

Advancing Municipal Natural Asset Management through Standardized Evaluation

by

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A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Arts

in

Planning

Waterloo, Ontario, Canada, 2021

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

In Canada, many urban and near-urban ecosystems are in decline. As well, engineered infrastructure is aging, its capital and operating costs are rising, and municipal service delivery is strained. Local governments are searching for new strategies to deliver services in financially and environmentally sustainable ways. They are also looking to incorporate ecosystems and ecosystem services into their understanding of service delivery. Unfortunately, many municipalities struggle to view these ecosystems as green infrastructure that can provide local communities with a wide range of important services such as stormwater management. However, some Canadian municipalities are beginning to incorporate ecosystems and the services they provide into their asset management planning and service delivery frameworks, an approach known as municipal natural asset management. To conduct municipal natural asset management, municipalities should restore, conserve, inventory, and track ecosystems under their jurisdiction.

As more municipalities incorporate municipal natural asset management, evidence of its efficacy is required to upscale and mainstream this approach. Therefore, the purpose of this research is to evaluate municipal natural asset management programs. Evidence from this evaluation will contribute to a broadening database of the beneficial outcomes of a municipal natural asset management program. To do this, this research created a rigorous evaluation framework for municipal natural asset management and has applied it to a national cohort of five case studies. This evaluation framework includes a Program Logic Model and an Evaluation Matrix as two common evaluation tools. As well, evaluation questions, indicators, benchmarks, and a five-point, colour-coded scoring system were created for program outcomes based on four distinct outcome streams in the Program Logic Model. These four outcome streams are (i) Awareness, Capacity and Education Outcomes, (ii) Implementation Outcomes, (iii) Ecosystem Rehabilitation and Restoration Outcomes and (iv) Service Delivery Outcomes. Findings from the evaluation showed that the five municipalities received high scores for Awareness, Capacity and Education Outcome indicators and some Implementation Outcome indicators. However, the municipalities did not receive high scores in later Implementation Outcome indicators, Ecosystem Rehabilitation and Restoration Outcome indicators, and Service Delivery Outcome indicators.

These findings reveal that municipalities are aligning municipal natural asset management with existing municipal climate action initiatives. Moving forward, Canadian local governments should focus on partnerships and champions to enable municipal natural asset management, recognize municipal natural asset management as a full municipal program, and use existing tools to identify sites for ecosystem rehabilitation and restoration. Findings from the evaluation also provide insights on complex and complicated Program Logic Models, nested outcomes, and outcome streams. This evaluation framework should be improved upon so more municipalities can be evaluated simultaneously and automatically. Finally, local governments should explore using funding from COVID-19 Pandemic Recovery to integrate municipal natural asset management.

Acknowledgements

I would like to thank my advisor, Dr. Michael Drescher, and my committee member, Dr. Mark Seasons, for their careful critiques, direction, and support during the entirety of the research and writing process.

Thank you to all the local government staff who participated in interviews and shared information to support this evaluation.

I would like to extend a special thank you to Roy Brooke and the entire Municipal Natural Assets Initiative team whose partnership was paramount to getting this research off the ground.

An added thank you to my family, namely my mother, father, and brother who have each supplied the necessary love and encouragement in their own unique way. Most of all, thank you to my partner Sabrina Raposo, who is a source of light and is a constant reminder of why this work is needed.

Lastly, I would like to acknowledge that my work and the work of University of Waterloo takes place on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. Our main campus is situated on the Haldimand Tract, the land promised to the Six Nations that includes six miles on each side of the Grand River. As well, I would also like to acknowledge all the traditional and unceded territory on which the municipalities discussed in this thesis reside and stress the many facets of Indigenous knowledge that should guide municipal and environmental policy and practice.

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Chapter 1: Background

1.0 Introduction

In Canada, many urban and peri-urban ecosystems are in decline. Unfortunately, many municipalities only understand and manage these natural assets as aesthetic or social amenities. They struggle to account for ecosystems as green infrastructure that can provide local communities with a wide range of important services. However, some Canadian municipalities are beginning to incorporate ecosystems such as wetlands, forests, or streams into their infrastructure and asset planning to maintain and improve municipal services. This “municipal natural asset management” requires local governments to restore, conserve, inventory, and track ecosystems under their jurisdiction. However, more practical evidence is needed to mainstream this approach as a standard practice. This evidence must show that restored and conserved ecosystems can provide services that complement built infrastructure and that municipalities meet the necessary conditions to implement this approach successfully.

Therefore, the subject of this thesis is the evaluation of a cohort of municipal natural asset management case studies in Canada. By using program evaluation methods, evaluation tools, and research-based aspects of ecosystem service management, this evaluation bridges a gap in research on program evaluation and ecosystem services. This research will address what municipalities are reaching program outcomes and how they are doing so. This will result in more evidence-based decision-making for municipalities considering municipal natural asset management.

This thesis is divided into six chapters. In the first chapter, the research topic is introduced, the background of work completed prior to the research is discussed, and the

research objectives are outlined. In the second chapter, the literature is explored. Through that process, this thesis will bring together research in ecosystem service management and program evaluation. Using this literature, an evaluation framework will be created. In the third chapter, the evaluation framework is presented to gather, analyze, and interpret data from a cohort of municipalities that have implemented municipal natural asset management. In the fourth chapter, key background information is shared for all five of the municipalities as well as maps of their natural assets. Then, the results of the evaluation are presented in the fifth chapter. Subsequently, in the sixth chapter, lessons learned, recommendations, future directions for research, and limitations of the evaluation are presented. The sixth chapter also concludes the thesis.

1.1 Municipal Services and the History of Canadian Municipal Infrastructure Decline

Much of this thesis focuses on ecosystem-based provisioning of municipal services. Municipal services are the services that are provided to residents of a local municipality in exchange for property taxes, user fees, and/or non-tax revenue paid by residents and businesses in the local area (Association of Municipalities Ontario, 2021). This can include storm sewers, parks and recreation, public transit, water, and sewage. These services are vital to life in urban and peri-urban areas. The services provided by a municipality depend on the history and geography of the municipality, as well as provincial laws and regulations. For example, municipalities need varying services that address their local needs. This could include infrastructure and services to prevent adverse effects such as overland flooding from snowmelt or rainstorms. The property taxes, user fees, and other revenue sources differ across municipalities, which then affects the funding available for services.

Across Canada, the infrastructure that provides these municipal services is beginning to fall apart and its repair is costly. Canada's 2019 Infrastructure Report Card shows that for just potable water, wastewater, and stormwater linear assets, 30% are in fair or worse condition (TCIRC, 2019). Most of the country's roads, bridges, stormwater, and sewer systems were built just after the Second World War, and up to 70% are at the end of their lifecycle (George & Sekine 2017). To compound this problem, municipalities are also faced with declining budgets, even prior to the COVID-19 Pandemic, which makes traditional infrastructure renewal projects and service delivery much more difficult. Cities own two-thirds of their infrastructure but receive only eight percent of all tax dollars for this infrastructure (Tassonyi & Conger 2015). Historically, municipalities have set aside very little money for infrastructure operations, maintenance, and renewal (Di Matteo 2017). The Government of Canada also recognizes this decline in infrastructure by committing to spend \$187.8 billion on infrastructure projects from 2016-17 to 2027-28 (Nahornick et al. 2020). Despite these renewed investments, Canada's Infrastructure Report Card consistently shows that much of our infrastructure is still at risk (TCIRC 2019; TCIRC 2016).

To address infrastructure decline, municipalities in Canada are adopting an integrated approach that brings together skills, expertise, and activities to make informed decisions on infrastructure and to treat this infrastructure as an asset. This process is known as asset management. Modern, structured asset management processes have, as their central principle, the cost-effective and reliable delivery of services rather than a focus on a specific asset type to deliver these services (Asset Management BC 2015).

1.2 Global and Canadian Ecosystem Decline

Alongside this problem of declining infrastructure, many urban or peri-urban ecosystems are either encroached upon or are in declining health. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, one of the foremost experts in this field, confirms this on a global level (IPBES 2019). In Canada, we are at risk of losing land-based natural systems that contribute services valued at \$3.6 trillion (IPBES 2018). Since European settlement, 50 million acres of wetlands have been lost in Canada. Now less than 0.2% of Canada's wetlands are within 40 kilometres of major urban centres (EarthTalk 2008). Climate change continues to cause many of the adverse effects plaguing urban or peri-urban ecosystems (Mitsch & Hernandez 2013).

Climate change and its effects are unequivocal (IPCC 2014). Cities are at an increased risk of withstanding the worst of these effects. Given the very narrow window of opportunity for avoiding dangerous climate warming (IPCC 2018), the policy focus on mitigating the emission of greenhouse gases must now shift to also adapting to the impacts of climate change (IPCC 2007, pg. 5). Policy and scientific focus on preserving life-sustaining natural capital and ecosystem services has grown since the 2005 Millennium Ecosystem Assessment, which signalled dramatic declines in Earth's vital natural systems (MEA, 2005). Ecosystem services are the benefits people obtain from ecosystems. There are four categories or types of ecosystem services which include provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling (MEA 2005, pg. V; IPBES 2019, pg. 3). Unfortunately, the global status of these ecosystem services shows that many of these crucial

services are in decline (MEA 2005, pg. 7; IPBES 2019, pg. 3) and have been in decline for some time.

Biodiversity and ecosystem services are intrinsically linked as biodiversity plays a role at all levels of the ecosystem service hierarchy. These roles include acting as a regulator of underpinning ecosystem processes, as a final ecosystem service, and as a good itself that is subject to valuation (Mace et al. 2012). Unfortunately, “future disruptions of ecological assemblages as a result of climate change will be abrupt because within any given ecological assemblage the exposure of most species to climatic conditions beyond their realized niche limits occurs almost simultaneously” (Trisos et al., 2020). This means that the potential biodiversity loss will not be concentrated within select ecosystems or gradual over several years, but can and will affect every kind of ecosystem service suddenly and without recourse.

1.3 Addressing Two Declines with Nature-based Solutions

To address infrastructure decline and ecosystem decline, some municipalities have started to incorporate ecosystem-based adaptation and nature-based solutions into their service delivery portfolios. Ecosystem-based adaptation and nature-based solutions are ways to protect our local natural environments and adapt to the effects of climate change, while also providing local services through ecosystems that municipalities need (Elmqvist et al. 2013). These strategies are important for municipalities to consider. As institutions and stakeholders grow increasingly concerned with climate adaptation needs in urban and peri-urban areas, programs that focus on adaptation will receive added public and private funding and consideration (Bierbaum et al. 2013). In addition, nature-based solutions and ecosystem-based adaptation are cost-effective long-term solutions for hydrological risks and land degradation (Keesstra et al. 2018). While

local governments are exploring various strategies to deliver their services in more financially and environmentally sustainable ways, they are also looking to incorporate ecosystem services into their understanding of service delivery. This includes managing natural assets through steps such as inventory, renewal, monitoring, and evaluation.

1.4 What are Natural Assets?

Natural assets are the biological and physical resources that produce ecosystem services. The Municipal Natural Assets Initiative (MNAI) defines natural assets as “ecosystem features that provide, or could be restored to provide, services just like the other engineered assets, but historically have not been considered on equal footing or included in asset management plans” (Brooke et al. 2017, pg. 4). These assets are not a part of the built environment but belong to the natural environment. They can include areas such as healthy forests, wetlands, lakes, or rivers. For example, during heavy rainfall, wetlands can deliver services similar to a built stormwater management system (Kittelson 1988; Ogawa & Male 1990). As well, during heatwaves, urban forests can decrease heat island effects, thus complementing urban cooling centres (Ziter et al. 2019). Therefore, natural assets can help communities adapt to the effects of climate change. Municipal natural asset management is just like asset management, although it is applied to the “green” assets in a municipality. Unfortunately, many local governments only understand, measure, and manage their natural assets for a narrow range of aesthetic or social amenities and not for the wide range of essential services natural assets can provide (Nilon et al. 2017).

Healthy and well-managed municipal natural assets can form part of the solution to the challenge of engineered infrastructure decline by providing core local government services, such as stormwater management, at capital and operating costs that may be lower than engineered

alternatives (Talberth et al. 2012; Sahl et al. 2016). In addition to reduced cost, there is evidence that natural assets may provide co-benefits in ways that conventional engineered assets do not (Kramer 2014). Ecosystem services can also create green jobs, produce new investment instruments, all while creating contributions to international targets such as the Sustainable Development Goals (Gómez Martín et al. 2020; Vicente-Vicente et al. 2019). While the amount of research into the possibilities of municipal natural asset management is still low, natural assets have been identified as one of the tools for climate change adaptation (Schaefer et al. 2015). As well, some governments have recognized natural assets, including the 7th Environment Action Programme of the European Union which listed natural asset management as a key objective (DGE 2014). Canadian municipalities can already make use of a variety of infrastructure funding programs to co-finance municipal natural asset management such as the Investing in Canada Infrastructure Program, the Disaster Mitigation and Adaptation Fund, Canada Infrastructure Bank, and the Federal Gas Tax Fund (Cairns et al. 2019).

1.5 Examples of Municipal Natural Asset Management in Canada

For municipalities to start managing their natural assets, several action steps have been identified. This includes sharing information on the concept & process, establishing alignment with existing policy mandates, creating partnerships, developing legislation, and working to incorporate the concept and processes into long-term high-level planning policies (Drescher et al. 2018). While these steps are not an absolute requirement, they can position municipalities to take advantage of the largest number of opportunities while minimizing barriers.

In Canada, the Town of Gibsons on Canada's Pacific Sunshine Coast in British Columbia was the first municipality to adopt policies in municipal natural asset management, specifically

around the local aquifer and stormwater ponds (Town of Gibsons 2018a). These freshwater ecosystems provided services at a fraction of a cost to the Town of Gibsons will also preserving valuable green space in the municipality. The Municipal Natural Assets Initiative (MNAI) was created as a Canadian not-for-profit to refine and upscale the Town of Gibsons' approach and turn it into mainstream approach. The MNAI 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 in developing leading, sustainable, and climate-resilient infrastructure (Brooke et al. 2017, pg. 2). Following the progress made by the Town of Gibsons, the MNAI then worked with (i) the City of Grand Forks, British Columbia; (ii) the District of West Vancouver, British Columbia; (iii) the City of Nanaimo, British Columbia; (iv) the Region of Peel, Ontario; and (v) the Town of Oakville, Ontario. Each of these municipalities piloted municipal natural asset management with MNAI and now form the first cohort of municipalities to be evaluated (Cairns 2020).

Municipal natural asset management is a new program for many municipal planning and asset management departments, and few municipalities have done a full inventory of their natural assets. Municipal asset management of any kind is a recent practice (Ministry of Infrastructure 2016). For example, the Government of Ontario just introduced Ontario Regulation 588/17 in 2017, which mandates that every municipality prepare an asset management plan for its core municipal infrastructure assets by July 1st, 2021, and for all its other municipal infrastructure assets by July 1st, 2023 (O. Reg 588/17). With other provinces soon to follow (Cranston 2018), more municipalities are starting to consider what the inclusion of a municipal natural asset management program will mean for their municipal service delivery and asset management policies.

1.6 The Need for Evaluation

To provide the data necessary to upscale municipal natural asset management towards national interest, every local government must understand, measure, and manage their natural assets. This will require the market demand for municipal natural asset management, multiple players to meet that demand, and overarching norms and standards so that efforts are effective, comparable, and replicable. Program evaluation should be established as one of these standards. Program evaluation can investigate what does and does not work in a program. It can highlight the effectiveness of a program to the community and potential funders. Finally, it can improve staff practices, all while increasing the capacity for planning (Seasons 2021). Unfortunately, research in program and plan evaluation reveals that there is a significant gap between theory and practice, especially for nature-based solutions or ecosystem-based adaptation (Donatti et al. 2020). While existing research in municipal natural asset management program outcomes is limited, developing an evaluation framework and then applying that framework to a select number of case studies can address gaps while producing lessons for future municipal natural asset management implementation efforts.

As momentum for municipal natural asset management continues to build, an evaluation framework is required for municipalities that are progressing through such a program. This evaluation framework will then be applied to the first cohort of municipalities to create a description of progress. This description will help other municipalities learn lessons from the municipalities evaluated which can inform decision making. As well, funders of municipal natural asset management programs can use the data gathered to examine what their investments are producing. Finally, insurers and capital markets, who are starting to show interest in this

field, can use the findings to place municipal natural asset management projects and programs in investment portfolios.

To address the need for an evaluation framework, this thesis research evaluated the MNAI's first cohort of municipalities as a series of case studies. The goal was to evaluate how municipal natural asset management was first implemented and what has changed in municipalities since the program intervention. The development of a rigorous evaluation framework will allow for the standardized evaluation of municipal natural asset management programs. Standardization of such a framework ensures that the data acquired from multiple programs can be mapped onto one aggregate evidence database. The standardized data will then allow for comparison between programs and a deduction of general patterns. The developed evaluation framework will document modifications to municipal operations and management, as well as short- and long-term outcomes of municipal natural asset management programs.

Therefore, the purpose of this research was to collect evidence of municipal natural asset management program outcomes in Canadian municipalities. To produce this evidence, the current research gathered findings on these program outcomes as well as the challenges and opportunities of municipal natural asset management through evaluating, describing, and communicating results from a cohort of five municipalities across Canada. The presentation of this evidence will support local governments in making evidence-based decisions on the effective management of their natural assets.

In pursuit of this purpose, this thesis set several objectives. Connected to each objective are several action items that were completed to achieve the objective:

Objective 1: Familiarization with managerial and ecological underpinnings of municipal natural asset management. This objective was pursued with the following actions:

- A. Reviewed asset management and ecosystem service management literature.
- B. Creation of a natural asset management literature database.
- C. Creation of a natural asset bibliography.

Objective 2: Creation of an evaluation framework for municipal natural asset management programs within the first cohort. This objective was pursued with the following actions:

- A. Reviewed the evaluation literature.
- B. Creation of an evaluation literature database.
- C. Creation of an evaluation literature bibliography.
- D. Creation of an evaluation design and evaluation plan.

Objective 3: Application of the evaluation framework to the first cohort of municipalities in British Columbia and Ontario. This objective was pursued with the following actions:

- A. Creation of an interview guide.
- B. Interviewed relevant stakeholders.
- C. Accessed and extracted data from local government documents.

- D. Analyzed interviews and local government documents.
- E. Populated indicators and cohort database with analysis results.
- F. Produced case studies and lessons learned to communicate findings of this evaluation to stakeholders.
- G. Communicated evaluation findings.

1.7 Chapter Summary

In review, this chapter introduced the research statement of this thesis, explained the specific aspects of the research topic, and described why this research is important for municipal natural asset management and municipalities considering such an approach. Through an exploration of the history of infrastructure and asset management in Canada as well as research into the decline in global urban and peri-urban ecosystem health, municipal natural asset management is introduced as a solution to these two urban problems. Natural assets are the biological and physical resources that produce ecosystem services. Natural assets can help municipalities deliver core services while also contributing to conservation and ecosystem management goals. More municipalities in Canada are beginning to integrate a municipal natural asset management approach into their infrastructure decision-making. Therefore, there is a need to produce evidence from a program evaluation to continue upscaling municipal natural asset management towards significant national interest.

Chapter 2: Literature Review

1.0 Introduction

In this chapter, the academic literature is reviewed, highlighting existing research on program evaluation and municipal natural asset management. First, the review approach is discussed, with a specific focus on gathering the necessary literature from the field of program evaluation and municipal natural asset management. This includes gathering research on indicators, data collection methods, ecosystem services, and nature-based solutions. Then, the current research on municipal natural asset management in Canada is presented to demonstrate the need for evaluating municipal natural asset management programs. Following this, research on existing evaluation methodologies for ecosystem services, green infrastructure, and nature-based solutions is outlined. Finally, this chapter concludes with current research gaps.

This literature review uses several key concepts that must be explicitly defined and reviewed. To start, this thesis research exists at a crossroads between program evaluation and ecosystem-based climate adaptation. Program evaluation is “the evaluation of a set of interventions designed to address specific program issues” (Seasons 2021, pg. 200). Therefore, at the root of this program evaluation is the creation of a framework that can effectively determine whether municipal natural asset management interventions are addressing ecosystem decline and infrastructure decline. Ecosystem-based climate adaptation is the use of biodiversity and ecosystem services “as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change” (Lo 2016, pg. 3). In a municipal service delivery framework, services offered by ecosystems can be nurtured, harnessed, and maximized to reduce the burden on physical infrastructure while incentivizing municipalities to make a more concerted effort in conserving and preserving these ecosystems.

When building an evaluation framework for municipal ecosystem-based climate adaptation, the stakeholders involved, the municipal context, and the long-term impacts must be considered. In this thesis, the definition of stakeholder used is “any agency, organization, group, or individual with a direct or indirect interest in a program and a program-based intervention” (Seasons 2021, pg. 200). The municipal context is the circumstances that form the setting of a municipality, wherein this case, the setting is the integration of municipal natural asset management. Lastly, impacts are the positive or negative, primary, or secondary, intended, or unintended long-term effects directly or indirectly produced by a program-based intervention (Seasons 2021, pg. 197). These terms will not only be used in the rest of this chapter but will also be used in the remainder of the thesis, so their definitions carry significant weight.

2.1 Literature Search Strategy

To sufficiently address the purpose of this thesis, this research needs to combine literature in municipal natural asset management and program evaluation. Therefore, the following bodies of literature were isolated: “Program Evaluation Methods”, “Municipal Reasoning for Implementing an Ecosystem Services Framework”, and “Climate Change Adaptation Strategies”. These bodies of literature were isolated as each of them address various aspects of this thesis research. “Program Evaluation Methods” must be included as the design and methodology for the evaluation of programs can be quite specific (Fink 2015). It is important to consider these specifications and suggested tools throughout the entirety of this research. As well, research in previous evaluations for ecosystem services, green infrastructure, or other climate change mitigation and adaptation programs were considered. “Municipal Reasoning for Implementing an Ecosystem Services Framework” is included due to the multitude of ecosystem

service-based programs. Municipalities may want to harness these services for a diverse set of needs. Understanding the reasoning behind this is fundamental to understanding why and how municipalities have implemented municipal natural asset management and what long-term goals they may have set. As well, the concept of ecosystem services has a long and at times, contentious history (Chan et al. 2020). An understanding of that history should be included in this literature review. The final body of literature is “Climate Change Adaptation Strategies”. Municipal natural asset management has been identified as one of the tools for climate change adaptation (Schaefer et al. 2015). However, the terminology of “natural assets” and “natural asset management” is not in widespread use. Natural assets are often lumped together with green infrastructure, ecosystem rehabilitation and restoration, traditional asset management, natural capital, etc. Therefore, when searching for this body of literature, it is important to do a wide search to capture all nomenclatures.

To conduct a wide literature search, several common terms were identified with specific terms for each body of literature. These common search terms include “urban”, “municipal”, “city”, “peri-urban”, and “climate change adaptation”. For “Program Evaluation Methods”, the specific search terms were: “program evaluation”, “plan evaluation”, “evaluation methodology”, “stakeholders”, “database”, “program goals”, and “evaluation indicators”. In particular, the last term of “evaluation indicators” will be critical for this thesis as determining best practices for creating or identifying indicators can set a precedent or a potential procedure to follow. For “Municipal Reasoning for Implementing an Ecosystem Services Framework”, the search terms were: “incentives”, “scalability”, “impacts”, and “long-term”. These specific search terms gathered research on why a municipality would want to implement municipal natural asset management, and thus, what questions they want to be answered in an evaluation. Finally, for

“Climate Change Adaptation Strategies”, the search terms were “ecosystem services”, “ecosystem-based adaptation”, “green infrastructure”, “strateg*”, “nature-based solution”, and “impact”. These terms were included to build the context-specific knowledge for some of these strategies.

Each of these bodies of literature intersects with one another. For example, climate adaptation strategies often incorporate an ecosystem services framework to supplement the delivery of services that may be affected by climate change (Vignola et al. 2009; Jones et al. 2012). As well, there are growing calls to evaluate ecosystem service projects and programs (Chan et al. 2020). Lastly, as local, provincial, and federal governments contribute more funds to climate change adaptation strategies, they will look for evaluation frameworks that report beneficial program outcomes (Baker et al. 2012). The evaluation of various climate adaptation strategies will inform future decision-making on what strategies to pursue.

2.2 A Brief History of Infrastructure and Asset Management in Canada

As discussed in Chapter One, the municipal management of assets is a recent practice. Yet, the building of infrastructure was a key part of Canada’s fiscal history. From the construction of the Canadian Pacific Railway to the building of the Saint Lawrence Seaway, major infrastructure projects represented a significant portion of national economic spending. However, following a succession of financial crises from the 1970s to the early 1990s, Canada’s physical infrastructure deteriorated (Di Matteo 2017, pg. 64). In many ways, that deterioration in local infrastructure has never quite recovered. With so many key infrastructure assets in need of rehabilitation or full reconstruction, it was critical to create a system of reporting to decide what needed immediate attention (Fig. 1 – Asset Management BC 2015). In 2009, “all Canadian municipalities were required to change their financial reporting by incorporating Tangible

Capital Assets (TCAs) into their financial statements. This was mandated by the Public Sector Accounting Board (PSAB) and became PSAB Standard 3150” (Cranston 2018, pg. 6).

Municipalities now must record what assets they own and their financial value.



Figure 1: The Sustainable Service Delivery Framework used by Asset Management BC.

Since the addition of this requirement to report, Canadian provinces have been better able to target where infrastructure investments are needed. As well, the provinces have also added requirements for municipalities to follow. For instance, to address the issues brought on by the degradation of existing infrastructure, the Province of Ontario implemented the *Asset Management Planning for Municipal Infrastructure Regulation, O. Reg. 588/17* in early 2018. This regulation requires Ontario municipalities to implement many of the essential components of asset management such as inventory, lifecycle management, and financial strategy. By July

1st, 2023, municipalities are required to have an approved asset management plan for all municipal infrastructure assets (O. Reg. 588/17).

Despite this new direction, municipalities are still struggling to fund infrastructure rehabilitation and restoration. As demands for municipal services rise, municipalities are struggling to keep up. As well, due to the onset of the COVID-19 pandemic, these issues have been compounded upon. Before the COVID-19 pandemic, the outstanding municipal debt stood at just over \$61 billion on December 31, 2017 (Fiera Capital 2017). In April 2020, during the onset of the COVID-19 pandemic, data from the Federation of Canadian Municipalities showed that Canadian communities faced a “minimum of \$10-15 billion in near-term non-recoverable losses just due to COVID-19” (FCM 2020). Some provinces were even considering allowing municipalities to run deficits (Bula 2020). While the early transfer of the Gas Tax Fund (now renamed the “Canada Community Building Fund”) in June 2020 did alleviate the most pressing concerns, the transfer was only for \$2.2 billion. The Financial Accountability Office of Ontario estimates that just in Ontario, municipal budgets will see a negative impact of \$4.1 billion in 2020 and \$2.7 billion in 2021, for a joint negative impact of \$6.8 billion over two years due to the COVID-19 Pandemic (FAO 2020).

2.3 Defining Ecosystem Services

The concept of ecosystem services was created in 1997, in Gretchen Daily’s seminal work *Nature’s Services: Societal Dependence on Natural Ecosystems*. However, the history of research into ecosystem services is much more extensive. The origins of ecosystem services can be traced to the late 1970s. It starts with the framing of beneficial ecosystem functions as services to increase public interest in biodiversity conservation and to create new arguments for

ecosystem protection (Westman 1977; Ehrlich & Ehrlich 1981; Ehrlich & Mooney 1983; de Groot 1987). It then continues in the 1990s with the mainstreaming of ecosystem services in the literature (Costanza & Daly 1992; Common & Perrings 1992; Daily 1997), and with increased interest in methods to estimate their economic value (Costanza et al. 1997). Daily defined the function of ecosystems as the “conditions and processes through which natural ecosystems, and the species that inhabit them, sustain, and enrich human life” (Daily 1997). This definition has grown to be primarily associated with ecosystems’ contributions to human well-being as end products of various ecosystem functions. De Groot et al. (2002) defined ecosystem goods as a subset of ecosystem services that are the tangible material products that result from ecosystem processes that are then used by humans such as wood, fuel, or food. Currently, the term “ecosystem goods” is not in use anymore as “ecosystem services” and “ecosystem goods” were aggregated into a singular class of ecosystem services (Costanza et al. 1997). This aggregation has since been adopted by others, including the United Nations’ Millennium Ecosystem Assessment. This history on the variability of ecosystem goods and services definitions shows that these definitions are determined by the people who value and use them.

Most recent research studies of ecosystem services were built on the conceptualization of ecosystem services put forward by the United Nations’ Millennium Ecosystem Assessment (MEA 2005). This assessment and subsequent research identify four categories or types of ecosystem services (Lam & Conway 2018; IBPES 2019; CICES 2013):

1. Provisioning services which include food, fibre, fuel, wood, medicines, and pharmaceuticals.

2. Regulating services including climate moderation, erosion control, and water purification.
3. Cultural services including spiritual enrichment, recreation, and aesthetic experiences.
4. Supporting services including photosynthesis, pollination, habitat, and nutrient cycling.

Municipalities implicitly and explicitly make use of these ecosystem service types in a variety of ways. However, our understanding of these services has grown where they can now be directly incorporated into municipal planning. For example, municipalities are using the concept to expand their efforts in rehabilitating and restoring key ecosystems (Zepp et al. 2016; BenDor et al. 2017; Honey-Rosés et al. 2014). As well, some municipalities are using the ecosystem service concept to support and justify conventional planning approaches, deal with emerging challenges, and support urban place-making (Thompson et al. 2019). Additionally, many municipalities are now incorporating ecosystem services into their municipal service delivery strategies. This means that municipalities are looking at ecosystem services to supplement, complement or completely deliver services that traditionally, municipalities have relied upon built infrastructure to provide.

Municipalities are also incorporating ecosystem services to jumpstart a green economy. For example, a municipality could provide potential economic opportunities such as green jobs, the selling of carbon offsets as a new investment instrument, while contributing to international targets such as the Sustainable Development Goals (Gómez Martín et al. 2020; Vicente-Vicente et al. 2019). The green jobs and carbon offsets would be based on the restoration, conservation, and maintenance of green infrastructure. The potential for green jobs could increase investments and city branding. Green infrastructure, which provides ecosystem services, is cost-effective in producing a specific target service or service bundle. Green infrastructure also provides co-

benefits because of additional ecosystem service generation (Spahr et al. 2020). Finally, municipalities should consider the precautionary principle. This principle states that green infrastructure should be preserved as a possibility when we are uncertain about reductions of future services and the potential irreversibility of ecosystem degradation (Kroeger et al. 2019).

While the concept of ecosystem services has become central for many environmental policy efforts, both in the developed and developing world (Lo 2016; Chaplin-Kramer et al. 2019; Díaz et al. 2019; IPBES 2019; Sachs & Reid 2006), it has also faced many critiques. While this thesis will not litigate each of these critiques, Chan et al. (2020) identified five main categories for these critiques which are: (i) the need for biophysically informed valuation, (ii) the applicability of monetary valuation, (iii) the need to include measurements of demand and access, (iv) the need to tailor communication of ecosystem services, and (v) the challenges with social inclusion and ecosystem services.

Critique One: The Need for Biophysically Informed Valuation

Early research into the concept of ecosystem services (Costanza et al. 1997) valued the ecosystem services of entire systems in static dollar values. While these figures can be strong for awareness efforts on the importance of natural capital, they do not account for constant biophysical changes as well as changing the nature of ecosystems to be entirely value-laden.

Critique Two: The Applicability of Monetary Valuation

Most valuations of ecosystem services are monetary valuations. However, monetary valuation is effective from a consumer perspective rather than a citizen perspective (Sagoff 1998). The difference is that consumer valuations are done from the perspective of willingness to pay rather than expressions of morals as values (Chan et al. 2011). In addition, most mainstream

research avoids calculations of “intangible” benefits that are difficult for monetary valuation to complete (Daniel et al. 2012; Langemeyer et al. 2018; Milcu et al. 2013).

Critique Three: The Need to Include Measurements of Demand and Access

The field of ecosystem services has done little work on the dynamics of demand and access (Villamagna et al. 2013; Wieland et al. 2016), even with research suggesting that social drivers such as poverty and inequality can obstruct access to ecosystem services (Berbés-Blázquez et al. 2016; Hicks & Cinner 2014; Nesbitt et al. 2019; Robards et al. 2011; Turner & Turner 2008; Wieland et al. 2016). What is important for researchers to remember is that changes in both ecosystems and social systems can change ecosystem service measurements.

Critique Four: The Need to Tailor Communication of Ecosystem Services

Despite the uptake of the ecosystem service terminology as an awareness effort, there have been calls to more carefully tailor research implications in more concrete terms. For example, biodiversity enhances needed services and human well-being (Chan et al. 2020).

Critique Five: The Challenges with Social Inclusion and Ecosystem Services

This critique holds three sub-critiques. The first is that the language of ecosystem services may alienate some audiences, such as Indigenous peoples as well as academic disciplines, such as interpretive social sciences (Sikor 2013). Second, issues of justice, equity and social implications of ecosystem service programs and policies are missing from ecosystem service research (Corbera et al. 2007). Third, ecosystem services are not recognizing relational values such as reciprocal responsibilities (Combetti et al. 2015).

This thesis does not definitively address each of these critique categories, but it does address two research gaps. Namely, these two gaps are the lack of long-term evaluation of ecosystem service programs and the effectiveness of policies in addressing biophysical underpinnings. Currently, the research in municipal ecosystem services is still new. It will be some time before research produces data on changes in biophysical metrics or measurements because of the time needed for the restoration and rehabilitation of natural assets. However, through the evaluation framework, a roadmap for municipal natural asset management and beneficial ecosystem rehabilitation or restoration outcomes has been created. While the critiques levied against the concept of ecosystem services are serious, the results from this thesis show that a concept like ecosystem services can produce beneficial ecosystem outcomes. If research can encourage the creation of policies and programs like municipal natural asset management that embed the ecosystem services concept, municipalities can meet environmental and socio-economic goals. The concept of ecosystem services can then shift policy and decision making towards integrating the biophysical and social aspects of ecosystem services into traditional land development planning (Liu et al. 2015; Fürst et al. 2017). While still early in the program lifecycle, this integration is starting to occur through municipal natural asset management, especially when it comes to zoning bylaws, official plan objectives, program funding, and other implementation indicators.

2.4 Climate Change Adaptation Strategies

There have generally been two responses to the challenges of climate change: climate change mitigation and climate change adaptation. Climate change mitigation means lessening or reducing the amount of greenhouse gas emissions into the atmosphere to prevent the warming of the planet (IPCC 2018). Climate change adaptation is the altering of behaviour, systems, and

societal functions towards living with the impacts of climate change (IPCC 2018; VijayaVenkataRaman et al. 2012). While municipal natural asset management certainly has aspects of both responses, it is categorized as a climate change adaptation strategy due to the attention it places on shifting municipal service delivery towards a resilient ecosystem service framework (Asset Management BC 2015).

The terms natural assets and green infrastructure are often used interchangeably, but natural assets are a type of green infrastructure. Definitions of green infrastructure include designed and engineered elements created to mimic or replicate natural functions and processes for human needs (Rutherford 2007). The definition that this research will use is the following: “green infrastructure is defined as the natural vegetative systems and green technologies that collectively provide society with a multitude of economic, environmental and social benefits” (Green Infrastructure Ontario Coalition 2021). While green infrastructure can provide ecosystem services, “much of the emphasis in current discourse is on those elements that provide ecological and hydrological functions and processes for managing water” (Brooke et al. 2017, pg. 6). Other terms related to green infrastructure include low-impact development, rainwater management, or natural stormwater management.

More recently, “ecosystem-based” adaptation (EbA) has emerged as a form of climate change adaptation. It uses biodiversity and ecosystem services “as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change” (IUCN 2016 pg. 3). Ecosystem-based adaptation takes a problem-focused, multi-disciplinary approach to climate change adaptation by fully and completely integrating ecosystem services and biodiversity into municipal considerations. As a part of ecosystem-based adaptation, it is important to see municipal natural asset management as a nature-based solution. Nature-based solutions are

“actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (IUCN 2016, pg. 1) In other words, nature-based solutions look to the restoration, rehabilitation, and management of key ecosystems as foundational to addressing other problems (Science for Environment Policy 2021). In this case, municipal natural asset management is a nature-based solution that addresses the problem of infrastructure and service delivery decline. Nature-based solutions are financially advantageous due to a reduction in initial capital expenses, a reduction in ongoing operational expenses and for the strategic investment in aging resources (Science for Environment Policy 2021).

Decision-makers have shown that they will choose to use different climate change adaptation strategies based on specific risk metrics and choice metrics that disproportionately correlate with various socioeconomic attributes (Siders & Kennan, 2020). For example, research in climate change adaptation has shown that when engaging with stakeholder groups, they may not always respond to climate change concerns in the same way and may be less or more willing to pay for ecosystem services (Tran et. al, 2017). Furthermore, Verburg et. al (2012) found large spatial variation in adaptation measures for the provisioning of ecosystem services across Western Europe according to different scenarios. This means that trade-offs and synergies must be considered (Schaefer et al. 2015). For example, reducing land-use intensity in specific parts of an area may lead to increased pressure in other regions, resulting in trade-offs. Another example is the inclusion of ecosystem services in cost-benefit analyses for adaptation measures which can lead to selected optimization of a few services. Lin & Petersen (2013) completed research on an innovative approach to adaptive management known as guided transition, where ecosystem functions that are important to the social and environmental system are preserved through

transitions between institutional structures. For example, a case study in the Boundary Waters Canoe Area Wilderness in the Superior National Forest in northeastern Minnesota showed that climate change is affecting forest composition, especially in terms of the species present in the area. Thus, if carbon sequestration was a critical goal to the success of the wilderness area, the implementation of new tools to account for changes in species composition is needed. This may lead to specific management strategies such as prescribed burns. These findings suggest a need for practical natural asset management programs in municipalities, even though specific program understanding, and application may be limited at the current time (Lin & Petersen 2013, pg. 28).

A significant part of implementing urban climate change adaptation strategies involves citizens and other stakeholders. Considering stakeholder preference and perceptions for ecosystem services, green infrastructure, nature-based solutions, and other urban climate change adaptation strategies can be beneficial for planning purposes (Barnhill & Smardon 2012; Campbell-Arvai 2019). As well, different stakeholders bring different forms of knowledge to the process. For example, the knowledge provided by environmental education services is associated with urban worldviews, local ecological knowledge is linked to rural worldviews, and stakeholders are more likely to recognize an ecosystem's capacity if they have a higher level of formal education, higher environmentally oriented behaviour, and if they are female (Martín-López et al. 2012). Even with these factors considered, civic consciousness, in general, has been increasing with more people willing to take part in nature-based solution planning (Shan 2012; Beery 2018). Implementation should make use of this growing civic consciousness to forward urban climate change adaptation strategies with active participation from the community.

2.5 Funding Climate Change Adaptation

In a practice-oriented setting, communities that are implementing ecosystem service management approaches are hoping to garner more provincial and federal support for these initiatives. However, most research has still focused on the aesthetic perspective of green infrastructure (Tillie & van der Heijden 2016) or the social place-making provisions of green infrastructure (Donaldson & Joao 2020; Arias-Arévalo et. al, 2017). To build large-scale support, programs need to show a level of adequacy in meeting traditional municipal service demands and financial asset management standards, especially to access robust funding provisions (Matsler 2019). Levitt (2010) identified three funding programs that could be transported into natural asset management: tax incentives, market-based incentives, and fiscal incentives. Cairns et. al (2019) also reviewed six of Canada's major infrastructure funding programs and their applicability to natural assets. The six infrastructure funding programs were:

1. Investing in Canada Infrastructure Program – Green Infrastructure Stream
2. Disaster Mitigation and Adaptation Fund
3. Canada Infrastructure Bank
4. Federal Gas Tax Fund (renamed as the Canada Community-Building Fund)
5. Green Municipal Fund
6. Municipalities for Climate Innovation Program

This research found that the broadening of the Investing in Canada Infrastructure Program's definition of natural assets towards alignment with capital assets points to high potential for municipal natural asset management programs to be eligible for the Green Infrastructure Stream funding. As well, both the Green Municipal Fund and the Municipalities

for Climate Innovation Program also provide strong opportunities for municipal natural asset management programs. However, the Disaster Mitigation and Adaptation Fund and the Canada Infrastructure Bank require large-scale projects or programs that may be challenging for municipalities focusing on small-scale natural assets (Cairns et al. 2019). While the Federal Gas Tax Fund was constrained to traditional capital assets, recent changes to the now Canada Community-Building Fund show that the program is now open for natural infrastructure programs or projects.

2.6 Challenges to Implementing Climate Change Adaptation

There are several challenges or gaps in the incorporation of climate change adaptation strategies. In research completed by the IUCN, these gaps include the specific need for information on downscaling projections of climate change impacts and meteorological data, the impacts of climate change and economic development in specific sectors, and the various sides of environmental vulnerabilities in the context of natural hazards and how they can affect ecosystems and natural resources (Davis & Turner Walker 2013; UNECA 2011; Nang 2013). At the local level, there is an additional gap known as the “application gap” wherein knowledge of microclimate regulation is not being translated into knowledge for climate-responsive urban design (Klemm et al. 2017). To address these gaps, some researchers created several design guidelines for climate-responsive urban green infrastructure. For example, a microclimate analysis is vital to developing applicable climate-responsive design (Klemm et al. 2017 pg. 69). Other research describes three main information needs: (i) the production of stronger evidence on nature-based solutions for climate change adaptation and mitigation to raise awareness and increase implementation, (ii) adaptation for governance challenges in implementing nature-based

solutions by using reflexive approaches, and (iii) considerations for socio-environmental justice and social cohesion when implementing nature-based solutions (Kabisch et al. 2016). As well, EbA still evokes images of adapting built infrastructure to climate change rather than using green infrastructure (Scarano 2017, pg. 67). Research also points to the hesitancy of practitioners to take up green infrastructure programs due to the lack of data on performance characteristics and insufficient technical knowledge and experience (Zuniga-Teran et al. 2020).

For municipal natural asset management, these assets must also be understood, managed, and valued by municipalities in terms of the services that they can provide (e.g., localized or downstream flood management) (Brooke et al. 2017). By doing this, researchers can present a compelling argument to municipalities that they must consider these ecosystem areas on par with their built infrastructure in their short-term and long-term planning. This improved understanding must also be accompanied by changes in organizational structure, management approaches, and investment patterns to enable the successful implementation of municipal natural asset management (Nefedov 2017; Mekala & MacDonald 2018). For example, despite the clear benefits of similar green infrastructure programs being well understood, current approaches have been decentralized and loosely coordinated (Mekala & MacDonald 2018, pg. 407). Without a clear standardized evaluation of program outcomes, municipalities may risk favouring development over the environment.

2.7 Evaluation in Municipal Planning

Evaluation is a crucial part of any policy, plan, or program development. “Evaluation is the systematic assessment of the operation and/or outcomes of a program or policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the

program or policy” (Weiss 1998, pg. 4). Evaluation relies on monitoring, “which provides continuous assessment of the activities that constitute policies, programs, processes, or plans” (Seasons 2021, pg. 43) To prepare for this systematic assessment, a substantial part of this research was focused on the development of an evaluation framework, methods, and appropriate tools. Without such a framework, it would be impossible to know whether the program is delivering outcomes as intended.

Seasons (2021) identifies three main generations in the evolution of evaluation theory and tools for urban and regional planning. This history of plan evaluation methodology begins in the 1960s and 70s with highly rational and technical analyses of planning objectives and proposals often with computer modelling exercises (Hill 1968; Lichfield et al. 1975; McLoughlin 1970). At that time, cost-benefit analysis was the most prominent evaluation method. The second generation of evaluation tools focused on how well plans were achieving goals. To measure this, Morris Hill (1968) developed the goals achievement matrix which introduced predetermined goals and aims into the analytical process of already existing tools (Miller & Patassini 2005, pg. 4). Environmental impact evaluations are related to this kind of work (Alexander 2006). The third generation, which is still the generation we are currently in, follows two forms: conformance evaluations and performance evaluations. Conformance evaluation are “evaluations that traces the links between policy intentions and plan results to determine the extent to which results conform to intentions” (Seasons 2021, pg. 195). Performance evaluation are “an assessment of the extent of influence that the plan exerts on decision-makers and on the decision-making process generally” (Seasons 2021, pg. 199). This evaluation framework uses a conformance evaluation approach. The reason for this choice will be discussed in Chapter 3. Despite the evolution in evaluation methods and tools, “evaluators must settle for an imperfect

understanding, probable but not definite explanations, and hunches about causes, effects, and future possibilities” (Baum 2001, pg. 155)

Planning has been criticized for lacking plan or program evaluations. Many municipalities do not or cannot evaluate their plans in a consistent, structured, formal, or regular manner (Guyadeen & Seasons 2016). Most medium-sized and large Canadian cities include some statements on the importance of plan monitoring and evaluation in their community plan documents. However, many of these statements are mostly ambitious, signaling intent but there is rarely any follow-up (Seasons 2021, pg. 102-103). Only a few cities have instituted a comprehensive plan monitoring and evaluation process, among them (i) Victoria, British Columbia; (ii) Calgary, Alberta; (iii) Toronto, Ontario; (iv) the Region of Peel, Ontario; and (v) the Edmonton Metropolitan Region Board, Alberta (Guyadeen et al. 2019). There are even fewer examples of Canadian municipalities with monitoring and evaluation processes specific to climate adaptation plans.

In urban planning, the two general modes of evaluation are plan evaluation and planning evaluation. Plan evaluations are distinct types of evaluation such as plan quality evaluation, plan implementation evaluation, and plan outcomes evaluation. Planning evaluation is the evaluation of planning processes and planning practice (Guyadeen & Seasons 2018). This thesis mixed both modes to examine the quality, implementation, and outcomes of municipal natural asset management programs as well as the procedural aspects of municipal natural asset management. The reason for the mixing of these two modes is that this evaluation framework and the application of this framework do not consider the effectiveness of a municipal natural asset management program but are focused on the progress that the municipalities have made. With municipal natural asset management still being a new municipal service delivery strategy, there

is a lack of established processes, practices, and norms related to its planning. Thus, while these processes are still being developed, this evaluation framework must consider both modes.

2.8 Challenges for Program Evaluation in Planning

There are a few general challenges to an effective evaluation in planning. These challenges are the lack of accepted outcome evaluation methodologies, the attribution gap, and institutional hurdles (Guyadeen & Seasons 2018). Starting with the lack of accepted outcome evaluation methodologies, there is little guidance on how to gauge whether plans can be seen as successful, even if evaluation is focused on implementation or outcomes (Berke et al. 2006; Brody et al. 2006). Research suggests that a gap exists between plan intentions and plan implementation. This may be due to the quality of the plans, the capacity of the planning agency, and the stakeholders involved in implementation (Guyadeen & Seasons 2018). This lack of research means there is little information for planning professionals to best assess and improve plan implementation and the realization of stated plan goals.

However, the existing literature does point to the importance of using indicators for program evaluations. Indicators are a quantitative or qualitative factor or variable that can measure “resources, inputs, desired and unintended outcomes, interim markers of success, program processes, program environment, and trends and patterns related to these factors” (Seasons 2021, pg. 44). Indicators are foundational for data collection that is used in program evaluation. Indicators should meet the following five criteria: validity, reliability, ability to measure the direction of change, sensitivity to difference, and relevance. The indicators developed and used in this research will be presented at the end of Chapter 3. However, there are several challenges with selecting indicators that contribute to an attribution gap. The attribution

gap are the challenges with identifying or creating indicators to assess the causal links of a program. These challenges include the ambiguous rationale for selecting indicators, difficulties in measuring planning goals, and access to appropriate data (Guyadeen & Seasons 2018, pg. 106).

Past research into ecosystem service indicators has shown that indicators should be flexible given that research into urban ecosystem services is also growing (Dobbs et al. 2011). With growing research on metrics and measurements for ecosystem health, those metrics or measurements should impact the creation and application of indicators. As well, this thesis focuses on five municipalities. Therefore, standardized indicators must be flexible enough to account for different municipal contexts. Finally, consider the critique of the applicability of monetary valuations for ecosystem services described in Section 2.2. If evaluators adopt similar static indicators that do not account for how degradation, climate change, and other factors can affect ecosystem service delivery, these indicators may be out of date before the evaluation process has even been completed. There are also calls for integrating socio-economic indicators in ecosystem service evaluations. This can be difficult as data can be scarce and expert knowledge must be relied upon. However, understanding the socio-economic conditions of the surrounding region can inform how ecosystems supply direct and indirect benefits for the specific context (Depellegrin et al. 2016, pg. 452).

The third challenge is the institutional hurdles to conducting plan evaluation. These challenges can include organizational culture and political constraints. “For plan evaluation and planning evaluation to be recognized as important functions in planning agencies, the organizational culture must recognize and value the benefits of evaluating plans and their outcomes” (Guyadeen & Seasons 2018, pg. 107). In addition, the political process of

placemaking that is used to garner public support can then lead politicians to fear that an evaluation could reveal their failures or inadequacies (Laurian et al. 2010).

2.9 Evaluation Methods

The use of a counterfactual may be the gold standard for supplying evidence for the effectiveness of a municipal program. A counterfactual “estimates what would have been the economic, sociocultural, institutional, or other conditions of the intended beneficiaries in the absence of the project’s interventions” (Bamberger et al. 2012, pg. 28). However, research also suggests that designing a suitable evaluation framework is only possible after the initial investigation of the partner programs and initial consultations with key stakeholders, which allows the formulation of meaningful evaluation questions (Preskill & Jones 2009). In this cohort, there were no appropriate baselines established to quantitatively measure the contribution of a municipal natural asset management intervention. Thus, this research uses qualitative methods to contribute to a better understanding of why, and more specifically how the municipalities are reaching specific outcomes.

Before conducting a program evaluation or review, most researchers built a literature database (Scarano et al. 2017; Donatti et. al. 2020; Siders & Keenan 2020; Nesbitt et al. 2019). This literature database is not only used to gather data on the program, but specific to this evaluation, is also used to understand how natural assets, ecosystem services, and environmental management interact with one another. These searchable databases can then be accessed by future evaluators to compare results and contribute more evidence. While building a database, the literature also stresses the importance of drafting a data analysis plan. Such a plan should

establish a reliable coding system, how to enter the data, how to clean the data, and finalizing the database (Fink 2015). More information on this process will be shared in Chapter 3.

2.10 Gaps in Evaluation Practice

After examining the literature, there are at a minimum, three major gaps in evaluation practice. The first gap is the lack of municipal climate adaptation measures that have been evaluated. While climate adaptation measures have been shown to help people adapt to the adverse effects of climate change (Lo 2016), there is limited knowledge on how to successfully implement and integrate these measures in specific local contexts. One way to address this gap is by identifying barriers and opportunities. Some municipalities do this through SWOT analysis. “A SWOT analysis is a method commonly used to assist in identifying strategic directions for an organization or in practice” (Mobaraki 2014). By explicitly describing the strengths, weaknesses, opportunities, and threats to climate change adaptation measures before implementation begins, municipalities could more effectively plan to integrate said measures. As well, by identifying barriers and opportunities, other municipalities can learn lessons from these experiences and alter their work plans to align with effective strategies more closely. This could also lead to standardization in approaches, where comparisons across municipalities become even easier to make.

The second gap is the lack of information on how to manage institutional barriers to plan evaluation. While the literature clearly shows the benefits of municipal plan evaluation (Fink 2015; Seasons 2021), political constraints and a lack of a culture of accountability in municipalities continue to be large barriers for evaluation. While there is some research on why

some municipalities may be resistant to plan evaluation (Laurian et al. 2010), there is even less research on how municipalities can manage these constraints and barriers.

The third and final gap is how to best identify social, economic, and environmental indicators for ecosystem-based adaptation programs. Standardization of municipal natural asset management program evaluation is a critical part of this thesis. However, this standardization must also be mindful of the various social, economic, and environmental conditions that municipalities may be facing as they integrate municipal natural asset management. This can be difficult to balance. These socio-economic indicators can better inform researchers on the direct and indirect benefits provided by ecosystems, such as public health benefits, areas for economic opportunity, and areas for recreation (Egerer et al. 2018; Gomez Martin et al. 2020). However, the selection and interpretation of these indicators can also be prone to bias and specific agendas (Seasons 2021, pg. 73).

2.11 Key Findings

Natural assets are the biological and physical resources that produce ecosystem services. Ecosystem services are increasingly becoming a key part of municipal service delivery through the preservation, development, and integration of an ecosystem services framework. This framework is represented through various program types with a key focus on determining the value that ecosystem services provide to municipalities. While the monetary valuation of ecosystem services is seen as the most generic form of valuation, other forms of valuation such as biophysical or socio-cultural are also common. Municipalities can use these ecosystem services to supply, complement, or maintain existing municipal services that have typically been delivered through built infrastructure. By adopting tools, policies, and practices associated with

asset management, more municipalities are considering the entire range of assets in their jurisdiction that can provide some form of service delivery.

There are a variety of approaches for a climate adaptation strategy with a specific focus on ecosystem service delivery. This includes municipal natural asset management, but can also be represented in a green infrastructure strategy, ecosystem-based adaptation (EbA), nature-based solutions, low-impact development, etc. Municipalities may make use of these various strategies due to a variety of factors which include but are not limited to, choice and risk metrics, funding opportunities, availability of space, stakeholder preferences, and municipal context. However, there are also gaps in the existing research. This includes the lack of context-specific knowledge, poor coordination between strategies, and a lack of evaluation examples to create a municipal culture of accountability.

Evaluation is a critical part of any kind of policy development. While the history of municipal planning evaluation methods is relatively short, there have been a significant number of changes for the literature to identify three separate generations. Despite these evolutions, planning evaluation is still lacking across much of Canada. In addition, there is little research on establishing any kind of evaluation methodology for municipal ecosystem service frameworks, green infrastructure, or municipal natural asset management. Existing research does show that most methodological approaches focus on a quantitative approach with specific indicators and mapping to the potential delivery of ecosystem services and that consultation with stakeholders is critical. There is little research on whether an ecosystem service framework could fully complement all forms of traditional service delivery through built infrastructure.

2.12 Chapter Summary

In review, this chapter has examined the existing literature on the history of infrastructure and asset management in Canada, ecosystem services as a utilitarian concept for municipalities, how the integration of climate change adaptation strategies is currently practiced, municipal program evaluation, and the challenges with this kind of evaluation. Through this review process, research shows that infrastructure and asset management in Canadian municipalities is a recent practice. To compensate for the loss of services due to failing infrastructure, more municipalities are looking to ecosystem services for municipal service delivery while also adapting municipalities to the effects of climatic change. In Canada, climate change adaptation can take various forms, including ecosystem-based adaptation and nature-based solutions that can be dependent on several factors to be successful. However, research and evidence are required before more municipalities take up these strategies.

Regarding program evaluation in municipal planning, this has also undergone a significant evolution with three specific generations over the last fifty years. Unfortunately, many municipalities have not evaluated their municipal plans and programs. As well, there are several challenges with implementing these evaluations. These challenges include institutional hurdles, lack of information on barriers, and lack of municipal climate adaptation measures that have an existing evaluation methodology or framework. However, some tools such as a literature database show promise in building a successful evaluation.

Chapter 3: Methods

3.0 Introduction

This chapter presents the methods used to address the research purpose, objectives, and actions outlined in Chapter 1. The first few sections describe the basic principles and tools behind building an evaluation framework for municipal natural asset management. The next sections describe the qualitative methods used to gather, sort, and analyze the data, as well as the approach used for presenting the results. The last two sections explain the steps taken to ensure research rigour and to consider the ethical implications.

3.1 Evaluation Framework

All program and plan evaluations follow a particular design and structure based on the context of the program or plan being evaluated (Fink 2015, pg. 10). For example, a standard evaluation design could include comparing the participants in one program with participants in an alternative program. Comparisons can also occur at one particular time or several times throughout a program's lifecycle (Bamberger et al. 2012). When designing an evaluation framework, one must consider what kind of comparison will reveal the most meaningful information for the goals of the evaluation. For this thesis, the comparison this evaluation is making is to indicator values. Therefore, indicator values are the standard for which all program performance will be measured against. Through this approach, the evaluation can produce the most accurate results on what outcomes have been achieved in the municipalities evaluated relative to program goals. Therefore, if the evaluation shows that outcomes are not being met, there may be modifications to the program intervention.

Guidance for creating an evaluation framework and selecting evaluation methods that address ecosystem rehabilitation and restoration goals and service delivery goals is limited in the literature. However, research does show that evaluation teams may select particular methods for stakeholder-oriented reasons such as the feasibility of stakeholder participation, the inclusion of local knowledge, communication, and decision-making (Seasons 2021, pg. 123-124). In addition, there are also pragmatic reasons such as the availability of data, resources, and expertise (Harrison et al. 2018). Harrison et al. (2018) also developed various decision trees for selecting methods for biophysical, socio-cultural, and monetary valuation assessments. However, a similar decision tree for plan or planning evaluation does not currently exist. To make up for this lack of guidance, this evaluation framework is informed by prior work that reviewed ecosystem-based climate change adaptation approaches utilizing concepts from program evaluation theory. These findings stress the importance of differentiating between direct adaptation activities (e.g., ecosystem protection) and enabling activities (e.g., creation of ecosystem protection plans), as well as between outputs (e.g., lands to be protected) and outcomes (e.g., reduced infrastructure damage) (Donatti et al. 2020). Finally, these findings also underscore the use of proper indicators, measurements, and timing of evaluations.

The use of an evaluation framework (i.e., the conceptual links between evaluation questions, indicators, measurements, project outputs and project outcomes) is important for conducting a rigorous program evaluation. Logically linking each part of such a framework will ensure that data collected from the evaluation questions will match with the program outcomes chosen for evaluation. Not including an evaluation framework risks the evaluation becoming too scattered or irreproducible, especially for the analysis of ecosystem services (Villamagna et al. 2013).

3.1.1 Real World Evaluations approach

This thesis research will rely on the work of Michael Bamberger et al. (2012) and Mark Seasons (2021) for scoping the evaluation framework. In work on conducting evaluations, Bamberger et al. (2012) created the Real World Evaluations (RWE) approach for the selection of an appropriate impact evaluation design, in light of budget, time, and data constraints as well as political influences. Scoping the evaluation framework involves several steps which include identifying the evaluation purpose and context, creating the evaluation design framework, selecting the evaluation design, and deciding on the tools and techniques to strengthen any evaluation design. This chapter will use the RWE approach and research completed by Mark Seasons to explore the methodological choices this thesis research made.

The first step of scoping an evaluation framework, is to “clarify the intent of the exercise and the expectations of the stakeholders” (Seasons 2021, pg. 114). Bamberger et. al (2012) identifies several evaluation purposes, including: (i) developmental, (ii) formative, (iii) summative, (iv) to adapt the program, (v) to promote learning, (vi) to aid resource allocation, and (vii) to identify emerging problems (Bamberger et al. 2012, pg. 211 & 214). Formative evaluations help managers and program staff to improve the design and implementation of an ongoing intervention or to learn lessons that can improve future interventions (Rossi et al. 1999; Wholey 2004). Therefore, the evaluation purpose of this thesis is a formative evaluation because municipal natural asset management is ongoing and will continue after the evaluation is completed. The evaluation results will aid managers and planners in improving the design and implementation of municipal natural asset management in their own municipalities. Municipalities that have yet to implement municipal natural asset management can take up the lessons learned here to inform their own implementation strategy. As well, this evaluation

framework also uses aspects of a conformance evaluation approach. Local governments have set particular intentions for their municipal natural asset management programs which include sustainable service delivery and the protection, valuation, and monitoring of natural assets. While a performance evaluation would examine the extent of influence that municipal natural asset management exerts on decision makers and municipal staff (Guyadeen & Seasons 2016), municipal natural asset management is such an explicit program intervention that a conformance evaluation approach is more appropriate for this framework (Laurian et al. 2004).

Along with identifying the purpose of the evaluation, there are other aspects of the framework that should be considered. This includes valuable information on the complexity of the intervention, the scale of the intervention, the budget given for the evaluation, evaluability, feasibility and the stage of the program at which the evaluation was commissioned (Seasons 2021; Bamberger et al. 2012; Newcomer et al. 2015). The complexity of a municipal natural asset management program can be quite high, as there can be several different stakeholders involved in any one municipality, with multiple expected outcomes. As well, the scale of the intervention can be large, but this depends on political commitment to municipal natural asset management. For example, if program outcomes are not being met because management have not committed to municipal natural asset management, then the scale of the intervention may be small. In terms of program stage, all municipalities piloted municipal natural asset management and have begun incorporating a municipal natural asset management program into their municipal operations and management. The current stage of the program at which the evaluation was commissioned is at the end of the initial intervention or post-test.

The second step of scoping the evaluation framework is settling on the evaluation design. As Bamberger et al. (2012) explain, the aspects identified in the first step of the Real World

approach determine the appropriate evaluation design. There are three major factors that shape the evaluation design. These factors are the point in the program cycle at which the evaluation is commissioned, the number and timing of other planned data collection events, and whether a well-matched control group is possible or available (Bamberger et al. 2012, pg. 215-216). As mentioned, this evaluation was commissioned post-test, or at the end of the initial intervention. Data collection is also only occurring post-test. Finally, there is no control group for this cohort. Another consideration here is for the research paradigm. This thesis research adheres to a pragmatic approach. A pragmatic approach is a research design that focuses on expediency and realistic expectations to solve problems (Seasons 2021, pg. 199). Such an approach is best suited for this thesis research as the creation and application of an evaluation framework for various municipal natural asset management programs must be both rigorous and approachable for municipal staff and stakeholders.

Given these observations, this thesis utilized the following design framework: post-test analysis of the program group with no baseline data and no comparison group (Bamberger et al., pg. 223). This evaluation design means that data is collected after the implementation of municipal natural asset management and data is not compared with an external comparison group or with data collected prior to the implementation of municipal natural asset management. Rather, the data will be presented through case studies. This evaluation design has advantages and disadvantages. One advantage of this design is its usefulness with investigative studies to understand how a program is working and providing an initial analysis of results. Some disadvantages with this evaluation design include an inability to measure change occurring during the life of the program, difficulty in confirming that outcomes are because of the program implemented, and an inability to control for external events (Bamberger et al. 2012, pg. 225;

Seasons 2021 pg. 152). However, a notable difference from this design is that some assessments of change will be enabled by using document reviews. Through document review, it is possible to gather some information from dates prior to the implementation of municipal natural asset management to indicate a baseline condition. Despite these disadvantages, this selected evaluation design framework is the most common design scenario and “with the use of sound qualitative techniques, [this evaluation design framework should] be considered to be as or even more methodologically rigorous than any experimental or quasi-experimental design” (Bamberger et al. 2012, pg. 223).

The third step of scoping the evaluation framework is to identify the indicators and benchmarks. The choice of an evaluation design affects the work that can be conducted. The focus of this thesis was on understanding what outcomes each municipality is reaching in comparison to identified indicators. In the evaluation literature, indicators and benchmarks are two key factors for ensuring effective program measuring. Indicators are qualitative or quantitative variables that describe status or trend in a program (Weiss, 1998; Seasons 2021). Benchmarks are the key points of reference or values for the conclusions reached in any evaluation (Baker & Wong 2006; Barrados & Blain 2012). In other words, the specific value of each indicator variable is the benchmark (Seasons 2021, pg. 67). For this thesis, at least one indicator variable was created for each program outcome. However, this research did not include the evaluation of biophysical indicators such as changes in ecosystems, as these changes may take several years until they are detectable. In future years, the current evaluation framework could be expanded to include biophysical indicators.

The fourth step of scoping the evaluation framework is to select the methodological approach. The current research employed a qualitative approach. Most program evaluations are

primarily mixed methods, with a heavier focus on qualitative methods such as interviews, literature reviews, document reviews, and focus groups (Seasons 2021; Fink 2015). The primary reason for choosing a qualitative research approach was that qualitative data analysis methods were useful in building an evidence database to support the scores used for the evaluation. Thus, all the reviewed documents and interview transcripts could be extracted, coded, and stored in a single database. The evidence used in this evaluation comes directly from those reviewed documents and interview transcripts. As well, a qualitative evaluation was chosen as most of the outcomes selected for evaluation were of a qualitative nature. However, when biophysical indicators are included in future evaluations, there may be more of an opportunity to include quantitative approaches, shifting the evaluation framework towards a mixed-methods approach.

3.2 Tools Used

In program evaluation, there are two tools commonly used to strengthen the basic evaluation design, the Program Logic Model (PLM) and the evaluation matrix. Both tools are described in the next sections.

3.2.1 Program Logic Model

PLMs are graphical depictions of the assumed or hypothesized chain of causes and effects leading to the outcome of interest (Fink, 2015; Seasons 2021). This form of program logic model is known as a change model schema. The most common template of a change model schema has an explanation of the situation, inputs or program components, baseline activities, outputs, outcomes, and impacts (Chen et al. 2018). The program logic model also explains the external factors of the program and the assumptions that the program is making for the causal relationships. External factors are the factors beyond the direct control of a program. This can

include economic factors, political factors, organizational and institutional factors, environmental factors, and socioeconomic and cultural factors. Assumptions are made about the cause-and-effect links between the initial situation and the intended outcomes. However, the best use of the program logic model is as a visual example of the program theory, where the logic model describes how a program is expected to produce intended outcomes (Bamberger et al. 2012, pg. 315). Therefore, the relationships between each part of a PLM must be logical. An example of a generic program logic model is shown in Figure 2.

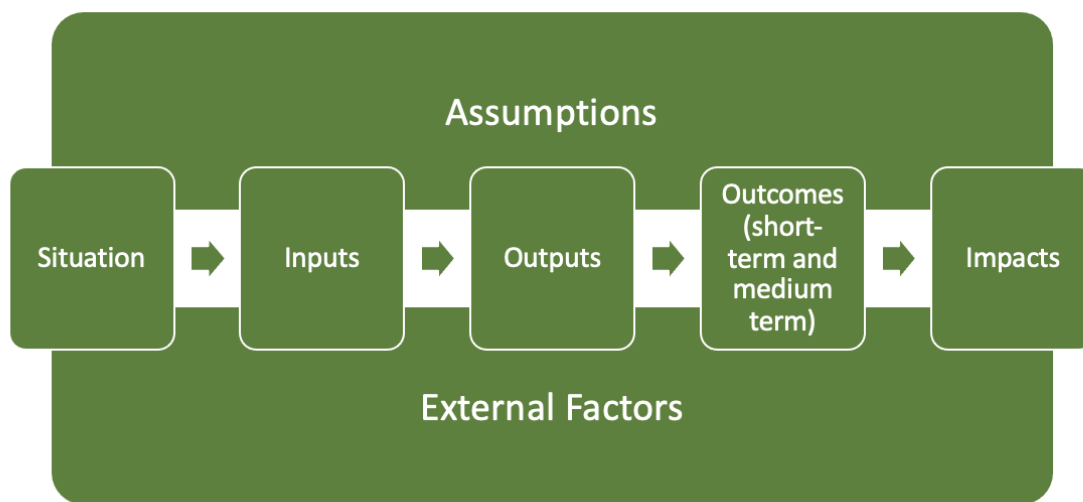


Figure 2: A generic template of a program logic model.

A program logic model can be used by both the evaluation team and the program managers to help create relevant indicators for each stage of the program and the logical links in the program theory. McLaughlin and Jordan (2004) identify the following three benefits of logic models that can contribute evidence for the selection of key indicators:

1. They point to potential issues in the evaluation, improving data collection and utility.
2. They can identify elements that are essential to the success of the program or elements with weak logical links to stated goals, improving the design of the evaluation.

3. They communicate all components of the program to stakeholders.

In the program logic model created for this evaluation framework, the design and layout of a conventional logic model was modified to include “outcome streams” (see Appendix 1). Outcome streaming is the displaying of the linkages between outcomes of the same category, such that these outcomes have a unique logical relationship between them. Through a collaborative effort with key stakeholders, short-term and medium-term outcome characterization was removed, to instead group different outcomes based on related categories. Without “streaming” the outcomes, a program logic model could become too cluttered and difficult to follow. Streaming the outcomes demonstrates the different outcome types and the unfolding of the outcomes’ causal relationships through time. Each outcome is a clear stage of progress in each outcome stream, which then feeds into the progress of the entire program. Through a cascading design, the staggered timing of the different outcome streams, enabling functions, and the connections between individual outcomes within the stream are also displayed.

In the evaluation literature, there is a similar concept to outcome streaming known as “nesting”. “Nested models refer to a group of logic models that are related but offer varying levels of detail about the program often ranging from high level general overview to specific information” (Abdi & Mensah 2016, pg. 6; Taylor-Powell & Henert 2008). An example of a nested program logic model can be seen in Figure 3 (Taylor-Powell & Henert 2008, pg. 33). Therefore, instead of creating separate logic models for each of the outcome categories, streams were created and then nested in the PLM to provide a general overview of the entire program but also the specific theory within each outcome stream.

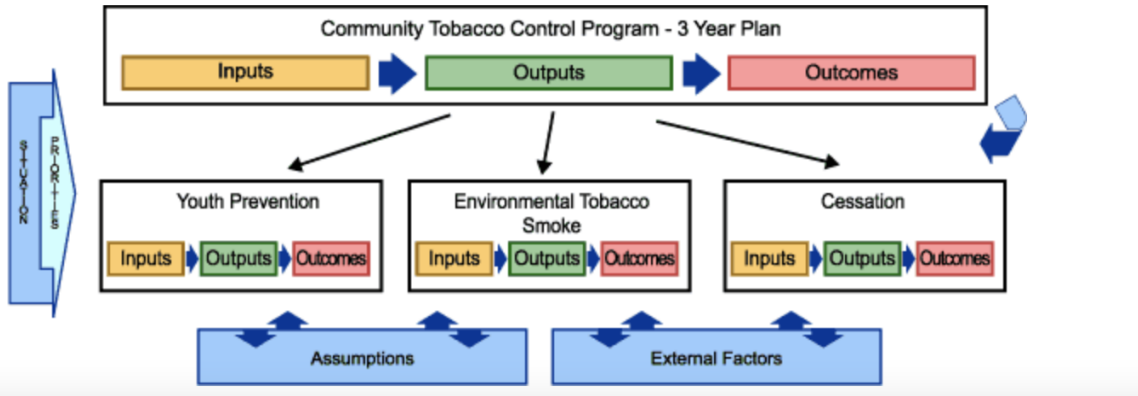


Figure 3: An example of a nested program logic model with streamed outputs for a Community Tobacco Control Program.

To create outcome streams, a list of outcomes was produced, categorized, and then grouped into typologies. As there were many potential outcomes, these outcomes needed to be sorted and arranged so they could be equally represented on the PLM. Therefore, grouping outcomes based on similarities or patterns opened the possibility of using a streaming or nested approach. For example, the Awareness, Capacity, and Education Outcome Stream (Fig. 4) was created by combining ‘education & awareness’ short-term outcomes with ‘engagement & partnerships’ short-term outcomes. In consultation with stakeholders, ‘education & awareness’ and ‘engagement & partnerships’ were assumed to be some of the earliest expected outcomes of a municipal natural asset management program.



