



ENGINEERS &
GEOSCIENTISTS
BRITISH COLUMBIA



Natural Assets Management Considerations for Engineering and Geoscience Professionals



Companion Guide to the Engineering and Geoscientists BC Professional Practice Guidelines –
Local Government Asset Management July 2021

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Municipal Natural Assets Initiative





Invest in Nature

The Municipal Natural Assets Initiative (MNAI) 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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Abbreviations

MNAI	Municipal Natural Assets Initiative
AM BC	Asset Management BC
CNAM	Canadian Network of Asset Managers
FCM	Federation of Canadian Municipalities
AG	Advisory Group
PPG	Professional Practice Guideline
AM	Asset Management
NAM	Natural Asset Management

Foreword

This report references foundational documents, guidelines, and frameworks on asset management and natural asset management. These are listed below. Specific references are noted throughout.

AUTHORIZING ORGANISATION	TITLE	LINKS
AM BC	AM Framework	www.assetmanagementbc.ca/wp-content/uploads/Asset-Management-for-Sustainable-Service-Delivery-A-BC-Framework-.pdf
	AM Framework (Short)	www.assetmanagementbc.ca/wp-content/uploads/Asset_Management_Framework_-_short_template_v6.pdf
	Primer on Integrating Natural Assets	www.assetmanagementbc.ca/wp-content/uploads/Integrating-Natural-Assets-into-Asset-Management.pdf
	AM Roadmap	www.assetmanagementbc.ca/wp-content/uploads/Guide_for_using_the_Roadmap20-AMBC-Sept_23_2011.pdf
	AM Roadmap Diagram	www.assetmanagementbc.ca/wp-content/uploads/Roadmap_Diagram-AMBC-Sept_23_2011-1.pdf
MNAI	NAM Primer	mnai.ca/media/2019/06/MNAI-Org-Charts.pdf
	Defining and Scoping Summary, 2017	mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf
	Defining and Scoping Summary, 2019	mnai.ca/media/2019/07/SP_MNAI_Report-1-June2019-2.pdf
	Gibsons Economic Valuation Case Study	mnai.ca/media/2018/01/TownofGibsons_CaseStudy.pdf
	Learning from Gibsons	mnai.ca/media/2019/07/SP_MNAI_Report2-June2019.pdf
CNAM	Competency Framework	cnam.ca/wp-content/uploads/2020/02/CNAM_AM-Competency-Framework_v1.0_2020.pdf

Table of Contents

Table of Contents	1
1 Introduction	2
1.1. Purpose	3
1.2. Terms	3
1.3. Background.	4
1.4. Indigenous Knowledge	6
1.5. Land, Title and Jurisdiction	7
1.6. Climate Change Adaptation, Mitigation, and Low Carbon Resilience	8
2 Roles and Responsibilities	9
3 Guidance and Considerations for Professional Practice	12
3.1. Assess Natural Asset Management Practices	15
3.2. Assess the Current State of Natural Assets	16
3.2.1. The Natural Asset Inventory	17
3.2.2. Assess the Condition of Natural Assets	21
3.2.3. Determining Risks to Natural Assets	25
3.2.4. Determining Current Levels of Service	28
3.2.5. Determining Natural Asset Service Value.	30
3.3. Planning for Natural Asset Management.	31
3.4. Implementing Natural Asset Management	33
3.4.1. Implement Natural Asset Management Practices	33
3.4.2. Measure and Report Natural Asset Management	36
Sources.	38

1 Introduction

This document recognizes the rights of Indigenous people to cultural practices relating to land and natural systems, as outlined in the United Nations Declaration on the Rights of Indigenous Peoples¹. It values the potential role of Indigenous peoples, as land-keepers, in the management of natural assets and, more generally, the criticality of Indigenous knowledge of human-ecosystem relationships.

Natural assets provide well-established benefits such as improved air and water quality, climate stability, and protection from flood and erosion impacts. They also underpin most economic activity, supporting the production of essential goods and delivery of essential services.

Within this context, the term “municipal natural assets” refers to the stock of natural resources or ecosystems that is relied upon, managed, or could be managed by a municipality, regional district, or other form of local government for the sustainable provision of one or more local government services². For example, urban greenspaces, parks, wetlands and protected areas can provide important stormwater management services, reduce flooding, offer recreation spaces, and buffer the effect of extreme heat in urban settings, thus reducing the prevalence of respiratory infections and heat-related illnesses. When natural assets are not managed effectively, their ability to provide services, and hence the values associated with those services, can decline. Natural assets therefore need to be carefully managed as part of core infrastructure systems to ensure a sustainable supply of services, the more so as our climate continues to change and put pressure on existing engineered systems. There is growing evidence that this can be done effectively using local government asset management practices³ in conjunction with natural asset management-specific tools.

As key stewards of urban built environments and core members of asset management teams, Engineering and Geoscience Professionals play critical roles in assessing and managing natural assets. This guidance document aims to support Engineering and Geoscience Professionals in integrating natural asset considerations, including the contribution and value of Indigenous Traditional Knowledge to natural asset management, into local government asset management practices. In this way, Engineering and Geoscience Professionals can help optimize service delivery outcomes for communities.

1 www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf

2 Brooke, R., O'Neill, S. J., & Cairns, S. (2017). *Defining and Scoping Municipal Natural Assets*. Municipal Natural Assets Initiative. mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf

3 Cairns, S. (2020a). *Cohort 2 National Project Overview*. Municipal Natural Assets Initiative. mnai.ca/media/2020/02/MNAI-CohortSummary.pdf

1.1. Purpose

Engineers and Geoscientists BC, the regulatory body for engineering and geoscience in British Columbia, is developing Professional Practice Guidelines (hereafter referred to as the Engineers and Geoscientists BC AM Practice Guidelines) on local government asset management; these include natural asset management as a fully integrated component.

This document, hereafter referred to as the *NAM Considerations Document*, is a companion to the Engineers and Geoscientists BC AM Practice Guidelines. It is intended for licensed Engineering and Geoscience Professionals employed by or contracted by local governments (as defined by the Engineers and Geoscientists BC AM Guidelines). It offers detailed considerations for integrating natural assets effectively into local government asset management, while simultaneously acknowledging and valuing Indigenous peoples and their intimate relationship with, and insights into, the natural environment, which often positions them as rightful advocates of the land being managed.

Using this document alongside the Engineers and Geoscientists BC AM Practice Guidelines will help Engineering and Geoscience Professionals to:

- Integrate natural asset considerations into the asset management process
- Access tools and resources relevant to natural asset management

Natural asset management is an emerging and evolving discipline, so this *NAM Considerations Document* is neither prescriptive nor comprehensive. Rather, it offers Engineering and Geosciences Professionals an overview of current, appropriate practices in natural asset management and points to resources on specific management activities.

1.2. Terms

All terms used in this document have been defined by MNAI or are based on the meaning defined by Engineers and Geoscientists BC as described in the *Professional Practice Guidelines: Local Government Asset Management, 2021*.

Green infrastructure can be defined as elements of both natural and built environments that support ecosystem and community health⁴. Natural assets are defined in this document as a subset of green infrastructure, as depicted in the diagram below, to mean ecosystem features that deliver, or could be restored to deliver, core municipal services. It is noted that, currently, and because this field is in its infancy, definitions of both green infrastructure and natural assets may vary from resource to resource.

⁴ www.metrovancouver.org/services/regional-planning/PlanningPublications/ConnectintheDots.pdf

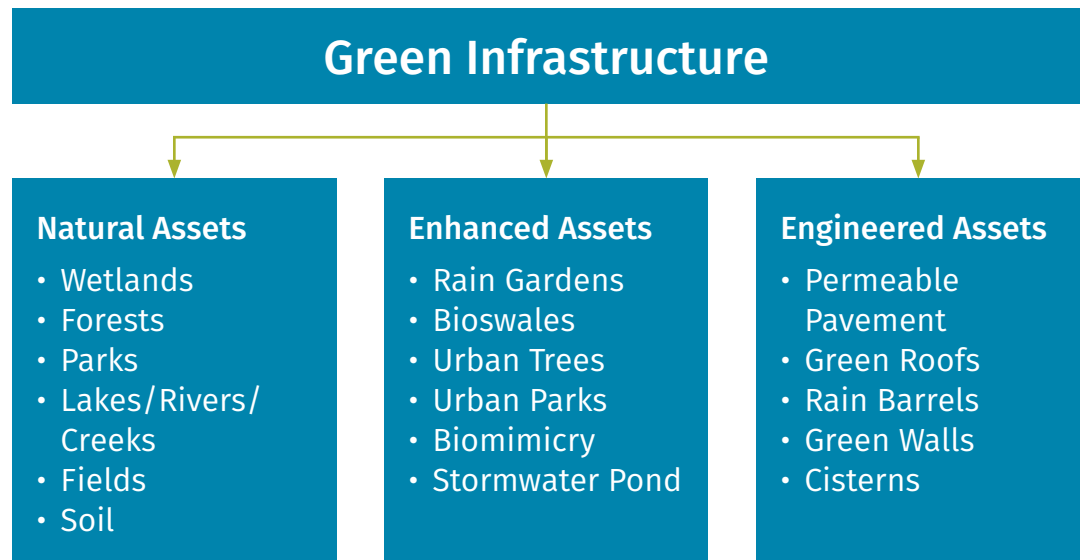


Figure 1.1: Examples of green infrastructure.

