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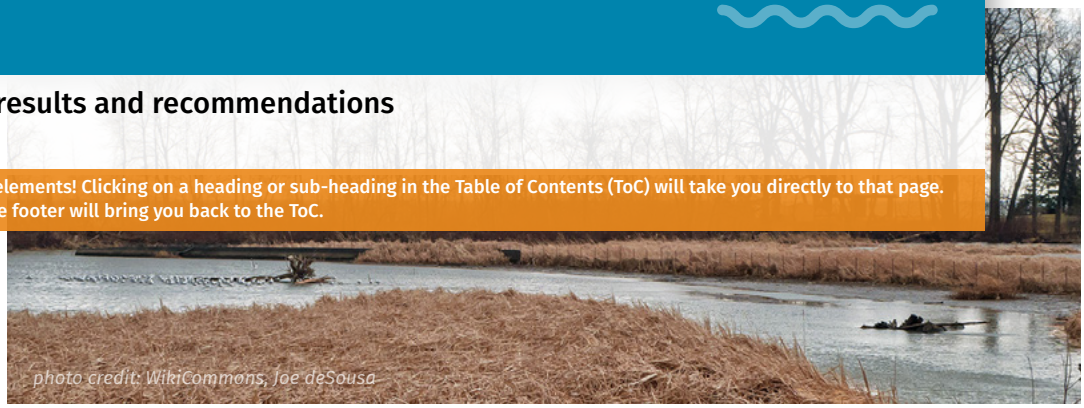
Toward natural asset management in the

City of Mississauga

Ontario

Summary of inventory results and recommendations
December 2021

This document features interactive elements! Clicking on a heading or sub-heading in the Table of Contents (ToC) will take you directly to that page. Also, clicking on page numbers in the footer will bring you back to the ToC.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Municipal Natural Assets Initiative

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.

Disclaimer

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Table of Contents

1 Purpose

This document summarizes the results of a project to develop a natural asset inventory in the City of Mississauga, Ontario, 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 assets. Doing so can enable local governments to better 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.

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

What is a natural asset inventory?

Natural asset inventories provide details on the types 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.

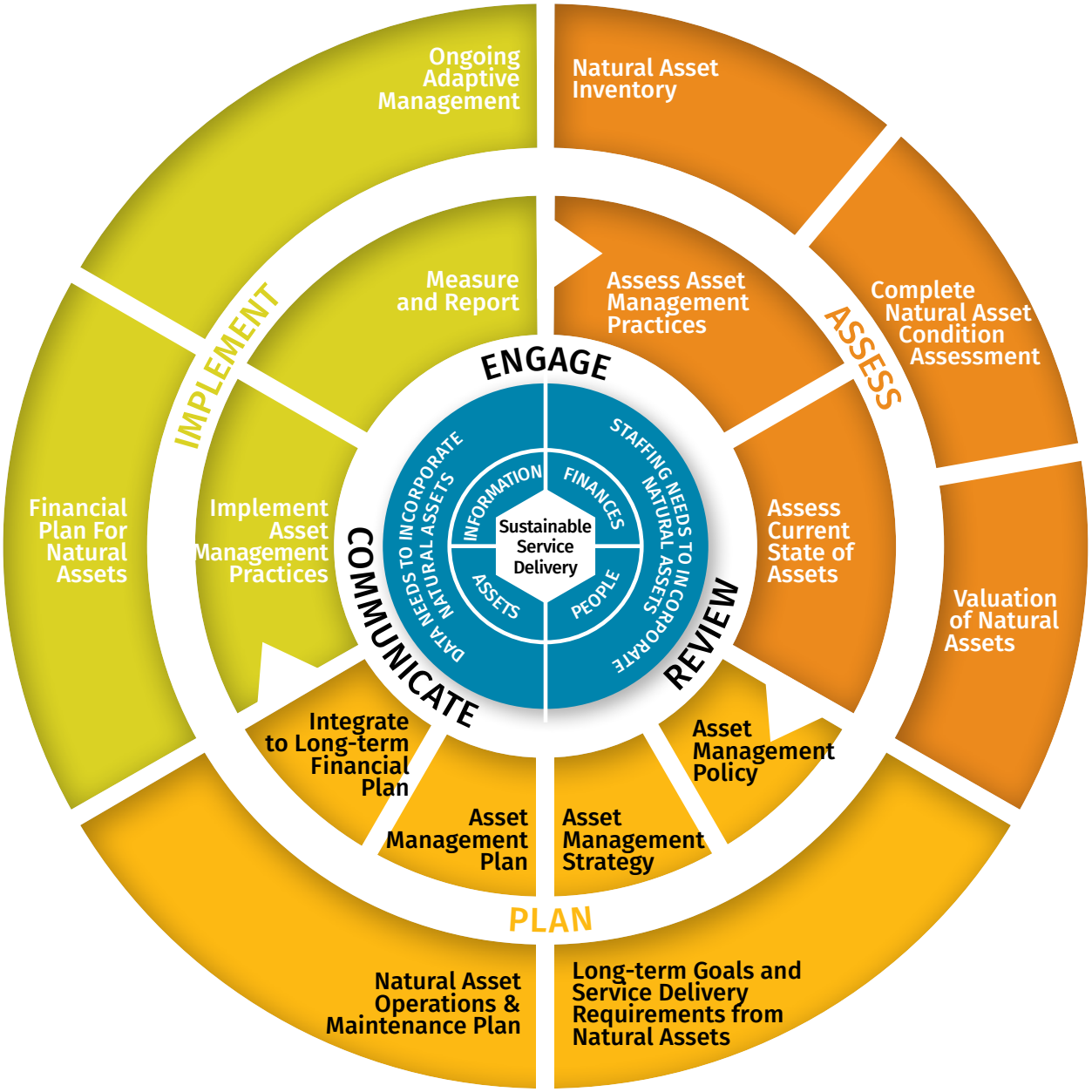


Figure 1: The Asset Management Process. MNAI has adapted this for use with natural assets.

