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Implementation of Nature-Based Solutions in Canada

Case Studies

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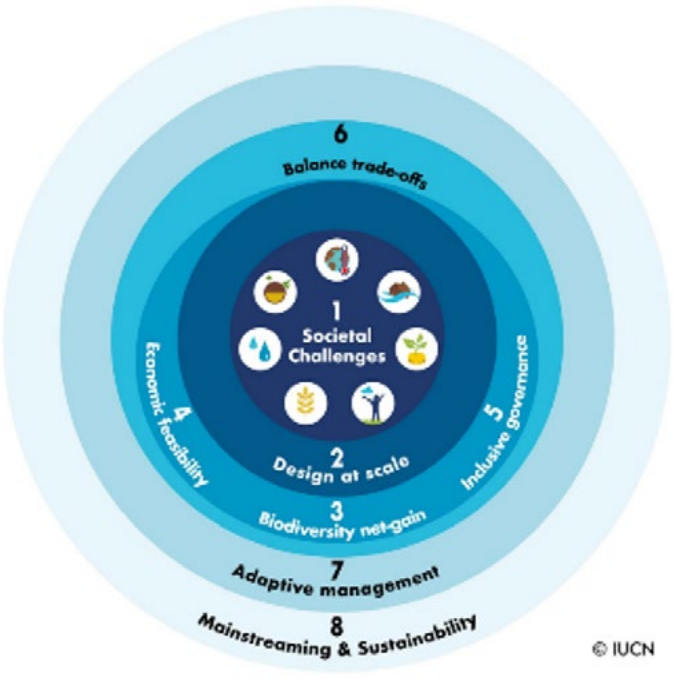
ABOUT THIS REPORT

Introduction

According to the United Nations Environment Assembly, nature-based solutions (NbS) are "actions to protect, conserve, restore, sustainably use, and manage natural or modified ecosystems to address social, economic, and environmental challenges effectively and adaptively, simultaneously providing human well-being, ecosystem services, and resilience and biodiversity benefits." Such an all-encompassing concept has advantages in mobilizing support for widespread NbS implementation. But it also has risks in that economic development, infrastructure planning or conservation as usual can be repackaged as NbS and fail to meet the promise of addressing multiple challenges cost-effectively, benefiting people and nature on equitable terms. Published in 2020, the IUCN Global Standard for Nature-based Solutions is one tool to support the design and assessment of NbS projects, as well as comparison of projects across jurisdictions. Implicit in the IUCN's eight interrelated criteria (Figure 1) is the following impact hypothesis: ***IF a nature-based solution responds to key societal challenges [1], matches the scale of the problem [2], acknowledges and balances trade-offs [6], is cost-effective [3], has inclusive governance [5] AND includes provisions for adaptive management [7] and policy integration [8] THEN it will ensure net ecosystem gain [3] and social equity [5] over the long term.***

Figure 1: Conceptual framework of the IUCN's Global Standard for Nature-based Solutions, which includes the eight criteria shown and 28 underlying indicators.



Building on the IUCN Global Standard as a guiding framework for analysis and interview research, this report contains four case studies documenting NbS implementation in Canada. In addition to shedding light on factors that enable or detract from NbS effectiveness at the project level, this case study research contributes to the evidence base on the utility of the IUCN Global Standard as tool to predict effective, high-quality NbS projects. Commissioned to ESSA Technologies Ltd. (ESSA) by the David Suzuki Foundation, this case study report is a companion document to a baseline inventory and analysis of 38 NbS projects implemented in Canada between 1992 and 2022. Development of this case studies report involved the following steps:

1. Identification of case study objects: From the inventory of 38 NbS projects, DSF selected 10 of interest to the organization and ESSA selected the final four, taking into account diversity in jurisdictions, environmental settings and governance.

2. Development of data collection and analysis tools: A rapid literature search on NbS case study research and consultation of the IUCN's guide for application of the Global Standard informed the development of an interview guide, a case study outline and an NbS assessment rubric. The case study format includes i) narrative sections summarizing the problem context, approach to NbS, impact and outcomes, barriers and enablers of success, and key lessons learned and ii) a table summarizing the ESSA team's qualitative assessment of the project against IUCN criteria, using the rubric in Table 1.

Table 1: Assessment rubric used in the case studies in this report, simplified from IUCN 2020a.

ICON	KEY (% OF INDICATORS)	VERBAL QUALIFIER	OUTPUT
☐	≥75	Strong	Intervention adheres to IUCN Global Standard
◐	≥ 50 & < 75	Partial	
	≥ 25 & < 50		
■	<25	Insufficient	Intervention does not adhere to IUCN Global Standard

3. Data collection and information gathering: We conducted one-hour interviews with 13 individuals between January 15 and February 2, 2023, interviewing at least three individuals per case study. All interviews were remote, led by one member of the ESSA team, who recorded the interview, generated automated transcripts and drew on them to populate the case study. To triangulate and complement interview data, the ESSA team undertook additional reviews of literature. Hearing from Indigenous representatives was critical in two of four case studies, given the leadership role of Indigenous nations or communities on those projects. However, despite repeated efforts, we were unsuccessful in securing all of the intended interviews.

4. Synthesis and reporting: The ESSA team synthesized interview data and supplementary literature and wrote case study narratives and completed the

IUCN assessment rubric for each case study. All interviewees and the DSF team had an opportunity to review and provide feedback on draft case studies, which the ESSA team addressed to the extent possible in this final report. In addition to completing individual case studies, ESSA team members met to discuss salient insights with cross-cutting applicability.

What follows are the four case studies, in order of geography, from north to west to eastern Canada. The report ends with conclusions based on the collection of case studies.