Source: mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf

1.3. Background

Many local governments are seeking new strategies to deliver core services in more financially and environmentally sustainable ways, while valuing and supporting the Indigenous relationship with land. These new strategies recognize asset management as a key tool to manage infrastructure, and within this context local governments are recognizing that natural assets such as aquifers, forests, streams and foreshores can provide equivalent or better services compared to many engineered assets - often with no capital costs and lower operating costs⁵. Local government natural asset management is an important part of creating sustainable solutions to the multifaceted problems of supplying municipal services in the face of aging infrastructure, urban growth, declining budgets, and increasing pressure from climate change.

Natural assets can provide not only core municipal services but also benefits such as recreation, climate regulation, clean air, natural habitat, and biodiversity. These, in turn, can improve the overall health and well-being of communities. Natural assets should be managed as part of a local government's core infrastructure, and their role in service delivery should be incorporated into a community's asset management plan. However, there are currently financial accounting and other limitations that may inhibit the recognition and valuing of natural assets. Simultaneously, natural assets, and the ecosystems in which they reside, should be recognized as key to Indigenous ways of being.

⁵ Cairns 2020(a)

As municipal asset management evolves, local governments will increasingly seek to understand, value and ultimately manage their natural assets in order to optimize service delivery. By employing natural assets to provide core services, the local governments are addressing critical challenges they face, namely:

- **Management of community financial and asset risk:** Municipalities may be able to identify potential liabilities, and reduce or forego capital and operating costs for engineered stormwater facilities by preserving forest areas. In other words, natural assets can, in some cases, provide the same benefits or services to municipalities as built assets, with lower costs. Engineering and Geoscience Professionals play a crucial role in ensuring municipalities recognize the benefits of natural assets.
- **Enhancement of service provisioning to communities:** In a municipal context, there is growing evidence that natural assets offer services such as managing stormwater, including increased flooding due to climate change, providing clean water, and protecting communities from damages caused by storms and storm surges. Additionally, these elements have been shown to decrease the risk of diseases and health conditions such as heart disease, depression, diabetes, and more. Engineering and Geoscience Professionals can help define baseline services provided by natural assets and identify solutions/practices that leverage them to optimize service delivery.
- **Partner with First Nations in support of local infrastructure enhancements:** Natural asset management offers an opportunity to align municipal operations with the Government of British Columbia's objective to support improvement of community and regional infrastructure to further the environmental, economic and social health of communities. A list of key strategies is available in the B.C. Ministry of Municipal Affairs 2020/21 - 2022/23 service plan⁶. For example, because Indigenous leaders identify as the ancient keepers of our land, they may provide valued insights into how best to communicate to the public the intangible value of natural assets, and may provide practical insights into alternative management options.
- **Climate resilience:** In addition to unprecedented biodiversity loss⁷, climate change is a significant driver for local governments' attention to natural assets. Natural assets contribute to climate resilience and will become more valuable as the climate changes⁸. For example, some natural assets such as forests and grasslands sequester carbon and thus support urban climate mitigation efforts. Other assets such as healthy foreshores and floodplains reduce the effects of flooding,

6 www.bcbudget.gov.bc.ca/2020/sp/pdf/ministry/mah.pdf

7 ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf

8 www.mnai.ca/results-from-first-national-mnai-cohort

sea level rise and storm surges that will increase due to climate change in many communities. Preserving and enhancing these assets creates positive climate change mitigation and adaptation outcomes. Engineering and Geoscience Professionals can help identify actions to optimize the climate change mitigation and resiliency functions of natural assets and can offer guidance to policy makers to select/amend policies that drive strategic actions.

1.4. Indigenous Knowledge

Traditional Indigenous knowledge relies on nature-based solutions and has a key role to play in adaptation and resilience strategies at the local, national and global levels⁹.

It also builds qualitative data from a large number of variables instead of building quantitative data based on a small number of variables¹⁰. Expressing this knowledge in asset management frameworks will predictably lead to better, more robust understandings of natural assets of all kinds and is thus a vital component of natural asset management.

When local governments interweave Indigenous knowledge, world views and perspectives into asset management and find meaningful ways to recognize Indigenous cultural and natural assets within local government processes, it can enhance respectful relationships that support reconciliation, the implementation of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), and the Pan-Canadian Framework which recognizes the importance of climate action that is respectful of Indigenous peoples and integrates their knowledge.

At present, there are few agreed-upon tools, guides or mechanisms to recognize Indigenous knowledge about natural and cultural assets and integrate these into local government asset management processes. There are, however, embryonic efforts to develop such tools, and examples of First Nations working in partnership with local governments on natural asset management¹¹. These tools may provide some guidance for Engineering and Geoscience Professionals seeking meaningful partnership with Indigenous peoples.

Furthermore, the Convention on Biological Diversity (CBD) provides guidance on integrating Indigenous Knowledge in Section 8(j) in its requirement that contracting parties “respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and

9 See for example www.cbd.int/traditional/what.shtml
[https://reliefweb.int/sites/reliefweb.int/files/resources/Indigenous peoples' knowledge and climate adaptation \(9 August 2020\).pdf](https://reliefweb.int/sites/reliefweb.int/files/resources/Indigenous%20peoples%20knowledge%20and%20climate%20adaptation%20(9%20August%202020).pdf)

10 Berkes F. and Berkes M.K. 2008.

11 See for example www.mnai.ca/comox-update

promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices.¹²

The *Tkarihwaïé:ri1 Code of Ethical Conduct on Respect for the Cultural and Intellectual Heritage of Indigenous and Local Communities Relevant for the Conservation and Sustainable Use of Biological Diversity* may also provide guidance in the form of a code of conduct¹³.

1.5. Land, Title and Jurisdiction

Natural assets do not follow jurisdictional or ownership boundaries. Furthermore, very few local governments rely exclusively on services from natural assets they own entirely. Therefore, local governments must concern themselves not only with natural assets they own or manage, but also with natural assets they do not own or manage but rely on for services. This is consistent with the overall logic of asset management's focus on service delivery.

As an example, the Comox Lake Watershed is a multi-use, multi-owner watershed that is the drinking water source for more than 45,000 people in Comox Valley, but the Comox Valley Regional District (CVRD) owns little of the land in the watershed. To help address this, CVRD chairs a Watershed Advisory Group consisting of the K'ómoks First Nation, land-owners, regulators, the Comox Valley Land Trust, Comox Valley Conservation Partnership, and technical advisors. This group has developed a watershed protection plan to ensure the watershed continues to provide a valuable source of clean drinking water in perpetuity.

As another example, the Town of Gibsons' aquifer provides water to its residents. The headwaters and natural assets that contribute to aquifer recharge, however, are well outside its jurisdiction and ownership. As such, Gibsons' asset managers must concern themselves not only with the natural assets they own, but also the ones they do not own but on which they only rely on. Gibsons is pursuing an approach with regional partners to secure a land tenure within the provisions of the Water Sustainability Act. This would recognize the role of natural assets in providing critical services such as drinking water and drainage, as well as ecosystem services like slope stabilization, coastal protection, habitat, and pollination that play a key role in protecting the community.

¹² www.cbd.int/traditional

¹³ www.cbd.int/traditional/code/ethicalconduct-brochure-en.pdf

1.6. Climate Change Adaptation, Mitigation, and Low Carbon Resilience

Natural asset management is typically framed in terms of service delivery. However, natural asset management can be equally well understood from other perspectives. For example, sustainable service delivery requires an underlying ecosystem that is healthy, which in turn requires that it be a biodiverse ecosystem; and, biodiversity is linked to climate change mitigation and adaptation outcomes¹⁴.

There are also many direct linkages between natural asset management and climate action. For example, the United Nations Sustainable Development Goal (SDG) 13 includes several climate action targets, and in each case there are linkages to natural asset management:

- Natural assets can, to a degree, adapt to a changing climate and continue to provide required services well into the future, which can strengthen resilience and adaptive capacity (SDG Target 13.1).
- Natural asset management planning involves the development of knowledge and data around service delivery in future climate scenarios. (SDG Target 13.2 and 13.3).
- If services are provided by a natural asset in place of an engineered asset, this may result in lower embodied carbon than grey infrastructure, sequestered carbon, and, depending on the energy source, reduced emissions-intensive processes such as air conditioning, and stormwater pumping, filtering and treatment. This supports, for example, the implementation of the UN Framework on Climate Change (SDG Target 13a).

Natural asset management can also support low carbon resilience (LCR) - an approach that recognizes that mitigation and adaptation are intertwined and seeks to reduce both climate risk and emissions while achieving multiple co-benefits that are priorities for municipalities and First Nations¹⁵.