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

3 Local government context

3.1. General

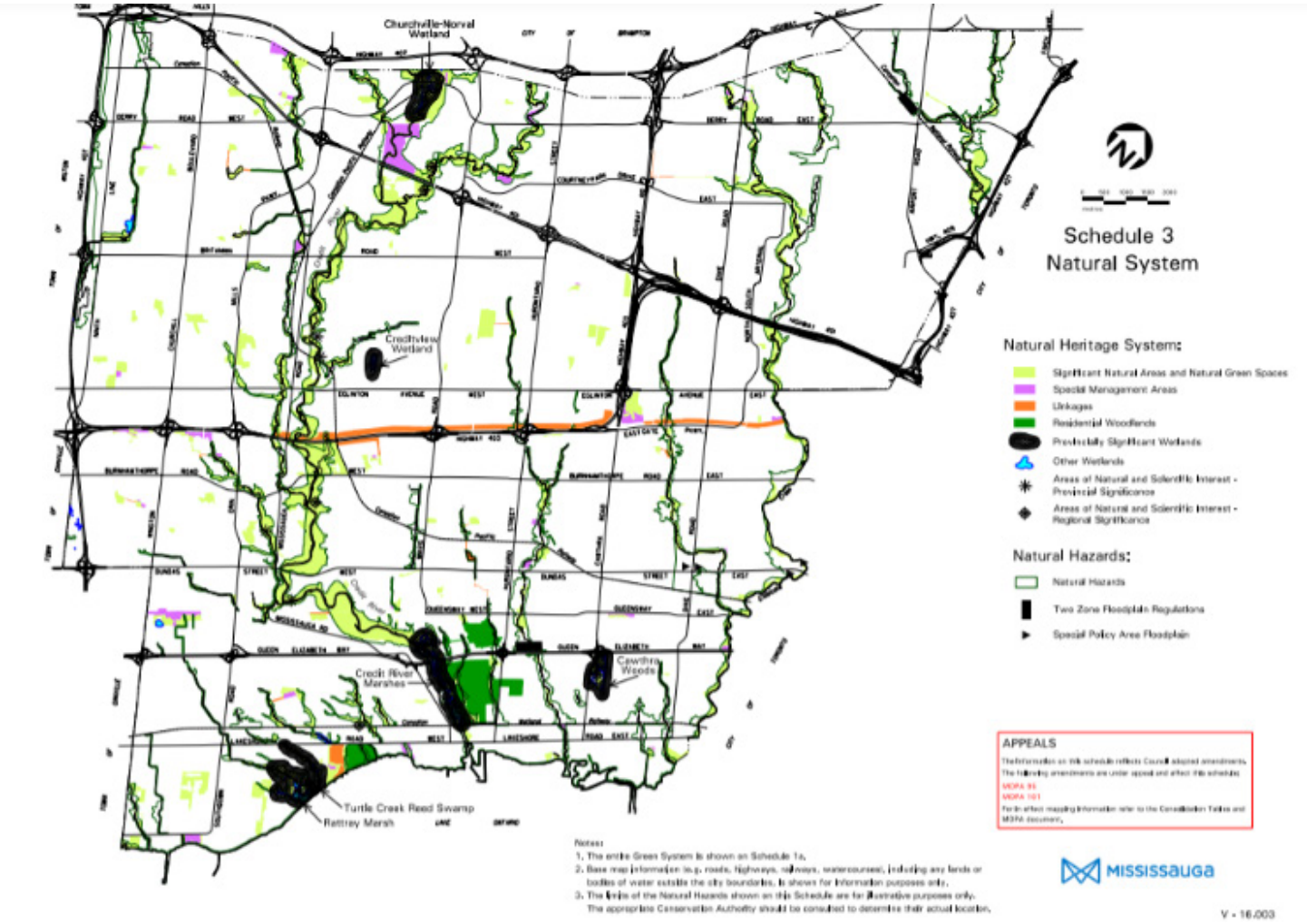


Figure 2: City of Mississauga[3].

The City of Mississauga (population ~800,000) is situated on the shores of Lake Ontario in the Regional Municipality of Peel, Ontario. It is the second-most populous municipality in the Greater Toronto Area and third-most populous in Ontario[4].

The City of Mississauga currently identifies forests, wetlands and cultural assets[5] as priority natural assets. It identifies three types of priority natural asset management services: regulating services for water and air quality, supporting

3 *Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Mississauga.*

4 *Official Plan. (2020, September). City of Mississauga. Retrieved April 2021 from www6.mississauga.ca/onlinemaps/planbldg/MOP/Schedules/NaturalSytmWetlands_V8_V-16.003.pdf*

5 *"culturally significant assets" are noted in the City of Mississauga asset management plan 2021 glossary: https://www.mississauga.ca/wp-content/uploads/2021/09/17161558/2021-Corporate-Asset-Management-Plan.pdf*

services for habitat diversity and biodiversity, and cultural and socio-economic services such as recreational opportunities.

The City of Mississauga's 2019 Climate Change Action Plan places priority on "resilient and green infrastructure," notes the wide range of goods and services from nature upon which the community relies, and that protecting ecosystems will increase resilience and the ability to cope with climate change[6].

The City of Mississauga's interest in natural asset management relates to better understanding and defining green infrastructure and providing a basis for a full natural asset management program. The City of Mississauga also identifies the natural asset inventory as relevant to:

- Maintaining, protecting, restoring, and expanding its natural assets.
- A natural asset management approach that is compatible with its existing plans and strategies.
- Knowledge development and sharing and internal communication amongst municipal staff/departments.
- Developing a replicable approach to integrate natural assets into municipal asset plans.
- Quantifying the service value that natural assets provide.

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[7] 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 readiness assessment helps local governments prioritize actions that increase their effectiveness in managing all assets, including natural ones.

Competency 1: Policy & Governance

The City of Mississauga's readiness assessment indicates it is beginning to make progress on asset management and on incorporating natural asset management. It is generally at an early-to-intermediate stage, depending on the competency area. It has a corporate asset management policy that is starting to guide its actions and which includes natural assets. At an organization-wide level, the City of Mississauga has identified the benefits it would like asset management to provide but does not yet have a corresponding strategy. It is at an early stage in monitoring and measuring progress in implementing its asset management system.

6 *yoursay.mississauga.ca/climate-change*

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

Competency 2: People & Leadership

In terms of people and leadership, the City of Mississauga has a cross-functional corporate asset management team that communicates regularly. There are multiple staff members developing management plans for some natural assets who are on the cross-functional asset management team; however, those plans have been developed in isolation and have not been readily/formally incorporated into city-wide asset management discussions. While Council supports resourcing the City of Mississauga's asset management needs, it has not specifically identified natural assets as an asset management need.

The City of Mississauga has an asset management improvement roadmap for stormwater assets, including storm sewers, stormwater management facilities and watercourses. The asset management roadmap recognizes the role of natural assets in providing stormwater services and has tracked some lifecycle management activities for natural assets. However, specific objectives have not yet been identified for these natural assets; this is a gap that this inventory will help address. The 2021 stormwater management asset management plan includes a list of both high-level and detailed improvement tasks including developing a detailed description of the quantities, costs and conditions related to infrastructure for most watercourses and stormwater management facilities assets. The City of Mississauga has completed condition and maturity assessments for its stormwater assets but notes they do a poor job of assessing natural assets because the focus is on engineered assets.

Competency 3: Data & Information

In terms of documenting asset information for engineered assets, the City of Mississauga is at an intermediate-to-advanced level. For example, its inventory includes condition information and a basic risk assessment for stormwater management assets within the context of the City of Mississauga 2021 asset management plan. For natural assets, by contrast, it has basic data and information for watercourses relating to stormwater management. This inventory project has supported the mapping of watercourses assets in greater detail.

In relation to performance data, the City of Mississauga has completed condition assessments for all major parks, road and stormwater assets and has set general service levels. Most condition information for stormwater engineered assets is based on age and expected useful life of storm sewers and stormwater management facilities. However, for watercourses (encompassing engineered and natural assets), the condition of reaches are based on high-level field assessments. Natural assets are not specifically scored but are considered together with engineered condition scores.