Figure 4: A copy of the Awareness, Capacity, and Education Outcome Stream.

Municipal staff need to be trained and educated on these concepts to create actionable policy objectives. The public need to be educated and aware to maintain consistent public

support and hold elected officials accountable. As well, if municipal staff do not have the organizational capacity to coordinate a municipal natural asset management program, they can partner with local organizations to increase available resources and add capacity (Spicer 2015; Hamel 2007). Partnerships can also feed into the policy design process (Geddes 2007).

Therefore, capacity is assessed through the number of partnerships a municipality has created.

Next, the Implementation Outcome Stream was created (Fig. 5). This stream was created through combining the remaining short-term outcome categories which included strategy, policy & bylaw, programs, financing, investments & operations, and finally, third-party support for municipal natural asset management.

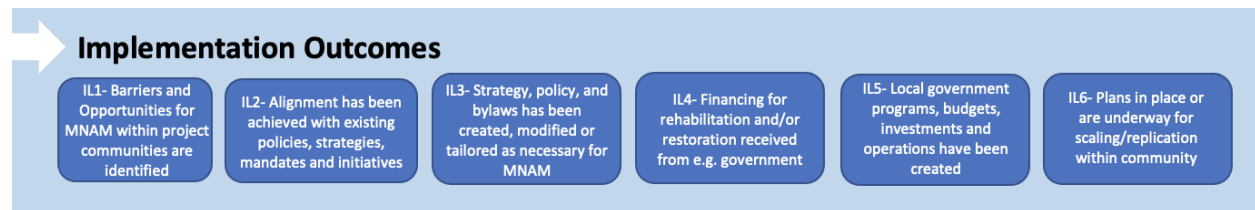


Figure 5: A copy of the Implementation Outcome Stream.

After municipalities develop the capacity for municipal natural asset management, there must be similar developments for the implementation of municipal natural asset management as a program. This can occur through changing key policy documents, by creating new policies, and by allocating appropriate funds. As well, this outcome stream also includes the identification and addressing of barriers and opportunities. The identification of barriers and opportunities in municipal natural asset management programs is a crucial step in upscaling this approach, especially as it relates to the role of planners and planning policy (Drescher et al. 2018).

Therefore, more data on barriers and opportunities in different municipal contexts can contribute more knowledge on municipal experiences.

Following the Implementation Outcome Stream, an Ecosystem Rehabilitation and Restoration Outcome Stream was developed from medium-term outcomes (Fig. 6). This stream was created by combining outcomes related to the health of natural assets through creating a rehabilitation or restoration project and measuring the quality of ecosystem services.

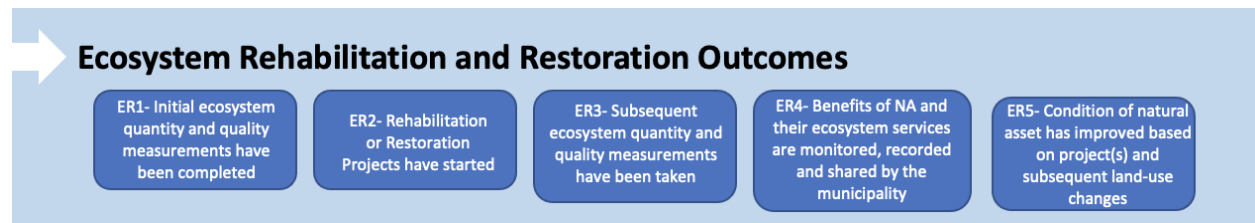


Figure 6: A copy of the Ecosystem Rehabilitation and Restoration Outcome Stream.

For natural asset areas to deliver key services and co-benefits, they need to be healthy or show improvements in their health. Therefore, this outcome stream describes necessary outcomes to rehabilitating and restoring key ecosystem areas.

Lastly, there is the Service Delivery Outcome Stream (Fig. 7). This stream combines the remaining medium-term outcomes and focuses entirely on service provision from natural assets. Therefore, these outcomes focus on service levels due to a fully healthy natural asset and evidence of increased co-benefits. Co-benefits are the added benefits we experience when we adapt or mitigate climate change effects. These co-benefits can also enhance sustainability outcomes. They are not the direct benefits of climate action. For example, when greenhouse gas emissions are reduced, there is a reduction in air pollution. Air pollution causes heart and lung diseases and cancer. Therefore, by reducing greenhouse gas emissions, there is a public health co-benefit (Scovronick et al. 2019).

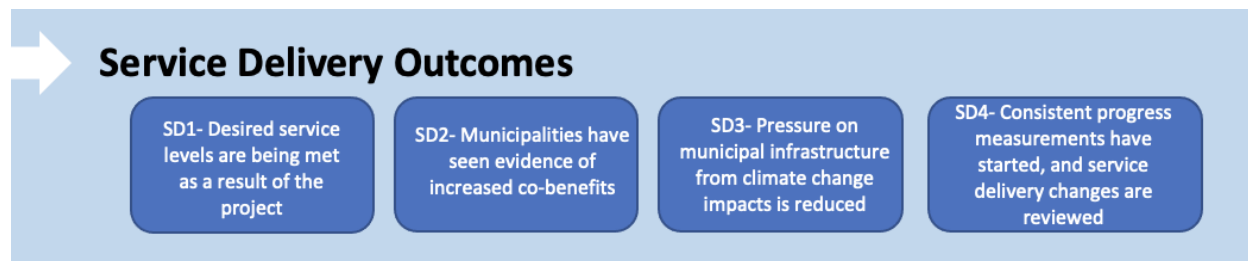


Figure 7: A copy of the Service Delivery Outcome Stream.

The program logic model also has the following external factors: (i) the political context of the municipalities; (ii) the cost of replacing engineered assets; (iii) the selection and availability of natural assets of interest; (iv) climate change; (v) a declining environment; (vi) the economic context of the municipality; (vii) provincial or federal funding provided; and (viii) that each municipality is completing the program at a similar timeframe to each other. While all these external factors are outside of the program’s direct control, they can all seriously affect the program. For example, if the municipalities are not completing the program at a similar timeframe, it becomes more difficult to compare these municipalities and draw patterns. As the lifecycle of each municipal natural asset management program continues, differences in timeframe will become increasingly exacerbated.

The assumptions the program logic model makes include the following: (i) municipal natural asset management programs are setting ambitious but achievable goals; (ii) private landowners and public stakeholders are willing to work with municipalities in pursuing program objectives; and (iii) the municipality is assessing the results of the program at various stages to learn about their own performance and inform future steps. While these are assumptions, they are based on stakeholder experiences and best practices on municipal programs and natural resource management. For example, staff from the Municipal Natural Assets Initiative and the David Suzuki Foundation were consulted and provided feedback before inclusion of these assumptions.

These stakeholders were consulted as they were familiar with municipal natural asset management and each of the municipalities evaluated.

3.2.2 Evaluation Matrix

The second tool created was an evaluation matrix. An evaluation matrix is a table with a row for each evaluation question and columns that address evaluation design issues, such as data collection methods, data sources, analysis methods, timings, etc. (Bureau for Policy, Planning and Learning 2015). Evaluation questions can be organized in several ways, but one of these ways is through an evaluation matrix which groups questions into broad thematic clusters and is then supported by questions that refer to some aspect of the program’s direction and progress (Markiewicz & Patrick 2016). Therefore, the evaluation matrix links each evaluation question with the means for answering that question. Developing evaluation questions is an iterative process (Seasons, 2021 pg. 129). Each evaluation questions should be considered in relation to all other aspects of the evaluation and the program logic model. Thus, the final set of questions are logically connected to the program outcomes. Finally, evaluation questions should be reviewed by key stakeholders to “ensure that the evaluation remains grounded in their needs” (Seasons 2021, pg. 129). A generic example of an evaluation matrix can be found in Figure 8 (Government of Oregon 2020).

Criterion Number	Evaluation Criteria	Evaluation Measures
Goal 1 Coordination Goal: Develop and maintain a Transportation System Plan that is consistent with the goals and objectives of the City, [applicable] County, and the state.		
C1.1	Compliance with State policies, plans, standards, and requirements	To what extent does the project ensure compliance with State policies, plans, standards, and requirements?
C1.2	Consistency with the regional transportation plan	To what extent does the project ensure consistency with the regional transportation plan?
C1.3	Compliance with local land use plans, comprehensive plans, and regional transportation plans.	To what extent does the project comply with local or regional land use, comprehensive, and transportation plans? Measured by whether or not the project is identified or compatible with an adopted plan.
C1.4	Incorporate projects identified in other state, regional, or local plans	Is the projects included in an existing state, regional, or local plan? Is the project inconsistent or would it impede implementation of another project included in an existing state, regional, or local plan

Figure 8: A generic example of an evaluation matrix.

The use of indicators and benchmarks as numerical factors for performance measurement is quite common in evaluation design and evaluation matrixes (Season 2021; Bamberger et al. 2012). Indicators are qualitative or quantitative variables that describe status or trend in a program (Weiss 1998; Seasons 2021). Benchmarks are the key points of reference or values for the conclusions reached in any evaluation (Baker & Wong 2006; Barrados & Blain 2012). Evaluation matrixes not only describe the indicators and benchmarks for each evaluation question, but where data for that evaluation question will come from, how to analyze that data, and when that data can be expected in the program’s lifecycle. That way, the evaluation matrix serves as the guiding document for conducting an evaluation that measures desired outcomes.

A few common difficulties with indicators can be overcome by using an evaluation matrix. One of these difficulties is insufficient attention to the measurement of inputs, activities, and outputs needed to achieve the higher levels of the outcome hierarchy. By using an evaluation matrix, evaluators emphasize that inputs and activities “operate at all or most levels of the outcome hierarchy” (Funnell 2000, pg. 96). By using outcome streams and a cause-effect process, the evaluation matrix mediates outcomes through inputs, activities, and outputs. Another

difficulty is that the assignment of values, weights, and scores can be subjective. Many times, evaluators choose benchmarks for their feasibility and reliability. As well, evaluators may weight evaluation questions differently based on assumptions of the program. However, an evaluation matrix makes outcomes hierarchical and attaches all other parts of the program theory together as the “backbone” of the program logic model. This makes it impossible to overlook outcomes when designing evaluation questions and creates a more robust and comprehensive evaluation framework (Funnell 2000, pg. 97).

Another important benefit for creating an evaluation matrix with at least one evaluation question for each outcome is that future evaluators can take up an evaluation matrix and a program logic model to address unanswered questions. These unanswered questions may not have been included in the initial evaluation due to time constraints, political constraints, or a lack of funding (Bamberger et al. 2012). As well, during future evaluations, an evaluation matrix design is flexible so that “evaluators can review the [evaluation] matrix, update it, and use it as a guide for implementing the evaluation” (Imas & Rist 2009, pg. 242). In this way, future evaluations can easily change the evaluation matrix if needed.

After the creation of the program logic model and the outcome streams, this evaluation matrix was developed (see Appendix 2). In the program logic model, a code was created for each outcome box. This code connects to an evaluation question in the evaluation matrix. This way, the relationship between the program outcome and the evaluation question for that outcome is clear. There is at least one evaluation for each outcome box. Following this, indicator variables, data sources, analysis methods, timings, and benchmarks were created. The rows of evaluation question in the matrix provide a starting point for organizing data collection, analysis, and report

writing. Stakeholders from the Municipal Natural Asset Initiative and the David Suzuki Foundation also reviewed the evaluation matrix. As the development of an evaluation matrix is an iterative process, these stakeholders collaborated to create the data sources, analysis methods, and timings for each evaluation question row. Questions to stakeholder included: (i) “what data is already available?”, (ii) “what has been used in past evaluations? was it successful?”, and (iii) “when can we expect data to become available?” Through these discussions and revisions, the final evaluation matrix was agreed upon. Figure 9 shows a small excerpt of this evaluation matrix.

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<i>AC3</i> <i>Question 1 – Have the municipalities made the general public aware of natural asset management occurring?</i>	Number of townhalls, information sessions, and other general consultation events on NAM	Local government records and meeting minutes on public consultation efforts	Percentage of NAM consultation events with high attendance in comparison to other consultation events	After initial public consultation efforts and the dissemination of informational materials	More than 50% of NAM consultation events have a high attendance rate from local citizens
		Information materials disseminated to the public	Coded segments of information materials list importance of conducting MNAM		All (100%) of information materials describe one reason for conducting MNAM
To what extent is the program meeting implementation outcomes?					
Goals: To ensure appropriate changes and steps in planning and municipal development process to reflect the importance of MNAM in municipal service delivery					
<i>ILI</i> <i>Question 1 – Have the municipality and relevant stakeholders identified any barriers or opportunities to MNAM within the project community?</i>	Number of barriers or opportunities identified in MNAM delivery within the project community	Local government planning documents and stakeholder responses to MNAM e.g.: - White papers - Technical reports - Financial summaries - Investigative journalism	Percentage of government documents and consultation process reviews that clearly identify the issue of barriers and opportunities with specific examples	After municipality has completed capacity-building outcomes	100% of topically relevant government documents and reviews identify barriers and opportunities and provide specific examples

Figure 9: A small excerpt of the evaluation matrix in this evaluation framework.

In this evaluation matrix, the evaluation questions, the indicators for the question, the data sources, analysis methods, and timings are all listed in the table. Each evaluation question may have multiple data sources and analysis methods in one row to ensure that data is not only

coming from as many reliable sources as possible, but that analysis is presenting the data in a way that fully addresses the evaluation question. In addition, benchmarks were added. As there is no external comparison group, the benchmark is a point of reference (Seasons 2021, pg. 195) or value used to assess how close municipalities are to indicator variable values that indicate achieved outcomes of the municipal natural asset management program. There may also be multiple benchmarks for one indicator variable. Multiple benchmarks can more accurately capture the entirety of the indicator variable. During data collection and analysis, the evaluation matrix was consistently re-examined to see if changes needed to be made. While there are a total of 26 evaluation questions in the matrix, eleven evaluation questions were chosen for the municipalities evaluated. While all 26 evaluation questions are important, through input from stakeholders, these eleven were chosen for their relevance to the current stage of the program for each municipality and to ensure multiple scores for each of the outcome streams. As well, not all interview questions could be asked during a limited study timeframe. Section 3.6 discusses which evaluation questions, indicators and benchmarks were evaluated.

3.3 Data Collection

The primary data collection methods for this research were interviews followed by document reviews. This next section will discuss how these methods work, why they were chosen for this research, and how they were applied given the evaluation context.

Interviewing program staff is a critical method for many evaluations. It gives evaluators the opportunity to gather nuance from documents as well as hear directly from staff on how the program may or may not be reaching outcomes (Seasons 2021, pg. 156). Semi-structured interviews were chosen over unstructured interviews or structured interviews as semi-structured

interviews allow for a level of comparability and interpretation while maintaining structure (Bryman et al. 2009; Jamshed 2014). In this context, semi-structured interviews also allow for the creation of an interview guide based on the evaluation questions in the matrix while giving an opportunity for nuance to emerge. As each municipality has an entirely different context in which they are engaging with municipal natural asset management it is important for interviewees to detail and describe that context. However, a limitation of semi-structured interviews is that answers are susceptible to biases and interpretation differences.

In addition, this interview guide uses open-ended questions. By using open-ended questions, researchers do not know what answers may be available. Instead, open-ended questions give those with the most expertise an opportunity to reveal processes and critical information. Open-ended questions can help researchers investigate multi-faceted interventions while giving the interviewee an opportunity to share and consider an answer (Bryman et al. 2009). However, there are a few disadvantages with open-ended questions. One of these disadvantages is that interviewees may move away from the study's focus and not provide relevant answers. Additionally, data analysis can be difficult as the interviewer may personally interpret answers, leading to inaccuracies (Bryman et al. 2009). To address this disadvantage, key background documents, the program logic model, and the evaluation matrix were used to inform the formulation of the interview guide. Members of the David Suzuki Foundation and the Municipal Natural Assets Initiative reviewed the interview guide for clarity and to ensure that interview questions were open-ended but remained on topic. As well, these stakeholders prioritized the interview questions in the guide. The prioritization of interview questions ensured that the most relevant questions were asked during interviews. Select students at the University

of Waterloo's School of Planning Master's program also reviewed the interview guide for clarity.

Using the interview guide, program managers or directors were asked specific questions on the management practices for natural assets, changes in service delivery because of municipal natural asset management, changes to planning policy to accommodate municipal natural asset management, and barriers met when first implementing municipal natural asset management. The interviews were conducted with program managers or directors remotely via teleconferencing to accommodate COVID-19 safety measures. The interviews were conducted over the teleconferencing application Microsoft Teams and lasted about 45 minutes each. These conversations were audio-recorded after receiving verbal consent. If managers and/or directors were not available for a full interview, a supplemental survey was created for managers and/or directors to complete. However, all interviewees were available for an interview. The interview guide can be found in Appendix 3.

Through the Municipal Natural Assets Initiative, partnerships were created with the five municipalities evaluated. As a part of the Municipal Natural Assets Initiative's involvement in their asset management planning and piloting, relevant managers and directors from the municipalities agreed to take part in this evaluation. Therefore, municipal staff were aware that this research would occur, were aware that their contact information would be shared, and did not have to be directly recruited. Instead, the Municipal Natural Assets Initiative provided the researcher with a list of key contacts for interviews to be scheduled over email. Of the six municipalities in the first cohort, five municipalities responded to the recruitment emails conveying their willingness to be interviewed. Unfortunately, after multiple attempts to contact representatives for the municipal natural asset management in the Region of Peel, they were not

included in this research. All interviews were conducted between November 2020 and March 2021. After the interviews have been completed the audio-recorded interviews were transcribed verbatim. The transcript was sent back to each interviewee for revisions.

Following the completion of interviews, documents were reviewed. Documents can provide insight into how organizations function and what values or practices guide their decision making (Bowen 2009). Therefore, a document review can organize documents, summarize patterns, and reveal key information from them. In program evaluation, the purpose of a document review “is to find information about what a program is and how it is intended to work, including program mission, outcomes, goals, objectives, activities, processes, outputs, and transactions that must occur to achieve outcomes” (Trevisan & Walser 2015, pg. 25). There are several advantages of a document review. Documents, especially those that are available electronically, can be readily available and accessible and are an unobtrusive data collection method. They can also provide contextual and historical information especially when used in combination with another data collection method (Russ-Eft & Preskill 2009). However, there are also disadvantages. The purpose of documents and their intention may be unknown which means that content is misleading (Smith 1989). As well, there may be access issues, which can cause evaluators to be unsure on whether the documents gathered are representative of all program documents (Russ-Eft & Preskill 2009).

After the completion of each interview, interviewees were asked to share documents related to the responses given in the interviews or related to their municipality’s natural asset management program. These documents included official plans, zoning bylaws, strategic plans, and municipal natural asset management policies. More specifically, the document reviews targeted program records (e.g., technical reports from piloting, strategies, and backgrounds),

policies and procedures, council and committee meeting notes, lessons and learnings from stakeholders, external research, informational materials, and program materials available to local government staff. This review was conducted to build necessary background understanding and to extract information required to measure indicator values. Furthermore, when documents were reviewed, consideration was given to communication material was presented in terms of language used, visuals for information accessibility, etc. This was done to determine how coherent lines of communication between organizations, the municipality, and relevant stakeholders were maintained.

Many of these documents were in the public domain and made available through each municipality's website. To find these documents, each of the participating municipalities' website had a dedicated section for municipal natural asset management or had a searchable database. As well, documents were also retrieved through "snowballing". In systematic literature reviews, "snowballing refers to using the reference list of a paper or the citations of a paper to identify additional papers" (Wohlin 2014, pg. 1). In this document review, additional documents were identified for review by scanning through the citations or referenced documents.

3.4 Data Analysis

This research uses a qualitative content analysis approach. Qualitative content analysis is a method of text analysis. "This process is essentially substantive, driven by content, rather than procedural" (Bamberger et al. 2012, pg. 314). The basis of this approach is to break text, whether this text is reviewed documents or interview transcripts, into smaller units, then group them into coding categories and themes to derive meaning. This form of analysis can help in investigating nuances in interview responses. From there, thematic analysis was used. Thematic analysis is the "macro and micro-examination of the data and identification of emergent patterns and themes"

(Bamberger et al. 2012, pg. 314). Once themes have been identified, data can be reorganized, allowing the details related to each theme to be examined closely and a narrative can emerge. In qualitative content analysis, the creation of codes to distinguish each theme can be useful. As well, the quantification of some of the codes is an accepted mode of analysis (Gläser & Laudel, 2013; Hsieh & Shannon, 2005; Schilling, 2006), though overuse of quantification in interpretation is discouraged (Gläser & Laudel 2013; Mayring 2000). Quantification of coding was also applied for the current research and utilized for determining some scores.

As the data collection methods are linked to the program logic model and the evaluation matrix, data analysis methods will be linked to these tools as well. Each of the analysis methods described in the evaluation matrix are connected to the indicator values which the municipalities are compared to. As well, the creation of codes for each outcome box in the program logic model and the use of outcome streams created the themes used for analysis *a priori* (Bamberger et al. 2012, pg. 315).

The software used for qualitative content analysis was MAXQDA (Version 2020.4). This qualitative data analysis software was selected due to its accessibility, ease of coding, a small learning curve, and the software's data analysis capabilities. Through the creation of a MAXQDA database, both the selected documents and interview transcripts were divided by municipality. The reviewed documents were analyzed for content such as key words as identified in the evaluation matrix. The content analysis of the interviews was more direct and less iterative as the interview responses were already divided by interview questions that correspond with an evaluation question and the outcome streams.

Two rounds of coding were conducted, with a third round to ensure reliability and accuracy. Emergent coding categories did not have to be created. Instead, each evaluation question and corresponding indicator, data source, analysis method, timing, and benchmark were used as coding categories, which is known as a closed coding system (Plowright 2011, pg. 9). Closed coding is a highly structured coding strategy. Codebooks can provide definitions for codes and to maximize coherence among codes (Guest et al. 2012). The evaluation matrix is this codebook. This approach is often used in health sciences (Creswell & Creswell 2018, pg. 196) where program evaluation has also been widely used (Seasons 2021). A benefit of this coding approach is that researchers do not have to develop their own coding categories, making the coding process more efficient. As well, coding justifications are more understandable, making the data more transferable between different researchers or other members of an evaluation team. However, a challenge with this coding approach is that nuance can still emerge during the analysis that cannot be captured by the predetermined codes. The data from each was used as the basis for determining scores.

3.5 Scoring System

To present results and best communicate findings from the evaluation, a balanced scorecard approach was used. There are four steps to creating a balanced scorecard: identifying the measures, assigning weights, balancing the measures, and setting specific targets (Scholey & Schobel 2018 pg. 12). For the first step of identifying the measures, there are several guidelines for identifying these measures. For instance, there is a difference between leading and lagging scorecard measures. “A leading measure predicts future performance while a lag measure reports on past performance” (Scholey & Schobel 2018, pg. 12). Most of the awareness, capacity, and education benchmarks and the implementation benchmarks are lagging measures whereas many

of the ecosystem rehabilitation and restoration benchmarks and the service delivery benchmarks are leading measures. As well, there is a difference between efficiency vs effectiveness measures. Efficiency measures refer to the strong use of resources (such as the application of funding for ecosystem restoration and rehabilitation) while effectiveness measures show whether those resources are achieving desired results (whether full ecosystem rehabilitation and restoration has occurred).

The second step is to assign weights. However, weighting is not necessary, and it is assumed that without defined weights each of the outcome streams and the indicators within those streams are weighted equally (Scholey & Schobel 2018, pg. 13). This evaluation framework and scorecard did not include weighting which means that all indicators are evaluated and weighted equally. However, there is a possibility to consider weighting in future iterations of this evaluation framework (see Chapter 6). The third step is to balance the measures named in Step 1. This includes ensuring the correct balance between lagging, leading, efficiency, and effectiveness measures. The last step is to set specific targets. These targets or benchmarks are a result that, if achieved, determine that progress has been made in that particular indicator. In this evaluation framework, indicators can be measured in a range or through an individual scoring system.

Scores were determined using a five-point colour-coded scoring system (Fig. 10). This colour-coded scoring system describes how municipalities are reaching outcomes compared to indicators. A colour-coded scoring system adds a dimension to reporting that makes evaluation reports more “user-friendly and accessible to non-technical users of the information” (Abbott et al. 2007 pg. 651). In addition, the five-point scale is used as “a three-point scale is too coarse for

reliable results, while a seven-point or more scale is too fine and difficult for assessment staff to interpret consistently” (Abbott et al. 2007 pg. 651).

Aggregate Benchmark Scoring ex. AC3Q1 – Public Awareness

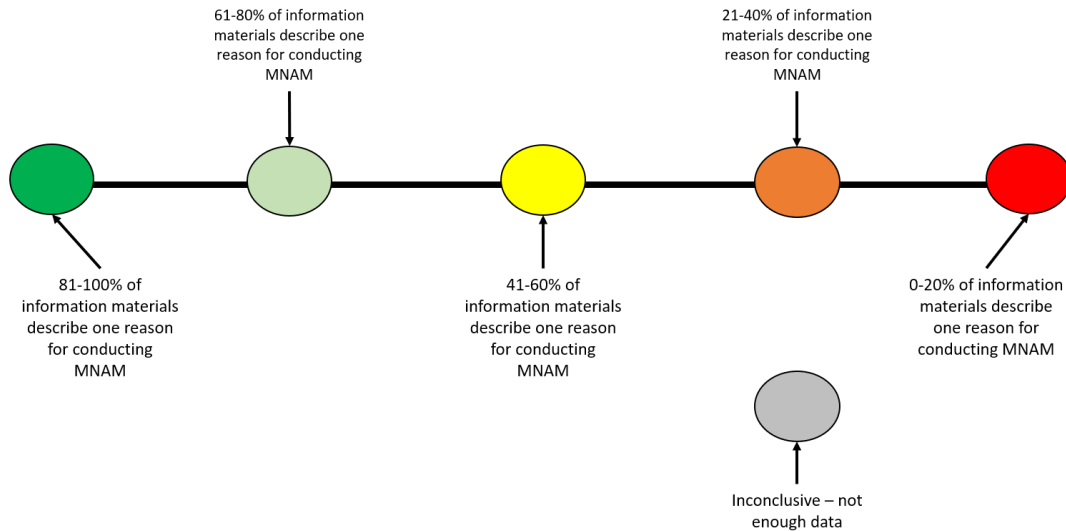


Figure 10: A visual depiction of the five-point scoring system.

Every colour in the scoring system can signify a range. This is especially useful for the aggregate or composite benchmarks. Aggregate benchmarks are benchmarks that contain multiple parts to make up a whole. In the case of this evaluation, it most often signifies percentage-based scoring systems. If a municipality reached the benchmark set for the evaluation question, they received a Dark Green score. A Red score was given if the municipality has little to no positive data for a score. A Grey score was given if the municipality is missing any data, positive or negative, for an indicator to assign a score. For individual benchmarks, or benchmarks that are looking for a specific number, only Dark Green, Red, or Grey colour scores will be used. For example, if a benchmark is set at “at least one partnership established”, this is

not conducive to a percentage-based score. Therefore, for these individual benchmarks, scores are given similar to a pass/fail scoring system.

The use of individual or aggregate benchmarks is similar to research in single versus composite indicators. While single indicators capture a single phenomenon, composite indicators can “tell a more complete story about a policy issue than is possible with single indicators alone” (Seasons 2021, pg. 69). However, there are also risks. For example, calculation errors or data sensitivity can make them vulnerable to manipulation (Irwin & St. Pierre 2014; Kitchin et al. 2015; Saltelli 2007). To counteract these risks, frequency analysis was used to calculate the number of codes per aggregate benchmark to determine a score.

3.5.1 Subjectivity in Scoring

While every effort has been made to remove or reduce bias in assigning scores for the evaluation questions assessed, without specific quantification of available data and sophisticated scoring ranges, scores cannot be assigned with full objectivity. Subjectivity in qualitative evaluations is common. “Subjective judgement is involved not only in developing findings but also in the process of identifying what should be counted or measured, how data should be categorized or recorded, what the critical data sources are, which features of a program contribute to its outcomes, or which criteria are appropriate for judging program quality” (Bamberger et al. 2012, pg. 137). Subjectivity can add broader input, additional interpretations, and examples to enhance the results of the evaluation and areas for improvement. As well, careful balance between objective criteria and subjective feedback lends credibility (Frederiksen et al. 2012). In this evaluation, scores are assigned at the discretion of the evaluator based on their interpretation of the indicator, the indicator variable, and the benchmark in the evaluation

matrix in contrast to the available data. While subjective judgement is used, each score is supported by the available data and is comparable across the five municipalities.

Balanced scorecards do use both objective and subjective factors when creating a balanced score. As well, there is evidence that senior managers prefer subjective performance indicators over objective ones in the design of the balanced scorecard (Northcott & Smith 2011). However, there are some drawbacks to this approach. For example, evaluators may place greater or exclusive emphasis on certain types of measures, even when other types of measures can provide relevant information (Ittner et al. 2003). Chapter 6 will discuss next steps of this research, which includes the creation of a possible automated evaluation application which could remove subjectivity during the scoring process. Section 3.7 will discuss other strategies used to ensure rigour and discipline subjectivity, especially when reaching conclusions in program evaluations.

3.6 Evaluation Questions Chosen

As previously mentioned, eleven of a possible 26 evaluation questions were used for this evaluation. These eleven evaluation questions are connected to indicator variables that in turn have one or more benchmarks to use as reference points. As well, each of the evaluation questions align with an interview question. This next section provides a brief description of the eleven evaluation questions, indicators, and benchmarks. A copy of the evaluation matrix that contains all evaluation questions, indicators, and benchmarks along with the data sources, analysis methods, and timings can be found in the Appendix 2. A copy of the interview guide can be found in Appendix 3.

3.6.1 Indicators and Benchmarks for the Awareness, Capacity, and Education Stream

For this outcome stream, two evaluation questions were chosen.

First Question: Have the municipalities made the general public aware of natural asset management occurring?

The indicator for this evaluation question is the number of townhalls, information sessions, and other general consultation events held for municipal natural asset management. This evaluation question has two separate benchmarks. The first benchmark is that more than 50% of natural asset management consultation events have a high attendance rate from local citizens. The second benchmark is that all (100%) of municipal information materials describe one reason for conducting municipal natural asset management. This evaluation question examines how local government staff are raising awareness of municipal natural asset management occurring in their municipalities. Creating this awareness can lead to public support, which may be important to keep political will from faltering.

Second Question: Have municipal staff partnered with academic institutions, relevant local non-government institutions, or private landowners?

The indicator for this evaluation question is the number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners. The benchmark is that at least one formal or informal partnership is with an academic institution, relevant local non-governmental organization, or private landowner. Partnerships can be incredibly important for facilitating municipal natural asset management especially under the strong resource constraints that most municipalities experience (Drescher et al., 2018). As well, partnerships can better manage the resources of multiple stakeholders and can create guiding standards that all parties must follow. While the number of partnerships does

not necessarily mean that these partnerships are effective, it does show that municipalities have made a deliberate effort to work with other stakeholders.

3.6.2 Indicators and Benchmarks for the Implementation Stream

For this outcome stream, four evaluation questions were chosen.

First Question: Have the municipality and relevant stakeholders identified any barriers or opportunities for municipal natural asset management within the municipality?

The indicator for this evaluation question is the number of barriers or opportunities identified in municipal natural asset management delivery within the municipality. This evaluation question has two separate benchmarks. The first benchmark is that all (100%) of relevant government documents identify barriers and opportunities and provide specific examples. The second benchmark is that all (100%) of managers provide at least one barrier or opportunity encountered and acted upon. By identifying barriers and opportunities and then acting upon them, municipal staff show a sense of adaptability regarding their program and the important process of learning-by-doing (Drescher et al., 2018). As well, local government staff can educate other municipalities on potential barriers and opportunities they might encounter. By using two benchmarks, the evaluation draws on data on barriers and opportunities identified in documents and from the perspective of staff. As well, evaluators can compare data from the interviews and from documents to track differences in the responses.

Second Question: Have the municipalities made changes to their official plan, zoning bylaw, Secondary Plans, etc.?

The indicator for this evaluation question is the number of changes made to the official plan, zoning bylaw, secondary plans, etc. The benchmark for this indicator is all (100%) of

relevant municipal planning policy documents were changed to integrate municipal natural asset management practices. While many municipalities may already have policies on protecting key ecosystem areas, changing all policies to describe municipal natural asset management practices puts these key ecosystem areas under a single framework. As well, municipal natural asset management can be quite extensive, touching on aspects ranging from engineering policy to finance policy.

Third Question: Have new projects received funding or financing?

The indicator for this evaluation question is the amount of funding and financing received for municipal natural asset management projects. The benchmark for this indicator is all (100%) of municipal natural asset management projects have available funds to ensure a full lifecycle. The restoration, rehabilitation, and maintenance of natural assets can be a significant source of expenses for municipal natural asset management. Staff and the use of their resources should also be considered in budgetary processes. As well, this evaluation question can explain whether municipalities who are allocating a significant amount of financial capital for municipal natural asset management are seeing more outcomes in ecosystem rehabilitation and restoration and service delivery as compared to other municipalities. Lastly, data from this evaluation question can generate lessons for other municipalities on potential sources of external funding.

Fourth Question: Have staff created new natural asset management policy, strategies, and plans?

The indicator for this evaluation question is the number of new natural asset management policies, strategies, and plans. The benchmark for this indicator is all (100%) of natural asset management-relevant policies, strategies, and plans created to support municipal natural asset

management within the project community. The creation of new municipal natural asset management policies, strategies and plans that shows that municipalities are incorporating municipal natural asset management into their core service delivery framework. As well, progress in ecosystem rehabilitation and restoration outcomes and service delivery outcomes can create feedback loops in a municipal natural asset management program, causing the creation of new policy, strategies, and plans.

3.6.3 Indicators and Benchmarks for the Ecosystem Rehabilitation and Restoration Stream

For this outcome stream, three evaluation questions were chosen.

First Question: Are measurements or metrics being used for assessing ecosystem service quality?

The indicator for this evaluation question is the number of ecosystem service quality measurements or metrics within a municipal project area that are kept in the natural asset inventory. The benchmark is Four. While there can be many ecosystem services in just one natural asset area, identifying and measuring changes to provisioning, regulating, cultural and supporting ecosystem services should be a priority, especially if the natural asset requires significant rehabilitation and restoration.

Second Question: Has the municipality created a rehabilitation or restoration project?

The indicator for this evaluation question is the number of sites selected as potential rehabilitation or restoration project(s). The benchmark for this indicator is that the community has identified at least one possible site for the creation of a natural asset management projects that fits with larger natural asset management goals. Rehabilitation or restoration is a concrete step of recognizing the value of a fully healthy natural asset. As well, creating a rehabilitation or

restoration project that fits with larger goals also shows that municipalities are starting to think of natural assets through a program-based approach.

Third Question: Has the monitoring of natural assets and ecosystem services occurred?

The indicator for this evaluation question is the number of relevant indicators identified for monitoring and evaluation. The benchmark for this indicator is that the municipality has identified at least one key indicator of ecosystem service delivery over the lifecycle of the natural asset management project(s). Monitoring and evaluation are important components of any form of sustainable service delivery. Therefore, the municipalities in this cohort should look to create their own monitoring and evaluation indicators that fit the goals of their municipality. These indicators must be specific to ecosystem service delivery in the municipality.

3.6.4 Indicators and Benchmarks for the Service Delivery Stream

For this outcome stream, two evaluation questions were chosen.

First Question: Is there record of increased co-benefits?

The indicator for this evaluation question is the percentage increase in co-benefits metrics monitored by the project community. The benchmark for this indicator is the increase in co-benefits from natural asset management. Unlike built infrastructure, natural assets are also able to deliver co-benefits such as increased public health and recreation. These co-benefits can be an incentive for municipalities to pursue municipal natural asset management.

Second Question: Has pressure been reduced on traditional municipal infrastructure that would have been impacted by climate change?

The indicator for this evaluation question is the amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change. The benchmark for this indicator is a decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure. As municipal natural asset management becomes a more prevalent form of sustainable service delivery in a municipality, there should be a reduction in the budgeting for renewing built infrastructure.

3.7 Rigour

Ensuring rigour in evaluation research is critical for the results to be truthful, accurate, and valuable (Bengtsson 2016; Krefting 1991). Program evaluations are “the most rigorous when (i) the evaluation is a priority for the organization, (ii) a supportive organizational culture exists, (iii) management requires evaluation, (iv) evaluation is not motivated by personal interest, and (v) evaluation is likely to reveal success” (Mitchell & Berlan 2016, pg. 247). As well, for the reliability and validity of results to be actively reached, strategies for ensuring rigor must be built into the research process and not at the completion of the study (Morse et al. 2002). To ensure reliability in qualitative research, data collection and analysis methods must be consistently applied and transparent (Long & Johnson 2000, pg. 31). Validity is normally established through consideration of three main aspects: content validity, criterion-related validity and construct validity. Content validity is the degree to which the entirety of the phenomenon under investigation is addressed, criterion-related validity is the comparison of the tools and findings with an established standard and construct validity is the consideration of the proximity of the instrument or tool to the construct in question (Long & Johnson 2000, pg. 31-32).

There are also various means to establish rigor in program evaluations and qualitative research. The strategy used the most in this thesis was triangulation. Triangulation is the use “of

multiple data sources, data collection methods, or investigators” (Long & Johnson 2000, pg. 34). As mentioned, the evaluation matrix also has multiple data sources and analysis methods for one evaluation question. Therefore, the use of triangulation can illuminate different perspectives of the evaluation question and lead to the deduction of new patterns in the data (Long & Johnson 2000, pg. 35). Another strategy used was peer debriefing. Debriefing is the “exploring of one’s analysis and conclusions to a colleague or other peer on a continuous basis” (Robson 2016, pg. 404). As the interviews were conducted with a sole investigator, responses were then shared with the thesis supervisor, which is a key part of their role (Holloway & Wheeler 1996, pg. 165). By reviewing with peers, you can “stimulate consideration and exploration of additional perspectives and explanations at various stages of the process of data collection and analysis” (Long & Johnson 2000, pg. 34). During the entirety of the creation of the evaluation framework, each step and tool was discussed between the evaluation team and a group of stakeholders as a part of this peer debriefing.

In addition, other practical steps were taken to ensure rigour of the research. For the creation of the evaluation framework and design, each step in building this framework was reviewed by multiple stakeholders. As well, the interview guide was also reviewed and ranked by stakeholders. Once interviews and initial transcriptions were complete, recordings and transcriptions were reviewed and compared with interviewer notes to ensure that nuance was captured. Rigour was also maintained during coding. Although the coding system was created deductively using the program logic model and the evaluation matrix, accuracy and reliability checks were conducted. Direct quotes from interviews will be used in Chapter 5 to provide evidence of the results. As well, when possible, answers in interviews were compared with data found through document review. This includes, but is not limited to, statements made on

partnerships, policies, and ecosystem service monitoring. Finally, findings from this evaluation are compared to literature findings and other research in this area.

3.8 Ethical Considerations

Researchers and evaluators must consider the ethical issues that may arise during their work (Creswell & Cresswell 2018; Berg 2001; Hesse-Biber & Leavy 2011; Sieber 1998). This research uses a practice-oriented model where there is a relationship between research and practice and both sides benefit from it (Hambleton 2007). In this model, “researchers provide descriptions and explanations of specific planning problems, as defined, and framed by practitioners, and this information allows practitioners to develop innovative approaches to solving problems, whilst allowing researchers to understand the issues with which practitioners are grappling” (Farthing 2016, pg. 181). Program evaluations are a part of this model.

In evaluation, there are ethical standards established for professional evaluation practice. In Canada, these standards are set by the Canadian Evaluation Society and cover three main thematic areas: competence, integrity, and accountability (Yarbrough et al. 2011; Seasons 2021, pg. 133). Competence addresses whether evaluators can design and carry out the evaluation. Integrity is the declaration or avoidance of conflicts of interest while keeping privacy, confidentiality, and anonymity. Accountability is the establishment of positive, respectful, constructive client relations, clarifying and communicating evaluation constraints, and ensuring clear and balanced findings.

When conducting an evaluation, the evaluator must always be aware of who is asking for the evaluation, why they are asking for the evaluation, and what results the program management are hoping to see (Yarbrough et al. 2011; Bamberger et al. 2012). This thesis work was no

different. Within each of these municipalities, this program intervention could lead to changes in the municipality that could then result in the loss of jobs or the shrinking of project budgets. This can place the evaluator in a compromising situation. Therefore, the ethical, political, and economic implications must be carefully considered and when unavoidable, should be described to participants as a risk. By being as transparent as possible, evaluators can ensure they are meeting ethical standards while still producing strong scholarship (Fink 2015).

As this thesis used two primary data collection methods, ethics review was needed. Part of the research ethics process for this evaluation was identifying conflicts of interest and attempting to minimize or manage these conflicts in a manner that was satisfactory to the Research Ethics Board. As well, it was important to achieve informed consent from interview participants while maintaining confidentiality. While risks are minimal, there is a small chance that participants could encounter social risks or harms such as loss of status, loss of privacy, loss of reputation, and/or loss of control of information about self. Informed consent was achieved by providing research subjects with relevant study details through the email script and information letter. Participants were invited to ask questions before, during and after the interview. The fact that they could withdraw from the study at any time was iterated in the information letter as well as verbally. Study participants interviewed via internet-based platforms were informed that no internet transmissions are completely secure, and it was ensured that they were comfortable proceeding with the interview. Following the interviews, data was securely stored. Personal identifiers were removed, ensuring that the societal benefits of the study findings and recommendations outweigh risk to study participants.

The University of Waterloo Research Ethics Board approved this study and its data collection procedures. The University of Waterloo ethics file number is #42146.

3.9 Chapter Summary

In review, this chapter presented the evaluation framework and methodology used in this thesis research. From identifying the evaluation purpose, to selecting the appropriate design option, this chapter has used the RealWorld Approach from Bamberger et al. (2012) and research from Mark Seasons (2021) to scope the framework for this particular context. As well, a program logic model with outcome streams and an evaluation matrix were created as the primary tools for the evaluation. The data collection methods used are interviews and document review. These are two qualitative data collection methods. Therefore, to analyze the data collected, qualitative content analysis, thematic analysis, and frequency analysis were used for assigning scores. These scores were displayed in a balanced scorecard using a five-point colour-coded scoring system. This evaluation uses eleven out of a total 26 evaluation questions from the evaluation matrix. These eleven evaluation questions were chosen for their relevance to the current stage of the cohort's municipal natural asset management programs. Rigour was ensured by using validity, triangulation and peer debriefing. Finally, potential ethical issues were minimized by removing personal identifiers from interview responses and by ensuring that the evaluator is competent and accountable.

Chapter 4: Case Studies

4.0 Introduction

This chapter provides an overview of each municipality evaluated as a part of this thesis. Each section presents the geographic context, demographic information, and changes in land-use development in the municipality. In addition, this chapter shares key background information on the piloting results from the municipalities produced in partnership with the Municipal Natural Assets Initiative (MNAI). Finally, maps will be used to show the location of the municipality, the main natural assets in the municipality, and land use patterns in the municipal area.

4.1 Town of Gibsons

The Town of Gibsons is a small coastal community with a population of 4,605 (Statistics Canada 2017a) in southwestern British Columbia, approximately 46 kilometres northwest of Vancouver. The Town of Gibsons is a member municipality of the Sunshine Coast Regional District (Fig. 11 – Waterline Resources 2013, pg. 1). According to the last two censuses, its population grew from 4,437 people to 4,605 people – a 3.8% change (Statistics Canada 2017a). In 2009, the United Nations recognized International Awards for Liveable Communities recognized the Town of Gibsons as one of the most liveable communities under 20,000 (Richter 2009, para 1-2).



Figure 11: Map of the Town of Gibsons and the Sunshine Coast Regional District.

The Town of Gibsons was North America’s first community to integrate natural assets into their asset management, infrastructure services, and planning policies. In 2014, the Town of Gibsons became the first municipality in North America to pass a municipal asset management policy that defined and recognized natural assets as a separate asset class and created specific obligations for their operation, maintenance, and replacement (Town of Gibsons 2014). In 2016, the Town of Gibsons became a founding member of the Municipal Natural Assets Initiative (MNAI) which has worked to upscale the Town of Gibsons’ approach to a larger number of municipalities (Town of Gibsons 2018a).

While the Town of Gibsons has integrated several natural assets into the scope of its municipal natural asset management program, it is most well-known for its work on the Gibsons

Aquifer which started in 2009 (Fig. 12 - Waterline Resources 2013, pg. 4). Although the Town of Gibsons' considerable experience with municipal natural asset management can make it more difficult to compare the Town of Gibsons with the other municipalities in this cohort, the Town of Gibsons has been included to provide data specific to Ecosystem Rehabilitation and Restoration Outcomes and Service Delivery Outcomes. In addition, the results from the Town of Gibsons will be useful for other municipalities considering the long-term benefits of municipal natural asset management. The lessons they have learned are invaluable for a robust municipal natural asset management program in any municipality.

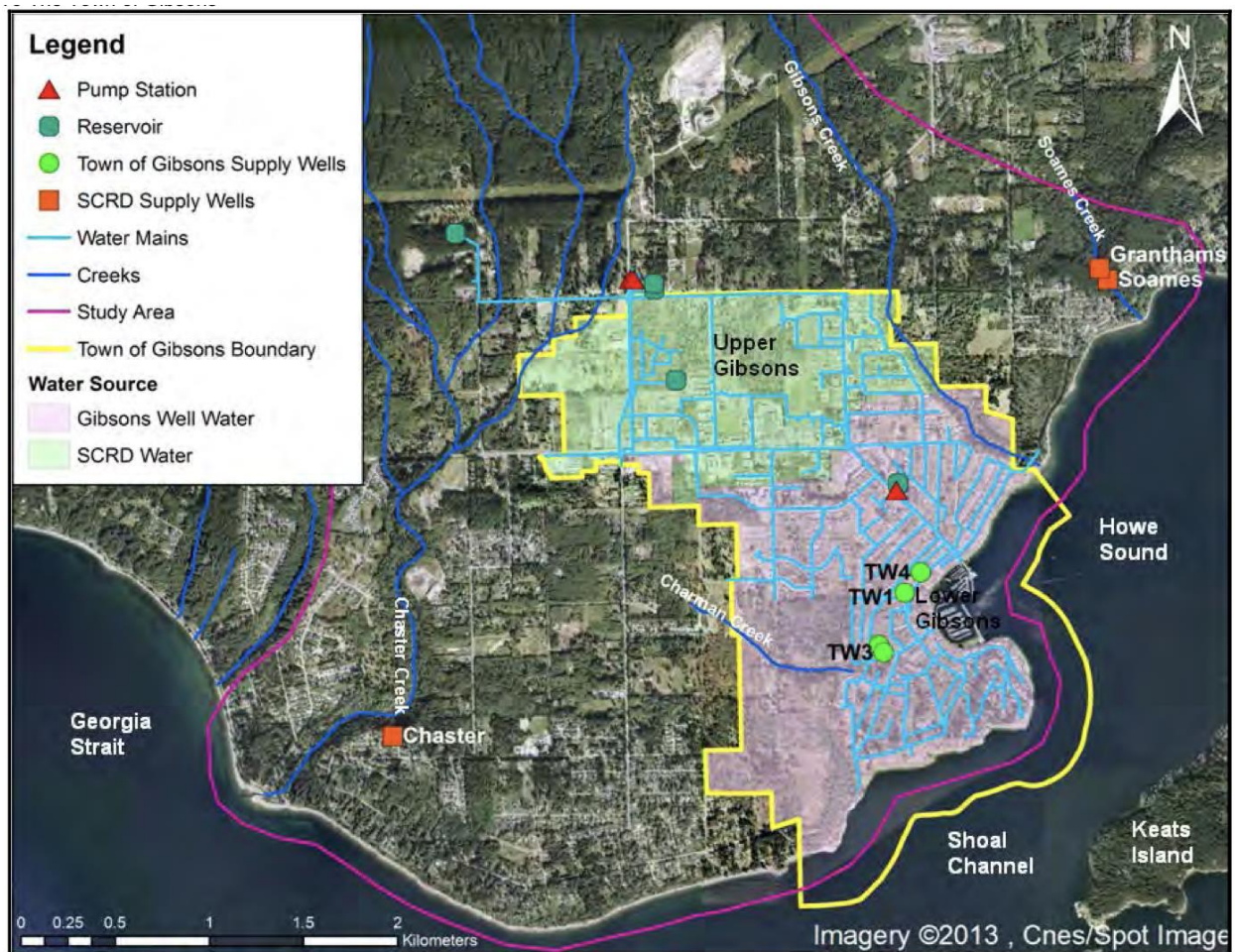


Figure 12: Map of the Water Distribution and Supply System as it relates to the area of the Gibsons' Aquifer.

4.2 City of Grand Forks

The City of Grand Forks is a small city in British Columbia just north of the Canada-U.S. border. The 2016 census measured the population at 4,049 people (Statistics Canada 2017b). Overall, the population of the City of Grand Forks has declined a rate of 0.01% per year over the past 15 years from 2001 to 2016. The City of Grand Forks is a member municipality of the Regional District of Kootenay Boundary. The City of Grand Forks is located at the junction of the Kettle and Granby Rivers and is mostly surrounded by forest and agricultural lands. The City of Grand Forks has shown a keen sense of the values of its natural assets and is advanced in asset management planning (MNAI Technical Team 2018a, pg. 6). Due to massive river floods in 2017 and 2018, the City of Grand Forks and the MNAI decided to assess flood mitigation benefits from the Kettle River Floodplain under different development scenarios. The piloting results demonstrated that the Kettle River floodplain provides – at a minimum – between \$500 and \$3,500 per hectare in flood damage reduction for downtown buildings in the City of Grand Forks during high flow events (MNAI Technical Team 2018a, pg. 5).

In May 2018, the City of Grand Forks and the outlying communities along the Kettle and Granby Rivers experienced a “1 in 200-year flood event that significantly damaged large portions of the community’s infrastructure, dwellings, and economic base (Fig. 13 - Dinsdale & City of Grand Forks 2020, pg. 3). In January 2019, the City of Grand Forks applied for \$49.9 million in funding for flood protection infrastructure and a buyback program from the Federal Disaster Mitigation and Adaptation Fund (DMAF) program (Dinsdale & City of Grand Forks 2020, pg. 4). The City of Grand Forks also applied for a \$3-million grant from the National Disaster Mitigation Program (NDMP) for flood protection and stormwater improvements on the east side of the downtown. In June 2019, the City of Grand Forks received confirmation of a

total of \$51.6 million for flood response efforts, including Provincial funding for the work sent under the NDMP program.



Figure 13: A Map of the Grand Forks area purchased for the Federal Disaster Mitigation and Adaptation Fund program.

4.3 District of West Vancouver

The District of West Vancouver (DWV) is a district municipality northwest of the City of Vancouver, British Columbia. It is one of three municipalities that make up the North Shore along with the District of North Vancouver and the City of North Vancouver. The 2016 census showed that the District of West Vancouver has a population of 42,473, a slight drop from 42,694 in the 2011 census (Statistics Canada 2017d). Despite the rapid population growth of the City of Vancouver and the wider region, the District of West Vancouver is only projected to see its population increase to 60,000 residents by 2041 (Metro Vancouver 2020, pg. 68).

MAP 16. REGIONAL LAND USE DESIGNATIONS



Figure 14: A Map of West Vancouver’s regional land use designation from West Vancouver’s 2018 Official Community Plan.

The DWV has committed to an asset management approach that incorporates climate resiliency. An infrastructure management study was completed for the DWV in 2010 that outlined sustainable infrastructure replacement funding levels over the next 100 years (AECOM 2010). This study formed the basis for expanding the current asset management program to include condition assessments of drainage infrastructure, coordinated capital planning between infrastructure renewal projects, and development of integrated stormwater master plans (MNAI Technical Team 2018b, pg. 7).

As part of their piloting with the MNAI, the DWV was interested in understanding the financial case for stream daylighting as it relates to a 90-metre stretch of Brothers Creek and

applying the methodology to other streams with potential for daylighting. Stream daylighting is the opening of buried watercourses and restoring them to their natural conditions. This pilot study revealed that daylighted parts of the Brothers Creek could provide stormwater management benefits equal with the upgraded engineered infrastructure required to meet current stormwater standards (i.e., 1 in a 200-year event) and that the capital costs of restoring the creek are similar to those of upgrading culverts to meet stormwater requirements (MNAI Technical Team 2018b, pg. 5). However, because regulations make it easier to keep a stream buried underground than to restore it to a natural state, the stream daylighting project has stalled (MNAI 2019). Since this stalling, the District of West Vancouver completed an inventory of its natural assets and delivered a presentation and report to Council in June of 2019.

4.4 City of Nanaimo

The City of Nanaimo is a city on the southeast coast of Vancouver Island just west of mainland British Columbia. It is approximately 110 kilometres northwest of Victoria, the capital of British Columbia, and 55 kilometres west of British Columbia's largest city, Vancouver (Fig. 15 – City of Nanaimo 2008). The Strait of Georgia separates the City of Nanaimo and the City of Vancouver. The City of Nanaimo is B.C.'s sixth-largest city and by 2019 was supporting a population close to 100,000 according to the City's best estimates (Manhas 2020, pg. 5). The population is expected to grow to 106,000 by 2024 (Manhas 2020). The City of Nanaimo is a member municipality of the Regional District of Nanaimo which is British Columbia's fifth-most populous Regional District.

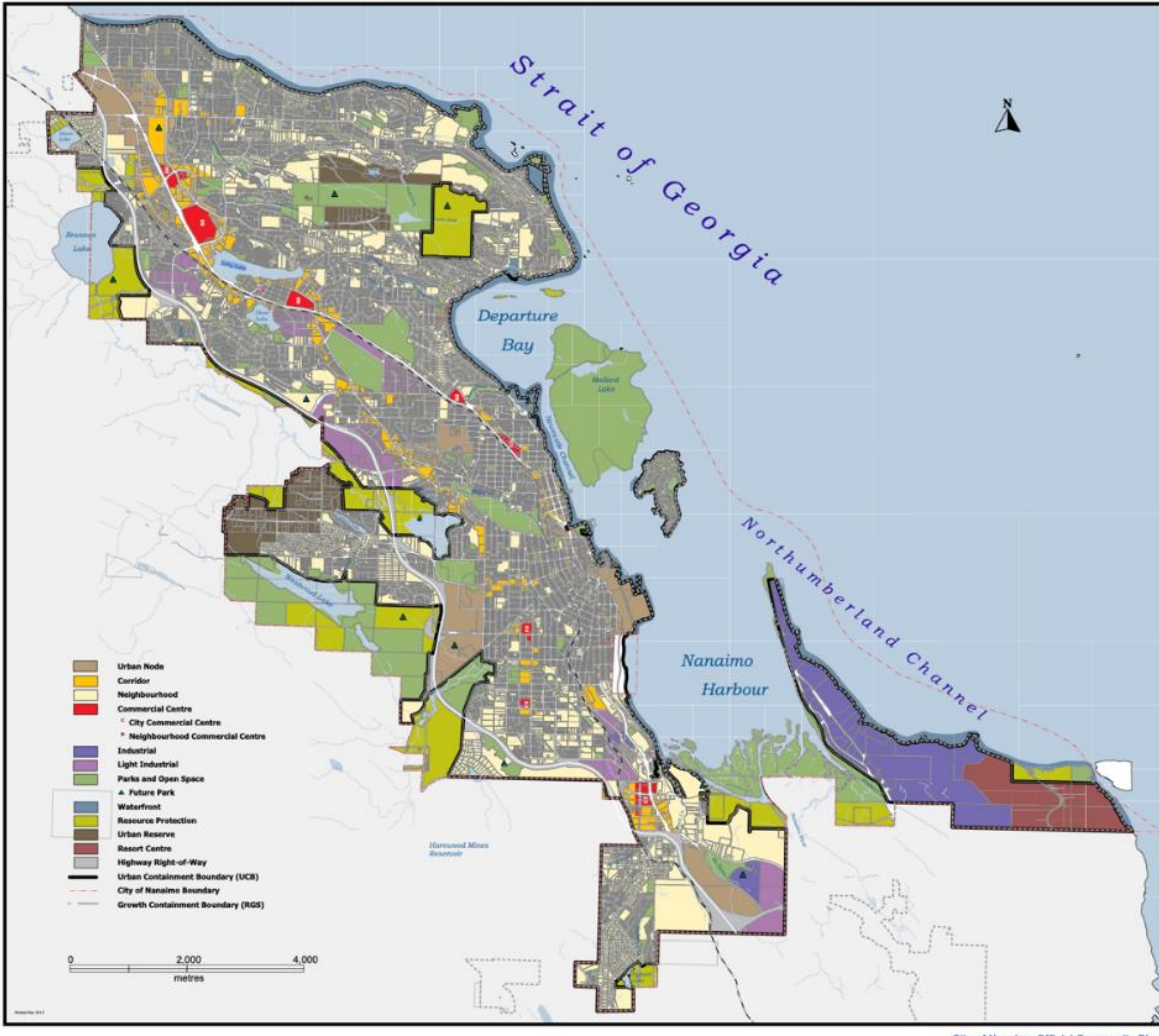


Figure 15: Future Land Use from the City of Nanaimo’s 2008 Official Community Plan Nanaimo.

The City of Nanaimo has an experienced background in asset management, with a formal asset management approach for its infrastructure in place for 15 years. In 2018, the City of Nanaimo owned and maintained over \$3 billion in engineered infrastructure assets. This includes roads, water mains, facilities, drainage systems, parks, and the sewer system (City of Nanaimo 2018c).

Through their involvement in the MNAI’s piloting, the City of Nanaimo started to expand their asset management framework to consider the role of natural assets. The primary natural asset of interest was the Buttertubs Marsh Conservation Area, a 55-hectare (133 acres)

reclaimed wetland and floodplain habitat in the City of Nanaimo (Fig. 16). The Buttertubs Marsh Conservation Area is next to the Millstone River, which flows through the centre of the city. The City of Nanaimo selected the Buttertubs Marsh Conservation Area as a study site because of its stormwater retention and flood mitigation properties within the community, its importance as a local natural landscape, the availability of data, and ongoing partnerships with Ducks Unlimited, the Nature Trust of BC, and other local stewardship groups (City of Nanaimo et al. 2017).

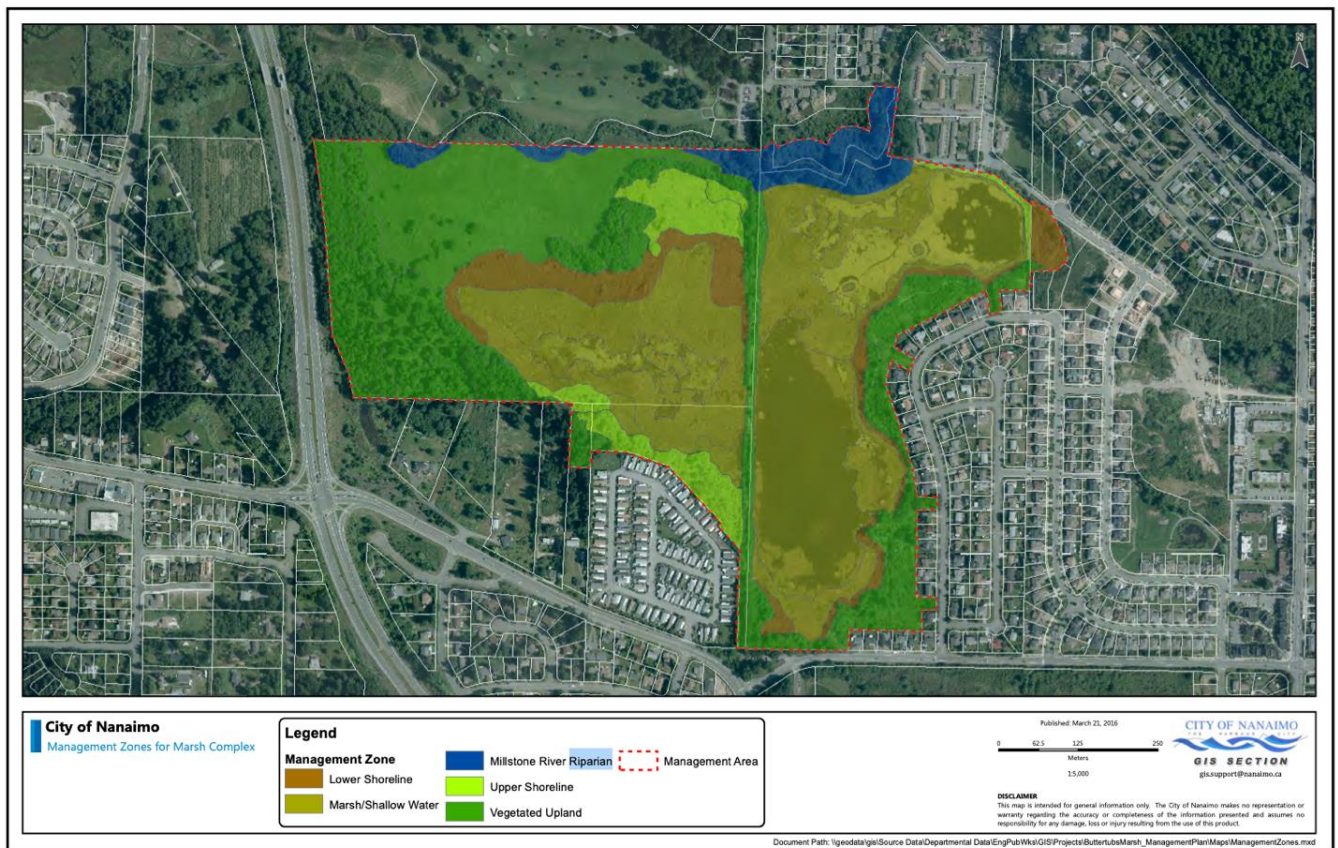


Figure 16: A map of the Buttertubs Marsh Management Zones.

The piloting showed that the Buttertubs Marsh Conservation Area provides a significant peak flow attenuation function and an overall water volume retention function (MNAI Technical Team 2018c, pg. 5). Applying a replacement cost approach and using the cost of constructing a stormwater management pond or wetland for the required storage volume of \$150 per cubic

meter as a benchmark, the storage benefit of the Buttertubs Marsh Conservation Area was valued at \$4,694,295. Under various climate change scenarios, this value increased to between \$6,559,676 and \$8,207,305 (MNAI Technical Team 2018c, pg. 5).

4.5 Town of Oakville

The Town of Oakville is in Ontario's Golden Horseshoe, approximately halfway between Toronto and Hamilton, in the Halton Region on Lake Ontario. The 2016 Census reported a population of 193,832 (Statistics Canada 2017c). This figure is expected to rise rapidly as the Town of Oakville is a part of the Greater Toronto Area, one of the most densely populated areas in Ontario and Canada (Statistics Canada 2011). The entire Halton Region is one of the fastest-growing regional municipalities in Canada and is home to the City of Burlington, the Town of Halton Hills, the Town of Milton, and the Town of Oakville (Fig. 17).

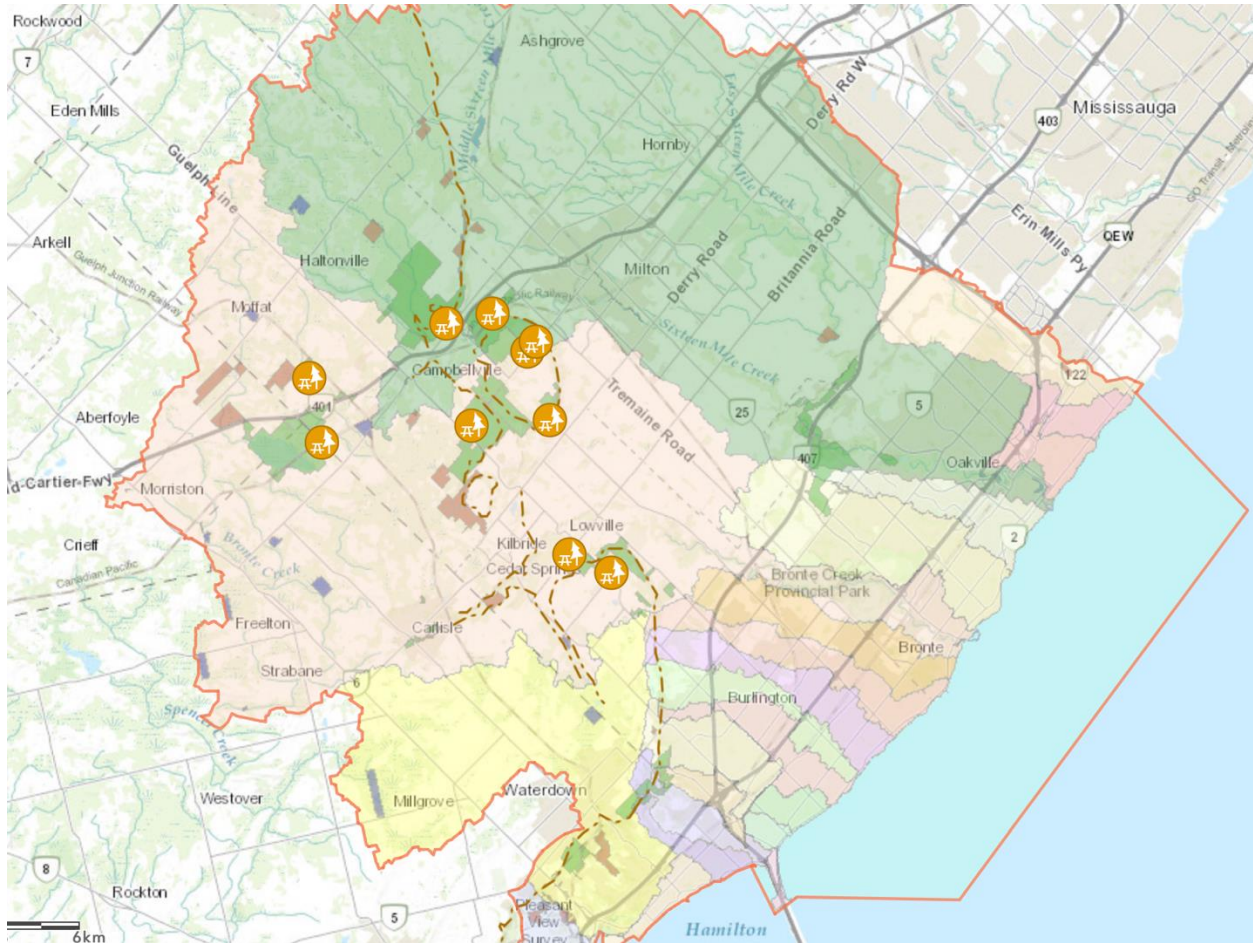


Figure 17: A watershed base map from Conservation Halton.

The Town of Oakville has a significant climate change and asset management background. Following the Public Sector Account Board (PSAB) 3150 Initiative, the Town of Oakville has maintained a complete inventory of the town’s engineered assets since 2008 (MNAI Technical Team 2018d, pg. 7). In addition, the Town of Oakville joined the national Partners for Climate Protection (PCP) program in 2005 and joined the Local Governments for Sustainability’s (ICLEI) Building Adaptive and Resilient Communities (BARC) framework in 2011 as one of the first 12 signatories. ICLEI awarded the Town of Oakville Milestone 5 of the five-milestone program for the implementation of its Climate Change Strategy and community education program (Town of Oakville, 2021c).

The natural asset selected for piloting was the Maplehurst Remnant Channel site, situated in an older part of the Town of Oakville. The site was chosen as it has a remnant stream, drainage ditches, and both public and private natural assets. Using a replacement cost method for valuing conveyance and attenuation services provided by the remnant channel under existing and intensified development scenarios, it was demonstrated that it would cost the Town of Oakville between \$1.24 million and \$1.44 million to replace approximately 240-metre channel with engineered infrastructure (MNAI Technical Team 2018d, pg. 6).

4.6 Chapter Summary

In review, this chapter presents background information on the five municipalities that are a part of the first national cohort of municipal natural asset management programs. Many of these municipalities are facing unique challenges such as population growth and increased pressure to urbanize. Each municipality piloted municipal natural asset management with the MNAI, and the program outcomes achieved since piloting municipal natural asset management will be the basis of the evaluation results presented in the next chapter.

Chapter 5: Results

5.0 Introduction

This chapter presents a summary of evaluation findings based on the review of key documents and interviews. A five-point colour-coded scoring was used to assign a score for each indicator variable evaluated. This chapter also presents quotes from interview responses and references to documents to provide evidence for each scoring decision. This chapter is divided into sections based on the four outcome streams in the Program Logic Model. Findings for all five municipalities will be shared in each section for that particular outcome stream. A copy of all interview transcripts used in this chapter can be found in Appendix 4. To ensure the anonymity of municipal staff interviewed, personal identifiers have been removed from all quotes. Instead, numbers and M/F signifier (Male/Female) will be used.

The indicator scores for each municipality were merged into a scorecard for each municipality, and these individual scorecards were combined to create a comparison scorecard (Fig. 18). The individual scorecards for each municipality and more specific information and explanations for scoring can be found in Appendix 5. By creating this comparison scorecard, the findings become easier to compare across the five municipalities and patterns become noticeable. The remainder of this chapter will discuss these findings and comparisons. The next chapter will explore how these patterns compare to other research in program evaluation, green infrastructure, ecosystem services, and municipal natural asset management.


































































Indicator (Benchmark)	Gibsons	Grand Forks	West Vancouver	Nanaimo	Oakville
Awareness, Capacity and Education Indicators					
Number of general consultation efforts for NAM (Benchmark 1: More than 50% of NAM Consultation events have a high attendance rate) (Benchmark 2: All [100%] of information materials describe one reason for conducting MNAM)	 	 	 	 	 
Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners (At least 1 formal or informal partnership)					
Implementation Indicators					
Number of barriers or opportunities identified in MNAM delivery within the project community (Benchmark 1: 100% of relevant documents identify barriers and opportunities) (Benchmark 2: All [100%] of managers at least one barrier)	 	 	 	 	 
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAM)					
Amount of funding and financing received for projects (All [100%] of projects and programs have available funds to ensure a full lifecycle)					
Number of new NAM policy, strategies, and plans (All [100%] of NAM policy, strategies, and plans created to support MNAM)					
Ecosystem Rehabilitation and Restoration Indicators					
Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory (All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory)					
Number of sites selected as potential rehabilitation or restoration project(s) (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals)					
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects)					
Service Delivery Indicators					
Percentage increase in co-benefit metrics monitored by project community (Increase in co-benefits from natural asset management)					
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure)					

Figure 18: Comparison Scorecard for all five municipalities evaluated.