¹⁴ www.cbd.int/development/doc/biodiversity-2030-agenda-technical-note-en.pdf

¹⁵ act-adapt.org/wp-content/uploads/2020/02/Natural-Assets-Valuation-Report.pdf

2 Roles and Responsibilities

As noted in the Engineers and Geoscientists BC Practice Guidelines, asset management is a multi-faceted, multi-disciplinary practice. People in different functions in a local government work collaboratively to plan, budget for, and proactively manage infrastructure required to serve their communities now and in the future. These functions may be filled by employees of, or consultants to, a local government and typically include:

- Generalist roles overseeing or managing a local government's asset management program (e.g., asset managers, analysts, or coordinators)
- Senior administrative leadership (responsible for strategic direction, accountability for creating and adhering to asset management policies and principles)
- Elected officials (responsible for governance oversight, fiscal responsibility, as well as refining the needed assets and their use)
- Engineering and Geoscience Professionals
- Other applied science and environmental and/or design professionals (e.g., foresters, landscape architects, ecologists, hydrogeologists, horticulturalists, etc.)
- Operations and maintenance professionals
- Finance professionals
- Planning professionals
- Procurements/supply chain professionals
- Information and recording professionals
- Information technology/information systems professionals

People responsible for integrating natural asset management into local government asset management will include many of those noted above and may be involved in:

- Developing and maintaining an inventory of natural assets
- Determining the condition of natural assets
- Defining services provided by each natural asset
- Identifying risks to the natural assets and the services they provide (for example, climate change, public use impacts, and upstream activities)
- Risk-based valuations of the natural assets
- Developing relevant policies and budgeted plans to proactively manage natural assets and optimize their role in service delivery
- Identifying and collaborating with those who influence the protection and management of natural assets

These tasks are described in more detail in Section 3. The multidisciplinary asset management team integrating natural assets into the local government asset management activities and programs will need to ensure that natural asset management considerations are brought into their climate action planning, including climate risk assessment activities.

Table 2.1 describes technical skills needed to undertake natural asset management effectively. Other specialists, such as sustainability managers, climate planners, city managers, and resilience officers, may also be needed.

Skills	Specialist							
	Civil/ Hydrotechnical Engineer	Water Quality Engineer*	Hydrologist	Aquatics scientist/ ecologist	GIS Specialist	Accountant	Environmental economist	Geoscientists
Integrated stormwater management planning								
Hydrology								
Hydraulics								
Stormwater modelling								
Water Quality								
Design								
Sediment Dynamics								
Spatial mapping/data acquisition								
Natural Asset valuation								
Natural Asset Condition Assessment								
Accounting/GAAP								
Biology/Aquatics								
Forestry/ terrestrial ecology								
Construction/Estimating								

*Water Quality Engineer may be required to possess hydrologic and hydraulic expertise

Table 2.1: Technical knowledge skill sets relevant to Natural Asset Management

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

Engineering and Geoscience Professionals offer knowledge and skills directly relevant to natural asset management, including:

- Professional technical knowledge, including assessment, design, construction, operations, and maintenance experience;
- Practical approaches to cost estimation and economic appraisal;
- Technical communication and/or data visualization techniques; and
- Skills in stakeholder engagement, systems thinking, process design and implementation, and problem-solving.

The Engineering and Geoscience Professionals' skills lend themselves to supporting a professional, open-minded, and curiosity-driven environment, such that asset management teams genuinely collaborate in managing complex challenges. Engineering and Geoscience Professionals can, and should, offer systems thinking and problem-solving skills, in addition to technical knowledge. Further, the team environment is an opportunity to welcome the Indigenous knowledge perspective into decision-making through meaningful consultation and, where appropriate, Engineering and Geoscience Professionals should support this.

Asset management's central focus is sustainable service delivery. This means that it matters less whether services are delivered by natural assets or engineered assets, and more whether those services are cost-effective and reliable. Engineering and Geoscience Professionals often lead asset management work and can help the team maintain this focus on outcomes (e.g., service delivery) rather than the means to deliver the outcome (e.g., asset type) across the asset management phases of assess, plan, and implement (see Figure 3.1).

Specific responsibilities regarding natural asset management are often negotiated within the team and may evolve. Engineering and Geoscience Professionals can help the asset management team identify where additional skill sets, such as those listed in Table 2.1, may be required.

3 Guidance and Considerations for Professional Practice

There is growing evidence that natural assets can be understood, valued and managed using local government asset management frameworks employed by local governments across Canada.

The outer ring in Figure 3.1 below describes the main steps involved in asset management. The steps are based on the Asset Management for Sustainable Service Delivery: A BC Framework¹⁶, which depicts the continual cycle of asset management through three phases: Assess, Plan and Implement. Natural asset management should be integrated at every step of this process.

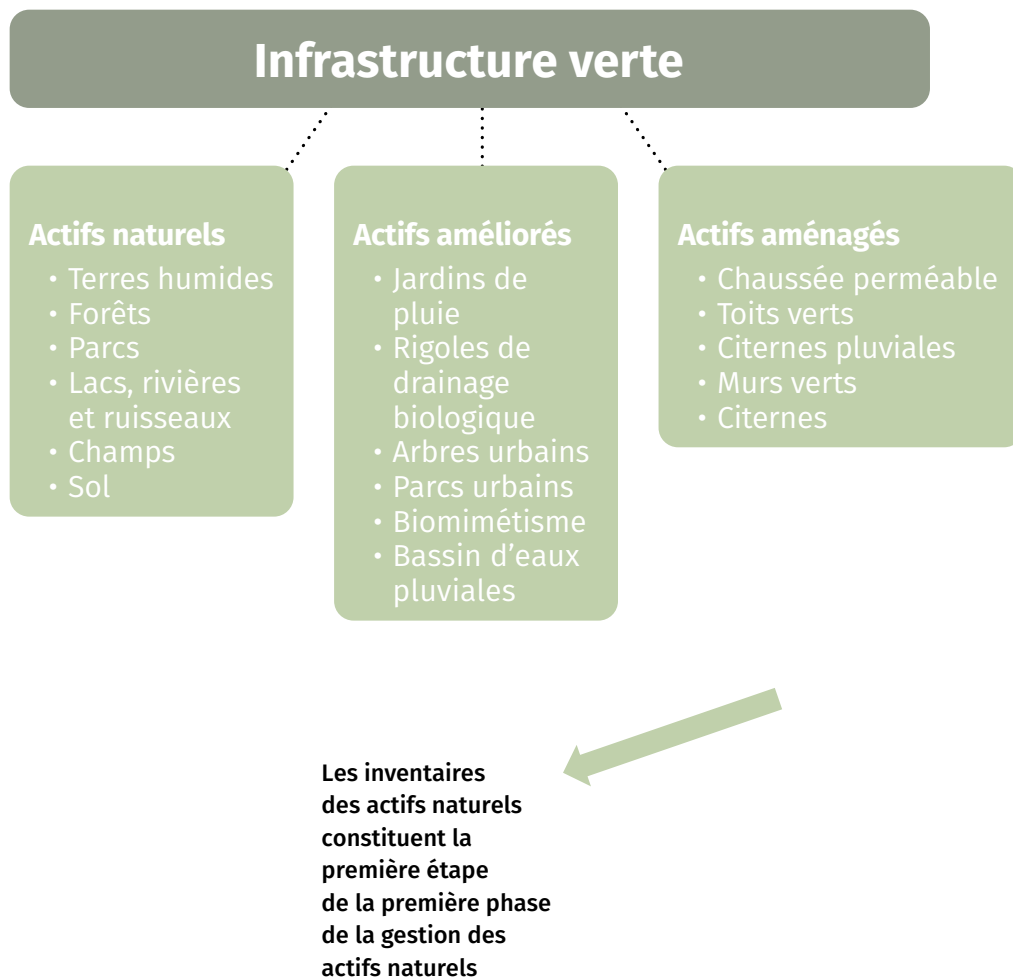


Figure 3.1: This figure illustrates the asset management framework provided by Asset Management BC (2013).

¹⁶ A document published by AM BC (2013).

Assess Phase

During the assessment phase, local governments identify natural assets and assess their condition, the risks they face, the services they currently provide, and the value of those services. Sections 3.1 and 3.2 have information regarding considerations for the Engineering and Geoscience Professional during this phase.

Plan Phase

During the planning phase, local governments seek to understand:

- How natural asset services may change for better or worse as a result of land use changes, rehabilitation, degradation, climate change and other potential changes
- The values of the services provided by natural assets in future modelled scenarios
- Based on the foregoing, the consideration of natural asset management priorities, timing and funding required to achieve the local government's desired outcomes
- What high-level policies require change or need to be developed to achieve those outcomes (noting that actual changes and/or development occurs as part of the implementation phase)

Section 3.3 has information on considerations for Engineering and Geoscience Professionals relating to the planning phase.

Implement Phase

Implementation options for natural asset management can span a range of activities, as shown in Table 3.1. All phases in the asset management cycle are part of an ongoing process of continuous improvement. Implementation phase priorities will therefore change over time based on a local government's needs. See section 3.4 for more detailed information on considerations for Engineering and Geoscience Professionals during the implementation phase.