Competency 4: Planning & Decision-making

The City of Mississauga is at an intermediate stage in collecting financial data for its assets. It has basic lifecycle cost tracking for most stormwater assets and has identified 10-year infrastructure gaps. It has a 10-year capital budget as well as a four-year operating budget that it updates annually. For natural assets, it has basic cost tracking for lifecycle activities as part of the stormwater program.

Asset investment planning is at a relatively early stage because different departments use different approaches, and even within departments there are some aspects of asset investment planning that are structured while others are not. For example, investment planning for various stormwater assets is both structured (e.g., pond dredging) and ad hoc (watercourse and storm sewer prioritization). The City of Mississauga has completed basic risk assessments but they are not readily used for planning purposes yet. Its stormwater asset management plan is based on short- and long-term issues and priorities with a focus on engineered assets and has not yet been optimized to identify where and when funds need to be spent. Investment needs related to stormwater natural assets are considered in the capital planning process when they align with other municipal needs (e.g., flood protection, erosion control).

The City of Mississauga has basic cost information for forest assets and no financial information for other natural assets. There are no asset management plans yet for forest assets, nor is there a standardized approach to investment planning for these or other natural assets. The City of Mississauga does have some maintenance plans for certain critical natural assets through its Parks and Forestry operations though. While it does have a 10-year capital budget for forests that is re-assessed annually, the budget has not been very detailed the past five years.

4 Natural asset inventory

4.1. Inventory overview

MNAI's natural asset inventories have two main components 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 the City of Mississauga 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

TTo establish the inventory, MNAI obtained data from the City of Mississauga, Ontario GeoHub, and conservation authorities. MNAI combined the spatial data layers to establish a comprehensive depiction of natural assets. Table 1 describes the data sources used to develop the inventory and condition assessment.

TABLE 1: SUMMARY OF DATA SOURCES

DATASET NAME	SOURCE	PURPOSE
ELC	City of Mississauga	Used to create the base landcover dataset to be used for the natural asset inventory. The various ELC names were classified into higher level asset types such as forest and wetland. Also used to create a filter which natural assets overlap with ELC.
Southern Ontario Land Resource Information System (SOLRIS) 3.0	Ontario GeoHub	Used to supplement the ELC in creating a base natural asset inventory and for determining land use intensity surrounding natural assets.
River_shape	City of Mississauga	Used to insert river polygons into base natural asset inventory.
ResWoodlot	City of Mississauga	Used to insert forest polygons into base natural asset inventory.
Street	City of Mississauga	Used to perform road density condition assessment.
dta_Subwatersheds_CVC	Credit Valley Conservation	Used to summarize assets by their respective sub-watersheds.
TRCA Subwatersheds	Toronto and Region Conservation Authority	Used to summarize assets by their respective sub-watersheds.
Subwatersheds	Conservation Halton	Used to summarize assets by their respective sub-watersheds.

TABLE 1: SUMMARY OF DATA SOURCES		
DATASET NAME	**SOURCE**	**PURPOSE**
dta_GenReg_CVC	Credit Valley Conservation	Used to summarize area of natural assets within the CVC regulation limit.
HRCA_RegulationLimit	City of Mississauga	Used to summarize area of natural assets within the HRCA regulation limit.
Conservation Authority Administrative Area	City of Mississauga	Used to summarize area of natural assets within each conservation authority.
NAS	City of Mississauga	Used to summarize area of natural assets within NAS designated lands and indicate whether the asset falls within the natural areas system.
SMA	City of Mississauga	Used to summarize area of natural assets within SMA.
SWM_Facility	City of Mississauga	Used to summarize area of natural asset overlap with SWM facilities.
TreesPark20210403	City of Mississauga	Used to join a count of park tress to their respective natural asset.
Ward	City of Mississauga	Used to assign natural asset to associated ward.
CityWideHazard	City of Mississauga	Used to summarize area of natural assets within the city-wide hazard area.
Mississauga OfficialPlan_2010	City of Mississauga	Used to assign existing official plan description based on area of asset overlapping with parcel from MOP dataset.
PolicyCode	City of Mississauga	Used to assign existing land use descriptions based on area of asset overlapping with parcel from policy dataset.
ZoneGreenlandOverlay	City of Mississauga	Used to determine natural asset area within greenlands designation.
Zoning	City of Mississauga	Used to assign zoning category based on area of asset overlapping with parcel from zoning dataset.
CityOwnedParcel	City of Mississauga	Used to determine natural asset area that the City of Mississauga owns.
ParkBoundary	City of Mississauga	Used to summarize area of natural assets within parks.
WoodedArea_shape	City of Mississauga	Used to summarize area of natural assets in wooded area.
Pedestrian Trail	City of Mississauga	Used to summarize length of trails within natural assets.

TABLE 1: SUMMARY OF DATA SOURCES		
DATASET NAME	**SOURCE**	**PURPOSE**
Culvert	City of Mississauga	Used to summarize number/length/location of culverts in natural assets.
MSSG_nDSM	City of Mississauga	Used to assign mean canopy height to natural assets.
TreesStreet20210403	City of Mississauga	Used to assign count of street trees within natural asset and list majority/minority species type in asset.

The inventory project defined a total of 8,634 individual assets, covering 5,399 hectares (ha), as noted in Table 2. The majority of this area was forest cover, followed by built-up pervious assets.

TABLE 2: SUMMARY OF NATURAL ASSETS BY TYPE		
NATURAL ASSET TYPE	**NUMBER OF ASSETS**	**TOTAL AREA (HA)**
Agriculture	256	627
Beach	20	2
Built-up Pervious	563	1,545
Forest	4,000	1,864
Grassland	265	574
Shrubland	220	240
Water	1,979	281
Wetland	1,331	265
Total	**8,634**	**5,399**

Figure 3 shows the spatial distribution of the natural assets.