5.2 Awareness, Capacity, and Education Outcomes

5.2.1 Awareness and Education

For the Awareness Capacity, and Education Outcome Stream there is a lack of attendance rates for municipal natural asset management consultation events across all municipalities evaluated. Therefore, almost all municipalities received a Grey score for the first indicator (more than 50% of natural asset management consultation events have a high attendance rate). Even when data for attendance rates are available, it is not always clear whether those rates are for

municipal natural asset management consultation. It appears that most municipalities have not held a consultation event exclusively for municipal natural asset management. Instead, consultations for municipal natural asset management were often embedded in other projects or programs. However, all municipalities did use digital resources to provide reasons for conducting municipal natural asset management. These reasons included service delivery, ecosystem rehabilitation, and restoration, and incorporating environmental valuation techniques. However, there are some differences in the content of these information materials.

Town of Gibsons

The Town of Gibsons made a concerted effort to spread awareness of municipal natural asset management. However, there are no attendance rates or number of consultation events for municipal natural asset management within a year. The Town of Gibsons did hold a public hearing on March 10th, 2015, with approximately 200 attendees and 149 pages of written submission (Town of Gibsons 2015c, pg. 2). The comments from attendees refer to protecting natural assets such as the Gibsons' aquifer. On September 4th, 2019, and September 18th, 2019, two public information meetings were held for expanding service from the Gibsons' Aquifer to Water Zone 3, which covers Upper Gibsons (Town of Gibsons 2019b; Town of Gibsons 2019c). There were no attendance data for either of these meetings. On Monday, September 14th, 2020, a virtual public hearing was held for the new Tree Preservation Bylaw. At this meeting, the Town of Gibsons received 22 written submissions of comments (Town of Gibsons 2020f).

The Town of Gibsons does publish information materials on what natural assets are, how they are managed, and the objectives of this management, as part of an education and outreach campaign. In these information materials, the Town of Gibsons frames municipal natural asset management as the provision and delivery of key infrastructure services and enhanced

recreational use (Searle 2016; M1 2020, para. 38). For example, an article from the local Coast Reporter in 2015 lists the following as benefits of municipal natural asset management: (i) no up-front costs, (ii) no replacement costs, (iii) lower operating costs, and (iv) a natural asset that could last indefinitely if properly managed (Roberts 2015). Along with building awareness through media resources, the Town of Gibsons has also held in-person harbour clean-up events with the Nicholas Sonntag Marine Education Centre (NSMEC 2020c).

This evaluation has two separate indicators. For the first indicator, there is a lack of data on attendance rates for municipal natural asset management consultation events. Therefore, a Grey score was given for the first indicator (Fig. 18). For the second indicator, all information materials produced by the Town of Gibsons accurately describe one reason for conducting municipal natural asset management. Therefore, a Dark Green score was given for the second indicator (Fig. 18).

City of Grand Forks

In the City of Grand Forks, most of the municipal natural asset management consultation events and information materials focused on recovering from the May 2018 flood. A public flood recovery meeting was held on July 9th, 2018, and July 11th, 2018, to discuss needed infrastructure upgrades and future flood potential (City of Grand Forks 2020b, pg. 2) Following the decision that the City of Grand Forks would rehabilitate and re-establish the floodplain and riparian areas in the North Ruckle, South Ruckle, and Johnson Flats neighbourhoods, public meetings were held on September 19th, 2018, and October 3rd, 2018. After complaints that residents needed more updates, a public meeting was held on September 19th, 2019, where municipal staff committed to “improved communication and engagement with project and community

stakeholders to ensure they have a say in decisions regarding their futures” (City of Grand Forks 2020b, pg. 7).

The City of Grand Forks then approved the implementation of a Communications Plan. The Communications Plan developed key messages for internal and external audiences to ensure project understanding and prompt messaging on land acquisition and restoration processes and timelines. The City of Grand Forks also created the Recovery to Resilience campaign in October 2019 to “optimize communication and collaboration among key stakeholders during floodplain restoration and infrastructure upgrades from 2019-2023” (City of Grand Forks 2019, pg. 3). In total, 13 public meetings were held from June 2018 to November 2019. Data were not available on the number of attendees for any of these meetings.

The information materials developed for the Recovery to Resilience campaign describe a few reasons for managing the floodplain and riparian areas as natural assets. Benefits for restored floodplains and wetlands are listed as increased recharge of groundwater, the reduction of sediment pollution, and the provision of habitats. These information materials also use the language of municipal natural asset management by stating that the “restoration of the floodplain and riparian areas provides a durable, regenerating ‘natural asset’ that costs far less over time than hard infrastructure” (City of Grand Forks 2019, pg. 2). Interviewed staff mentioned that residents have been supportive of floodplain restoration (M2 2021, para. 42). Finally, the City of Grand Forks has been a part of extensive media coverage for their flood recovery efforts, including a series of Global News video stories on flood mitigation and land acquisition issues and the roles played by all levels of government (City of Grand Forks 2020b, pg. 8).

The City of Grand Forks has not collected information on the number of residents or property owners who attended consultation events. Therefore, a Grey score was awarded for the

first indicator (Fig. 18). For the second indicator, the City of Grand Forks has made a concerted effort to describe the benefits of floodplain restoration to former property owners and City residents, which has been noticed and appreciated by city residents. Therefore, the City of Grand Forks received a Dark Green for the second indicator (Fig. 18).

District of West Vancouver

The District of West Vancouver has held some in-person consultation events for natural assets. For example, the District of West Vancouver held a Clean Shoreline Community cleanup event on April 22nd, 2018, at Cliff Cove Beach in Whytecliff Park with 20 volunteers (North Shore News 2018). On April 27th, 2019, a second annual Clean Shoreline Community cleanup event was held with 38 volunteers. The purpose of the event was to build community awareness on the importance of keeping the beaches clean.

Some consultation for municipal natural asset management was held through the 2020 and 2021 Budgets. In the 2020 Budget, a new 0.5% natural capital or climate response levy was proposed to fund municipal natural asset management. For this budget, the District of West Vancouver held three Budget Information Meetings on January 28th, 29th, and 30th. 37 residents attended the January 28th meeting, 18 residents attended the January 29th meeting, and 19 residents attended the January 30th meeting (DWV 2020c; DWV 2020d; DWV 2020e). For the 2021 Budget, the District of West Vancouver held virtual information sessions, fielded email inquiries, and created presentations, documents, and recordings (Gordon 2021, pg. 8). The most common theme identified in the responses to both budgets was “do not support tax increase & feel that taxes are already high”. But there were also concerns that active transportation and climate change initiatives should remain priorities (DWV 2021a, pg. 8).

Regarding information materials developed, the District of West Vancouver created and published a Natural Asset Booklet in 2020. Staff were planning to distribute this booklet in schools before the COVID-19 Pandemic (F1 2020, para. 62). This booklet lists several reasons for a municipal natural asset management approach and focuses particularly on the urban forest, waterways, foreshore, and parks (DWV n.d.). For example, the ecosystem services listed are stormwater management, climate regulation, natural habitat, recreation, flood control, erosion protection, and public health co-benefits. As part of their Budget 2021 consultation, staff explained the need for a high general asset levy and the importance of including “natural asset maintenance and climate action emergency response into all aspects of the asset management plan” (Gordon 2021, pg. 6).

For the first indicator, the District of West Vancouver has not held consultation events specific to municipal natural asset management. Therefore, the percentage of municipal natural asset management consultation events with a high attendance rate cannot be calculated and thus, the District of West Vancouver received a Grey score for this indicator (Fig. 18). For the second indicator, the limited dissemination of the Natural Asset Booklet hampered awareness and education outcomes. Therefore, the District of West Vancouver received a Light Green score for this indicator (Fig 15).

City of Nanaimo

In the City of Nanaimo, no specific consultation events have been held for municipal natural asset management. However, consultation events have been held for the upcoming Official Community Plan Update. For Phase 1 of the Reimagine Nanaimo campaign, the City of Nanaimo received more than 9,000 inputs from website comments, online discussion groups, statistical surveys, and public ideas questionnaires (City of Nanaimo 2021b). One of the most

significant areas of concern for participants was a loss of natural areas. Specifically, “over 60% of respondents in both surveys rated every environment/climate change issue listed as very important or important” (City of Nanaimo 2021b, pg. IX).

The City of Nanaimo developed some information materials that provide various reasons for municipal natural asset management. For example, as part of the Reimagine Nanaimo campaign for the Official Community Plan Update, the City of Nanaimo listed some climate adaptation measures. These measures include protecting watersheds and riparian areas through stewardship efforts, urban forest protection regulations, and low-impact development for stormwater management (City of Nanaimo 2020f). The City of Nanaimo also publishes the “Natural Connections” newsletter once every 3-6 months. This newsletter explains the various restoration projects the City of Nanaimo has completed since the last newsletter and how these projects are beneficial to the larger community (City of Nanaimo 2020g). Finally, on the City of Nanaimo’s website, an entire section is dedicated to green initiatives.

For the first indicator, the City of Nanaimo does not have attendance rates for the Official Community Plan Update or municipal natural asset management consultation events. Therefore, the City of Nanaimo received a Grey score for this indicator (Fig. 18). For the second indicator, the City of Nanaimo accurately describes reasons for municipal natural asset management. Therefore, the City of Nanaimo received a Dark Green score (Fig. 18).

Town of Oakville

Finally, the Town of Oakville has held a few consultation events for municipal natural asset management. For example, the Town of Oakville held two public information centres (PICs) at strategic points throughout the development of the Stormwater Management Master

Plan (Wood Environment & Infrastructure Solutions 2019, pg. 7). However, there is no attendance data for the number of attendees for the Stormwater Management Master Plan PICs. The Munn's Creek Erosion Mitigation EA Study held two PICs on April 30th, 2019, and March 12th, 2020 (Aquafor Beech Ltd. 2020). Twenty-five Town of Oakville residents attended both PICs. The first PIC presented the study background, the environmental assessment (EA) process, the existing conditions, and alternative concepts. The second PIC presented the evaluation of alternatives, preliminary design drawings, and considerations for implementation and construction (Aquafor Beech Ltd. 2020, pg. IV).

The Town of Oakville has also published a few information materials that describe some aspects of municipal climate change action. For example, interviewed staff mentioned flyers were developed that explain important services offered by natural areas, channels and stormwater ponds (F2 2021, para. 24). In 2011, the Town of Oakville published an Eco-Letter for teachers that contained curriculum resources, in-class activities, and free presentations aimed at helping students become better stewards of the natural environment (Town of Oakville 2011, pg. 4). Finally, The Town of Oakville's website maintains two dedicated web pages on stormwater ponds and natural areas and streams. These web pages describe the importance of these areas, why the Town of Oakville maintains these areas and actions that residents can take to protect these areas (Town of Oakville 2020d).

In conclusion, the Town of Oakville received a Red score for the first indicator as the only applicable consultation events with attendance rates had low attendance rates relative to the Town of Oakville's population (Fig. 18). For the second indicator, the Town of Oakville has several information materials for climate change action. However, these information materials do

not describe the introduction of municipal natural asset management in the Town of Oakville. Therefore, the Town of Oakville received a Yellow score for this indicator (Fig. 18).

5.2.2 Capacity

For the capacity indicator, each municipality has created at least one partnership with an academic institution, relevant non-governmental organization, or private landowner. Therefore, all municipalities received a Dark Green score for the indicator. All municipalities entered a partnership with a community-based environmental non-governmental organization (eNGOs). The partnerships, regardless of whether they were formal or informal, were in place before municipal natural asset management piloting. All the eNGOS are focused on environmental degradation, can offer expertise, and can engage the community through a variety of awareness events (NSMEC 2020b; M2 2020; DUC & City of Nanaimo 2012). As well, the partnerships led to the completion of a climate change adaptation, green infrastructure, or nature-based solution project. While the benchmark for this indicator was “at least one partnership”, most of the municipalities greatly surpassed this.

Town of Gibsons

The Town of Gibsons along with the Smart Prosperity Institute, the David Suzuki Foundation, and Brooke & Associates formed the Municipal Natural Assets Initiative (MNAI) through a memorandum of understanding (M1 2020, para. 36). The MNAI provides scientific, economic, and municipal expertise to support and guide local governments in identifying, valuing and accounting for natural assets (Brooke et al. 2017, pg. 2). The Town of Gibsons also has partnerships with the Sunshine Coast Regional District, the Nicholas Sonntag Marine Education Centre, and the Sunshine Coast Streamkeepers Society. Through these partnerships,

the Town of Gibsons has entered into several agreements for the management of natural assets, such as the Healthy Harbour Project (NSMEC 2020a). Finally, the Town of Gibsons has also engaged the Squamish Nation on a few natural asset management projects, specifically around the protection of cultural assets (M1 2020, para. 36; Town of Gibsons 2020a, pg. 4). Indigenous engagement is required as part of the funding requirements for the Healthy Watershed Initiative Grant for the Source to Sea Project. Municipal staff must “provide plans to support meaningful engagement, employment opportunities, and outcomes that serve First Nations and Indigenous partners in project implementation and learning” (Newman 2021a, pg. 26-27). With such a considerable number of partnerships, the Town of Gibsons received a Dark Green score for this Capacity indicator (Fig. 18).

City of Grand Forks

The City of Grand Forks also has a few informal and formal partnerships for ecosystem conservation, rehabilitation, and restoration. One of these partnerships is with the Granby Wilderness Society (M2 2021, para. 53). The Granby Wilderness Society is a local environmental organization that works in the Regional District of Kootenay Boundary. The Granby Wilderness Society has a specific interest in riparian restoration and species-at-risk that includes their lead biologist writing a Conservation Action Plan for Species at Risk (Coleshill 2010). In 2019, the Regional District of Kootenay Boundary approved \$10,000 for the Granby Wilderness Society and the Boundary Habitat Stewards group to form the Boundary Integrated Watershed Service (Alan 2019a). The Boundary Integrated Watershed Service handles the Kettle River Watershed Management Plan (RDKB 2014) and restores and enhances black cottonwood riparian forests (Alan 2019b).

In 2018, there was an attempt to formalize a partnership between the City of Grand Forks and the Granby Wilderness Society through a commitment to conserve natural areas and manage wildlife, but this process stalled with a change in municipal management (M2 2020, para. 53). In conclusion, the City of Grand Forks has several partnerships, even beyond the organizations mentioned here. Therefore, the City of Grand Forks received a Dark Green score for this indicator (Fig. 18).

District of Vancouver

The District of West Vancouver maintains several partnerships with stewardship groups in the West Vancouver area. These steward groups work with the District of West Vancouver to protect key ecosystems, plan for management changes, and educate the public on the importance of sustainability, climate change, and environmental protection. These stewardship groups are the Friends of Cypress Provincial Park Society, the Lighthouse Park Preservation Society, Nature Vancouver, North Shore Black Bear Society, the North Shore Wetland Partners, Ocean Ambassadors Canada, Old Growth Conservancy Society, West Vancouver Shoreline Preservation Society, West Vancouver Streamkeeper Society, and West Vancouver Nature House.

Most of these stewardship groups focus on a particular species or ecosystem. In addition, most of the steward groups monitor the ecosystems or species they are focused on (F1 2020, para. 24; Bufo Incorporated et al. 2006, pg. 34; Kerr Wood Leidal Associates 2021). The District of West Vancouver has also partnered with British Pacific Properties, a real estate development firm in the West Vancouver area. The District of West Vancouver and BPP developed an Area Development Plan that would allow for denser forms of development to protect a large, forested

area (F1 2020, para. 56). Therefore, with so many partnerships, the City of Grand Forks received a Dark Green score for this capacity indicator (Fig 15).

City of Nanaimo

The City of Nanaimo started partnerships with Ducks Unlimited Canada, Vancouver Island University, and the Partnership for Water Sustainability in BC for the Buttertubs Marsh Conservation Area (M3 2021, para. 19; M3 2021, para. 45). Ducks Unlimited Canada (DUC) is a national eNGO that conserves, restores, and manages wetlands and associated habitats for the benefit of North America’s waterfowl (DUC 2021). DUC has worked with the City of Nanaimo since the 1980s, with a specific interest in the enhancement and management of the Buttertubs Marsh Conservation Area. In 2012, DUC and the City of Nanaimo strengthened their partnership through the cooperative purchase of the West Marsh – adjacent to Buttertubs (DUC & City of Nanaimo 2012, pg. 5).

Vancouver Island University (VIU) runs a bird banding station at Buttertubs West Marsh and has published monitoring reports on the bird banding process (Nature Nanaimo 2021). VIU and Nanaimo City Council recently signed a Memorandum of Understanding between the City and the University to foster collaboration, pursue areas of common strategic interest, and participate in joint initiatives, projects, and activities (Vancouver Island University 2021). Finally, the Partnership for Water Sustainability in BC is a significant contributor to the Millstone River Ecological Accounting Process. This process “provides local governments with a methodology and metrics so that they can operationalize ‘maintenance and management’ of stream corridor systems” (Partnership for Water Sustainability in BC 2021b, pg. 1). The City of Nanaimo is also working to build partnerships with the Snuneymuxw First Nation and the Snaw-Naw-As First Nation. In conclusion, the City of Nanaimo has formed partnerships with several

eNGOs for municipal natural asset management. Therefore, the City of Nanaimo received a Dark Green score for this indicator (Fig. 18).

Town of Oakville

Finally, the Town of Oakville continues to maintain several environmental-oriented partnerships. These partnerships include joining the Global Covenant of Mayors for Climate and Energy, Credit Valley Conservation Authority, Conservation Halton, University of Waterloo's Partners for Action, Oakvillegreen Conservation Association, the Halton Environmental Network, the Institute of Catastrophic Loss Reduction, and the GTA Clean Air Council. While each of organizations is interested in some form of climate action, only a few are directly involved in green infrastructure and natural asset management. For instance, Credit Valley Conservation Authority and Conservation Halton protect, restore, and manage impacts on Ontario's water resources through an integrated watershed management approach. Conservation Halton is working to protect the Natural Heritage System in the southern part of the Town of Oakville. The Natural Heritage System is made up of 900 hectares of protected land that is currently privately owned but will be conveyed into public stewardship as part of the development process (Town of Oakville 2021d).

Oakvillegreen Conservation Association and the Halton Environmental Network educate and build awareness on climate action and environmental sustainability through tours, film screenings, and virtual conferences (Oakvillegreen Conservation Association 2021; Halton Environmental Network 2021; F2 2021, para. 19). Finally, the GTA Clean Air Council identifies common priority areas for collaborative actions through annual Declarations that serve as work plans for the Council (Clean Air Council 2019). In the 2019-2023 Intergovernmental Declaration on Clean Air and Climate Change, one of the new commitments is to "strengthen municipal

capacity to consider and develop Value Propositions and Business Cases for Green Infrastructure” (Clean Air Council 2019, pg. 6). With a considerable number of partnerships, the Town of Oakville received a Dark Green score for this capacity indicator (Fig. 18).

5.3 Implementation Outcomes

5.3.1 Barriers and Opportunities

Each municipality was able to identify at least one barrier against or opportunity for municipal natural asset management. The nature of these barriers and opportunities varied widely and often depended on municipal context. However, there were some similarities. For example, many of the municipalities were constrained by staff capacity. In smaller municipalities, such as the City of Grand Forks, staff are juggling multiple roles which can stretch them thin (M2 2020, para. 44). In larger municipalities, such as the Town of Oakville, more staff need to be trained or educated on municipal natural asset management (F3 2021, para. 33). Key documents and interviewed staff also identified a few opportunities. These opportunities included aligning municipal natural asset management with existing asset management policy, aligning municipal natural asset management with existing ecosystem rehabilitation, restoration, and conservation work, and leveraging existing climate change adaptation work to include municipal natural asset management. Finally, the COVID-19 Pandemic continues to be both a barrier and an opportunity for municipalities.

Town of Gibsons

One of the first barriers identified by the Town of Gibsons was organizational structure. Interviewed staff mentioned that to implement municipal natural asset management, there is a requirement to work with different departments, such as Finance and Engineering (M1 2020,

para. 42). Town of Gibsons staff acted on this barrier through two approaches. For the first approach, the Town of Gibsons management created education and training courses for inter-department collaboration. A second approach was through “trial by fire”, where management would increase the number of projects each department was working on, so they were forced to produce practical solutions together (Town of Gibsons 2015a). For the second barrier, the Town of Gibsons staff mentioned lacking municipal natural asset management tools and policies. More specifically, staff mentioned that a clearer direction and directive from the provincial government with rules and regulations could build the necessary roadmap for municipalities (M1 2020, para 44). To address this governance issue, the Town of Gibsons is working to develop a predictive model that would include 20-25 variables to help more governments understand the opportunities provided by municipal natural asset management (M1 2020, para 44).

For both indicators (documents identify barriers and opportunities; managers identify barriers and opportunities), the Town of Gibsons staff and reviewed documents have identified opportunities and barriers. Thus, for this indicator, the Town of Gibsons received two Dark Green scores (Figure 5.1).

City of Grand Forks

The primary barrier encountered by the City of Grand Forks was the public reception and subsequent confusion regarding the property buyout program. Land appraisals for the purchase of private property were completed using post-flood values which caused pushback from residents who disagreed with this appraisal method (City of Grand Forks 2020b, pg. 5; M2 2021, para. 38). To address this barrier, the City of Grand Forks had to adjust the proposed capital project budgeting and invest more than originally planned. This moved the cost of the Land Acquisition Program from \$51,000,000 to \$55,000,000 (M2 2021, para. 38). A related barrier for

the City of Grand Forks was the lack of a clear communication strategy on the buyout program. To act on this barrier, the City of Grand Forks implemented a Communications Plan and adopted the Recovery to Resilience campaign to develop clear internal and external messaging. Internal messages ensured a common project understanding, a commitment to speak with a unified voice, and compassionate approaches to affected property owners. External messages ensured that affected property owners would receive clear, concise, and timely messaging on land acquisition and restoration processes and timelines. (City of Grand Forks 2020b, pg. 7).

For the Program Charter for the Disaster Mitigation and Adaptation Fund, the City of Grand Forks experienced cost-related, scheduling, scope-related, and limited data constraints. For cost-related constraints, the City of Grand Forks acknowledged that as currently constructed, the funding approved for this program is limited with little possibility for future funding (Dinsdale & City of Grand Forks 2020, pg. 13). In terms of scheduling constraints, there are regulatory requirements to working in and near the river. A substantial portion of the flood mitigation work will need to be scheduled around “fish windows”. These windows are “regulatory approved timeframes where such works within a stream, river, or water body can occur” (Dinsdale & City of Grand Forks 2020, pg. 13; Government of British Columbia 2018). Thus, even though design, pre-construction, mobilization, and out-of-stream work can start, construction would need to be delayed until a fish window.

The DMAF Program Charter also identified two synergies or opportunities. The first opportunity is scope overlap. The City of Grand Forks could overlap proposed projects and work in parallel with other non-DMAF related planned City works (Dinsdale & City of Grand Forks 2020, pg. 15). This could “leverage economies of scale, optimize timings of works, reduce disruption, and/or decrease costs associated to set-up, access, material purchase and

mobilization” (Dinsdale & City of Grand Forks 2020, pg. 15). The second opportunity is the leveraging of retained assets. Once properties are bought, improvements made to the property may hold some added value for the City of Grand Forks. “This creates an opportunity to repair, sell and/or relocate some of these assets for profit and for non-profit when considered and combined with some City investment and other 3rd party benefactor programs” (Dinsdale & City of Grand Forks 2020, pg. 15).

Throughout the City of Grand Forks’ flood recovery and mitigation program, City of Grand Forks’ staff have consistently identified numerous barriers and opportunities. As well, reviewed documents also describe barriers and opportunities identified and acted upon throughout the DMAF program lifecycle. Therefore, the City of Grand Forks received a Dark Green score for both indicators (Fig. 5.2).

District of Vancouver

The most significant barrier for the District of West Vancouver continues to be the COVID-19 Pandemic. Since the District of West Vancouver compiled a comprehensive list of the investment requirements for its general fund assets in 2015, the District of West Vancouver has made considerable progress in achieving its asset management goals. However, the COVID-19 Pandemic has created several setbacks in this program. In general, “support for capital projects had to be reduced to the \$8 million asset levy alone. Because funding for capital was reduced by more than 50%, many important and worthwhile projects had to be postponed” (Gordon 2020, pg. 6). This has worsened what staff have described as a “deferred maintenance” problem, where work is often postponed or stretched due to under-investment in asset maintenance (Gordon 2020, pg. 9). “In some cases, disposal with or without replacement may be the only reasonable option, while in others, retention, restoration, and re-use may be preferred. In

any case, it is clear that significant funds and significant effort will be required” (Gordon 2020, pg. 10).

Due to this barrier, District of West Vancouver staff had to significantly scale back investment into their natural assets. This includes the removal of a 0.5% Natural Capital and Climate Response levy from the 2020 Budget. For the 2021 Budget, staff recommended a joint asset management levy of 3.0%, at a minimum to ensure optimal service delivery (Gordon 2021, pg. 3). Council approved a 2.5% levy as future revenues are still uncertain. “Although it is anticipated that there will be funds available from prior years’ projects that were completed under budget, and that these funds may be used to cover some of the shortfall, they will not be sufficient to meet all requirements, so some will need to be postponed” (Gordon 2021, pg. 4).

In conclusion, the District of West Vancouver has identified and sufficiently explained that the COVID-19 Pandemic is a major barrier impeding program outcomes. However, this is the only barrier identified by the District of West Vancouver. In addition, no opportunities were identified by interviewed staff or reviewed documents. Therefore, the District of West Vancouver received a Light Green score for both indicators (Fig. 18).

City of Nanaimo

In the City of Nanaimo, interviewed staff mentioned that the most significant barrier is the number of resources and funding. Specifically, interviewed staff stated that they “don’t have the time and there are other priorities that are in front of us right now that we’re working on” (M3 2021, para. 26). Related to this, staff have also had to work through some departmental siloing between the Planning Department and the Engineering Department as there are questions on which department should take lead on these projects. To address this barrier, interviewed staff

stated that the City of Nanaimo is creating an asset management committee and hiring an asset management manager. One of the responsibilities of this position will be to integrate natural assets and hard assets into one process (M3 2021, para. 27). According to interviewed staff, restoration projects are ongoing in the City of Nanaimo, but these projects are not seen as part of a larger holistic effort. For the scores, since the reviewed documents did not identify municipal natural asset management barriers and opportunities, the City of Nanaimo received a Red score for the first indicator (Fig. 18). However, all interviewed staff accurately described a staff capacity barrier and a funding barrier, so the City of Nanaimo received a Dark Green score for the second indicator (Fig. 18).

Town of Oakville

In the Town of Oakville, barriers identified by interviewed staff focused on issues with planning, financing, education, and capacity. According to interviewed staff, the maintenance and operations of natural assets were not historically well established in the Town of Oakville. This contributed to a reluctance to take on projects or change policies where the benefits were not understood and there were competing development interests. To address this barrier, staff have incorporated pilot studies and natural asset training courses to educate staff on the services natural assets provide (F2 2021, para. 32). Interviewed staff noted that they are just starting to incorporate natural assets in the asset registry. This also means that staff are currently managing natural assets like a built asset as they continue to gather more information on these areas. In terms of capacity and funding barriers, staff noted that they struggle with finding the time to complete funding applications for green infrastructure and natural asset work (F3 2021, para. 35). To address this barrier, the Finance department created a position in December 2020 dedicated to handling funding and grant applications (M4 2021, para. 54).

In reviewed documents, the creek erosion mitigation projects describe barriers and opportunities with implementing proposed solutions. For example, one of the barriers to providing flood storage for the Joshua's Creek Flood Mitigation Study is that a significant area of land would be required to handle downstream flooding, especially during extreme weather events (Town of Oakville 2021b, pg. 18). For the Munn's Creek Erosion Mitigation Environmental Assessment Study, identified opportunities include the options to address both erosion and flooding issues, to restore or enhance riparian and aquatic habitats, and to educate the public and landowners about stream corridor management and encroachment issues (Aquafor Beech Ltd. 2020, pg. I).

In all the reviewed documents, the Town of Oakville lists and describes both general and specific barriers and opportunities for creek restoration work. Therefore, the Town of Oakville received a Dark Green score (Fig. 18). For the second indicator, staff described several barriers the Town of Oakville is working through for municipal natural asset management. Therefore, the Town of Oakville received a Dark Green score for the second indicator (Fig. 18).

5.3.2 Policy Changes

Most municipalities have started to make some changes to existing policies, plans, and bylaws to integrate municipal natural asset management. This includes dedicating a significant portion of policy documents to municipal climate and environmental action. Some municipalities already have policies that align with municipal natural asset management, especially if they have updated these policies, plans, and bylaws in the past five years. Other municipalities have not yet created policies but are working on upcoming changes. However, most municipalities are not explicitly using the language of municipal natural asset management when changing policy.

Rather, the policy framework is modified so that similar practices to municipal natural asset management are strengthened.

Town of Gibsons

The Town of Gibsons did make initial changes to their relevant planning and infrastructure policy to integrate municipal natural asset management practices. Starting with the Official Community Plan, the Town of Gibsons has changed or added several key policies to account for municipal natural asset management practices. The Town of Gibsons' Official Community Plan was updated in March of 2015 to include several new policies, objectives, and goals related to municipal natural asset management. This includes policies for appropriate natural asset displays, provincial and federal advocacy, water asset management policies for the Gibsons' Aquifer, parkland access, and managing natural asset services (Town of Gibsons 2015b).

In 2014, Gibsons passed a municipal asset management policy manual that defines and recognizes natural assets as an asset class or category (Town of Gibsons 2014). As well, this policy manual describes several objectives and principles to ensure that natural assets can be operated, maintained, and replaced. These objectives and principles include “managing Town of Gibsons Engineered and Natural Assets by implementing appropriate Asset Management strategies and appropriate financial resources for those assets” (Town of Gibsons 2014, pg. 2) and that “Natural Assets are recognized as performing essential service delivery and will be identified and managed in a similar manner as Engineered Assets” (Town of Gibsons 2014, pg. 3). The Town of Gibsons has made changes to every key part of their relevant planning and asset management policy to integrate municipal natural asset management. Therefore, the Town of Gibsons received a Dark Green score for this indicator (relevant policy changes) (Figure 5.1).

City of Grand Forks

The City of Grand Forks has made some changes to key policies to integrate municipal natural asset management practices. In 2018, City Council adopted a policy for its urban forest, with a guiding principle that states that “a healthy urban forest provides habitat, ecosystem function and amenity values to the City” (City of Grand Forks 2018, pg. 1). This policy recognizes several services provided by an urban forest including a reduction of air pollution, dust control, noise control, shade, habitat improvement, biodiversity, and soil stabilization. This policy also outlines risk management, tree selection, and tree removal. In the City of Grand Forks’ Asset Management Financial Policy, their asset management approach is described as “founded on the concept of sustainable service delivery” (City of Grand Forks 2016a, pg. 1).

The City of Grand Forks is also updating its Official Community Plan. Project Area #4 of the Official Community Plan RFP describes the creation of a floodplain designation, zoning amendment(s), and park dedication (City of Grand Forks 2021, pg. 4). According to interviewed staff, the City of Grand Forks has a work plan in place to overhaul the Floodplain Management Bylaw and the Zoning Bylaw in three areas to help protect natural assets and support the conservation and restoration of these assets (M2 2021, para. 28). As well, the City of Grand Forks wants to create a limit on how far out into the floodplain development could occur. This could prevent the filling and loss of wetlands and open floodplain areas (M2 2021, para. 28).

In conclusion, the City of Grand Forks has made many changes to key policies to integrate municipal natural asset management practices. However, the City of Grand Forks is missing changes in its asset management policy and changes to several zoning bylaws. Therefore, the City of Grand Forks received a Yellow score for this indicator, with the expectation that the score could change after the Official Community Plan is updated (Fig. 18).

District of Vancouver

The District of West Vancouver has made some changes to key policies to protect and conserve natural assets. On June 10th, 2019, District staff presented the District of West Vancouver's Natural Capital Asset Inventory to Council with the recommendation that the inventory is "incorporated into the District's financial planning, asset management, financial reporting, and capital budgeting processes and decisions" (Gordon 2019, pg. 5). According to interviewed staff, the natural asset inventory has now been integrated into the overall asset management program (F1 2020, para. 47). In that report, the District of West Vancouver acknowledges that they do not have bylaws or policies that are directly related to natural capital and ecosystem services (Gordon 2019, pg. 1), but they do have bylaws that regulate the preservation of features in the natural environment. This includes the Creeks Bylaw, the Interim Tree Bylaw, the Parks Regulation Bylaw, and the Watercourse Protection Bylaw.

The District of West Vancouver's Official Community Plan also "supports the valuation of natural capital through restrictions on development to protect environmentally sensitive lands and includes policies that provide the community-wide framework and intent for ongoing protection and restoration of these assets, as well as direction for future reviews to address emerging issues such as climate change" (Gordon 2019, pg. 2). These policies include the use of low-impact storm and rainwater management to mimic natural conditions, using green infrastructure to manage increases in frequent storm events, managing land uses to protect the value of watercourse and riparian corridors, providing opportunities to vary development form and density, and protecting the shoreline and its significant environmental and cultural features (DWV 2018).

In conclusion, the District of West Vancouver has several existing policies and plans that do not require major modification to fully integrate a municipal natural asset management approach. However, as acknowledged by staff, there is no specific description or mention of natural asset management or ecosystem services as a concept. Therefore, the District of West Vancouver received a Yellow score (Fig. 18).

City of Nanaimo

The City of Nanaimo is currently working on an update to their Official Community Plan. One of the goals identified in the scoping work for the Official Community Plan is a “green approach” and access to nature and outdoor recreation. “A Green Nanaimo is about how we can support the lands, air, and waters that sustain us. It is about advancing collective knowledge, living in harmony with our environment, and responding to the impacts of climate change while protecting people, businesses, and infrastructure” (City of Nanaimo 2021d, pg. 9). These goals were identified from the engagement summary completed by the City of Nanaimo as part of the Reimagine campaign, which highlighted residents’ concerns about the loss of natural areas in the City of Nanaimo and their wish to see more access to nature, parks, and open space (City of Nanaimo 2021b, pg. V).

The City of Nanaimo also has a Tree Management and Protection Bylaw. This bylaw regulates permits on the pruning or removal of trees. Residents must submit a Tree Removal Permit which can only be approved if the tree meets one out of a possible seven tree removal criteria. As well, the Tree Management and Protection Bylaw defines and classifies significant trees that are not allowed to be removed, regardless of criteria. The City of Nanaimo defines significant trees as “any tree that is of particular significance to the City due to size, age, landmark value, overall cultural, ecological heritage or social impact, scientific value, and any

tree that is protected as wildlife habitat for an egg or nest as defined in the *Wildlife Act*” (City of Nanaimo 2020d, pg. 5).

Finally, the City of Nanaimo has several watercourse protection regulations that include setback requirements for protecting riparian areas. Since 1997, land use activities adjacent to watercourse and riparian areas in the City of Nanaimo have been regulated under the City Watercourse Development Permit Area (DPA) and the City’s Zoning Bylaw (City of Nanaimo 2020h). The Zoning Bylaw states that no new structures, buildings, additions, driveways, parking lots, fences, etc., can be built within a watercourse setback area. These setback areas vary, depending on the size of the watercourse, condition of the riparian area, and its connectivity to other watercourses. Therefore, the City of Nanaimo has made numerous policy changes that align with municipal natural asset management. However, there is no mention of municipal natural asset management in the Official Community Plan Update in the City of Nanaimo, even though this update is occurring after municipal natural asset management piloting. Therefore, the City of Nanaimo received a Yellow score for this indicator (Fig. 5.4).

Town of Oakville

The Town of Oakville has not made changes to planning policy documents to explicitly integrate municipal natural asset management. However, policies, plans, and strategies already align with municipal natural asset management principles and practices. In the 2019-2022 Strategic Plan, one of the key areas of focus is the environment. The goal for this key area of focus is to “protect greenspace and promote environmentally sustainable practices” (Town of Oakville 2019, pg. 8). To achieve this goal, the Strategic Plan sets out several objectives. These objectives are to ensure effective stewardship of the Town’s natural environment, to create a climate change resilient community, and to transition to a low carbon future.

In the Town of Oakville's Official Plan, one of the key land use designations is the Natural Area designation. "The Natural Area designation identifies and ensures the long-term preservation of the existing natural heritage system, which includes natural features such as wetlands, woodlands, and valleylands" (Town of Oakville 2018b, pg. C-2). The Town of Oakville uses this designation to mark several natural areas in the Town of Oakville that have development regulations or restrictions. Another section of the Livable Oakville Plan that aligns with a municipal natural asset management approach is the 'Achieving Sustainability' section. The sustainability objectives include the preservation, enhancement, and protection of the Town's environmental features, natural heritage systems, and waterfronts as well as the maintenance and growth of the urban forest. The Plan specifically states that the urban forest will increase until a 40% canopy cover can be achieved (Town of Oakville 2018b, pg. C-41). Two significant policy focuses for this section are Subwatershed Planning and Stormwater Management. As well, the Town of Oakville's Official Community Plan also has policies for the Urban Forest and Hazard Lands (Town of Oakville 2018b, pg. C-48).

Lastly, the Town of Oakville has adopted several bylaws that protect natural asset areas. The most prominent of these bylaws is the Private Tree Bylaw. This bylaw applies to all private property in the Town of Oakville and prohibits "the injury, destruction or removal of any tree with a diameter equal to or greater than fifteen (15) centimetres on a lot, or any tree required to be retained or planted as a condition of an approved site plan, without first obtaining a permit pursuant to this By-law" (Town of Oakville 2017, pg. 5). In conclusion, the Town of Oakville already has several policies that align with municipal natural asset management practices. As well, the Town of Oakville is scheduled to make further changes to strengthen these policies in

upcoming plan reviews. Therefore, the Town of Oakville received a Light Green score for this indicator (Fig. 18).

5.3.3 Project Funding

Scores for the “funding and financing received for municipal natural asset management projects” indicator varied based on how well municipalities used external funding sources and whether they were appropriately budgeting for projects. Municipalities are conservative in their spending, especially for new projects and programs like municipal natural asset management, which could contribute to delays in project funding and financing (Tassonyi & Conger 2015). As well, if municipalities cannot reliably commit to fully funding an ecosystem rehabilitation and restoration project before work begins, they may not start any work on the project, even if they could commit to short-term funding. Political support is a significant factor for whether municipal natural asset management is fully funded or financed. This factor will be discussed in more detail in the next chapter.

Town of Gibsons

The Town of Gibsons has applied to numerous external grants and funding opportunities for municipal natural asset management projects and programs. In 2018, the Town of Gibsons “received approximately \$249,000 through the federal-provincial Clean Water and Wastewater Fund to update their Integrated Stormwater Management Plan which made several recommendations to the Town” (Town of Gibsons 2018a, pg. 20). In July 2020, the Town of Gibsons was awarded \$955,000 from the Province of British Columbia (\$382,000) and the Government of Canada (\$573,000) to construct an additional stormwater pond at Whitetower Park (Town of Gibsons 2020b). On June 8th, 2021, Town Council approved the award of the

Whitetower Pond Tender to Pirate Excavating for \$814,963.36, falling within the \$955,000 grant awarded (Newman 2021c, pg. 2). Town Council also authorized a budget reallocation of \$45,000 from Drainage Development Cost Charges and \$20,000 from the Groundwater Management Zone project to fund the Source to Sea project. Of those funds, \$39,367 was spent in 2020 for the Source to Sea Project and current budget estimates set project costs at \$85,000 for 2021 (Newman 2021a; Newman 2021b). In conclusion, the Town of Gibsons has been able to secure various funding options for municipal natural asset management projects. Therefore, the Town of Gibsons received a Dark Green score for the financing indicator (Fig. 18).

City of Grand Forks

The City of Grand Forks has maintained strong accounting records as part of the Disaster Mitigation and Adaptation Fund (DMAF) program requirements. In January 2019, the City of Grand Forks applied for a \$49.9 million DMAF grant to cover the costs of property buyouts and flood protection infrastructure including restored wetlands, dikes, storm drainage, and riverbank stabilization (Dinsdale & City of Grand Forks 2020, pg. 4). The DMAF program charter listed the estimated budget, including contingencies, at just under \$56.9 million. Budgeting for natural infrastructure was set at \$11,875,535 (Dinsdale & City of Grand Forks 2020, pg. 24). In 2020, the City of Grand Forks completed agreements for funding of \$51.7 million, with contributions of \$20 million from the Government of Canada and \$31.7 million from the Province of British Columbia (City of Grand Forks 2020c, pg. 24).

Current financial statements show that the City of Grand Forks “incurred \$15,298,107 of expenditures under the DMAF program, including \$3,595,000 of land acquisition costs, \$4,756,485 for residential improvements, \$2,169,981 for additional buyout compensation, and \$2,394,641 for program design and support, construction, and management costs. Expenditures

also included cash payments of \$2,382,000 for deferred property purchase agreements which will be completed in 2021” (City of Grand Forks 2020c, pg. 24). To pay for these costs, the City of Grand Forks received a cash advance of \$23,194,000 from the Province of British Columbia. According to interviewed staff, the City of Grand Forks has enough funds for the entire lifecycle of the DMAF program (M2 2021, para. 31).

Other riparian restoration projects in the City of Grand Forks are funded through a combination of private funding from property owners and contributions from the Habitat Conservation Trust Fund in British Columbia (M2 2021, para. 31). In 2019, the Habitat Conservation Trust Fund awarded the Granby Wilderness Society \$50,000 for a black cottonwood forest restoration project (Alan 2019a). In conclusion, the City of Grand Forks can fully fund the DMAF program and other projects as currently budgeted. Thus, the City of Grand Forks received a Dark Green score for this indicator (Fig. 18).

District of Vancouver

In the District of West Vancouver, funding for municipal natural asset management was changed due to the COVID-19 Pandemic. On February 4th, 2020, a Natural Capital and Climate Response levy of 0.5% was approved by District Council in the District of West Vancouver’s 2020-2024 Five Year Financial Plan (Budget 1) (DWV 2020c, pg. 5). However, once a public health emergency was declared and Budget 1 was withdrawn, Budget 2 removed the proposed Natural Capital and Climate Response levy. Budget 2 expected that the removal of this levy contributed to a total tax loss of \$1.7 million (DWV 2020b, pg. 13). However, under materials published for the 2021 Budget, the withdrawal resulted in over \$12 million in lost revenue and an additional \$7 million that needed to be diverted to support continued public safety maintenance measures and a COVID-19 response (Gordon 2021, pg. 3).

In 2015, the Fiscal Sustainability Review showed that an investment of at least \$13.9 million is required each year to maintain assets at an optimal level (Gordon 2020, pg. 12). Thus, the 2021 Budget proposes a total General Asset Levy of 3.0%, at a minimum, to replenish the amount needed to keep all assets function optimally (Gordon 2021, pg. 1). On March 8th, 2021, District Council approved a 2.5% General Asset Levy. However, there are some municipal natural asset management projects listed in the 2021 Budget, including the Coastal Marine Management Plan Implementation (Gordon 2021). Currently, the District of West Vancouver has not applied for or received external funding that is specific for municipal natural asset management. In conclusion, the District of West Vancouver received an Orange score for this indicator because the District of West Vancouver was not able to commit to the 3.0% General Asset Levy or a 0.5% Natural Capital levy (Fig. 18).

City of Nanaimo

In the City of Nanaimo, funding for municipal natural asset management is not explicitly tracked in financial documents. As well, the City of Nanaimo and Ducks Unlimited Canada do not track funding, maintenance, and operation costs for the Buttertubs Marsh Conservation Area. In the 2019 Budget, \$1,777 was budgeted for a Buttertubs Marsh Hydrology Study, \$108,253 is budgeted for the Climate Change Resiliency Strategy, and \$1,000 is budgeted for the Jingle Pot Marsh Restoration. In the 2020 Budget, \$31,923 is budgeted for the Climate Change Resiliency Strategy, a total of \$111,000 is budgeted from 2020-2024 for the Natural Parks Areas Assessment Program, and a total of \$69,130 is budgeted from 2020-2022 for the Water Course Restoration and Enhancement Program (City of Nanaimo 2020e, pg. 33).

In the 2021 Budget, \$104,060 is budgeted for the Natural Parks Areas Assessment Program from 2021-2024 and \$51,750 is budgeted for the Water Course Restoration and

Enhancement Program. In addition, \$75,000 is budgeted for 2021 for the Community Action Sustainability Plan Update (City of Nanaimo 2021c, pg. 37-38). In both the 2020 and 2021 budgets, there is no explicit information on the BMCA. Interviewed staff stated that funding was sufficient to complete municipal natural asset management piloting (M3 2021, para. 38). While interviewed staff do state that funds have been provided for ecosystem rehabilitation and restoration projects, there is no explicit inclusion of municipal natural asset management budgets for the BMCA in the 2019, 2020, and 2021 Budgets. For this reason, the City of Nanaimo received a Yellow score for this indicator (Fig. 18).

Town of Oakville

Lastly, the Town of Oakville has a variety of funding options for municipal natural asset management projects. For example, a bioswale project received partial funding from the Province of Ontario (F2 2021, para. 51). In another example, the Town of Oakville received funding from the Great Lakes Guardian Community Fund for the Bronte Bluffs Restoration and Water Quality Improvement. The project budget was set at \$25,000 for new plantings, slope stabilization, and the purchase and installation of a lookout. In the Town of Oakville's 2020 and 2021 Budget documents, municipal natural asset management is shifted between a variety of programs and departments. For example, in the 2020 Approved Operating Capital Budget, projects that align with municipal natural asset management are under the Development Engineering program budget, the Planning Services program budget, and the Parks and Open Space program budget (Town of Oakville 2020c).

However, in the 2021 Budget, most of the municipal natural asset management projects are under the Development Services program. For example, in the 2021 Budget and Business Plan, one of the key initiatives of the Development Service program is to “develop new policies

and procedures that complement and protect new natural assets which serve to enhance our natural areas and complement our Biodiversity Strategy” (Town of Oakville 2021a, pg. 29). The projects in the recommended capital budget for 2021 include erosion work for Munn’s Creek (\$1,213,000), storm pond maintenance (\$105,000), and Environmental Studies and Monitoring (\$70,000) (Town of Oakville 2021a, pg. 36). However, under the key initiatives section for the Parks and Open Space program, work is scheduled for the implementation of an invasive species strategy and an update to the Urban Forest Strategic Management Plan. Capital projects include parks and trail maintenance (Town of Oakville 2021a, pg. 238). Although municipal natural asset management projects are not recorded under a single program, each of these projects is appropriately budgeted. Therefore, the Town of Oakville received a Dark Green score (Fig. 18).

5.3.4 New Policies

Most municipalities have not created new natural asset management policies, strategies, and plans. Many of the municipalities are focused on implementing policies that align with municipal natural asset management rather than creating new policies. Municipal staff are aware of the need to create new policies, strategies, and plans that are specific to municipal natural asset management. However, the municipalities did not change existing plans, strategies, or programs to implement natural asset management plans, strategies, or programs.

Town of Gibsons

The Town of Gibsons is developing an urban forestry plan by committing to developing a Reforestation Strategy, a complete tree inventory, establishing a target tree density, developing a Tree Management Plan, and adopting a Tree Preservation Bylaw (Town of Gibsons 2020d, pg. 4; Town of Gibsons 2020a, pg. 2; Town of Gibsons 2021b). Some of this projected work has

already started. For example, through acquiring LiDAR data for the Town of Gibsons, the current extent of the urban forest was determined, which will be the basis for establishing the tree density target. The 2020 Budget Supporting Document also lists several other projects for municipal natural asset management. This includes a Fringe Area Plan for the co-management of regional natural assets (Town of Gibsons 2020a, pg. 3). The Town of Gibsons has also begun creating a long-term master plan for its marine foreshore area (Kerr Wood Leidal Associates 2014, pg. 1). Several municipal natural asset management projects will contribute to this master plan, including a foreshore condition assessment, the Source to Sea Project, the Healthy Harbour Project, and a Coastal Resilience Project with the Municipal Natural Assets Initiative (Vadeboncoeur & Mathews 2014).

Finally, the Town of Gibsons also created a Harbour Area Plan with several policies to protect marine natural assets. For example, Policy 5.3.3 of the Plan states that the Town of Gibsons will “maintain and enhance the natural shoreline and aquatic zone through planting, by avoiding “hard” infrastructure in the foreshore, and by creating wetlands and marsh areas for habitat and to protect shorelines against erosion from currents, fetches, and wakes (Town of Gibsons Harbour Area Project Team 2015, pg. 33). Therefore, the Town of Gibsons has created many new policies, strategies, and plans for municipal natural asset management. For this reason, the Town of Gibsons received a Dark Green score for this indicator (Fig. 18).

City of Grand Forks

In the City of Grand Forks, no new municipal natural asset management policies, plans, strategies, or procedures have been created (M2 2021, para. 23). However, staff are aware of the need to create ecosystem service-based planning, but this planning has not been embraced or prioritized by senior management. The City of Grand Forks has completed a sensitive ecosystem

inventory and mapping supported by LiDAR data, which will be used to support future policy creation (Durand 2018). As the City of Grand Forks is aware of the need to create new municipal natural asset management policies, they received a Red score for this indicator (Fig. 18).

District of Vancouver

The District of West Vancouver has created a few new policies, strategies, or plans that apply municipal natural asset management principles and practices. For example, the District of West Vancouver created the Shoreline Protection Plan 2012-2015 to protect and enhance one of the community's "greatest natural assets" (DWV 2012b). This plan listed twelve short-term and long-term priority projects to build on earlier success and enhance the shoreline area. The District of West Vancouver also created a Foreshore Development Permit Area which will control where development is allowed on the coastal floodplain. The permit area is based on calculations of interim flood construction levels for the District of West Vancouver coastline (Keith 2020a, pg. 64). The District of West Vancouver has also created a North Shore Sea Level Rise Risk Assessment and Adaptation Management Strategy to create a coordinated set of action areas to manage the risk of sea-level rise (Kerr Wood Leidal Associates 2021, pg. 1). One of the recommended actions is to "incorporate findings and adaptation measures into asset management and/or natural asset management plans" (Kerr Wood Leidal Associates 2021, pg. 8-4) and to "restore naturally resilient environments" (Kerr Wood Leidal Associates 2021, pg. 7-8).

Finally, the District of West Vancouver completed a LiDAR Tree Canopy Study in 2020 to produce evidence of the efficacy of the Interim Tree Bylaw. Findings showed that the total tree canopy increased from 2013 to 2018 for the entire District of West Vancouver and within the area of existing neighbourhoods (Keith 2020b, pg. 19). Based on the results of the study and to maintain this tree canopy, staff proposed no change to protected tree size, no increased

flexibility to remove trees, additional protected tree species, and tree protection on neighbouring lots during construction activities (Keith 2020b, pg. 20). In conclusion, the District of West Vancouver received a Yellow score for this indicator as there is a lack of plans, policies, or strategies that centre on municipal natural asset management.

City of Nanaimo

The City of Nanaimo is responsible for the Buttertubs Marsh Conservation Area (BMCA) Management Plan. “The goal of this document is to update information, highlight achievements and prioritize the next steps through the establishment of management targets” (City of Nanaimo et al. 2017, pg. 6). Also included in the BMCA Management Plan is a description of all ecosystems displayed in five distinct management zones. These management zones are based on ecological features and an updated Terrestrial Ecosystem Mapping. For each management zone, a description of the vegetation, wildlife, or habitat values is provided. In addition, the BMCA Management Plan describes the land use activity, the management direction, priority management actions, and five-year management targets for each of the management zones (M3 2021, para. 45).

Next, the City of Nanaimo has a Climate Change Resilience Strategy. This Strategy has six themes for climate adaptation action along with several objections and priority actions. One of the priority actions is to inventory the City of Nanaimo’s natural assets and incorporate them into the City’s asset management program to protect and maintain their function (City of Nanaimo 2020a, pg. 24). The City of Nanaimo has committed to completing a natural asset inventory and strategy by 2022, with work scheduled to begin in 2021 (City of Nanaimo 2020a, pg. 4). Finally, the City of Nanaimo has also collaborated on the Coastal Douglas-fir and Associated Ecosystems Conservation Partnership Conservation Strategy (CDFCP 2021). In

conclusion, the City of Nanaimo created several new policies that align with municipal natural asset management practices. However, some scheduled plans, policies, and strategies have not yet been created. Therefore, the City of Nanaimo received a Yellow score for this indicator (Fig. 18).

Town of Oakville

The Town of Oakville has developed several climate action policies, strategies, and plans that support municipal natural asset management. First, the Town of Oakville's Climate Change Strategy aims to increase the Town of Oakville's capacity to protect against and respond to the effects of climate change by presenting climate data from Environment Canada (Town of Oakville 2015). The Strategy uses pictogram symbols and a vulnerability scale to describe potential climate change impacts (Town of Oakville 2015, pg. 5-6). As well, the Climate Change Strategy includes adaptation actions for creeks, channels, urban forests, trails, and other natural areas.

Second, the Urban Forest Strategic Management Plan recognizes the Town of Oakville's urban forest as green infrastructure. The Plan describes the extensive benefits that the urban forest provides, including reducing air pollution, cooling, windbreaking, shading, improving water quality, habitat, and aesthetic appreciation (Urban Forest Innovations & Kenney 2008, pg. 2). The Urban Forest Strategic Management Plan sets performance indicators, such as a 40% tree canopy cover (Urban Forest Innovations & Kenny 2008, pg. 9). According to interviewed staff, the Forestry Department does a physical tree count every 10 years and is currently completing the 2021 tree inventory (M4 2021, para. 67).

Third, the Town of Oakville adopted the Oakville Strategy for Biodiversity in 2018. The Strategy recognizes the natural areas and watercourses in the ravines of Bronte Creek, 14 Mile Creek, and 16 Mile Creek as well as the woodlands of North Oakville and Iroquois Shoreline Woods as some of the most important and best quality natural habitats to support native species biodiversity (Town of Oakville 2018c, pg. 16). Also in 2018, the Town of Oakville implemented the 2019-2022 Environmental Sustainability Strategy (ESS). “The ESS provides an overarching environmental sustainability vision, while also bringing together environmentally-related deliverables set out in the town’s other master plans and strategies, and sets out new actions where there are gaps in implementation” (Town of Oakville 2018d, pg. 7). Under the Sustainable Environment theme of the ESS, actions related to municipal natural asset management include (i) implementing a Stormwater Master Plan and (ii) accounting for natural capital and ecosystem services in financial planning using the municipal natural asset management pilot study (Town of Oakville 2018d, pg. 21). In conclusion, the Town of Oakville has already created several policies, strategies, and plans that align with municipal natural asset management. However, some of the actions mentioned in these documents have not yet been completed. Therefore, the Town of Oakville receives a Light Green score for this indicator (Fig. 18).

5.4 Ecosystem Rehabilitation and Restoration Outcomes

5.4.1 Ecosystem Service Quality Metrics

The ‘ecosystem service quality metric’ indicator had the lowest scores in this evaluation. Most municipalities have created or identified a few ecosystem service quality metrics such as water quality as required by provincial law. However, they have not identified ecosystem service quality metrics for all the major municipal ecosystem services in their respective natural asset inventories. For example, one metric that was not included in any of the municipalities was a

cultural ecosystem service quality metric. As one of the four main categories or types of ecosystem services, measuring cultural ecosystem services should be included and accounted for in decision-making. The municipalities that already have ecosystem service monitoring program received higher scores for this indicator (Light Green). As well, municipalities that have created new natural asset management policies, plans, and strategies included ecosystem service quality metrics or measurements.

Town of Gibsons

The Town of Gibsons monitors several basic ecosystem service quality metrics and measurements. In total, the Town of Gibsons collects quantitative data for ecosystem service quality metrics for water quality, air quality, aquifer recharge level, stormwater service provision, flood mitigation servicing, habitat provision, and qualitative data on user well-being. The Gibsons' Aquifer, the Whitetower Park Stormwater Ponds, and the Healthy Harbour Project are the three major natural assets where ecosystem services are monitored. The Town of Gibsons monitors water quality, water storage, aquifer recharge level, recharge temperature, and water supply for the Gibsons' Aquifer (Waterline Resources 2013a).

For the Healthy Harbour Project, ecosystem service monitored are the biota and benthic elements of the marine ecosystems, including eelgrass, herring, crabs, salmon, and clams (Machado & NSMEC 2019, pg. 4). Specifically, the Town of Gibsons recognizes that eelgrass beds “provide the infrastructure service of attenuating wave activity during storm surge events and help prevent coastal erosion, maintaining the foreshore’s integrity. In turn, these services protect the upland public and private properties and essential municipal infrastructure, including sewer services” (NSMEC 2020a, pg. 10). Finally, for the Whitetower Park Stormwater Ponds, major ecosystem services monitored are stormwater management services (Sahl et al. 2016;

Newman 2021c). In conclusion, almost all major ecosystem service categories in identified natural assets have some form of metric or measurement in the Town of Gibsons. However, the Town of Gibsons has not created or identified a cultural ecosystem service quality metric. Therefore, the Town of Gibsons received a Light Green score for the Service Quality Metrics indicator (Fig. 18).

City of Grand Forks

One ecosystem service quality metric that the City of Grand Forks has identified is habitat suitability for the Western Rattlesnake and Lewis's Woodpecker. "Each class and subclass [were] assessed by local biologist Jenny Coleshill (Granby Wilderness Society) using a four-rank system (nil, low, medium, and high) for its suitability to provide features selected by the species for living (feeding, travel) and breeding (large cottonwood snags) or denning (rock and talus caves and crevasses)" (Durand 2018, pg. 34). However, these rankings do not consider actual species occurrence data or classify ecosystems (Durand 2018, pg. 41).

The City of Grand Forks also completed a sensitive ecosystem inventory and mapping. Phase 1 of this study was an air photo interpretation supported by LiDAR which resulted in a canopy model (M2 2021, para. 17). Through their sensitive ecosystem inventory and mapping classification, the City of Grand Forks has recognized their old forest, broadleaf woodland, woodland, grassland, sparsely vegetated, riparian, wetland, and freshwater ecosystems as sensitive (Durand 2018, pg. 12). Interviewed staff mentioned that they will use this data to select sites for future ecosystem rehabilitation and restoration projects (M2 2021, para. 19). In conclusion, the City of Grand Forks identified some preliminary ecosystem service quality metrics. However, these metrics only address a few aspects of ecosystem service quality. Therefore, the City of Grand Forks received an Orange score for this indicator (Fig. 18).

District of Vancouver

In the District of West Vancouver, ecosystem service quality is measured through the valuation estimation of services. In the District of West Vancouver's natural asset inventory, ecosystem service valuations were prepared for the forest, waterways, foreshore, and parks. For the forests, ecosystem services valued include clean water supply and filtration, stormwater management, clean air, carbon sequestration, habitat, and recreation (Solsticeworks 2019, pg. 10). For waterways, the ecosystem services valued are clean water supply, water regulation, water filtration, habitat, and recreation (Solsticeworks 2019, pg. 16). For the foreshore area, the ecosystem services valued are storm surge protection, erosion regulation, recreation, and habitat. For parks, the only ecosystem service valued is recreation.

However, these valuations are conceptual estimates and not a ledger. Thus, these valuation estimates do not reflect changes in real-time. In other plans, strategies, and policies, some ecosystem service quality metrics and measurements were created. For example, the District of West Vancouver's Integrated Stormwater Management Plan measures baseline water quality, benthic invertebrate, and flow (Kerr Wood Leidal Associates 2017). In conclusion, the District of West Vancouver identified a few preliminary ecosystem service quality metrics. However, these metrics are related to the valuation of services. Therefore, the District of West Vancouver received an Orange score for this indicator (Fig. 18).

City of Nanaimo

The City of Nanaimo monitors some ecosystem service quality metrics for the Buttertubs Marsh Conservation Area (BMCA). As part of the Conservation Agreement between Ducks Unlimited Canada and the Province of British Columbia, bio-inventory monitoring is conducted

every five years (City of Nanaimo et al. 2017, pg. 8). There is also monitoring for wildlife and vegetation through a Species at Risk inventory. Finally, one of the priority management actions for the land management areas is to “establish permanent baseline monitoring plots/transects” (City of Nanaimo et al. 2017, pg. 20). According to interviewed staff, the City of Nanaimo uses the Province of British Columbia’s sensitive ecosystem inventory as a metric to help staff identify key areas when trying to acquire additional parkland (M3 2021, para. 49).

Finally, the Millstone River Ecological Accounting Process built in basic ecosystem service monitoring metrics that the City of Nanaimo will have access to (Partnership for Water Sustainability in BC 2021b). These metrics include hydrological function, aesthetic uses, intrinsic nature values, and support of municipal infrastructure. While the City of Nanaimo selected and monitored some ecosystem service quality metrics, the City of Nanaimo has not identified or created a metric for the BMCA. In addition, the City of Nanaimo has not identified an ecosystem service metric for cultural ecosystem services. Therefore, the City of Nanaimo received a Yellow score for this indicator (Fig. 18).

Town of Oakville

In the North Oakville area, the Town of Oakville identified four sites for monitoring. In each of these sites, the Town of Oakville monitors several water quality metrics including temperature, chloride, and phosphorous (F2 2021, para. 74). Most of the monitoring metrics are for total suspended solids (TSS) which are then shared through the State of the Environment reporting program. In 2015, the Town of Oakville reported that the “maximum levels of TSS decreased in all creeks, with the most significant drop appearing in Fourteen Mile” (Environmental Policy Department 2016, pg. 3).

The Town of Oakville also monitors the amount of green space area and biodiversity quality in green space. “In 2015, there was a total of 2,501 hectares of publicly held open space, 1,522 hectares of that is town owned” (Environmental Policy Department 2016, pg. 3). When the Town of Oakville adopted the Oakville Strategy for Biodiversity (OSB), targets and indicators were created to report on biodiversity improvements. The OSB targets include direct and indirect measures of biodiversity protection. Direct measures of biodiversity protection are measurements that monitor species groups such as Species at Risk or invasive species, habitats that support biodiversity, and the quality of aquatic habitats (Town of Oakville 2018c, pg. 82). Indirect measures of biodiversity protection are measurements that assess the success of programs and policies that identify, protect, enhance, and restore biodiversity. In conclusion, the Town of Oakville monitors several ecosystem service quality metrics. However, the Town of Oakville has not identified a cultural ecosystem quality metric or measurement. Therefore, the Town of Oakville received a Light Green score for this indicator (Fig. 18).

5.4.2 Rehabilitation Site Selection

All municipalities identified at least one site for an ecosystem rehabilitation and restoration project. Therefore, all municipalities received a Dark Green score for this indicator (Fig. 18). Most of these sites were identified in other plans, strategies, or policies that then align with municipal natural asset management. These sites were not contaminated or heavily polluted, but did require some form of infrastructure improvement, restoration of a major ecosystem feature, or rehabilitation to maximize ecosystem function. Finally, municipal champions, partnered organizations, or concerned residents could advocate for a specific site rehabilitation and restoration through various communication channels.

The Town of Gibsons identified the Whitetower Park as the site for the construction of an additional stormwater pond to settle out sediments and remove pollutants from the stormwater before it enters the adjoining Charman Creek (Town of Gibsons 2020b). “The expansion will enable the stormwater ponds to service 47.7 hectares of land and help address long-term erosion and water quality impacts of past development on Charman Creek” (Town of Gibsons 2020b, para. 3). Charman Creek has also been the subject of resident-led efforts to protect a 13-hectare parcel of the land (Eckford 2018; Woodrooffe 2020a). For the Healthy Harbour Project and the Source to Sea Project, if rehabilitation or restoration is needed for a specific area, there are stipulations in project documents for this work. For example, the Healthy Harbour Project identified the Gibsons Landing marine facility as requiring restoration for eelgrass cover (NSMEC 2020a, pg. 17; Woodrooffe 2020b). Therefore, the Town of Gibsons has identified a few sites for ecosystem rehabilitation and restoration and received a Dark Green score for this indicator (Fig. 18).

City of Grand Forks

The City of Grand Forks is operating under two different project scales for the identification of rehabilitation and restoration sites. The first scale of rehabilitation and restoration projects is the restoration of riparian cottonwood ecosystems along the banks of the Kettle and Granby rivers (M2 2021, para. 12). This restoration project has led to 450 to 500 linear metres of restored riverbank through planting and bioengineering to restore plant cover and habitat quality in the project area. The second scale of projects is the large scale floodplain restoration under the DMAF program charter. The neighbourhoods of North Ruckle, South Ruckle, and Johnson Flats will be restored to a natural floodplain, Oxbow wetland, re-contoured wetland areas, floodways, or restored riparian area (M2 2021, para. 15). These natural

floodplains will provide more room for high water flows during flood events and protect sites from erosion. As well, the City of Grand Forks will construct engineered and hybrid infrastructure such as dikes and earth berms (Dinsdale & City of Grand Forks 2020, pg. 8). In conclusion, the City of Grand Forks has identified multiple sites for restoration projects and thus received a Dark Green score for this indicator (Fig. 18).

District of Vancouver

In the District of West Vancouver’s Vinson, Brothers, and Hadden Creek Integrated Stormwater Management Plan, fifteen project sites were identified for improvement, including for invasive species management, riparian protection, restoration, planting, stream daylighting, and in-stream habitat enhancement (Kerr Wood Leidal Associates 2017, pg. 7-7 – 7-9). As well, the North Shore Sea Level Rise Risk Assessment and Adaptive Management Strategy identified several Comprehensive Adaptation Planning Zones (CAPZ). CAPZ are areas on the North Shore where flooding could extend “well beyond the first row of development/properties” (Kerr Wood Leidal Associates 2021, pg. 7-12). For each CAPZ, the planning context, probability of flooding, and initial integrated adaptation concepts are presented in the Strategy. Some of these concepts include ecosystem restoration and adaptation through re-establishing natural shoreline materials to prevent erosion. In conclusion, the District of West Vancouver identified a site for rehabilitation or restoration as part of existing initiatives. Therefore, the District of West Vancouver received a Dark Green score for this indicator (Fig. 18).

City of Nanaimo

The City of Nanaimo maintains a large inventory of sites identified for monitoring and ecosystem restoration. These sites are Departure Bay Centennial, East Wellington Park,

Harewood Centennial Park, Linley Point Gyro Park, Nanaimo Estuary, Robin's Park, Third Street Park, and Woodstream Park. For some of these sites, the City of Nanaimo has installed Chronolog photo monitoring so staff and residents can observe restoration progress over time. However, the major site for ecosystem rehabilitation and restoration in the City of Nanaimo is the Buttertubs Marsh Conservation Area (BMCA). The land management directions in the BMCA Management Plan describe the current land use, the management direction, priority management actions, and five-year management targets (City Nanaimo et al. 2017). Under the restoration land use activity, priority management actions are to map invasive species, remove invasive species, plant native species, and manage the south boundary (City of Nanaimo et al. 2017, pg. 20). In conclusion, the City of Nanaimo has identified several sites for ecosystem rehabilitation and restoration and received a Dark Green score for this indicator (Fig. 18).

Town of Oakville

The Town of Oakville's Creek Inventory and Assessment Study describes erosion concerns for each of the creeks within the Town's boundaries. For example, Munn's Creek's bank protection measures are failing, and eroding banks are putting recreational trails and private property at risk (Aquafor Beech 2016, pg. 29). To address these erosion concerns, an armour stone retaining wall will be built and the slope on the east side of the stream will be restored (Aquafor Beech 2020, pg. V). In the Town of Oakville's Shoreline Inventory and Assessment Report, potential shoreline restoration sites are assigned a structure and safety score based on two separate evaluation scales. This report identifies the top ten priority sites that received the lowest overall scores (Shoreplan Engineering 2017). In 2018, Town Council approved \$3,789,000 in funding to cover several high-priority restoration projects related to significant flooding that the Town of Oakville experienced in 2017 (Mark & Kelly 2018, pg. 2). Sites

identified in the Shoreline Inventory and Assessment Report were monitored for changes brought on by new flooding. In conclusion, the Town of Oakville identified several sites for ecosystem rehabilitation or restoration and therefore, received a Dark Green score for this indicator (Fig. 18).

5.4.3 Monitoring Indicators

All municipalities evaluated created or identified at least one indicator that relates to municipal natural asset management. Therefore, all municipalities in this cohort received a Dark Green score for this indicator (Fig. 18). Most of the indicators focus on ecosystem service provision, capital or operating costs, changes in management and operations, and growing protected ecosystem areas. As well, most of these indicators were identified in other programs, policies, strategies, or plans. However, these documents specifically mention municipal natural asset management or use similar management and operation practices.

Town of Gibsons

In the Town of Gibsons, several indicators were identified for each natural asset management project. For example, as part of the ongoing Level 3 Eelgrass Assessment for the Healthy Harbour Project, plant density, level of biodiversity, shoot length, identifiable species, leaf area index, and the location and number of buoys were identified as indicators for eelgrass sites (NSMEC & Town of Gibsons 2020, pg. 2). These indicators were selected based on best practices for mapping and monitoring eelgrass habitat in British Columbia (Environment Canada & Precision Identification Biological Consultants 2002). For the Gibsons' Aquifer, identified indicators include renewable groundwater resources per capita, total groundwater abstraction and recharge, number of contaminated sites, groundwater contribution to base flow, and public

outreach on groundwater sustainability (Waterline Resources 2013b, pg. 217). Finally, the Town of Gibsons staff also noted that a tree density target will be the primary indicator for an upcoming Urban Forest Plan and Tree Management Plan. In conclusion, the Town of Gibsons has identified more than one key indicator for natural asset management projects and has been awarded a Dark Green score for this indicator (Fig. 18).

City of Grand Forks

The City of Grand Forks' DMAF Program Priority Matrix identified a few indicators for property acquisition and floodplain restoration. These indicators are (i) property acquisition required, (ii) critical infrastructure protection, (iii) protection of public safety, and (iv) public opinion (Dinsdale & City of Grand Forks 2020, pg. 20). During interviews, staff mentioned that the most important indicator for the City of Grand Forks is the area of floodable land (M2 2021, para. 25). This indicator will take a municipal natural asset management approach for monitoring the conveyance capacity of the land. Second, staff mentioned incorporating a flood management cost indicator which would encompass both private and public costs of continued flooding and flood responses (M2 2021, para. 26). Therefore, the City of Grand Forks has identified multiple indicators for municipal natural asset management and thus received a Dark Green score for this indicator (Fig. 18)

District of Vancouver

The District of West Vancouver already has several indicators that staff monitor for municipal operations and management. However, these indicators are not specific to municipal natural asset management. In interviews, staff described three indicators under consideration: interface between constructed and natural infrastructure (F1 2020, para. 30), sea-level rise (F1

2020, para. 37), and flood risk (F1 2020, para. 40). In the North Shore Sea Level Rise Risk Assessment & Adaptive Management Strategy, several indicators are listed as targets to monitor and evaluate progress and outcomes. These indicators are specific to “tracking the progress of implementing this Strategy and outcomes of sea-level rise adaptation (Kerr Wood Leidal Associates 2021, pg. 8-6). In the Vinson, Brothers, and Hadden Creek Integrated Stormwater Management Plan, performance indicators were identified as part of a monitoring framework. These indicators include dissolved oxygen, temperature, pulse count, flow duration, mean taxa richness and number of erosion sites (Kerr Wood Leidal Associates 2017, pg. 8-5). These indicators will be monitored for municipal natural asset management purposes. Therefore, the District of West Vancouver was awarded a Dark Green score for this indicator (Fig. 18).

