow)
- Forest fire
- Invasive species
- Development pressure and construction activity
- Pollutant loading from urban, agricultural, or industrial sources
- Drought (current and future)
- Coastal erosion
- Ice jams

- Storm surge and sea level rise
- Lack of flood hazard mapping
- Political policy change
- Extreme weather events
- Planning policy
- Appropriate zoning
- Social convention and norms
- Accurate understanding of hard asset quality and hard asset failure
- Siltation

Each risk was then ranked low, medium or high according to the probability of an impact occurring, and the relative magnitude of its negative consequences. To assess impact and consequence, Charlottetown considered four questions:

1/ what impact is likely to happen?

2/ what is the consequence of that impact happening?

3/ what can be done to mitigate the impact probability and/or consequence?

**4/** what cues will signal the need for mitigation?

5.3. Results of the risk identification process

The risk identification process revealed:

- 5 high-level risks (storm surge and sea level rise, erosion, invasive species, lack of flood hazard mapping, and development pressure and construction activity)
- 1 medium-high level risk (extreme weather events)
- 9 medium-level risks (flooding – overland flow, pollutant loading, political policy change, drought, planning policy, appropriate zoning, social convention and norms, accurate understanding of hard asset quality and hard asset failure, and siltation)
- 3 low-level risks (forest fire, overuse of trails/dumping, and ice jam)

The identified risks affect natural assets across the entire area within Charlottetown's boundaries. In particular, coastal areas, low-lying areas, and larger forest stands have been identified as vulnerable.

Risk Matrix
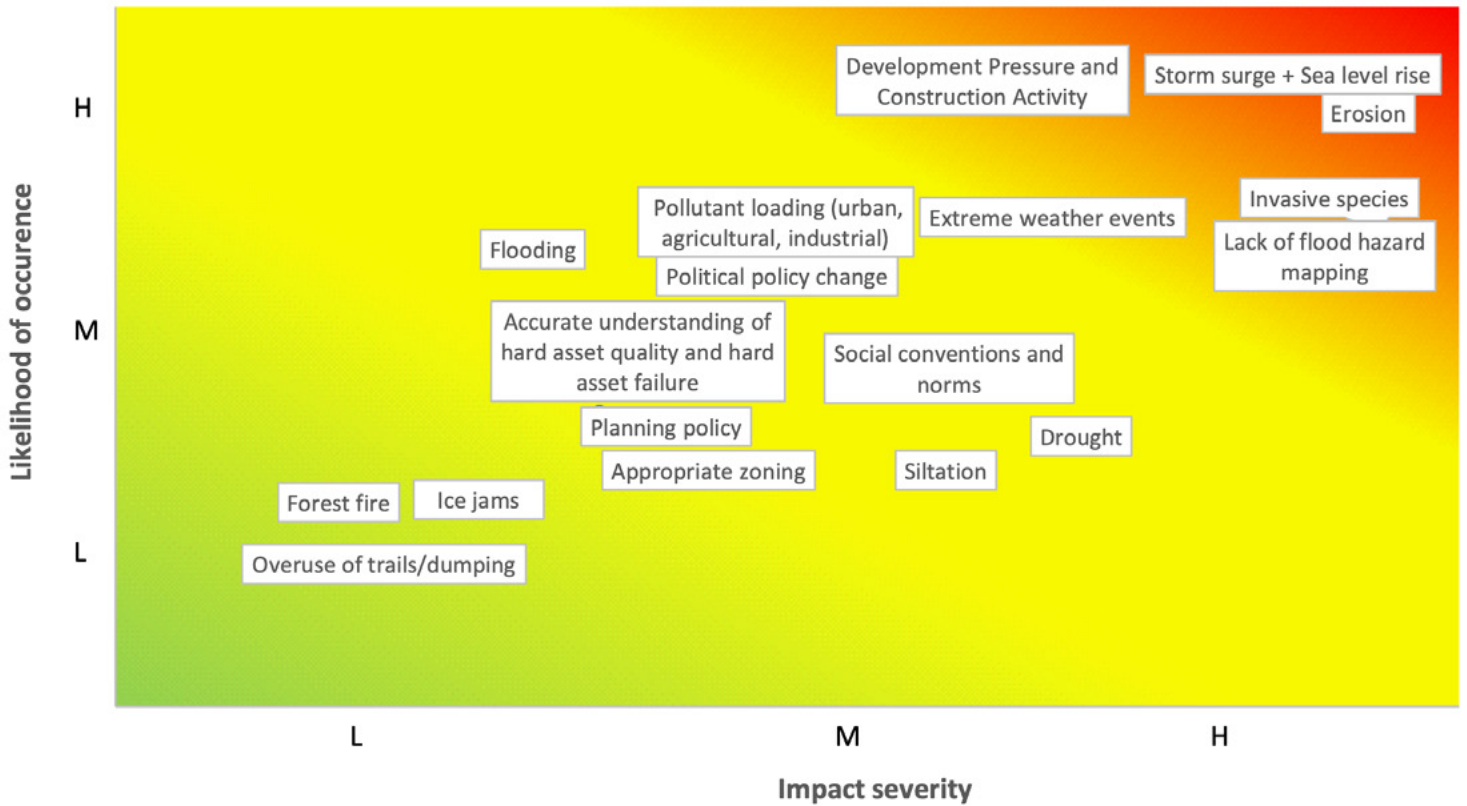
Figure 6: Results of risk management process