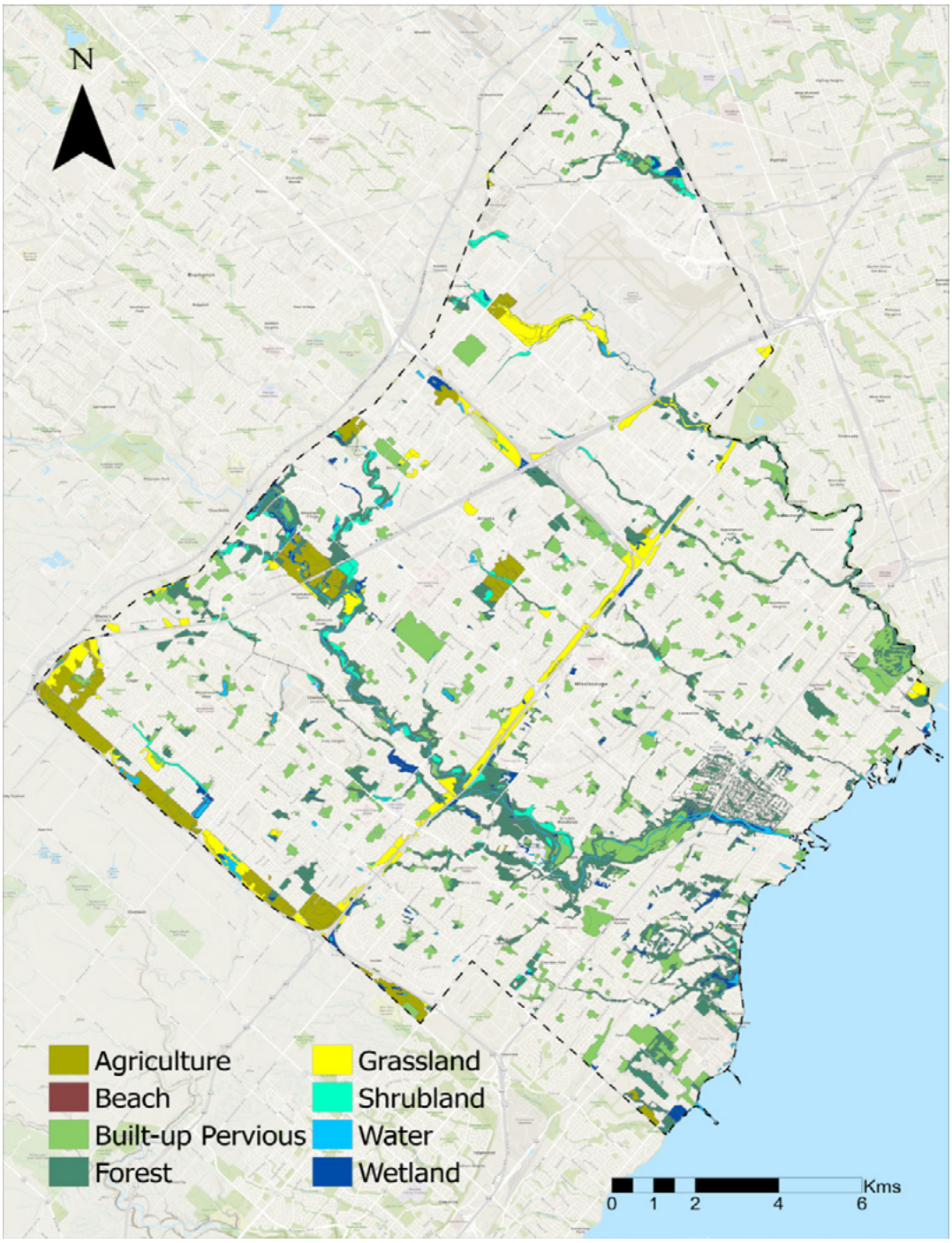


***Figure 3**: Spatial distribution of natural assets.*

4.3. Asset registry

Each asset within the inventory has a unique identification number that allows users to select and analyze individual assets and manipulate corresponding data 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 the City of Mississauga's registry showing natural asset characteristics and details.

TABLE 3: EXCERPT FROM THE REGISTRY

Natural Asset Registry

Asset ID	Asset Type	Sub-Asset ID	Asset Area (ha)	Area in Subwatershed (ha)	Sub-Watershed	Ward	Conservation Authority	Count of Park Trees	Count of Street Trees	ELC Name	Existing Land Use	NAS Area (ha)	City Owned Area (ha)	Interior Forest Area (ha)	Mean Canopy Height (m)	Adjacent Land Use Score	Permeability Score	Relative Size Score	Road Density Score	Total Score
AGR10	Agriculture	AGR10-1	0.23	0.23	Mimico Creek	5	Toronto and Region Conservation Authority	0	0		Open Space / Greenlands	0.00		0.00	0.10	3	5	1	1	10
AGR104	Agriculture	AGR104-4	0.00	0.00	Etobicoke Main Branch	3	Toronto and Region Conservation Authority	0	0		Open Space / Greenlands	0.00		0.00	0.30	6	5	1	1	13
AGR108	Agriculture	AGR108-1	3.44	3.44	Little Etobicoke Creek	3	Toronto and Region Conservation Authority	0	2		Vacant	0.00		0.00	0.05	6	5	1	1	13
AGR11	Agriculture	AGR11-1	0.06	0.06	Mimico Creek	5	Toronto and Region Conservation Authority	0	0		Open Space / Greenlands	0.00		0.00	0.74	3	5	1	1	10
AGR111	Agriculture	AGR111-1	0.12	0.12	6	11	Credit Valley Conservation	0	1		Residential Detached	0.00		0.00	0.62	6	5	1	1	13
AGR112	Agriculture	AGR112-1	0.32	0.32	6	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	0.02	8	5	1	1	15
AGR113	Agriculture	AGR113-1	0.39	0.39	6	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	0.12	7	5	1	1	14
AGR114	Agriculture	AGR114-1	6.70	0.02	6	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	0.51	7	5	1	10	23
AGR114	Agriculture	AGR114-2	6.70	0.00	6	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	1.83	8	5	1	10	24
AGR114	Agriculture	AGR114-3	6.70	6.68	9	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	0.02	8	5	1	1	15
AGR115	Agriculture	AGR115-1	1.01	1.01	9	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	0.01	7	5	1	1	14
AGR117	Agriculture	AGR117-1	0.01	0.01	6	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	1.65	8	5	1	10	24
AGR117	Agriculture	AGR117-2	0.01	0.00	9	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	0.91	8	5	1	10	24
AGR118	Agriculture	AGR118-1	0.38	0.20	6	11	Credit Valley Conservation	0	0		Open Space / Greenlands	0.00		0.00	1.89	7	5	1	10	23
Total			**7,915.63**	**5,399.02**				**38551**	**5806**			**2,233.87**		**17.97**	**7,990.38**					

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 4 is a screenshot from the dashboard that MNAI provided to the City of Mississauga. The full version can be accessed at *go.greenanalytics.ca/Mississauga*. As is shown in the screenshot below, the dashboard includes an inventory of street tree assets within the municipal boundary.