Local Government Education & Capacity

- Educate staff and thereby increase understanding of the role of NAM in delivering services
- Ensure human resources and procurement practices around NAM (e.g., training, hiring or contracting the required skill set, etc.) are adopted
- Provide staff with additional training where needed

Strategy, Policy, Bylaw

- Develop a natural asset management policy or ensure natural assets are considered in the local government's asset management policy
- Develop a natural asset management strategy or integrate, where possible, NAM into all asset management strategies
- Update the Official Community Plan to reflect NAM priorities and practices
- Subdivision/Development Bylaw changes to reflect NAM objectives, including leaving existing natural assets in place wherever possible
- Update Bylaws (e.g., related to Subdivision, Development Cost Charge, and Zoning)

Programs, Financing, Investments, and Operations

- Undertake natural asset rehabilitation
- Undertake natural asset acquisition
- Integrate NAM into stormwater management planning and design
- Monitor existing NAM projects
- Scale up activities from subwatershed
- Produce costed operations and maintenance plans for NAM projects

External Engagement, Awareness, and Partnerships

- Develop and implement mechanisms to engage and collaborate with other natural asset owners whose natural assets the local government relies on for service delivery
- Partner with the holders of Indigenous knowledge to incorporate traditional Indigenous knowledge into management practices relating to natural assets
- Engage the public at the school/community levels to increase awareness of ecosystem services, the multifunctionality of natural assets, and the consequent value of natural assets to the community
- Develop university partnerships to support studies and analysis of aspects of NAM affecting the local community
- Partner with community groups in support of cross-boundary initiatives aimed at addressing issues arising from multiple jurisdictions
- Communicate NAM outcomes through financial reports and to the community

Third-Party Support for NAM

- Seek funding from public infrastructure programs for NAM projects
- Explore options for novel insurance solutions
- Seek capital markets funding for NAM projects

Table 3.1: Examples of Natural Asset Management Implementation Phase Activities

3.1. Assess Natural Asset Management Practices

Engineering and Geoscience Professionals will usually be part of a team involved in the assessment of a local government's asset management practices to determine organizational capacity to undertake asset management. When reviewing these practices, Engineering and Geoscience Professionals must use their professional knowledge of assets and asset management, including natural assets.

Table 3.2 below describes the critical practices that local governments should be assessing to determine whether they are effectively incorporating NAM into their asset management practices. The practices are organized according to six key asset management competency areas defined in the Canadian Network of Asset Managers Asset Management Competency Framework.

Competency categories	Natural asset management practices
People & Leadership	Determining whether the organization at all levels recognizes and acknowledges the value of natural assets
Policy & Governance	Determining whether natural asset management practices are strategically aligned with, and inform, local government vision, values, and goals
Planning & Decision-Making	<p>Determining whether the local government is fulfilling the following requirements as part of their asset management planning and decision-making:</p> <ul style="list-style-type: none"> ■ Defining the role of natural assets ■ Determining the current condition of natural assets ■ Identifying current and future risks to natural assets ■ Performing risk-based valuation of the natural assets ■ Identifying stakeholders who may influence the protection and management of natural assets ■ Determining the service value of natural assets ■ Identifying current and future service needs with stakeholders
Data & Information	Determining to what extent the local government has developed and is maintaining a natural asset inventory and monitoring the condition of natural assets
Asset Management Practice	Assessing whether and how natural asset management practices are being integrated across the organization
Life Cycle Delivery	Assessing the status and effectiveness of ongoing lifecycle and adaptive management of natural assets, including maintenance

Table 3.2: Assessing Natural Asset Management Practices based on the CNAM Asset Management Competency Framework

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

Engineering and Geoscience Professionals may be involved in assessments of asset management practices the local government is undertaking. When involved, they should use their professional knowledge to identify and document the status of the natural asset management practices described above. During this review, the Engineering and Geoscience Professional should consider the possibility of missed opportunities to incorporate Indigenous knowledge into these practices.

The Federation of Canadian Municipalities (FCM) offers an Asset Management Readiness Tool¹⁷ that can be used to support a local government's assessment of its asset management practices. MNAI has adapted the tool for specific use in the context of natural asset management¹⁸. Engineering and Geoscience Professionals are well placed to advocate for the use of a readiness scale, and/or lead the effort, and to support the inclusion of natural asset management in assessments. Understanding the community's level of natural asset management maturity is helpful to ensure that subsequent efforts are targeted and appropriate for the context.

3.2. Assess the Current State of Natural Assets

A first step in local government asset management is to build an understanding of what the assets are, where they are located, the condition they are in, and the risks to the assets that could affect service delivery. The same understanding is needed for natural assets, with the exception that the focus must be on assets the local government relies on, not just the ones it owns. This information is typically contained in a natural asset inventory.

Bearing in mind that the key focus is on service delivery rather than the details of the asset delivering the service, it is vital to consider throughout this stage that natural assets follow watershed or ecological boundaries, not ownership/jurisdiction boundaries. The Engineering and Geoscience professional can play a vital role in helping the local government understand and characterize the natural assets on which the local government relies, not only those that it owns.

¹⁷ fcm.ca/sites/default/files/documents/resources/tool/asset-management-readiness-scale-mamp.pdf

¹⁸ This can be accessed here: [MNAI Maturity Scale](#)

3.2.1. THE NATURAL ASSET INVENTORY

Inventories provide details on the type of natural assets a local government relies upon¹⁹, their condition, boundaries and the risks they face. They can be expressed through a tabular registry (Figure 3.2), or other means such as dashboards (Figure 3.3). The latter can provide additional insights as they enable users to explore different aspects of the data. For instance, information can be quickly summarized by watershed area, or, if users want to dive into the specifics of forest assets, they can filter the data to focus on that particular asset.

Many variables can be taken into consideration when identifying data inputs for natural asset inventories; however, at a minimum, almost all start with two data sets:

- Watershed, sub-watershed, or other catchment area boundary
- Detailed land cover (e.g., forest, wetlands, grasslands, etc.) and land use mapping of the area within the catchment boundary

As local governments build their knowledge of natural assets and the services these assets provide, they can progress to developing more detailed inventories that include:

- 1/ A hierarchy beginning with a major asset class, flowing down to sub-asset classes that make sense as units of measurement and management for natural assets
- 2/ The geographic location of these assets and sub-assets
- 3/ Their role, function or service
- 4/ Ownership of the natural asset, or governance details if multiple jurisdictions have ownership, or if the local government manages but does not own the asset
- 5/ Its estimated life
- 6/ The estimated or assessed condition of the asset
- 7/ The probability of failure
- 8/ The consequence of failure
- 9/ A risk score for the asset
- 10/ Replacement cost or value

This information provides the local governments a basis for:

- Communicating that natural assets provide services the community relies upon
- Considering the extent of the reliance on the assets, the existence of other options to deliver the same service(s), and the presence of threats or risks to the natural assets

¹⁹ *Note: many local governments rely on services from natural assets they do not own.*

Local governments are encouraged to seek guidance from knowledgeable groups while building a natural asset inventory. MNAI, for example, has available a range of products related to inventories. The US Department of Agriculture: Forest Service (2020) and Hudson River Estuary Program (2014), as another example, suggests the following methods for creating inventories:

- **Register maps:** to depict the location and area covered by the natural assets within the community (e.g., the location and area of a wetland). Figure 3.2 provides one example of a register map.
- **References:** Information sources such as journal papers and reports that focus on specific details such as river water quality and quantity, environmental flow, soil type, features of forest patch, or microbial biome of the wetland system.
- **Data acquisition studies:** These are studies which present data from suitable monitoring stations, measurable parameters, temporal frequencies of sampling (eg., physico-chemical water quality, health of wetlands, forest covers, soil fertility, hydrogeological conditions, debris flow in rivers).

Logy Bay - Middle Cove - Outer Cove Natural Asset Inventory											
Natural Asset Registry											
Asset ID	Natural Asset Class	River Basin	Asset Area (ha)	Trail Name	Trail Length within Asset	Road Length within Asset	Disturbance Rating	Surface Permeability Rating	Adjacent Land Use Rating	Relative Asset Size	Condition Rating
AGR0000001	Pasture / Forages	Outer Cove	1.70		0.00		0 Category 1 (intact)	Medium	Poor (Close to Intense land uses)	1	3 - Poor
AGR0000002	Pasture / Forages	Outer Cove	6.28		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000003	Pasture / Forages	Kennedys	7.82		0.00		6 Category 2 (degraded)	Low	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000004	Pasture / Forages	Kennedys	4.60		0.00		0 Category 1 (intact)	Medium	Poor (Close to Intense land uses)	1	3 - Poor
AGR0000005	Pasture / Forages	Kennedys	1.96		0.00		8 Category 2 (degraded)	Low	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000006	Pasture / Forages	Outer Cove	4.06		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000007	Pasture / Forages	Kennedys	1.65		0.00		4 Category 2 (degraded)	Low	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000008	Pasture / Forages	Kennedys	4.25		0.00	25	Category 2 (degraded)	Low	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000009	Pasture / Forages	Outer Cove	0.00		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000010	Pasture / Forages	Outer Cove	0.36		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000011	Pasture / Forages	Outer Cove	2.58		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000012	Pasture / Forages	Coakers	3.40		0.00		0 Category 2 (degraded)	Low	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000013	Pasture / Forages	Coakers	4.49		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000014	Pasture / Forages	Coakers	6.89		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000015	Pasture / Forages	Coakers	0.00		0.00		0 Category 2 (degraded)	Medium	Good (Distant land uses)	1	3 - Poor
AGR0000016	Pasture / Forages	Coakers	1.97		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000017	Pasture / Forages	Druksens	0.72		0.00		0 Category 1 (intact)	Medium	Poor (Close to Intense land uses)	1	3 - Poor
AGR0000018	Pasture / Forages	Coakers	0.98		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
AGR0000019	Pasture / Forages	Coakers	1.19		0.00		0 Category 2 (degraded)	Medium	Poor (Close to Intense land uses)	1	4 - Very Poor
FOR0000001	Broadleaf	<NA>	0.18		0.00		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000002	Broadleaf	<NA>	0.27	Cobblers	91.24		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000003	Broadleaf	<NA>	0.09		0.00		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000004	Broadleaf	<NA>	0.27	Cobblers	30.08		0 Category 1 (intact)	High	Good (Distant land uses)	1	1 - Good
FOR0000005	Broadleaf	<NA>	0.09		0.00		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000006	Broadleaf	<NA>	0.06	Cobblers	18.28		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000007	Broadleaf	<NA>	0.09	Cobblers	0.92		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000008	Broadleaf	<NA>	0.06	Cobblers	9.60		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair
FOR0000009	Broadleaf	<NA>	0.09		0.00		0 Category 1 (intact)	High	Poor (Close to Intense land uses)	1	2 - Fair