City of Nanaimo

The City of Nanaimo created several draft indicators for monitoring progress for the upcoming Official Community Plan. The indicators that could align with municipal natural asset management are “the area of lands dedicated for natural area protection” and “water samples meeting British Columbia’s water quality guidelines” (City of Nanaimo 2021d, pg. 9). The City of Nanaimo also created draft targets or benchmarks for each of these indicators. For example, the current draft target for “the area of lands dedicated for natural area protection” is an increase in area, with a specific target yet to be determined. In the City of Nanaimo’s Climate Change Resilience Strategy, several adaptation-related indicators were created. These indicators are (i) growth in the volume of water stored, (ii) value of assets in unprotected future floodplain, (iii) canopy cover, and (iv) capital infrastructure projects assessed for climate risk (City of Nanaimo et al. 2020, pg. 37). In conclusion, the City of Nanaimo created several indicators useful for

monitoring and evaluating municipal natural asset management and received a Dark Green score for this indicator (Fig. 18).

Town of Oakville

In the Town of Oakville’s Environmental Sustainability Plan, municipal staff developed a State of the Environment reporting program to provide data on key indicators. The State of the Environment monitors fifteen indicators that are organized under four themes. Under the “Sustainable Environment” theme, the Town of Oakville monitors water quality, permeable surface area, air quality, and area of green space (Town of Oakville 2018d). Results show that from 2013-2018, the Town of Oakville added 18 hectares of land as green space (Town of Oakville 2018d, pg. 50).

The Town of Oakville also monitors the “number of education and outreach programs that increase community awareness on environmental sustainability issues”. By monitoring the number of events that the Town of Oakville hosts and/or participates each year, it can help “assess efforts in raising the profile of the environment and supporting [sic] households and businesses in their sustainability efforts” (Town of Oakville 2018d, pg. 61). Finally, the Town of Oakville has an Urban Forest Health Monitoring Program. The Town of Oakville’s woodland areas are assessed each year on a three-year rotation. A report card is then produced which monitors indicators for invasive plant presence and animal presence as well as ash tree mortality (Town of Oakville 2020a). In conclusion, the Town of Oakville identified several indicators for monitoring and evaluation and was awarded a Dark Green score (Fig. 18).

5.5 Service Delivery Outcomes

5.5.1 Monitoring Co-Benefit Metrics

Most municipalities had little available data to show they are reaching service delivery outcomes. Therefore, scores are either low (Yellow, Orange, and Red) or there was no available data to give a score (Grey). Based on the timings in the evaluation matrix, this was expected given that the initial program intervention was introduced in the municipalities only a few years ago. As well, natural assets must be restored or rehabilitated to a level where they are delivering ecosystem services and the municipality is tracking that service delivery. For example, most municipalities have not identified or created co-benefit metrics. Therefore, municipalities did not have data that showed an “increase in co-benefits from municipal natural asset management”.

Town of Gibsons

The Town of Gibsons has listed potential co-benefits from upcoming municipal natural asset management projects. These co-benefits include (i) improvements to biodiversity and habitat creation, (ii) improvements to water quality, retention, and absorption, (iii) improvements to livability, (iv) cost savings, (v) increased human health and wellbeing, (vi) enhanced carbon storage and green space, and (vii) greater recreation opportunities (Town of Gibsons 2020a). As well, the Town of Gibsons also recognized potential co-benefits from the restoration of eelgrass from the Healthy Harbour Project. However, the Town of Gibsons has not identified or created any specific co-benefit metrics for these identified co-benefits. Additionally, the Town of Gibsons does monitor a few public health co-benefit metrics for the Gibsons’ Aquifer. These co-benefit metrics include Escherichia Coli levels, total Coliform levels, the absence of contaminants, amount of water pumped, colour, pH, and numerous other metrics of public health

interest (M1 2020, para. 24; Waterline Resources 2021, pg. 2-15; Town of Gibsons 2018b). With some positive data to report, but a lack of overwhelming evidence, the Town of Gibsons receives an Orange score for this indicator (Fig. 18).

City of Grand Forks

The City of Grand Forks received a Grey score for this indicator (Fig. 18). The City of Grand Forks is currently focused on restoring key floodplain and wetland areas and has not identified or created any co-benefit metrics. However, documents do describe potential co-benefits that restored floodplains and wetlands could provide. These co-benefits include new sites for recreation, species habitat, and the stabilization of downtown economic development (City of Grand Forks 2019, pg. 1). Interviewed staff also mentioned that the City of Grand Forks is aware of co-benefits provided by their urban forest, and they will monitor co-benefits using LiDAR tools (M2 2021, para. 21).

District of Vancouver

In the District of West Vancouver's natural asset inventory, potential co-benefits are listed such as aesthetic appreciation, public health, increased property values, education, tourism, and culture (Solisticeworks 2019). The District of West Vancouver also included some preliminary valuation for co-benefits gained from natural assets in their natural asset inventory. For example, the potential educational benefits for engaging students in a stream daylighting project were valued at \$192,000 in 2017 (Solisticeworks 2019, pg. 15). However, no co-benefit metrics were identified. Thus, the District of West Vancouver received a Grey score for this indicator (Fig. 18)

City of Nanaimo

The City of Nanaimo also has not identified or created co-benefit metrics or measurements. However, several key documents list potential co-benefits. For example, in the City of Nanaimo’s Climate Change Resilience Strategy, one of the additional actions is to “assess the potential economic benefit to the City as a result of climate change to help offset costs” (City of Nanaimo et al. 2020, pg. 32). The City of Nanaimo’s Urban Forestry Management Strategy also lists potential co-benefits (City of Nanaimo 2010, pg. 15). In conclusion, until a co-benefit metric is identified or created a positive score for this indicator cannot be given. Therefore, the City of Nanaimo receives a Grey score (Fig. 18).

Town of Oakville

Finally, the Town of Oakville has not identified or created a co-benefit metric for municipal natural asset management. As part of the Town of Oakville’s State of the Environment Report, air quality health is measured, but air quality is not linked to natural asset protection, conservation, rehabilitation, or restoration (Town of Oakville 2018d, pg. 48). Therefore, the Town of Oakville received a Grey score for this indicator (Fig. 18).

5.5.2 Municipal Budget for Grey Infrastructure Renewal

For a “decrease in municipal budget spent on retrofitting and renewing grey infrastructure”, most municipalities actually had an increase in budget forecasting which resulted in Red scores (Fig. 18). Despite efforts made to integrate municipal natural asset management, budgeting is still focused on grey infrastructure renewal. As well, funds dedicated to this renewal have grown in consecutive years in almost all municipalities evaluated. Finally, some municipalities are anticipating funding shortfalls due to reduced revenue generation from the COVID-19 Pandemic and increased spending to fund healthy and safety protocols.

Town of Gibsons

The Town of Gibsons received a Yellow score (Fig. 18) as interviewed staff were able to share some data that municipal natural asset management saved the Town of Gibsons \$0.75 on the dollar for an engineered alternative to a drainage system in Upper Gibsons. The engineered alternative was expected to cost \$4,500,000. However, the expansion of a stormwater pond cost only \$955,000 (M1 2020, para. 30). The Town of Gibsons is also building a model to calculate overall return on investment valuation for all infrastructure improvements needed per square kilometre. Thus, the Town of Gibsons would be able to calculate the returns from replanting the forest, restoring the integrity of major creeks, and redesigning the foreshore (M1 2020, para. 31).

City of Grand Forks

In the City of Grand Forks, the net book value of Tangible Capital Assets increased from 2019 to 2020 by \$6,260,516. The net book value of Tangible Capital Assets under construction decreased by \$1,802,592 across Tangible Capital Asset categories (City of Grand Forks 2020c, pg. 17). However, it is not clear whether this decrease is due to municipal natural asset management or the purchase of new assets which is causing the increase in net book value for Tangible Capital Assets. Therefore, a Red score was given for this indicator (Fig. 18).

District of West Vancouver

In the District of West Vancouver, interviewed staff mentioned that grey infrastructure renewal comes before municipal natural asset management (F1 2020, para. 43). Staff also mentioned that the District of West Vancouver is continuing to search for new ways to fund municipal natural asset management. In conclusion, the District of West Vancouver has not

reduced funding for grey infrastructure renewal. Therefore, the District of West Vancouver receives a Red score for this indicator (Fig. 18).

City of Nanaimo

In the City of Nanaimo's 20 Year Infrastructure Investment Plan, the City of Nanaimo is anticipating significant projected funding shortfalls for the General Fund (\$124 million) and the Water Fund (\$121 million) (City of Nanaimo 2017, pg. 12). However, municipal natural asset management is not included in the 2020-2024 Financial Plan or the 2021-2025 Draft Financial Plan. This is consistent with interview responses that described the City of Nanaimo's municipal natural asset management approach as "piecemeal" (M3 2021, para. 24). In conclusion, the City of Nanaimo has a significant funding shortfall for traditional assets that will require various strategies. However, municipal natural asset management is not mentioned as one of these strategies. Therefore, the City of Nanaimo received a Red score for this indicator (Fig. 18).

Town of Oakville

Staff from the Town of Oakville stated that municipal natural asset management, green infrastructure and low-impact development are a complement to grey infrastructure and these strategies do not "negate the need for end-of-pipe infrastructure" (F2 2021, para. 83). The Town of Oakville lacks a clear financial accounting system for municipal natural asset management. In the Town of Oakville's Financial Statements, operating and capital budgets for the asset management program are expected to increase from \$746,000 in 2020 to \$1,129,500 in 2023 (Town of Oakville 2021a, pg. E-48). Some new natural asset management projects are also listed under the Development Services program. However, without clear data showing a decrease in

grey infrastructure renewal due to municipal natural asset management, the Town of Oakville received a Red score for this indicator (Fig. 18).

5.7 Chapter Summary

In summary, this chapter presents the findings from the evaluation study from the Town of Gibsons, the City of Grand Forks, the District of West Vancouver, the City of Nanaimo, and the Town of Oakville. w

Chapter 6: Discussion

6.0 Introduction

This chapter compares the results presented in Chapter 5 with existing research on monitoring and evaluation, municipal natural asset management, and other ecosystem-based adaptation approaches. In addition, this chapter presents a few key lessons for municipalities and researchers that were learned throughout the research process. Finally, this chapter closes with recommendations for how municipalities can address low scores, how future research could further mitigate the limitations of the evaluation, and potential professional practice opportunities.

6.1 General Discussion

Based on the results of the evaluation, the municipalities evaluated have high scores for Awareness, Capacity and Education indicators and some Implementation indicators. Specifically, municipalities are making the public aware of municipal natural asset management through the creation of information materials, are adding capacity through the creation of partnerships, and are identifying barriers and opportunities to municipal natural asset management. However, municipalities are receiving lower scores for Ecosystem Rehabilitation and Restoration indicators and Service Delivery indicators. Specifically, municipalities have not created ecosystem service quality measurements or metrics for all ecosystem service types, have not created co-benefit metrics, and have not reduced spending on built infrastructure renewal. One of the most significant findings of this evaluation is that municipalities who have created policies, projects and programs that address ecosystem degradation and climate change adaptation are aligning those policy, project, and program mandates with municipal natural asset management.

However, this leads most municipalities to perceive municipal natural asset management as a component of existing climate adaptation and mitigation initiatives, rather than as a separate program intervention, which can lead to a piecemeal approach (Deetjen et al. 2018; Burch 2010; Burch et al. 2014).

The Town of Gibsons was the municipality that received the highest scores. Their experience with integrating municipal natural asset management has resulted in increased public awareness of natural assets, the creation of new partnerships for natural asset management projects, changes to key planning policy, the allocation of funds for natural asset management projects, and the creation of innovative programs and strategies that directly implement municipal natural asset management as a core tenet of the Town's sustainable service delivery. Even for the creation or identification of ecosystem service quality measurements or metrics and all service delivery indicators, the Town of Gibsons has higher scores in comparison to the other municipalities.

The District of West Vancouver received the lowest scores in this evaluation. While the District of West Vancouver built one of the first natural asset inventories in Canadian municipalities, the COVID-19 Pandemic created a considerable number of challenges (Gordon 2020). These challenges include the elimination of a Natural Capital and Climate Response levy, a reduction of the general asset management levy, the delay of several projects, and a reduced public awareness campaign. However, interviewed staff acknowledged the need to make municipal natural asset management a financial priority in the District of West Vancouver. There was also a lack of political support to fund the projects and programs needed to integrate municipal natural asset management. Therefore, intended program outcomes are lagging in the District of West Vancouver in comparison to the other municipalities in this cohort. Interviewed

staff mentioned that they are looking for direction on the next steps needed for a municipal natural asset management approach (F1 2020, para. 31).

Besides service delivery outcomes, where timing is the most significant factor, the “number of new natural asset management policies, strategies, and plans” and the “number of ecosystem service quality measurements and metrics” had the lowest indicator scores across the municipalities evaluated. Many municipal staff and officials have poor climate literacy which is a barrier to climate action. This can constrain department-wide understanding and incorporation of climate-related information into decision-making, such as ecosystem service quality measurements and metrics (Coningsby & Behan 2019). As well, municipalities are less likely to create new policies, strategies, and plans with limited climate change information and impact analyses. This can inhibit identifying and agreeing on adaptation goals (Reckien et al. 2015). Of particular concern was poor climate literacy among senior managers and city councillors which reduce the ability of environmental staff to secure funding. For example, the interviewed staff from the City of Grand Forks noted that senior management and political leadership have not prioritized ecosystem measurement planning (M2 2021, para. 23). High rates of staff turnover are also a barrier for creating new natural asset management policies, strategies, and plans and the number of ecosystem service quality measurements and metrics. Staff turnover can make it “difficult for municipal climate programs to mature and reach latter stages (i.e., from planning and pilot stages towards monitoring, reporting and program evaluation)” (Coningsby & Behan 2019, pg. 6). Four-year municipal election cycles and shifting priorities from the council create a similar barrier whereby funding and other supports are provided in a stop-start manner.

In addition, most municipalities are prioritizing ecosystem service monitoring for climate change mitigation over climate change adaptation (Guyadeen et al. 2019). Although managing

natural assets and ecosystem services does mitigate some of the effects of climate change, municipal natural asset management is categorized as a climate change adaptation strategy due to the attention it places on shifting municipal service delivery towards a resilient ecosystem service framework (Asset Management BC 2015). Thus, if municipalities are focused on climate change mitigation, they may not monitor metrics for climate change adaptation. For example, the Town of Oakville's participation in ICLEI Canada's Partners for Climate Protection program means that most climate-related policies, strategies, and plans will focus on mitigation and reducing GHG emissions (Guyadeen et al. 2019, pg. 133). There are several reasons that municipalities emphasize climate mitigation over adaptation. Adaptation is a complex issue that requires long-term strategies, commitments, and measures (Bassett & Shandas 2010; Betsill & Bulkeley 2006; Heidrich et al. 2013). As well, there is a need for specific biophysical indicators and measures for climate adaptation planning (Donatti et al. 2020).

Finally, the municipalities evaluated did not measure attendance for municipal natural asset management consultation events. If there is no data on how many people attended a particular consultation event, an attendance rate cannot be calculated. Therefore, almost all municipalities received Grey scores for this indicator. In general, most municipalities have low attendance rates for engagement events despite high resource inputs (Coningsby & Behan 2019, pg. 10). In survey research completed by Ipsos, only 20% of people who participated in the study said they have ever participated in a municipal public consultation, with 12% of those respondents saying they have done so in the past two years (Knaus 2017). Barriers to participation include lack of communication, availability, and the feeling that contributions will not have an impact on decision-making. Best practice insights that can help local governments improve public policymaking about climate change are (i) emphasizing climate change as a

present, local, and personal risk; (ii) facilitating more affective and experiential engagement; (iii) leveraging relevant social group norms; (iv) framing policy solutions in terms of what can be gained from immediate action; and (v) appealing to intrinsically valued long-term environmental goals and outcomes (van der Linden 2015).

The next few sections will discuss a few critical lessons learned throughout this evaluation that municipalities should be aware of when considering municipal natural asset management. While these lessons may not be universal for all municipalities, they should be viewed as potential opportunities to enable municipal natural asset management and to better use municipal resources.

6.2 Lesson 1: Activating and Enabling Local Partnerships and Champions

Partnerships and champions are key external and internal drivers for climate action in Canadian municipalities. All municipalities in this cohort manage at least one partnership for climate action. In some cases, the municipalities had several partnerships. Many municipalities have advanced a wide range of climate change programs in partnership with community organizations. These organizations include utilities, eNGOs, and conservation authorities. Overall, evaluation findings show that (i) municipalities are interested and capable of partnering with other organizations in the pursuit of municipal natural asset management, (ii) there is a variety of organizations, at the provincial, regional, and local levels that municipalities can partner with, and (iii) many of the interviewed staff expressed great appreciation for these partnerships. “Both the private and public sectors rely increasingly on NGOs and community-based groups to help meet current challenges, particularly labour and skills shortages” (Giguere 2003, pg. 3). Some municipalities, such as the Town of Gibsons with the Municipal Natural Assets Initiative, created and funded a local eNGO by creating a Terms of Reference (TOR) and

a board of directors. Another advantage of partnerships is that they can reduce municipal risk and resources by leveraging staff and community partner skills and experiences (Coningsby & Behan 2019, pg. 4). Municipalities in this cohort used their partnerships for community outreach, scientific expertise, and some ecosystem service monitoring.

Champions are also needed to advocate for municipal natural asset management. Community champions are people in the community who take on an issue or project and raise effective awareness and support for it (Lindsay et al. 2019). Champions do not require a measured level of expertise or skill to be a community champion but can still play a crucial role alongside professionals in leading change (Van de Kerkhof & Wieczorek, 2005). Community champions can offer insightful suggestions, can challenge potential “groupthink” of professionals, and set clear expectations for future cooperation (Lindsay et al. 2019). While municipal natural asset management has several beneficial outcomes for municipal service delivery and ecosystem rehabilitation and restoration, there may be questions from skeptical community members. There can also be urban growth pressures that threaten natural asset areas (Bengston et al. 2004). Community champions can address community concerns while ensuring that the process remains transparent and open.

Champions can emerge from municipal staff working on municipal natural asset management. To build policy capacity, personal motivation is one of the strongest positive predictors of increasing biodiversity efforts in municipal land-use planning (Allred et al. 2021, pg. 14). Influential champions can act as catalysts within a municipal organization to create a large coalition, energize staff, and push for beneficial program outcomes. In the City of Grand Forks, municipal natural asset management continues to be championed by a few planning staff members who led the municipality through their flood recovery efforts. “Because of the

interdisciplinary nature of their roles, planners would appear to represent ideal candidates to become champions of municipal natural asset management, who can take the necessary steps to lead the project and mobilize support for it” (Drescher et al. 2018 pg. 16). City of Grand Forks staff wear “multiple hats” for the municipality and are often involved in multiple projects (M2 2021, para. 44). As well, interviewed staff are already aware of the next steps for their municipal natural asset management program including ecosystem service planning and monitoring. Champions should be activated and enabled during the earliest stages of a municipal natural asset management program. Strong champions are needed to drive the process, overcome challenges, and push for program implementation throughout the local government.

6.3 Lesson 2: Building a Municipal Natural Asset Management Program

In addition to activating champions and nurturing partnerships with local organizations, municipalities must build capacity to integrate municipal natural asset management as a standalone program rather than as a component of other climate action initiatives. One of the ways municipalities can do this is by securing support from senior managers, city councillors, and other key decision-makers to properly integrate ecosystem service monitoring into municipal policies, plans and programs. Currently, most of the municipalities use municipal natural asset management practices on a per-project basis rather than as an entire policy or program. Municipal officials are more likely to create procedures, plans, and projects rather than policies as policies need approval from the local council. “This process is more complicated and fraught with opposition to increased regulation” (Allred et al. 2021, pg. 14). Integrating climate change into the Official Plan provides a direct mandate for the implementation of climate actions related to land use planning and development (Coningsby & Behan 2019).

For municipal natural asset management, this planning integration must include provisions for monitoring ecosystem services and creating new municipal natural asset management policies. One way to build added capacity for municipal natural asset management programs is to share data on local ecosystem degradation and biodiversity loss with vocal stakeholders and municipal leaders (Allred et al. 2021; Howlett 2015). As well, municipalities can work together on a regional basis to bridge capacity needs and share resources, including staff. Intermunicipal collaboration is an effective strategy for addressing different aspects of natural asset management, including connectivity, watershed protection, and climate action.

In addition, few municipalities account for and track a municipal natural asset management program in their financial documents. Current financial asset management standards in North America are ill-equipped to “fit” natural assets into existing asset management practices (Matsler 2019). One reason for this is that components of natural assets (such as trees, soils, and bodies of water) cannot be recorded into financial documents. While changes are needed at the provincial and federal levels to enable municipal accounting of natural assets, municipalities can also shift their reporting in some ways to account for ecosystem service provision. For example, the Town of Gibsons added a Tangible Capital Asset Notes to their financial statements that acknowledges “the importance of natural assets and the need to manage them in conjunction with engineered assets” (Town of Gibsons 2018a, pg. 10). There can also be tensions on what valuation methods should be used. For example, most asset management programs use replacement cost and not service value “to value assets because their goal is to assess all physical assets in a consistent way across all sectors that is comparable to all other businesses and municipalities” (Matsler 2019, pg. 166). Replacement costs for physical assets are much more available than replacement costs for natural assets, especially at the

component level. Therefore, incorporating ecosystem service quality metrics and measures is needed to ensure comparable data.

However, natural asset accounting standards “presents society with a double-edged sword” (Matsler 2019, pg. 167). The development of standards that measure service delivery from natural assets and green infrastructure will re-prioritize municipal budgets towards the maintenance of urban nature. At the same time, this standardization may optimize green infrastructure to provide some services over others, limiting overall ecosystem service benefits and local concerns.

6.4 Lesson 3: Use Existing Tools to Identify Sites for Municipal Natural Asset Management

All municipalities in this evaluation could identify sites that require ecosystem rehabilitation or restoration, can describe reasons for identifying these sites, and have developed indicators to capture key data for ecosystem rehabilitation and restoration projects. Some of the partnered organizations identified these sites for municipalities. For example, the Granby Wilderness Society and the Boundary Habitat Stewards identified black cottonwood riparian forests that required restoration in the Grand Forks area (Alan 2019b; M2 2021, para. 53). The success of restoration and rehabilitation projects depends in part on identifying preferred sites for restoration that will target ecosystems of concern. Species distribution modelling can be effective for municipalities to identify sites for habitat restoration (Zellmer et al. 2019). Municipalities can also use data from ecosystem service quality metrics to identify sites for ecosystem rehabilitation and restoration. For example, research on cultural ecosystem services in the Laurentian Great Lakes shows that ecosystem service benefits are the primary rationale for the investments in restoration programs to address food-web disruptions, widespread algal blooms, frequent beach closings, and invasive species (Allan et al. 2015). Analyzing ecosystem service stress through

spatial analyses can be another effective strategy. However, this does require the identification and monitoring of key ecosystem service quality metrics for a particular area (Allan et al. 2013).

In municipalities that have not identified sites for ecosystem rehabilitation or restoration, some tools and methods can assist municipal decision-makers. For example, the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) model has been used to quantitatively analyze ecosystems and to divide sites for ecosystem restoration (Zhang & Fang 2021). The Relative Aggregated Value of Ecosystem Services (RAVES) index is a practical tool to prioritize restoration sites across large spatial scales (Comín et al. 2018). In this cohort, some municipalities conducted LiDAR studies to create a better understanding of their urban forest canopy (Durand 2018; Keith 2020b). The results from those studies helped determine where ecosystem rehabilitation or restoration may be needed at specific sites. Canadian municipalities can also look to resources developed by provincial governments to guide site identification. For example, the Province of British Columbia produced Ecological Restoration Guidelines (2002) for restoration projects. These guidelines include setting restoration and priorities, planning, implementation, maintenance, monitoring, resources, and creating a restoration plan. The guidelines also link to the Terrestrial Ecosystem Restoration Program which “designated restoration priorities based on the Biogeoclimatic Ecosystem Classification subzones of the Province” (Douglas 2002, pg. 19).

Supply and demand mapping for ecosystem services can pair with valuation studies for site identification. This mapping can include the four types of ecosystem services, such as regulating services (Nedkov & Burkhard 2012) and cultural ecosystem services (Fagerholm et al. 2016). This mapping can also lead to regional partnerships across various municipalities so that resources can be shared. As well, municipalities can take advantage of differences in ecosystem

service supply and demand for municipal needs (Martínez et al. 2020). For example, the Town of Gibsons conducted a valuation study for the Whitetower Park Stormwater Ponds. The valuation study showed that the local stormwater ponds provide the highest level of ecosystem service supply for stormwater services (Sahl et al. 2016).

6.5 Lesson 4: Intended Program Outcomes Can Occur Simultaneously

Program outcomes, outcome streams, and the enabling conditions within these streams do not always occur sequentially. While this Program Logic Model used a cascading design between outcome streams and a linear design within each outcome stream, the municipalities are seeing intended program outcomes at different points than as described in the Program Logic Model (found in Appendix 1). The most significant reason for this is that municipalities are integrating municipal natural asset management as part of existing policy mandates for climate action. Therefore, program outcomes that are aligned with other municipal initiatives are more likely to be immediate priorities for municipalities (Venkataramanan et al. 2019; Watkin et al. 2019). For example, all municipalities have identified at least one site that requires ecosystem rehabilitation or restoration. As well, all municipalities have identified at least one indicator for the lifecycle of a natural asset management project. These two outcomes are a part of the Ecosystem Rehabilitation and Restoration Outcome Stream. Outcomes in this stream are expected to occur after outcomes in the Awareness, Capacity and Education Outcome Stream and the Implementation Outcome Stream. However, a few municipalities received poorer scores for indicators in these streams while receiving high scores for indicators in the Ecosystem Rehabilitation and Restoration Outcome Stream.

In program theory, there is a distinction between what is complicated and complex. Complicated program theory contains several different components while a complex program

theory is uncertain and emergent (Glouberman & Zimmerman 2002). “Complicated interventions that have many components pose challenges to evaluations, given the limited number of variables that can be identified and empirically investigated. But it is complex interventions that present the greatest challenge for evaluation and the utilization of evaluation, because the path to success is so variable and it cannot be articulated in advance” (Rogers 2008, pg. 31). The Program Logic Model for this evaluation framework is both complicated and complex. One aspect of these complicated and complex interventions is alternative causal strands. Alternative causal strands are when a program intervention can be successfully reached through one or another causal strand (Rogers 2008, pg. 36-37). Therefore, the four outcome streams can be seen as alternative causal strands. For example, if a municipality already has several zoning bylaws and official plan policies that align with municipal natural asset management, the municipality does not necessarily need to change the policy language towards municipal natural asset management for those policies to be successful. Specifically, evaluations with alternative causal strands can involve “comparative analyses over time of carefully selected instances of similar policy initiatives implemented in different contextual circumstances” (Sanderson 2000, pg. 447). While a municipal natural asset management program can be the same program across municipalities, these findings shows that program implementation is not the exact same. The opportunities, barriers, and natural assets of interest are all significant differences that can impact program outcomes.

6.6 Gaps Addressed

This thesis research addresses three gaps in the research on municipal natural asset management, ecosystem services, and ecosystem-based adaptation approaches. First, it creates a robust monitoring and evaluation framework for municipal natural asset management programs

that addresses the lack of long-term evaluations for ecosystem service programs (Chan et al. 2020). This research also addresses how to select indicators for changes in public awareness of municipal natural asset management, changes in municipal operations and maintenance, and municipal ecosystem service monitoring (Depellegrin et al. 2016; Donatti et al. 2020). The development of the monitoring and evaluation framework enabled standardized evaluation results and the creation of an evidence database. Through the Program Logic Model and the evaluation matrix, standardized indicators were created for expected program outcomes. The monitoring and evaluation of these standardized indicators enabled comparisons between projects and a deduction of general patterns across the five municipalities. As well, the creation of the evidence database ensures the accessible storage of data.

The second gap this research begins to address is measuring the effectiveness of policies in addressing biophysical underpinnings, such as biophysically informed valuation and the need to include measurements for ecosystem service demand and access (Chan et al. 2020). While municipalities are just starting to produce data for the restoration and rehabilitation of natural assets, the evaluation framework scores municipalities for creating new natural asset management policies, identifying or creating ecosystem service quality metrics and measurements, the identification or creation of co-benefit metrics, and a reduction in municipal budget forecasted for grey infrastructure renewal due to ecosystem service delivery. However, results from this evaluation show that more data is needed on how municipalities are using these metrics and measurements to inform decision-making.

The third gap is the management of opportunities and barriers for program evaluation and ecosystem service-based programs (Laurian et al. 2010). Specifically, this research contributes to emerging knowledge on how the COVID-19 Pandemic continues to affect municipal operations

and management. While much of the economy was shut down, essential municipal services continued (Switzer et al. 2020). To bring financial relief for people and businesses, provincial and local governments announced tax incentives, deferred tax payments, and delayed tax increases. However, this loss of revenue has altered municipal service delivery. For example, the District of West Vancouver had to postpone many important and worthwhile projects due to reductions in funding (Gordon 2020). In early March 2021, the Province of Ontario announced \$500 million in additional funding for Ontario municipalities struggling to cope with the ongoing financial impacts of the COVID-19 Pandemic. Those funds are in addition to the \$695 million directed from the \$19 billion federal Safe Restart program (Fox 2021). While some municipalities are using provincial and federal funds to offset pandemic-related losses, other municipalities are using funds to restart postponed projects. More research is needed on how allocated funds were spent by municipalities and whether municipal revenue losses are recoverable due to provincial and federal funding.

6.7 Limitations of the Evaluation

While every effort has been made to mitigate the limitations of this thesis research, some notable limitations should be mentioned. First, due to time constraints with data collection, only eleven out of a possible 26 evaluation questions in the evaluation matrix were used for this cohort of municipalities. The scores received are not based on a complete evaluation of all evaluation questions in the evaluation matrix. Therefore, the results of this evaluation may not accurately reflect all the available data. To mitigate this limitation, the most pertinent evaluation questions were chosen through careful consideration by key stakeholders. Second, the COVID-19 Pandemic was another significant limitation. Due to health and safety protocols and travel restrictions, staff interviews were delayed, rescheduled, or in the case of site visits, removed

from the research design. In addition, the Region of Peel was not included in the cohort evaluated, as they did not respond to participation requests. It is suspected that Region of Peel staff was unable to take part due to the COVID-19 Pandemic. Third, documents available for review were limited to digital documents available on each municipality's website or shared after staff interviews. While all major policy documents were available on each municipality's website, it is unknown what supplemental documents were not included.

Finally, the lack of an automated or systematic scoring system means that there is some element of subjective interpretation in assigning scores for the balanced scorecard. While triangulation, validation, and review strategies were used to ensure rigour in the research results, the scoring system is based on the evaluator's interpretation of the available data and the indicators in the evaluation matrix. When there is no formal weighting of this scorecard, evaluators can "provide their own weighting, creating linkages in their own minds as a cognitive simplification strategy to help them interpret the [balanced scorecard]" (Rich 2007, pg. 9). If subjectivity is undesirable in future applications of this evaluation framework, weights for indicators evaluated should be included. As well, this limitation strengthens the argument for the creation of an automated or systematic scoring system. This will be discussed in more detail in the next section.

6.8 Implications for Planning Education, Program Evaluation Theory and Practice

The level of detail in this evaluation shows the importance of comprehensive plan and program evaluation for local governments. Evaluations can improve plan processes, policy efficacy, stakeholder acceptance and support, and implementation strategies (Seasons 2021, pg. 181). As well, evaluations can develop new skills for municipal staff and community stakeholders, improve resource allocation, and build meaningful relationships with members of

the community impacted by program or plan interventions (Fitzpatrick et al. 2011, pg. 484). Therefore, appropriately funding monitoring and evaluation outweigh immediate financial costs.

Funding comprehensive plan and program evaluation also means providing adequate training and education on why evaluation is important, methods for evaluating plans and programs, and the role that planners play in monitoring and evaluation frameworks. This thesis research has established an evaluation framework for municipal natural asset management. For the evaluation framework, the tools, and methods to be used again, other external evaluators or municipal staff must be trained on their application. Courses in plan monitoring and evaluation should be offered at the undergraduate and graduate level or as an element of policy, studio, or project-based programs (Seasons 2021, pg. 182). As well, professional planning institutes, such as the Canadian Institute of Planners or the Ontario Professional Planners Institute should provide continuous professional learning and training for plan monitoring and evaluation. The need for training and education in plan or program monitoring and evaluation will only increase with the number of climate-focused initiatives municipalities are starting to incorporate (Donatti et al. 2020; Guyadeen et al. 2019).

Lastly, the findings from this research have implications for program evaluation theory and practice. As described in Lesson 4, the design of outcome streams in Program Logic Models should not just incorporate rigid sequential designs, but rather designs that can match varied municipal situations. The cascading design of the Program Logic Model in this evaluation framework (see Appendix 1) borrows from previous program evaluation practice with nested outcomes to produce an innovative design approach. Second, more evaluation-focused research is needed on analyzing the barriers and opportunities for municipal climate change adaptation and mitigation (Reckien et al. 2015). Finally, program evaluation theory and practice should be

aware of the insufficient consideration given to stakeholder engagement and attendance for climate-focused consultation events (Guyadeen et al. 2019). These gaps also confirm the need for a performance evaluation approach for municipal natural asset management. A performance evaluation can examine the ways in which barriers, opportunities, and stakeholder engagement intersect to exert influence on municipal natural asset management.

6.9 Next Steps

There are several available steps for academic research and professional practice to take following this thesis research. The most immediate research step is to monitor and evaluate more municipalities in a second national cohort. The Municipal Natural Assets Initiative, the eNGO that this research partnered with, has identified this second cohort. These municipalities are (i) the City of Courtenay, British Columbia; (ii) the District of Sparwood, British Columbia; (iii) the City of Oshawa, Ontario; (iv) the Town of Florenceville-Bristol, New Brunswick; (v) the Town of Riverview, New Brunswick and (vi) the Village of Riverside-Albert, New Brunswick. As well, the Region of Peel in Ontario will be included in this second cohort as they did not take part in the first cohort. A second national cohort will increase the understanding of modifications municipalities are making to their operations and management to incorporate municipal natural asset management. As well, more applications of the evaluation framework will strengthen the tools developed here and create an opportunity to incorporate suggested improvements.

Another research step is to modify the evaluation methodology and framework for a larger number of projects and long-term use. This means automating the evaluation framework so that hundreds of municipal natural asset management projects and programs could be monitored and evaluated simultaneously. While this thesis provided a high level of detail for each municipality in this cohort, it is not feasible to replicate this research process for hundreds

of municipalities. Therefore, an automated algorithm is required to analyze existing data and produce dashboard-level results on program outcomes (Watkin et al. 2019). As well, an automated algorithm will be capable of monitoring and evaluating these municipalities over several years. Based on the timings in the evaluation matrix, reliable data for some of the evaluation questions may not be available for a few years. Therefore, a long-term monitoring and evaluation framework means that these five municipalities can be re-evaluated in an expedited process.

Along with modifications to the evaluation framework for long-term use and a larger number of municipalities, there should also be modifications for the geographic context and ecological context of the municipalities. In this cohort, there are geographical and ecological differences within the five municipalities. For example, there are differences in climate, population, municipal history, ecosystems, species, and municipal services which can affect municipal operations, management, and service delivery. As well, the geographical and ecological context determine what natural assets municipalities are primarily focused on (Bartesaghi Koc et al. 2017). However, the evaluation framework was not modified for this cohort to account for these differences. Research is also needed for the development of biophysical indicators for natural assets. These indicators should specifically target the changes in key ecosystems and should be based on ecological research to determine ecosystem health. For example, these indicators could include measurements for mineral presence in freshwater, leaf cover for urban forests, or shoreline erosion for coastal municipalities. In addition, evaluation methods and indicators are needed for assessing the performance of nature-based solutions against natural hazards (Kumar et al. 2021), for cost-effectiveness (Seddon et al. 2020), and city-scale (Hutchins et al. 2021).

In professional practice, local government staff should aim to increase public support, engagement, and consultation for municipal natural asset management. If municipalities are struggling with getting high attendance rates for consultation events, they should diversify their community engagement approaches. This includes targeting pre-existing community events, creating pop-up community outreach workgroups, and ensuring flexibility in attending community events (Coningsby & Behan 2019, pg. 10). Municipalities can also produce clear internal and external messaging on natural assets, their management, and ecosystem service provision. This messaging should focus on the local effects of climate change and how natural assets can build resilience.

To establish a long-term monitoring and evaluation framework, municipalities and their champions should work collaboratively with the Accounting Sector, the Engineering Sector, the Planning Sector, the Financial Sector, and other interested partners. Through these partnerships, norms and standards could be established, especially regarding the level of service natural assets would be expected to provide, relative to traditional infrastructure. For example, the Province of British Columbia will have the first professional asset management standards for engineers and geoscientists, with natural assets as a core component (Engineers & Geoscientists British Columbia 2021). These standards, known as the Capital Asset Management Framework (CAMF) Guidelines outline governance and oversight, risk management, planning, processes and approvals, public communications, project personnel, capital procurement, budgeting, reporting, monitoring, performance measurement, financing, and accounting. A primer has already been released on how other municipalities in British Columbia may integrate natural assets into their asset management frameworks (Asset Management BC 2019).

Another professional step is to expand the number of municipalities incorporating municipal natural asset management. Many municipalities have started to build natural asset inventories or make modifications to municipal operations and management. Federal, provincial, and local governments could use initiatives to drive more municipalities to integrate municipal natural asset management. There are a few examples that municipal natural asset management champions could replicate. The most well-known of these initiative campaigns was the Public Sector Accounting Board (PSAB) 3150 Initiative that required Canadian municipalities to record and report on their tangible capital assets on or after January 1st, 2009. In the Province of Ontario, the Municipal Finance Officers' Association (MFOA) and the Association of Municipal Managers, Clerks, and Treasurers of Ontario (AMCTO) created a partnership to provide information and training for PSAB 3150 (CNAM 2007 pg. 3). In the Province of Alberta, a Liaison Committee was set up with representatives from the Alberta Urban Municipalities Association, the Alberta Association of Municipal Districts & Counties, the Local Government Administration Association, the Alberta Rural Municipal Administrators Association, the Government Finance Officers Association and Alberta Municipal Affairs to provide updates and ensure consistent communication (CNAM 2007 pg. 6). Similar partnerships and strategies should be considered to mainstream municipal natural asset management, with the municipalities in this cohort taking a leading role in sharing their expertise.

Municipal natural asset management should also be implemented in provincial planning frameworks. Unfortunately, provincial planning policies, such as the *Planning Act* and Provincial Policy Statement in Ontario, make minimal reference to ecological services and their functions (Lam & Conway 2018). The current emphasis on land development and growth restricts the ability of municipalities to incorporate nature-based solutions that protect ecosystems. When

provincial policy changes, revisions, or updates are shared, these five municipalities and their partners should petition their respective provincial governments to integrate policies and definitions on ecosystem services and natural asset protection.

Finally, more Canadian municipalities can also integrate municipal natural asset management through newly announced federal funding opportunities. In the 2021 Federal Budget, also known as “A Recovery Plan for Jobs, Growth, and Resilience” the federal government proposed \$200 million over three years, starting in 2021-2022, to Infrastructure Canada to establish a Natural Infrastructure Fund to support natural and hybrid infrastructure projects (Government of Canada 2021, pg. 182). In addition, Budget 2021 also proposed \$1.4 billion over 12 years to top up the Disaster Mitigation and Adaptation Fund (Government of Canada 2021, pg. 178). This exact fund was used by the City of Grand Forks to fund their floodplain restoration program and could be used by other municipalities experiencing natural disasters. With the current Liberal Government of Canada calling an election, it remains to be seen what party will form the next government and what changes will be made to funding opportunities for municipal natural asset management.

6.10 Chapter Summary

This chapter discussed the findings from the evaluation of five municipalities for municipal natural asset management programs. The findings show that in this cohort, municipalities are receiving high scores for Awareness, Capacity and Education indicators and some Implementation indicators. However, scores are much lower for creating or identifying ecosystem service quality measurements and metrics as well as all Service Delivery indicators. There are four high-level lessons that municipalities, municipal staff, key stakeholders, and other researchers should be aware of based on the findings from this evaluation. These lessons are (i)

partnerships and champions are needed to enable municipal natural asset management, (ii) municipalities should consider a program-based approach for municipal natural asset management, (iii) municipalities can make use of existing tools to identify sites for ecosystem rehabilitation and restoration and (iv) program outcome streams do not have to occur sequentially.

This research also addresses a few research gaps discussed in Chapter 2, namely the creation of an evaluation framework as well as data on barriers and opportunities for municipal natural asset management. Moving forward, more research is needed on creating an automated or systematic scoring system so that hundreds of municipal natural asset management programs could be evaluated simultaneously. As well, partnerships are needed in the accounting sector, the engineering sector, the financial sector, and the planning sector to lead initiatives for municipal natural asset management. Finally, municipalities should also look to federal budget commitments as opportunities to fund municipal natural asset management.

6.11 Conclusion

This research built a program evaluation framework for municipal natural asset management projects occurring in Canadian municipalities. Municipal natural asset management is an ecosystem-based adaptation approach for addressing declining municipal infrastructure service provision and increasing urban ecosystem degradation. Through the creation and application of this evaluation framework, standardized evaluations for municipalities can be completed. Standardized evaluations will lead to patterns, lessons, and recommendations for future changes to municipal operations and management. Once municipalities modify their municipal operations and management, natural assets can enhance service provision, improve community financial and asset risk, and increase climate resilience.

An ecosystem service-based approach like municipal natural asset management addresses two issues that urban municipalities are facing in Canada: infrastructure decline and ecosystem decline. By acknowledging and protecting the services ecosystems provide, Canadian municipalities can adapt themselves to the negative effects of climate change. Through municipal natural asset management, some Canadian municipalities have started to integrate these services. However, more evidence is needed to foster support among local officials and staff. This research used two common tools in program evaluations: the Program Logic Model and the evaluation matrix. This research adapted the common template of a Program Logic Model to group program outcomes based on specific typologies. The evaluation matrix created evaluation questions with indicators, data sources, analysis methods, timings and benchmarks. Although 26 total evaluation questions were created, eleven evaluation questions were used for this evaluation. By using these common program evaluation tools and methods, this research found that in general, municipalities evaluated are receiving high scores in Awareness, Capacity and Education indicators and some Implementation Indicators.

Municipalities across Canada are facing an increasing array of pressure including the effects of climate change, degradation of natural resources, and aging infrastructure. Ecosystem service-based approaches like municipal natural asset management can provide adaptive, resilient and cost-effective nature-based solutions, which can alleviate the pressure many municipalities are facing. As engineering and accounting standards for Canadian municipalities are changing to account for ecosystem services and green infrastructure, municipal leaders can apply for new funds from federal budgets and recovery plans to address service gaps caused by the COVID-19 Pandemic. Municipalities can use this thesis research to make evidence-based decisions on the management of their natural assets now and into the future.

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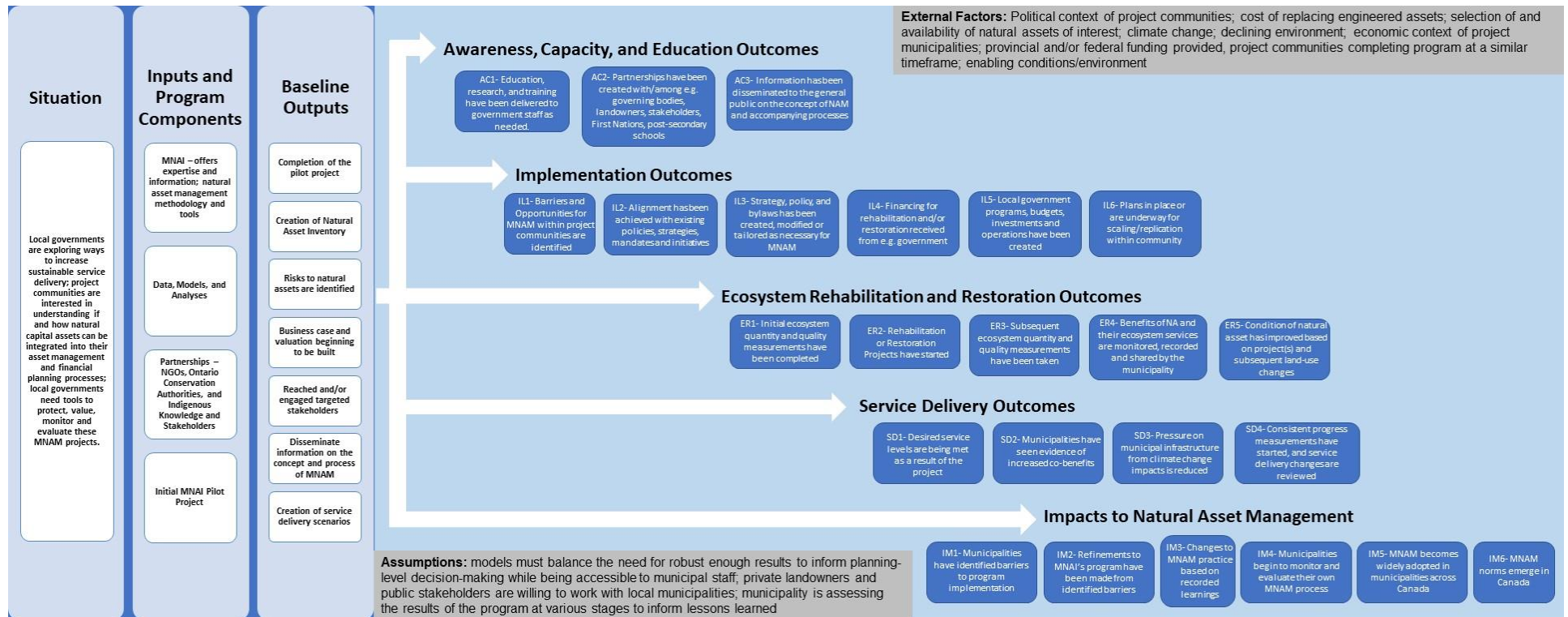
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Appendix 1 – Program Logic Model



Appendix 2 – Evaluation Matrix

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
Are the municipalities meeting the awareness, capacity, and education outcomes?					
Goals: To ensure staff are operating with the appropriate awareness and education when beginning to implement municipal natural asset management (MNAM). Further, they have established the appropriate capacity to integrate natural asset management (NAM).					
<i>ACI</i> <i>Question 1 – Have relevant municipal staff been trained in NAM?</i>	Number of relevant staff having participated in NAM training	Human resources records on staff training received	Percentage of staff who participated in NAM training	After municipality has started with NAM training	All (100%) of relevant staff have received NAM training
		Interviews with managers asking about staff training received	Percentage of staff who participated in NAM educational activities		
<i>ACI</i> <i>Question 2 – Have levels of education on natural assets increased among relevant municipal staff?</i>	Staff rated education level with natural asset concepts after NAM training	Human resource training records and responses to training	Percentage of staff who participated in NAM training	After municipality finished MNAM training and educational activities	All (100%) of relevant staff have received NAM training
		Example survey item: “Rate your education level regarding NAM” – verbal indicators (very good, good, somewhat, etc.)	Percentage of staff who give a high rating in NAM education		
		Interviews with managers asking about staff NAM education levels	Percentage of staff who are rated as having high rating in NAM education		
<i>ACI</i> <i>Question 3 – Have relevant municipal</i>	Number of staff who understand natural assets can	Example survey item: “Please state your agreement or disagreement with the	Percentage of correct responses	After municipality finished MNAM training and	All (100%) of responses are correct

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<i>staff understood how the program can change their service delivery?</i>	deliver municipal services	following statement: Natural wetlands can store rainwater during major downpours.”		educational activities	
		Interviews with staff asking, e.g.: “Can you provide an example of how a natural area delivers a public service in your community?”	Coded segments of interview transcripts provide credible examples of service delivery by NAs		All (100%) of relevant staff provide at least one example of a public service provided by NAs
AC2 <i>Question 1 – Have municipal staff incorporated relevant local knowledge and concerns?</i>	Number of engagements with local sources of knowledge	Government records regarding engagements with local sources of knowledge (e.g., open houses, interviews, door-to-door campaigns)	Number of engagements that incorporate local sources of knowledge	After municipalities have established engagements	At least one (1) engagement with local sources of knowledge for each major program phase
AC2 <i>Question 2 – Have municipal staff partnered with academic institutions, relevant local non-government institutions, or private landowners?</i>	Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners	Local government records on formal and informal partnerships with academic institutions, relevant local NGOs, or private landowners	Number of formal and informal partnerships that involve academic institutions, relevant local non-governmental organizations, or private landowners	After municipalities have established said formal and informal partnerships	At least one (1) formal or informal partnership is with academic institutions, relevant local non-governmental organizations, or private landowners
AC3	Number of townhalls, information	Local government records and meeting minutes on public consultation efforts	Percentage of NAM consultation events with high	After initial public consultation efforts and the	More than 50% of NAM consultation events have a high

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<i>Question 1 – Have municipalities made the general public aware of natural asset management occurring?</i>	sessions, and other general consultation events for MNAM		attendance in comparison to other consultation events	dissemination of informational materials	attendance rate from local citizens
		Information materials disseminated to the public	Coded segments of information materials list importance of conducting MNAM		All (100%) of information materials describe one reason for conducting MNAM
To what extent is the program meeting implementation outcomes?					
Goals: To ensure appropriate changes and steps in planning and municipal development process to reflect the importance of MNAM in municipal service delivery					
<i>ILI</i> <i>Question 1 – Have the municipality and relevant stakeholders identified any barriers or opportunities to MNAM within the municipality?</i>	Number of barriers or opportunities identified for MNAM delivery within the municipality	Local government planning documents and stakeholder responses to MNAM e.g.: <ul style="list-style-type: none"> - White papers - Technical reports - Financial summaries - Investigative journalism 	Percentage of local government documents that clearly identify the issue of barriers and opportunities with specific examples	After awareness, capacity, and education outcomes	All (100%) of relevant local government documents identify barriers and opportunities and provide specific examples
		Interviews with managers asking: “Are there any barriers or opportunities that your community encountered when attempting to integrate MNAM? Did you act upon these? How?”	Coded segments of interview transcripts on barriers or opportunities faced by the municipality		All (100%) of managers provide at least one barrier or opportunity encountered & acted upon

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<i>IL1</i> <i>Question 2 – Have the municipality and relevant stakeholders acted upon identified barriers or opportunities to MNAM within the project community?</i>	Number of identified barriers or opportunities acted upon for MNAM delivery within the project community	Local government planning documents and stakeholder communications e.g.: <ul style="list-style-type: none"> - White papers - Technical reports - SWOT Analysis 	Coded segments of local government planning documents and stakeholder responses that detail actions taken for barriers or opportunities	After awareness, capacity, and education outcomes	At least one (1) high priority barrier or opportunity within organization’s control is acted upon
<i>IL2</i> <i>Question 1 – Can the municipality draw any alignment with existing policy and initiatives?</i>	Number of similarities between MNAM practice and existing policies and initiatives	Local government planning documents e.g.: <ul style="list-style-type: none"> - Asset Management Plan - Technical Reports - Official Plan - Strategic Plan - Briefing notes to Council - Climate adaptation plan/strategy 	Coded segments of local government planning documents with existing similarities to MNAM practice	After awareness, capacity, and education outcomes and during early implementation stages	MNAM is aligned with at least one existing policy or initiative
<i>IL3</i> <i>Question 1 – Have the municipalities made changes to their OP, ZBL, Secondary Plans, etc.?</i>	Number of changes made to OP, ZBL, Secondary Plans, etc.	Local government planning documents: <ul style="list-style-type: none"> - Asset Management Plan - Official Plan - Zoning By-law - Secondary Plans 	Percentage of changes to local government planning documents to implement MNAM	After initial implementation outcomes	All (100%) of relevant municipal planning policy documents changed to integrate MNAM practices

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
		Interviews with municipal planners asking: “What changes, if any, has your municipality made to implement NAM into your municipal planning policy documents?”	Coded segments of interview transcripts show changes made to local government planning policy documents before and after MNAM		
<i>IL4</i> <i>Question 1 – Have new projects received funding or financing?</i>	Amount of funding and financing received for MNAM projects	Project funding and financing documents from e.g.: <ul style="list-style-type: none"> - Insurance Sector - Banking Sector - Federal and Provincial Grant Applications 	Calculation of funding available per project within the municipality	After changes made to relevant municipal planning policy documents	All (100%) of MNAM projects have available funds in order to ensure a full lifecycle
		Interviews with managers asking: “Have natural asset management projects received funding or financing? How much? From where?”	Coded segments of interview transcripts describing funding or financing received for MNAM projects		
<i>IL5</i> <i>Question 1 – Has funding or financing been applied to the creation of new NAM programs?</i>	Amount of funding budgeted for a municipal natural asset management program	Program and project funding allocated to NAM projects in: <ul style="list-style-type: none"> - Technical reports - Budgeting documents 	Calculation of funding allocated per program and project within the community	After the creation of new MNAM programs and projects	100% of MNAM programs and projects are appropriately budgeted for year-over-year operations and management

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<i>IL6</i> <i>Question 1 – Have staff created new NAM policy, strategies, and plans?</i>	Number of new NAM policies, strategies, and plans	Local government planning documents e.g.: - NAM plans, policies, strategies	Percentage of NAM policies, strategies and plans created to integrate NAM within project communities	After the creation of MNAM programs and projects	All (100%) of NAM-relevant policies, strategies, and plans created to support MNAM within project community
Are municipalities on track to meet Ecosystem rehabilitation and Restoration outcomes?					
Goals: Once implementation has occurred, monitor natural assets and ecosystems to see increases in rehabilitation, restoration, or management metrics for natural asset health					
<i>ER1 and ER3</i> <i>Question 1 – Are measurements or metrics being used for assessing ecosystem service quality?</i>	Number of ecosystem service quality measurements or metrics within a municipal project area kept in the natural asset inventory	Records of ecosystem service measurements or metrics in a natural asset inventory	Percentage of major ecosystem services that are assessed with a measurement or metric	After the establishment of NAM policy, strategies, and plans	All (100%) of the major ecosystem services within a municipal area have measurements or metrics stored in a natural asset inventory
<i>ER1 and ER3</i> <i>Question 2 – How many natural assets areas have measurements been taken from?</i>	Number of natural asset areas with measurements identified in the natural asset inventory	Records of measurements or metrics for natural asset sites within the municipality kept in the natural asset inventory	Percentage of identified natural asset areas with measurements	After the creation of the natural asset inventory and the establishment of NAM policy, strategies, and plans	All (100%) of major natural asset areas within the municipality have measurements taken

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
ER2 <i>Question 1 – Has the municipality created a rehabilitation or restoration project?</i>	Number of sites selected as potential rehabilitation or restoration project(s)	Municipal Planning Documents including, but not limited to: <ul style="list-style-type: none"> - Rehabilitation or Restoration Project Technical Report(s) - Environment and Lifecycle Assessments 	Number of potential sites identified within the municipality	After initial measurements of ecosystem quantity and quality within the project community	Community has identified a (1) possible site for the creation of a NAM project that fits with larger NAM goals
			Coded segments of NAM planning policy documents that describe potential sites and reasoning for a rehabilitation or restoration project		
ER2 <i>Question 2 – Where natural assets are intact and healthy, have the municipality created an operations and maintenance plan?</i>	Creation of an operations and maintenance plan	Municipal Planning Documents including, but not limited to: <ul style="list-style-type: none"> - NA Operations and Maintenance Plan 	Coded segments of NAM planning documents that describe maintenance and operations	After initial measurements of ecosystem quantity and quality within the municipality	Local government has outlined a maintenance plan for the next 10 years
ER3 <i>Question 1 – Is the quality of ecosystem service improving?</i>	Number of target ecosystem services that have seen improvement due to NA	Records of improvement in ecosystem service measurements or metrics in a natural asset inventory	Percentage of targeted ecosystem services that have seen improvement over a given time-	After the creation of rehabilitation and restoration project(s) or an operations and maintenance plan	All (100%) of target ecosystem services show improvement– e.g. RTE Abundance, RTE Diversity,

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
	rehabilitation and restoration		period (e.g. 5-year, 10-year)	(e.g. 1-year, 5-year, 10-year)	Buffer Suitability of Surrounding Land, Area of Protected Zone
<i>ER4</i> <i>Question 1 – Has the monitoring of NA and ecosystem services occurred?</i>	Number of relevant indicators identified for monitoring and evaluation	Municipal documents of a monitoring framework including e.g.: <ul style="list-style-type: none"> - evaluation plan - program logic model - evaluation matrix 	Coded segments of municipal documents that detail indicator, data source, analysis method, timing, and benchmark	1 year after the creation of the NAM project	Municipality has identified at least one (1) key indicator for the lifecycle of the NAM project(s)
		Interviews with Managers asking: “Has your team selected any relevant indicators for the creation of a monitoring framework? What are those indicators?”	Coded segments of interview responses which detail the selection of relevant indicators		
<i>ER4</i> <i>Question 2 – Have the relevant indicators been measured and evaluated?</i>	Percentage change in relevant indicators identified for monitoring and evaluation	Municipal documents of completed evaluations	Coded segments of municipal documents that detail changes in relevant indicators	After the completion of the first evaluation	All (100%) of relevant indicators have been measured and evaluated
<i>ER5</i> <i>Question 1 – Has the condition of natural assets improved based on projects and</i>	Improvement of natural assets in the scoring of key tracking metrics as	Records of natural asset condition and relevant metrics stored within natural asset inventory	Percentage of improvement in key tracking metric since the commencement of	After the implementation of the NAM project	Higher natural asset condition performance as indicated by key tracking metric

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<i>subsequent land-use changes?</i>	selected by the local government		MNAM and the rehabilitation and restoration project		
		Municipal planning documents: <ul style="list-style-type: none"> - Technical Reports - Lifecycle and Environmental Assessments 			
Are municipalities on track to meet service delivery outcomes?					
Goals: Once MNAM projects have matured in their lifecycle, service delivery levels are met and benefits not possible with grey infrastructure are recorded.					
<i>SD1</i> <i>Question 1 – Due to the rehabilitation and restoration project, are desired sustainable service levels being reached?</i>	Number of municipal services now supplemented by natural asset management projects and policies	Municipal planning documents: <ul style="list-style-type: none"> - Lifecycle Assessment - Asset Management Reports regarding service level delivery 	Number of services now supplemented by natural asset management	After the implementation of the NAM project	Municipal services are supplied through natural assets that supplement grey infrastructure
<i>SD2</i> <i>Question 1 – Is there record of increased co-benefits?</i>	Percentage increase in co-benefits metrics monitored by the project community e.g., importance of CES as recreation	Records of increased use of natural areas e.g., for leisure, recreation after management or restoration	Calculation of the increase of co-benefits from natural asset management project(s)	After the implementation of MNAM	Increase in co-benefits from natural asset management

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
<p><i>SD2</i></p> <p><i>Question 2 – Is there record of decreased negative effects?</i></p>	<p>Percentage decrease of negative effect metrics monitored by local government e.g., number of urban heat stroke cases</p>	<p>Urban temperature measurements for UHI, general public and municipal staff, hospital records</p>	<p>Calculation of the decrease of negative effects from natural asset management project(s)</p>	<p>After the implementation of MNAM</p>	<p>Decrease in negative effects of dense grey infrastructure and built environment</p>
<p><i>SD3</i></p> <p><i>Question 1 – Has pressure been reduced on traditional municipal infrastructure that would have been impacted by climate change?</i></p>	<p>Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change</p>	<p>Interviews with Managers asking: “Do you expect less spending on municipal services because of the services provided by natural assets?”</p>	<p>Coded segments of interview responses which detail an expectation that spending will decrease due to municipal natural asset management</p>	<p>After the implementation of MNAM policies and plans</p>	<p>Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure</p>
<p><i>SD4</i></p> <p><i>Question 1 – Are municipalities measuring and reviewing progress to their service delivery?</i></p>	<p>Number of service delivery progress reports and updates delivered to key stakeholders</p>	<p>Record of municipal documents:</p> <ul style="list-style-type: none"> - Service Delivery Reports 	<p>Coded segments of municipal documents that explain changes to service delivery due to MNAM</p>	<p>After the creation of an initial monitoring framework and internal evaluation plan</p>	<p>At least 1 service delivery progress measurement report written after first 5 years of MNAM</p>

Appendix 3 – Interview Guide

As described in Chapter 3, this thesis applied eleven evaluation questions from the evaluation matrix (Appendix 2). However, this interview guide created questions interview questions for almost all 26 evaluation questions in the matrix. The interview questions used for this report and the corresponding evaluation questions are surrounded by asterisks (e.g., *example *).

ACI Question 1 – Have relevant municipal staff been trained in natural asset management?

Interview Question: How much training or education have municipal staff received on natural asset management and related concepts such as ecosystem services management?

Who is this addressed to: Managers

Reasoning: Our evaluation needs to know what training has prepared municipal staff to implement natural asset management. If the training was successful or has received positive feedback from managers and staff, then other municipalities should look to adopt similar training. Furthermore, we also want to compare training received with education levels of staff before implementing natural asset management to ensure that the project has a greater chance of success.

Interview, Survey or Both: Interview

ACI Question 2 – Have levels of education on natural assets increased among relevant municipal staff?

Interview Question: What would you rate your staff's education level of natural asset management or related issues such as ecosystem services management? Why would you give this rating? Would you say there has been an increase in your staff's education level from when you first started this project?

Who is this addressed to: Interview for Managers, Survey for Staff

Reasoning: As stated in the question above, we want to be able to compare responses from the training question to levels of education to see where staff are being trained in natural asset management, and how effective that training is in delivering an increased education of key natural asset management concepts. As well, we also want to see if high education levels in natural assets lead to ease of implementation of natural asset management.

Interview, Survey or Both: Both – survey question could be a self-rating from staff while interview question for managers would be more generic and take an overview of the entire team/department.

AC1 Question 3 – Have relevant municipal staff understood how the program can change their service delivery?

Interview Question: Can you provide an example of how a natural area delivers a public service in your community?

Who is this addressed to: Municipal staff

Reasoning: This is a question to see if municipal staff understand the connection between municipal services and protecting natural assets. As well, this question may give insights on staff understanding of how municipal natural asset management operates in their municipality. Lastly, the details in their response may give some insights into their level of education on key concepts.

Interview, Survey or Both: Interview

AC2 Question 1 – Have municipal staff incorporated relevant local knowledge and concerns?

Interview Question: Are there specific local stakeholders with knowledge of your natural assets or ecosystem services? Have you engaged with them? Have they provided any input and how has this been addressed?

Who is this addressed to: Managers

Reasoning: Participatory approaches to environmental planning have proven to be highly effective, as shown in the literature. Therefore, project communities should look at engaging with local stakeholders who know their natural assets that municipalities have either not considered or have not been aware of. This could include private landowners, local climate scientists, activists, etc. As well, these stakeholders could be a potential barrier if their concerns go unheard in the education and capacity outcome stream.

Interview, Survey or Both: Interview

**AC2 Question 2 – Have municipal staff partnered with academic institutions, relevant local non-government institutions, or private landowners? **

***Interview Question:** Are you aware of any partnerships or collaborations with other organizations to implement natural asset or ecosystem services management in your municipality? What kind of partnerships are these, who participates, and what are the benefits for the partners? *

Who is this addressed to: Managers

Reasoning: Although these partnerships may not be formal, it is important to be aware of who municipalities are working with, no matter the capacity. For example, some municipalities in Ontario may have partnerships with conservation authorities that are not available to municipalities in other provinces. If these partnerships are effective, they could be recommended for other municipalities in their relevant contexts.

Interview, Survey or Both: Interview

**AC3 Question 1 – Have the municipalities made the general public aware of natural asset management occurring? **

***Interview Question:** What public engagement efforts have you made to make the general public aware of natural asset or ecosystem services management? *

Who is this addressed to: Managers

Reasoning: Although we are not speaking to the general public on natural asset management occurring in their community, it is important to understand how the municipality is engaging with the public re changes and the reasoning for this. As well, knowing which engagement activities worked well may be useful for other municipalities.

Interview, Survey or Both: Both – Survey question could be “Select the kinds of public consultation efforts your municipality has made for making the public aware of natural asset management – open house, pamphlets, informational packets, etc.”

**IL1 Question 1 – Have the municipality and relevant stakeholders identified any barriers or opportunities to MNAM within the project community? **

***Interview Question:** Are there any barriers or opportunities that the municipality or your partners have encountered when attempting to implement municipal natural asset or ecosystem services management? Did you act upon these? How did you do that? *

Who is this addressed to: Managers

Reasoning: We have previous research completed on this very subject, but it is important to compare that research to the experiences of project communities and whether there is any new information on this subject. We should also acknowledge that our prior work might not have covered all barriers and opportunities. As well, insights on this topic should be shared with other municipalities that encounter similar barriers or opportunities.

Interview, Survey or Both: Interview

IL1 Question 2 – Have the municipality and relevant stakeholders acted upon identified barriers or opportunities to MNAM within the project community?

Interview Question: Not needed as a separate interview question – potential answers are covered in interview question IL1 Q1.

Who is this addressed to: N/A

Reasoning: N/A

Interview, Survey or Both: N/A

IL2 Question 1 – Can the municipality draw on any alignment of natural assets management with existing policy and initiatives?

Interview Question: Can you name and explain at least one existing municipal policy initiative or planning goal that natural asset or ecosystem services management aligns with in your community?

Who is this addressed to: Managers

Reasoning: This question not only looks to see if there is alignment for implementing natural asset management but if project communities are already thinking of climate resilience in their municipal planning. If climate resilience is already a serious policy issue for the municipality, there may be more instances of alignment, and therefore, ease of implementation.

Interview, Survey or Both: Interview

**IL3 Question 1 – Has the municipality made changes to their Official Plan, Zoning By-law, Secondary Plans, etc. to accommodate natural asset or ecosystem services management? **

***Interview Question:** What changes, if any, has your municipality made to implement natural asset or ecosystem services management into your municipal planning policy, such as your Official Plan, By-laws, etc.? *

Who is this addressed to: Managers

Reasoning: For implementation to occur on a comprehensive level, measured changes need to be made to appropriate policies. While each municipality's official plan or zoning by-law will be different, similar changes could be adopted by other municipalities. Furthermore, responses to these changes from the public could provide additional insights.

Interview, Survey or Both: Interview

**IL4 Question 1 – Have new projects received funding or financing? **

***Interview Question:** Have natural asset or ecosystem services management projects received funding or financing? Was this funding or financing sufficient to complete the project as planned? From where did the funding or financing come? *

Who is this addressed to: Managers

Reasoning: Although specifics may be difficult to provide, how much funding projects have to work with and where this funding was provided from will not only aid other municipalities looking to start municipal natural asset management but can also lead to other research opportunities. These research opportunities include investment patterns, investment structures, and willingness-to-pay studies. As well, exploring available funding opportunities can show potential financiers where there are existing gaps. Finally, the level of funding relative to the required funds could contribute to an understanding of project success.

Interview, Survey or Both: Interview

IL5 Question 1 – Has funding or financing been applied to the creation of new natural asset management programs or plans?

Interview Question: Has the municipality funding budgeted to implement a new natural asset or ecosystem services management program or plan? What kinds of programs or plans are these and what aspects of these programs or plans are funded?

Who is this addressed to: Managers

Reasoning: Although much of this question may be covered by internal municipal planning documents, the second part of the interview question could be critical. Determining where the most amount of funding is needed and how municipalities are approaching budgeting for natural asset management could yield insights on where investments are needed on a program-level. This question goes beyond IL5 Q1 as budgeting should extend beyond individual project implementation to the larger program level.

Interview, Survey or Both: Interview

**IL6 Question 1 – Have staff implemented new NAM programs or plans? **

***Interview Question:** Has the municipality implemented, or is currently implementing, natural asset or ecosystem services management programs or plans? *

Who is this addressed to: Managers

Reasoning: This question goes beyond IL6 Q1 is addressing whether natural asset or ecosystem services management programs or plans actually are being carried out. Answers to this question might already be provided during IL6 Q1 or the answer to IL6 Q1 might have been ‘no’ in which case this question could be skipped.

Interview, Survey or Both: Interview

**ER1 and ER3 Question 1 – Are measurements or metrics being used for assessing ecosystem service quality changes from before to after ecosystem rehabilitation or restoration? **

***Interview Question:** Can you name and describe a metric the municipality is using to monitor ecosystem service quality improvements achieved through an ecosystem rehabilitation or restoration project? *

Who is this addressed to: Manager

Reasoning: This interview question tries to gain insight on several key areas in ecosystem rehabilitation and restoration. The first area is what qualitative or quantitative metrics municipalities are using. The second, which is much more subtle, is what metrics are most important to the municipality, and thus, the first to come to mind during an interview. A ranking of metrics could provide information on what ecosystem services municipalities are focusing on and why. The third area is whether municipalities are assessing ecosystem rehabilitation and restoration outcomes at all to establish whether the project was successful.

Interview, Survey or Both: Both – this same question could be included on a survey as a fill-in-the-blank or as a choice amongst several.

ER1 and ER3 Question 2 – How many natural asset areas that have been rehabilitated or restore have measurements been taken from?

Interview Question: How many and which natural asset areas or ecosystems that have been rehabilitated or restored is your municipality monitoring?

Who is this addressed to: Managers

Reasoning: Ultimately, one of the goals of MNAI is to protect and conserve as many natural areas as possible from degradation. Therefore, MNAI will want to know how many natural assets municipalities are protecting, restoring, or rehabilitating. However, this answer could also be contingent on an existing green infrastructure network, the urban density of the project community, and the availability of natural assets within municipal boundaries. All these considerations will be a part of the answers here and lead to additional insights for the evaluation.

Interview, Survey or Both: Both – could work as a survey question for managers as well, same question, given a range for a number of areas (1-5, 5-10, 10-15, etc.)

**ER2 Question 1 – Has the municipality created rehabilitation or restoration projects? **

***Interview Question:** Did the municipality conducted natural asset or ecosystem rehabilitation or restoration projects? Why did the municipality select these areas for rehabilitation or restoration? *

Who is this addressed to: Managers

Reasoning: As we address in the next evaluation and interview question, not all natural assets require restoration or rehabilitation. However, understanding the reasoning behind why a site was selected for rehabilitation or restoration is important as it could demonstrate the kinds of decisions municipalities make in these areas. This could include service delivery, ease of restoration or rehabilitation, cost, etc.

Interview, Survey or Both: Interview

ER2 Question 2 – Where natural assets are intact and healthy, has the municipality created an operations and maintenance plan?