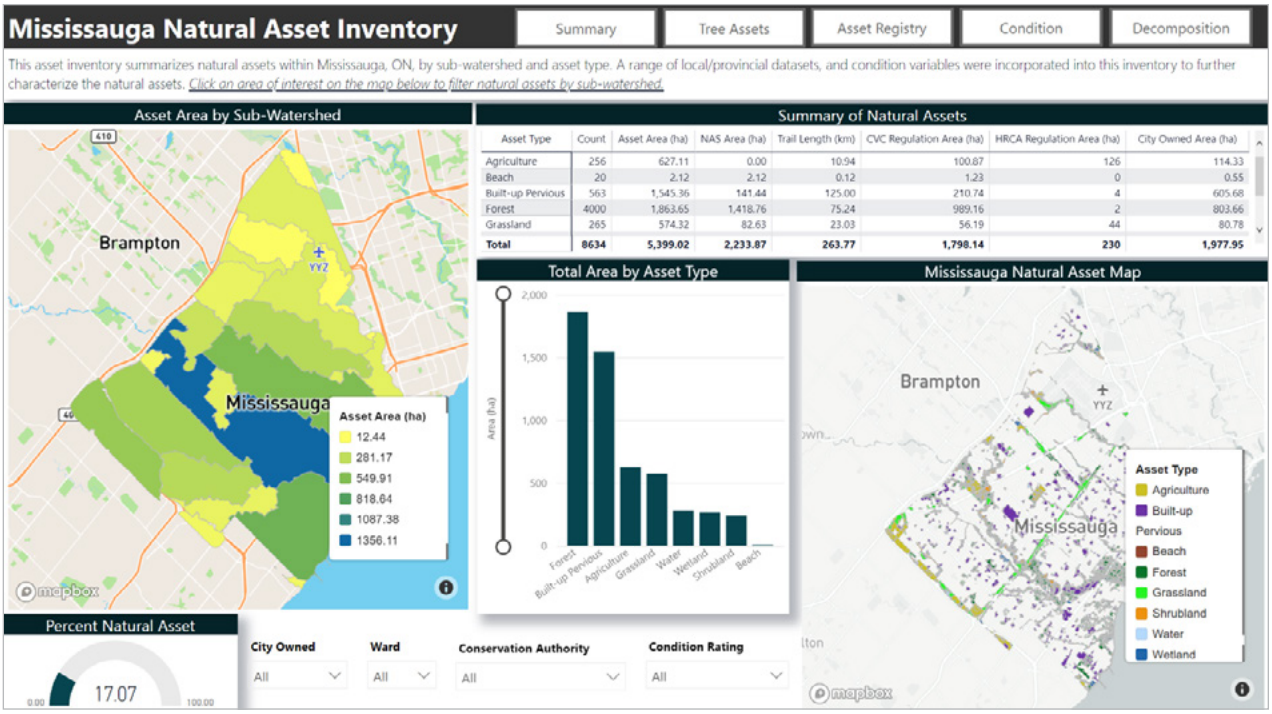


Figure 4: Screenshot of main inventory summary.

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 information, 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 the City of Mississauga. 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 of roads per km squared), medium density (assets with between 1km and 2km of roads per km squared) and low density (assets with less than 1km of road per km squared).	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	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. If there are no human land uses within 100 m of the assets, the assets are scored 10. If there are intensive land uses within 100 m of the assets, the score is 0.	Natural asset inventory plus spatial representation of land use as well as intensity rankings of land uses

** Data sources provided in Table 1 unless noted here.*

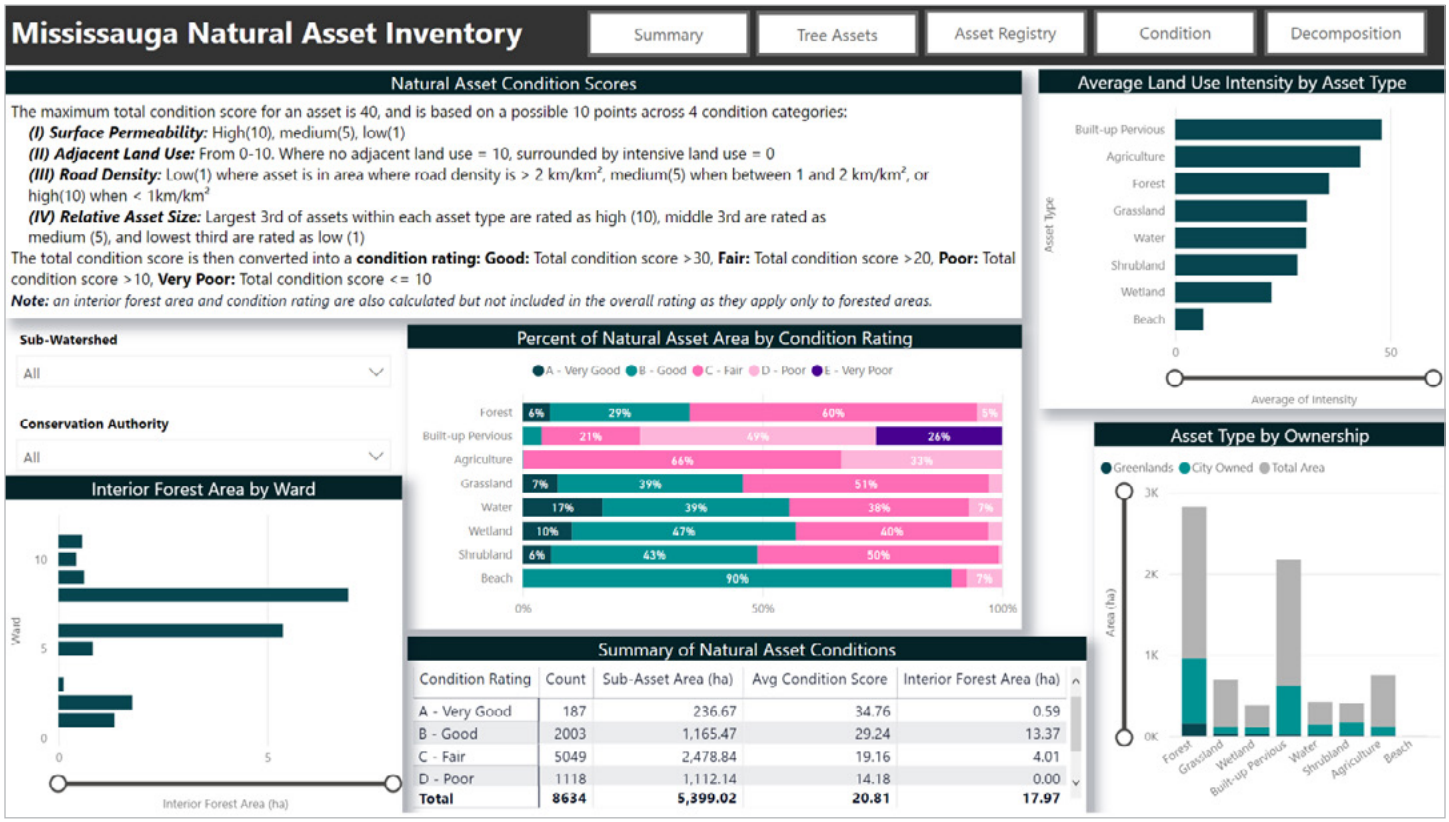
Once conditions were allocated to each asset, an overall score was derived for the project area. The maximum possible score for an asset was 40, based on a possible 10 points for each of 4 categories:

- 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:

- **Very good -** assets with a score of 33 or higher
- **Good -** assets with a score of 25 to 32
- **Fair -** assets with a score between 17 to 24
- **Poor -** assets with a score between 9 to 16
- **Very Poor -** assets with a score lower than 9

Figure 5 summarizes the natural asset condition assessment results per the online dashboard.



Condition Rating	Count	Sub-Asset Area (ha)	Avg Condition Score	Interior Forest Area (ha)
A - Very Good	187	236.67	34.76	0.59
B - Good	2003	1,165.47	29.24	13.37
C - Fair	5049	2,478.84	19.16	4.01
D - Poor	1118	1,112.14	14.18	0.00
Total	**8634**	**5,399.02**	**20.81**	**17.97**

Figure 5: Screenshot of condition assessment details.