Figure 3.2: An example of a tabular data registry expression of an inventory

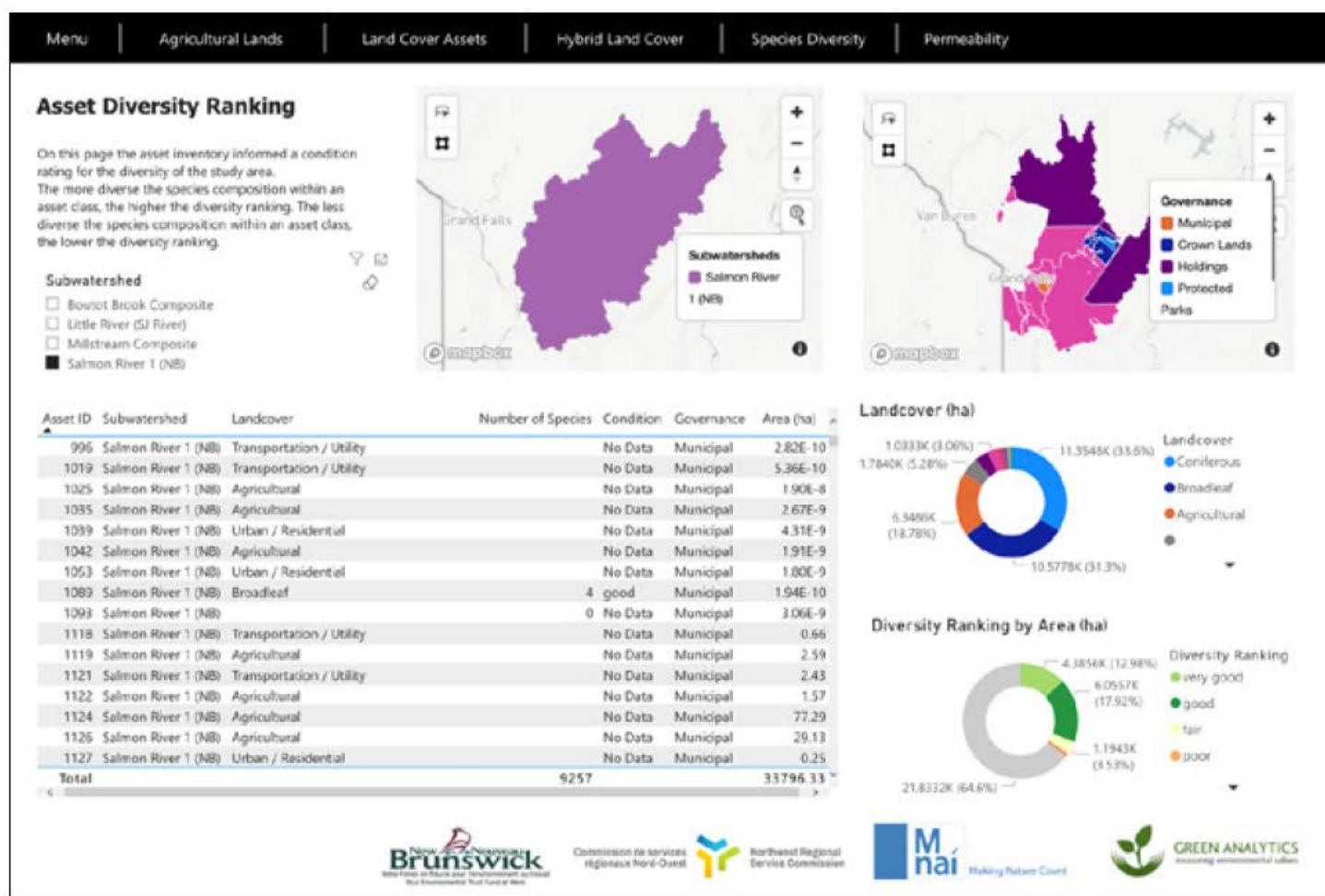


Figure 3.3: An interactive dashboard being used to express inventory data.

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

Consistency in Approach

Engineering and Geoscience Professionals can help ensure the natural asset inventory shares the same characteristics and structure as the one used for engineered infrastructure assets, and is built into the same asset management system the local government is using.

They can also help ensure that inventories align with any emerging norms regarding natural asset management so it is consistent with efforts of other communities, thus facilitating learning, information exchange, and comparable approaches to watershed management.

Appropriate Level of Detail in the Natural Asset Inventory

Engineering and Geoscience Professionals can help ensure that the level of detail for each asset in the inventory aligns with the uses to which the inventory will be put, and with the local government's capacity to keep the inventory current.

Inclusion of Natural Asset Characteristics that Support Climate Risk Assessment

When possible, Engineering and Geoscience Professionals should include carbon mitigation and sequestration data about natural assets to support climate risk assessment. With growing consensus on the importance of land-based carbon sequestration and storage, many are turning to existing tools to inform the effectiveness of natural asset management for estimating greenhouse gas (GHG) emissions and removals.

The 2018 Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 C indicated that the world will be faced with severe climate impacts even if stringent mitigation action is implemented, with the possibility of experiencing far worse outcomes under higher emissions trajectories. The 2019 IPCC report, Special Report on Climate Change and Land, highlighted how land plays a key role in storing greenhouse gases and estimated that 30 per cent of the world's greenhouse gas (GHG) emissions were absorbed by land from 2008 to 2017. This is helping to increase interest in natural asset management as a tool for climate mitigation and adaptation.

Some natural asset inventories being developed by MNAI for communities already contain details of stored carbon. Modeling tools exist to explore other aspects of carbon and natural assets but challenges remain, such as:

- Some tools developed in regions outside of Canada (e.g., the InVEST suite of models²⁰) may not include all relevant ecosystems;
- Other tools may only address a subset of natural assets (e.g., i-Tree²¹ focuses on forest-based assets);
- Comprehensive models that consider multiple land classes are under review for the Canadian context (e.g., Moja Global²²);
- Some models that provide multi-service trade-offs are under development and available only as prototypes (e.g., ARIES²³).

Engineering and Geoscience Professionals will need to consider the suitability of a range of options in this fast-evolving area.

20 See for example naturalcapitalproject.stanford.edu/software/invest

21 See for example www.itreetools.org

22 moja.global

23 ecosystemsknowledge.net/aries

Ownership/Governance of Natural Assets

A key difference between the management of built and natural assets is that many natural assets that provide services to communities are not owned or directly managed by the local government delivering the services. Nevertheless, local governments must understand their role in service delivery to ensure that measures are taken to monitor and protect those services or develop alternatives to service delivery should they risk being compromised. For this reason, Engineering and Geoscience Professionals should ensure that every natural asset on which the local government relies for services is accounted for in the inventory. This is vital to the success of most natural asset management efforts.

3.2.2. ASSESS THE CONDITION OF NATURAL ASSETS

A condition assessment (which, in the context of natural assets can be thought of as a health assessment) is an important part of a traditional asset inventory. It indicates how well an asset is performing by tracking the proportion of assets in “good,” “fair” and “poor” condition. The assessment can be used to identify gaps between the present state of assets and the desired state of assets and associated services. This will inform other aspects of the asset management process, such as customer and technical levels of service provided by natural assets, asset risks, and asset operations and maintenance costs.

The condition of built infrastructure assets is generally determined using standard engineering or geoscience practices and guidelines. Condition assessments for natural assets, by contrast, can be done using a number of approaches and currently there is no single standard.

EXAMPLE: General Condition Assessment Approaches to Natural Assets

General condition assessment approaches applied to traditional assets can also be applied to natural assets and may include the following action items:

- 1/** Collect data through detailed inspection and analysis
- 2/** Survey municipal representatives who have experience working with the assets
- 3/** Use proxy information such as age of material, soil environment, estimated service life, etc.

The approach and specific methods to be employed for natural assets depend on the size of the study area, budget, and staff capacity.

Other condition assessment approaches could be:

The individual asset approach:

For a narrowly defined asset or suite of assets, with sufficient budget and staff capacity, a condition assessment that examines individual assets is the preferred approach. This approach sequentially works through the assets in

the asset inventory and assigns a condition rating to each. The rating can be informed by the results of a detailed inspection, based on expert knowledge, be drawn from existing research or reports if available (e.g., environmental impact assessments), or deduced from proxy information linked to the assets and the services they provide.

In a condition assessment done in Sparwood, B.C., community representatives examined natural areas to develop a baseline condition assessment. Based on the field assessment, each area was given a condition rating based on expert field staff judgement. Opportunities for improvement were also noted. The results of this assessment are summarized in Table 3. Condition ratings were defined as follows:

- **Very good:** Well maintained, good condition, no signs of deterioration in ecological conditions.
- **Good:** Ecological conditions appear to be sufficient, some minor localized (or isolated) impacts noticeable, which may be a warning sign of possible decline.
- **Fair:** Clear signs of deterioration in ecological function and service-influencing factors.
- **Poor:** Condition is below standard with large portion/s of the system exhibiting significant deterioration in ecological function.
- **Very poor:** Widespread signs of advanced deterioration, unlikely the natural asset is providing any functional service.