Interview Question: Does the municipality have in place monitoring and maintenance plans for healthy natural assets or ecosystems?

Who is this addressed to: Managers

Reasoning: This question would be for project communities who already have healthy natural assets and inquires whether they have created an operations and maintenance plan. This question aims at covering the whole natural asset portfolio of the municipality, not just the assets that require restoration or rehabilitation as in ER2 Q1.

Interview, Survey or Both: Interview

ER3 Question 1 – Is the quality of ecosystem services improving?

Interview Question: Have you seen an improvement in the metrics your team or municipality is using to monitor ecosystem service quality?

Who is this addressed to: Managers

Reasoning: This question complements question ER1 & ER3 Q1. It focuses on whether the ecosystem rehabilitation and restoration projects were successful in improving natural asset health and ecosystem services delivery. As well, this question also addresses the metrics selected for measurement. What we would be looking for is not only an improvement in key metrics but what metrics are improving and by how much. This could provide critical information for other municipalities looking to start their natural asset management journey.

Interview, Survey or Both: Interview

ER4 Question 1 – Has the monitoring of natural assets and ecosystem services occurred?

Interview Question: Has the municipality monitoring plans in place for the services produced by its natural assets or ecosystems?

Who is this addressed to: Managers

Reasoning: While we are creating an evaluation framework here, we want municipalities to commit to a monitoring framework as these projects evolve over the decades. If these monitoring frameworks are successful in their municipalities, we should look to translate them into other project communities. Different from ER1 & ER3 Q1, this question is not focused on rehabilitation or restoration project outcomes but service delivery by natural assets or ecosystems over the longer term.

Interview, Survey or Both: Interview

**ER4 Question 2 – Which indicators are being used for the monitoring of natural assets and ecosystem services and have the indicators been evaluated? **

***Interview Question:** Which indicators is the municipality using for the monitoring of its *natural assets and ecosystem services*? How have these indicators been decided upon and evaluated for usefulness? *

Who is this addressed to: Managers

Reasoning: This question would be a follow-up to the interview question for ER4 Question 1. The indicators used for evaluation and monitoring could inform how effective these approaches are and whether changes need to occur, especially if the municipality is unfamiliar with program or plan evaluation. As well, if the municipality is familiar with program or plan evaluation, their approach could be beneficial for other project communities starting their natural asset management journey.

Interview, Survey or Both: Interview

ER5 Question 1 – Has the condition of natural assets or ecosystems improved based on projects and subsequent land-use changes?

Interview Question: Has the condition of natural assets or ecosystems in the municipality improved? Which actions at the operational or policy level have led to this?

Who is this addressed to: Managers

Reasoning: Overlapping with ER3 Q1 but at a larger scale. ER3 Q1 aims at individual ecosystems while the current questions aim at the landscape-scale. While this study may not have the capacity to verify or compare this improvement to a standard, it does provide insight on what kinds of actions project communities are using and whether other municipalities could also use these actions.

Interview, Survey or Both: Interview

SD1 Question 1 – Due to the rehabilitation and restoration project, are desired sustainable service levels being reached?

Interview Question: Has the delivery of municipal services in your community changed since implementing natural asset or ecosystem services management? If it has improved, has natural asset or ecosystem services management contributed to this improvement?

Who is this addressed to: Manager or municipal staff

Reasoning: While this question could work as just an interview question for managers, a survey question allows us to reach a larger number of staff who may have received more feedback from users, residents, or other stakeholders. As well, one natural asset area may provide several services that can go beyond the scope of one department. However, as a survey question, we lose the ability to ask what municipal services specifically or how staff understand “improvement”.

Interview, Survey or Both: Both

**SD2 Question 1 – Is there record of increased co-benefits? **

***Interview Question:** Are you monitoring any co-benefits of natural asset or ecosystem services management? Is there evidence of such co- benefits occurring? *

Who is this addressed to: Managers

Reasoning: This question has several different threads it can follow, just based on the sheer number of co-benefits offered by natural assets. However, there may be a select number of co-benefits that most project communities are focusing on, specifically around regulating ecosystem services and cultural ecosystem services. While not the focus of this research, these co-benefits may provide additional insight. As well, the performance of these benefits could also provide evidence for the usefulness of natural asset management. Having said that, these co-benefits might be difficult to establish and connect to natural asset management.

Interview, Survey or Both: Interview

SD2 Question 2 – Is there record of decreased negative effects of urbanization or environmental degradation?

Interview Question: Are there any negative effects of urbanization or environmental degradation you are monitoring? Is there evidence of these negative effects decreasing because of natural assets or ecosystem services management?

Who is this addressed to: Managers

Reasoning: Like SD2 Q1, this interview question follows similar reasoning. For example, there could be several negative effects of urbanization or other environmental degradation, but municipalities may only be monitoring a select few that are the most concerning. The insights from this question could also warrant additional research on this topic. Having said that, a decrease in these negative effects might be difficult to establish and connect to natural asset management.

Interview, Survey or Both: Interview

**SD3 Question 1 – Has pressure been reduced on traditional municipal infrastructure that would have been impacted by climate change? **

***Interview Question:** Are spending increases on municipal services due to climate change been limited because of the services provided by natural assets or ecosystems? *

Who is this addressed to: Managers

Reasoning: While our evaluation question may be difficult to get a complete answer for, this interview question can provide some insights on how natural asset management is changing service delivery in project communities in the current climate change context.

Specifically, if municipalities are expecting to spend less on municipal services, natural asset management could be providing similar services for that cost.

Interview, Survey or Both: Interview

SD4 Question 1 – Are municipalities measuring and reviewing progress to their service delivery?

Interview Question: Are you, or are you intending to, monitor progress in your municipal service delivery with natural asset or ecosystem services management? What are the results of this monitoring thus far?

Who is this addressed to: Managers

Reasoning: One of the intended goals of MNAI is the independent progress of municipalities in MNAM. Part of our evaluation should look to see what municipalities have planned to do after the conclusion of their pilot project in the long run. As well, we would also want to see if municipalities will share that information not only with us as the evaluators but with other municipalities interested in natural asset management.

Interview, Survey or Both: Interview

Appendix 4.0 Interview Transcripts

Appendix 4.1 District of West Vancouver Interview Transcript

LM: OK so I'll get started here with reading the reading through the script:

LM: So this study, titled “Advancing Municipal Natural Asset Management through Monitoring & Engagement” is an evaluation on your municipality’s natural asset management strategy and process. The purpose of this evaluation is to establish a standardized evaluation procedure for natural asset management projects, build a database for beneficial outcomes of municipal natural asset management, and finally, create a user guide for continuous monitoring of natural asset management. This procedure will notify you, your staff, and other interested parties about how this process is performing relative to selected indicators. The results of this evaluation will also suggest recommended improvements to municipal projects. The information collected here will also be used for research in my (Lucas Mollame) Master’s thesis.

LM: This interview will be used to help this research team analyze your municipality’s natural asset management process. More specifically, your answers will provide data that can be measured relative to selected indicators.

LM: This interview will be a video-conference interview held over the platform Microsoft Teams. This interview is expected to take 30 minutes. Your participation in the study is voluntary. You can withdraw your consent at any time during the interview by informing the researcher (Lucas Mollame). You can also skip questions by informing the researcher.

LM: The session will be audio-recorded to ensure an accurate transcript of the interview. You will have an opportunity to review this transcript before the project proceeds to data analysis. This transcription will be used for creating anonymous quotations.

LM: So, do you have any questions currently with what I just stated?

F1: No.

LM: Excellent, OK so just some consent questions all I need is a yes or no from you.

LM: Are you aware the interview will be audio recorded to ensure accurate transcription in analysis?

F1: Yes.

LM: Do you give permission for the use of anonymous quotations in any thesis or publication that comes from this research?

F1: Yes.

LM: Do you agree of your own free will to participate in the study?

F1: Yes.

LM: Excellent great so let me just mark that down. Yes, OK great. OK let's get started with the meat and potatoes here: so, we'll start off with some measurement questions. So, these questions have to do with your own municipalities monitoring process how that's being set up, if it's in place, so some questions related to that. So, to get started, does your municipality have in place monitoring and maintenance plans for healthy natural assets or ecosystems?

F1: I'm not quite sure how to answer that question. We do not have anything specific to monitoring the state and condition of the natural assets however, we have incorporated natural assets through an inventory into our overall asset management structure and part of the overall structure is to monitor state and condition for all assets. I believe that the staff who are responsible for the various assets do understand that natural assets are now part of our asset management suite of assets and they are monitoring their state and condition, but I can't give you specifics on exactly what they're doing. It might be helpful at this point to say that what we have done is actually an inventory of natural of our natural assets for the municipality and that's what I mean when I say we have, we have a we have incorporated them into our asset management structure.

F1: And we have, every year, we actually update our asset ledger, and we have state and condition rankings and to be honest we have not done that yet for the natural assets so the inventory was pretty high level and we're just beginning to explore what it would mean to actually monitor them. On the other hand, what we did find when we did our inventory, was that we had we looked at three major areas: we looked at water courses and streams and we have a lot of regulations and monitoring of the enforcement of regulations in terms of setbacks and so on and riparian areas. And so, we have very good mapping of the streams and we have enforcement of the riparian area regulations and so on.

F1: Foreshore is another area. We have what's called a coastal marine management working group which is documenting the current state and condition of the foreshore and of course is quite challenged at this point considering flood control levels and what kinds of measures might be reasonable to propose in order to preserve the foreshore as it is. That one was a very tricky one because with the, there's a lot of controversy even in the scientific community about sea level rise and how quickly it might happen and what is a reasonable response. There's a lot of fairly expensive technological solutions out there; you know we could put up gates under the landscape bridge or we could build a giant firm and you know etc. so, yeah.

F1: It's not the same as saying "OK, we have a culvert here and we have a pipe, and it has a 30-year life or 100-year life" and we send a video camera down to see how it's doing and you know natural assets are not like that. The other thing is the forest canopy that we inventoried, and we have done that. That one is probably the area where we've done actually the most work to monitor the state and condition we've done what's called lidar studies, and we were able to draw on a lidar study from the region which had been done earlier so now we have comparative data and we were able to show what areas of the municipality the forest canopy had we are still intact, where, where it had possibly increased, and then where it had decreased, and you know come up with consideration of strategies as to what kind of response we need to make there.

F1: We got a lot of trees in West Vancouver, quite a lot, lots and lots of trees and some people feel that we have more than enough trees and other people or not in agreement with that so it's been fairly controversial.

LM: OK great. You touched on a lot, of a lot of things and a lot of other questions so I apologize if I repeat...

F1: That's OK

LM...questions and you have to re answer them again, but in terms of, in terms of specific services whether they be ecosystem services, or traditional services that the municipality delivers have you folks created any monitoring plans for these services that are produced by natural assets?

F1: So, we have, as I say we have a monitoring plan for the forest or for tree canopy, and with each sort of pass I guess you should, I should say, it looking at this we are refining it. You know, there was a lot of controversy about the most recent lidar study about whether we were capturing hedges and there's a lot of questions about hedges, and there's some really big hedges, and are those really trees, so I mean you start getting into some really, really interesting questions. So, in terms of monitoring the streams, we haven't put anything more in place than we have, but what we do have is quite a bit. Water quality is being monitored; the health of the stream is being monitored. We also have volunteer groups in the community such as stream keepers who their interest is really, the, they weren't so interested in ecosystem services specifically, or they weren't actually calling them that, they're interested in salmon and how you know, whether the salmon are returning to the streams, but that has of course led them to be very concerned about any kind of encroachment on the natural habitat and including people dumping their swimming pool chemicals and all the rest of it. So, you know there's quite a lot of monitoring going on, at many different levels in the community.

F1: Air quality, interesting enough, is something that's monitored by the region. Which is helpful because it's very difficult to monitor it on a municipality basis. So we have also some regional, you know, beginning to sort of look at this a little bit differently like, not just you know, it's a good thing to monitor all this stuff but the actual understanding of the ecosystem services and what it is we're trying to preserve and monitor has gotten a lot of traction.

LM: And for that air quality monitoring done by the region, do you receive that information as well?

F1: Yeah, we do, we do, we definitely do. And it's, well, in the past few years, we've had issues in the summer because of smoke coming from California. And the air qualities been worse, than in the whole rest of the world, the worst in the world! But you know so of course there's, there's a lot of concern about that, and then there's a lot of like: "well what are we supposed to do about it?" kinds of questions being asked. And that is fairly typical I think, when people begin to grasp the ecosystem services concept.

LM: So, you just, you described a couple of metrics already, but can you name another one that your municipality is using to, kind of keep track, of these ecosystem service quality improvements through ecosystem rehabilitation or restoration?

F1: Um, I think actually...no, nothing more actually comes to mind I think I mentioned everything that, that I've thought of. There's a lot of things under consideration. For instance, we're considering...right now we manage our stormwater system as part, we have what's called a sewer and drainage utility. So, we manage sewer drainage, the sanitary sewer drainage together. We are considering having a separate utility for stormwater management because that would allow us to set up more formal monitoring programs around stormwater management, which is one of the big ecosystem services provided by the natural capital in West Vancouver, when there's absolutely no way we could manage the stormwater by replacing all the streams with constructed infrastructure.

F1: And there's also a lot of consideration of the interface between constructed in infrastructure and natural infrastructure if you will. So, you know, in general there...we are trying to move towards better understanding of the natural drainage system and how we can work with that. But that's not monitoring exactly, it's more deepening of understanding of how the system works. It's hard to monitor if you don't know what kind of performance you're looking for. You have to understand that first before you can say what you're going to monitor or how you're going to monitor. The only place I actually know in British Columbia, and maybe in Canada, that has a complete understanding or, you know, even maybe there still working on it but an effective monitoring system that they've actually built into all of their municipal practices is Gibsons. They are the only ones that have done this so far.

F1: And you know, we're a bit...we've done the inventory, where you know, we kind of got these...we're really reconsidering our whole environmental portfolio, how it should be organized, and what it is that we should be doing. Like OK we've got the inventory, we've got all kinds of information which isn't maybe organized as systematically as it should be, and what's our next step? I've actually...you know, I'm asking that question: what is the next step we should be doing here? And where do we go from here? I know Gibson's they're doing something called Source to Sea so that they completely understand their water system. And they are hoping that will give them the information that they will need to then monitor what's going on with the water system, and you know, know quickly you know, if there's any areas of concern that that should be responded to.

LM: Well, thank you for that, those are great, great answers. We'll move now to a different category; these are more so "changes on the ground". So, these may be very difficult for you to make any sort of conclusions on, but just to get, just to get your thoughts however preliminary they may be, I think may, or is really helpful for this project. So, to start: have you seen any improvement in in the metrics your team or municipality is using to monitor ecosystem service quality. So as an example, you mentioned streams, water quality...have you seen an improvement there in data quality.

F1: We've seen improvement...I've seen improvement in the level of attention that this is getting. You know whether that's actually translated into changes in quality on the ground is difficult to say.

F1: But certainly, there is a very much higher level of understanding. I mean an understanding is certainly not perfect, among staff and also in the community. But the question is now routinely being asked: what effect does this, whatever it is...is being proposed have on our natural assets and on our ecosystem services. Now some people have, what I would call a sentimental attachment to nature as in, you know, nature is good and interfering with it is not good. And I'm like well "Are you moving out of your house or?"

F1: This is not sensible really, but you know...there those kinds of questions getting asked but much more intelligent, sensible questions also are being asked. You know it's people are no longer OK with the idea that trees can cut down because they got in our view etc. So I think there's a much greater level of attention and that that inevitably is going to translate into a higher level of scrutiny from the public and staff and it's shifting this understanding that is really key. And then we will then we will probably see improvements to quality yeah when this gets to be more systematic and more accepted.

LM: Absolutely...absolutely OK I got a little bit more here on municipal service delivery. So, has the delivery of any of your municipal services changed since implementing natural asset or ecosystem service management? Have you seen any changes there?

F1: Yeah, we, we...the changes are gradual, but you know we have more recording of information into our systems...both our graphical information system, GIS, and into our maintenance connection which is our asset management system. We have more, like I said, consideration at when individual projects are being proposed as to what the ecological impacts of that would be. And we... you know, not really as a result of the natural asset inventory being done, but there's a, there's a rising level of concern in the community about climate changes and things like sea level rise and that, in turn, has led to greater scrutiny of impacts on natural assets and ecosystem services because people are now they're kind of connecting the dots if you will. You know, climate change is not something that just happened you know like COVID, you know what the heck...it just came out of nowhere and we had to do react. Climate change is not that kind of issue that's happening as a result of the way that we have been living. So, people are beginning to understand that there's a connection between what we do and what happens with our ecological systems. So, I've seen that starting to happen.

LM: Excellent OK. So, I have a question on costs here and on funding. So, have there been any spending increases on municipal services due to climate change.

F1: Yeah, definitely there have been. They're like I say...I'm putting in for a project which I'm sure will be funded as to you know, next steps what do we do what do we do with next steps... there's been increased funding like I say for asset management and for recording information into GIS and so on and also we're working on projects to connect up all these systems because having this information spread around all over the place is not helpful, or not as helpful as it could be because these things are connected. So, you know, we have an enterprise resource management system call JDE: that's what I would call an accounting system.

F1: And then we have maintenance connection which is an asset management system, we have GIS, and we need to connect all these things up and have a single source of truth that's, pretty obvious. So, there's been spending on that. Sort of information management and getting the information to be coordinated and available to everybody in the organization so that everybody has the same information and understands it and then of course the public also have the same information, anymore information out to the public. The public are now getting interested in things like floodplains. Which they maybe not have wanted to pay that much attention to before. One of the things that I find interesting that I think is sort of helping this whole move is the insurance industry who are now telling individual homeowners "we cannot insure your property for flood damage etc." You know, they are taking a much greater interest because their whole business is risk and understanding risk. They're taking a much greater interest in the impact of the you know...things that people are doing that that are standing in the way of natural systems or they're putting natural systems out of whack or causing them to change. And they grasped onto this concept really quickly, I think.

F1: So now people, you know, whether they you know, people who really would rather not pay that much attention to this are having to pay attention to it. And is that causing people to you know...it's not so much monitoring in a formal sense, but it's paying attention. There is more attention being paid. Two things like what is on the foreshore you know the foreshore is not, is no longer just the beach right? Which is where we go to have a picnic. It is now understood that you know, there's nothing permanent about that foreshore, and it is part of a system which may not

be going in the direction that the people who bought houses next to it wanted to go and, so yeah they need to there's much more attention being paid to that and to what could possibly be done to influence these systems.

LM: That's great. And how has there been, a...perhaps the best way to characterize it is as a shift, for example: money that was traditionally being spent on retrofitting old buildings, building sand bars for example, other grey infrastructure...has money that was traditionally being allocated for that now being shifted towards natural assets or natural capital in any way?

F1: I can't say that it has specifically. I can't think of specific instances where that is happening. I mean, along with most municipalities in Canada probably in the world we have an infrastructure deficit. So, we have a lot of grey infrastructure that's falling apart and so that's a huge concern and what to do about that...and then you know...getting money for that, has kind of come I guess, in front of getting money for natural capital work. However, we're trying to you know, I can't say that money's been shifted but I can say that we're trying to find ways to find, so that's one reason I think a storm water utility might be helpful because storm utilities are funded by rates not through taxes. You can send people a bill and they don't notice it as much. And it also kind of, raises the profile of what you're trying to do. So, I would say we're more in a situation of trying to find money to shift than being able to shift it yet. And where money has been shifted, and this is not directly related to natural assets and ecosystem services, but it's somewhere in the same spectrum...money has been shifted to, for instance, GHG reduction, creating an electric fleet and the infrastructure to support that.

F1: Which means actually abandoning the gasoline powered fleet, and the infrastructure which supported that...renovating buildings so that the systems inside them are far more energy-efficient...has actually had a big influence on that as well because it's made two things very clear: one is that technology - you have to support technology. You have to you know, we've all gotten an and technology maybe then we may...when we start talking about monitoring natural assets, things like sea level rise and so on technology is influencing that. And the understanding that we now have the, you know, this is the way that we're going to work in the future and also you know, people are not commuting, everybody's working from home...if we're recreating a building how are we recreating it?

F1: The whole idea of you know, a giant gathering place with a lot of places and chairs where everybody sits all next to each other...I'm not so sure we're actually going to be having those in the future. Which means we've got a lot of stranded assets but, that may...I I don't know how quickly people are going to want to run go back to places, sports arenas, or concert halls where everybody sits right next to everybody else. Even when we have a vaccine! I just don't know if people are going to do that. So, you know, there's a whole lot of re...stepping back and rethinking going on and a whole lot of thinking about nature and how we interface with nature and how to make that work better.

LM: Excellent, OK we're going to move to maybe a little bit more policy-oriented questions... so I wanted to know if, what changes if any has your municipality made to implement natural assets or ecosystem service management into your municipal planning policy? This could include your OP or official plan, your bylaws, and anything like that.

F1: So, as I said, we've actually done an inventory of natural assets and integrated that into our asset management program. I don't think we've changed any of our bylaws yet, because like I said, we have some pretty robust bylaws around stream management and so on. And it's going to

be...work on the foreshore is ongoing. So, it's going to be an...also well there's been a new tree management bylaw which has been put in place. It doesn't particularly address the natural asset issue, but it does restrict and set out regulations around the cutting of trees which is not something that, like I say there, are lots of trees here and there was a general feeling that you know didn't matter if anybody cut trees because there was lots of trees but that's all changed now. Now it's now being regulated so there's been a lot of regulation and although there is no specific mention in those tree right, in that tree cutting regulation bylaw, preservation of natural capital there is an underlying assumption that preservation of the forest canopy is important.

F1: And yeah, that's sort of informing it in the background, I think. You know, we already have regulations about what people can put in...I mean their federal regulations about what can be done with fish bearing streams...and then as they say the stream keepers are quite active in making sure that the streams remain fish bearing. And there's a lot of efforts that are being made to reconnect streams to the ocean, and you know, create fish enhancing I guess you would say fish enhancing...what I am trying to say here...fish enhancing works I guess. You know which are not exactly where the stream is right now, but the stream isn't where it would go naturally anyway. So, trying to return the stream to a more natural part of course.

LM: Do you know of any other natural asset or ecosystem rehabilitation or restoration projects going on in your municipality? I know you; I know you mentioned obviously the streams are a big one, the forest canopy, but and any other ones maybe they have like a specific name or that that you may know...

F1: No...there's, I can't tell you about any specific. There's a lot of things under consideration like I said, for the foreshore which is a huge issue and many stakeholders involved. And, you know, the streams we've talked about, the forest we've talked about, so there's no nothing specific happening that I could point to where we've gotten an impaired natural asset that we're trying to rehabilitate. It's more a situation where we're saying: "well OK, we're actually fairly rich right now but we need to be careful otherwise we're going to lose it all" and so we maybe need to stop moving in certain directions. But, at the same time, you know there's considerable pressure to densify and create more housing...huge affordable housing issue, and that kind of in some ways, it's like "OK well yeah we'd like to keep all these trees but we actually have to build a big housing development" so you know how are we going to do that...and there's some other things to kind of challenging: for instance, and I just mentioned building...building housing projects in the forest is challenging.

F1: I mean yeah you can do that, and you can preserve a lot of trees but then you've got wildfire interface issues. So, you know, those two things are kind of going in opposite directions...so how are you going to manage this forest when you know we're seeing a situation where the forest is drying up and catching on fire? We actually had an investment, pretty urban, you may I don't know if you're very familiar with the lower mainland, but you know we've got the lower mainland area and then West Vancouver is actually up on the side of a mountain so to speak...and we actually had a forest fire at one point. It did not get into the built-up area, it was managed with a lot of help from the province, but there are in the West in particular there are very serious issues with fires. So, you know that has to be thought about as well. Might not be possible to preserve things and also lived next to them, and also not have those other challenges.

LM: Absolutely. We're just going to move on because, I know, just being mindful of time here I don't want to keep you for too long. Thank you again for staying.

F1: Right sorry I was late but yeah.

LM: That's alright. So, I don't want to keep you for any longer than I have to, so just being mindful...do two more questions...so you mentioned these stream keepers which I think are great and really fit into kind of what we're looking for in terms of partnerships with different organizations or different communities. Are there any other partnerships or collaborations that West Vancouver has maybe even with some private landowners, people that may own property in the forest canopy, or around that they've kind of brought into these projects or have had informal or formal discussions with?

F1: So, there's a there's a major property owner in the northern part of West Vancouver. So, I said we were on the side of a mountain, and then a lot of the mountain is still forested. A lot of that, what we call the upperlands forested area, is owned by British Pacific Properties – BPP. British Pacific Properties are a worldwide Real Estate Corporation owned by the Guinness family and they built the Lions Gate Bridge, and they are been the owners of this property.

F1: I mean they were sort of the original developers of West Vancouver as an idea of a place to live, and they've been the owners of this property for decades. So yeah, we do work with BPP, and we've recently got them to agree that instead of continuing to develop sort of large single-family estate-like developments, they would consider what we're calling Cypress Village which would be one area which would be relatively densely developed, and in exchange for that, another very large forested area would be preserved. So yeah, there's definitely been partnerships with BPP, and they do they also are the ones that are building the apartment complexes in the forest. Again there, you know they've been discouraged and or are working with the district not to build giant single-family homes and instead to build denser forms of development but then there's, which in turn, preserves more of the natural ecosystem around them. But there is of course, also this challenge of making them fire resistant.

F1: So, you know we have a wildfire protection plan, we have you know, we have to talk to all of the people that live at the interface about how they need to manage their properties...not to make them more resistant to fire. But if the temperature continues to rock, which is what I was this is inevitably going to happen, the whole ecosystem here not to mention in the rest of the planet...will be affected by that, and it's hard to foresee what the consequences of that may be.

F1: The other partners I want to mention are the First Nations. We work with the Squamish nations and also the Coastal Salish nation on the North Shore. The Salish in particular are very ecologically conscious, and very concerned. They have, of course, many hundreds if not thousands of years of history as part of their culture, about this area because that's how long they've lived here, and they are very concerned. I mean, this area used to be so abundant with food that you know, they could just go out and pick it up. And a lot of that has disappeared. And they are acutely aware of it, and so they are monitoring the health of the ocean in particular here and are very concerned. And we are not working with them on a formal basis, but we've certainly worked with them in sort of information exchange on forums. And again, you know it's hard to know where it where is this concern? Is it at the top of the list, is it at the middle of the list, is at the bottom of the list? So many other things kind of get in the

way. But I do know that that there's a there's a very high level of concern and there's a strong feeling that a lot of what we as the settler community have done has done absolutely nothing to help the ecosystem around here and that we need to change direction in some way.

LM: No that's great, especially that last point there. I'm glad that you brought that you brought them up though that's excellent. So, this is just my last question and then I promise that I'll let you go.

F1: Right, great.

LM: So you mentioned that the public is starting to get more and more concerned, which is which is great, what like specific public engagement efforts has the municipality made just to make the general public aware of whether it be natural capital natural assets or ecosystem services etc.

F1: So we did our inventory, we published our inventory, it's available on the website and along with the report which explains what these concepts are, and how we came up with the inventory, and how we did the valuation in the inventory. We also published a booklet which we are actually we're hoping to distribute in the schools but COVID has kind of, you know, made that a bit problematic. But we still got it, and we're still intending to do it when we can, and you know I have done some distribution at the booklet. I was, before COVID hit, doing a lot of public speaking on this topic and it's gradually coming back, you know, I've done some zoom speaking and I just remember... you're just reminding me actually, I have a request to speak that I need to respond to...and I tried to do it as much as I can and then of course working with him MNAI. They've been trying to put out a lot of information...so like I say, it's gradual.

F1: The other thing is through, the course of doing the inventory, we did have a staff working group who were working on the inventory and they came from across the organization and of course, they became much more familiar through I mean...you know, we became much more familiar with the whole concept of natural capital and ecosystem services through working on the inventory. I'm actually, when I do my public speaking, what I try to do is encourage people to do to do inventories, and to pay attention to the inventory in their area. I actually have spoken on this at a couple of national forums. I was in Ottawa, and someone from Parks Canada approached me and said, "well do you think Parks Canada should do a natural capital inventory?" and I'm like "Yeah!" that's it that's what I'm saying. Do the inventory, make the list. Once you have the list then you start thinking "OK now what are we supposed to be doing with this stuff you know?"

F1: If you don't have the inventory, and you don't have the list, then those things don't get considered when decisions are being made. If there is no accounting, there is no, you know, what you don't consider it. So, you know, I am an accountant, and I am keen on the idea that you know, we should be accounting for things and this is...and so that is what I tried to speak on. Is that everyone should have this inventory. Once you have the inventory, you realize that you know, yeah there's challenges. Natural capital assets do not pay any attention to the lines that we like to draw, which say OK here is the boundary, they do not pay any attention to human boundaries there challenging to value...although there are ecological economists out there, they can do this. They are not like what we ordinarily think of as assets, you know, which depreciate and so on. That's not what natural assets do. And it requires a lot of systems thinking and even design thinking in order to figure out what to do, but that is what I you know I have been trying to do that to put that message out there.

LM: Excellent. Well with that I think I think we can very safely conclude. I want to thank you again for all these answers, for your time. I am sure especially given the circumstances you are probably quite busy. So, I am very thankful and very glad that you could fit me in here to get these questions in it and like I said at the beginning that everything that you provide here will be of tremendous value for the work that I am trying to do and that of course will also be made available to you, your municipality, your staff as well.

F1: Thank you. No, I wish you all the best in your studies, in the work you are doing there, and I'm very happy to know you're not actually the first MA candidate...you're the first one from Waterloo but you're not there I talked to someone from Dalhousie about two weeks ago who's doing something different, not the same issue but you know working in this area. And the more people we can get involved, the better. And so, I am very happy to be able to help and to know that that this works going on in the academic world as well as out here on the ground, you know it all works together great.

LM: Absolutely, the one last thing that I wanted to ask you: you mentioned of course the inventory is available on the website...are most of the documents related to your natural assets on your West Vancouver website?

F1: They are. We have a natural capital page which I think is still there, so you should be able to find them. If there is something that I mentioned that you would like to have some more information on just shoot me an email and say you know, if it's not there I'll find it for you.

LM: OK thank you very much that is all. I hope you have a great rest of your afternoon now. And again, thank you very much for your participation it will be beneficial for what we are trying to do.

F1: Great, excellent. OK bye now.

LM: OK bye.

Appendix 4.2 Town of Gibsons Interview Transcript

LM: Great there we go, fantastic. OK we will just get started with reading through the script:

LM: So, this study titled advancing municipal natural asset management through monitoring and engagement is an evaluation of your municipality's natural asset management strategy and process. The purpose of this evaluation is to establish a standardized procedure for natural asset management projects, build the database for beneficial outcomes of municipal natural asset management, and finally, to create a user guide for continuous monitoring of natural asset management. This procedure will notify you, your staff, and other interested parties about how this process is performing relative to selected indicators. Results of this evaluation will also suggest recommended improvements for municipal projects. The information collected here will also be used for research in my (Lucas Mollame) master's thesis.

LM: So, this interview will be used to help this research team analyze your municipality's natural asset management process. More specifically, your answers will provide data that can be measured relative to selected indicators. So, this interview will be a video-conference interview held

over the platform Microsoft Teams. This interview is expected to take 30 minutes. Your participation in the study is voluntary. You can withdraw your consent at anytime during the interview by informing the researcher (myself). You can also skip questions by informing me as well.

LM: This session will be audio-recorded to ensure an accurate transcription of the interview. You will have an opportunity to review this transcript before the project proceeds to data analysis. This transcription will be used for creating anonymous quotations. So, do you have any questions with that currently?

M1: No, no, no questions so far thanks.

LM: So are you aware that the interview will be audio recorded to ensure accurate transcription analysis; I just need a yes or no from you.

M1: Yes, I am.

LM: Do you give permission for the use of anonymous quotations in any thesis or publication that comes from this research?

M1: Yes, I do.

LM: Do you agree of your own free will to participate in the study?

M1: Yes, I do.

LM: OK, let me mark that down.

LM: So, we can get we can get started here. So, the reason that we are so happy to talk to you is because in a lot of ways Gibsons is the most advanced of any municipality that is working with MNAI, or has worked with them in the past, and is undergoing natural asset management at least in Canada. So, we have a number of questions here that have been developed. Some municipalities are a little bit further behind in the program, whereas we are hoping that some of the answers that you'll give we can kind of see where maybe some municipalities can move towards as they continue along throughout this process.

LM: So, to start off we are going to be asking some questions on maintenance plans. So, does your municipality have in place monitoring and maintenance plans for healthy natural assets or ecosystems?

M1: Yes, we do and in fact we have that for different types of assets. The aquifer is the most extensive monitoring that we have and that is related to recommendations in the aquifer mapping study going back to 2012...that we are looking both for quantitative and qualitative targets. I am happy to report that, you know, 10 years into it, the aquifer appears to have more water and its quality appears still to remain intact. Where we are also making plans to expand monitoring is in our drainage system; those are the recommendations that came from the storm water management plan from 2019 and that will be further informed by the work coming up in the Source to Sea Project.

M1: So, in essence we want to have monitoring both in terms of devices, but also in a reporting side of it from a dashboard perspective, that we are able to monitor the condition and the service levels of these assets in the very public sort of reel in terms of real-life feed in a sense...

LM: Excellent, so you mentioned that you see you seen some improvement especially in water quality and quantity which is great; are there any other metrics that you guys are keeping an eye on and have you seen any improvement in those metrics for any of your natural assets that you are working with?

M1: Um, yes. So, the aquifer (just sticking with that for a second) the improvements have been sort of, on the side of the quality. One of our concerns is sort of trying to demonstrate the policy control you need to have over the land to, you know, provide in itself is a form of monitoring because it's the implementation of the monitoring to the policy, and so we created a specific policy for that. It is called a development permit area guidelines requirement for a permit related to aquifer protection.

M1: So, the applicant needs to demonstrate that their works are not negatively impacting the aquifer in terms of contamination issues around well heads, or sort of, impacts on the structural integrity of the aquitard, the cover of the aquifer itself. There are areas that you can drill without additional peer review of those permits as well. So, it is a relatively advanced you know so, there is a mix of policy and actual physical monitoring. Further, all that information is added into predictive model, or sort of a 3D model, that we are able to have some confidence about then being able to show the increase in the levels of the aquifer which is you know...if you contrast that with our growth and development and yet we're leaving more water into the system than we were before and are able to measure that. So that is the value of a full monitoring for one of them anyway.

LM: Excellent, so you had mentioned too that the condition has changed, the natural assets has improved, which is great: can you just expand on that little bit more what specific improvements have you seen? Any data that you can share?

M1: We can share, we will have a report to share with you very soon it is just the 2020 results, but we have 2019 and 2018 that what we have going back every year. I think the greatest success is the absence of contamination. That makes sense. So, we are primarily managing for that and we try to separate the monitoring...sort of the cup and the straw you know, the cup is the aquifer, and it is a different regime of monitoring in the straw system, the distribution above ground. And that is more related to sort of health-type levels sort of, contamination issues around E coli or other types of bacteria so on. The first one, the first set sort of in the cup itself, in the aquifer, it is related again, as I said, to the quality and quantity.

M1: We're basically on a quantity perspective, primarily monitoring that we are not taking more than we need. That we are not taking more than were permitted for which we are not. But we have also realized that we are building a model for, you know, monitoring and in some ways ultimately, engagement. So, the last project I had to do yesterday was sort of finished drafting a letter in response to a local group that sort of provided an unrequested report claiming that we're running out of water and that we approved too many developments. So, we're able to say, you know, "I don't know where you got your number, but here's our evidence" and the regulator (the province in this case) has confirmed that. So that

goes, there is another sort of risk management and sort of, even reputationally risk that we are managing which is an important element of the work.

LM: Absolutely. I mean so far with some of the people that I've talked to everyone always goes back to you guys "Gibsons, Gibsons, Gibsons" you know the work that they are doing is very aspirational that they want to get to that level so I can definitely understand that part of it, especially the reputation part. You mention something on the health levels and I just want to stick to that a little bit: are you monitoring things like changes in e. Coli levels where you have seen a decrease in things like e. Coli or other sorts of health benefits from the natural assets?

M1: Yeah. So we're monitoring sort of how we interact with it from the time that we pump her off the ground. Then we have got health obligations in terms of the quality of that water like being absent of contamination in this case. In some cases. We are required to chlorinate though not very much but...Nevertheless, so there is that type of reporting and we have got different...a dozen or more points of contact where we collect samples on a scheduled basis, and it is sent to a lab for public reporting. If there is any issue, then we do those tests and review our practices then and then take different measures. So, we have got like a backup chlorine system if there is an issue that arises, we turn that on - it sort of flushes out the system and so on.

M1: It speaks to risk management as much as anything, in that you know it is no different than anybody else that provides a service. You have got 5000 people using that service every day and our monitoring is when we are able to say, "it's good to drink" and it wasn't always good to drink. So, that it is probably the most delicate job we have, so that is an important aspect of it.

LM: Well, that is great, especially the sending off data from different points of contact that is excellent, that is really great. Something I did want to ask is you mentioned obviously in with any municipality there are development pressures. Have there been any negative effects due to urbanization or developmental degradation of the area that you are monitoring, that you are aware of?

M1: Yeah, it is hard to miss. Unfortunately, in private lands within sort of developable land which, in itself, implies that there will be development on it. But the real issue is the loss of trees and urban deforestation for development is a real thing and we have not sort of cracked that nut per se. I have less or no concern about the public areas in the natural corridors and so on that we are rushing in some ways to protect. We are trying to justify that protection on the basis of our dependency on climate resilience and service provision, but we are more limited on the public lands and even the crown lands for that matter.

M1: Whether it is from active forestry activity or land development it is probably one of the biggest issues that we have that is causing other complications you know just putting aside you know, important things like habitat loss and biodiversity and so on strictly speaking where we see those in fact in land disturbances and drainage in particular and this point you know, the side-by-side planning that that happens its sort of a death by 1000 cuts, no pun intended. But the long-term impacts that very few people monitoring that. So, we are working on urban forestry plan and a strategy to do just that and we flew LIDAR this fall to take a highly detailed analysis of you know, what is on the ground, what is the density of those trees, what types of trees, and so on. Not yet a tree battery with an email address yet, but we are talking about just getting a sense of what

percentage of coverage we have, and an understanding of what areas contribute to what service, and then just further enhances the ability of us and others to protect those lands. So, the loss of trees related to forestry and developments are certainly a concern

LM: OK, so I wanted to ask a question too on spending. So, has spending on municipal services to climate change; have they been limited because of the services provided by natural assets? Are you seeing a benefit in terms of budgetary reasons?

M1: Yeah. Well, there's two types of spending, I guess or maybe three types of things. There's sort of capital projects, operations, and then I'd sort of add sort of value of the assets, or the absence of depreciation in the case of a natural asset. So, on the capital side, what we've seen with one project so far, was that restoring and improving a natural area that was contributing to the drainage system in Upper Gibsons provides opportunity to avoid constructing you know about \$4,500,000 of engineered alternative so we saved on that capital because we're able to expand those ponds for about \$0.25 on the dollar. \$955,000 rather than \$4,500,000 and still within their project (and I have another example or two) but within the project, the maintenance and operations on the concrete option (and I do not want to put concrete, it is not that concrete is bad) it is just that engineered option required ongoing monitoring of it then replacement and maintenance which projected to be in a \$75,000-\$100,000 a year. Well, the natural asset not only costs less, but it costs a fraction to maintain and that the dredging of those palms is expected to cost you know \$20 or \$30,000 every three or four years and so...and then there is some tree replacement and some soil upgrades and so on but over time it is miniscule by comparison. And then the value of these assets, the multi purpose of it...it is also something is sort of we haven't truly put a value on it yet.

M1: But that is also where we get a lot of seniors another sort of using the space for public health. So, that is an important element. So, it is a very valuable asset. We [are] increasing the value of our assets, decreasing our operational costs, and we are doing that with relatively low investment. What we want to be able to demonstrate is the return on investment overall: what is the cost per square kilometre of improvements we need to make in Gibsons? We only have 4 square kilometers so it shouldn't be hard to calculate! But, you know, from an insurance perspective, we think there is a dollar to be calculated in terms of what the return would be if we replant the forest, and restore the integrity of these three major creeks, and redesign the foreshore including some of the marine environment.

M1: So, we see these three many interventions as you know my cost is \$40,000,000 or \$50,000,000 but we are getting close to being able to calculate what the return is from a climate resiliency perspective and avoided disasters or issues later. I think that is where we are heading from that perspective.

LM: No, I think that is a big piece. With the research that I have been doing so far, it seems that one of the most important things is that return on investment component that if, especially municipalities coming out of this pandemic who may be cash-strapped, they can look to save some money. I think is a big part of bringing them on board.

M1: We do not ask enough questions of people that get funding like, we do not get anymore funding because of what we're doing necessarily compared to somebody that builds that pipe option, and you know don't even analyze an alternative. I think that is an important element of due diligence of funders just sort of, asking you know more in-depth questions about "so what other alternatives?" and "what are the costs in climate impacts?" and so on.

LM: So, I wanted to ask a question on partnerships because I think that's been a big component; can you describe some of the partnerships that that you have with maybe some local organizations in order to implement natural assets? This might be like, you mentioned the local group is a little bit worried about some of the use of the water, that you might be running out of water but, have you partnered especially in the early stages with any local groups even the province as well, private industry, whatever it may be?

M1: Certainly. So, locally it has been a bit of a grind only because you know sometimes people from outside the community recognize your work before those internally, but that is a minor issue. The partnerships we are developing would you know, [be] monitoring groups; for example, stream keepers, bear wildlife habitat folks, biodiversity type folks, and working with First Nations obviously, with the Squamish Nation; sort of a protection of cultural assets, and natural assets are not that different in a lot of ways from a due diligence and care perspective.

M1: Then we also partnered with arts and culture groups, or in marine education. We have a partnership with the local stewardship group through Gibsons Public Market and its Marine Education Centre. We've been developing a natural asset management approach for harbor, for marine environment. Then, externally, our whole existence like that necessarily come through discussion but like: we started MNAI with David Suzuki Foundation and Smart Prosperity Institute because we originally reached out to DSF and said, you know, they had done a study on the value of the Greenbelt and one on the Howe Sound region, but you know, just telling communities that their neighborhood is worth 8 billion dollars in services is good, but we needed to sort of bring their down to our level and from our perspective.

M1: So that is when we launched this eco-asset strategy and then formed a partnership through an MOU with Ottawa U and DSF and then Roy Brooke who provided, and still does provide, the Secretariat and Executive Development as well. Directorship I should say. So that is a major partnership, and then you know groups like the public sector accounting board, engineering societies, universities, but also the provincial agencies, like the partnership for water sustainability. SFU and climate organizations like FCM. We also do international work been to South Africa, and we have presented to New Zealand, Australia, US, so we have quite a bit of reach. We have basically a little policy lab for natural capital, and it has been fun, and so it's through partnerships that we do this stuff. We get, you know, probably average around 10 or 15 pieces of national media which you know, you pay nothing for and other than just spending the time and reporting what we are doing so it has been very helpful to those partnerships and having other people tell our story.

LM: Sounds like you guys have certainly been busy, certainly!

M1: Yeah.

LM: OK, so I wanted to kind of reflect a little bit on your journey throughout this. Have there been any barriers or opportunities that your municipality encountered when you were first attempting to implement municipal natural asset or ecosystem services management and then, if there were these barriers, how did you act upon do you act on them?

M1: I think the first set of barriers are sort of a workplace culture. So, I have to go to the finance [department] and say, "where's our list of natural assets?" since we use these things everyday, "well they're not on our list" you know, "why aren't they on our list" and so on. Then you end up with them on the list. If you go to engineering and say, "you know, we are only managing a pipe here and there and yet it drains all the way from the

top of the mountain to the ocean; what are we doing about the rest?” and so then, you know, you got an update on your policy to do that. So, there is that type of culture, and a lot of it does not happen because of culture, and if people cross their arms and refuse to do it (a lot of them do) and so we are not doing anything special. We are just doing what, honestly, everything I have shared with you. It is what we should be doing and when people realize this is also what you need to adapt to climate change then, from everything we have seen, natural asset management is to climate adaptation what energy management is to climate mitigation.

EM: We cannot get out of this problem by simply reducing emissions. Cities do not necessarily know the difference. On the policy side, the challenges...it is hard for a council and for a community in general to sort of differentiate between planting trees and solar panels and organics and sea level rise...and it is all one big box of a list of things to do and just to organize that you know takes some serious thinking.

EM: So, there is that type of...there is a culture, and then we're still lacking some more tools and some more policies. We need a clear direction and directive I should say from government to say “you need to inventory, assess, restore, maintain, and monitor your natural assets and we're going to allow you to operate in partnership with others at a watershed scale” because that is the scale. We have a governance issue and a scale issue as well. Then you have just the tools that we need. Things like right now we are working on predictive model: it is 20 maybe 25 variables. So, we can understand not just the questions we want to know [like] “what is the impact on air quality by planting trees”. Those types of questions, but also, the emerging questions the things we do not know that go together or not and so if we are going to plant you know, 2 billion trees, we have to put the right trees in the right place otherwise we're kind of missing the opportunity.

EM: It's like installing columns in a house but they're not really square, or you know engineered to support the weight. So those are sort of the types of barriers. There is lots of them you know. It is not uncommon. The one other sort of overarching piece here is do we still operate primarily between having conservation or development in cities, in government, in general. We are trying to demonstrate that this is both. This is actually what restorative development can look like, where we intend to show that in 20 years, we will have more water in the aquifer, we will healthier creeks, and we will have more trees than we had before and yet will have more people living there and that's possible in our view.

LM: OK just being mindful of the time I do not want to keep you for too long I just have one more...

EM: I am good. I got my next call at 20 after.

LM: Great. So, you mentioned some of these policy changes that that you have made...I am hoping we can get a little more specific here in terms of changes to your OP or official plan, your zoning by-law, any secondary plans to accommodate natural assets or ecosystem services. I am sure now those changes have been made but back when they were first being introduced.

EM: Yeah, definitely. Or the financial plan. We have notes on the financial plan that basically recognize the value natural assets. Then we have also made changes around formally recognizing natural assets as fundamental to our infrastructure. So, there is that asset management policy update. Then we changed the definition of infrastructure in the official community plan to basically say “our engineered infrastructure is interconnected and interdependent on nature to function”. That is an important direction. [If] communities did those three things...you cannot sort of jump into managing a natural asset. If you get a bunch of money to restore wetlands and you have no policy, you know management system,

that is going to...it is going to be hard to maintain, let alone manage [and] monitor that overtime if there is nothing in place because it's mostly it's like "oh those are provincial creeks" right and you drive right by it. [If] you are working on a catch basin that drains into it and you do not see the connection between. [If] you think about it, as a cubic meter of water, it changes your perspective that were supposed to carry that through responsibly, embed as much as we can into the ground, and try to cost the least amount to the taxpayers possible while preserving the environment.

EM: It is a bit of a tall task, but it is sometimes we forget about their goal. Then there's operations and maintenance plans, like understanding that some of these assets are multi-departmental and that you cannot just assign one, so the management plans for these areas need to reflect sort of the team approach and assign responsibility and budgets for that matter more accurately. When you see a disconnect between trail maintenance on the trail that goes near a creek and then grass cutting, so we cut too much of the vegetation we need to filter the water that runs into the Creek and that is often the sign of disconnect between policies. A minor example, but it is kind of what we are talking about in other ways.

M1: And then, you know, parks master plans. You know, things like that, you know, parks master plans are you know, 10 years behind the times if not 20 in the sense that we are still kind of managing parks for beauty and having sort of...and that goes all the way to national parks that is a disconnect between the park itself and the services. We do some work with Parks Canada around that type of stuff just even from a provincial perspective. Such a contradiction of purposes and you see it in Ontario near you, with the constant erosion of the Greenbelt because people just see it as blockage to their growth and development versus an opportunity to work around it and with it and so on so that is a different policy.

LM: No, it is funny that you mentioned that National Park piece because I, just as a side note, I took a class on national parks this term and we were having some discussions about you know, where does park planning go in the future and I constantly bring up well if we are designing parks for beauty, we are losing something in the services that we provide. I think it is important that you know there is certainly an element where we want it to be accessible for people and I think there is a line between managing beauty and accessibility, but I think there is more work that could be done to kind of maybe less so focus on the beautification aspects and more so on kind of what the parks offer as an even longer-term planning. So, it is funny that you mentioned that but...

M1: Yeah, for sure. We will see. You know, it goes all the way to like emergency planning and the policy around that. A very quick example: like if we lose our forest or the piece of a beach you do not have insurance for that, so you seek disaster assistance from now. The province, up until a year ago, they did not recognize the loss of natural areas as being something they had prepared to restore, but they would give you money had we had a, you know, wooden boardwalk with cement blocks around it. We replace every part, but they will not give you money for sand and trees to restore the beach. So, we argue that because we have been doing some work at the federal level, we eventually got our money to do just some work. But that's sort of an example of alignment of federal and provincial policy to protect natural areas for obvious reasons.

LM: I did want to ask you, if you have a few more minutes, in terms of outside funding that you guys have received, whether it be from the province or with the Government of Canada, if you could kind of expand on that a little bit in terms of the funding options that were available or continue to be available for this kind of work if there are any.

M1: Well, when we started it was a bit like “oh there's no natural asset box” right so, it is like “is this a pipe, or road, or building, or what is it?” and then it's like a little box “natural asset”. Anyway, that type of stuff so that took a couple years of grading through, but I would say with confidence, that today I am not aware of any infrastructure, or climate, or type of fund it does not recognize natural assets. I think it is a huge win, an important milestone. Almost every time we showed up to ask for money, like to do this study on the valuation, to design a natural option, to build a natural option, to restore a natural option, all of that was sort of a first one, first off. But once you sort of have your...because we have been stacking policies, and direction, and backing that up and implementing it people have, I sense, an increase in their confidence and that has meant more funding for us. Just last week, got, I am not talking about the numbers, but it is in the millions of dollars that we have received, and we have helped MNAI also raise funds. All of our work is free, like I don't...the Town of Gibsons other than getting money to do studies or whatever, like I think that's an important piece. I think we have been trying to work hard to keep this public intellectual property to stay public and to provide you know accessibility to this knowledge and transfer adequately to communities think that is an important piece of it.

LM: OK I think with all that, we can give it a close. I wanted to thank you again for agreeing to participate in this. Your answers are fantastic, a lot of valuable information for us to go through. I know as well that just as you said that a lot of the studies are published online, on your website, and can be found there. Are there any studies that you know of, that might not be available there that you would be willing to send myself?

M1: Well, I know I can send you my slide deck with some speaker notes if that helps, just sort of where we structure things a little bit.

LM: Sure, that is helpful.

M1 But you talk about documents from Gibson specifically or...

LM: Yeah!

M1: OK the other piece that I would like to share with you perhaps is our resiliency strategy. It is embedding a little carbon resilience and mitigation in adaptation and so we just sort of, it's a mix of sustainability planning, with strategic planning, and so you'll see. We use that to work with council as a first step, to say you know before we spend any money sort of “this is our things to organize and where every action is at” and then there's a prioritization process to go through just to understand does this raise emissions, lower emissions, increase vulnerability, decrease vulnerability and try to end up on that sweet spot, and then there's sort of the implementation aspect of it which is part of this work which is a big still unknown for cities. We get some reaction from the first studies that we would provide to people ago “OK here you go” and it is like “what do you want to do with this information?” like “these numbers are too big” and they do not know where to put it. If you write it on a sticky note, “OK I'll put it up on the board”. I can just reach my arm and stick it in the box, but they do not have that structure yet and so I am going to send you that structure and those notes. So, for it is worth it is again it is just where the thinking is coming from and so on. Again, it is not just me, I am just the maestro over it in some ways, but people are really doing and thinking this stuff. Our motto is “to work on practical solutions for impossible situation” so if you can have that attitude then you cannot work in Gibsons.

LM: Excellent.

M1: Thank you very much, keep well.

LM: Yeah, I wanted to thank you again, I'll be sending off an appreciation letter too once all this is kind of taken care of and I'll also send you a copy of this transcript too once we're ready to go with that, but again I really wanted to thank you for the time.

M1: Good chat Lucas keep well.

LM: Yeah, you too. Enjoy the holiday season.

M1: Likewise, Bye-bye.

Appendix 4.4 City of Grand Forks Interview Transcript

LM: Excellent, OK. OK great. So just to start off I just have a consent form to read over and then at the end there will be some questions. All I need from you it is just a verbal consent so it's just a yes or no with some of the questions. So, I will get started here: this study titled “Advancing Municipal Natural Asset Management through Monitoring and Engagement” is an evaluation on your municipality’s natural asset management strategy and process. The purpose of this evaluation is to establish a standardized evaluation procedure for natural asset management projects, to build a database for beneficial outcomes of municipal natural asset management, and finally, to create a user guide for continuous monitoring of natural asset management. This procedure will notify you, your staff, and other interested parties on how this process is performing relative to selected indicators. The results of this evaluation will also suggest recommended improvements for municipal projects. The information collected here will also be used for research in my (Lucas Mollame’s) Master’s thesis. This interview will be used to help this research team analyze your municipality’s natural asset management process. More specifically, your answers will provide data that can be measured relative to selected indicators. This interview will be a video-conference interview held over the platform Microsoft Teams. This interview is expected to take 30 minutes. Your participation in the study is voluntary. You can withdraw your consent at any time during the interview by informing the researcher (Lucas Mollame). You can also skip questions by informing the researcher. The session will be audio-recorded to ensure an accurate transcript of the interview. You will have an opportunity to review this transcript before the project proceeds to data analysis. This transcription will be used for creating anonymous quotations.

LM: So, with all that said, do you have any questions?

M2: No that sounds great. Thanks.

LM: Great OK. So, I have the consent questions here: so are you aware the interview will be audio recorded to ensure accurate transcription and analysis?

M2: Yes.

LM: Do you give permission for the use of anonymous quotations in any thesis or publication that comes from this research?

M2: Yes.

LM: Do you agree of your own free will to participate in the study?

M2: Yes.

LM: Excellent OK let me just mark that down.

LM: Excellent. OK, so we will get started here with just some questions on some of those some of those projects that you have mentioned. So, has your municipality conducted natural asset or ecosystem rehabilitation or restoration projects, and then, if so, why did the municipalities select these areas for rehabilitation or restoration?

M2: Sure...so there's kind of two scales here. One is the existing projects that we started with which is riparian restoration. So, in partnership with the local conservation organization, we have been supporting the restoration of riparian cottonwood ecosystem along the banks of the Kettle and Granby rivers in areas that are dominated by agronomic grasses and various invasive plants and you know, fairly low riparian habitat quality overall compared to what the potential is in that area. So far this has led to about 450 to 500 linear metres of restoration and mostly through planting and bio-engineering but, to be bank planting above high watermark just to start getting some cover and habitat quality back in that area.

M2: So that has been an ongoing since I guess about 2017, about three years. [There has] been a bit of public information: there is a map kiosk with information on the species and ecosystems at risk that are supported by the restoration, there has been combination of volunteer groups, and staff, and student groups involved in the replanting.

LM: Excellent.

M2: The big scale project which is deep in planning right now, is the restoration of...I got the figures here...We've currently got about 8 hectares of floodable open space, some of which is intact Oxbow wetlands that are part of the floodplain, but there's a lot of it that's just kind of open park that doesn't receive heavy management and that kind of thing. So, floodable open space. Through the disaster mitigation and adaptation fund project, we are increasing that eight hectares to about 23 hectares of open floodable lands. Sort of focusing on the ecosystem side of it, about half of that, once the final designs are in, we are aiming for about half of that to be restored Oxbow wetlands, re-contoured wetland areas, floodways that are using natural infrastructure approaches, and restored riparian areas where there is currently a dyke. That is a major change in the kind of natural assets at the core of our community.

LM: Excellent to hear. OK, so I guess in terms of these projects then, in your restoration efforts, have you seen any improvements in the metrics your team or municipality is using to monitor these ecosystem areas?

M2: So, so far from metrics we undertook an initial sensitive ecosystem inventory. A phase one that was mostly through air photo interpretation also supported by lidar. So, we have got a canopy model from lidar. We have not gone back and rerun the canopy model with the new lidar data. Unfortunately, our lidar acquisition last year had data quality issues so we are going to have to wait for another round in coming years but, overall, there has been no change in metrics. We will get back into capacity questions later on, but there isn't a lot of active monitoring for a lot of our natural assets. We just try to have some awareness of our crews so that they are not clearing areas that have been planted and that kind of thing. The other...I guess there is one other component that is changed since maybe 2016. We started having a more, I guess conservative approach, to managing repairing cottonwood with danger trees and in particular leaving as much of the stem as possible, so topping them rather than full removal, leaving the large, weighted debris in the nearby wetland areas as opposed to removing. I said that that kind of a bit of ecosystem function thinking has been added and actually embraced by the crew and that's been typically bringing in an arborist in some case a biologist to assess the wildlife attributes to conserve. So, I think qualitatively it is embedded in our tree management policy now for the city-owned trees to consider the wildlife attributes.

LM: Excellent. So now I know now this one might be a little bit advanced, because you mentioned some of the some of the monitoring components are still missing... I have a question then on the municipal services. So, has the delivery municipal services in your community changed since implementing these ecosystem service projects, has it improved and have natural assets, or these ecosystem services contributed to this improvement? Now, I know you mentioned that the monitoring is still yet to be in there so maybe you might not have an answer to this question yet, but if you have any thoughts at this point, I think they would be helpful.

M2: Yeah, there is no change of course known without the monitoring of the...and the biggest project as well, you know there will be monitoring of the implementation of that one but yeah nothing has happened for the other ones. In terms of area conserved though, since undertaking MNAI and our sensitive ecosystem inventory, the city has actually dedicated I think about 3 hectares of wetland as a protected natural area, and as well as another, I think it's 12 hectares of grassland and aspen parkland and other sensitive ecosystems. So, basically undertaking that protection of areas that are both sensitive to development and also offered you know a lot of natural benefits. So, we are, you know, I would say lacking on the monitoring end but definitely continuing on the conservation side.

LM: Excellent so I have been wanting to ask you I guess the reverse of that question. So, are there any negative effects of urbanization or environmental degradation that you're monitoring or that the city is keeping in mind? Is there any evidence of these negative effects decreasing because of natural assets or ecosystem services management? I guess the second part there I think you have already touched on but are there any negative effects that you are monitoring, or you are keeping in mind.

M2: The one thing that we will be monitoring with our canopy model once we get the update is the overall tree cover and so we are conscious of you know, the benefits of the tree canopy in the city. But there is definitely an ongoing kind of tree clearing by individual property owners and we're aiming to you know, with the city-owned property, aiming to conserve and replace trees that have to be removed but we don't have a

corresponding protection for private land and so we're aiming to bring that in our bylaws and hope to be able to monitor and have some alliance using the lidar tools.

LM: Excellent. So, then I guess I wanted to move then towards implementation, and we talked a little bit about this. So, you mentioned some of these projects going on. Are there any ecosystem service programs, plans, some overarching frameworks that these projects are falling under or are they more so individual projects or have you created kind of I guess, the structure for these projects I guess would that fall under and that those are reflected in maybe some secondary plans or some other programs that the municipality has started?

M2: Ideally, but no we have not done that. So, at a program-plan level I know we have had some identification in some draft official community plan material about implementing the...I forget what we called it um...but we were aware of the need to do the overall ecosystem measure planning I think at individual staff level, but it hasn't been...I'd say it hasn't been embraced or hasn't just been prioritized at the overall senior management or political leadership level. So, we are able to kind of carry through on a big project as an individual project as a sort of 1 priority area as funding allows, but there isn't a systematic approach unfortunately yet to ecosystem management and protecting and managing ecosystem services.

LM: I did have a question on indicators and again it might be a little bit too early to say at this at this stage in time, but I was wondering if you had any indicators in mind that you that the municipality would be looking to monitor once that monitoring piece has been brought in.

M2: Yeah so, the big one in terms of...so I guess the floodplain is the largest ecosystem service area that we are looking to improve delivery on and so the key indicator there is area of course of floodable land that is, you know, does not require repair after flood so basically has just a natural asset management approach and the conveyance capacity so that the depth and amount of water that can flow through that area to attenuate flood flows and flood velocity. So currently we have modeled the predicted benefits. Once we have the land restored, the buildings removed, and the land recontoured, going back in and having the lidar evaluation will help us you know, update those models to show if we have achieved that.

M2: It is basically a hydraulic question combined with the damages question. The big focus of our MNAI project in the pilot phase was avoided damages. So, looking at if there was improved or decreased floodplain function upstream within the municipality, what would be the impact on damages in the downtown area. That indicator itself will be basically moved because will be protecting downtown with dikes and floodwalls but there is an opportunity, I think to look at feature flood management costs compared to before. So, when you have communities vulnerable to regular flooding and volume or magnitude is increasing, the costs are a really big driver and so we're wanting to look at what are the private and public costs of continued flooding, continued flood responses, versus a natural asset approach that just allows that land to be flooded. So, yes, we will be monitoring costs as well as the overall capacity. The other the other key one is just your typical riparian functional kind of metrics. So, tree canopy cover, the layers...I am forgetting the terminology of course here...but the vegetation complexity basically, and we have different layers of vegetation not just trees and grass and yeah just that overall kind of ecosystem quality stuff in terms of attenuating floods.

LM: Excellent. Yeah, I know that that is a great piece to have in mind even without like the actual monitoring component. In many ways selecting the selecting the indicators is one of the most challenging steps, so to already have that already have that line is that is really good to hear. I wanted

to go back – you mentioned some changes in your zoning bylaw and maybe your OP as well too. I wanted to ask, what changes your municipality has made to implement maybe natural assets or ecosystem service management into your planning policy. This could be either in your OP or your bylaw whatever it may be.

M2: Yeah. So, we have not completed the changes yet, but major effort over the last couple of years is actually been flood recovery as well and then getting into this disaster mitigation and energy plan. But we have got a work plan in place for 2021 to overhaul the floodplain management bylaw, the official community plan, and the zoning bylaw in three areas basically to help protect natural assets and support the conservation [and] restoration of them in particular. But with the protection of it, having one of the big losses of floodplain function is when people build, let us say, in a semi-rural property build their house well out into the floodplain, and then they elevate their driveway, they build a dike around their house, and then all of the areas lose to the floodplain in terms of having a functional floodable area that can carry the flood flows. And so, we are seeking to implement – haven't made the changes yet and we expect some of them will be controversial – but we're seeking to make those changes so that we have a limitation how far out into the floodplain people will be able to build on their properties and preventing the filling and loss of wetlands and open floodplain area.

M2: I think that is one of the biggest changes that will see – in addition to the other one which is more about safety than it is floodplain function, but it certainly supports it – is the top of steep banks because of the erodible qualities in the area rather than allowing building 30 meters from the edge of the river as our bylaws currently state. We need to modernize and how they geomorphically appropriate setback from the top of bank that depends on how much erosion is happening or likely to happen. So, that in itself can help create more opportunity to protect the natural areas along higher banks.

LM: Excellent. I also had a question on funding or financing for these projects. Have natural assets or these restoration projects – have they received adequate funding and then, was this funding sufficient to complete the project as planned, and from where did the funding or financing come from?

M2: Sure. So, for the smaller ongoing riparian restoration projects, there is a combination of private funding from property owners as well as...this was arranged through the non-profit but, I think it was one of the provincially available conservation and restoration funds, so you know there is some...I think its Habitat Conservation Trust Fund in BC. So, HCTF has been able to help support some of the restoration of the riparian cottonwood community. The federal and provincial funding for the major program looks to be sufficient for the major restoration initiatives underway. I think we will have to seek additional funding for some of the, you know, going beyond floodable open space to kind of high ecosystem quality and so we are still determining that right now. So, we have got enough to remove the buildings and infrastructure, buy all the land, remove the dikes, recontour the land, etc. I do not think we have fully costed out or have the funding available in our program to undertake the full extent of the restoration activities of the large Oxbow so will be seeking more funding for that.

LM: I am not too sure if your municipality is doing this, but where natural assets are already intact and healthy, is there a desire or has there been already some mechanism to protect these areas from future development? So not just so much these restoration efforts, which are in and of

themselves excellent, but already where some of these areas are healthy – a desire to want to protect to protect these and the services that they provide.

M2: Yeah absolutely. So that has been kind of a staff – and to some extent – council priority over the last four years, and so we have a designation in our parks bylaw for protected natural area that rather than being an open space or amenity-type park, it is primarily dedicated for ecosystem conservation, research, and associated works restoration, etc.

M2: So, the Johnson Flats wetland was the first to be dedicated under that park formula and it really increases the kind of the management-level required to not damage it with our works on adjacent – like there's the large wetlands next to a cemetery for instance, and staff used to just dump the grass clippings over the edge into the wetland, and now they've got actually move them somewhere else. So, it is fine, they take them back into the composting program. So, there has been a few changes like that. With a large grassland and aspen parkland restoration, we have got a few mechanisms in place to simply add parcels of land into the protected natural area zone and we refer to them colloquially as nature parks. So that is, it is a pretty user-friendly term.

LM: Excellent. No, it's funny that you mention that, because actually one of my first jobs after my – I guess during my undergrad, was I worked for my local municipality's cemeteries, parks, and roadside grass department so it's funny that you mentioned that. I am getting flashbacks now of our own procedures I guess I would say.

M2: Yeah, yeah.

LM: I wanted to ask – I guess thinking back to when these projects were first introduced, were there any barriers or opportunities that the municipality or maybe some of the local groups that you partnered with did they encounter when attempting to implement these projects and how did you act upon these barriers?

M2: I would say for the riparian restoration works on public land, there really have not been any barriers other than funding and the local conservation group has been good at getting funding over the years for getting work done. We haven't yet had to dedicate city funds towards that, but we do support it with – a crew does watering and some of the maintenance for the trees once they're getting established in support that way after the initial funding is done. I would say that on the large project level, the biggest issue with the floodplain restoration is we have actually been buying out and are nearly complete the buyout of over 80 properties to undertake that work. So, it's a major floodplain restoration in a settled community and you've got all of the challenges that can come with implementing that: pushback from residents, you know dealing with trying to determine what's fair, and having a voluntary program which is avoiding expropriation has been our largest objective in that and it's certainly been a costly program. So, we have had to adjust our capital projects and invest more from the city than we were originally planning into that overall funding efforts. Originally would have been about a \$51,000,000 program because of the increase in cost for property acquisition to get to something fair or closer to fair we are up over \$55,000,000.

LM: Excellent.

M2: I guess actually one other thing that is interesting...when some of the neighbors to the natural areas when you go into dedicate it as a park, they've got some concerns about you know, will it change their access, will it increase people wanting to walk by or in front of their property into the park, just kind of some of the normal neighborhood concerns I think which just shows we need to do some more education in that area.

LM: It is great that you mention that because I wanted to touch on that question next and I think that is a big part of it is the public awareness effort, so I wanted to ask what public engagement efforts have you made to make the general public aware? I know you mentioned at the beginning that there have been some efforts on that, and I was just wondering if you could kind of expand on that a little bit and just describe some of those efforts and maybe what the results of those have been whether they have been more approachable or difficult.

M2: Yeah, so maybe starting once again with the smaller-scale project, the riparian work has really been well received. There was some, you know, a ribbon cutting for one of the restoration projects, there was a, you know, that this kiosk sign was actually like a map installation on a large boulder and on a prominent portion of where the trans-Canada trail runs through the community. So, I think signage in three of our natural areas and down in our city park about riparian and wetland function those have been really well received. They are starting to get bit dated, we need to update them and that kind of thing. But it has definitely been a good project so far. We held open houses early in our review of the official community plan when we started updating the work program and identified that conserving natural areas and ecosystem quality, walkability you know, like path networks and that kind of thing was really important to the community. There is a lot of feedback at our open house host session that was very supportive of increasing the conservation areas and a lot of people feel that helps make Grand Forks unique is the amount of really beautiful open space within and just directly beside the city. Lots of really great trails right in and around the community about through the natural areas. So, I think that the amenity value has really been identified and you know I think that the next piece in terms of engagement will be in the development of the new draft official community plan components that we are doing updates related to those functions.

M2: For the large demo program, most of the effort was really about reaching out to property owners and other affected stakeholders about the change in terms of purchasing their properties, in terms of what would happen with the area after. But something that is really gratifying is that their support among the previous property owners – the people have been bought out – they were...they liked the idea that the land would be used for natural floodplain or playing fields that could flood or other community amenities. That was kind of a silver lining for them and were very opposed to the idea that one of the counselors had brought up of selling the land to industry which we cannot do anyways under the funding agreement. But I would say that the natural asset aspect of communication has generally been easy, but we have not done enough either internally or externally to increase awareness of how natural assets function for the community.

M2: And you know I think part of it is I definitely want to get into kind of constraints here, but the big aspect is we're fully flat out and we wear a lot of hats. So, you know, I'm involved in everything from development planning, to restoration work, to some of the capital projects as well as in the community planning. The breadth of the work environment involved in this municipality is sometimes difficult to have enough capacity to do, you know...this definitely affects monitoring and it also affects the communication efforts I would say. So, yeah, we definitely look for some support especially in public education tools about natural assets that could be easily tailored to the ones in our community but, I think that would be really helpful.

LM: Yeah...you just led into my next question here, that that was going to be in regard to moving forward. What do you think your next steps are as a municipality moving forward? You have touched on these throughout. You can just kind of gloss over them again or if there is some that you might not have mentioned. And then, what are the challenges in fulfilling these next steps or getting to these next steps?

M2: Yeah, in terms of ones that are in our work program and we have got funding for: incorporating the natural assets in our official community plan, including the full plane function as well as the non floodplain natural assets that were identified in the sensitive ecosystem inventory. So, we have the funding for that work, and it is part of her 2021 work plan so it's actually entering the planning process, which is great, it's really exciting. And then on the restoration side, our next steps were actually aiming to do some kind of design charette about the major 11-hectare restoration project. So, that will incorporate community stakeholders and you know, knowledge holders I guess from regional First Nations and others in the actual engagement around how to restore this land and what it will be in the future of Grand Forks. So, it is a really big engagement opportunity there and I think that that the overall challenge is having I think, enough information delivery and engagement among staff and committee stakeholders about what these behind-the-scenes things are doing. So I think there's not enough familiarity by the public of the uneven – even by staff I think – of the overall priority on natural assets and you know, it's been 2 council terms since the original project and we haven't had a chance to engage systematically about what the overall program looks like so I think getting that as part of work plan and getting buy-in is definitely one of the accompanying parts for our work this year to make sure that we've got access in that way.

M2: We've got some really good data and materials on our natural assets, but we don't have really good information tools. I think it is a bit of a challenge too, is being able to craft you know, craft information about the benefits, about what we know, and what we don't know, about the city's assets, natural assets. But we are I guess, literally swamped by our poor-quality infrastructure in our sewers and our water system in other areas so, with the big priorities still remain trying to deliver core services and I think one of the challenges is sometimes are natural assets understood to be part of core services? Are they nice to have? Are they bonuses? And we still struggle with that a little bit still and senior leadership.