Overall, about 237 ha (or 4 per cent) of natural assets were assessed in very good condition, 1,165 ha (or 22 per cent) of the natural assets were assessed in good condition and 2,479 ha (or 46 per cent) were assessed in fair condition.

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 Condition Score
Very Good	187	237	35
Good	2,003	1,165	29
Fair	5,049	2,479	19
Poor	1,118	1,112	14
Very Poor	277	406	7
Total	**8,634**	**5,399**	**21**

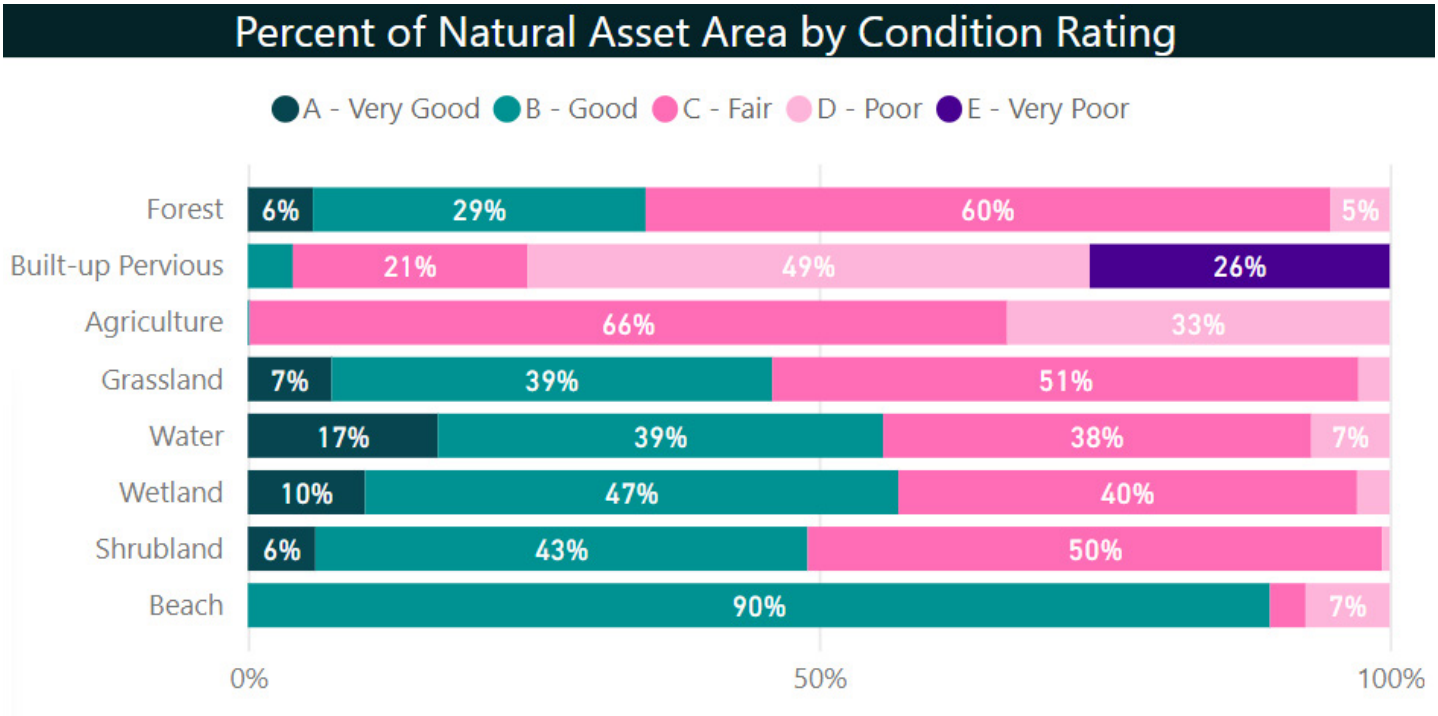


***Figure 6**: Summary of condition rating by natural asset type.*

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. That said, 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 the City of Mississauga 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, the City of Mississauga considered possible risks that the loss of forest, water, and wetland functions could pose to existing engineered infrastructure, personal health and safety, and private property, including:

- Invasive species to forest assets
- Drought to forest assets
- Extreme storm events to forest assets
- Development pressure to forest assets
- Forest fires to forest assets
- Infrastructure maintenance and repair to forest assets
- Erosion to water assets
- Hydrologic alterations to water assets
- Pollution to wetland assets

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, the City of Mississauga considered four questions:

- **i/** what impact is likely to happen over the next 10 years?
- **ii/** what is the consequence of that impact happening?
- **iii/** what can be done to mitigate the probability of impact and/or consequence?
- **iv/** 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 [invasive species, drought (specifically to young trees), extreme storm events (specifically to street trees), development pressure in privately-owned areas, and infrastructure maintenance and repair]
- 4 medium-high level risk [drought (specifically to established trees), development pressure (specifically public development), hydrologic alterations, and pollution]
- 3 low-level risks [extreme storm events (specifically to woodlots), forest fire, and erosion]

In terms of scope, the identified risks affect forest, water, and wetland natural assets across the City of Mississauga, including those on both public and private lands. Forests and street trees, in particular, are vulnerable to multiple high-level risks. The identified risks also have the potential to negatively impact engineered assets (both city-owned and non-city-owned), personal health, and safety.