6 Implications

This section provides insights that can be gained from considering both the inventory - including the condition and risk assessments - and the asset management readiness assessment. It is divided into (a) potential priorities for the local government (b) possible actions for the further development of the inventory, and (c) steps the community can consider to advance to a full natural asset management initiative.

6.1. Potential priorities for the local government

Combining the results of the condition assessment with outcomes of the risk identification highlights potential priorities on which Charlottetown could focus natural asset management efforts. These are:

- **Storm surge and sea level rise:** Prince Edward Island is one of the most vulnerable areas to sea level rise in Canada; sea levels rose more than 30 centimeters between 1911 - 2015[6]. The frequency and severity of hurricanes and storm surges have also increased, threatening coastal communities, infrastructure, industry, and health and safety. Such risks were ranked as a high-level risk to forests and wetlands in coastal, riverine, and lower elevation areas (areas below 2.47 meters). Charlottetown has engaged in projects to assess risk and resilience in the context of climate change[7] and developed recommendations to bolster resilience[8]. The recommendations include the development of a task force to oversee progress, integrated planning that leverages goals and objectives, investments in green infrastructure including natural asset management, regulations to restrict development in flood hazard areas, and identification of multiple funding sources and mechanisms. Participants to the inventory risk identification exercise also noted the need to separate impacts from one-time events such as storm surges from events that occur over time, such as sea level rise.

- **Erosion:** Erosion - including coastal, riverine, and wind erosion – was identified as a high-level risk to all natural assets in coastal and riverine areas and the fields above Wales College. Given that PEI is composed of highly erodible sandstone bedrock and is experiencing ongoing submergence of its coast, Charlottetown may need to replace or re-design its coastal highways, bridges, sewer, and water infrastructure.[9] Charlottetown is considering steps including erosion and flood risk assessment and technical and financial feasibility of adaptation measures. These could include consideration of natural assets as they may bolster resilience, lower costs, and bring additional co-benefits to the community.

- **Invasive species:** Invasive species are affecting natural assets including forests and wetlands in all areas of Charlottetown. They can negatively impact local biodiversity and natural habitats, as well as economic losses to forestry, agriculture and fisheries sectors and decrease recreational opportunities. Charlottetown has implemented public education campaigns for invasive species and has a management program for Dutch Elm Disease, which includes monitoring, sanitation, tree planting, communication, education, and community engagement[10].