Asset Zone	Catchment	Description	Physical Condition	Potential for Improvement (Y/N)	Potential Improvement opportunities
Upper Natural Area	A	Red Maple	Good	Y	Note 1
Upper Natural Area	A	Sparse White Birch	Poor	Y	Note 2
Upper Natural Area	A	White Birch	Good	Y	Note 1
Upper Natural Area	A	White Spruce	Good	Y	Note 1
Lower Developed Area	A	Developed	Fair	Y	Note 3
Lower Developed Area	A	Road	NA	N	
Lower Developed Area	A	Transmission Route	Fair / Poor	N	
Lower Developed Area	A	Unclassified Forest	Fair / Poor	Uncertain	Note 4
Upper Natural Area	B	Unclassified Forest	Fair	Y	Note 1
Upper Natural Area	B	White Birch	Good	Y	Note 1
Upper Natural Area	B	Poplar	Good	Y	Note 1
Upper Natural Area	B	Red Maple	Good	Y	Note 1
Upper Natural Area	B	White Spruce	Good	Y	Note 1
Upper Natural Area	B	Beech	Good	Y	Note 1
Upper Natural Area	B	Eastern hemlock	Good	Y	Note 1

Table 3: Natural asset condition assessment for the project area

A simplified approach:

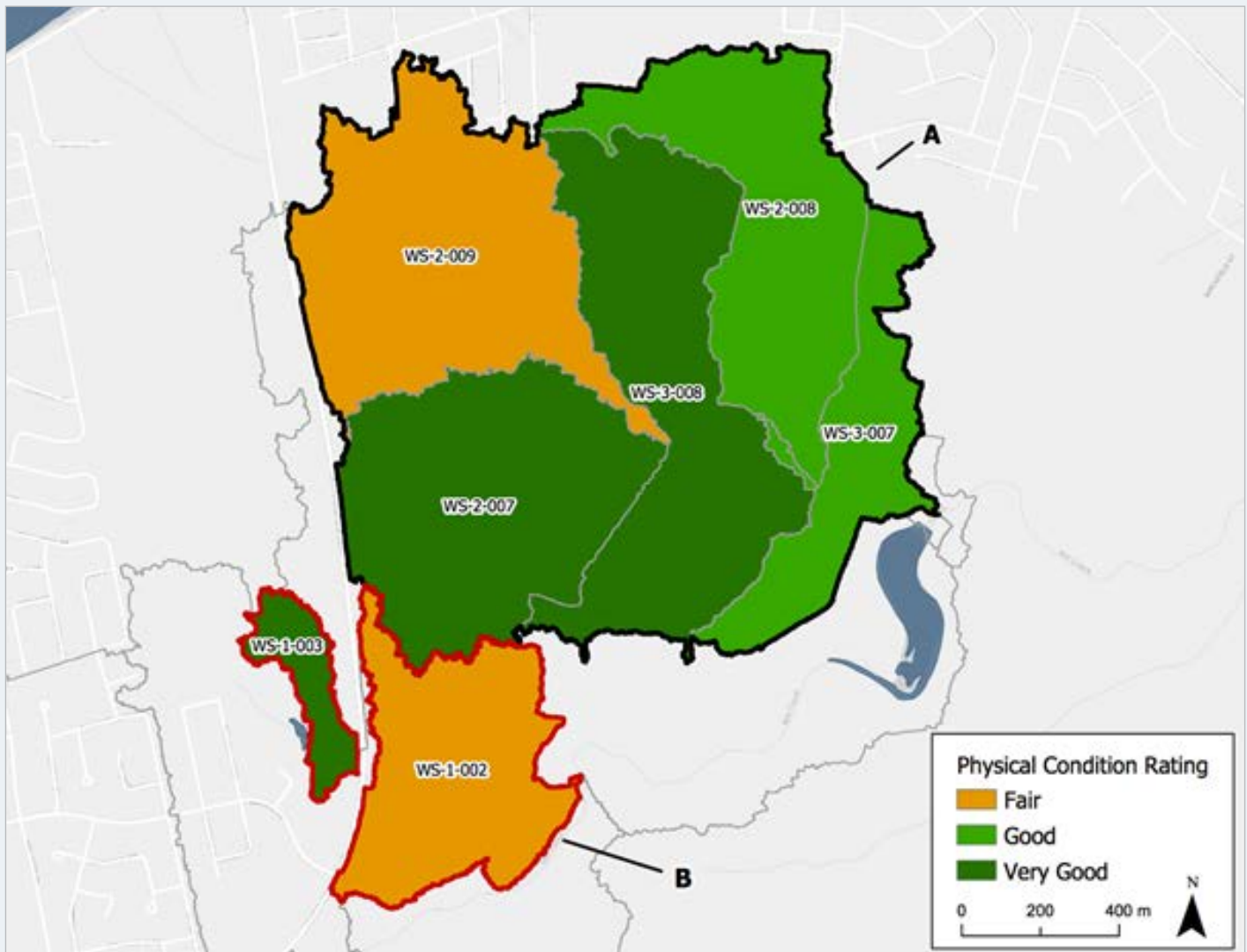
For study areas that are too large, with limited budget and staff capacity, it may not be possible or feasible to individually assess every asset in the natural asset inventory. In such a case, a more simplified approach may be the best way to proceed. A simplified approach relies on two key components:

- 1/ Measure the asset extent (e.g., measure the area of forested lands using land-use data)
- 2/ Qualitatively assess conditions drawing on whatever relevant information is available (e.g., land-use or other “macro datasets” or local datasets such as forest asset inventories maintained by municipal forest departments).

This information can be combined into a simple system that specifies the condition of various components of the assets by area and quality. For example, the forest assets of a municipality could be assessed as x hectares of pristine mixed-wood forest, y hectares of moderately disturbed mixed-wood forest, and z hectares of severely disturbed mixed-wood forest.

The municipality of Riverview, New Brunswick, undertook this type of condition assessment, where the goal was to obtain a high-level assessment of the existing natural assets to help inform future management actions and decisions pertaining to those assets. This was achieved by classifying the condition of the watersheds’ ability to provide stormwater management services. Condition ratings ranging from very poor to very good were allocated based on per cent impervious surface within the watershed shown in the table figure below. A ‘very good’ condition rating reflects a catchment with natural assets largely intact with little ecological deterioration. Catchments with greater than 10 per cent impervious surface typically experience negative effects to streams and wetlands due to erosion and increased sedimentation from increased runoff as described by the “urban stream syndrome.” Restoration and/or maintenance may be required to improve and/or maintain their ecological function.

Sub-catchment condition	Criteria	Interpretation
Very Good	0-5% impervious surface	Well maintained, good condition, no signs of deterioration in ecological conditions.
Good	5-10% impervious surface	Ecological conditions appear to be sufficient, some minor localized (or isolated) impacts noticeable, which may be a warning sign of possible decline.
Fair	10-20% impervious surface	Clear signs of deterioration in ecological function and service-influencing factors.
Poor	20-30% impervious surface	Condition is below standard with large portion/s of the system exhibiting significant deterioration in ecological function.
Very Poor	> 30% impervious surface	Widespread signs of advanced deterioration, unlikely the natural asset is providing any functional service.



Map 1: Condition rating of watersheds' ability to provide stormwater management services

The condition of natural assets provides an indication of how well it is delivering target services, which is dependent on its overall health or ecological integrity. Ecological integrity assessments gauge an ecosystem's composition, structure, processes and connectivity against reference conditions. Ecosystems that retain their diversity of native species and natural processes are hypothesized to be more resistant and resilient to current and future direct and indirect threats.

Over time, natural assets and their condition can change due to both human and ecological influences. Therefore, natural assets require continuous management, so their intended levels of service over the short- and long-term can be maintained. When initiating a natural asset management program, a natural assets assessment can provide a snapshot of the current natural asset conditions and can thereby support estimating the costs required to maintain the natural assets at their optimal service levels.

Condition assessments should aim to develop a baseline as a fixed point of reference for comparison purposes. A typical benchmark assessment should include a well-defined study area, the natural asset under consideration, purpose and scope of the baseline assessment, and a record of the assessment in the form of a baseline report. Thereafter, the effectiveness of various interventions to manage the natural assets can be determined, in part, by changes to condition.

Condition assessments must encompass two concepts: first, the condition of a natural asset in relation to services of interest; and second, condition in the broader sense of the integrity of the underlying natural asset and consider factors such as its biodiversity and connectedness.

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

The Engineering and Geoscience Professional should advocate for the collection of data that give a sufficiently holistic representation of natural asset health. For example, a wetland that stores floodwater effectively may not be healthy from a conservation perspective.

More generally, the Engineering and Geoscience Professional should consider that, while current condition assessment activities appropriately reflect the environmental science view of natural assets and ecosystems more generally, these activities may be augmented or enhanced by the Indigenous knowledge view of the assets.

When it is not possible to access data (e.g., if it is owned by an entity that is unable to share it), it can be possible to rely on the best available data (often provincial or federal datasets) for the region and adjust the approach as needed depending on the resolution of the data available.

3.2.3. Determining Risks to Natural Assets

Once local governments have completed their natural asset inventory and condition assessment, they should undertake a risk identification exercise. In the context of asset management, risk is defined as the product of the probability of an impact occurring and the relative magnitude of its negative consequences. It is a rapid assessment of the key risks to natural assets in terms of their ability to provide target services, informed by expert opinion of local hazards.