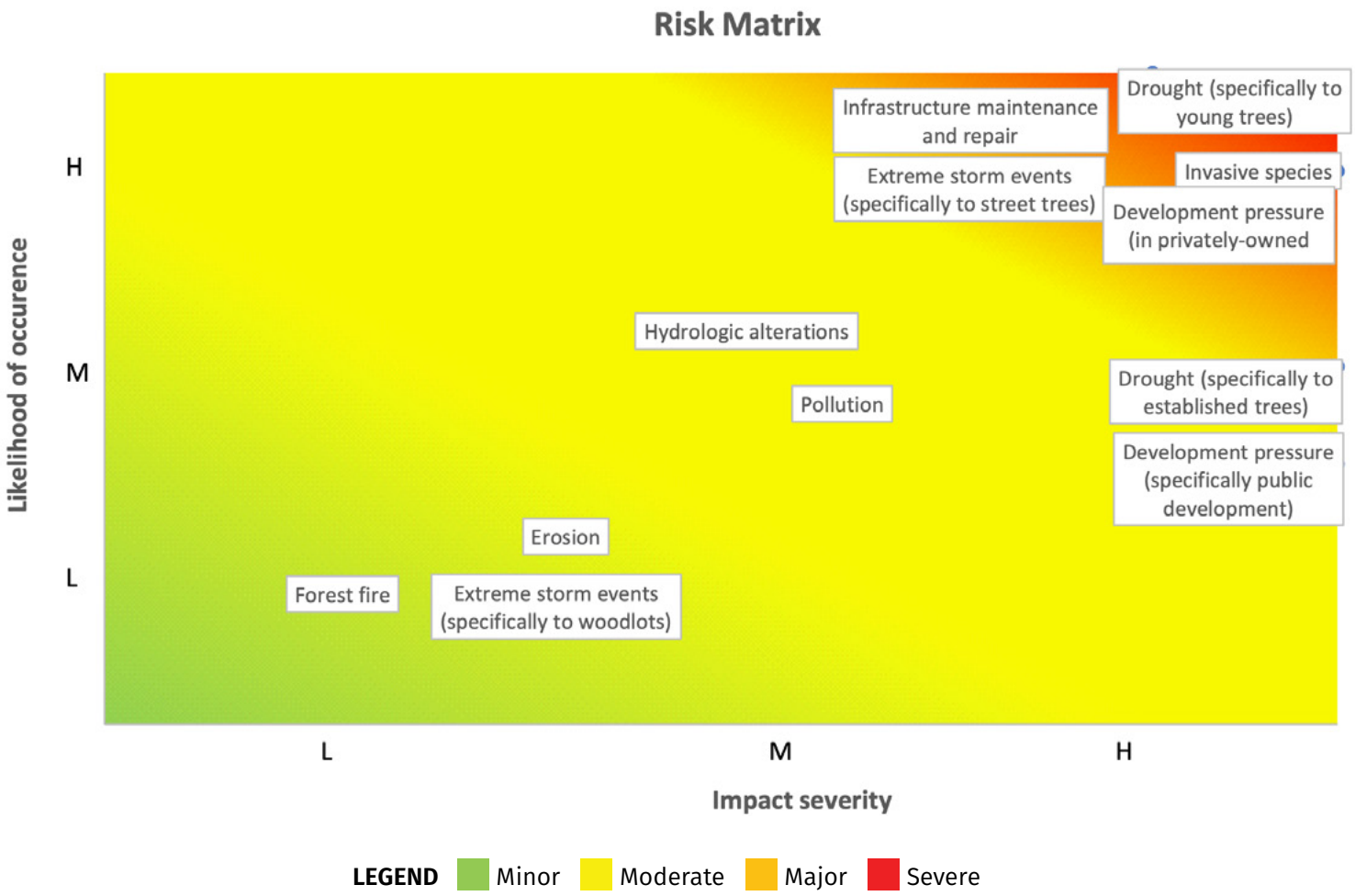


Figure 7: Results of risk identification process.

5.4. Potential priorities for the local government

The outcomes of the risk identification process highlight potential priorities on which the City of Mississauga could focus their natural asset management efforts. Where possible, these are also informed by the condition assessment. These are:

- **Invasive species:** The City of Mississauga identified invasive species as a high-level risk to forests, including street trees and woodlots. Invasive species reduce the resiliency and biodiversity of a forested ecosystem, which in turn can reduce ecosystem services such as aesthetic values, quality of life, and physical and mental health benefits associated with time in nature. Invasive species can lower property values and increase municipal costs to control and eradicate target species and replace native species. Priority plants identified include 25 invasive plants. Some of these are found city-wide such as Emerald Ash Borer; others are localised, such as the Gypsy Moth, which is prevalent in the southern half of the city. Others are past threats, such as the Asian long-horned beetle which was once prevalent in the Malton area, while oak wilt and hemlock are potential emerging threats. In response, the

City of Mississauga has an Invasive Species Management Plan[8] that includes goals, targets, and timelines; methods for prioritization of resources; engagement opportunities; management actions; costing and staffing requirements; and funding opportunities.

- **Drought risk to young trees:** The City of Mississauga identified drought as a high-level risk to young trees, particularly in areas with low canopy cover and a large concentration of young trees. An example is the downtown core where high road density was a factor in forest condition being ranked poor. The inability to maintain and grow the urban forest canopy reduces biodiversity and ecosystem services such as water filtration, water storage, and stormwater retention. It will also increase capital costs to replace trees and/or stormwater infrastructure. The City of Mississauga waters approximately 10,000 young trees a year as they are more susceptible to drought. Established trees failing in response to drought, and potentially other pressures, have been observed.
- **Extreme storm events to street trees:** The impact of extreme storm events, which are increasing in frequency and severity with climate change, have damaged urban forests, particularly street trees across the City of Mississauga. These losses may cause health and safety concerns, damage property, impact surrounding ecosystems, and result in clean-up and replacement costs.
- **Development pressure in privately-owned areas:** Development pressure in privately-owned areas was identified as a high-level risk to forest assets. Residential woodlots, which have less policy and land-use protection than public woodlots, are of particular concern. The risk is experienced across the City of Mississauga but is of heighted concern in the downtown core where canopy cover is already low. The loss and fragmentation of woodlots can reduce carbon sequestration and storage, climate resilience, water filtration and storage, stormwater retention, air quality, biodiversity, the survivability of young trees, and results in significant public opposition. Maintaining and managing natural assets in privately-owned areas is a common challenge, with few tools available. Performance bonds and covenants are examples of tools to prevent or remedy damage to natural assets from development and which could be explored.
- **Infrastructure maintenance and repair:** The City of Mississauga had identified impacts to forest assets resulting from ongoing infrastructure maintenance and repair as a high risk, particularly to its street trees. Road reconstruction can result in the removal of significant root networks and restrict growing space, resulting in a decline of ecological health. Environmental impacts are typically commensurate with the scale of infrastructure repair and the loss of trees can reduce stormwater services, aesthetic values and health benefits, while creating significant replacement costs. Maintenance costs are higher for young trees.

8 *City of Mississauga, 2021.*

Table 6 lists and provides brief descriptions of risk mitigation strategies. Future stages of the MNAI process can address these.

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

6 Recommendations

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 (6.1) opportunities to strengthen natural asset management at an organization-wide level, (6.2) possible actions for the further development of the inventory, and (6.3) steps the City of Mississauga can consider to advance to a full natural asset management initiative.

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

The City of Mississauga would like to include additional natural assets such as riparian plantings in its inventory and improve condition assessments for natural assets. It plans to develop a methodology for more detailed condition assessments and monitor natural assets following inventory completion. These actions could support the refinement of replacement values for watercourses and stormwater management facilities.

The City of Mississauga could use this inventory project as a basis to support staff working on natural asset plans to connect to broader asset management discussions. This inventory could also provide a rationale to formalize natural asset management work in the City of Mississauga's asset management team, a gap noted in the readiness assessment. This could build both awareness of the role of natural assets in service delivery, and support for resourcing natural asset management activities. Information gained from the inventory, including condition assessments and risk identification, would also support the City of Mississauga in developing the three-to five-year natural assets roadmap that it is considering.

Finally, the City of Mississauga identified an overall need to standardize systems and approaches to asset investment planning across the organization. Natural asset considerations should be integrated into this effort.