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6   *Province of Prince Edward Island, 2015.*

7   *City of Charlottetown, 2019a.*

8   *City of Charlottetown, 2019b.*

9   *Province of Prince Edward Island, 2015.*

10   *City of Charlottetown, 2021.*

- **Development pressure and construction activity:** Development pressure and construction were identified as a high-level risk to forests, wetlands, agriculture, shrubland, grassland, waterways, creeks, ponds, and springs. Areas at heightened risk include existing agricultural land within City boundaries; Andrew's Pond North; sub-catchments within the East Royalty area (e.g., Wrights Creek 1406, 1455); Hillsborough Park (e.g., Wrights Creek 1454 and Riverside 2158); and the North River sub-catchments 1394, 1393 and 1364. Concerns were noted relating to types of development (low density, single family homes), as well as limited regulations around the construction processes when high-risk negative impacts are most likely. While Charlottetown now has an inventory of natural assets, next steps could include further refinements to natural asset types within each class (e.g., categorizing wetlands into palustrine, isolated, riverine, and coastal wetlands) to further refine risk and regulations surrounding development.

- **Lack of flood hazard mapping:** Flood hazard mapping exists but is not readily available for use and/or not being conveyed to appropriate parties. As such, this risk was ranked high, with the potential to negatively impact natural assets across Charlottetown. Given the severity of flooding impacts, continued efforts for open access to maps with the Province should be pursued.

TABLE 6: RISK MITIGATION STRATEGIES	
Accept	Risk may be acceptable if probability and consequences are small
Minimize	Risk under local government's control that warrants exposure reduction
Share	Partners in a project permit the sharing of larger risks to reduce it for each
Transfer	Insurance, fixed price contracts, and other risk transfer tools

Table 6 lists and provides brief descriptions of risk mitigation strategies.

Opportunities to strengthen natural asset management at an organization-wide level

Charlottetown is at an early stage of asset management and thus in a good position to incorporate natural assets as it makes progress. For example, if Charlottetown develops an asset management policy, roadmap or strategy, the natural asset inventory will provide a good foundation upon which to include natural asset management objectives. In this context, staff noted that developing a roadmap for natural asset management could be a next step upon completion of the natural asset inventory.

Charlottetown's Environment and Sustainability Department has staff dedicated to environmental management and operations including a Forest and Sustainability Officer, a Water Coordinator, and an Urban Forestry Technician. This provides a good foundation for making progress in natural asset

management. To develop staff capacity, a next step could be to complete a staff competency review to identify required skillsets for natural asset management and fill essential gaps.

6.2. Possible actions for the further development of the inventory

Based on the inventory, Charlottetown could consider the following, regardless of whether or not it pursues a full natural asset management process. These are mostly incremental measures.

- Refine the inventory to reflect natural asset types within each class (e.g., wetlands can be broken down into palustrine, isolated, riverine, and coastal wetlands).

- Expand the risk identification to include field verification of results.

- Further develop the condition assessment and risk assessment using local climate projections, land use modelling, and other data already at their disposal.

- Identify linkages between services and assets, and assess the condition of, and risks to, the assets from the perspective of their ability to deliver services. From a hydrological hazards perspective (e.g., coastal and riverine flooding, sea level rise), the wetlands and forested areas in the watersheds will be key, as is the need to separate impacts from one-time events such as storm surge from events that occur slowly over time such as sea level rise.

- Pursue erosion and flood risk assessments, and technical and financial feasibility of adaptation measures that incorporate the role of natural assets.

- Engage the Province of Prince Edward Island for open access to Flood Hazard Mapping.

- Schedule regular updates (e.g., every 3-5 years) of the inventory, condition assessment and risk identification to understand trends.

- Share the inventory with adjacent local governments to stimulate collaboration.

- Initiate or enhance monitoring - for example, using gauges, water level sensors and loggers to improve understanding of trends, feed into condition ratings of assets, and gather information for modelling.

- Maintain interest and momentum to move towards a full natural asset management project.