Risk identification is different from a formal Risk Assessment, which is more resource-intensive and comprehensive. In addition to the consideration of a wider range of risks, risk assessments can involve specifying priorities, acceptable levels of risk, procedures to be followed within the organization, allocation of resources, and identification of necessary policies. It may also involve setting up systems to ensure that required actions are in place to manage the assessed risk.

In comparison, the goal of risk identification is to identify the high priority risks to natural assets and their associated services. This is a helpful starting point for setting priorities for further analysis. The outputs of risk identification should be assessed against a municipality's risk tolerance. Risks of high priority and low tolerance can then be formally assessed to identify and evaluate actions that can be taken to reduce vulnerability.

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

A variety of tools are available to the Engineering or Geoscientist Professional for risk identification. Alternatively, the Engineering and Geoscience Professional may wish to support workshop-style efforts to identify risks.

EXAMPLE

MNAI has developed an approach to guide the risk identification process that begins with bringing together key people in the local government to identify common risks, assess the likelihood of each risk occurring, and the severity of the impact. A list like the one below that shows common risks to natural assets is generated with the group:

- Overuse of trails/dumping (e.g., health and safety on nature trail system along eroding creek channel)
- Flooding
- Forest fire
- Forest and woodlot management practices (e.g., tree removal by-laws)
- Drought
- Invasive species
- Development pressure
- Pollutant loading from urban, agricultural, or industrial sources
- Risks to existing infrastructure (e.g., storm drain impacts)
- Erosion of creek banks along steep slopes leading to slope collapses
- Watershed and creek erosion impacts of turbid waters in creek/delta to aquatic life
- Delta deposition of large quantities of sediment carried by the creek
- Ice jams and erosion
- Overuse of salt on roads

The group then assesses the likelihood and severity of impact of each risk using rating scales like the ones shown in Tables 3.2(a) and 3.2(b) below:

Likelihood Rating	Event Type	
	Recurrent Impact (Probability of occurrence in next 10 years)	Single Event (only occurs once)
Almost Certain (5)	Could occur several times per year	More likely than not – probability greater than 50%
Likely (4)	May arise about once per year	50/50 chance
Possible (3)	May arise once in ~10 years	Less likely than not but still appreciable – probability less than 50% but still quite high
Unlikely (2)	May arise once in 10 years to 25 years	Unlikely but not negligible – probability low but noticeably greater than zero
Rare (1)	Unlikely during the next 25 years	Negligible – probability very small, closer to zero

Table 3.2 (a): Example of a risk likelihood rating scale for natural assets

Impact Rating	Description of rating
Catastrophic (5)	Irrecoverable damage/irreversible impacts to the asset and/or major loss of its functions.
Major (4)	Major, widespread impacts to the asset in the medium/long-term and/or severe and widespread loss of ecological functions. Damage that could be reversed with intensive efforts (e.g., introduction of tree disease – similar to Environmental Appeal Board).
Moderate (3)	Moderate impacts on the asset in the short/medium-term. Isolated but moderate instances of damage to the ecosystem functions that could be reversed with intensive efforts.
Minor (2)	Minor, localized impacts on the asset in the short-term. Isolated but minor instances of damage to the ecosystem functions that could be reversed.
Negligible (1)	Appearance of threat but no real impacts on the asset or its functions.

Table 3.2(b): Example of a severity of impact rating scale for natural assets

Each risk is then given a risk score, which is the product of likelihood and severity of impact (likelihood rating X severity of impact rating). The score can be used to support local governments in setting priorities for implementation.

3.2.4. Determining Current Levels of Service

Levels of service for infrastructure refers to the quality, function, and capacity of the service provided by a natural asset. Table 3.3 on the next page provides examples of how natural assets can support a local government's service delivery role alongside conventional grey infrastructure.

EXAMPLE:

Municipal Water Services	Ecosystem Services	Natural Assets	Engineered Replacement
Drinking Water Supply	Aquifer Recharge	Aquifer & Source Water Area	Pipes for bringing in water supply
	Lake Recharge	Lake Watershed	Water Treatment Plant
	River Headwaters	Headwater lands	
Drinking Water Treatment	Water Purification	Wetlands, forests, vegetation	Water Treatment Plant
	Water Filtration		Water Treatment Plant
Stormwater Management	Rainwater Absorption	Wetlands, forests, vegetation	Stormwater pipes, culverts, storm drains, stormwater ponds
	Rainwater Filtration		Water Treatment Plant
Flood Mitigation	Rainwater Absorption	Wetlands, forests, vegetation	Dams, retaining walls, embankments

Table 3.3: Examples of Natural Assets Employed in Service Delivery

The Engineering and Geoscience Professional, together with other specialists, can determine the levels of service provided by natural assets using a similar process as is used for conventional infrastructure, with a notable exception: *natural assets generally provide multiple services*, and it is important for a local government to determine:

- The *primary services* of interest to the local government. Typically, these will be the services for which the local government is responsible for delivering, as these will be the ones relevant to Asset Management. Examples may include stormwater management, flood mitigation, drinking water filtration, and source water protection.

- The *additional services* of interest to the local government, which could include recreational services, health promotion, habitat provision, and cultural services. These may not be services that the local government is responsible for delivering, but which are nevertheless of relevance to the community. Of special importance is the support given by these additional services to local Indigenous communities.

Determining the primary levels of service with a degree of accuracy adequate for asset management purposes typically requires modeling. The modeling software will depend on services of interest, and the local government's skills and resources. The U.S. EPA's Stormwater Management Model (SWMM), for example, can be used to simulate hydrologic and hydraulic processes, the impact of land use changes on these processes, and the effects of several management options. SWMM 5, another example, is capable of adequately representing natural assets such as ponds and wetlands, and is commonly used to simulate and compare multiple stormwater management scenarios. Hydrological model outputs then inform economic valuation of the stormwater retention and flood peak reduction benefits provided by the system of ponds and wetlands.

To determine additional levels of service provided by natural assets, benefit transfer methods and other techniques can be used. Benefit transfer is the process of transferring a previously determined value of a natural asset to other similar assets to provide an order-of-magnitude estimate of their value.

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

Engineering and Geoscience Professionals can play a critical role in determining primary and additional levels of service provided by natural assets by selecting the modeling approach, calibrating and running the model, and interpreting the results. Their interpretation can be enhanced by drawing on Indigenous knowledge and interpretation of the services that natural assets provide or should provide.

Engineering and Geoscience Professionals should consider natural assets alongside engineered assets as part of an integrated system that delivers core municipal services. Understanding how natural and engineered assets interact and can be managed as a system can assist in meeting desired service levels. For example, a community may deem the need to manage flood events through a hybrid approach of engineered and natural infrastructure, and to consider natural asset solutions as part of a more comprehensive and phased flood management strategy with a wide range of approaches, including natural assets, engineered assets, and changes to bylaws and policies.

3.2.5. Determining Natural Asset Service Value

Currently, there is no standard approach for measuring natural asset service value. In MNAI's process, the primary objective of the economic evaluation of natural assets is to measure and demonstrate their contribution to specific services delivered by a local government. These 'operational' figures support asset management decision-making. It is critical to note that the valuations relate to services from natural assets, rather than trying to determine any intrinsic value to the asset itself.

A secondary but equally important objective is to measure additional service values from the same natural assets to users other than the local government – for example, citizens and businesses that may receive quantifiable health, social or economic benefits from tourism, recreation, forestry, agriculture, farming, etc. The latter values may not relate directly to the local government or its asset management priorities, but can create a holistic understanding of value and support community awareness and engagement in discussions about service delivery.

Together, the operational and additional service valuations provide a composite valuation, which, while far from exhaustive, provides a basis for both asset management and community awareness.

Valuations can happen at two stages:

- During the assessment phase, to determine the value of services currently being provided
- During the planning phase, to determine the value of services in various future potential scenarios

To ensure that natural asset valuations are sufficiently rigorous to be used for asset management planning, modeling that considers market-based comparators such as replacement costs to deliver an equivalent service should be used to determine the value of the services provided. Other valuation methods, described in the AMBC Primer on Integrating NAM, include:

- **Damage cost avoided:** the value of the service provided by the natural asset is estimated based on the cost of damages avoided through the maintenance, protection, or enhancement of natural assets.

- **Benefits Transfer:** The previously determined value of a natural asset is transferred to other similar natural assets to provide an approximate estimate.

Benefit transfer methods will typically be more useful in determining additional values, given that they provide coarser results and are, by definition, not place-based.

The Public Sector Accounting Board restricts local governments from putting a value on natural assets in their financial statements and in their financial reporting. This should not be seen as a limitation in the valuation of natural asset services. Valuation is still possible and desirable in the context of planning for financial and asset management, during which local governments must determine most cost-effective service delivery options that best manage risks and meet desired levels of service over the long-term.

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

To assist in determining the value of services from natural assets, Engineering and Geoscience Professionals can leverage existing policy analysis or research in the jurisdiction of interest. For example, Alberta has developed a wetland offset policy in which they specify a “compensation” value (measured in \$ per ha) for lost wetlands. Alberta communities could use these values as placeholders for the wetlands contained within the inventory. An average cost of replacement value per unit area can be developed, based on known costs associated with restoring, rehabilitating, and naturalizing degraded or damaged natural assets. If needed, other experts can be enlisted to develop a per unit area average value based on benefits transfer techniques.