LM: Absolutely and I like I can definitely empathize and it's so funny too it's almost oxymoronic. The fact that these small municipalities with the few resources that they have are really the leaders in this kind of new way of thinking about some of these green infrastructure areas and in so many ways that they are kind of leading the charge. But then, the challenge comes with the fact that they're small municipalities and their resources – just like you've expressed – are already stretched thin enough and then there comes that challenge of the fact that you know is natural assets just a bonus on top or can it really be seen as a core feature? That is a really a big issue and a big challenge. I can definitely empathize with that.

M2: Yeah, and you know I think it is interesting; we have got a funding for doing an update of our asset management plan this year and unfortunately there wasn't scope in the budget to include natural assets as part of that. It really focuses on core critical services and so that is definitely... that is a bit challenging yeah. So, we've got to kind of include it in the parks or the natural areas outside so.

LM: Well, just being mindful of the time here, I was just wondering [if we could] do maybe one more question then we can kind of end off?

M2: Sure, sure.

LM: Excellent. You mentioned some of these partnerships throughout or some of these other organizations that you have worked with, I was just wondering if you could kind of describe in more detail these partnerships or collaborations with organizations that you have been working with and kind of who they are, and what they are kind of looking out for, and what are the benefits for them.

M2: Sure. I think the strongest one has been with - it is called Granby Wilderness Society. They originally were founded to help create a new wilderness park at the North End of the River that comes down into Grand Forks from the North. But they are heavily involved in restoration and conservation and their lead biologist has done most of the ecosystem mapping for repairing cottonwood in the region, as well as Lewis's Woodpecker which is - we have the highest number of breeding pairs in Canada for this woodpecker which is really cool feature of our ecosystems that adds some value for people too about conserving those areas. So, I would say our best partnership has just been ongoing community presence of Granby Wilderness Society. Their biologist has spoken to council several times, has provided input to our tree management policy, and can come to our public works manager about a work plan for restoring some riparian area, and "hey we've got this funding available for doing this work or that work - which of the sites would fit best for you know, the city's objectives and how can we get that into management plans". That has been a really easy but informal partnership. There was...two years ago, there was an effort to make a compact or an accord to more formalize the conservation of natural areas by the city and kind of show that leadership and I think it stalled out a bit with change in management at one point. That would be interesting to kind of bring that out again. To kind of try to formalize the intent a little bit more and make some commitments about conserving natural areas, about managing wildlife trees, just got to try to encode the good work happening in various little projects into a bit more of a strategic level so that has not happened yet. I think that would be a good opportunity to kind of formalize that partnership a bit.

M2: We are also looking for university partnerships for sure. We have got some interest in watershed science from University of BC which has an Okanagan campus and so they have got some water and watershed researchers that are certainly interested. But we are not in a university town, so we just do not have that direct presence and involvement of students. So yeah, definitely a struggle a little bit. When I worked in Alberta in one of the watersheds planning advisory councils there, we had opportunity work with three different universities on major SSHRC- and NSERC-funded projects. It was, you know, huge initiatives that were funded by the province, and it was really neat to be able to get a lot of watershed science happening. I think that has been hard to kind of attract the attention and there is nothing really systematic here to support us right now.

LM: OK I think with all that, that leaves us with a lot of really good information, and I am really happy with how this went. Again, I want to thank you for taking the time I know now we have gone a little bit over time actually, so I appreciate you sticking around I hope I didn't intrude too much into your day.

M2: No worries, it was my pleasure.

LM: Do you have any questions for me before I guess we close off here or anything?

M2: So, yeah just briefly at the beginning, you kind of mentioned the overall project description...do you have a website or other information on the project that I can share back and then also monitor for when there are maybe some materials that might be coming out that would kind of support the participating municipalities in implementing our programs and what we are learning from others?

LM: Absolutely! Yeah, no we do have some resources that I can send your way. The research group that I am a part of, we have a blog that I have posted on with some updates and I will send this to you through an email these various links and things like that. But as we start to begin to publish this data - we have also published some things on “The Conversation” which is like an academic-style, more academic-oriented blog with kind of some of the information there. But I think as we get ready to kind of move forward with data publishing, of course we are going to look to other areas to present as well. Of course, MNAI will also, I am sure, be tracking...

M2: Yeah.

LM: ...there are kind of publishing as well too. But I have no doubt that as we get ready, we are going to be sharing that information with you. I think that is the biggest thing because we see the value that you've given us, and we hope that the research that we're doing is of value for you and for the other municipalities that we've been in contact with.

M2: Excellent.

LM: So that is yeah, that is a big part of it too. I am more than happy to share, as we get ready to kind of publish some things here, some of the updates, and some of the stuff that we are doing as well to keep you guys in the loop.

M2: Well fantastic, excellent.

LM: I think the plan is to – at least for my thesis anyways - is to have that kind of published in August but I imagine even before then that time will also have more updates at least in the meantime with just where things are, and how things are going, but for the big, long thing it will probably be August time is when we are hoping to have that published.

M2: Excellent, alright well good luck with pulling all of the analysis and stuff together and yeah looking forward to hearing more from your work in other communities involved as well.

LM: Absolutely I actually just had one more question for you in terms of finding some of the – I don't know if you've mentioned – that you have maybe some published information online. Would your website be the best place – like the Grand Forks website – would that be the best place, or do you have maybe some other information that you would be willing to share through email?

M2: resilience.grandforks.ca. We have been using it to some extent. We are going to try to bring it back to within the main project website, but you will be able to see some information on the overall restoration program within that. So yeah, just go to resilience.grandforks.ca and there is definitely some information there. You can get in pretty deep into the hazard assessment that led to the overall project background on floodplain

function. Definitely some decent reference material in there so if you are looking for something specific or like support of the you know, kind of plans related to the project, I can definitely refer you to find some of those.

LM: Excellent thank you. Alright OK, well I hope you have a great rest of your morning!

M2: Thanks, you as well.

LM: ...and will be in touch. I will send along that that email with some places where you can kind of follow us along too and I will be in touch I was well through email as well with updates as they come.

M2: Alright sounds good. Well, have an excellent day.

LM: OK all the best.

Appendix 4.3 City of Nanaimo Interview Transcript

LM: OK so let us get started. This study titled “Advancing Municipal Natural Asset Management through Monitoring and Engagement” is an evaluation on your municipality’s natural asset management strategy and process. The purpose of this evaluation is to establish a standardized evaluation procedure for natural asset management projects, to build a database for beneficial outcomes of municipal natural asset management, and finally, to create a user guide for the continuous monitoring of natural asset management. This procedure will notify you, your staff, and other interested parties on how this process is performing relative to selected indicators. The results of this evaluation will also suggest recommended improvements to municipal projects. The information collected here will also be used for research in my (Lucas Mollame’s) Master’s thesis. This interview will be used to help this research team analyze your municipality’s natural asset management process. More specifically, your answers will provide data that can be measured relative to selected indicators. This interview will be a video-conference interview held over the platform Microsoft Teams. This interview is expected to take 30 minutes. Your participation in the study is voluntary. You can withdraw your consent at any time during the interview by informing the researcher (Lucas Mollame). You can also skip questions by informing the researcher. The session will be audio-recorded to ensure an accurate transcript of the interview. You will have an opportunity to review this transcript before the project proceeds to data analysis. This transcription will be used for creating anonymous quotations.

LM: So, currently with all that script being read, do you have any questions at this time?

M3: No, I do not have any questions, I am fine yeah.

LM: OK great. So, we will get to those consent questions: So, are you aware the interview will be audio recording to ensure accurate transcription and analysis?

M3: Yes.

LM: Do you give permission for the use of anonymous quotations in any thesis or publication that comes from this research?

M3: Yes.

LM: Do you agree of your own free will, to participate in this study?

M3: Yes.

LM: Great, let me just mark that down here...fantastic. OK great. So, I had sent along those interview questions...we unfortunately do not have the time to answer all of them, so I will be picking from some of the ones that I've already asked some of the other municipalities just so we the same data here.

M3: Just a quick question, was the intention to have a longer interview?

LM: If you're available to do a second interview, we can of course schedule that. Although I found with the interviews that we've been doing so far at the time allotted is perfectly fine. Maybe we go over about 10 minutes or so but...

M3: No that's fine, I was just curious that's all.

LM: If you were interested in doing a second interview to ask more questions, I would of course be open to that as well, but we can discuss that more at the end of the interview.

M3: Sure, that's fine.

LM: OK, so to start the questions that we do have will [result in us] going backwards in time starting with some of the earlier projects and some of the some of the earlier information there, [then] working towards the present. So, to start, we have a question on partnerships. So are you aware of any partnerships or collaborations with other organizations to implement natural asset or ecosystem service management in your municipality, and then, if so, what kind of partnerships are these? Who participates? And what are the benefits for the partners?

M3: And that is in the municipality, is that right? Just to be clear?

LM: That's right.

M3: OK, yeah, it's well it really comes back to how you define municipal natural assets I guess, but it just so happens I am working with the regional district of Nanaimo, and the University of Vancouver Island, and an organization called the Watershed Sustainability Partnership of BC. So, what they're doing is actually an ecological accounting process, they're developing that, and I think this is a parallel approach to what Roy had worked on with us at Buttertubs. And it's a study that's focusing on an area called the Millstone River Greenway, and its basically kind of a parallel process that we're working through just to see if it's kind of a proof-of-concept thing. So, it is basically kind of looking at land values around

ecological features and trying to get an assessment for what the maintenance and operation cost for maintaining these features would be, and they just finished their final report, and I believe it is going to become published within the next month. That is probably the most obvious one that I can think of. But yeah, I will not elaborate too much more but if you know you know as other code questions come up, we can chat about other things but...

LM: Sure OK, well then moving then to public awareness efforts, just for general public: So, what public engagement efforts have you made to make the general public aware of natural asset or ecosystem service management in the municipality?

M3: You know it is funny how it is evolved, it's interesting because when we finished working with Roy, we did go to our council and had a bit of a report back on what we had done it Buttertubs. There was a decision by the council to actually put it on their strategic plan – that a natural asset strategy and inventory would be a priority for this council to have completed by the next election. So, we have that slotted in 2022 to complete. So, it is still to come, but there has been a lot of conversation around natural assets and what that means and actually we're hearing about it from the community itself – like a lot of the conservation groups.

M3: We partnered with the Nature Trust of BC with the pilot study that we did, but we're also hearing it from other primarily environmental stakeholders and it's coming up in conversation which during our – we're also doing kind of an OCP, an official community plan update so we're doing our public engagements, were hearing the phrase or the term natural assets coming up in the conversation a lot more and part of it is just asking what that means, part of it is people coming with an assumption about what that entails. So, it is kind of a healthy discussion in the community about it so and an interest so...

LM: Fantastic. No, you kind of hit the nail on the second part of the question there to be in terms of whether those conversations have been generally positive or negative has the community been or...how should I say...have they been hesitant to the concept of natural asset management or more accepting or where do you find that they stand?

M3: Yeah, it may depend where you're coming from but I would say from a conservation perspective, I would say there's a lot of interest in this because I think there's a feeling that this is going to be an avenue for finding secure funding for the restoration and enhancement of a lot of natural features within the city and a recognition that these systems, these natural systems, need to be kind of looked at and maintained just like anything else. And I guess in a more holistic or program kind of way as opposed to being piecemeal or project based. And in truth like a lot of communities, that is really how we look at it right now there's specific projects that look at specific wetlands, or streams, or tree restoration projects, or urban forest restoration projects but it's not necessarily seen as a whole, and that's really what the debate is about right now. So, I think from the development side, I am not hearing any conversation about this and probably from the few people that do bring it up, there's concern or questions around cost and whether or not this is something the city could afford to do or should do. But I would say right now that is a minority...yeah, it is in the minority that kind of comment. Like I say it is early days.

LM: Certainly. So, then I have some questions on – we've kind of touched on this in some of our questions so far – but have there been any barriers or opportunities that the municipality or some of your partners that you work with encountered when attempting to implement municipal natural asset or ecosystem service management and then, if so, did you act upon these and then, how did you act upon them?

M3: Yeah, I guess what I should say then is, as I say, we put it in our strategic plan, so it is on our books that we're going to be going down this road, but we haven't got there yet. We have been getting some pushback from some in the community [who are] wondering why we are taking so long to get to get on board with this, and the truth is staff resources and funding. We just don't have the time and there are other priorities that are in front of us right now that we're working on. But we know in the back of our minds we are kind of seeing this as something we're still going to accomplish by the end of next year, so we're not concerned in that regard. I guess it's a little bit of who leads the charge because I'm in the planning section but there are engineering staff that are involved in this and there's some internal discussion about who should be kind of be centred in this process and moving forward with it.

M3: We are setting up an asset management committee and we are hiring an asset management manager [who] will kind of be overseeing a lot of the fixed or you know, hard infrastructure in the city but I think what I'm going to be talking to them about is including natural assets as part of the responsibility of the committee on this new position. So then there will be actually a point person who can integrate the natural assets on the hard assets side and work within the same process. I hope that answered your question, I hope it did not get off too much, but I don't know it's...

LM: No, it certainly does. It is wonderful to hear the steps that you're taking, and I can definitely share with you that you are not alone in terms of the concerns that you raise upon in terms of the staff capacity to do so, as well as in terms of who leads the charge, we're definitely not alone in that in that regard whatsoever that's something that we have been hearing quite a bit.

M3: OK

LM: So, then I wanted to ask – I guess the question is in terms of policy – and then from here I wanted to ask what changes if any as your municipality made to implement natural assets or ecosystem service management into your municipal planning policy, such as your official plan bylaws etc.? I know you mentioned some of the work that is going into your OP update that's coming in, but maybe in terms of some of the smaller pieces of policy – any changes to bylaw to reflect kind of a natural asset approach?

M3: Well, if you break it down to the next level, there is a lot going on. We have some pretty good, I think watercourse protection regulations that include setback requirements for protecting riparian areas for example in wetlands. We do have a tree bylaw and a tree management strategy so there's direction at the subdivision level about what trees need to be protected and creating tree protection areas. So not necessarily individual trees, but groves of trees, say a particular significant species within a subdivision context that has to be set aside and protected, and then there's a funding mechanism that compensates for any loss of any significant trees as part of a tree management plan and all that funding goes into tree planting programs within the city. Again, I would say capacity is our weak point on that level, because we're getting the money, we're doing the bylaw implementation and enforcement, but we're not getting trees in the ground as fast as we could. I guess that is our concern in that regard. We work with a lot of different partners on implementing restoration projects and we're looking at wetlands and some of the watercourses in the city.

We work with groups like, well, the Nature Trust of BC is a conservation organization that owns lands within the city that we co-manage, and then we share resources and expertise on different kinds of projects. A lot of invasive species control and basically ecological restoration projects so, in getting more native species planted or established in some of these areas. You know maybe that is enough for now. That is just a kind of a few examples...there's probably a few other things that I'm missing but that's just that's just kind of a couple of examples for you.

LM: Certainly, no that is fantastic and by all means if you think of them even after the interview you could always email me as well and...

M3: Maybe this is the important point in all this too is all this has been going on for years. This is like standard kind of approaches we've taken but the new element in all this is kind of having that connection back to the engineering side, where we're looking at our storm systems, were looking at some of our building requirements, and looking at it from you know what the storm pipes that enter the wetlands and the water courses...we need to see this as a whole system and we need to kind of compensate or soften the impacts that excessive stormwater might have on fishbearing streams.

M3: So what can we do to kind of design within the storm system to kind of help kind of mitigate that impact and I guess, ultimately where this is heading to – and this is where we're not quite at – is having the engineers really see the wetland and the riparian areas as part of the storm system you know, and seeing that from a maintenance perspective too. So, we're still...I wouldn't say they're totally against the concept, but I think there's a lot of detail and work that needs to be kind of just figured out between you know planners and engineers around what that means and looks like. But honestly, that's where the strategy and the inventory are going to come into play because that's going to make it clearer for everybody what exactly are we talking about when we're talking about a natural asset and what do we actually have in the city that we define as a natural asset so that everyone is very clear about that.

M3: That's probably part of the issue is the you know, the definition is convenient for anybody who wants to kind of come up with an issue or make a point, but unless there's a very clear definition that engineering, and finance, and planning can all agree and say “yeah that's what we're talking about” – and the community – then there's always this kind of a grey area that we're always kind of spinning around and talking about, but not being very clear about and I think that still needs to be worked out to be honest.

LM: Certainly. And those are some fantastic points there in terms of terms of what is needed I guess to move to the next level. It is great to see these individual pieces, but it's really – I think as you described earlier – that holistic kind of coming together that is still needed but the mere fact that you could identify that is already a great step in the right direction.

LM: You had mentioned this earlier in your answer in terms of funding or financing, so I wanted to ask how some of these restoration projects receive funding or financing and then was this funding sufficient to complete the project as planned and then, from where did the funding or financing come from?

M3: Yes, I would say yeah, I mean there's lots of examples and then I mean there's a – depending on the project on the scale of project, it might have come from a capital budget. I know our Engineering Department did some significant engineered wetland development as part of a subdivision project. I worked with some neighborhood conservation groups and stream keepers on some in-stream restoration for fish habitat. That

was a combination of city in-kind contributions and external funding applications and grants and I also worked with a few of my colleagues on a creek realignment and restoration project where it was primarily again city project capital money that went toward the project without any external funding applied for.

M3: So, I guess it depends on the scale and the funding available and I guess, the staff direction you know? What is our priority to focus on at that given point? And some projects are brought to us by the community work, versus projects that staff are already aware of, and were looking at seeking for funding either through the internal budget process or by looking for funding externally through grants.

LM: And have you found that funding whether it be through grants or whether it be through the capital budget – is that sufficient or have you had to kind of make the – how should I say this – make the project work depending on the amount of money that is available?

M3: Oh well yeah, I guess it's kind of like that scope of work exercise you go through: what can you afford? and I mean you can always phase projects out over multiple years if you're feeling like you're not able to accomplish everything in one go and you can kind of be more strategic about what you're asking and what you're focusing on and there's a couple of examples of what we're doing. It's been like three or four years easily of different phases working on a particular stretch of creek for example on a restoration project but knowing that funding isn't going to be available in the first year, we're going to have to kind of break it up and spread it out over a few years.

M3: I think more in the engineering world, there is much more longer-term kind of planning as far as capital projects, but dates and when the money is available can be kicked back so there's a little bit more flexibility about when these projects come on stream. And that can be a frustration, or you know, or not depending on what the priority is for the engineering department at the time. So, I guess that it in fairness to your question, I guess the simple answer is you know, there is not enough money for everything we're being asked to do or thinking about, but we're trying to be creative and responsive to you know the reality right.

LM: Absolutely, no, absolutely. And again, I do not think that's a unique situation by any means. It's unfortunate, but that's the fact, especially when in my opinion, these projects are so very important, but the name of the game is creativity in terms of trying to make some of these things work so, it's good to see that but that's at least working for you in meantime.

LM: I did have a question – we kind of touched on this in part in terms of the policy question – but I wanted to ask how has the municipality implemented or are they currently implementing natural asset or ecosystem service management programs or plans? Now, what I'm looking for here would be more so in terms of secondary plans – maybe you have like an urban forestry plan for example, maybe there's a specific area that you have outlined or selected as a site for a secondary plan. Whatever it may be, if you do have so if you could kind of go into a little bit of detail on that.

M3: You know I think I...let me see here...yeah, well, I think what I touched on earlier as one example...again the Buttertubs – the Nature Trust of BC and the city – we worked on developing a conservation management plan for the Buttertubs marsh area and it is a number of different properties. Some city-owned, some owned by the province, some owned by a conservation organization called Ducks Unlimited and we basically are trying to co-manage all these properties together under one kind of umbrella agreement and it's basically kind of settings certain policies and

restoration priorities for all the properties. I mean we meet as a committee and we basically kind of work through the plan as we go forward. I think that could be one good example.

LM: Certainly.

M3: Park plans! Old parks get biological assessments done as part of the process too through the acquisition process, so when a new park is purchased or basically kind of created through subdivision, we get a biologist to do an assessment and they look at the current ecological, you know, state of the park but also give recommendations for any kind of restoration priorities and that's what we usually kind of look at when we're out looking for funds or allocating a budget to do restoration work going forward. And again, it's a mix of maybe what the city budget can provide plus any kind of partnerships we can get through conservation groups, or stewardship groups, or external grants that we might apply for a specific project. And yeah, I mean I could list off a number of city parks that had these plans already and basically quite similar so.

LM: Fantastic. So, then I wanted to kind of shift towards more of an ecosystem rehabilitation and restoration questions here: in terms of some of the restoration projects that you have been doing and that have been going on, can you name or describe a metric that the municipality is using to monitor ecosystem system service quality improvements achieved through some of these projects?

M3: Yeah, we've done something called – it was a number of years ago – it was, there's something called by the province called the sensitive ecosystem...the inventory so it was basically like a high-level ecosystem inventory assessment done by the province and they created a series of classifications that identified you know, key rare ecological features on East Vancouver Island where the city is here. So those are like things that we've basically adopted that inventory and incorporated that into our development permit area guidelines for the city. So, Gary Oak Meadows, and riparian stream group riparian areas, are kind of, some of those key features or coastal bluffs. So, they're fairly large – they're basically half a hectare or larger – but they kind of give us a metric of what kind of ecological feature that [are] recognized by the province, that we can kind of look for when we're looking at a development and trying to acquire you know parkland. So, we might look at those features and say that's what we want to try and acquire as part of a subdivision application.

M3: I think on a smaller scale though, the province also has an endangered species listing like a red list and a blue list species, and we try and look for presence of those during our park assessments. And as we kind of do our restoration plans, we try and monitor for the presence of these endangered species and do these periodic kinds of check-ins over time as the, you know, as the years go by for a particular park so. And then work is done to try and – if there's any adjustments that are needed, we might do an assessment, we can hire a biologist to do a more thorough look at you know, if there's an absence, or we're not finding what we had originally seen when we purchased a park, we'll look for some recommendations or prescriptions about what we can do to turn that around. I mean there's a couple of examples we have here, and we've been doing that.

LM: I know we are running a little bit short on time here...do you have time for another question or two or should we cut it here?

M3: Oh no, that's fine – we can do another couple questions.

LM: Sure excellent, thank you very much. Well, I wanted to ask that – I think you kind of touched on this on in your last answer – but in terms of some of these some of these projects that you have going on, and specifically that sensitive ecosystem inventory assessment – have you seen an improvement in some of these areas that you do have a restoration project underway? Have you seen an improvement in kind of some of these key metrics that you're monitoring or kind of, this assessment that the province has, based on some of the metrics that they have outlined?

M3: Yeah, it's a – I'll warn you it's a coarse metric, and maybe that's one of our limitations, is having the funding and resources to do more detailed assessments and maybe that's where we need to do more work is to have, kind of, a more regular detailed assessments of some of these key ecological features that we need to be tracking. I think we have a very kind of broader, coarse kind of approach, and you know, it works to an extent, but I know we are going to get challenged more and more about this and having to do more to try and improve ecological diversity going forward. So, we are going to have to step it up, I guess. That is kind of my feeling about it.

LM: Exactly that, and really that kind of touches on something else that I was going to ask but, I think we have covered it sufficiently here in terms of the monitoring which is kind of the next big thing especially once you get the actual natural asset inventory in place and the strategy in place – that coming up with the sufficient monitoring framework for these areas is really important because there are a number of metrics that you could be looking at: the level of E. coli in certain stormwater runoff for example, and then the health benefits that come from that. I mean there are a number of things that you or your municipality could be looking to monitor so it's key to work towards that I guess after you finish this this next step here.

M3: Yeah, maybe there is one dimension that I forgot that it's kind of, it's a good thing too – there's a partnership that we have developed with our regional district where they're working with residents who volunteer their time to do kind of citizen-science approach and they do water quality monitoring on some of the urban streams in the city. And they are very basic tests: you know, water temperature, dissolved oxygen, benthic invertebrates, the sedimentation levels through a secchi disk...anyway, basically those broad kinds of parameters and it's... there's a quality control through the province, through their water quality biologist who does a kind of, a back-check of all the results that come in and make sure that the data is as accurate as can be and that information is posted publicly on the regional district website. So, it's a good way of, kind of, tracking in you know – like I say through the simple tests anyways – some of the water quality parameters around the region including several creeks in the city as well. And I think that's a great way to try and do this while working within the limited budgets and time as you have so.

LM: Absolutely. No, of course you have to you have to start somewhere and [to have that] kind of work already in place, I mean...as I mentioned I'm from Ontario here, and I don't think we have a system like that so, I mean already that's a step ahead in terms of where some of our municipalities here are. The last question, I had here and then we can kind of end off and send each other on our way is just in terms of service delivery and this is a question in relation to climate change and spending increases: so how are spending increases on municipal services due to climate change - have they been limited because of the services that you're looking to provide through natural assets? Now I know that this question is kind of looking more into the future and it's difficult to anticipate what your service delivery outcomes could be once your natural assets are fully accounted for, but do you expect at this point in time that pressure would kind of be reduced on traditional municipal infrastructure because of an increased focus on your natural assets?

M3: Yeah, we... just last summer we completed a climate resiliency strategy. So, we hired a consultant for that and it was kind of twofold: they did a sea-level rise study for the city and looked at some broad weather prediction parameters that are available through the province and made some you know, basically some estimates on the risk and impact on the city infrastructure. So there was a number of recommendations that kind of touched on a lot of different departments in the city. But I'd say definitely there was interest on more resources for more restoration and enhancement of some of the watercourses in the city because there was concern of course about as you know, climate and climate change increases – the hotter summers, the drier summers you're going to have these impacts on water levels, on fish bearing streams, so we need to be looking at how we can hold and retain water for summer release and who's going to be responsible for that. More tree planting of course came up as a high priority all throughout the city as a bit of a climate mitigation but also an adaptation measure. I guess looking at that, looking at parks, and engineering, and planning, and how they integrate and how they need to kind of work together more closely to kind of make sure that these recommendations are followed through going ahead.

LM: Excellent. So, I think with that then, we can pretty much close here. I wanted to thank you for your time. I can imagine that especially given the current circumstances, the municipalities are quite busy, but I wanted to thank you again for taking some time out of your day to speak with me. I want to as well assure you that the answers and the information that you provided here along with some of the information I've been able to gather just through document review will not only help me in completing this research but the hope is that it will also help your municipality moving forward as a step – you can look at maybe some of the other steps that other municipalities are taking and more easily identify well “what's next for us once we once we get to this point” and kind of what are the milestones or what are the outcomes that we should be looking for. So, I hope that this research will provide those answers for you and that it will be of use to you moving forward. So again, I wanted to thank you for your time today and if you have any questions for me please now is the time to ask.

M3: No, it's fine thanks. I appreciate what you have told me and looking forward to hearing what the results are so, yeah...because like I say we will be working on our inventory and strategy in the near future so it would be nice to kind of check around and see where everyone is at and yeah, we can kind of work together and/or share information to kind of make sure we can keep up with everyone else.

LM: Certainly yeah...I've been making great use of the City of Nanaimo website to kind of pull some information from there...I wanted to ask now that I have you, if there are any documents that you kind of talked about or anything that comes to mind that may not be publicly available on your website but that you would be willing to share with myself...if you want to send that via email. If there's nothing that you can think of right off the top of your head now that's totally fine, but if something comes up just, by all means, please feel free to share that.

M3: Well, I'll tell you what: if there's anything specific you're looking for... give me some examples and I can see what I can do for you how's that?

LM: Sure.

M3: Because I mean yeah there's definitely some material on the website but there's a lot more that we can have access to that you know, we can provide, but yeah, just let us know where the holes are that you think might be it might be helpful to have some more information about and I can help you with that.

LM: Absolutely, OK great. Then I'll be in contact there for that.

M3: OK

LM: then once again thank you for your time, I hope you have a great day...I guess it's nearly the afternoon there for you folks! Have a great rest of your afternoon, rest of your morning, and all the best and we will be in touch of course.

M3: Alright, well thanks! Nice meeting you!

LM: Likewise.

M3: Good luck, bye!

Appendix 4.5 Town of Oakville Interview Transcript

LM: OK, so, this study titled “Advancing Municipal Natural Asset Management through Monitoring and Engagement” is an evaluation of your municipality’s natural asset management strategy and process. The purpose of this evaluation is to establish a standardized evaluation procedure for natural asset management projects, to build a database for beneficial outcomes of municipal natural asset management, and finally, to create a user guide for continuous monitoring of natural asset management. This procedure will notify you, your staff, and other interested parties on how this process is performing relative to selected indicators. The results of this evaluation will also suggest recommended improvements for municipal projects. The information collected here will also be used for research in my (Lucas Mollame’s) Master’s thesis. This interview will be used to help this research team analyze your municipality’s natural asset management process. More specifically, your answers will provide data that can be measured relative to selected indicators. This interview will be a video-conference interview held over the platform Microsoft Teams. This interview is expected to take 30 minutes, although with more people, hopefully we can extend that for a little bit longer. Your participation in the study is voluntary. You can withdraw your consent at any time during the interview by informing the researcher (myself). You can also skip questions by informing the researcher. The session will be audio-recorded to ensure an accurate transcript of the interview. You will have an opportunity to review this transcript before the project proceeds to data analysis. This transcription will be used for creating anonymous quotations.

LM: So, with that script being read, are there any general questions from that?

F2: No.

M4: Zero.

LM: So just, again, some consent questions. All we need is a yes or no... Are you aware that the interview will be audio recorded to ensure accurate transcription and analysis?

All: Yes.

LM: Do you give permission for the use of anonymous quotations in any thesis or publication that comes from this research?

All: Yes.

LM: Do you agree of your own free will to participate in this study?

All: Yes.

LM: So, we have a couple of different outcome streams that we are monitoring. Again, as I mentioned earlier, some of them you may be able to speak to now, some of them may be a little bit premature. That is OK. So, the first part of the program that we are going to start off with here is awareness, capacity, and education-related outcomes. So, the first question that I have is in relation to partnerships. These may be partnerships that you have established with private partners or only public partners. So, are you aware of any partnerships or collaborations with other organizations to implement natural asset or ecosystem service management in your municipality? What kind of partnerships are these? Who participates and what are the benefits for the partners?

F3: So, Kristina?

F2: We did that one LID right? That was a partnership with...um I know Donna was involved... it was with Conservation Halton yeah. And also, I don't know if it was Oakville Green?

F3: Yeah.

F2: Oakville Green and Conservation Halton. There was a consultant involved that donated their time to do the design of a bioswale and then, the Town put in money to contribute to the work and offered our time for review and then permitting, that type of thing. I know there is interest on their part to do more of that. They are looking at opportunities...I know Oakville Green is also doing tree planting, so they have reached out to us to look for areas where they want to take a group out to do tree planting in the natural heritage. And so we work with our Forestry Department to look at "OK where do we know we've done tree removals for creek works, where do we know we're going to be going (so we don't want them to go there because we don't have to cut them down)" and then we talked to Forestry about where we've done removals for Emerald Ash or for the ice storm that we had years back and try and supplement those areas with tree planting.

F3: Yeah, so those are the two major ones that I had as well. When we are talking about natural assets we had, yeah, like I do not know what Forestry has done for natural assets, but they partner with Oakville Green on a lot of tree plantings as well and naturalization.

LM: And just so I am recording this right, is this something that they more so came to you with, that this was their idea, or is this something that you collaborated with from the very beginning?

F2: They came to us with the idea, and they had secured funding. So, they secured funding and I can look up where, I forget where, but they had secured the funding, they wanted the partnership because I think then we matched that funding to make it a reality. But they spearheaded it and they involved us from the beginning.

F2: I know they also last year reached out. They have an interest in permeable pavement on the private side. So, for driveways, they were looking at driving an initiative on permeable pavement on driveways, and basically you know the town does not do work on private land. Driveways are the homeowner's responsibility. So, we were going to look down the road at discussions on how we can support that program and recognizing that we do not do work on private property.

F3: Yeah, that is the Halton Environment Network doing work on that one.

F2: That is right. Yeah.

F3: We did go in on a funding application with Conservation Halton for permeable parking lots when there was some kind of construction going on, but I don't believe we received that so then we didn't go ahead but we tried.

LM: OK, no that's great, that's great, and then I guess moving from the partnership side towards more of the general public, have you made any public engagement efforts in regards to your natural asset management strategy? Have there been any outreach efforts? I am thinking of things like townhalls, perhaps putting together a brochure...any information related to that that you would have released then to the public.

F2: So, we have information on our website about natural areas and channels, and you know a lot of the time when we go out to do the creek erosion projects and we meet with the adjacent neighbors, or they call us to come look at the erosion, we find that they have dumped you know tree branches and yard clippings and everything else on the slope thinking it helps the stability. And then you know, part of that is education. So, we have developed flyers for natural areas and channels and that information is also on our website. Then we have handed those flyers out along with [information on] stormwater management ponds. We have a lot of communication around those, and we have handed them out at quite a number of engagements that Trisha's group participates in, like public outreach events. Energy week and those types of things.

LM: How have you found the reception for example in terms of the stormwater management ponds? Have you found the public has had generally positive reception towards these and these areas or any concerns?

F2: Um it is a mixture. You get...I mean people pay a premium to live adjacent to these facilities but then you tend to get more rodents and that type of thing in these open areas right. So that is a complaint we have had and algae. We do get algae in our ponds in the summer. Certain years, not every year, but most. And so, from an aesthetic point of view and an odour point of view, you get complaints. But, in general, town residents love the amenities. They love the trails. I mean we have incorporated our ponds into the trail system and our parks areas, so I would say the majority is positive.

F3: Phil partnered...well not just Phil alone...but your Department with Conservation Halton to do those rain gardens and the naturalization and all of that as well. They did a series of workshops a couple of years, not too many years ago at QE park as well, did they not Kristina?

F2: Yes, that is right. Conservation Halton runs those, but he participated to talk about LIDs and that kind of thing, yeah.

LM: Excellent, I – no that is great, and I'm sure at least anecdotally, I've seen a real uptick especially during COVID-19, in regard to the usage of these areas and I think a renewed sense of appreciation for these that maybe before, I think was still present, but I think I'm starting to see that a little bit more. Just from the general public, having an appreciation for these areas and what they offer. OK now we will move from awareness and capacity to implementation, and this will be [examining] the actual operational changes you may have made in municipal structure or how you are doing things in regard to natural asset management. So, one of the first questions we wanted to ask if there are any barriers or opportunities that your municipality or some of the partners that you work with have encountered when attempting to implement municipal natural asset or a natural capital strategy into your asset management strategy? And if there were any barriers did you act upon them? How so?

F2: So, you mean incorporating them into the strategy or actually planning to build them?

LM: Both.

F2: So, for years they were considered new, and the maintenance and operations around them were not well established and there was reluctance to look at more of the operations side and more of maintenance side to know what we were taking on, how often do they need to be cleaned out, what is involved, who is going to do it. Then, you know, through just education and pilot studies and that type of thing, then we - I think, we are on board with doing these. The thing that makes it difficult a lot of the time is competing interests right. So, from the Town's perspective, we look to do these in right-of-way projects and facilities. And in the right-of-way, usually when we are going to widen the road, we have utilities, we have got trails, sidewalks, trees. If we have ditches, we try and retain them. The wording of our master plan actually notes that they provide a service that we should retain from an infiltration, water balance, and informal water quality treatment. It is not easy you know to keep the ditches when you have all these other objectives. So, it also comes down to safety right. If there's large trucks, look at the type of road it is. Sometimes the urban cross-section is desired for that reason. So, there are lots of barriers and I think the only way we can continue to drive is through pilot opportunities. So, the approach we have taken on the more recent road-widening jobs is you are not going to have the LID the entire length of the right-of-way, but you look at strategic points where you can convey water from the urban cross-section into those. So even though it is going to go to formal treatment you still have the informal treatment in specific areas. That is usually you know, bioswales, infiltration gardens that type of thing. I do not know if you have anything to add.

F3: No, I do not know, my barriers really were just like the planning, and finance, and education right. Like I think right now, and I know that this is a question for later, but a lot of our staff are now taking the natural asset courses and things like that, which we can get into later. But yeah, I think it has just been a bit of slow uptake due to that.

LM: Well that that actually leads me to where I wanted to go next is in terms of staff capacity. Some of the issues that we have seen in other municipalities, especially the smaller municipalities, has been an issue of under-staffing. Have you found a similar thing or is it more so a training aspect, getting staff up to speed on these concepts to make sure that they are applying them in their work?

F3: There are a lot of capacity issues. I know when we have even looked at funding the applications to apply for funding for some of this work, we do not even have the time to do those funding applications. So, I think capacity is definitely an issue.

M4: I think education is an issue too. A lot of the planners may not be used to thinking this way, so trying to educate them into those concepts takes time.

LM: I would definitely tend to agree with that as well. That is something hopefully that is improving over time, but I think that you're starting to see more and more reflected in that just because there is a bridge. Like obviously, I am coming from an academic background, and some of these concepts are a little bit more well understood but it's a little bit different when you're getting into what's actually being done on the ground. So, we are trying to make that make that bridge, I guess, a little bit easier.

M4: I know from the asset management group perse, like the people that look after the asset registry and stuff, we are slowly getting educated on these assets and starting to put practices in place to keep them in the system and all those other things that go with that. So, we manage them more like a traditional asset as we learn more about them and capture all that information. But that process is really just starting for us.

F3: Yeah, and finance has been sitting in on a lot of that too which is good.

LM: I will be getting to a question on financing as well. First, I would like to then move to – I guess maybe some more policy-related questions: what changes, if any, has your municipality made to implement natural asset or ecosystem service management into your municipal planning policy? This could be everything from your OP, your bylaws, any secondary plans, an asset management plan, whatever it may be.

F3: And you are asking since the pilot project?

LM: If there was work done prior to the pilot project, sure, I would be happy to hear about that as well.

F3: Well, I mean it is in our Official Plan. I do not know how much it is encouraged or implemented through, but it has been in our Official Plan since 2014.

F2: The latest provincial policy statements speak to it a lot more directly than they have in the past right.

M4: I do feel, I am not sure if it is a plan or whatever it is, but a lot of the “Build Back Better” concepts are taking more consideration into all those other natural assets while they are doing those things I believe, yeah.

LM: We are hopefully starting to see that I think a little bit more to [where] these nature-based solutions are a possible avenue as [municipalities] explore this area a little bit more. As you know, municipalities are no doubt struggling during this time with funding issues, and this is kind of a

way I think to hopefully again make it easier on the municipality to achieve these goals. I just wanted to push a little bit further on this: has there been, in terms of like a bylaw change, anything in relation to setback areas, tree planting or tree cutting bylaws...anything like that introduced?

F3: Our tree bylaw was strengthened a few years ago but we have had it on the books for quite a few years now.

LM: Well, that is good to see. Every municipality is different: some that we have seen have made some significant changes since the pilot project but others, at least from what I am gathering here, it seems that you guys had a very strong foundation even prior to the start of the piloting project, and there might have been some tweaks, a little bit of strengthening here or there, but it seems that that foundation has really served you guys well.

F3: Yeah, I was going to say our corporate strategic goals right now are very heavily focused on asset management and natural asset and climate change so hopefully we will be seeing a bigger push and some more action.

LM: OK then moving then to a question on financing and funding, for some of these natural asset projects or ecosystem service management projects, have they received funding or financing? And then, was this funding or financing sufficient to complete said project? And where did the funding or financing come from?

F2: So, with the bioswale I mentioned, I will have to look up where the funding came from, I think it was the province, but I'll look it up...and it was not a lot of funding at all. We had to kick in money, and I do remember there was hope of paying the consultants a little bit and I think in the end, they got nothing. It was all sort of donated time. And I know in construction, when they went to build the bioswale, it is near the shoreline and they started excavating and found fill and debris instead of...

F3: Right, yeah.

F2: ...probably did not do Geotech you know, with a limited budget we had. So, I think probably in the end it was not nearly enough.

M4: And after saying that, we just hired a centralized person to look after a lot of these funding and grant applications. That person was just hired in December I believe, because I think Finance recognized how difficult it is to fill out those applications and do all those other things. So we're hoping that having it centralized and taking that burden on, that will help with some of that stuff, because you know I feel that many applications – it's a daunting exercise, the value sometimes is not worth the money that they're giving you because you have to track it and do all that stuff, but by the time you add up all the time to do that, that doesn't equate to the money they're giving you.

F3: Yeah, that can be one of the barriers that we have experienced as well.

LM: And you are certainly not alone in that regard. I mean I've chatted with a few other municipalities and some have mentioned – they are mostly in British Columbia so I'm sure things are a little different – but most of them have mentioned that even just a few years ago, the concept of natural assets wasn't even available on some of these application forms, trying to trying to convince whoever you're trying to pine for money that this is valuable work, is itself a challenge, let alone as you mentioned, filling out these laborious applications that certainly did not make it easy to or wise, maybe some would say, to put time into this.

M4: Even on the back end of that, is tracking the invoices to meet the grant funding application demands. Sometimes the financial staff were going through invoices and parsing things up and doing all those other things just in order to meet the requirements. The burden becomes extra because it is not the way the process is working, so we have to break our process in order to do the reporting requirements which always is creating inefficiencies when that happens.

LM: OK now, most of the questions from now will be kind of looking towards the future and maybe what you may have planned in the near term and hopefully in the long term as well – looking first kind at new plans or new projects that you may have on the horizon: is the municipality implementing any natural asset or ecosystem service programs or plans in the near future or in the long-term future I guess as well too. Are there are any plans for that?

F3: Directly for natural asset management?

M4: This is my perspective, and Kristina you can jump in here, is I feel as more and more projects are happening, people are taking consideration of natural assets within their overall project of things. So, it may not be a specific new project, but I think more considerations happening around natural stuff when projects are happening. I feel, I do not know how accurate that is, Kristina can jump in and say otherwise if that is the case.

F2: No, I agree.

LM: Also, something else that may or may not be happening: any plans for rehabilitation or restoration of any natural areas in the near term or long-term?

F2: Certainly, from our reforestation program, there is a lot of work that goes into that and determine areas that need it.

F3: I know forestry has so much of the data already, like to do a natural asset valuation for them would be not quite as onerous because they have so much data already.

F2: You mean like tree inventory work?

LM: Are there any plans to do an inventory for forestry at this point in time?

M4: Every 10 years they do a physical inventory count I think they are just doing one now actually.

F3: And so yeah, we are just doing our risk assessment for the asset management plan and our climate adaptation plan as well, so a lot of these again are being flagged as actions. They are not concrete plans at this point but that would be a next step.

M4: And I think through Kristina and Diana's area, they are indicating a lot of like bioswales, and LIDs, and infiltration pits and all those other things. So, we are slowly capturing that kind of stuff and putting it into our system so that it can be properly managed, and operated, and maintained, and planned for coming down the road. Which we never did in the past. We never put it in the system. We probably just kept it in our heads, or on sheets and spreadsheets, or GIS and that kind of stuff.

LM: OK now moving to maybe some of the natural areas that you are keeping in mind here, are there any metrics that your team or the municipality is using to monitor ecosystem service quality? Now these would be like physical measurements – I am thinking of things like water quality for example of a specific stream. That would be an example of something.

F3: Yeah, so Kristina has a lot of that info.

F2: Sorry can you repeat that?

LM: In terms of the natural areas that you may be monitoring or keeping in mind for your natural assets, is there a metric that the municipality is specifically monitoring? This could be something like water quality, for example, of a specific stream, that you have in mind.

F2: So, we do – as part of our development plan for North Oakville like north of Dundas – we do water quality and full monitoring. So, we look at the impact on flow in the streams. We have four sites and we also, at those sites, we look at water quality indicators: temperature, chloride, phosphorous, and now we are actually looking at benthics and then on our stormwater ponds... because that's what they're designed to do. We have done other like temperature and that type of thing on them, but the bulk of the work is on TSS because that is how you measure if they are working or not. We have done a little bit of work on trying to monitor LID's. So, we had a permeable pavement parking lot where we did flow monitoring to try and determine how much flow it was sort of removing or delaying in the system and we did also do that – it's hard to do if the LID is not set up for monitoring from the get-go.

F2: So sometimes we have just had visual inspections, like for instance, the bioswale where you look to see what was coming out of it because we did not have a monitoring courts to put equipment in that type of thing right. And then I know through development, where we're requiring infiltration components, like site plan agreements, or having the developer monitor to put in the monitoring ports for the bioretention or whatever they're designing and having them demonstrate that they are functioning and it's, you know, a lot of them worry – not because we're not going to assume it, we want to know to inform our process better – like how well are these performing you know, how much water they really sort of retain and attenuate.

LM: Absolutely. That is something hopefully, as this kind of advances along, that we are going to start to see maybe standards in relation to monitoring natural assets right from the jump as you mentioned or in these green infrastructure areas like permeable pavements for example right from the jump. To see some standards in terms of what exactly you want to be looking for change throughout the process.

F2: Well, you know it helps. We certainly do want to move towards standards and streamlining what we are getting, so that the infrastructure is you know – we get a lot of pushback, and so the more data you have, to demonstrate “look this is what you got to do to get the effect”. And as years go by, there is more and more monitoring. 10 years ago, we did not have this monitoring. So, it was very hard to argue the fact.

LM: We're going to move into our last stream here. This is in relation to service delivery outcomes. Now again, these are pretty high-level and might be a little bit advanced for where the municipality is but from what I am gathering, you have done a lot of very excellent work and are ahead

of at least some of the other municipalities that I've talked to which I think is very good and something that should be a good note for the work that you guys are doing.

LM: In terms of co-benefits of natural assets...this could be a reduction in things like Urban Heat Island effect for example, greater usage of trails even, cultural ecosystem services where there is a really strong appreciation in the community in terms of these trails as a site for recreation...has there been any monitoring here? Any qualitative or quantitative monitoring of an increase in these kinds of co-benefits?

F3: Conservation Halton is doing a carbon sequestration study right now that touches a little bit on Oakville as well but more regionwide.

F2: At one point we provided – we have two weather – like so we have got several rain stations across town, and two of those stations were full weather stations at one point with wind, temperature, recording it you know every five minutes. And we did provide that data...trying to remember who it was...it was Conservation Halton and others that were looking at Heat Island. There might have even been an academic that was doing research on heat island impacts, but we have given that information. We no longer operate those full stations that just logistics of this you know, not working. I think we are all just simply rain gauges now but, we did feed that data and then we are very open with our data. We share a lot of data with Conservation Halton and the Region.

LM: Now, I guess we are very close to the end here, so I have just one more question: in terms of spending increases on traditional assets instead of natural assets do you see and again, this can be in the next five years, next 10 years...do you see a reduction on traditional spending for traditional assets and an increase in spending on the services provided by natural assets?

F2: I mean the LIDs are great at the high frequency events right, the 90% rainfall. It does not negate the need for the end of pipe infrastructure in our experience, so I'd love to say I'd see one decreasing but I don't know that I do. Maybe slightly, but you still need a lot of that infrastructure and at the same time we have got areas of town that were developed prior to those best management practices being in place so there's lots of retrofit and upgrades. You know, not just renewals, and there's areas where we do not have storm sewers where we could look at a combination of grey and green infrastructure. I do not know that I necessarily see a decrease in the one, but I think I see an increase in the other. I do not know if you'd agree with that or not Shawn.

M4: No that is exactly – I agree with you 100%. You know everything is a dynamic and you got to try to work in as much green as possible but ultimately you still got to maintain and keep the level of service that is currently there and some of it is hardened infrastructure and that is just the way it is going to be. It is going to be a blend of things. But I have not noticed any direct increase but it is kind of hard to tell because it's all being slowly mashed together sort of.

F2: I think maybe you know, ask us that question in 10 years.

LM: And I think that's – you just kind of hit the nail on the head. That's the point of this exercise and what we're trying to do is that we kind of capture these answers now and then the hope is that we can come back in a year's time, in five years time, in 10 years time, to see what it's changed. Maybe not so much in terms of the questions of what you did 10 years ago, but more so what has changed in the answers of “we're not

sure this may be where we're heading” and then we get the opportunity to look back and say “well is that in fact where you headed or did you just go in a different direction and was it successful or not”.

LM: So, no that is great to see and that's not exactly kind of captures but what we are trying to do here. So, I think with all that, we can kind of end off. Again, I want to thank you for your time, thank you for contributing to this, the whole hope as well is that the data that you provide here will be a benefit for you just as I described there, and that you also have the opportunity to see what some of the other municipalities that MNAI has worked with are doing and what they might be moving into, and to share ideas and data. Are there any questions before we kind of close off in terms of my work or anything related to that?

M4: No, I have no questions.

F2: Will we get copied on a summary or?

LM: Yes! So the plan right now at least for myself – we will be writing a kind of final cohort – you are part of the first cohort, so I think that's yourself and about five or six other municipalities – and that will detail the methodology that was done here, what exactly the monitoring report is aiming to capture, and just some, again, some details on what we've chatted about here and what the other municipalities have found in their natural asset management journey. You can expect to see that – we are starting to already kind of put that together now – the hope is that you will see that by August at the very latest if not even earlier. And then there will be some additional conferences that I hope to present at too or MNAI may put a chat together as well to talk about these things.

F3: Great look forward to seeing it.

LM: One last thing that I forgot to mention – if there are there any documents in relation to kind of what we chatted about here, any materials that you mentioned that you want to share with me, I would be more than happy to receive those. I do not think...there's nothing that immediately comes to mind here that that you mentioned but if anything comes to mind for you that you may want to share or CC me on, I'd be more than happy to read through that.

F2: Great, thanks Lucas.

LM: OK, yes well, I hope you guys have a great rest of your morning, rest of your day, and I will be in touch. I will be sharing a copy of this transcript as well as an appreciation note for the time you have spent.

All: Great thanks

Appendix 5 – Individual Scorecards

5.1 Town of Gibsons

5.1.1 Awareness, Capacity and Education

Awareness and Education

The Town of Gibsons has made a concerted effort to spread awareness of municipal natural asset management among the public. However, there is little data to report on the exact number of consultation events related to municipal natural asset management within a given year, nor is there any data on the number of people attending these consultation events. For example, the Town of Gibsons has held a few public hearings with specific details that relate to municipal natural asset management. On March 10th, 2015, a public hearing was held with approximately 200 attendees and 149 pages of written submission (Town of Gibsons 2015c, pg. 2). The comments from attendees refer to protecting natural assets such as the local aquifer. However, the subject of this public hearing was the creation of garden suites on public property. On Wednesday, September 4th, 2019, and Wednesday, September 18th, 2019, two public information meetings were held on expanding service from the Gibsons Aquifer to Water Zone 3, which covers Upper Gibsons (Town of Gibsons 2019b: Town of Gibsons 2019c). There are no details on how many individuals attended those meetings. On Monday, September 14th, 2020, a virtual public hearing was held for the introduction of the new Tree Preservation Bylaw for the Town of Gibsons' urban forest. At this meeting, the Town of Gibsons received 22 written submissions of comments (Town of Gibsons 2020f).

The Town of Gibsons does publicize information on what natural assets are, how they are managed, and what the objectives of this management are as part of a larger education and outreach campaign on their website. As well, the Town of Gibsons website supports an archive of media resources on their natural asset management dating back to 2012. These media resources include a YouTube video that explores how the Town is investing in the protection and enhancement of a local natural asset (Searle 2016). The Town regularly speaks to both local and national media outlets to highlight municipal natural asset management (EM 2020, para 38).

In terms of the content of these information materials, the Town of Gibsons frames municipal natural asset management through the provision and delivery of key infrastructure services and enhanced recreational use. For example, in the YouTube video mentioned above, staff explain how Whitetower Park's stormwater ponds are storing, treating, and filtering most of the Town of Gibsons' rainfall throughout the year. To make that message clear, staff compare the ponds to kidneys which serve a similar function in the human body (Rick Searle 2016, 0:00-0:27). In the articles, radio stories, reports, and other media resources, the Town of Gibsons have contributed to, the public receives a similar message. For example, in a Globe and Mail article from 2016, the Town of Gibsons is used as an example for considering the value that nature provides through its services (Brooke 2016). An article from the local Coast Reporter in 2015 lists the following as benefits of natural asset management: (i) no up-front costs, (ii) no replacement costs, (iii) lower operating costs, and (iv) a natural asset that could last indefinitely if properly managed (Roberts 2015). Along with raising awareness through traditional and social media, the Town of Gibsons also engages the community directly through harbour clean-up

initiatives. On October 16th, 2020, the Nicholas Sonntag Marine Education Centre hosted a community clean-up event for the Town of Gibsons' Harbour. The event was designed "to create community awareness & educate our volunteers about ecosystem health, while actively doing our part to clean up human-caused hazards & waste" (NSMEC 2020c).

Awareness and education outcomes have two separate indicators. For the first indicator (number and success of consultation efforts), there is a lack of specific data on the attendance rates for natural asset management consultation events. Therefore, a Grey score has been given (Fig. 19). For the second indicator (information about reasons for MNAM), all information materials produced by the Town of Gibsons accurately describe at least one reason for conducting municipal natural asset management. Therefore, a Dark Green score has been given for this indicator (Fig. 19).

Capacity

As part of their early work with natural assets and municipal natural asset management, the Town of Gibsons created several partnerships with other organizations interested in natural asset management. This includes the Smart Prosperity Institute, the David Suzuki Foundation, and Brooke & Associates (EM 2020, para 36). These partners came together to form the Municipal Natural Assets Initiative to upscale the Town of Gibsons' natural asset management approach to other municipalities. In interviews, staff described that when they first launched their eco-asset strategy, a partnership was formed through a memorandum of understanding between these three organizations that led to the creation of the Municipal Natural Assets Initiative.

In addition to these partnerships, the Town of Gibsons has more recently engaged and worked with the Sunshine Coast Regional District, the Nicholas Sonntag Marine Education Centre, and the Sunshine Coast Streamkeepers Society, for various natural assets of interest. The Sunshine Coast Regional District is the local regional government for the Town of Gibsons and seven other electoral areas and member municipalities. The Sunshine Coast Regional District is focusing on asset stewardship from a regional perspective. The 2019-2023 Strategic Plan lists asset stewardship as a "strategic focus area" with such tactics as "incorporate natural asset stewardship into Corporate Asset Stewardship Strategy" (SCRD 2021, pg. 8). The Town of Gibsons' 2020 Budget Supporting Document listed the creation of a regional water governance model for the co-governance and co-management of the region's natural water assets. Support for this project has come from the District of Sechelt, the Sunshine Coast Regional District, and the Town of Gibsons municipal staff (Town of Gibsons 2020a, pg. 4).

Next, the Gibsons Marine Education Society opened the Nicholas Sonntag Marine Education Centre in 2017 "to advance education and to protect the environment for the benefit of the public by undertaking projects that sustain the marine ecosystem of Howe Sound, British Columbia" (NSMEC 2020b). The Centre is a community aquarium operating under a collect-hold-release model with several education programs and events. The Centre partnered with the Town of Gibsons in 2020 under a four-year agreement for the management of natural assets within Gibsons Harbour through the Healthy Harbour Project (NSMEC 2020a). Finally, the Sunshine Coast Streamkeepers Society is a community-based stewardship organization that does regular creek assessments and yearly salmon spawning surveys for a few creeks in the Town of Gibsons area. As well, the Streamkeepers Society works on invasive plant removal, recording

air, and water temperatures, and restoring the Charman Creek Riparian Zone in the Town of Gibsons through the reintroduction of native species (Sunshine Coast Streamkeepers 2021).

The Town of Gibsons has also engaged the Squamish Nation on a few projects. To start, the Town of Gibsons and the Squamish have agreed on the importance of doing this work for the protection of cultural assets (EM 2020, para 36; Town of Gibsons 2020a, pg. 4). As well, the Town of Gibsons Council has committed to establishing a Healing Forest within Whitetower and the Charman Creek ravine. “The National Healing Forest initiative envisions creating a network of forests and green spaces across Canada, where Indigenous and non-Indigenous peoples can come together in the spirit of reconciliation to heal, reflect, meditate, talk, share and build respect and understanding as a result of the Residential School legacy and the findings of the National Truth and Reconciliation report” (Town of Gibsons 2020g). The Town of Gibsons has also committed to engaging with Indigenous partners on ongoing projects. For example, the Town of Gibsons has received partial funding from the Healthy Watershed Initiative Grant for the Source to Sea Project. “A requirement of the grant is for staff to provide plans to support meaningful engagement, employment opportunities, and outcomes that serve First Nations and Indigenous partners in project implementation and learning” (Newman 2021a, pg. 26-27). With such a considerable number of partnerships focused on municipal natural asset management, the Town of Gibsons has earned a Dark Green score for the Capacity indicator (i.e., number of partnerships) (Fig. 19).

5.1.2 Implementation

Barriers and Opportunities

One of the first barriers identified by the Town of Gibsons was organizational structure. In interviews, staff mentioned that to implement municipal natural asset management, there is a requirement to work with different departments, such as Finance and Engineering (EM 2020, para 42). These departments may have different approaches to work which makes inter-departmental collaboration more difficult. Town of Gibsons staff acted on this barrier pursuing two approaches. Following the first approach, Town of Gibsons management created education and training courses for inter-department collaboration. A second approach was through “trial by fire”, where management would increase the number of projects each department was working on, so they were forced to produce practical solutions together. For example, in their Eco-asset Strategy, the Town of Gibsons acknowledges that a municipal natural asset management approach requires team-based, collaborative approaches across Town departments and disciplines. Before the introduction of the Eco-asset Strategy, “Town departments traditionally addressed different aspects of the foreshore in isolation; Public Works would address storm outfall related issues, and Parks would address recreation or horticultural matters” (Town of Gibsons 2015a, pg. 11). This piecemeal approach can silo Town departments in a way that negatively affects outcomes for natural assets.

As a second barrier, Town of Gibsons staff also mentioned lacking natural asset management tools and policies. More specifically, staff mentioned that a clearer direction and directive from the provincial government with rules and regulations could build the necessary roadmap for municipalities (EM 2020, para 44). To address this governance issue, the Town of Gibsons is working to develop a predictive model that includes 20-25 variables to help more

governments understand the opportunities provided by municipal natural asset management (EM 2020, para 44). Despite this barrier, the Town of Gibsons has made several changes to existing policy through a commitment to the principles of municipal natural asset management. This includes a Tree Preservation Bylaw, an update to their Asset Management policy to include climate resiliency and risk, the 2019-2022 Strategic Plan, and the Town of Gibsons Financial Plan (EM 2020, para 49).

In terms of opportunities or enabling conditions, staff from the Town of Gibsons believe that from a policy standpoint, a municipality must do the following three things to enable municipal natural asset management: (i) formally recognize natural assets as fundamental to infrastructure, (ii) change the financial plan to recognize the value of natural assets, and (iii) change the definition of infrastructure in the Official Community Plan to include “our engineered infrastructure is interconnected and interdependent on nature to function (EM 2020, para 49). For both indicators used for this evaluation question (documents identify barriers and opportunities; managers identify barriers), the Town of Gibsons staff and review documents have identified opportunities and barriers. Thus, for this indicator, the Town of Gibsons has been awarded a Dark Green score (Fig. 19).

Policy Changes

The Town of Gibsons did make initial changes to their relevant planning and infrastructure policy to integrate municipal natural asset management practices. Starting with the Official Community Plan, the Town of Gibsons has changed or added several key policies to account for municipal natural asset management practices. This includes policy 6.2.6 which aims to grow Gibsons’ natural assets “by pursuing opportunities for reclamation of habitat, greening of streets and other projects that benefit both environment and community” (Town of Gibsons 2015b, pg. 29). As well, the Official Community Plan looks to grow the Town of Gibsons’ parks, trails, and outdoor recreation access by creating “a system of linked parks and trails to provide opportunities for both active and passive outdoor uses” (Town of Gibsons 2015b, pg. 42). The Town of Gibsons’ Official Community Plan was updated in March of 2015 to include several new policies, objectives, and goals related to municipal natural asset management. This includes policies for appropriate natural asset displays, provincial and federal advocacy (Town of Gibsons 2015b, pg. 30), water asset management policies for Gibsons Aquifer (pg. 34), parkland access (pg. 42-43), and managing natural asset services (pg. 70-74)

The Town of Gibsons has also been utilizing provincial level policy to facilitate municipal natural asset management. For example, under the Development Cost Charges section of the *Local Government Act* in British Columbia, the Town of Gibsons found that charges can be collected for improvements to natural asset areas. Therefore, “on July 19th, 2016, the Town of Gibsons was able to “adopted a revision to the Development Cost Charges Bylaw 1218 which included a \$3.2 million valuation for an increase in the Whitetower storm retention pond volumes” (Town of Gibsons 2018a, pg. 25).

In 2014, Gibsons passed a municipal asset management policy manual that defines and recognizes natural assets as an asset class or category (Town of Gibsons 2014, pg. 1). As well, this policy manual describes several objectives and principles to ensure that natural assets can be

operated, maintained, and replaced. These objectives and principles include “managing Town of Gibsons Engineered and Natural Assets by implementing appropriate Asset Management strategies and appropriate financial resources for those assets” (pg. 2) and that “Natural Assets are recognized as performing essential service delivery and will be identified and managed in a similar manner as Engineered Assets” (pg. 3).

Also in 2014, the Town of Gibsons “added a statement to the Significant Accounting Policies – Tangible Capital Asset Note in their financial statements to acknowledge the importance of natural assets and the need to manage them in conjunction with engineered assets” (Town of Gibsons 2018a, pg. 10). In the “2020-2024 Financial Plan Bylaw” a key policy now includes “preserving natural assets and other environmentally-sensitive areas of the Town” (Town of Gibsons 2020c, pg. 6). The Town of Gibsons has made changes to every key part of their relevant planning and asset management policy to integrate municipal natural asset management. Therefore, the Town of Gibsons receives a Dark Green score for this indicator (relevant policy changes) (Fig. 19).

Project Funding

The Town of Gibsons has available funds for various municipal natural asset management projects and programs they have started or are continuing to work on. In 2018, the Town of Gibsons “received approximately \$249,000 through the federal-provincial Clean Water and Wastewater Fund to update their Integrated Stormwater Management Plan which made several recommendations to the Town” (Town of Gibsons 2018a, pg. 20). In July of 2020, the Town of Gibsons was awarded \$955,000 from the Province of British Columbia (\$382,000) and the Government of Canada (\$573,000) to construct an additional stormwater pond at Whitetower Park. This money was awarded under the Rural and Northern Communities Infrastructure Stream of the Investing in Canada Plan (Town of Gibsons 2020b). On June 8th, 2021, Town of Gibsons’ council approved the award of the Whitetower Pond Tender to Pirate Excavating Ltd. for \$814,963.36, excluding GST, falling within the \$955,000 grant awarded (Newman 2021c, pg. 2).

In addition, the Town of Gibsons is working with the Municipal Natural Assets Initiative on the Source to Sea project. This project will install surface water monitoring in all the creeks located in the Gibsons Aquifer watershed through hydrometric stations on the waterways to determine seasonal discharge values (Town of Gibsons, 2021c). Council has authorized the budget reallocation of \$45,000 from Drainage Development Cost Charges and \$20,000 from the Groundwater Management Zone project to fund the Source to Sea project. Of the authorized funds, \$39,367 was spent in 2020 for the Source to Sea Project and current estimates have the 2021 budget for that project set at \$85,000 (Newman 2021a; Newman 2021b). According to interviewed staff, infrastructure funding grants and programs have changed since the Town of Gibsons began working on a municipal natural asset management approach to include natural assets. When the Town of Gibsons started this work, many of these external funding options did not recognize natural asset management as a legitimate service delivery strategy (EM 2020, para 55). However, staff now believe that any major infrastructure or climate-focused fund now recognizes natural assets and a natural asset management approach (EM 2020, para 55).

The Town of Gibsons has been able to secure various external funding options for natural asset management projects. As well, the Town of Gibsons has dedicated some part of revenue sources, such as property taxes and development charges, to natural asset management projects. This combination of funding sources covers the costs for the entire lifecycle of several projects. Therefore, the Town of Gibsons receives a Dark Green score for the Financing indicator (Fig. 19).

New Policies

The Town of Gibsons continues to develop new municipal natural asset management policies, plans, and procedures. On September 18th, 2020, the Town of Gibsons adopted a Tree Preservation Bylaw to protect the community's tree cover. The purpose of the Tree Preservation Bylaw is to regulate "the damage, removal, and replacement of trees within the Town of Gibsons and to preserve the overall ecological function of the Urban Forest" (Town of Gibsons 2020d, pg. 4). In addition, this bylaw regulates the altering, cutting, damaging, or removing of trees within the Town of Gibsons and it describes the conditions under which permits will be granted for the altering, cutting, or removal of trees. This bylaw is the first towards building an Urban Forest Plan.

Under the Town of Gibsons' Five-Year Financial Plan, urban forestry planning has been identified as a three-year project (Town of Gibsons 2021a). In their 2020 Budget Supporting Document, the Town of Gibsons has committed to developing a Reforestation Strategy with priority given to "areas that provide the best opportunity to reduce risk and increase resilience" (Town of Gibsons 2020a, pg. 2). In addition, the Town of Gibsons has identified that an Urban Forest Plan will provide a complete tree inventory, determine the percentage of tree canopy in the Town, enable Council to establish a target tree density, develop a Tree Management Plan, and address the role that trees play in a natural asset system (Town of Gibsons 2021b). Some of this urban forest work has already begun. For example, through acquiring LiDAR data for the Town the current extent of the urban forest could be determined, which will be the basis for establishing the tree density target.

In addition to the Urban Forest Plan, the 2020 Budget Supporting Document has listed several other projects that focus on municipal natural asset management. One of these projects is a Fringe Area Plan with the Sunshine Coast Regional District that includes the co-management of regional natural assets (Town of Gibsons 2020a, pg. 3). A Fringe Area Plan has been identified by Town Council as a priority in the 2019-2022 Strategic Plan. A fringe area is a land that is on the periphery of municipalities. This land is often subject to development pressure (Meligrana 2003). As of December 31st, 2020, preliminary discussions with the Sunshine Coast Regional District have occurred with the following action item planned: "lead the development of a Fringe Area Plan with Sunshine Coast Regional District at a watershed scale, including Aquifer protection, flood protection, transportation routes, Asset Management and land-use planning" (Town of Gibsons 2020e, pg. 12).

Finally, the Town of Gibsons has begun creating a long-term master plan for its marine foreshore area (Kerr Wood Leidal Associates Ltd. 2014, pg. 1). Several ongoing projects contribute to this master plan, including an initial foreshore condition assessment, the Source to

Sea Project, the Healthy Harbour Project, and a Coastal Resilience Project with the Municipal Natural Assets Initiative. As stated in the foreshore condition assessment, the goal of the foreshore redevelopment is “to ensure the shoreline, associated infrastructure, and adjoining development is properly protected from an anticipated sea level rise of about one metre around the Town of Gibsons by the year 2100” (Kerr Wood Leidal Associates Ltd. 2014, pg. 1; Vadeboncoeur & Mathews 2014).

As part of their Official Community Plan, the Town of Gibsons does have a Harbour Area Plan which acknowledges that the harbour area has many natural assets, including streams, vegetation, and hillside topography. The plan states that there are four main elements needed to achieve protection of the natural assets in and around the Harbour area: identification, assessment, approvals guidance, and mitigation or enhancement options (Town of Gibsons Harbour Area Project Team 2015, pg. 32). As a part of these four elements, the Town of Gibsons has also created several policies to protect its marine natural assets. For example, Policy 5.3.3 states that the Town of Gibsons “maintain and enhance the natural shoreline and aquatic zone through planting, by avoiding “hard” infrastructure in the foreshore, and by creating wetlands and marsh areas for habitat and to protect shorelines against erosion from currents, fetches, and wakes (Town of Gibsons Harbour Area Project Team 2015, pg. 33). The Harbour Area Plan also states that staff will prepare a report card every two years to assess the Harbour Area through several sustainability indicators and include benchmarks and milestones (Town of Gibsons Harbour Area Project Team 2015, pg. 42).

The Town of Gibsons has created many new natural asset management-focused policies, strategies, and plans for the multitude of natural assets directly under the jurisdiction of the Town of Gibsons. As well, the Town of Gibsons is creating plans with their regional government for the management of large natural asset areas. For this reason, the Town of Gibsons has received a Dark Green score for the New Policies indicator (Fig. 19).

5.1.3 Ecosystem Rehabilitation and Restoration

Service Quality Metrics

For their natural asset areas, the Town of Gibsons is monitoring several ecosystem services categories produced by their natural asset areas. In total, the Town of Gibsons collects quantitative data on water quality, air quality, aquifer recharge levels, stormwater service provision, flood mitigation services, and habitat provision as well as qualitative data on user well-being. However, while some data on user well-being is collected, there are no other qualitative or quantitative cultural ecosystem service metrics that the Town of Gibsons currently monitors. For example, staff report that the Whitetower Park space is “extremely popular with Gibsons’ citizens and visitors” but, there is a lack of detail on why citizens and visitors enjoy the park and what they use the park for.

The Gibsons’ Aquifer, the Whitetower Park Stormwater Ponds, and the Healthy Harbour Project are the three major natural asset areas where ecosystem service monitoring occurs in the Town of Gibsons. Starting with the Aquifer, the Town of Gibsons monitors water quality, water storage, aquifer recharge level, recharge temperature, and water supply (Waterline Resources Inc. 2013a). Waterline Resources Inc., a hydrogeology and environmental consulting firm, does

this monitoring on behalf of the Town of Gibsons. The Gibsons Aquifer continues to be the main source of water for Town residents. Therefore, these services are key to ensuring service provision now and into the future. In fact, “computer model simulations indicate that the Gibsons Aquifer should be able to meet future demand where the Town is anticipated to grow to 10,000 residents. This assumes that 73% of the population obtain water from Town wells. This is also true under worst case climate change conditions” (Waterline Resources Inc. 2013a, pg. iii).

For the Healthy Harbour Project, the ecosystem services monitored are the biota and benthic elements of the marine ecosystems, including eelgrass, herring, crabs, salmon, and clams. As well, cultural, and aesthetic values of the harbour area are also considered (Machado & NSMEC, 2019, pg. 4). However, project documents do not provide more information on these cultural and aesthetic values. The Town of Gibsons recognizes that eelgrass beds “provide the infrastructure service of attenuating wave activity during storm surge events and help prevent coastal erosion, maintaining the foreshore’s integrity. In turn, these services protect the upland public and private properties and essential municipal infrastructure, including sewer services” (NSMEC 2020a, pg. 10). Currently, restoration activities are occurring to protect eelgrass beds and to accurately measure their services throughout the Healthy Harbour Project four-year agreement.

Finally, for the Whitetower Park Stormwater Ponds, the major ecosystem services monitored are stormwater management services. In the Town of Gibsons’ Official Community Plan, staff note that alternative drainage systems, such as stormwater ponds, focus on infiltration and treat stormwater as part of the hydrologic cycle, enhancing aquatic and terrestrial habitats (Town of Gibsons 2015b, pg. 73). As well, the Town of Gibsons also conducted a valuation study of the stormwater management ponds. This valuation study found that the location of the ponds is ideal for attenuating peak flows from upstream and provides more flood mitigation through peak flow reduction than considered engineered alternatives (Sahl et al. 2016). These services continue to be monitored by the Town of Gibsons and upgrades are made when needed, such as the dredging of the ponds (Newman 2021c).