6.3. Steps to a full natural asset management project

If Charlottetown wishes to proceed with a full natural asset management project, including implementation, they would need to consider the following steps:

1/ **Confirm scope, roles and responsibilities**. Undertake a meeting or workshop to confirm (a) assumptions [for example, that water management and development pressure are the primary services of concern] (b) roles, responsibilities and capacities (c) community capacity to undertake a larger project.

2/ **Fill essential knowledge gaps**. If discussions on scope and certainty and related data needs for modelling indicate the need for additional data, these could be filled.

3/ **Modelling**. Modelling the levels of service that natural assets currently provide, and the levels of service under different potential management, local climate change projections, and rehabilitation or restoration scenarios, is central to natural asset management as it gives communities the ability to explore how different actions will affect the health and corresponding performance of natural assets.

4/ **Economic assessment**. The economic assessment component provides a market-based indication of (a) the current value of the services from natural assets if they had to be provided by an engineered means, and (b) the costs and values of different interventions in terms of service delivery.

5/ **Planning**. This step allows local governments to explore different scenarios such as "what happens to the services provided by the wetland if there is significant building upstream?" or "what happens to the services if the forest is restored?" Using modelling, changes in service levels can be understood and quantified. Corresponding values can also be determined through continued economic assessment. Based on the foregoing, local governments can begin to consider and prioritize actions ranging from status quo to planning, regulatory, financial operations, maintenance, acquisition, and monitoring interventions.

6/ **Implementation**. The natural asset implementation phase is part of an adaptive management cycle, not a finite journey. It is during this time that actions identified based on the previous steps can begin to be implemented. MNAI can provide ongoing advice / guidance on policy pieces and integration of the above information for 12-18 months. After this point, the local government, together with local partners and service providers, would ideally have the capacity to continue these efforts on their own.

7/ **Ongoing monitoring**. Project monitoring is essential to learn whether interventions are working and to share lessons and learnings from other communities undertaking natural asset management. MNAI would typically stay involved with the community for three years through a monitoring arrangement to be established with the communities.

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Annex: Results of Charlottetown's risk identification

This Annex contains the results of Charlottetown's use of MNAI's risk identification tool, which they self-administered with guidance from MNAI. Table 1 was the main product, developed by Charlottetown personnel, that resulted from the exercise.

Step 1: Identification of risks

Common Risks to Natural Assets:

- Overuse of trails/dumping
- Flooding (current and future)
- Forest fire
- Invasive species
- Development pressure
- Pollutant loading from urban, agricultural, or industrial sources (e.g., overuse of salt on roads)
- Drought (current and future)
- Erosion
- Ice jams
- Storm surge
- Lack of flood hazard mapping
- Lack of land management plans
- Lack of monitoring reports
- Construction activity
- Political policy change

Step 2: Complete survey

TABLE 1: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected and Id #	Location (on map, with risk #)	Notes
1/ Flooding - overland flow (current and future)	M	Forest, wetlands	Low-lying areas, identified assets within floodplain	Understood as seasonal impact likely to get worse over time Feeling there is strong resilience of natural assets to handle overland flooding
2/ Storm surge + sea level rise	H	Forest, wetlands	Coastal areas, riverine areas, areas below 2.47m	Need to separate impact of one-time event (storm surge) vs. events that occur slowly over time (sea level rise)
3/ Erosion	H	All	Coastal areas, riverine areas, areas with not much cover	Considering coastal, river erosion and wind erosion
4/ Pollutant loading (urban, agricultural or industrial)	M		Wetlands, water ways	
5/ Extreme weather events	M / H	Forests, wetlands, agriculture	All throughout Charlottetown. Coastal and open areas/ wooded areas are likely to be at a higher risk	Hurricanes, tropical storms, high winds/rain
6/ Invasive species	H	All	All areas of Charlottetown	Invasive species already affecting natural assets
7/ Forest fire	L	Forest, agriculture	Larger forest stands	
8/ Overuse of trails/ dumping	L	Park land, forests, water courses	City Parks and natural areas with trails	
9/ Political policy change	M	All	Depends on the policy, many areas could be affected	