Engineering and Geoscience Professionals may collaborate with financial professionals, ecologists, Indigenous knowledge experts, and with others to determine the monetary value of natural assets, and other community experts, including Indigenous knowledge experts, to determine the social value of these assets.

3.3. Planning for Natural Asset Management

To build natural asset management considerations into local government asset management plans and long-term financial plans, it is important to consider how the services provided by natural assets may be affected in the future. Analyzing potential future scenarios will help Engineering and Geoscience Professionals and others on the asset management team to develop and budget for implementation options that can protect or enhance the services provided by natural assets.

A key first step in the planning phase of the natural asset management cycle is exploring and modeling:

- natural asset responses to future scenarios (for example, changes relating to land use, rehabilitation or degradation), which, in turn, result in changes to service levels; and
- the values of the services in future modeled scenarios.

As with baseline evaluations during the assessment phase, modeling that takes place in the planning phase can be divided into:

- 1/ Modeling those services from which the local government benefits directly and is responsible for delivering (e.g., flood prevention, stormwater management, drinking water filtration); and
- 2/ Modeling those services that, while important, may not be within direct local government scope (e.g., pollination, ecosystem health, biodiversity).

For natural asset management purposes, the former will typically be the primary consideration. These services should be determined and characterized using modeling to ensure accuracy and relevance. Computer modeling packages will likely be the same commercially available options as are used to manage engineered municipal assets.

Since the future scenarios to be explored will be contextual (for example, vary according to local climatic, development, planning and other variables), scenario questions to investigate could include:

- How will the selected natural asset(s) perform in future climatic conditions?
- What would happen to services if 25% or 50% of a watershed were destroyed by wildfire?
- What would happen to services from natural assets if zoning or setbacks were changed, thus altering the condition of natural assets? Here, various “condition multipliers” can be used in the modeling.
- What would happen to services if the natural asset area were increased through acquisition or decreased through development?
- What would happen if a natural asset became contaminated due to pollutant loading from industrial, agricultural or other sources?

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

Engineering and Geoscience Professionals can play key roles in helping the asset management team identify and evaluate realistic and relevant scenarios to model, and ensure that the modeling is of sufficiently high calibre to support the intended natural asset management decision making.

Once modeling of future scenarios is complete, the information can be used to develop natural asset management plans that define priorities, timing and

funding required to achieve different outcomes. High-level policies that need to be developed or modified to support the implementation of natural asset management practices tend to be identified in this phase and earmarked to be put in place during the implementation phase.

3.4. Implementing Natural Asset Management

Proactive management of natural assets may depend on or be supported by implementation of natural asset-related strategies or asset management plans developed in the planning phase.

Whether or not a local government has formally adopted natural asset management, Engineering and Geoscience Professionals should make themselves aware of existing policies, strategies or plans of the local government to determine implications for how natural assets should be protected and managed. For example, some local governments may already have a Climate Action Plan, a Resilience Strategy or an Environmental Sustainability Strategy that should guide infrastructure decisions.

3.4.1. IMPLEMENT NATURAL ASSET MANAGEMENT PRACTICES

Successful implementation of natural asset management depends on following, and continually improving, asset management activities, plans and programs that include natural asset considerations.

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

EXAMPLE

Key considerations for Engineering and Geoscience Professionals during the implementation phase include:

Local government education and capacity

- Working with the asset management team to ensure the local government is aware of critical science and technical issues that may influence policies and strategies relating to natural asset management.

Increased staff understanding of role of NAM in delivering service

- Determining whether additional expertise is required for engineering- or geoscience-related practice areas concerning natural asset management.
- Promoting the inclusion and protection of natural assets by emphasizing service delivery rather than only the operation and maintenance of built infrastructure.

Cooperation with other jurisdictions and partners

- Helping local governments understand and quantify services they rely on from natural assets that are under the ownership and/or jurisdiction of others. This may necessitate evidence-based strategies to engage entities other than local governments.
- Ensuring appropriate engagement with keepers of Indigenous knowledge.

Human resources practices

- Ensuring local governments either employ or access the right skill sets through specialists to undertake natural asset management.
- Providing or coordinating staff training where needed.

Natural Asset Policy, Strategy, Bylaws

- Ensuring relevant policies, strategies and bylaws are aligned with, and support, the use of natural assets, and ensuring the use of natural assets are incorporated into the relevant policies, strategies and bylaws.
- Explaining / supporting asset management emphasis on service delivery rather than the operation and maintenance of built infrastructure.
- Supporting / explaining role of natural assets in providing cost-effective and reliable services.

Official Community Plans / Regional Growth updates

- Explaining / supporting asset management emphasis on service delivery rather than the operation and maintenance of built infrastructure alone.
- Supporting / explaining role of natural assets in providing cost-effective and reliable service.

Subdivision bylaw changes

- Supporting Subdivision and/or Development Services Bylaw changes that support restorative development by fully recognizing the role of natural assets and the services they provide.
- Determining/exploring options to protect natural assets that provide services.
- Encouraging local governments to explore natural asset options to avoid or delay building new engineered assets.

Development Cost Charge Bylaws changes

- Determining, with the appropriate B.C. Government Ministry, whether development cost charges can be applied to the services provided by natural assets.

Zoning changes

- Based on modeling efforts, helping to determine if zoning changes / setbacks are needed to enable natural assets to provide required services.

Programs, Financing, Investments and Operations

- Ensuring local government finances and invests in natural assets so they remain sustainable.
- Ensuring operations do not encroach on, or otherwise contaminate or disturb, natural assets.

Rehabilitation and Acquisition Projects

- Based on modeling efforts, helping determine the role of rehabilitation and acquisition of natural assets in providing cost-effective services.

Integration of NAM into key / priority processes

- For example, ensuring natural assets are considered in the development of organization-wide strategic planning processes, the development of master plans for specific service areas like transportation, and stormwater management.

Monitoring project

- Designing and implementing monitoring protocols for natural asset projects, including data collection, analysis, and reporting of monitoring results.

Activities to scale up from sub-watershed

- Determining appropriate strategies to scale up sub-watershed activities across entire watersheds. This could include supporting the engagement of non-local government entities that own and/or have jurisdiction over natural assets on which local governments rely for services.

Costed Operations and Maintenance (O&M) plans

- Based on modeling efforts, helping to establish O&M plans that will result in long-term delivery of cost-effective services.

External engagement, awareness and partnerships

- Providing advice to help leverage partnerships and relationships to support protection and enhancement of natural assets.

Mechanisms in place to engage others with title/jurisdiction

- Supporting evidence-based discussions with community entities that have a role in stewarding natural assets. These may include schools, community organizations and university partners.

Funding from government infrastructure programs, insurance sector and/or capital markets

- Supporting development / provision of data that support funding applications for natural asset rehabilitation and restoration, where needed.

The Engineering and Geoscience Professional should also consider that recognizing First Nations' world view, knowledge and perspectives related to natural asset management can be critical to community resilience and well-being. It is imperative that Indigenous knowledge keepers and Indigenous communities be engaged and recognized early in the management process. The value of respecting Indigenous knowledge, in addition to scientific knowledge, is a cornerstone of natural asset management. It should never be the case that Indigenous knowledge is "inserted" into a process as an afterthought.

The Engineering and Geoscience Professional should also consider that, while rehabilitation and restoration efforts may be vital, it is often far more effective and less expensive to protect natural assets and avoid the need for rehabilitation.

The Engineering and Geoscience Professional should recognize the strong connections between municipal adaptation plans, the climate risk assessment that leads to those plans, and the potential for natural assets to mitigate the risks associated with flooding, heat extremes and other climate impacts²⁴. They have an important role in advising on the design of natural asset solutions that can accommodate extremes of flood, drought and heat.

3.4.2. Measure and Report Natural Asset Management

Measuring and reporting on natural assets are critical activities for driving continual improvement and adaptive management and providing evidence to update plans and activities.

Local governments must define what success means for natural asset management and the measures they will use to report their performance. Indicators may include the health of the natural assets, the management of risks to natural assets, desired level of service, the lifecycle cost savings of service delivery, or other co-benefits resulting from proactive management of natural assets.

Natural asset monitoring results can be included in the reporting cycle for local governments in the form of annual reports, asset management maturity and progress reports, service delivery or infrastructure report cards and dashboards.

Reports should have suitable time frames and contain information on the current state of the natural assets and expected future states. The target audience for natural asset management reports can be staff, council or board, other impacted jurisdiction(s), and the public. Reports of natural assets can also serve as communication tools with the general public and hence use of suitable language is vital to success.

²⁴ For example, see the June 2018 ICF report to the Canadian Council of Ministers of the Environment entitled "Best Practices and Resources on Climate Resilient Natural Infrastructure" ccme.ca/en/res/natural_infrastructure_report_en.pdf

CONSIDERATIONS FOR ENGINEERING AND GEOSCIENCE PROFESSIONALS

The Engineering and Geoscience Professional plays an important role in developing monitoring and reporting protocols, including determining performance indicators for natural assets. Due to the complexity of understanding how natural assets deliver services, monitoring protocols will vary depending on the type of asset, service of interest and the local context. It is important that Engineering and Geoscience Professionals collaborate with other professionals when developing monitoring and reporting procedures. Engineering and Geoscience Professionals should collaborate with their multidisciplinary asset management team to define key performance indicators (KPIs), and can use additional resources such as reviews or reports, to identify best suited KPIs.

The Engineering and Geoscience Professional can also provide assistance in catering the level of detail of the reports for specific audiences.

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