Based on the identified benchmark, the Town of Gibsons has been awarded a Light Green score for the Service Quality Metrics indicator (Fig. 19). Almost all major ecosystem service categories in identified natural asset areas have some form of metric. However, the Town of Gibsons has not fully identified comprehensive cultural ecosystem service metrics.

Rehabilitation Site Selection

The Town of Gibsons has identified several sites for potential rehabilitation or restoration projects. First, the Town of Gibsons identified Whitetower Park as the site for the construction of an additional stormwater pond to settle out sediments and remove pollutants from the stormwater before it enters the adjoining Charman Creek (Town of Gibsons 2020b). “The expansion will enable the stormwater ponds to service 47.7 hectares of land and help address long-term erosion and water quality impacts of past development on Charman Creek” (Town of Gibsons 2020b, para 3). Even though the area is technically under the jurisdiction of the Province of British Columbia, the Town of Gibsons recognizes the stormwater service potential provided by this site (Town of Gibsons 2018a, pg. 21). As well, there have also been previous citizen-led initiatives to

protect a 13-hectare parcel of Charman Creek lands. In October 2018, Town of Gibsons' council was presented with a petition with 200 signatures requesting that the Charman Creek Lands be kept in a natural state (Eckford 2018). In September 2020, a second petition with 1,450 signatures was presented requesting that the lands be protected "in perpetuity" (Woodrooffe 2020a).

Second, as part of their work on the foreshore and harbour area, both the Healthy Harbour Project and the Source to Sea Project have stipulations that, if the restoration or rehabilitation of a specific area is needed, it can be completed under the scope of work. For example, under the Healthy Harbour Project's phased work, a report was presented to Council on December 15th, 2020, that showed a vibrant and healthy eelgrass habitat in the east Armour's Beach region, but more debris closer to the Gibsons Landing marine facility. Project documents from the close of Phase 1 to Phase 2 show that restoration activities have targeted Gibsons Landing for marine clean-up (NSMEC 2020a, pg. 17; Woodrooffe 2020b). The 2020 Healthy Harbour Report also states that the Nicholas Sonntag Marine Education Centre will monitor the impacts of the restoration work over the coming years (NSMEC 2020a, pg. 14) and that through further restoration, the coverage of eelgrass may increase. For the Source to Sea project, the project or site area is the same as the Town's 2013 Aquifer Study, with the expansion of monitoring for the entirety of the Gibsons Aquifer watershed. While the Source to Sea Project is primarily focused on monitoring and evaluating the natural assets that lie within the watershed, the results of this project can inform staff of where future restoration work can occur through a baseline inventory and a condition assessment (Newman 2021a, pg. 26). The Town of Gibsons continues to identify multiple sites for rehabilitation and restoration projects both on land and in the sea. A Dark Green score has been awarded for the Rehabilitation Site Selection indicator (Fig. 19).

Monitoring Indicators

The Town of Gibsons has identified several indicators for each project under their monitoring and evaluation framework. For example, in the Healthy Harbour Project, the Town of Gibsons has included the following indicators as a part of their ongoing Level 3 Eelgrass Assessment: plant density, level of biodiversity, shoot length, identifiable species, leaf area index, and location and number of mooring buoys (NSMEC & Town of Gibsons 2020, pg. 2). These indicators were chosen based on best practices for mapping and monitoring eelgrass habitat in British Columbia from Environment Canada (Environment Canada & Precision Identification Biological Consultants 2002).

As a part of their aquifer monitoring work, Town of Gibsons staff, in consultation with Waterline Resources Inc., identified several water-related indicators and benchmarks in the Groundwater Monitoring Plan. These indicators were first identified in 2013 when the plan was published and were refined through an adaptive management process (Waterline Resources Inc. 2013b, pg. 183). These indicators include, but are not limited to, renewable groundwater resources per capita, total groundwater abstraction and recharge, number of contaminated sites, groundwater contribution to base flow, and public outreach on groundwater sustainability (Waterline Resources Inc 2013b, pg. 217). These indicators have been monitored on an annual basis with reports submitted to the Town of Gibsons (Waterline Resources Inc. 2021). These indicators were selected to ensure that as the Town of Gibsons developed, staff were working

with high-quality monitoring data “to increase the accuracy and certainty of long-term groundwater resource management” (Waterline Resources Inc. 2013b, pg. 183).

While the Urban Forest Plan and Tree Management Plan have yet to be written, staff have already noted that the creation of a target tree density will be a primary indicator for both plans. In conclusion, the Town of Gibsons has identified more than one key indicator for natural asset management projects and has been awarded a Dark Green score for this indicator (Fig. 19).

5.1.4 Service Delivery

Monitoring Co-Benefits Metrics

The Town of Gibsons monitors some co-benefit changes. For example, under the “Natural Asset Management” section in the Town of Gibsons’ 2020 Budget Supporting Document listed co-benefits include: (i) improvements to biodiversity and habitat creation, (ii) improvements to water quality, retention, and absorption, (iii) improvements to livability, (iv) cost savings, (v) increased human health and wellbeing, (vi) enhanced carbon storage and greenspace, and (vii) greater recreation opportunities. However, not all co-benefits listed fall under the co-benefit definition stated in Section 3.2.1 in Chapter 3. Other co-benefits listed include a reduction in risks to property values and a reduction in the burden to grey infrastructure (Town of Gibsons 2020a, pg. 2). The Town of Gibsons’ Official Community Plan also lists a few co-benefits for key objectives including that a “trail network shall be promoted through the community and region to highlight recreational opportunities that will have a positive effect on the local economy” (Town of Gibsons 2015b, pg. 45). However, the Town of Gibsons has not included any specific quantitative measurements to show an increase in these co-benefits.

The Town of Gibsons does monitor co-benefit metrics for the local aquifer. According to interview responses and key documents, the Gibsons’ Aquifer continues to be monitored for Escherichia Coli levels, total Coliform levels, the absence of contaminants, amount of water pumped, colour, pH, and numerous other metrics of public health interest (EM 2020, para 24; Waterline Resources Inc. 2021, pg. 2-15; Town of Gibsons 2018b). For the Healthy Harbour Project, the Town of Gibsons recognizes that the restoration of eelgrass can lead to the stabilization of sediment, the provision of habitat for forage fish that support healthy salmon populations, supporting the biodiversity of species, carbon sequestration, socio-economic values around natural beauty, and eco-tourism (NSMEC 2020a, pg. 10). Currently, the Town of Gibsons has not collected data related to these expected co-benefits as restoration work is still ongoing.

While the Town of Gibsons has identified several co-benefits and has started to monitor some public health co-benefits for the Gibsons Aquifer, co-benefits in other natural asset areas must also be monitored. This will give a more accurate depiction of the co-benefit increases across the Town of Gibsons. Therefore, the Town of Gibsons receives an Orange score for the Monitoring Co-Benefits Metrics indicator (Fig. 19).

Municipal Budget for Grey Infrastructure Renewal

The Town of Gibsons has produced some data regarding the municipal budget spent on retrofitting engineered infrastructure. For instance, interviewed staff mention that by restoring

and improving a natural area that was contributing to the drainage system in Upper Gibsons, the Town of Gibsons did not have to construct a \$4,500,000 engineered alternative. Thus, they can save about \$0.75 on the dollar for a total upfront construction cost of \$955,000 to expand the stormwater ponds (EM 2020, para 30). In addition, maintenance and operation costs for the engineered alternative were expected to be between \$75,000-\$100,000 per year compared to the maintenance cost for the natural asset which is expected to cost between \$20,000-30,000 annually (EM 2020, para 30).

Interviewed staff noted that the Town of Gibsons is also working on calculating an overall return on investment valuation for all the infrastructure improvements needed per square kilometre. Thus, the Town of Gibsons would be able to calculate the returns from the replanting of the forest, restore the integrity of three major creeks, and redesign the foreshore as necessary (EM 2020, para 31). Finally, staff mentioned the need for infrastructure funding programs to ask other municipalities more questions on alternatives considered, especially if they did not consider a natural asset alternative (EM2 2020, para 34). Given the considerable work in progress, the Town of Gibsons has been awarded a Yellow score for this indicator (Fig. 19).














Indicator (Benchmark)	Site Score
Awareness, Capacity and Education Indicators	
Number of general consultation efforts for NAM (Benchmark 1: More than 50% of NAM Consultation events have a high attendance rate) (Benchmark 2: All [100%] of information materials describe one reason for conducting MNAM)	 
Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners (At least 1 formal or informal partnership)	
Implementation Indicators	
Number of barriers or opportunities identified in MNAM delivery within the project community (Benchmark 1: 100% of relevant documents identify barriers and opportunities) (Benchmark 2: All [100%] of managers provide at least one barrier)	 
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAM)	
Amount of funding and financing received for projects (All [100%] of projects and programs have available funds to ensure a full lifecycle)	
Number of new NAM policy, strategies, and plans (All [100%] of NAM policy, strategies, and plans created to support MNAM)	
Ecosystem Rehabilitation and Restoration Indicators	
Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory (All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory)	
Number of sites selected as potential rehabilitation or restoration project(s) (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals)	
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects)	
Service Delivery Indicators	
Percentage increase in co-benefit metrics monitored by project community (Increase in co-benefits from natural asset management)	
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure)	

Figure 19 – Balanced Scorecard for the Town of Gibsons.

5.2 City of Grand Forks

5.2.1 Awareness, Capacity, and Education

Awareness and Education

Most of the municipal natural asset management consultation events and information materials have focused on recovering from the May 2018 flood. After the conclusion of major rescue and emergency efforts, a public meeting was held on June 13, 2018 “to update attendees about hydrological, flood-protection planning, financial, insurance, and housing issues” (City of Grand Forks 2020b, pg. 2). A public flood recovery meeting was also held on July 9th, 2018, and July 11th, 2018, to follow up on affected citizens’ concerns and questions with major topics of discussion including infrastructure upgrades and future flood potential (City of Grand Forks 2020b, pg. 2). During this time, the City of Grand Forks conducted a survey to determine affected property owners’ views on buyout options. Findings from the survey showed that most property owners supported buyout if they received adequate compensation.

Following the decision that the City of Grand Forks would rehabilitate and re-establish the floodplain and riparian areas in the North Ruckle, South Ruckle, and Johnson Flats neighbourhoods, public meetings were held on September 19th, 2018, and October 3rd, 2018. As well, public meetings were held on December 13th, 2018, to inform South Ruckle residents and the general public of the hiring of Keystone Appraisals for property buyout valuations (City of Grand Forks 2020b, pg. 4). The Boundary Flood Recovery team, on behalf of the City of Grand Forks, reported in January and February public meetings that the City had applied for a \$49.9 million Disaster Mitigation and Adaptation Fund (DMAF) grant to cover the costs of property buyouts and flood protection infrastructure. In September of 2019, a meeting with “Owners of Properties the City wants to Repurpose for Future Flood Infrastructure noted the use of the Sendai Framework, which the Boundary Flood Recovery team and the City of Grand Forks were already using when responding to flood risks” (City of Grand Forks 2020b, pg. 6). A particular focus here was on “Building Back Better” in recovery, rehabilitation, and reconstruction. Residents suggested this approach would not “build back better” if it put people further into poverty. This group requested regular information in writing on all flood recovery efforts, including (i) appraisal processes and outcomes, (ii) buyout processes and timelines, (iii) project milestones and public events, (iv) grant agreements, requirements, and outcomes, and (v) flood mitigation infrastructure planning and upgrades.

On September 19th, 2019, a public meeting was held, with specific mention that residents would receive mailed notices about their appraisals and could set up individual meetings. Notice was given that residents in the buyout area could complete a survey regarding in-kind options for the buyout program. As well, the City of Grand Forks committed to “improved communication and engagement with project and community stakeholders to ensure they have a say in decisions regarding their futures” (City of Grand Forks 2020b, pg. 7). To do this, the City of Grand Forks approved the implementation of a project Communications Plan. This Communications Plan developed key messages for internal and external audiences to ensure common project understanding and timely messaging on land acquisition and restoration processes and timelines. The City of Grand Forks then created the Recovery to Resilience campaign in October 2019 to “optimize communication and collaboration among key stakeholders during floodplain

restoration and infrastructure upgrades from 2019-2023” (City of Grand Forks 2019, pg. 3). In total, thirteen public meetings were held from June 2018 to November 2019. Data is not available on the number of attendees for any of these meetings.

According to interviewed staff, property owners saw the restoration of lands to natural floodplains as a “silver lining” of the recovery process. As well, these property owners were opposed to the idea of selling the land to industry, as proposed by one city councillor (GW 2021, para. 43). In other consultation events for the City of Grand Forks’ Official Community Plan Update, the community identified conserving natural areas, ecosystem quality, walkability, and path networks as important policies (GW 2021, para. 42). During open house sessions, citizens have been supportive of increasing municipal conservation areas and see a large amount of green space in Grand Forks as a defining quality of the municipality.

The information material developed for the Recovery to Resilience campaign describes a few reasons for managing the floodplain and riparian areas as natural assets. Specifically, under the Recovery to Resilience public meeting display panels, added benefits of restoring floodplain areas and wetlands are listed. These benefits are the increased recharge of groundwater, the reduction of sediment pollution, and the provision of habitat for fish, birds, and pollinators. As well, this panel uses the language of municipal natural asset management by stating that “restoration of the floodplain and riparian areas provides a durable, regenerating ‘natural asset’ that costs far less over time than hard infrastructure” (City of Grand Forks 2019, pg. 2). Interviewed staff also mentioned that as a part of these restoration projects, a map and kiosk sign were installed that described the benefits of this work and basic functions of riparian and wetland areas. Staff noted that this signage has been well-received (GW 2021, para. 42).

Currently, the City of Grand Forks website does not have a dedicated section for municipal natural asset management. However, as a part of the Recovery to Resilience campaign, a second website was created for project updates. Visitors to this website have the option to sign-up for emailed project updates and a newsletter. This newsletter holds information on project updates, a FAQ section, and contact information for the City Resilience team (City of Grand Forks 2019). Finally, the City of Grand Forks has been a part of extensive media coverage on their flood recovery efforts, including a series of Global News video stories on flood mitigation and land acquisition issues and the roles played by all levels of government (City of Grand Forks 2020b, pg. 8).

This indicator variable has two identified indicators. For the first indicator on the number of natural asset management consultation events with a high attendance rate, the City of Grand Forks has not collected information on the number of residents or property owners who attended consultation events. Therefore, a Grey score has been given (Fig. 20). For the second indicator, the City of Grand Forks has made a concerted effort to describe the benefits of floodplain restoration to former property owners and City residents, which has been noticed and appreciated by city residents. Therefore, a Dark Green score has been given for information reasons provided for municipal natural asset management (Fig. 20).

Capacity

One of the most important partnerships for the City of Grand Forks is with the Granby Wilderness Society (GW 2021, para. 53). The Granby Wilderness Society is a local environmental organization that works in the Regional District of Kootenay Boundary. In

interviews, municipal staff mentioned that the Granby Wilderness Society was originally founded to create a new wilderness park at the North End of the Granby River. Most of their work centres around restoration and conservation, with a specific focus on riparian restoration and species-at-risk. For instance, in 2010, their lead biologist Jenny Coleshill wrote a Conservation Action Plan for Species at Risk in the Grand Forks Area (Coleshill 2010). In 2012, the Granby Wilderness Society, the Grand Forks Wilderness Association, the Boundary Weeds Committee, the Christina Lake Stewardship Society, and a habitat biologist from the Ministry of Forests, Lands and Natural Resources (now the Ministry of Forests, Lands, Natural Resource Operations and Development) formed the Boundary Habitat Stewards group (Chin 2012). The Boundary Habitat Stewards received \$250,000 a year in funding for three years from the Ministry of Forests, Lands, and Natural Resources to do prescribed burns. The Boundary Habitat Stewards also investigate protecting species-at-risk as well as black cottonwood riparian restoration planning.

In 2019, the Regional District of Kootenay Boundary approved a \$10,000 allocation to the Granby Wilderness Society and the Boundary Habitat Stewards group for the first project under the Boundary Integrated Watershed Service (Alan 2019a). The Boundary Integrated Watershed Service is a management service for all the Regional District of Kootenay Boundary's watersheds. They are also responsible for implementing the goals and actions laid out in the Kettle River Watershed Management Plan (RDKB 2014). This Plan created several key directions and action items for riparian restoration. This Management Plan and the environmental organizations involved have also engaged with First Nations and Aboriginal Peoples. Specifically, Action 1.1.5 of the Management Plan is to "ensure engagement and collaboration among local government and First Nations regarding regional water strategy development, restoration programs, and cultural initiatives in the Kettle River watershed" (RDKB 2014, pg. 12). As a part of the funding allocation, the Boundary Habitat Stewards are working to restore and enhance black cottonwood riparian forests (Alan 2019b). This ecosystem area was chosen as black cottonwoods are an endangered ecosystem across the entire province of British Columbia and are the habitat for the Lewis's Woodpecker, a provincially threatened species (Alan 2019b; GW 2020, para. 53). The Granby Wilderness Society has worked extensively with the Lewis's Woodpecker, including compiling known locations of nest sites, inventorying potential habitats, identifying threats and mitigation efforts, and applying for funding through the Habitat Stewardship program provided by the Government of Canada (Coleshill 2010, pg. 4).

In terms of their direct work with the City of Grand Forks, staff shared that the biologist for the Granby Wilderness Society spoke to council several times, provided input on the City of Grand Forks' tree management policy, and presented a work plan for the restoration of riparian area sites across the city (GW 2020, para. 53). However, the partnership between the City of Grand Forks, the Granby Wilderness Society, and the Boundary Habitat Stewards have not been formalized. In 2018, there was an effort to formalize a partnership between the City of Grand Forks and the Granby Wilderness Society through a commitment to conserve natural areas and manage wildlife, but this process stalled with a change in municipal management (GW 2020, para. 53). In addition, interviewed staff mentioned that the City of Grand Forks is interested in starting university partnerships. Specifically, the City of Grand Forks has received some interest from the University of British Columbia's Okanagan campus and their watershed science program (GW 2020, para. 54). According to interviewed staff, attracting interest to the City of

Grand Forks is difficult given that the City of Grand Forks does not have a direct connection with students.

Finally, as a part of their Disaster Mitigation and Adaptation Fund (DMAF) buyout program, the City of Grand Forks worked closely with the Federal Government of Canada and the Provincial Government of British Columbia. In the Project Charter for the DMAF program, the Province of British Columbia and the Government of Canada are listed as funding partners whose responsibility is to “provide the funding to the program and ensure the funds are expensed according to their respective programs’ requirements” (Dinsdale & City of Grand Forks 2020, pg. 22). Due to the informal and formal partnerships for ecosystem rehabilitation and restoration, the City of Grand Forks receives a Dark Green score for this indicator (Fig. 20).

5.2.2 Implementation

Barriers and Opportunities

The primary barrier encountered by the City of Grand Forks was the public reception and subsequent confusion regarding the property buyout program. After catastrophic flooding in May of 2018, the Disaster Mitigation and Adaptation Fund would be used to finance the purchase of private properties and install flood protection and natural infrastructure projects in flood-affected areas. However, land appraisals were completed using post-flood values which caused large-scale pushback from residents who disagreed with this appraisal method (City of Grand Forks 2020b, pg. 5; GW 2021, para. 38). To address this barrier, City Council considered what “in-kind” contributions it could offer property owners instead of pre-flood land values. However, these “in-kind” contributions did not receive much public support. Thus, the City of Grand Forks had to adjust the proposed capital project budgeting and invest more than originally planned. This moved the cost of the program from \$51,000,000 to \$55,000,000 for the Land Acquisition Program (GW 2021, para. 38). While the use of post-flood values did cause some erosion in public trust of the buyout program, interviewed staff mentioned that this did not change the entire perception of the program, especially as it relates to floodplain and wetland restoration. Local property owners described this restoration as a “silver lining”, according to interviewed staff (GW 2021, para. 43).

A related barrier for the City of Grand Forks was the lack of a clear communication strategy on the buyout program. This lack of a clear communication strategy has also raised some educational challenges for natural asset management. As mentioned earlier, there was significant confusion from property owners on the appraisal process and what land values would be used as part of the buyout program. Residents also raised concerns about the lack of consultation during “critical times in the development of mitigation and land acquisition programs” (City of Grand Forks 2020b, pg. 8). There has also been similar confusion over a new wetland dedication process. Some neighbouring property owners were concerned that this protection would change their access to the greenspace. To act on this barrier, the City of Grand Forks implemented a Communications Plan and adopted the Recovery to Resilience campaign to develop clear internal and external messaging. Internal messages ensured a common project understanding, a commitment to speak with a unified voice, and compassionate approaches to affected property owners. External messages ensured that affected property owners would receive clear, concise, and timely messaging on land acquisition and restoration processes and

timelines. The Recovery to Resilience campaign will continue until 2023 (City of Grand Forks 2020b, pg. 7).

For the Program Charter for the Disaster Mitigation and Adaptation Fund, the City of Grand Forks experienced cost-related, scheduling, scope-related, and limited data constraints. Starting with cost-related constraints, the City of Grand Forks acknowledged that as currently constructed, the funding approved for this program is limited with little possibility for future funding (Dinsdale & City of Grand Forks 2020, pg. 13). As well, due to higher spending with the Land Acquisition Program, the budget for the Flood Mitigation Program is constrained. Another cost-related constraint is the current conditions of the construction market. While this is not directly a result of the COVID-19 Pandemic, “project costs associated to labour, equipment, and material scarcity must be considered, and as such could pose a significant budgetary constraint to the program” (Dinsdale & City of Grand Forks 2020, pg. 13).

In terms of scheduling constraints, there are regulatory requirements to working in and near the river. A substantial portion of the flood mitigation work will need to be scheduled around “fish windows”. These windows are “regulatory approved timeframes where such works within a stream, river, or water body can occur” (Dinsdale & City of Grand Forks 2020, pg. 13; Government of British Columbia 2018). Thus, even though design, pre-construction, mobilization, and out-of-stream work can start, construction would need to be delayed until a fish window. As well, snow melt events known as “freshet” can also be a scheduling constraint “as its timing, duration and magnitude are not normally known until only a few days prior to an event” (Dinsdale & City of Grand Forks 2020, pg. 14). High water can make construction work unsafe and cause water infiltration issues during excavation and sub-surface works. Another scheduling constraint is the speed of land acquisition. To mitigate future floods, the high-priority projects are situated in higher-risk flood areas. However, if there is a significant delay with acquiring those properties, flood mitigation work cannot start, causing significant delays and risks to the entire project (Dinsdale & City of Grand Forks 2020, pg. 14). The last scheduling constraint is the length of time it can take to achieve permits and approvals. The program charter estimated that these approvals may “take between 90 to 140 days from application submittal to final permit approval” (Dinsdale & City of Grand Forks 2020, pg. 14). Thus, if the timings of approval and fish window timings do not align, construction work may be missed by a year.

The next constraint category is scope-related constraints. This constraint addresses the complexity of construction and the interconnectivity of the program. While some of the projects could be undertaken simultaneously, there is a risk that the scheduling or cost-related constraints could compound upon one another. As well, these projects could also cause significant disruptions to City and resident activities, risking the viability of key industries such as tourism. In addition, interviewed staff also mentioned that the City of Grand Forks already has a limited staff capacity (GW 2021, para. 44). Therefore, the coordination of multiple projects could pose some significant challenges and risks (Dinsdale & City of Grand Forks 2020, pg. 14-15).

The last constraint category addresses limited data constraints. In 2019, NorEx Engineering was hired by the City of Grand Forks “to provide cost estimates and support documents related to the physical flood protection and floodplain restoration works in the grant application” (City of Grand Forks 2020b, pg. 4). However, as a part of the preferred option cost estimation, several assumptions were used to inform the cost estimation. This was due to some data collection limitations. These limitations include limited hydraulic modelling to confirm the

effectiveness of proposed flood mitigation works, limited site visits to develop and confirm design cross-sections and space availability for structural flood mitigation, no geotechnical investigations to understand existing stratigraphy, water table, and fill material for designing cross-sections, and limited to no environmental assessments to confirm the impact of invasive species or applicability of bioengineering for erosion protection (NorEx Engineering Ltd 2019, pg. 3).

The DMAF Program Charter also identified two synergies or opportunities. The first opportunity is scope overlap. The City of Grand Forks could overlap proposed projects and work in parallel with other non-DMAF related planned City works (Dinsdale & City of Grand Forks 2020, pg. 15). This could “leverage economies of scale, optimize timings of works, reduce disruption, and/or decrease costs associated to set-up, access, material purchase and mobilization” (Dinsdale & City of Grand Forks 2020, pg. 15). The second opportunity is the leveraging of retained assets. Once properties are bought, improvements made to the property may hold some added value for the City of Grand Forks. “This creates an opportunity to repair, sell and/or relocate some of these assets for profit and for non-profit when considered and combined with some City investment and other 3rd party benefactor programs” (Dinsdale & City of Grand Forks 2020, pg. 15). These assets could then lead to an affordable housing strategy, or the City of Grand Forks could pursue for-profit development opportunities with the private sector to increase housing supply.

This indicator is connected to two indicator variables for identifying and acting upon barriers and opportunities. Throughout the City of Grand Forks’ flood recovery and mitigation program, City of Grand Forks’ staff have consistently identified numerous barriers and opportunities. As well, reviewed documents also describe barriers and opportunities identified and acted upon throughout the DMAF program lifecycle. Therefore, the City of Grand Forks has been awarded a Dark Green score for both indicators (Fig. 20).

Policy Changes

The City of Grand Forks has made some changes to key policies to integrate municipal natural asset management practices. In 2018, City Council adopted a policy for its urban forest, with a guiding principle that states that “a healthy urban forest provides habitat, ecosystem function and amenity values to the City” (City of Grand Forks 2018, pg. 1). This policy recognizes several services provided by an urban forest including a reduction of air pollution, dust control, noise control, shade, habitat improvement, biodiversity, and soil stabilization. This policy also outlines risk management, tree selection, and tree removal. In the City of Grand Forks’ Asset Management Financial Policy, their asset management approach is described as “founded on the concept of sustainable service delivery” (City of Grand Forks 2016a, pg. 1). The City of Grand Forks uses a framework created by Asset Management BC. Currently, this policy has not been changed to explicitly include natural assets or ecosystem service valuation. However, under the City of Grand Forks’ Strategic Plan 2015-2019 Fiscal Accountability theme, the City of Grand Forks is committed to never selling its natural assets and infrastructure (Paragon Strategic Services 2015, pg. 7). The City of Grand Forks also commits to several strategic projects and actions for natural asset areas. These include protecting the aquifer and related infrastructure from any external interests, developing policies and guiding principles to

protect valuable assets, and continue conservation education for the public (Paragon Strategic Services 2015, pg. 11).

The City of Grand Forks is also updating its Official Community Plan. On January 18th, 2021, the City of Grand Forks released a form notice on a Request for Proposals (RFP) for the Official Community Plan and Related Planning Initiatives. Project Area #4 of this RFP describes the creation of a floodplain designation, zoning amendment(s), and park dedication (City of Grand Forks 2021, pg. 4). According to interviewed staff, the City of Grand Forks has a work plan in place to overhaul the Floodplain Management Bylaw and the Zoning Bylaw in three areas to help protect natural assets and support the conservation and restoration of these assets (GW 2021, para. 28). According to interviewed staff, the City of Grand Forks wants to create a limit on how far out into the floodplain development could occur. This could prevent the filling and loss of wetlands and open floodplain areas (GW 2021, para. 28).

In conclusion, the City of Grand Forks has made many changes to key policies to integrate municipal natural asset management practices. However, the City of Grand Forks is still missing changes in its asset management policy for the specific recognition of natural assets as well as changes to several zoning bylaws. These changes are expected in the City of Grand Forks' new Official Community Plan. Therefore, the current score awarded is Yellow, with the expectation that this score could change (Fig. 20).

Project Funding

The City of Grand Forks has kept strong financial accounting records as part of the DMAF program requirements. In January 2019, the City of Grand Forks applied for a \$49.9 million DMAF grant to cover the costs of property buyouts and flood protection infrastructure including wetlands, dikes, storm drainage, and riverbank stabilization (Dinsdale & City of Grand Forks 2020, pg. 4). The City of Grand Forks also applied for a \$3-million grant from the National Disaster Mitigation Program (NDMP) for flood protection and stormwater improvements on the east side of the downtown. The program charter listed the estimated budget, including contingencies, at just under \$56.9 million. Per the DMAF program charter, budgeting for natural infrastructure costs was set at \$11,875,535 (Dinsdale & City of Grand Forks 2020, pg. 24). Just over \$5.2 million of that budget is the City of Grand Forks' current financial risk (Dinsdale & City of Grand Forks 2020, pg. 16). In 2020, the City of Grand Forks completed agreements for funding of \$51.7 million, with contributions of \$20 million from the Federal Government and \$31.7 million from the Province of British Columbia (City of Grand Forks 2020c, pg. 24).

In 2020, financial statements show that the City of Grand Forks “incurred \$15,298,107 of expenditures under the DMAF program, including \$3,595,000 of land acquisition costs, \$4,756,485 for residential improvements, \$2,169,981 for additional buyout compensation, and \$2,394,641 for program design and support, construction, and management costs. Expenditures also included cash payments of \$2,382,000 for deferred property purchase agreements which will be completed in 2021” (City of Grand Forks 2020c, pg. 24). To pay for these costs, the City of Grand Forks received a cash advance of \$23,194,000 from the Province of British Columbia. “\$8,981,017 was recognized as revenue in 2020, with the remaining \$14,096,136 of the advance recorded as deferred revenue. \$5,987,345 was recorded as federally eligible grant revenue in 2020, with the \$6,065,243 total Federal contribution to date included in accounts receivable”

(City of Grand Forks 2020c, pg. 24). According to interview responses and this financial statement, the City of Grand Forks has enough funds for the entire lifecycle of the DMAF program (GW 2021, para. 31).

Other riparian restoration projects are funded through a combination of private funding from property owners and contributions from the Habitat Conservation Trust Fund in British Columbia (GW 2021, para. 31). In 2019, the Habitat Conservation Trust Fund awarded the Granby Wilderness Society \$50,000 for a black cottonwood forest restoration project (Alan 2019a). The Habitat Conservation Trust Fund has a history of distributing funds to local environmental organizations in the Grand Forks area. In 2012, the Boundary Habitat Stewards received \$4,000 to examine the restoration potential of a nearby grasslands habitat (Chin 2012). According to interviewed staff, the City of Grand Forks may seek other funding for planned restoration activities (GW 2021, para. 31). The City of Grand Forks has budgeted \$25,000 for the Official Community Plan, the Zoning amendments, and Park Dedication for floodplain lands (City of Grand Forks 2021, pg. 4). In conclusion, the City of Grand Forks can fully fund the DMAF program as currently budgeted as well as new policies for floodplain lands. Thus, they have been awarded a Dark Green score for this indicator (Fig. 20).

New Policies

Interviewed staff shared that the City of Grand Forks is not at the point where they are considering new municipal natural asset management policies, plans, or procedures (GW 2021, para. 23). Staff are aware of the need to conduct ecosystem service measurement planning, but this planning has not been embraced or prioritized at the senior management or political leadership level. The City of Grand Forks has completed a sensitive ecosystem mapping and inventory compiled supported by LiDAR data, which will be used to support future policy creation (Durand 2018). This mapping provides some examples of Habitat Suitability Mapping for two locally occurring rare species, along with recommendations for future conservation actions.

The City of Grand Forks explored the possibility of a new natural asset management-type policy, with the Johnson Flats land dedication bylaw. This bylaw dedicates the Johnson Flats area as a wetland nature park, which prevents modification, use, or development that does not fall under the “ecological reserve” definition (City of Grand Forks 2016b). However, this bylaw dedication does not specifically mention ecosystem services provided by this ecosystem area nor municipal natural asset management practices. According to interviewed staff, the City of Grand Forks has dedicated approximately 3 hectares of wetland and approximately 12 hectares of grassland and aspen parkland as protected natural areas since completing the sensitive ecosystem mapping and inventory (GW 2021, para. 19). In conclusion, the City of Grand Forks is working on several policy new pieces for municipal natural asset management but has yet to implement them. Therefore, the City of Grand Forks receives a Red score for this indicator (Fig. 20).

5.2.3 Ecosystem Rehabilitation and Restoration

Service Quality Metrics

The City of Grand Forks has completed an initial sensitive ecosystem mapping and inventory. Phase One of this study was completed by air photo interpretation supported by LiDAR (GW 2021, para. 17). This has resulted in a canopy model. However, staff did note that the City of Grand Forks has not rerun the canopy model with new LiDAR data as their initial

LiDAR acquisition had data quality issues. These data have resulted in some operations changes such as leaving tree debris in nearby wetland areas as opposed to removing the debris. As well, the City of Grand Forks has brought in arborists and biologists to assess the wildlife attributes municipal staff wants to conserve (GW 2021, para. 17).

One ecosystem service that the City of Grand Forks is tracking is habitat suitability through specific rankings for Western Rattlesnake and Lewis's Woodpecker. These rankings will aid future conservation project planning. "Each class and subclass [was] assessed by local biologist Jenny Coleshill (Granby Wilderness Society) using a four-rank system (nil, low, medium, and high) for its suitability to provide features selected by the species for living (feeding, travel) and breeding (large cottonwood snags) or denning (rock and talus caves and crevasses)" (Durand 2018, pg. 34). However, this ranking does not consider actual species occurrence data and, as a part of the report recommendations, the City of Grand Forks is encouraged to conduct field verification and a full ecosystem classification (Durand 2018, pg. 41). These recommendations can help guide future conservation projects and provide the necessary data for determining development locations.

Through their sensitive ecosystem inventory and mapping classification, the City of Grand Forks has recognized their old forest, broadleaf woodland, woodland, grassland, sparsely vegetated, riparian, wetland, and freshwater ecosystems as sensitive (Durand 2018, pg. 12). Each of the sensitive ecosystems listed in the report is briefly described and defined. Some of these descriptions mention the ecosystem services these areas provide. For example, under the Woodland Sensitive Ecosystem Area description, the report describes woodlands as having "the potential to provide important ecological niches that other forest stands lack, are often inhabited by uncommon or rare species, and are generally sensitive to disturbances" (Durand 2018, pg. 15). During interviews, staff mentioned that they will use available data in the sensitive ecosystem inventory and mapping to select sites for future rehabilitation and restoration projects (GW 2021, para. 19).

In conclusion, the City of Grand Forks has identified some preliminary ecosystem service quality metrics or measurements. However, these metrics or measurements only address a few aspects of ecosystem service delivery. Therefore, the City of Grand Forks receives an Orange score for this indicator (Fig. 20).

Rehabilitation Site Selection

Interviewed staff described that the City of Grand Forks is operating with two different project scales for the identification of rehabilitation and restoration sites. The first scale of projects is in partnership with a local conservation organization for the restoration of riparian cottonwood ecosystems along the banks of the Kettle and Granby rivers (GW 2021, para. 12). These areas have been dominated by agronomic grasses and invasive plant species that have a low riparian habitat quality compared to the potential of the area. This restoration project has led to 450 to 500 linear metres of restored riverbank through planting and bioengineering to restore plant cover and habitat quality in the project area (GW 2021, para. 12). The second scale is large-scale restoration as part of the DMAF program charter. As part of their recovery from the 2018 flooding, the City of Grand Forks identified the neighbourhoods of North Ruckle, South Ruckle, and Johnson Flats as sites for floodplain and wetland restoration. In addition to restoration activities, the City of Grand Forks will construct engineered and hybrid infrastructure on

property bought through the buyout program (Dinsdale & City of Grand Forks 2020, pg. 4). These natural floodplains will provide more room for high water flows during flood events and protect critical sites from erosion. As well, the City of Grand Forks can incorporate community access trails and greenspaces into or on top of newly constructed flood mitigation works, such as dikes and earth berms (Dinsdale & City of Grand Forks 2020, pg. 8).

Staff stated that the City of Grand Forks owns eight hectares of floodable open space, some of which is intact Oxbow wetland that is a part of the floodplain (GW 2021, para. 15). As part of the DMAF program, that will be increased to about 23 hectares of open floodable land of which half will be restored to Oxbow wetlands, re-contoured wetland areas, floodways that are using natural infrastructure approaches, and restored riparian areas where there is currently a dike (GW 2021, para. 15). In conclusion, the City of Grand Forks has identified multiple sites for restoration projects, as part of the DMAF program and in partnership with local conservation organizations. Thus, the City of Grand Forks has been awarded a Dark Green score for this indicator (Fig. 20).

Monitoring Indicators

The City of Grand Forks' DMAF Program Priority Matrix has identified a few indicators for monitoring and evaluation of natural asset management projects that will receive a score. This program priority matrix describes the work packages, structural projects, priority rankings, weighting, and indicators as part of the DMAF program reporting requirements. These indicators include property acquisition required, protection of critical infrastructure, protection of public safety, and public opinion (Dinsdale & City of Grand Forks 2020, pg. 20).

According to interviewed staff, the most important indicator for the City of Grand Forks is the area of floodable land (GW 2021, para. 25). Staff described this indicator as taking a natural asset management approach for monitoring the conveyance capacity of the land. The City of Grand Forks modeled predicted benefits and following the completion of restoration activities, building removal, and recontouring of land, the City of Grand Forks will run a LiDAR evaluation (GW 2021, para. 25). Staff also mentioned incorporating a flood management cost indicator. This indicator would encompass the private and public costs of continued flooding and flood responses in comparison to a natural asset approach (GW 2021, para. 26). Finally, staff mentioned incorporating typical riparian function metrics as indicators. These would include tree canopy cover, vegetation complexity, and ecosystem quality. In conclusion, multiple indicators have been identified for the monitoring and evaluation of municipal natural asset management projects. Thus, the City of Grand Forks has been awarded a Dark Green score for this indicator (Fig. 20).

5.2.4 Service Delivery

Monitoring Co-Benefits Metrics

For the monitoring of co-benefits, the City of Grand Forks is currently focused on restoring key floodplain and wetland areas and has not started monitoring co-benefits produced in these areas. However, key program documents describe some potential co-benefits that fully restored floodplain and wetland areas could provide. These co-benefits include new sites for

recreation, species habitat, and the stabilization of downtown economic development (City of Grand Forks 2019, pg. 1). In interviews, staff also shared that the City of Grand Forks is conscious of the benefits provided by its tree canopy, and they are aiming to monitor changes in this canopy using LiDAR tools (GW 2021, para. 21). However, with no co-benefit metrics monitored by the City of Grand Forks, a Grey score has been given (Fig. 20).

Municipal Budget for Grey Infrastructure Renewal

In terms of the amount of municipal budget forecasted to be spent on renewing grey infrastructure, The City of Grand Forks' 2020 Financial Statement record of Tangible Capital Assets does not specifically list natural assets. However, the 2020 Financial Statement does provide some data. For example, the net book value of Tangible Capital Assets for the City of Grand Forks increased from 2019 to 2020 by \$6,260,516. In total, the net book value of Tangible Capital Assets under construction decreased by \$1,802,592 across Tangible Capital Asset categories (City of Grand Forks 2020c pg. 17). As well, the City of Grand Forks' long-term debt obligations for purchased assets in 2020 stands at \$3,220,135 (City of Grand Forks 2020c, pg. 16). However, with restoration work ongoing, the City of Grand Forks has been unable to conduct a comprehensive valuation study of the Kettle River floodplain. Therefore, the net book value of natural asset areas cannot be compared to changes in net book values for assets under construction or the construction costs of new assets. Thus, the City of Grand Forks cannot provide conclusive data on whether the municipal budgeting for grey infrastructure renewal will decrease due to services provided by the restored floodplain. Therefore, a Red score has been given for this indicator (Fig. 20).














Indicator (Benchmark)	Site Score
Awareness, Capacity and Education Indicators	
Number of general consultation efforts for NAM (Benchmark 1: More than 50% of NAM Consultation events have a high attendance rate) (Benchmark 2: All [100%] of information materials describe one reason for conducting MNAM)	 
Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners (At least 1 formal or informal partnership)	
Implementation Indicators	
Number of barriers or opportunities identified in MNAM delivery within the project community (Benchmark 1: 100% of relevant documents identify barriers and opportunities) (Benchmark 2: All [100%] of managers provide at least one barrier)	 
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAM)	
Amount of funding and financing received for projects (All [100%] of projects and programs have available funds to ensure a full lifecycle)	
Number of new NAM policy, strategies, and plans (All [100%] of NAM policy, strategies, and plans created to support MNAM)	
Ecosystem Rehabilitation and Restoration Indicators	
Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory (All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory)	
Number of sites selected as potential rehabilitation or restoration project(s) (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals)	
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects)	
Service Delivery Indicators	
Percentage increase in co-benefit metrics monitored by project community (Increase in co-benefits from natural asset management)	
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure)	

Figure 20 – Balanced Scorecard for the City of Grand Forks.

5.3 District of West Vancouver

5.3.1 Awareness, Capacity, and Education

Awareness and Education

The District of West Vancouver has held some interactive awareness events for natural asset areas. For example, in 2018, the District of West Vancouver held a Clean Shoreline Community cleanup event on Earth Day, April 22nd, at Cliff Cove Beach in Whytecliff Park. “A group of 20 volunteers collected 27 bags of garbage weighing almost 500 pounds” (North Shore News 2018). On April 27th, 2019, the second annual Clean Shoreline Community cleanup event was held with 38 volunteers. The purpose of this event is to build community awareness on the importance of keeping the beaches clean. Local stewardship groups also hold several educational events, including guided tours, summer camps, workshops, and guest lectures.

As well, the District of West Vancouver held numerous public engagement events for the 2020 and 2021 Budget. Municipal natural asset management was a significant focus for both budgets. For the 2020 Budget, the District of West Vancouver held three Budget Information Meetings on January 28th, 29th, and 30th. These meetings were Q&A sessions on the proposed budget which had not been voted on by Council. The main topic of questions from attendees was on the increase in taxes, with most of the attendees complaining about the increase and looking for alternative solutions. 37 residents attended the January 28th meeting, 18 residents attended the January 29th meeting, and 19 residents attended the January 30th meeting (DWV 2020c; DWV 2020d; DWV 2020e).

For the 2021 Budget, the District of West Vancouver held two Virtual Budget Information Sessions on January 28th and 29th, 2021. Staff also created an inquiry option on the Budget website, fielded email inquiries, and created presentations, documents, and recordings (Gordon 2021, pg. 8). In the Engagement Summary Report, the District of West Vancouver recorded that there were 727 public and stakeholder interactions during the 2021 Budget engagement period from January 26th – February 9th, 2021 (DWV 2021a, pg. 5). This includes over 500 visits to the project webpage, 50 people attending the two virtual meetings, 37 questions submitted to the online comment form, 140 written submissions received by Mayor and Council, and 14 written submissions received by staff project lead. Additionally, records were kept on social media engagements and e-newsletter recipients. The most common theme identified in the responses was “do not support tax increase & feel that taxes are already high”. But there were also concerns that active transportation and climate change initiatives should remain priorities (DWV 2021a, pg. 8).

However, the District of West Vancouver has not held other consultation events specific to municipal natural asset management. Therefore, the percentage of natural asset management events with a high attendance is difficult to separate from the number of attendees for the 2020 and 2021 budget events. Therefore, the District of West Vancouver receives a Grey score for this indicator (Fig. 21).

The District of West Vancouver created and published a Natural Asset Booklet in early 2020. Staff were planning to distribute this booklet in schools before the COVID-19 Pandemic (IG 2020, para. 62). Interviewed staff noted that some distribution of the booklet has now started,

and the booklet is available on the District of West Vancouver website. However, there is no information on whether a full distribution of the booklet has happened. The District of West Vancouver's Natural Asset Booklet lists several reasons for conducting municipal natural asset management. This Booklet focuses on the District of West Vancouver's forests, waterways, foreshore, and parks areas as the main sites for natural asset valuation. In addition, the District of West Vancouver lists the ecosystem services that these areas provide to residents. These services include stormwater management, climate regulation, natural habitat, recreation, flood control, erosion protection, and public health benefits (DWV n.d.). Interviewed staff also mentioned that before the COVID-19 Pandemic, they were organizing various presentations on this topic, to encourage other municipalities or organizations to build a natural asset inventory that would inform future decision-making (IG 2020, para. 62-63). As a part of their Budget 2021 outreach, staff explained the need for a high asset management levy and the importance of including "natural asset maintenance and climate action emergency response into all aspects of the asset management plan" (Gordon 2021, pg. 6). As well, staff reports have defined natural assets "as the stock of renewable natural resources (e.g., forests, plants, air, water, and soil) that combine to yield a flow of benefits to people" (Gordon 2020, pg. 11).

While the Natural Asset Booklet does effectively describe municipal natural asset management, its admittedly limited dissemination hampers positive awareness and education outcomes. Therefore, the District of West Vancouver receives a Light Green score for this indicator (Fig. 21).

Capacity

The District of West Vancouver already maintains several partnerships with stewardship groups in the West Vancouver area. While the partnerships between these stewardship groups and the District of West Vancouver have not been formalized, these stewardship groups continue to work with the District of West Vancouver to protect key ecosystem areas, plan for changes in ecosystem areas, and educate the public on the importance of sustainability, climate change, and environmental protection. These stewardship groups include the Friends of Cypress Provincial Park Society, the Lighthouse Park Preservation Society, Nature Vancouver, North Shore Black Bear Society, the North Shore Wetland Partners, Ocean Ambassadors Canada, Old Growth Conservancy Society, West Vancouver Shoreline Preservation Society, West Vancouver Streamkeeper Society, and West Vancouver Nature House.

Most of these stewardship groups are focused on a particular species or ecosystem areas, such as the North Shore Black Bear Society or the Lighthouse Park Preservation Society. In addition, most of these stewardship groups also do some form of monitoring. For example, interviewed staff mentioned that the West Vancouver Streamkeeper Society are monitoring the number of salmon in local streams, whether salmon are returning to the streams, and what kind of encroachment and degradation of salmon habitats is occurring (IG 2020, para. 24). Other stewardship groups are focused on managing ecosystem areas. For example, the Old Growth Conservancy Society was formed in 2007 following a recommendation made in the 2006 Strategy for Protection report commissioned by the District of West Vancouver. The purpose of this report was to develop a management plan for the Old Growth Conservancy area (Bufo Incorporated et al. 2006, pg. 34). As part of their scope of work, the Old Growth Conservancy Society monitors illegal tree cutting, vegetation, and soil conditions, and is now building a plant and fungus species list (Old Growth Conservancy Society 2021).

A major project for the District of West Vancouver has been the study, enhancement, and protection of their foreshore and shoreline area. The West Vancouver Shoreline Preservation Society has worked with the District of West Vancouver to spearhead the creation of the 2012-2015 Shoreline Protection Plan and the more recent foreshore habitat restoration work. The District of West Vancouver is also working to create a North Shore Sea Level Rise Risk Assessment and Adaptation Management Strategy to “understand and manage the present and future risks of sea level rise across the North Shore” (Kerr Wood Leidal Associates Ltd. 2021). Many of these stewardship groups have worked collaboratively on projects. For example, the Lighthouse Park Preservation Society, the North Shore Wetland Partners Society, the Old Growth Conservancy Society, the West Vancouver Shoreline Preservation Society, and the West Vancouver Streamkeeper Society approached the District of West Vancouver council on the formation of the West Vancouver Nature House. This facility was created in 2014 “to encourage residents and visitors alike to discover West Vancouver’s diverse natural setting, to explore and experience for themselves the joy of discovering nature in this urban environment” (West Vancouver Nature House Society 2014).

Interviewed staff also described a partnership with the British Pacific Properties (BPP). BPP is a large real estate development firm in the West Vancouver area that has an extensive history in the area. BPP recently provided funding for a stormwater protection project in the District of West Vancouver that would redirect excess runoff during extreme rainfall events (DWV 2019). According to interviewed staff, the District of West Vancouver and BPP are also working together on an Area Development Plan for the Cypress Village area. The goal of this Plan would be to allow denser forms of development that would then protect a large, forested area (IG 2020, para. 56). Finally, interviewed staff also mentioned partnering with local First Nations groups in the area. These groups are the Coastal Salish Nation on the North Shore and the Squamish Nation. In particular, the Coastal Salish Nation has expressed concern over the loss of traditional food sources and has begun monitoring the health of the ocean. While the District of West Vancouver is not working with the Coastal Salish Nation on a formal basis, they have exchanged information when appropriate (IG 2020, para. 58).

In conclusion, the District of West Vancouver has several partnerships with environmental stewardship organizations. These partnerships have resulted in projects with beneficial ecosystem protection outcomes. Therefore, the District of West Vancouver receives a Dark Green score for this indicator (Fig. 21).

5.3.2 Implementation

Barriers and Opportunities

The most significant barrier for the District of West Vancouver continues to be the COVID-19 Pandemic. Since the District of West Vancouver compiled a comprehensive list of the investment requirements for its general fund assets in 2015, the District of West Vancouver has made considerable progress in achieving its asset management goals. However, the COVID-19 Pandemic has created several setbacks in this program. In general, “support for capital projects had to be reduced to the \$8 million asset levy alone. Because funding for capital was reduced by more than 50%, many important and worthwhile projects had to be postponed” (Gordon 2020, pg. 6). This has worsened what staff have described as a “deferred maintenance” problem, where work is often postponed or stretched due to under-investment in asset

maintenance (Gordon 2020, pg. 9). This has caused more assets to fall under the high use, poor condition category. “In some cases, disposal with or without replacement may be the only reasonable option, while in others, retention, restoration, and re-use may be preferred. In any case, it is clear that significant funds and significant effort will be required” (Gordon 2020, pg. 10).

Due to this barrier for natural asset management in the District of West Vancouver, staff had to significantly scale back investment into their natural assets. This includes the removal of a 0.5% Natural Capital and Climate Response levy from the 2020 Budget. For the 2021 Budget, staff recommended a joint asset management levy of 3.0%, at a minimum to ensure optimal service delivery (Gordon 2021, pg. 3). Council approved a 2.5% levy as future revenues are still uncertain. “Although it is anticipated that there will be funds available from prior years’ projects that were completed under budget, and that these funds may be used to cover some of the shortfall, they will not be sufficient to meet all requirements, so some will need to be postponed” (Gordon 2021, pg. 4). However, despite the COVID-19 Pandemic, the District of West Vancouver has gone ahead with creating a singular asset management database to hold information about each asset in one place (IG 2020 para. 40). In conclusion, both reviewed documents and interviewed staff identified the COVID-19 Pandemic as the most significant barrier that continues to impact the District of West Vancouver.

In conclusion, the District of West Vancouver has identified and sufficiently explained that the COVID-19 Pandemic is a major barrier impeding program outcomes. However, this is the only barrier identified by the District of West Vancouver. In addition, no opportunities were identified by interviewed staff or reviewed documents. Therefore, the District of West Vancouver receives a Light Green score for both indicators (Fig. 21).

Policy Changes

The District of West Vancouver has made some changes to key policies to protect and conserve natural assets. However, asset management as a municipal policy is new in the District of West Vancouver. “In 2015, the District of West Vancouver put together its first comprehensive list of the twenty-year investment requirements of the entire suite of District general fund assets” (Gordon 2020, pg. 1). On December 5th, 2016, Council adopted the District’s Capital Asset Management Policy 02-30-367 which created the Asset Management Task Group (AMTG). “The AMTG is tasked with developing proactive guidelines and practices for managing, financing, and operating current assets, along with planning for future assets to support delivery of services” (Gordon 2020, pg. 2). On June 10th, 2019, District staff presented the District of West Vancouver’s Natural Capital Asset Inventory with the recommendation that the inventory is “incorporated into the District’s financial planning, asset management, financial reporting, and capital budgeting processes and decisions” (Gordon 2019, pg. 5). According to interviewed staff, with the completion of the District of West Vancouver’s Natural Capital Asset Inventory, staff have integrated that inventory into the overall asset management program (IG 2020, para. 47).

In that report, the District of West Vancouver acknowledges that they do not have bylaws or policies that are directly related to natural capital and ecosystem services (Gordon 2019, pg. 1), but they do have bylaws that regulate the preservation of features in the natural environment. This includes the Creeks Bylaw, the Interim Tree Bylaw, the Parks Regulation Bylaw, and the Watercourse Protection Bylaw. The Creeks Bylaw prevents “the fouling, obstructing or

impeding of the flow of any creek in the Municipality and to prevent public nuisances from occurring in, on or near the bank or channel of any creek” (DWV 1982, pg. 1). The Tree Bylaw sets out regulations on the cutting and damaging of trees (DWV 2016; IG 2020, para. 47). The Parks Regulation Bylaw regulates the use of parks and specifically restricts the environmental degradation of park areas. Finally, the Watercourse Protection Bylaw regulates requirements during construction work, the creation of a sediment control plan, and general protections for watercourse areas (DWV 2005b).

In addition, the District of West Vancouver’s Environmental Strategy and Parks Master Plan contains statements, actions, and guidance that support natural asset management and environmental protection. Starting with the Environmental Strategy, this Strategy describes actions to be taken for the management of creek habitats, the urban forest, and the foreshore area. For example, to protect creek habitats and corridors, recommended actions include “develop, update and implement revised bylaws to protect creeks [and] including designating creek corridors as mandatory Development Permit Areas” (DWV 2005a, pg. 10). For the foreshore area, the one recommended action is to “develop and implement a Foreshore Policy based on environmental protection” (DWV 2005a, pg. 15). Concerning the Parks Master Plan, under the management of natural areas, recommendation 4.3.1 is to “identify ecosystems in parks that may require special treatment to ensure their protection” (DWV 2012a, pg. 31). The Parks Master Plan also has an inventory of parks in the District of West Vancouver including Regional Parks, Provincial Parks, leased parks, parks created by a bylaw, and parks without a bylaw.

Finally, the District of West Vancouver’s Official Community Plan “supports the valuation of natural capital through restrictions on development to protect environmentally sensitive lands and includes policies that provide the community-wide framework and intent for ongoing protection and restoration of these assets, as well as direction for future reviews to address emerging issues such as climate change” (Gordon 2019, pg. 2). These policies include the use of low-impact storm and rainwater management to mimic natural conditions, using green infrastructure to manage increases in frequent storm events, managing land uses to protect the value of watercourse and riparian corridors, providing opportunities to vary development form and density, and protecting the shoreline and its significant environmental and cultural features (DWV 2018).

In conclusion, the District of West Vancouver has several existing policies and plans that do not require major modification to fully integrate a municipal natural asset management approach. However, as acknowledged by staff, there is no specific description or mention of natural asset management or ecosystem services as a concept. Therefore, the District of West Vancouver receives a Yellow score (Fig. 21).

Project Funding

The District of West Vancouver has had to make some funding changes due to the COVID-19 Pandemic. On February 4th, 2020, a natural capital or climate response levy of 0.5% was approved by District Council after a previous motion for a 1.0% levy was defeated (DWV 2020c, pg. 5). In the District of West Vancouver’s original 2020-2024 Five Year Financial Plan (Budget 1), this 0.5% tax levy increase was proposed to fund Natural Capital and Climate Response (DWV 2020b, pg. 5). However, once a public health emergency was declared and Budget 1 was withdrawn, Budget 2 removed the proposed Natural Capital and Climate Response levies. Budget 2 expects that the removal of this levy contributed to a total tax loss of \$1.7

million (DWV 2020b, pg. 13). In contrast, under information published for the 2021 Budget, the District of West Vancouver states that the withdrawal of the asset levy and the Natural Capital and Climate Response levy resulted in a total of over \$12 million in lost revenue and an additional \$7 million that needed to be diverted to support continued public safety maintenance measures and a COVID-19 response. In 2015, the Fiscal Sustainability Review of General Fund capital assets showed that an investment of at least \$13.9 million is required each year to maintain assets at an optimal level. This amount does not include the incremental costs of climate response or natural capital projects (Gordon 2020, pg. 12). Thus, the 2021 Budget proposes a total Asset Levy of 3.0%, at a minimum, to replenish the amount needed to keep all assets function optimally. On March 8th, 2021, Council approved a 2.5% Asset levy.

Proposed natural asset management projects listed in the 2021 Budget include the Coastal Marine Management Plan Implementation (\$55,000) and implementation of Shoreline Protection projects (\$210,000) (Gordon 2021). As well, a complete parks asset inventory has been proposed for funding from the COVID-19 Safe Restart Grant from the Government of British Columbia. The District of West Vancouver is planning to have an integrated environmental strategy in place, which would include investment in the maintenance of natural capital assets (Gordon 2020, pg. 11). Currently, the District of West Vancouver has not applied for or received external funding for its natural asset management projects.

Based on the assertion that a 3.0% tax levy is the minimum required to replenish the function of all assets and the removal of the 0.5% tax levy from 2020 Budget 2, the District of West Vancouver receives an Orange score for this indicator (Fig. 21) While the 3.0% levy will provide some relief to the District of West Vancouver's deferred maintenance problem, it does limit the ability of the District of West Vancouver to sufficiently fund municipal natural asset management.

New Policies

The District of West Vancouver is creating a few new policies, strategies, and plans that apply natural asset management principles. There has been a particular focus on the foreshore and shoreline areas for this work. In 2012, the District of West Vancouver created the Shoreline Protection Plan 2012-2015 to protect and enhance one of the community's "greatest natural assets" (DWV 2012b). This plan listed twelve short-term and long-term priority projects to build on earlier success and enhance the shoreline area. In addition, the District of West Vancouver is creating a Foreshore Development Permit Area which controls where development is allowed within the coastal floodplain. This permit area is based on the calculation of interim flood construction levels for the District of West Vancouver coastline (Keith 2020a, pg. 64).

The District of West Vancouver has also been working with North Shore partners to create a North Shore Sea Level Rise Risk Assessment and Adaptation Management Strategy to understand the risk of sea-level rise and to create a coordinated set of actions areas to manage that risk (Kerr Wood Leidal Associates Ltd. 2021, pg. 1). One of the recommended actions of this report is to "incorporate findings and adaptation measures into asset management and/or natural asset management plans" (Kerr Wood Leidal Associates Ltd. 2021, pg. 8-4). These adaptation measures are planning and governance measures, building and site measures, community-scale structural flood protection measures, and community-scale nature-based measures (Kerr Wood Leidal Associates Ltd. 2021, pg. 7-7). Community-scale nature-based measures utilize landscape features that reduce flood risk, primarily through attenuating wave

effects, while providing environmental or social co-benefits (Kerr Wood Leidal Associates Ltd. 2021, pg. 7-7). Included under community-scale nature-based measures is the “restoration of naturally resilient environments” (Kerr Wood Leidal Associates Ltd. 2021, pg. 7-8).

In May of 2019, the District of West Vancouver announced that they are implementing a stormwater diversion system for a creek system below Highway 1 in West Vancouver. According to the District of West Vancouver, “approximately 800 properties in the Westmount and Altamont neighbourhoods will be protected by this project” (DWV 2019). To fund this project, Council worked with British Pacific Properties (BPP) with the District of West Vancouver paying \$6.25 million and BPP paying \$9.75 million. However, this project does not specifically utilize a natural asset management approach. This project has been in the works since the Integrated Stormwater Management Plan was passed in 2013. In 2017, a report for the Vinson, Brothers, and Hadden Creeks was submitted and put focus on “the health and condition of the creeks and creek infrastructure, including the connections between the conditions and activities in the watersheds and their impacts and benefits on the creeks” (Kerr Wood Leidal Associates 2017, pg. iv). While not specifically using the terminology of natural asset management, this Plan does contain many similar principles including documenting the condition of the creek conveyance system, identifying enhancement opportunities for wildlife habitats, and identifying required remedial and new capital work items for the creek conveyance system.

Finally, the District of West Vancouver completed a LiDAR Tree Canopy Study in 2020 to produce evidence of the efficacy of the Interim Tree Bylaw. Findings from this showed that the total canopy increased from 2013 to 2018 for the entire District of West Vancouver and within the area of existing neighbourhoods (Keith 2020b, pg. 19). Based on the results of the study and to maintain the existing tree canopy, staff proposed no change to protected tree size, no increased flexibility to remove trees, additional protected tree species, and tree protection on neighbouring lots during construction activities (Keith 2020b, pg. 20). Staff also recommended that a funding request is included in the 2021 Budget to develop an Urban Forest Management Plan. However, funding for an Urban Forest Management Plan has not been included in the Proposed 2021-2025 Five-Year Financial Plan (Gordon 2021). During interviews, staff mentioned that the District of West Vancouver is looking to expand its LiDAR study by including other vegetation, such as hedges (IG 2020, para. 24). Therefore, given the lack of explicit integration of municipal natural asset management in new policies and the limited project work scheduled to be completed in 2021 and 2022, the District of West Vancouver receives a Yellow score for this indicator (Fig. 21).

5.3.3 Ecosystem Rehabilitation and Restoration

Service Quality Metrics

One measurement of ecosystem service quality in the District of West Vancouver is the valuation estimation of services. In the District’s 2019 natural asset inventory, ecosystem service valuations were prepared for their forests, waterways, foreshore, and parks area. Starting with the forest area, ecosystem services valued include clean water supply and filtration, stormwater management, clean air, carbon sequestration, habitat, and recreation (Solsticeworks 2019, pg. 10). For waterways, ecosystem services valued include clean water supply, water regulation, water filtration, habitat, and recreation (Solsticeworks 2019, pg. 16). For the foreshore area, the

ecosystem services valued are storm surge protection, erosion regulation, recreation, and habitat (Solsticeworks 2019, pg. 20). Finally, for parks areas, the only ecosystem service valued is recreation (Solsticeworks 2019, pg. 24). However, while each ecosystem service has a specific valuation method, the inventory makes it clear that these are conceptual estimates and not an actual ledger. Thus, these valuation estimates do not reflect changes in real-time data, but current knowledge on the value of services they provide.

As part of other plans, strategies, and policies, some ecosystem service measurements and metrics have been created. Starting with the District of West Vancouver's Integrated Stormwater Management Plan, baseline water quality, benthic invertebrate, and flow monitoring data for three creeks was collected, analyzed, and reported on. This includes "water quality monitoring at the Brothers/Hadden, West Vinson, and East Vinson monitoring sites in the dry and wet seasons, benthic invertebrate sampling in the Brothers/Hadden and West Vinson watersheds, and analysis of flood data from two active sites located downstream of all major tributaries in the Brothers and West Vinson catchments" (Kerr Wood Leidal Associates 2017, pg. 8-8).

In conclusion, the District of West Vancouver has identified a few preliminary metrics that relate to ecosystem service quality. However, the metrics identified in the natural asset inventory are valuation estimates and not based on quality. Therefore, the District of West Vancouver receives an Orange score for this indicator (Fig. 21).

Rehabilitation Site Selection

As a part of the Integrated Stormwater Management Plan, the District of West Vancouver has identified several sites for an ecosystem rehabilitation and restoration project. However, these sites were not explicitly identified for aligning with natural asset management goals. As part of the Vinson, Brothers, and Hadden Creek Integrated Stormwater Management Plan report submitted in 2017, 15 projects have been identified for improvement, including invasive species management, riparian protection, restoration, and planting, stream daylighting, and in-stream habitat enhancement. The rationale, benefits, estimated cost, and priority of each project is also included (Kerr Wood Leidal Associates 2017, pg. 7-7-7-9). For example, under riparian protection, restoration, and planting, one of the projects is to "improve riparian habitat along Hadden Creek within Capilano Golf & Country Club" (Kerr Wood Leidal Associates 2017, pg. 7-9). The rationale for this project is that by enhancing the habitat, the District of West Vancouver would see an improvement in creek water quality and increase connectivity between riparian forest patches upstream and downstream.

According to interviewed staff, the District of West Vancouver is not working on any specific ecosystem rehabilitation and restoration projects that fit into natural asset management goals and objectives. However, staff did mention "there are a lot of things under consideration" (IG 2020, para. 50). This includes work on the foreshore area. For example, as a part of the North Shore Sea Level Rise Risk Assessment and Adaptive Management Strategy, several Comprehensive Adaptation Planning Zones (CAPZ) have been identified. These zones are areas on the North Shore where flooding could extend "well beyond the first row of development/properties" (Kerr Wood Leidal Associates 2021, pg. 7-12). These CAPZs are Horseshoe Bay, Stearman Beach, Dundarave, Ambleside-Capilano Beach, Capilano East, Norgate-Mosquito, Mission-Lonsdale, Lynn-Seymour, and Maplewood. For each of these zones,

the planning context, probability of flooding, and initial integrated adaptation concepts are presented. Some of the adaptation concepts include ecosystem restoration and adaptation, such as re-establishing natural shoreline materials to prevent erosion. While some work has begun as a part of previous projects, the District of West Vancouver has not included any of the proposed adaptation concepts in the 2021 Budget.

Thus, while the District of West Vancouver has not identified a site for the creation of a natural asset management-specific project, as a part of existing policy and strategy initiatives, site identification has occurred. This includes the nine Comprehensive Adaptation Planning Zones for the North Shore Sea Level Rise Risk Assessment and Adaptation Management Strategy and the fifteen projects in the Vinson, Brothers, and Hadden Creek Integrated Stormwater Management Plan. Therefore, the District of West Vancouver receives a Dark Green score for this indicator (Fig. 21).

Monitoring Indicators

The District of West Vancouver understands the importance of identifying indicators for monitoring and evaluation. In 2016, the Key Performance Indicators Task Group drafted a comprehensive list of key performance indicators. The Task Group created 20 separate key performance indicators for the District of West Vancouver to “measure and demonstrate the financial performance of the District, and the organization’s ability to execute on strategic goals and objectives” (Key Performance Indicators Task Group 2016, pg. 41). Key performance indicators were created for the following six divisions: Engineering and Environment Services, Community Relations and Communications, Fire and Rescue Services, Planning and Development Services, Corporate Services, and Parks, Culture and Community Services. Key performance indicators include litres of water used per capita per day, number of public consultations per year, and energy use reduction per square foot of facility (Key Performance Indicators Task Group 2016, pg. 44-52). However, staff did not identify that these indicators would be used for natural asset management projects (IG 2020, para. 29).

While a specific indicator has yet to be identified, according to interviewed staff, there are monitoring projects and metrics under consideration. This includes examining the interface between constructed infrastructure and natural infrastructure (IG 2020, para. 30), sea-level rise (IG 2020, para. 37), and flood risk (IG 2020, para. 40). As a part of the North Shore Sea Level Rise Risk Assessment & Adaptive Management Strategy, several potential indicators and targets are included to monitor and evaluate progress and outcomes. For example, one of the progress indicators is the “percentage of strategy ‘specific actions’ that have been initiated or completed” with the target of 100% by 2030 (Kerr Wood Leidal Associates 2021, pg. 8-7). These indicators are specific to “tracking the progress of implementing this Strategy and outcomes of sea-level rise adaptation” (Kerr Wood Leidal Associates 2021, pg. 8-6) and do not mention that these indicators fit into a larger framework for monitoring and evaluating a natural asset management program.

As well, as part of the Vinson, Brothers, and Hadden Creek Integrated Stormwater Management Plan, several performance indicators have been identified for a monitoring framework. These indicators include water quality performance indicators such as dissolved oxygen and temperature, flow monitoring performance indicators such as pulse count and duration, benthic invertebrate biomonitoring performance indicators such as mean taxa richness

and recommended supplemental performance indicators such as the number of erosion sites (Kerr Wood Leidal Associates 2017, pg. 8-5). In addition to these performance indicators, several long-term targets have also been paired with indicators as benchmarks. Following Metro Vancouver's Monitoring and Adaptive Management Framework for Stormwater (MAMF), "core monitoring parameters are required to be monitored at a minimum every five years, although more frequent monitoring may be undertaken. The MAMF recommends watersheds with stable land use are monitored every three to five years" (Kerr Wood Leidal Associates 2017, pg. 8-6).

While the District of West Vancouver has not specifically identified an indicator for natural asset management projects, several indicators identified for other projects can easily be copied and integrated into a natural asset management monitoring framework. While the reports for the plan and strategy are specific to the areas studied, those areas are already included as part of the District of West Vancouver's natural asset inventory. Therefore, the District of West Vancouver receives a Light Green score for this indicator (Fig. 21).

5.3.4 Service Delivery

Monitoring Co-Benefits Metrics

The District of West Vancouver has acknowledged the potential of co-benefits in their natural asset inventory. For example, as part of the District of Vancouver's urban forest, listed benefits for habitat provision include aesthetic appreciation, public health, increased property values, education, tourism, and culture (Solsticeworks 2019). Specifically, the inventory report mentions that "trees are especially helpful in reducing what is called the "heat island effect" in which built-up areas have higher temperatures than green space" (Solsticeworks 2019, pg. 8). The District of West Vancouver has also included some preliminary valuations for benefits accrued from natural asset areas. For example, Westcot Elementary School is near Brothers Creek. The potential educational benefits for engaging students in a daylighting project were valued at \$192,000 in 2017 (Solsticeworks 2019, pg. 15). However, without any specific data measurements, the District of West Vancouver receives a Grey score for this indicator (Fig. 21).

Municipal Budget for Grey Infrastructure Renewal

Staff mentioned that funding for grey infrastructure renewal still comes before natural asset and natural capital work (IG 2020, para. 43). This is also shown in the merging of the 0.5% Natural Capital and Climate Response levy from Budget 1 2020 into the 3.0% general asset levy in Budget 2021. Staff also mentioned that the District of West Vancouver will continue to search for new ways to fund natural capital work. Therefore, the District of West Vancouver has not produced significant data that shows that municipal natural asset management is reducing the budget set for grey infrastructure renewal. Therefore, the District of West Vancouver receives a Red score for this indicator (Fig. 21).














Indicator (Benchmark)	Site Score
Awareness, Capacity and Education Indicators	
Number of general consultation efforts for NAM (Benchmark 1: More than 50% of NAM Consultation events have a high attendance rate) (Benchmark 2: All [100%] of information materials describe one reason for conducting MNAM)	 
Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners (At least 1 formal or informal partnership)	
Implementation Indicators	
Number of barriers or opportunities identified in MNAM delivery within the project community (Benchmark 1: 100% of relevant documents identify barriers and opportunities) (Benchmark 2: All [100%] of managers provide at least one barrier)	 
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAM)	
Amount of funding and financing received for projects (All [100%] of projects and programs have available funds to ensure a full lifecycle)	
Number of new NAM policy, strategies, and plans (All [100%] of NAM policy, strategies, and plans created to support MNAM)	
Ecosystem Rehabilitation and Restoration Indicators	
Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory (All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory)	
Number of sites selected as potential rehabilitation or restoration project(s) (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals)	
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects)	
Service Delivery Indicators	
Percentage increase in co-benefit metrics monitored by project community (Increase in co-benefits from natural asset management)	
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure)	

Figure 21 – Balanced Scorecard for the District of West Vancouver.