TABLE 1: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected and Id #	Location (on map, with risk #)	Notes
10/ Drought (current and future)	M	Agriculture, forest, wetlands, water ways	Across Charlottetown	Increasing with climate change
11/ Planning policy	M	Agriculture, wetlands, forest	Across Charlottetown	Public/community education and involvement
12/ Appropriate zoning	M	All		
13/ Lack of flood hazard mapping	H	All		Mapped but not available for use or being conveyed to appropriate parties
14/ Ice jam	L		Most likely where streams enter hillsborough river/harbour	Not an issue that we have dealt with in the past
15/ Social conventions and norms	M		Across Charlottetown	Gap between desire for change by early adopters and general public

Existing mindset of residents and social desire for more conventional forms of development |
16/ Accurate understanding of hard asset quality and hard asset failure	M	Wetlands, waterways		
17/ Siltation	M	Waterways, wetlands, agriculture		
18/ Development pressure and construction activity	H	Forests, wetlands, agriculture, shrubland, grassland		

Additional risk identification completed by Wright's Creek Watershed Group

Risk	Ranking (L/M/H)	Assets Affected and Id #	Location (on map, with risk #)	Notes
1/ Dumping	M?	Water, land, trees	By Acadian Bridge, Woods, Field above WC, top of Norwood Road, Royalty Oaks	High aluminum content in field soil sample, Garbage heaps uncovered during area cleanup spring 2020
2/ Flooding	M / H			
3/ Forest fire	M	Forests	Various	Fires being built in the woods
4/ Invasive species	H	Forests, wetlands	Everywhere (GB)	Glossy Buckthorn, Multiflora Rose, Yellow Flag Iris
5/ Development pressure	H	Waterways, urban greenspace	E.Royalty, H. Park	reopening of Acadian Bridge to traffic
6/ Pollutant	H	Waterways, adjacent to buffer zones	WC	Storm Drain empties into WC, salt from roads, ag chem, old landfill
7/ Drought	M	Tree plantings, waterway	Field above WC, entire watershed	WC is spring fed
8/ Erosion	H	Field, Woods, Waterways	Field above WC, ponds	
9/ Lack of land management plans	H	Waterways, land, forested areas		Housing Corporation Development plans awaited
10/ Construction activity	H	Creek, ponds, springs	Andrew's Pond North	New apartments and subdivision
11/ Andrew's Dam breach	L	Fish habitat lost, Loss of scenery, Sediment washed into marsh	Andrew's Dam	The dam is in good repair but the sluice system may need replacement in the long term. Fish passage will be needed before DFO will allow major repairs
12/ Oil spill at industrial site on Norwood Road near MacRae Drive	L?	Oil getting into creek, Fish kill	Norwood Road near MacRae Drive	

Risk	Ranking (L/M/H)	Assets Affected and Id #	Location (on map, with risk #)	Notes
13/ Airplane deicer gets into creek	L?	Contaminated water in creek	Charlottetown Airport	The airport says they collect it all
14/ Accident on St. Peters Road leading to oil spill entering Andrew's Pond	L	Contaminated pond water, Fish kill	Along St. Peters Road within Wright's Creek watershed.	
15/ Residential oil spill	L	Water table contamination	Within watershed	
16/ Beavers and beaver dams	H	Loss of mature and growing trees. Flooding from dams, impoundments	All along Wright's Creek	Follow management plan. Remove problem beaver dams and bevers as per plan.
17/ Sewer pumping station at the end of Bonny Blink fails	L?	Raw sewage entering Wright's Creek	End of Bonny Blink	Make sure rainwater from roofs and basement sump pumps do not go into sanitary sewer
18/ Siltation	M	Waterway	Above Andrew's Pond	Fish habitat, spring preservation
19/ Lack of monitoring and enforcement	M	Forest, tree planting, urban greenspace	All trails and forested areas	Increasing use of trails by motorized vehicles (ATVs, snowmobiles); camping, hunting, parties, drug use debris

Municipal Natural Assets Initiative