6.2. Possible actions for the further development of the inventory

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

- Complete risk identification for all natural asset classes outside of forests, water, and wetlands. This would include agricultural lands, beach, built-up pervious, grassland, shrubland, and riparian buffers.
- Refine risk identification so individual assets are scored.
- Expand the condition assessment and 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. For example, some condition metrics are more amenable to some asset types (e.g., relative asset size is well suited to forests and wetlands) and a more comprehensive condition assessment would allow the metrics employed to be selected for individual asset classes.
- 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 biodiversity, water management, and air quality perspective, the wetlands and forested areas in the watersheds will be key.
- Determine acceptable levels of risk to the City of Mississauga's risk mitigation strategies (see Table 6).
- Share the inventory with adjacent local governments to stimulate collaboration within the watershed.
- Initiate or enhance monitoring to improve understanding of trends and feed into condition ratings of assets and gather information for modelling.
- Schedule regular updates (e.g., every 3-5 years) of the inventory, condition assessment and risk identification to understand trends.
- Maintain interest and momentum in natural asset management to move towards a full natural asset management project.

6.3. Steps to a full natural asset management project

If the City of Mississauga wishes to proceed with a full natural asset management project, including implementation, it will 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**. MNAI can provide ongoing advice / guidance on policy pieces and integration of the above information for 12-18 months. After that, 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**. It is essential to continue monitoring the project 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.

Sources

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Annex: Results of the City of Mississauga's risk identification process

This annex contains the results of the City of Mississauga's use of MNAI's risk identification tool, which they self-administered with guidance from MNAI. Table 7 was the main product that the City of Mississauga's personnel developed from the exercise.

Step 1: Identification of risks

Common Risks to Natural Assets:

- Forest fire
- Invasive species
- Development pressure (in privately-owned areas)
- Development pressure (specifically to public development)
- Pollution (specifically to young trees)
- Drought (specifically to established trees)
- Erosion
- Extreme storm events (specifically to street trees)
- Extreme storm events (specifically to woodlots)
- Hydrologic alterations
- Infrastructure maintenance and repair

Step 2: Complete survey

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY					
Major Risks	**Current Impacts**	**Locations of Concern**	**Risk ratings**		**Notes/Mitigation Activities**
List the major risks that do or could threaten this asset (both natural and human-made).	How is this risk impacting the asset in Mississauga currently?	List any known locations within the City where these risks are already a concern.	Likelihood (L): Unlikely (1) Possible (3) Almost Certain (5) Consequence (C): Low (1); Medium (3); High (5)	Low, Medium, High	Are there any actions/plans/ policies in place to address these risks?
Invasive Species	**Forest Pests:** gypsy moth (LDD), Emerald Ash Borer (EAB), Asian long-horned beetle (ALHB) (not a current threat but past threat). Oak wilt and hemlock are not currently detected, but could be an emerging threat. **Invasive Plants**: 25 invasive priority plants in the City - some are priority city-wide, and others are of concern for priority areas.	**Gypsy moth:** southern half of the City. **EAB:** city-wide. **ALHB:** Malton area. Most invasive plants are city-wide.	L-5 C-5	High	Invasive Species Management Plan
Drought	For young trees in an urban setting, watering is key. The City of Mississauga waters approximately 10,000 young trees a year. All of these trees are vulnerable to drought. Difficulty establishing sustainable assets in and urban forest environment. Established assets are also failing in response to drought - anecdotally this has been observed in the City.	Areas with low canopy cover and have a large concentration of young trees (e.g. the Downtown core).	L: Established trees - 3 Young trees - 5 C: 5 - (both established and young trees)	Established trees – Medium Young Trees - High	

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Major Risks	Current Impacts	Locations of Concern	Risk ratings		Notes/Mitigation Activities
Extreme Storm Events	Extreme storm events are likely to become more frequent and severe due to climate change. The City has experienced many significant storm events that have damaged the urban forest to date. For example, in 2014 there was a significant ice storm that affected many trees in North/West Mississauga and in Paul Coffey park (though invasives likely drove these large-scale damages).	Street trees would be of largest concern. This would be city-wide, but there could potentially be greater concern in areas exposed to high-winds (e.g. by the water).	L: Street trees - 5 Woodlots – 1 C: Street trees - 5 Woodlots - 2	Street trees – (25) High Woodlots - Low	
Development Pressures	Development pressures are particularly relevant for residential woodlots (areas that are privately own but that have a larger tree canopy). When lost, these areas have a significant impact to the urban tree canopy, as the lost tends to be older, more established trees. Development changes also affect the ability of new trees to grow.	City-wide issue. However, it is a particular issue in the downtown area, where canopy is already low.	L: Private - 4 Public - 2 C: Private & Public - 5	Private – (20) High Public – (10) Medium	

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Major Risks	Current Impacts	Locations of Concern	Risk ratings		Notes/Mitigation Activities
Forest Fires	To date, forest fires are not a large concern for the City.	Currently, there are no specific locations of concern. However, human-caused fires, such as fireworks, bonfires, etc. have occurred, and could be of particular concern in high-use areas such as parks, isolated areas, along the waterfront, etc.	L: 1 C: 1	(1) Low	
Infrastructure Maintenance and Repair (e.g. road replacement, etc.)	Ongoing infrastructure maintenance and repair has been devastating to the street trees, and can result in a slow decline over time. Road reconstruction projects are a significant driver in particular. Infrastructure repair near roads can result in removal of significant root networks and of appropriate growing space.	City-wide this is a concern, for street trees in particular.	L: 5 C: 5	(25) High	

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Major Risks	Current Impacts	Locations of Concern	Risk ratings		Notes/Mitigation Activities
Erosion	Erosion impacts the stability of the watercourse and pond banks and the stability of other adjacent assets/ infrastructure (e.g., trees, private/ public property, animal habitat). Sediment can also accumulate instream and cause conveyence and erosion issues. It can also impact the storage capacity of ponds and reduce performance.	Natural watercourses throughout the City (e.g. Cooksville Creek, Little Etobicoke Creek, etc.)	L: 3 C: 2	(6) Low	The watercourse and SWM facility monitoring programs will identify issues with the natural assets. These issues are prioritized and addressed through the capital or operating programs. Development Requirements are established to mitigate the impacts of new developments on stormwater infrastructure (e.g. on-site stormwater controls to mitigate runoff). *www.mississauga.ca/wp-content/uploads/2020/08/ 26144147/Section-8-Storm-Drainage-Design-Requirements-1.pdf*

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Major Risks	Current Impacts	Locations of Concern	Risk ratings		Notes/Mitigation Activities
Hydrologic Alterations	Wetlands can be negatively impacted by changes to the historical frequency and volume of water. This can affect the soil chemistry and plant/ animal communities. New development in the watershed can increase the amount of stormwater runoff and/ or effect the groundwater conditions for existing wetlands. Construction activities may include dewatering and dredging of the wetlands. Climate Change can create more extreme rainfall and drought events.	All wetland locations	L: 3 C: 3	(9) Medium	Certain sub watersheds have very conservative site controls for stormwater runoff. Conservation Authorities regulate construction activities for most wetlands to mitigate the risks.
Pollution	Runoff from roadways, development, agriculture, old landfills/ contaminated sites or spills can contaminate wetlands. This can affect the soil chemistry and plant/ animal communities.	All wetland locations	L: 3 C: 3	(9) Medium	Street sweeping activities and catchbasin cleaning help to mitigate pollutants from the roads. Spill response programs help mitigate the damage caused by minor spills.

Municipal Natural Assets Initiative

Making Nature Count