5.4 City of Nanaimo

5.4.1 Awareness, Capacity, and Education

Awareness and Education

Many awareness sessions of the City of Nanaimo have been integrated into the City of Nanaimo's Official Community Plan Update. As part of the City of Nanaimo's feedback collection process, staff launched the Reimagine Nanaimo campaign in July 2020 to gather data on what city residents are concerned about for the City of Nanaimo's future. The City of Nanaimo also collected participation data. These data include where participants live, the age of participants, and how participants shared their ideas. In total, for Phase 1 of the Reimagine Nanaimo campaign, the City of Nanaimo received more than 9,000 inputs from website comments, online discussion groups, statistical surveys, and public ideas questionnaires (City of Nanaimo 2021b). The City of Nanaimo also tracked digital outreach, traditional media and announcements, and city advertising. One of the most significant areas of concern for participants was a loss of natural areas. As well, one of the most important qualities that participants want to preserve is an access to nature, parks, and open spaces. Specifically, "over 60% of respondents in both surveys rated every environment/climate change issue listed as very important or important" (City of Nanaimo 2021b, pg. IX). However, at this time, the City of Nanaimo has not held an engagement event specific to municipal natural asset management.

The City of Nanaimo has a variety of digital and hard-copy information materials that provide various reasons for a municipal natural asset management approach. For example, as part of a Reimagine Nanaimo background report prepared for the launch of the campaign, the City of Nanaimo discussed some climate adaptation measures that the City of Nanaimo is currently taking and could expand upon. These measures include protecting watersheds and riparian areas through stewardship efforts, urban forest protection regulations, and low-impact development for stormwater management (City of Nanaimo 2020f). This report also provided a few reasons for why these measures are needed. For example, the City of Nanaimo acknowledges that forest areas support rainwater management and healthy streams. The City of Nanaimo also publishes the "Natural Connections" newsletter once every 3-6 months. This newsletter explains the various restoration projects the City of Nanaimo has completed over the past months and how these projects are beneficial to the larger community. For example, the Spring 2020 newsletter explains that "riparian planting helps filter water absorbed through the soil and into streams, helps prevent erosion of the stream banks and will eventually provide shelter and shading and other benefits to our aquatic ecosystem and improving the water health of these water systems" (City of Nanaimo 2020g, pg. 5).

The City of Nanaimo and the Regional District of Nanaimo have also developed a few fact sheets for creek areas that may have ongoing projects. These fact sheets describe the project work, why the work is important, and the challenges faced by the creek. For example, in the Beck Creek fact sheet, ongoing project work includes water quality monitoring and riparian restoration. The listed benefits of this riparian area are shade, erosion control, fish habitat, and water filtration (City of Nanaimo 2018b). These fact sheets also advertise upcoming River Days. These events highlight the many values of the City of Nanaimo's waterways and aim to increase public awareness and encourage the stewardship of rivers in the community.

On the City of Nanaimo’s website, an entire section of the website is dedicated to green initiatives. These initiatives include the ongoing natural asset management work in the Buttertubs Marsh Conservation Area as well as other restoration monitoring sites and projects. One way that the City of Nanaimo is capturing restoration changes is through a “chronolog” or crowd-sourced timelapses of restoration sites. For the Buttertubs Marsh Conservation Area, the City of Nanaimo and the stewardship group Friends of Buttertubs Marsh developed a nature guide for the area that describes the species found in the Marsh and how they interact with each other.

This evaluation question contains two separate indicators for determining a score. For the first benchmark, the City of Nanaimo receives a Grey score (Fig. 22). While the City of Nanaimo has demonstrated a strong capacity to engage residents through their Official Community Plan Update, there is not specific data on the kinds of inputs received from the Official Community Plan Update and whether those inputs could be attributed to awareness of municipal natural asset management or other aligned practices. Therefore, there is no available data to determine whether natural asset management consultation events had a high rate of attendance. For the second indicator, in all related information materials, the City of Nanaimo accurately describes various reasons for conducting municipal natural asset management. Specifically, the City of Nanaimo has focused on ecosystem restoration as a valuable project for resident appreciation and service delivery. Therefore, the City of Nanaimo receives a Dark Green score for this indicator (Fig. 22).

Capacity

According to interviewed staff, the City of Nanaimo started partnerships with Ducks Unlimited Canada, the Regional District of Nanaimo, the University of Vancouver Island, and the Partnership for Water Sustainability in BC for the Buttertubs Marsh Conservation Area (RL 2021, para. 19; RL 2021, para. 45). Ducks Unlimited Canada (DUC) is a national environmental non-government organization that aims “to conserve, restore and manage wetlands and associated habitats for the benefit of North America’s waterfowl” (DUC 2021). DUC offers scientific expertise, education, policy, and partnerships on several impact areas across Canada. As well, DUC has created a few programs and services for waterfowl research, native plant solutions, agriculture, and the national boreal forest. Since 1986, DUC became the primary facilitator of on-the-ground conservation work in Canada through the North American Waterfowl Management Plan.

DUC has worked with the City of Nanaimo since the 1980s, with a specific focus on the enhancement and management of the Buttertubs Marsh Conservation Area with three other partners: the Province of British Columbia, the Nature Trust of British Columbia, and the Friends of Buttertubs Marsh (Buffett 2017). The Buttertubs Marsh West property is held by DUC as tenants-in-common. In 2012, DUC and the City of Nanaimo strengthened the partnership through the cooperative purchase of the West Marsh – adjacent to Buttertubs (DUC & City of Nanaimo 2012, pg. 5). One of the goals of this agreement was to provide recreational amenities to the public consistent with the conservation purposes for which the land was acquired. In addition to the management of the Buttertubs Marsh area, DUC has produced several monitoring reports as part of the requirements for the Government of Canada’s Ecological Gifts Program. This program “offers significant tax benefits to landowners who donate land or a partial interest

in land to a qualified recipient. Recipients ensure that the land's biodiversity and environmental heritage are conserved in perpetuity" (Environment and Climate Change Canada 2021).

Regarding the partnership with Vancouver Island University (VIU), the VIU Bird Banding Project "has conducted bird monitoring and banding in the Nanaimo area since 2013" (Nature Nanaimo 2021). Dr. Eric Demers from VIU operates a bird banding station at Buttertubs West Marsh and has published separate monitoring reports on the bird banding process. On April 19th, 2021, Nanaimo City Council and Vancouver Island University announced the signing of a non-binding Memorandum of Understanding (MOU) between the City of Nanaimo and the University. "Under the terms of the MOU, the City of Nanaimo and the University will work together to: (i) establish a framework for collaboration between the two organizations; (ii) adopt a cooperative approach to working together for the mutual benefit of the City and VIU, the students and broader community; (iii) pursue areas of common strategic interest; (iv) actively participate in joint initiatives, projects, and activities; and, (v) identify and address common areas of concern that may emerge during the life of the MOU" (Vancouver Island University 2021). An Executive Committee will be created with senior leaders from the City of Nanaimo and VIU. The MOU is effective as of Monday, April 19th, 2021, until December 31st, 2023.

Finally, the Partnership for Water Sustainability in BC (referred to as the Partnership) is a non-profit society formed from a technical committee that focused on delivering the Water Sustainability Action Plan for British Columbia. This Action Plan is integrated within the Living Water Smart, British Columbia's Water Plan (2008), which serves as the provincial government's call to action on water sustainability. The vision of the Partnership is "that water sustainability will be achieved through implementation of green infrastructure policies and practices" (Partnership for Water Sustainability in BC 2021a). The Partnership was also a significant contributor to the Millstone River Ecological Accounting Process. This report "provides local governments with a methodology and metrics so that they can operationalize 'maintenance and management' (M&M) of stream corridor systems" (Partnership for Water Sustainability in BC 2021b, pg. 1) Specifically, two of the Partnership's members served on the Project Committee. In addition, the Partnership for Water Sustainability in BC has contributed to a framework for asset management for sustainable service delivery which is a guiding principle for the creation of a municipal natural asset management framework. As part of this framework, a primer for integrating natural assets into asset management was developed. Another large project that the Partnership has been working on with the City of Nanaimo and other partners is an ecological accounting process for financial valuation of the Millstone River, mentioned above (The Partnership for Water Sustainability in BC 2021b; RL 2021, para. 19). According to interviewed staff, this ecological accounting process is an examination of land values for specific ecological features and an assessment of the maintenance and operation costs for maintaining those features (RL 2021, para. 19).

Another significant conservation partnership for the City of Nanaimo is the Coastal Douglas-Fir and Associated Ecosystems Conservation Partnership (CDFCP). The CDFCP is "a collaboration of agencies, organizations and land managers who are interested in promoting and protecting healthy Coastal Douglas-fir and Associated Ecosystems into the future" (CDFCP 2021, pg. 3). As part of the CDFCP, a broad mandate was created through a Terms of Reference and a Statement of Cooperation. The CDFCP also established five working groups to work on priority activities and strategies. These Working Groups are the Restoration and Stewardship Group, Science and Technical, Local Government, Resource Sector, Outreach and Education,

and Securement. The CDFCP has developed several reports and articles, including a Conservation Strategy, Terrestrial Ecosystem Mapping, and guides for collaborative conservation planning. The CDFCP recognizes that local governments should adopt natural asset valuation practices if it leads to beneficial conservation outcomes.

The City of Nanaimo continues to build partnerships with local First Nations communities, namely the Snuneymuxw First Nation. In 2005, the City of Nanaimo and the Snuneymuxw signed a Memorandum of Understanding that prioritized mutual respect and cooperation, and a commitment to a set of principles to guide the government-to-government relationship. “This was followed by the 2009 signing of a government-to-government Protocol Agreement that was renewed on May 27th, 2019” (City of Nanaimo 2020c, pg. 1). This agreement re-established regular meetings of the Protocol Working Agreement Group to coordinate economic opportunities, service provision, land use planning, and establish a joint decision-making process. The City of Nanaimo, the Snuneymuxw, Departure Bay Neighbourhood Association, and Departure Bay Streamkeepers have partnered on a restoration project for Departure Creek. This restoration will “enhance fish and wildlife habitat and create more opportunity for residents to enjoy nature and their neighbourhood” (City of Nanaimo 2018a). The City of Nanaimo is also working to build relations with the Snaw-Naw-As “whose Traditional Territory overlaps Snuneymuxw starting in the Neck Point Area towards the North of Nanaimo” (City of Nanaimo 2020c, pg. 2).

The City of Nanaimo has established partnerships with several organizations for the continued management of BMCA which is the main natural asset area of interest. Therefore, the City of Nanaimo receives a Dark Green score for this indicator (Figure 5.4).

5.4.2 Implementation

Barriers and Opportunities

Regarding barriers and opportunities identified, one barrier identified by interview staff is the number of resources and funding. Specifically, interviewed staff stated that they “don’t have the time and there are other priorities that are in front of us right now that we’re working on” (RL 2021, para. 26). Related to this, staff have also had to work through some departmental siloing between the Planning department and the Engineering department as there are questions on which department should take lead on these projects. To address this barrier, interviewed staff stated that the City of Nanaimo is creating an asset management committee and hiring an asset management manager. One of the responsibilities of this position will be to integrate natural assets and hard assets into one process (RL 2021, para. 27).

This integrated process will also let the City of Nanaimo move away from a piecemeal project-based approach towards a holistic, program-based approach. According to interviewed staff, restoration projects are ongoing in the City of Nanaimo, but these projects are not seen as part of a larger holistic effort. In the City of Nanaimo’s (2020) Climate Change Resilience Strategy, participants in the engagement process identified over 80 climate change impacts for the City of Nanaimo, many of which were challenges and only a small number of potential opportunities. For example, an included climate-related challenge is “increased flooding from overwhelmed stormwater drainage infrastructure, rivers and creeks” (City of Nanaimo et al. 2020, pg. 15). A climate-related opportunity for agriculture is a longer growing season.

However, the challenges and opportunities included in this Strategy are not specific to integrating municipal natural asset management practices.

Connected to this evaluation question are two separate indicators (1. proportion of relevant documents that identify barriers and opportunities; 2. proportion of managers that can identify at least one barrier). Since the reviewed documents do not identify natural asset management barriers and opportunities, the City of Nanaimo receives a Red score for the first indicator (Fig. 22). Since all interviewed staff accurately described a staff capacity barrier the City of Nanaimo receives a Dark Green score for the second indicator (Fig. 22).

Policy Changes

In addition to these plans and strategies that have already been implemented, the City of Nanaimo is currently working on an update to their Official Community Plan. One of the goals identified in the scoping work for the Official Community Plan is a “green approach” and access to nature and outdoor recreation. “A Green Nanaimo is about how we can support the lands, air, and waters that sustain us. It is about advancing collective knowledge, living in harmony with our environment, and responding to the impacts of climate change while protecting people, businesses, and infrastructure” (City of Nanaimo 2021d, pg. 9). These goals were identified from the engagement summary completed by the City of Nanaimo as part of the Reimagine campaign, which highlighted residents’ concerns about the loss of natural areas in the City of Nanaimo and their wish to see more access to nature, parks, and open space (City of Nanaimo 2021b, pg. V).

One natural asset area of focus for the City of Nanaimo is their urban forest. In 2010, the City of Nanaimo created their Urban Forestry Management Strategy (UFMS). The purpose of this strategy is to provide context and a framework for the sustainable management of the City of Nanaimo’s existing and future urban forest. “The Strategy recognizes [the] urban forest as a living utility, similar to roads, water systems and other necessities of an urban forest environment” (City of Nanaimo 2010, pg. 6). This strategy also describes the benefits of a sustainable urban forest, which include rainwater capture, air quality improvements, energy savings, food, public safety and health, wildlife habitat, economic benefits, property values, and aesthetics. Finally, this strategy “contains a series of modules that identify goals, objectives, and procedures that the City is either pursuing or will commit to over the next five years” (City of Nanaimo 2010, pg. 18). For example, under the “Parks and Natural Areas Management” module, the City of Nanaimo commits to developing forest management and natural areas plans for each of their urban parks (City of Nanaimo 2010, pg. 10). Finally, interviewed staff mentioned that the Urban Forestry Management Strategy provides direction at the subdivision level on which trees need to be protected and how to create tree protection areas (RL 2021, para. 31).

Along with the Urban Forestry Management Strategy, the City of Nanaimo has a Tree Management and Protection Bylaw. This bylaw regulates permits on the pruning or removal of trees. Residents must submit a Tree Removal Permit and can be approved if the tree meets one out of a possible seven tree removal criteria. As well, the Tree Management and Protection Bylaw defines and classifies significant trees that are not allowed to be removed, regardless of criteria. The City of Nanaimo defines significant trees as “any tree that is of particular significance to the City due to size, age, landmark value, overall cultural, ecological heritage or social impact, scientific value, and any tree that is protected as wildlife habitat for an egg or nest as defined in the *Wildlife Act*” (City of Nanaimo 2020d, pg. 5). In addition to the Tree Removal Permit, residents must also submit a Tree Management Plan. Fees collected during this process

are then submitted to a funding mechanism that compensates for the loss of any significant trees by planting additional trees within the City of Nanaimo (RL 2021, para. 31).

Finally, the City of Nanaimo has several watercourse protection regulations that include setback requirements for protecting riparian areas. Since 1997, land use activities adjacent to watercourse and riparian areas in the City have been regulated under the City Watercourse Development Permit Area (DPA) and the City's Zoning Bylaw (City of Nanaimo 2020h). The Zoning Bylaw states that no new structures, buildings, additions, driveways, parking lots, fences, etc., can be built within a watercourse setback area. These setback areas vary, depending on the size of the watercourse, condition of the riparian area, and its connectivity to other watercourses. Rivers and streams with significant riparian areas have 30 metre setbacks. However, most streams and creeks have 15 metre setbacks and minor streams that are isolated or only indirectly flow into fish bearing watercourses have a 7.5 metre setback. Lakes, wetlands, and marine foreshore areas all have 15 metre setbacks.

Therefore, the City of Nanaimo has made numerous policy changes that align with municipal natural asset management. However, there is no mention of municipal natural asset management in the Official Community Plan Update in the City of Nanaimo, even though this update is occurring after municipal natural asset management piloting. Therefore, the City of Nanaimo receives a Light Green score for this indicator (Fig. 22).

Project Funding

There is not a lot of data available regarding the funding of natural asset management projects and programs in the City of Nanaimo. The prior owners of the Buttertubs Marsh Conservation Area (BMCA) were given a significant income tax benefit from the Government of Canada's Ecological Gift Program. This gift provided substantial funding for the initial purchase of the BMCA but does not fund its operations and maintenance. The City of Nanaimo and Ducks Unlimited Canada do not explicitly track the funding for the maintenance and operations of the BMCA. In the 2019 Budget, \$1,777 was budgeted for a Buttertubs Marsh Hydrology Study, \$108,253 is budgeted for the Climate Change Resiliency Strategy, and \$1,000 is budgeted for the Jingle Pot Marsh Restoration. In the 2020 Budget, \$31,923 is budgeted for the Climate Change Resiliency Strategy, a total of \$111,000 is budgeted from 2020-2024 for the Natural Parks Areas Assessment Program, and a total of \$69,130 is budgeted from 2020-2022 for the Water Course Restoration and Enhancement Program (City of Nanaimo 2020e, pg. 33). In the 2021 Budget, \$104,060 is budgeted for the Natural Parks Areas Assessment Program from 2021-2024 and \$51,750 is budgeted for the Water Course Restoration and Enhancement Program. In addition, \$75,000 is budgeted for 2021 for the Community Action Sustainability Plan Update. In both the 2020 and 2021 Budget, there is no explicit information on the BMCA.

According to interviewed staff, funding was sufficient to complete the BMCA piloting as planned. Depending on the scale of the project, funds might come from a capital budget, city in-kind contributions, or external funding applications and grants (RL 2021, para. 38). Interviewed staff also mentioned that a scope of work exercise is required to determine what the City of Nanaimo could afford and what is a priority for them now (RL 2021, para. 41). As well, staff also mentioned that there are a few instances where work does have to be spread out over a few years. While interviewed staff do state that funds have been provided for ecosystem rehabilitation and restoration projects, there is no explicit inclusion of a natural asset management program in the 2019, 2020, and 2021 Budgets.

While, interviewed staff that funding is sufficient for the operations and management of the BMCA, there is a lack of data in financial documents that support this assertion. As well, the City of Nanaimo has not applied to external funding sources for municipal natural asset management. Therefore, the City of Nanaimo receives an Orange score for this indicator (Fig. 22).

New Policies

Regarding new natural asset or ecosystem service management programs and plans, the City of Nanaimo collaborated with several partners to create a Buttertubs Marsh Conservation Area (BMCA) Management Plan. This plan is a consolidation of the East and West Marsh Plans and the strategic review of the 2004 management plan. “The goal of this document is to update information, highlight achievements and prioritize the next steps through the establishment of management targets” (City of Nanaimo et al. 2017, pg. 6). Since the implementation of the 2004 management plan, the strategic review found that partners have completed 58% of the tasks with another 18% underway. This leaves 24% of the tasks not started at the time of the 2015 strategic review. To account for these remaining tasks and address current issues, several management goals have been included in the BMCA Management Plan. These goals are to (i) monitor, maintain and, where possible, enhance the Natural Ecosystems of the BMCA; (ii) provide for compatible public recreational and education use of the area; and (iii) cooperative management. (City of Nanaimo et al. 2017, pg. 9). Also included in this Plan is a description of all ecosystems through five distinct management zones. These management zones are based on ecological features and an updated Terrestrial Ecosystem Mapping. For each of these management zones, a description of the vegetation and wildlife or habitat values is provided. In addition, the Plan also explains the land use activity, the management direction, the priority management actions, and five-year management targets for each of the management zones (RL 2021, para. 45).

Another significant conservation plan or strategy developed that incorporates natural asset management practices is the Coastal Douglas-Fir and Associated Ecosystems Conservation Partnership Conservation Strategy (CDFCP Conservation Strategy). The City of Nanaimo is one of these partners. The CDFCP Conservation Strategy was implemented in 2015 and the purpose of creating a 30-year vision and goals for the CDFCP along with objectives and actions identified for the next five years. These short-term objectives include (i) provide sound science to support land securement and stewardship; (ii) conduct education and outreach; (iii) cultivate effective partnerships; (iv) facilitate securement of protected ecosystems; and (v) support active ecosystem management (CDFCP 2021, pg. 5). Specific to the last objective, one of the actions is to “work with local governments to develop plans, policies and bylaws and incentives that enhance CDF values” (CDFCP 2021, pg. 5). Therefore, the plans, policies, bylaws, and incentives developed by the City of Nanaimo may align with values of ecosystem protection and conservation.

The City of Nanaimo was also involved in the creation of a few older management plans for natural asset areas. This includes management work for the Nanaimo Estuary. In 2006, the Nanaimo Estuary Management Plan (NEMP) was implemented throughout the Regional District of Nanaimo. “The purpose of planning and management is to restore the productivity and diversity of the natural resources in the estuary with consideration for social and economic returns and benefits to the community as a whole” (Catherine Berris Associates 2006, pg. ii). This management plan contains management strategies for the fish and wildlife, water quantity

and quality, and human activities in and around the Nanaimo Estuary. For example, in the water quantity and quality section, one of the management strategies is to “use bacterial source tracking and other methods to investigate the sources of fecal coliform bacteria within the smaller watercourses of the Nanaimo and Chase Rivers” (Catherine Berris Associates 2006, pg. 40). While created prior to the implementation of the municipal natural asset management program, the Plan explicitly recognizes the Nanaimo Estuary as one of the greatest natural assets in the region.

Next, the City of Nanaimo has a Climate Change Resilience Strategy. The Climate Change Resilience Strategy has six themes for climate adaptation action. These themes are (i) Water Supply, (ii) Flooding and Drainage, (iii) Environment, Parks and Recreation, (iv) Well-being and Preparedness, (v) Land use and Buildings, and (vi) Corporate Governance and Mainstreaming. Each of these themes is addressed by objectives and several priority actions for each objective. An example priority action for municipal natural asset management contained in this strategy is inventorying the City of Nanaimo’s natural assets and incorporating them into the City’s asset management program to protect and maintain their function (City of Nanaimo 2020a, pg. 24). This priority action is part of the Environment, Parks and Recreation theme Objective 2, which is the assessment and restoration of the City of Nanaimo’s watercourse and marine ecosystems to become biologically diverse and resilient. Other related actions included in the Strategy are to “incorporate natural systems that help control stormwater flows (e.g., bioswales) into capital project planning (City of Nanaimo 2020a, pg. 20). This is an additional action under the Flooding and Drainage theme and Objective 1 which is the minimizing of urban and overland flooding resulting from heavy rainfall. Finally, the City of Nanaimo has committed to completing a natural asset inventory and strategy by 2022 (City of Nanaimo 2020a, pg. 4). Work on this natural asset inventory and strategy is scheduled to start in 2021.

In conclusion, the City of Nanaimo has created several new policies that align with municipal natural asset management practices. These policies include new management practices in the BMCA Management Plan. However, the City of Nanaimo has not created a new policy that incorporates municipal natural asset management. Therefore, the City of Nanaimo receives a Yellow score for this indicator (Fig. 22).

5.4.3 Ecosystem Rehabilitation and Restoration

Service Quality Metrics

The City of Nanaimo has started to create some ecosystem service quality metrics and measurements for key natural asset areas. Starting with the Millstone Watershed, flow, habitat area, water quality, and fish population were monitored in the 1998 Watershed Fish Production Plan and Atlas (Lanarc Consultants Ltd. 1998). In the Buttertubs Marsh Conservation Area (BMCA), there is not an extensive collection of ecosystem service data. However, there are some stipulations for ecosystem service monitoring in the BMCA Management Plan. For example, as part of the Conservation Agreement between Ducks Unlimited Canada and the Province of British Columbia, a bio-inventory monitoring is conducted every five years (City of Nanaimo et al. 2017, pg. 8). There is also monitoring for wildlife and vegetation through a Species at Risk inventory. Finally, one of the priority management actions for some of the land management areas is to “establish permanent baseline monitoring plots/transects” (City of Nanaimo et al. 2017, pg. 20). This work will be done in partnership with Vancouver Island University’s biology

department. As well, work is ongoing to monitor and restore the habitat of the Western Painted Turtle and Red-eared Slider.

According to interviewed staff, the Province of British Columbia shared a sensitive ecosystem inventory that was then incorporated into their development permit area guidelines. Staff mentioned that the City of Nanaimo uses this inventory as a metric for “what kind of ecological features are recognized by the province” to help them identify key areas when trying to acquire additional parkland (RL 2021, para. 49). The Sensitive Ecosystems Inventory (SEI) Project was published by the Ministry of Environment and Climate Change Strategy in 2011 and was last modified in 2020. However, this inventory does not mention the services produced by these sensitive ecosystems. Staff also recognize the inventory as a coarse metric (RL 2020, para. 54). In addition to the SEI Project, staff also mentioned that the Province of British Columbia maintains an endangered species listing. As staff prepare park restoration plans, there is a specific focus to monitor for the presence of endangered species (RL 2021, para. 50). Finally, the City of Nanaimo in partnership with the Regional District of Nanaimo, work with residents through a citizen-science approach to monitor water quality for the urban streams (RL 2021, para. 56). Currently, these are basic tests focusing on monitoring for water temperature, dissolved oxygen, benthic invertebrates, and sediment levels. The Province of British Columbia reviews the monitoring work, which is then posted by the Regional District.

Finally, the Millstone River Ecological Accounting Process also built in some basic ecosystem service monitoring metrics. For example, the ecological accounting process used in the study considers streams and their corridors to be an indicator of watershed health (Partnership for Water Sustainability in BC 2021b, pg. 1). The Study recognized that the study area delivers a “package of ecological services” such as hydrological function, aesthetic uses, intrinsic nature values, and support of municipal infrastructure (Partnership for Water Sustainability in BC 2021b, pg. 17). This research also resulted in a benchmark assessment for woodlands and tall vegetation. Specifically, the Study noted that the health or functioning condition of the Millstone stream riparian zone could be improved by restoring tree cover (Partnership for Water Sustainability in BC 2021b, pg. 8). However, specific measurements for ecosystem service quality were not included in the Valuation Study.

While the City of Nanaimo has selected and started to monitor some ecosystem service metrics, most of these metrics are quite rudimentary and are mandated by other regulations. In addition, the City of Nanaimo has not identified an ecosystem service metric for cultural ecosystem services. Therefore, the City of Nanaimo receives a Yellow score for this indicator (Fig. 22).

Rehabilitation Site Selection

The City of Nanaimo has a history of identifying sites for ecosystem restoration and rehabilitation projects. For example, the Millstone Watershed was identified as early as 1998 for the creation of a watershed fish monitoring plan. On the City of Nanaimo’s website under “Green Initiatives” the City of Nanaimo maintains a large inventory of sites identified for monitoring and restoration work. These sites are Departure Bay Centennial, East Wellington Park, Harewood Centennial Park, Linley Point Gyro Park, Nanaimo Estuary, Robin’s Park, Third Street Park, and Woodstream Park. The City of Nanaimo installed several “Chronolog” photo monitoring sites so staff and residents can observe progress over time. In addition to this restoration work, the most significant monitoring site for the City of Nanaimo is the Buttertubs

Marsh Conservation Area (BMCA). This site was the focus of the Municipal Natural Assets Initiative piloting. While the initial piloting started in 2018, the City of Nanaimo already had a management plan for the BMCA since 2004. The City of Nanaimo has continued to purchase additional parcels of land in the BMCA with partner organizations. As well, the Management Plan was updated in 2012 and again in 2017 (City of Nanaimo et al. 2017, pg. 31).

Throughout the management history of the BMCA, the City of Nanaimo has created targets for directing that management. These land management directions are for the West and East Marsh Area. These Land Management Directions describes the land use activity, the management direction, priority management actions, and five-year management targets. For example, under the restoration land use activity, priority management actions include mapping invasive species, removing invasive species, planting native species, and boundary management in the south of the area (City of Nanaimo et al. 2017, pg. 20). The targets for these actions are by Year 2 all invasive species are mapped; by Year 5 there is a 50% reduction in invasive species cover; and by the end of Year 5, all boundary issues are resolved. The inclusion of management targets will prioritize next steps.

The City of Nanaimo has considerable experience with the monitoring and evaluation of projects and programs for ecosystem conservation and restoration. Therefore, the City of Nanaimo receives a Dark Green score for this indicator (Fig. 22).

Monitoring Indicators

The City of Nanaimo has created several draft indicators for monitoring progress for the upcoming Official Community Plan. The purpose of these indicators is to monitor the City of Nanaimo's progress as they set goals for focusing the implementation of the Official Community Plan framework. The framework for the Official Community Plan is made up of five draft goals. The goal that aligns with municipal natural asset management practices is "A Green Nanaimo: Resilient & Regenerative Ecosystems". For this goal, the draft indicators are (i) the community's greenhouse gas emissions, (ii) the area of lands dedicated for natural area protection, (iii) water samples meeting British Columbia's water quality guidelines, (iv) the amount of household waste sent to the landfill, and (v) water consumption by residents" (City of Nanaimo 2021d, pg. 9). Along with these indicators, the City of Nanaimo has created at least one draft target or benchmark for each of these indicators. For example, the draft targets for the "household waste sent to the landfill" indicator is "by 2030 150 kg/household/yr; by 2040 120 kg/household/yr; by 2050 100 kg/household/yr" (City of Nanaimo 2021d, pg. 15). For the "area of lands dedicated for natural are protection", the current draft target is an increase in area, with a specific area target yet to be determined.

In the City of Nanaimo's Climate Change Resilience Strategy, several adaptation indicators have been created. While the Strategy acknowledges that measuring adaptation to climate change is challenging, these indicators are (i) linked to goals and objectives; (ii) allow adaptive and flexible planning; (iii) are inclusive of both process and outcome; and (iv) easy to measure and relatively accurate (City of Nanaimo et al. 2020, pg. 36). There are multiple identified indicators for the six themes in the Strategy. These indicators include growth in volume of water stored, value of assets in unprotected future floodplain, canopy cover, and capital infrastructure projects assessed for climate risk. In addition to these indicators, the Climate Change Resilience Strategy includes a description and explanation for each of these indicators. For example, the description for value of assets in unprotected future floodplain is

“calculation of the value of assets in the floodplain for the year 2100. Target of what will be protected by a certain year by flood management planning” (City of Nanaimo et al. 2020, pg. 37). The City of Nanaimo has created several indicators for the lifecycle of natural asset management projects and other restoration projects that align with natural asset management practices. Therefore, the City of Nanaimo receives a Dark Green score for this indicator (Fig. 22).

5.4.4 Service Delivery

Monitoring Co-Benefits Metrics

The City of Nanaimo has not yet incorporated monitoring or evaluation of co-benefits from natural asset management. However, in several of the key documents reviewed, the potential of co-benefits is explored. For example, in each of the six themes included in the Climate Change Resilience Strategy, there is some mention of co-benefit potential. For example, under the Corporate Governance and Mainstreaming theme, one of the additional actions is to “assess the potential economic benefit to the City as a result of climate change to help offset costs” (City of Nanaimo et al. 2020, pg. 32). In the Urban Forestry Management Strategy, several potential co-benefits are listed including economic benefits, aesthetic benefits, and safety benefits (City of Nanaimo 2010, pg. 15). However, the monitoring of these co-benefits is not included in the Strategy.

Until the monitoring of co-benefits ensues, a score cannot be given on whether an increase in co-benefits has occurred due to municipal natural asset management. Therefore, the City of Nanaimo receives a Grey score for this indicator (Fig. 22).

Municipal Budget for Grey Infrastructure Renewal

On April 5th, 2017, City of Nanaimo staff presented a 20 Year Infrastructure Investment Plan to City Council. The purpose of this plan is to show the projected investment required over the next twenty years for current infrastructure renewal, for new and upgraded infrastructure required due to growth, and for specific projects (City of Nanaimo 2020e, pg. 7). In the City of Nanaimo’s Infrastructure Fund, the projected funding shortfall for the General Fund is \$124 million, including \$43 million for Development Cost Charges (DCC) contributions. For the Sewer Fund, the projected DCC contributions shortfall is \$24 million. For the Water Fund, projected shortfall is \$121 million which includes \$50 million for DCC contributions (City of Nanaimo 2017, pg. 12). In the 20 Year Infrastructure Investment Plan, the strategies listed to reduce the funding gap include increases to property taxes, decommission underutilized or inefficient infrastructure, and implement improvements to the City of Nanaimo’s Asset Management System. However, natural asset management is not included as a potential strategy to reduce the funding gap. The 20 Year Infrastructure Investment Plan was completed prior to the natural asset management piloting study.

In the 2020-2024 Financial Plan, specific natural asset management projects that will supplement traditional infrastructure are not included as part of the infrastructure program breakdown. In fact, natural asset management work is not explicitly mentioned anywhere in the 2020-2024 Financial Plan. In the 2021-2025 Draft Financial Plan, there are little to no natural asset management projects included. This is consistent with staff interview responses that described the City of Nanaimo’s municipal natural asset management approach as piecemeal or

project based (RL 2021, para. 24). In both Financial Plans reviewed, a Municipal Natural Asset Management Program is not included.

While the City of Nanaimo has a significant funding shortfall for its traditional assets that will require various strategies, natural asset management is not included. As well, a municipal natural asset management program has not been included in Financial Plans for the City of Nanaimo. Therefore, the City of Nanaimo receives a Red score for this indicator (Fig. 22).














Indicator (Benchmark)	Site Score
Awareness, Capacity and Education Indicators	
Number of general consultation efforts for NAM (Benchmark 1: More than 50% of NAM Consultation events have a high attendance rate) (Benchmark 2: All [100%] of information materials describe one reason for conducting MNAM)	 
Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners (At least 1 formal or informal partnership)	
Implementation Indicators	
Number of barriers or opportunities identified in MNAM delivery within the project community (Benchmark 1: 100% of relevant documents identify barriers and opportunities) (Benchmark 2: All [100%] of managers provide at least one barrier)	 
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAM)	
Amount of funding and financing received for projects (All [100%] of projects and programs have available funds to ensure a full lifecycle)	
Number of new NAM policy, strategies, and plans (All [100%] of NAM policy, strategies, and plans created to support MNAM)	
Ecosystem Rehabilitation and Restoration Indicators	
Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory (All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory)	
Number of sites selected as potential rehabilitation or restoration project(s) (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals)	
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects)	
Service Delivery Indicators	
Percentage increase in co-benefit metrics monitored by project community (Increase in co-benefits from natural asset management)	
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure)	

Figure 22 – Balanced Scorecard for the City of Nanaimo.

5.5 Town of Oakville

5.5.1 Awareness, Capacity, and Education

Awareness and Education

The Town of Oakville has held a few consultation events for natural asset areas. These events are public information centres (PICs). For example, the Town of Oakville held PICs at strategic points throughout the development of their Stormwater Management Master Plan. The first PIC was held on June 23rd, 2016 at the Town of Oakville Town Hall. “Notifications of the PIC were sent to stakeholders, local residents, agencies and municipal staff by mail and email, as well as notices within the local newspaper” (Wood Environment & Infrastructure Solutions 2019, pg. 7). In addition, the Town of Oakville made Comment Forms available to members of the public so they could submit comments on-site or via mail, fax, or email. “The second PIC was held at the Town of Oakville Town Hall on June 25th, 2019, to present the preliminary preferred solutions to the public” (Wood Environment & Infrastructure Solutions 2019, pg. 7). The Stormwater Management Master Plan incorporates the municipal natural asset management pilot study as a possible strategy to improve stormwater management under different climate change scenarios. However, there is no available data on the number of attendees for any of the Stormwater Management Master Plan PICs.

There is data available for two other PICs held for creek erosion projects. The Munn’s Creek Erosion Mitigation EA Study held two PICs on April 30th, 2019, and March 12th, 2020. Twenty-five Town of Oakville residents attended both PICs. The first PIC presented the study background, environmental assessment (EA) process, existing conditions, and alternative concepts. The second PIC presented the evaluation of alternatives, preliminary design drawings, and considerations for implementation and construction. “Public feedback was provided to the study team during and after the PICs regarding preferences for balancing erosion mitigation measures versus construction disturbances in the creek corridor (i.e., loss of trees)” (Aquafor Beech Ltd. 2020, pg. IV). The Town of Oakville reports that in 2017, a total of 34 education and outreach programs were held that relate to sustainability (Town of Oakville 2018a, pg. 2). However, there is a lack of public consultation events that are specific to municipal natural asset management in the Town of Oakville. Therefore, the Town of Oakville receives a Red score for this indicator as the only applicable consultation events with attendance rates is the two PICs for the Munn’s Creek Erosion Mitigation EA Study (Fig. 23).

The Town of Oakville has published a few information materials that include basic reasoning for a climate adaptation approach. In the Climate Change Primer, the Town of Oakville has focused on providing general education on climate change for Town residents. This Primer also includes a few climate change objectives for the Town of Oakville (Town of Oakville 2014b, pg. 5). However, this Primer does not include municipal natural asset management as a specific adaptation action. According to interviewed staff, the Town of Oakville has developed flyers that explain the important services offered by natural areas, channels, and stormwater ponds. These flyers have been handed out at a few engagement events (OAK 2021, para. 24). The Town of Oakville has noticed a mixed reception to consultation efforts on stormwater ponds. Interviewed staff noted that residents feel there is an increased rodent and algae presence in stormwater ponds and have directed complaints to the Town.

However, staff noted that Town residents also love the recreational amenities offered by natural areas (OAK 2021, para. 26).

In 2011, the Town of Oakville published an Eco-Letter for teachers that contain curriculum resources, in-class activities, and free presentations aimed at helping students become better stewards of the natural environment. The Town of Oakville published an Elementary School Edition and a High School Edition (Town of Oakville 2011, pg. 4). The Town of Oakville's website maintains two dedicated web pages on stormwater ponds and natural areas and streams. These web pages describe the importance of these areas, why the Town of Oakville maintains these areas, and actions that residents can take to protect these areas. The Town of Oakville has also published a few informational videos on the ongoing work to clean stormwater ponds. These videos describe the services delivered by stormwater ponds such as water storage and sediment sequestration. In addition, these videos also describe current cleanout activities and repairs (Town of Oakville 2020d). At the time of writing, this video has been viewed 264 times.

The Town of Oakville receives a Yellow score for this indicator (Fig. 23). This score was given as a variety of information materials that align with municipal natural asset management messaging have been published by the Town of Oakville. However, these information materials do not specifically describe the introduction of municipal natural asset management in the Town of Oakville and are now outdated.

Capacity

The Town of Oakville has started and maintained several environmental-oriented partnerships. These partnerships include joining the Global Covenant of Mayors for Climate and Energy, Local Governments for Sustainability, Credit Valley Conservation Authority, Conservation Halton, University of Waterloo's Partners for Action/FloodSmart Canada, Oakvillegreen, the Halton Environmental Network, Institute of Catastrophic Loss Reduction, and the GTA Clean Air Council. While each of these organizations is interested in various aspects of the Town of Oakville's environmental policy, through these partnerships a significant amount of work has been completed or is underway. Some of these partnerships are programs in and of themselves. For example, the Global Covenant of Mayors for Climate and Energy supports solutions in cities that have the most impact on climate change by reducing emissions and fostering local climate resilience. Recently, the City of Oakville completed an intensive pilot study with the Global Covenant of Mayors and Local Governments for Sustainability (ICLEI). The Town of Oakville was selected as a "showcase city" whereby they would participate in two of ICLEI's local programs: The Partners for Climate Protection and Building Adaptive and Resilient Programs (Oakville 2021c).

Credit Valley Conservation Authority (CVCA) and Conservation Halton are two of the Province of Ontario's 36 Conservation Authorities (CAs). CAs protect, restore, and manage impacts on Ontario's water resources through an integrated watershed management approach. CAs work closely with the municipalities located in the watersheds they manage. This work includes technical support for land use planning, the regulation of development, interference and alteration, and monitoring drinking water quality and quantity. These CAs have and continue to work on several ecosystem protection, rehabilitation, and restoration projects. For example, Conservation Halton is primarily focused on the southern part of the Town of Oakville and the Natural Heritage System that runs through the New Communities of Oakville. The Natural Heritage System is made up of almost 900 hectares of protected land that is currently privately

owned but will be conveyed into public stewardship as part of the development process (Town of Oakville 2021d).

Oakvillegreen Conservation Association is a community organization focused on protecting the Natural Heritage System through advocacy, encouraging environmental awareness, and urban forest stewardship. Oakvillegreen Conservation Association has launched several programs since its founding in 1999, including native tree and shrub planting, hosting Corporate Greening Days, and leading Urban Forest Tours (Oakvillegreen Conservation Association 2021). Oakvillegreen Conservation Association has also been involved on several policy initiatives and plans including the Greenbelt Plan, the Provincial Policy Statement, the Planning Act, Halton's Official Plan, and Oakville's Official Plan. Staff also mentioned that Oakvillegreen was involved with LID developments and tree planting in the Natural Heritage System (OAK 2021, para. 15). Similar to Oakvillegreen, the Halton Environmental Network (HEN) also works to educate and build awareness on climate action and environmental sustainability across Halton Region. This organization has created and held several programs with activities including film screenings, virtual conferences, and urban gardening (Halton Environmental Network 2021). Staff mentioned that HEN has an interest in installing permeable pavements in driveways which the Town of Oakville could support (OAK 2021, para. 19).

The university-affiliated partnerships are particularly focused on flood preparedness. The University of Waterloo's Partners for Action and Western University's Institute for Catastrophic Loss Reduction work with the Town of Oakville to update policies, plans, and the public on flood preparedness. For example, the Town of Oakville held a "Keep Calm and Adapt – Emergency and Extreme Weather Preparedness Event" in May 2018. Attendees were encouraged to view resources from the University of Waterloo's Partners for Action and the Institute for Catastrophic Loss Reduction as education pieces for household and municipal flood preparedness. Finally, the Town of Oakville is a member of the GTA Clean Air Council. The Clean Air Council identifies common priority areas for collaborative actions through annual Declarations that serve as work plans for the Council (Clean Air Council 2019). For each of the Declaration items, targets are set, and results are presented annually to show progress in achieving Declaration goals. For example, in the 2019-2023 Intergovernmental Declaration on Clean Air and Climate Change, one of the new commitments is to "strengthen municipal capacity to consider and develop Value Propositions and Business Cases for Green Infrastructure" (Clean Air Council 2019, pg. 6).

In conclusion, the Town of Oakville continues to maintain several environmental-oriented partnerships with several organizations and therefore, receives a Dark Green score for this indicator (Fig. 23).

5.5.2 Implementation

Barriers and Opportunities

Town of Oakville staff and key documents identified several barriers and opportunities to natural asset management work and related actions. Barriers identified by interviewed staff focused on issues with planning, financing, education, and capacity. According to interviewed staff, the maintenance and operations for natural asset areas were not historically well established in the Town of Oakville. This contributed to a reluctance to take on projects or change policies where the benefits were not understood and there were competing development interests. To

address this barrier, staff have incorporated pilot studies and natural asset training courses to educate staff on the services natural assets provide (OAK 2021, para. 32). Interviewed staff noted that they are just starting to incorporate natural assets in the asset registry. This also means that staff are currently managing natural assets like a traditional asset as they continue to gather more information on these areas. In terms of capacity and funding barriers, staff noted that they struggle with finding the time to complete funding applications for green infrastructure and natural asset work (OAK 2021, para. 35). To address this barrier, the Finance department created a position in December 2020 dedicated to handling funding and grant applications (OAK 2021, para. 54).

In reviewed documents, the creek erosion mitigation projects describe barriers and opportunities with implementing proposed solutions. In the Creek Inventory and Assessment Study completed by Aquafor Beech consulting firm in 2016, barriers and opportunities were identified for each of the inventoried creeks. For example, one of the barriers to providing flood storage for the Joshua's Creek Flood Mitigation Study is that a significant area of land would be required to handle downstream flooding, especially during extreme weather events (Town of Oakville 2021b, pg. 18). As well, the Inventory and Study also list the advantages and disadvantages of several rehabilitation techniques. For instance, when implementing an armour stone wall, one of the advantages is that it is suitable for steep or eroded banks. One of the disadvantages is that an armour stone wall requires installation by heavy machinery (Aquafor Beech Ltd. 2016, pg. 25). For the Munn's Creek Erosion Mitigation Environmental Assessment Study, identified opportunities include the options to address both erosion and flooding issues, to restore or enhance riparian and aquatic habitats, and to educate the public and landowners about stream corridor management and encroachment issues (Aquafor Beech Ltd 2020, pg. I).

This indicator variable contains two separate indicators. The first indicator is for the identification of relevant barriers and opportunities in reviewed documents. In all the reviewed documents, the Town of Oakville lists and describes both general and specific barriers and opportunities for creek restoration work. Therefore, the Town of Oakville receives a Dark Green score (Fig. 23). For the second indicator, staff described several barriers the Town of Oakville is working through for municipal natural asset management and the actions taken to address these barriers. Therefore, the Town of Oakville also receives a Dark Green score for the second indicator (Fig. 23).

Policy Changes

The Town of Oakville has not made changes to large planning policy documents to explicitly integrate a municipal natural asset management approach. However, policies, plans, and strategies do align with municipal natural asset management practices. In the 2019-2022 Strategic Plan, one of the key areas of focus is the environment. The goal for this key area of focus is to "protect greenspace and promote environmentally sustainable practices" (Town of Oakville 2019, pg. 8). To achieve this goal, the Strategic Plan sets out several objectives. These objectives are to ensure effective stewardship of the Town's natural environment, to create a climate change resilient community, and to transition to a low carbon future. These objectives all have several action items connected to them for 2019 and 2020-2022. Interviewed staff also noted that many of the strategic goals are focused on asset management, natural assets, and climate change (OAK 2021, para. 49).

The Town of Oakville's Official Plan, known as the Livable Oakville Plan, was implemented in 2009 and applies to all lands within the Town except for the North Oakville East and West Secondary Plan areas. One of the key land use designations in the Livable Oakville Plan is the Natural Area designation. "The Natural Area designation identifies and ensures the long-term preservation of the existing natural heritage system, which includes natural features such as wetlands, woodlands, and valleylands" (Town of Oakville 2018b, pg. C-2). The Town of Oakville uses this designation to mark several natural areas in the Town of Oakville that have development regulations or restrictions. For example, under the regulations for Wetland as part of the Natural Area designation, the Town of Oakville requires that a minimum of a 30-metre buffer must exist between the development and the boundary of the wetland. A greater buffer width may be required due to an environmental impact statement or a subwatershed study. A subwatershed study and an environmental impact statement are required for any development proposed on lands within 120 metres of an individual wetland area (Town of Oakville 2018b, pg. D-26-D27). Buffers also existing for Woodlands and Valleylands. The Town of Oakville also protects Significant Wildlife Habitats, Environmentally Sensitive Areas, Areas of Natural and Scientific Interest, Fish Habitats, and Natural Corridors.

Another section of the Livable Oakville Plan that aligns with a municipal natural asset management approach is the Achieving Sustainability section. The sustainability objectives include the preservation, enhancement, and protection of the Town's environmental features, natural heritage systems, and waterfronts as well as the maintenance and growth of the urban forest. The Plan specifically states that the urban forest will increase until a 40% canopy cover can be achieved beyond the life of this Plan (Town of Oakville 2018b, pg. C-41). Two significant policy focuses for this section are Subwatershed Planning and Stormwater Management. For Subwatershed Planning, the Town of Oakville may require subwatershed studies. These studies will update current inventories of natural hazards, groundwater, surface water, fish habitat, water balance, natural features, and functions of natural systems. If a subwatershed study does not exist, an environmental impact statement may be required for planning applications adjacent to watercourses, headwaters, aquifers, natural features, and related physiographic or topographic formations that contribute to groundwater recharge or discharge (Town of Oakville 2018b, pg. C-45-C-46).

For Stormwater Management policies, the Livable Oakville Plan states that "where existing watercourses are sufficiently wide to carry storm flows, there shall be no modification of these areas, except for erosion control and water quality maintenance measures to the satisfaction of the Town, the Conservation Authority and the Province" (Town of Oakville 2018b, pg. C-46). If the watercourse cannot sufficiently accommodate storm flows, watercourse realignment can occur if it meets all requirements set by the Town, the Conservation Authority, and the Federal government. These requirements include erosion control, stabilization techniques, and all alterations. The Town of Oakville also stipulates that for watersheds that extend beyond the municipal boundary, stormwater management plans will be developed in conjunction with the adjacent municipality. Finally, existing groundwater recharge rates will be maintained in all developments, where possible (Town of Oakville 2018b, pg. C-47).

For the Urban Forest and Hazard Lands, the Town of Oakville considers the municipal-owned urban forest as green infrastructure. To protect this green infrastructure, the Town mandates that "for every square metre of leaf area that is removed from Town property or from Town road rights-of-way, sufficient trees will be replanted to replace the lost square metres of

leaf area” (Town of Oakville 2018b, pg. C-48). The Plan also requires that the Town of Oakville shall develop standards for the protection and planting of trees. Tree removal on private property is regulated by the Town of Oakville’s private tree protection bylaw. Finally, Hazard Lands are administered by the Conservation Authorities and the Official Plan states that “no new development or site alteration is permitted within hazard lands without the approval of the Conservation Authority” (Town of Oakville 2018b, pg. C-48). The Town of Oakville is now working on an Official Plan Review. In a 2019 Official Plan Review Update Staff Report, there were no specific mentions of changes to incorporate a municipal natural asset management approach or program.

The Town of Oakville also adopted Secondary Plans for the North Oakville East and West areas under the New Communities of Oakville Policy. A significant section for both plans is managing the Natural Heritage System. “The purpose of the Natural Heritage and Open Space is the establishment of a system, the majority of which is to be in public ownership, and the focal point of which is a linked natural heritage system enhanced by a range of open space facilities” (Town of Oakville 2009, pg. 14). Both Plans describe key land designations such as core preserve areas, linkage preserve areas, stream corridor areas, and boundaries. These Plans also recognize the role those natural areas play within the ecosystem and that they contribute to goals of environmental protection and enhancement. The North Oakville Secondary Plans Review was initiated in May 2017 in conjunction with the Official Plan Review so the North Oakville Plans and the Livable Oakville Plan can be made into one official plan document. The North Oakville Secondary Plans’ natural heritage system policies are scheduled to be revised, according to the 2019 Official Plan Review Update (Planning Services Department 2019, pg. 10).

Lastly, the Town of Oakville has adopted several bylaws that protect natural asset areas. The most prominent of these bylaws is the Private Tree Bylaw. This bylaw applies to all private property in the Town of Oakville and prohibits “the injury, destruction or removal of any tree with a diameter equal to or greater than fifteen (15) centimetres on a lot, or any tree required to be retained or planted as a condition of an approved site plan, without first obtaining a permit pursuant to this By-law” (Town of Oakville 2017, pg. 5). If this prohibition is broken, the Town of Oakville may fine a person between \$400-\$100,000.

In conclusion, the Town of Oakville already has several policies that align with municipal natural asset management practices. As well, the Town of Oakville is scheduled to make further changes to strengthen these policies in upcoming plan reviews. Therefore, the Town of Oakville receives a Light Green score for this indicator (Fig. 23).

Project Funding

Interviewed staff shared that the Town of Oakville has a variety of funding sources for natural asset management projects. For example, for a bioswale project completed in partnership with Oakvillegreen Conservation Association, the Town of Oakville received partial funding from the Province of Ontario (OAK 2021, para. 51). In another example, the Town of Oakville received funding from the Great Lakes Guardian Community Fund for the Bronte Bluffs Restoration and Water Quality Improvement. The project budget was set at \$25,000 for new plantings, slope stabilization, and the purchase and installation of a lookout.

Considering the Town of Oakville’s 2020 and 2021 Budget documents, natural asset management work and projects are shifting from a variety of programs and departments to be

concentrated in one or a few departments. In the 2020 Approved Operating Capital Budget, projects that align with municipal natural asset management work are under the Development Engineering program budget, the Planning Services program budget, and the Parks and Open Space program budget. For example, under the Parks and Open Space program, one of the key initiatives is to update the Urban Forest Strategic Management Plan. This Plan recognizes the urban forest in the Town of Oakville as green infrastructure. The 2020 Budget sets the cost for this work at \$30,000 (Town of Oakville 2020c, pg. 159). Under the Development Engineering program, the budget for creek erosion restoration work for Munn’s Creek is set at \$2,110,000 (Town of Oakville 2020c, pg. 267). However, in the 2021 Budget, most of the natural asset management projects are kept under the Development Services program, while some other projects that align with municipal natural asset management policies and practices fall under other programs. For example, in the 2021 Budget and Business Plan, one of the key initiatives of the Development Service program is to “develop new policies and procedures that compliment and protect new natural assets which serve to enhance our natural areas and complement our Biodiversity Strategy” (Town of Oakville 2021a, pg. 29). The projects included in the recommended capital budget for 2021 include erosion work for Munn’s Creek (\$1,213,000), storm pond maintenance (\$105,000), and Environmental Studies and Monitoring (\$70,000) (Town of Oakville 2021a, pg. 36). However, under the key initiatives section for the Parks and Open Space program, work is scheduled for the implementation of an invasive species strategy and an update to the Urban Forest Strategic Management Plan. Capital projects include parks and trail maintenance (Town of Oakville 2021a, pg. 238).

Although municipal natural asset work still is not kept under a single program umbrella, each of these projects is appropriately budgeted. Therefore, the Town of Oakville receives a Dark Green score (Fig. 23).

New Policies

In terms of new natural asset management policies, strategies, and plans the Town of Oakville has developed several climate-focused policies, strategies, and plans that support municipal natural asset management. The Town of Oakville has a Climate Change Strategy and an Urban Forest Strategic Management Plan that were adopted before the municipal natural asset management pilot study. These key documents contain policies that align with municipal natural asset management practices.

The Climate Change Strategy aims to increase the Town of Oakville’s capacity to protect against and respond to projected climate change by presenting climate data from Environment Canada and projecting how climatic change will impact the Town (Town of Oakville 2015). The Strategy uses pictogram symbols for potential climate change impacts. As well, the Town of Oakville assigns a vulnerability level for several climate impact statements. Finally, the Town of Oakville presents several adaptation actions for each of the forecasted climate impact statements (Town of Oakville 2015, pg. 5-6). For example, one of the climate impacts statements is “increased water use in summer months will occur due to an increase in average and extreme temperatures” (Town of Oakville 2015, pg. 46). To adapt to this impact, the Climate Change Strategy includes some of the policies, plans, and strategies that the Town of Oakville has adopted or is working on that will increase adaptation outcomes. One of these plans is the 2014 Water Sustainability Plan (WSP). “The WSP will integrate planning and management strategies to conserve and strategically manage water and minimize the discharge of pollutants to area

waterways and Lake Ontario” (Town of Oakville 2015, pg. 47). The Climate Change Strategy also includes actions to monitor the results of improved environmental performance in water conservation and to identify opportunities for cost savings through water conservation, efficiency, and re-use. The Climate Change Strategy adds adaptation actions for creeks and channels and urban forestry as well as trails and natural areas as the two themed impacts which align with natural asset areas.

The Urban Forest Strategic Management Plan recognizes the Town of Oakville’s urban forest as green infrastructure. The Plan also describes the extensive benefits that trees provide to urban communities, including a reduction in air pollution, cooling, windbreaking and shading functions, water quality, habitat, and aesthetic appreciation (Urban Forest Innovations & Kenney 2008, pg. 2). The structural value of the Town of Oakville’s urban forest was estimated at \$1.04 billion (Craig et al. 2016). The Urban Forest Strategic Management Plan sets performance indicators to measure progress towards the sustainability of Oakville’s urban forest. These indicators include reaching a 40% tree canopy coverage in 50 years (Urban Forest Innovations & Kenney 2008, pg. 9). Lastly, the plan provides implementation tools, such as a tree inventory to ensure that the Urban Forest Strategic Management Plan is progressing as planned. According to interviewed staff, the Forestry Department does a physical tree count every 10 years and currently is completing the 2021 inventory (OAK 2021, para. 67).

In 2012, the Town of Oakville adopted the North Oakville Urban Forest Strategic Management Plan. The North Oakville Urban Forest Strategic Management Plan states that of the 4,000 hectares of land in North Oakville, 1,603 hectares of the land area will be needed to achieve the 40% canopy tree cover target. The Plan includes several recommendations to meet the 40% canopy cover target. Some of these recommendations include implementing new landscape standards, conducting periodic site reviews to monitor tree health, and form partnerships with NGOs to raise awareness on the urban forest through planting events, parkland stewardship and green-space planning (Natural Resource Solutions & Dillion Consulting 2012, pg. iv-v).

In 2018, the Town of Oakville adopted the Oakville Strategy for Biodiversity. The Strategy aims to secure the long-term future of Oakville’s native plants and animals. The Strategy includes management opportunities, targets, and indicators. The Strategy recognizes the natural areas and watercourses in the ravines of Bronte Creek, 14 Mile Creek, and 16 Mile Creek as well as the woodlands of North Oakville and Iroquois Shoreline Woods as some of the most important and best quality natural habitats to support native species biodiversity (Town of Oakville 2018c, pg. 16). The Strategy includes 28 management opportunities. Each management opportunity identifies a problem, addresses options for management, describes potential stakeholders and sites, and includes measures for success.

For example, one of those management opportunities is the creation of an urban tree canopy. The Strategy identifies the problem by stating that “urban landscapes with limited green space and many areas with impermeable surfaces and compacted soils provide challenges for growing trees” (Town of Oakville 2018c, pg. 35). The management options are to prevent further loss of existing trees, to plant a diversity of native trees, and to protect existing trees from pests and diseases. The potential stakeholders include municipal and regional governments, the horticultural industry, environmental NGOs, and Conservation Authorities. The potential sites for implementation are residential areas, industrial and commercial lands, and campuses and

schoolyards. Finally, the measures of success are an increase in canopy cover, increased survival of tree plantings, an increasing percentage of permeable surfaces, improved health and growth rate of street trees, and reduced tree mortality due to pests and disease (Town of Oakville 2018c, pg. 36).

Also in 2018, the Town of Oakville implemented the new 2018-2022 Environmental Sustainability Strategy (ESS). The ESS is the third update of the Environmental Strategic Plan following the first Environmental Strategic Plan in December 2005 and the second update in 2011. “The ESS provides an overarching environmental sustainability vision, while also bringing together environmentally-related deliverables set out in the town’s other master plans and strategies, and sets out new actions where there are gaps in implementation” (Town of Oakville 2018d, pg. 7). In addition to setting environmental goals and initiatives, the ESS includes an updated set of environmental sustainability indicators. The ESS is organized into four themes: (i) Sustainable Environment, (ii) Sustainable Households, (iii) Sustainable Community, and (iv) Sustainable Government. The Sustainable Environment theme and the Sustainable Government theme closely align with the support of municipal natural asset management practices.

Under the Sustainable Environment theme, actions related to municipal natural asset management include the development and implementation of the Biodiversity Strategy, improving air regulations and airshed air quality, completing, and implementing a Stormwater Master Plan, accounting for natural capital and ecosystem services in financial planning using the municipal natural assets pilot study, and future implementation (Town of Oakville 2018d, pg. 21). Under the Sustainable Government theme, related actions include meeting with community partners to share environmental priorities, developing and implementing improved data acquisition and management, and expanding and continuing to support existing water conservation programs (Town of Oakville 2018d, pg. 31-32). However, the ESS does not include actions such as pursuing a municipal natural asset management approach for identified natural assets.

In conclusion, the Town of Oakville has created several new policies, strategies and plans that align with municipal natural asset principles, such as biodiversity. However, there is not a new policy, strategy, or plan that is specific to municipal natural asset management. Therefore, the Town of Oakville receives a Light Green score for this indicator (Fig. 23).

5.5.3 Ecosystem Rehabilitation and Restoration

Service Quality Metrics

The Town of Oakville monitors some basic parameters for their natural areas. First, interviewed staff mentioned that for the North Oakville area, the Town of Oakville has identified four sites and monitors several water quality indicators such as temperature, chloride, and phosphorous (OAK 2021, para. 74). However, most of the monitoring metrics are for total suspended solids (TSS). TSS data is shared through the State of the Environment Report. Through this Report, the Town of Oakville reported that in 2015, the “maximum levels of TSS decreased in all creeks, with the most significant drop appearing in Fourteen Mile” (Environmental Policy Department 2016, pg. 3). Most of the sites monitored for the State of the Environment Report show TSS levels below the Provincial Water Quality Objective. In addition, the Town of Oakville examines the impact that development has on flow in stream areas (OAK

2021, para. 74). For stormwater ponds, the Town of Oakville has recently added benthic zone monitoring.

The Town of Oakville also monitors the amount of greenspace area and biodiversity quality in these greenspaces. “In 2015, there was a total of 2,501 ha of publicly held open space, 1,522 ha of that is town owned” (Environmental Policy Department 2016, pg. 3). In 2016, there was a total of 2,519 hectares of publicly owned greenspace. While the State of the Environment Report recognizes that quantity is an important measurement, “quality is critical for supporting a rich variety of species necessary for a healthy ecosystem” (Environmental Policy Department 2016, pg. 3). Therefore, when the Town of Oakville adopted the Oakville Strategy for Biodiversity (OSB), targets and indicators were created to report on biodiversity improvements. The OSB targets include direct measures of biodiversity protection and indirect measures of biodiversity protection. Direct measures of biodiversity protection are measurements that monitor species groups such as species-at-risk or invasive species, habits that support diversity, and the quality of aquatic habitats (Town of Oakville 2018c, pg. 82). Indirect measures of biodiversity protection are measurements that assess the success of programs and policies that identify, protect, enhance, and restore biodiversity.

The OSB also sets specific targets to meet the Strategy’s goals. For example, one of the targets is that the Town of Oakville will protect “at least 17% of terrestrial and inland water areas in a natural state support biodiversity” (Town of Oakville 2018c, pg. 84). Another target is that the Town of Oakville’s species-at-risk populations stays secure or shows signs of recovery. All data gathered on indicators and targets will then go into a report card that “provides feedback to all stakeholders, acknowledging the progress made and provides encouragement to continue working to attain future targets” (Town of Oakville 2018c, pg. 82). A similar report card that the Town of Oakville has developed is the Forest Health Report Card. This Report Card also contains several indicators for urban forest health while monitoring for biodiversity quality. Specifically, the Forest Health Report Card includes measurements for general health, invasive plant presence, and the presence of invasive species (Town of Oakville 2020a).

Another metric that the Town of Oakville monitors is air quality. “Since 2015, the Air Quality Health Index (AQHI) has been reported by the Ontario Ministry of Environment and Climate Change to communicate the health risk posed by air pollution” (Town of Oakville 2018d, pg. 48). However, the Town of Oakville does not associate this metric with a particular natural area or natural asset. The Town of Oakville does not monitor for cultural ecosystem services as part of the State of Environment Report.

In conclusion, the Town of Oakville monitors several metrics that relate to ecosystem service quality. However, the Town of Oakville has not identified a cultural ecosystem quality metric or measurement. Therefore, the Town of Oakville receives a Light Green score for this indicator (Fig. 23).

Rehabilitation Site Selection

The Town of Oakville has selected a few sites for rehabilitation or restoration projects. While these restoration projects are not a direct part of a larger municipal natural asset management program in the Town of Oakville, the goals of the project do align with municipal natural asset management practices. For example, in the Creek Inventory and Assessment Study (2016), each of the creeks in the Town of Oakville is assessed. This assessment describes the

areas of erosion concern for each of these creeks. For example, for Munn’s Creek, “bank protection measures are failing and eroding banks are putting recreational trails and private property at risk” (Aquafor Beech Ltd. 2016, pg. 29). The Mitigation Environmental Assessment Study for Munn’s Creek describes potential solutions for addressing erosion concerns. These selective works include the construction of an armour stone retaining wall and a restoration of the slope on the east side of the stream (Aquafor Beech Ltd. 2020, pg. V).

In the Shoreline Inventory and Assessment Report, sites for restoration work are assigned a structure and safety score on two separate evaluation scales. The Report also identifies the top ten priority sites that receive the lowest overall score. For example, the Shelburne Promenade was rated as the lowest score in the 2016 report. Required work includes a safety fence to prevent pedestrian access to damaged areas of the wall, repairing extensive damage expected due to severe storms at any water level, and the eastern half of the site requires a detailed inspection (Shoreplan Engineering Ltd. 2017 pg. 11-12). Finally, in 2018, Town Council approved \$3,789,000 in funding to cover several high-priority restoration projects related to significant flooding that the Town of Oakville experienced in 2017 (Mark & Kelly 2018, pg. 2). Projects that were recognized in the Shoreline Inventory and Assessment Report were monitored for changes brought on by new flooding.

In conclusion, the Town of Oakville has identified several sites for ecosystem rehabilitation and restoration and receives a Dark Green score for this indicator (Fig. 23).

Monitoring Indicators

The Town of Oakville has a lengthy history of tracking and monitoring environmental indicators. For example, the Town of Oakville’s Official Plan states that “the Town shall regularly monitor key indicators”, especially if there are changes in the social, economic, environmental, technological, and demographic conditions (Town of Oakville 2018b, pg. F-16). As part of the Town of Oakville’s Environmental Sustainability Plan, the Town developed a State of the Environment reporting program to provide information on key indicators. The Town of Oakville tracks 15 indicators that are organized under the previously mentioned four themes: (i) Sustainable Environment, (ii) Sustainable Households, (iii) Sustainable Community, and (iv) Sustainable Government. The theme that is the most relevant to a natural asset management program is Sustainable Environment. Under this theme, the Town of Oakville tracks water quality, permeable surface area, air quality, and area of greenspace. Recent data shows that the Town of Oakville is making progress in its air quality and greenspace indicators while progress is stalled in the water quality and permeable surface area indicators. Focusing on greenspace, the Town of Oakville states that “greenspace contributes to important ecological services such as better air quality, water quality, flood protection, climate stability, and biodiversity protection” (Town of Oakville 2018d, pg. 50). From 2013-2018 the Town of Oakville added 18 hectares of land to greenspace.

The Town of Oakville also monitors the amount of education and outreach programs that increase community awareness on environmental sustainability issues. The Town of Oakville states that “monitoring the number of events that the town hosts and/or participates in each year helps assess efforts in raising the profile of the environment and supporting households and businesses in their sustainability efforts” (Town of Oakville 2018d, pg. 61). However, the Town of Oakville acknowledges that it is difficult to compare across years. Nevertheless, the trend is towards hosting fewer but larger events so staff resources are more effectively used. Finally, the

Town of Oakville has an Urban Forest Health Monitoring Program. A third of the Town of Oakville's woodland areas are assessed each year on a three-year rotation for invasive plant and animal species. A report card of the woodlands surveyed each year is produced to evaluate the health of the forest. In the 2020 Report Card, the Town of Oakville uses a colour-coded rating legend to indicate invasive plant presence and ash tree mortality. For example, in Colborne Park, nine trees are given a red rating for ash mortality. Both garlic mustard and euonymus are given a yellow rating as invasive plants (Town of Oakville 2020a, pg. 2).

In conclusion, the Town of Oakville has identified several indicators that align with municipal natural asset management and receives a Dark Green score for this indicator (Fig. 23).

5.5.4 Service Delivery

Monitoring Co-Benefits Metrics

As part of the Town of Oakville's State of the Environment Report, there are little to no indicators included that measure an increase in co-benefits from natural asset management. For example, under the air quality health index indicator in the 2017 highlight report, the Town of Oakville reported 91% of days as low health risk and 0% of days as high health risk. However, in the 2018-2022 Environmental Sustainability Strategy, air quality is not linked to any natural asset areas (Town of Oakville 2018d, pg. 48). Therefore, the Town of Oakville receives a Grey score for this indicator as there are no co-benefit metrics identified for the Town of Oakville (Fig. 23).

Municipal Budget for Grey Infrastructure Renewal

Regarding the amount of municipal budget forecasted for renewing built infrastructure, interview staff shared that currently, the Town of Oakville sees municipal natural asset management, green infrastructure, and low impact developments as a complement to grey infrastructure. More specifically, staff stated that "LIDs are great at the high-frequency events, the 90% rainfall. It does not negate the need for the end-of-pipe infrastructure in our experience" (OAK 2021, para. 83). As well, staff also shared that some areas of town were developed before asset management practices were put in place and will require a considerable number of retrofits and upgrades. However, staff also mentioned that there may be an opportunity to combine grey and green infrastructure in areas that are already lacking key grey infrastructure, such as storm sewers. Staff also said they expect more data for this indicator in ten years (OAK 2021, para. 83).

In the Town of Oakville's Financial Statements, natural resources are not recognized as assets in the consolidated financial statements. As well, these Financial Statements do not specify the amount spent on retrofitting and renewing tangible capital assets (Town of Oakville 2020b). However, the 2021 Budget and Business Plan do provide some data on operating and capital budgets in 2021 as well as 2022-2023 budget forecasts. In their 2020 Budget, the Town of Oakville spent \$746,000 on their asset management program with an expected expense increase to \$1,096,000 in the 2021 Budget. The 2022 forecast budget is for \$1,113,100 and the 2023 forecast is for \$1,129,500. Both forecasts expect an increase of 1.6% and 1.5% respectively (Town of Oakville 2021a, pg. E-48). Under the Development Services Program, new natural asset management policies and procedures are scheduled to be developed. The requested 2021 Budget amount for Development Services is \$5,186,800 in total expenses. \$5,143,000 is the total

expenses for several projects which include the maintenance of storm ponds and flood protection. However, not all of these projects are directly related to the continued management of natural areas. The 2022 forecast expects a 2.3% increase to \$5,308,300 and a 2.0% in 2023 to \$5,413,400 (Town of Oakville 2021a, pg. 35).

In the Town of Oakville's Financial Statements and Budget Plans, there is enough available data to conclude that there is an increase in grey infrastructure investment for both renewal and retrofit. Therefore, the Town of Oakville receives a Red score for this indicator (Fig. 23).














Indicator (Benchmark)	Site Score
Awareness, Capacity and Education Indicators	
Number of general consultation efforts for NAM (Benchmark 1: More than 50% of NAM Consultation events have a high attendance rate) (Benchmark 2: All [100%] of information materials describe one reason for conducting MNAM)	 
Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners (At least 1 formal or informal partnership)	
Implementation Indicators	
Number of barriers or opportunities identified in MNAM delivery within the project community (Benchmark 1: 100% of relevant documents identify barriers and opportunities) (Benchmark 2: All [100%] of managers provide at least one barrier)	 
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAM)	
Amount of funding and financing received for projects (All [100%] of projects and programs have available funds to ensure a full lifecycle)	
Number of new NAM policy, strategies, and plans (All [100%] of NAM policy, strategies, and plans created to support MNAM)	
Ecosystem Rehabilitation and Restoration Indicators	
Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory (All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory)	
Number of sites selected as potential rehabilitation or restoration project(s) (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals)	
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects)	
Service Delivery Indicators	
Percentage increase in co-benefit metrics monitored by project community (Increase in co-benefits from natural asset management)	
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure)	

Figure 23 – Balanced Scorecard for the Town of Oakville.