CASE STUDY 1: EDÉHZHÍE DEHCHO DENE PROTECTED AREA AND NATIONAL WILDLIFE AREA

The Edéhzhíe Dehcho Protected Area and National Wildlife Area
(Photo: © Rebecca Warren)

Project: The Edéhzhíe Dehcho Protected Area and National Wildlife Area

Type: Type 1 (Protect), boreal terrestrial ecosystem

Location: Dehcho region, Southeast Northwest Territories

Partners: Dehcho First Nations, Government of the Northwest Territories, Government of Canada, stakeholders from the oil and gas sector, mining sector and tourism sector, conservation groups

Implementation Details: Scale: Watershed scale, 14,218 square kilometres (1,421,800 ha); Timeframe: Process began in 1998, was established as an Indigenous protected area in 2018 and designated as a national wildlife area in 2022; Cost: $3.5 million over 10 years following establishment (including capital, operational and administrative costs). In addition, a $10 million contribution was made to the Edéhzhíe Trust Fund.

PROBLEM CONTEXT

In 1974, the Mackenzie Valley Pipeline Inquiry, also known as the Berger Inquiry after its head, Justice Thomas Berger, was commissioned by the Government of Canada to investigate the impacts of a proposed gas pipeline that would run through the Yukon and the Mackenzie River Valley of the Northwest Territories. Justice Berger recommended a 10-year moratorium to deal with critical issues before attempting to build the proposed pipeline. Those issues included settling Indigenous land claims and setting aside key conservation areas, with development of the Northwest Territories Protected Areas Strategy (NWT-PAS) addressing the latter. Through the NWT-PAS, the Government of Canada, the Government of the NWT and First Nations worked collaboratively to identify and protect ecologically important areas within

the NWT (NWT-PAS, 1999). Strategic planning, including setting priority areas for protection, took years. The Edéhzhíe emerged as a priority area, mainly because of its cultural and ecological importance to Dehcho and Tłı̨chǫ Dene peoples (ECCC, 2022a). Protecting this area also contributed to preserving food and water resources, as the landscape within the Edéhzhíe protects the headwaters of much of the watershed of the Dehcho region and is an important hunting and spiritual gathering place (ECCC, 2022a). More broadly, protecting the Edéhzhíe contributes to addressing the global challenges of biodiversity loss and ecosystem degradation, as the area contains unique wildlife habitat that supports a high concentration of fauna and flora, including a considerable assemblage of rare, vulnerable, threatened and endangered species, such as boreal woodland caribou and wood bison (ECCC, 2022a). Protecting the Edéhzhíe addresses several international commitments made by the Government of Canada, including the commitment to protect and conserve 25 per cent of Canada's lands and oceans by 2025 as part of Nature Legacy 2018 (Canada Wildlife Act: Regulations Amending the Wildlife Area Regulations and the Environmental Violations Administrative Monetary Penalties Regulations, 2021).

APPROACH

Protecting Edéhzhíe was a community-driven process. The process began in 2002, when the Dehcho First Nations and Tłı̨chǫ government advanced a 25,230 km2 area, identified as the Edéhzhíe, into the NWT-PAS, eventually leading to legislated protection (Edéhzhíe Candidate Protected Area Working Group 2009). Following its submission through the strategy, the First Nations governments asked the federal government to prohibit any new development in the Edéhzhíe area. The federal government agreed, and the Edéhzhíe was protected from development through a series of interim land withdrawals, but only until 2010 (CBC, 2018).

While under interim protection, five assessments were completed. An Edéhzhíe Working Group that included representation from the oil and gas sector, conservation groups, the mining sector, the tourism sector, the NWT government, indigenous communities in the NWT and several federal departments guided and oversaw the assessments. These examined and documented the cultural, ecological and economic values within Edéhzhíe to evaluate and provide, in part, the basis for proceeding with designation and management of the site (Edéhzhíe Candidate Protected Area Working Group, 2009). The assessments included:

- **Cultural assessment:** Focused on the oral history of the area, the assessment outlined extensive traditional use and strong cultural and spiritual connection to the area (Edéhzhíe Candidate Protected Area Working Group, 2009).
- **Ecological assessment:** Completed by consultants and the Canadian Wildlife Service, the assessment determined that the area supports several species at risk and contains four International Biological Program sites, one of which is key habitat for migratory birds. The area also contains three drainages in the Dehcho Region, which are of great importance to the subsistence economies and culture of several Dene communities around the Edéhzhíe (EBA and CWS, 2005).

- **Economic assessments:** Completion of three economic assessments (socio-economic, non-renewable resources and renewable resources) identified low renewable resource potential but moderate potential for non-renewable resources, including moderate to high potential for natural gas in the western part of the Edéhzhíe, low oil potential, moderate to high diamond potential in the eastern part of the Edéhzhíe and moderate mineral potential (lead/zinc and uranium) (IMG-Golder Corporation, 2006; Mills, 2008; Edéhzhíe Candidate Protected Area Working Group, 2009). Socio-economic assessments outlined low to moderate economic potential arising from resource extraction activities (Edéhzhíe Candidate Protected Area Working Group, 2009).

Following these assessments and a public review process, the EWG finalized its recommendations in a report, with the request for National Wildlife Area designation submitted to the federal government in July 2010. The report recommended to establish the Edéhzhíe as an NWA under the Wildlife Area Regulations, encompassing 14,250 km2 — or 57 per cent of the original area under study. This included recommendations that both the surface and subsurface lands of the NWA be fully and permanently protected (Edéhzhíe Candidate Protected Area Working Group, 2009). Additionally, the report recommended co-management of the area by the Dehcho and Tłı̨chǫ First Nations governments and the Government of Canada (Edéhzhíe Candidate Protected Area Working Group, 2009). The report went to governments and organizations represented on the working group, and in July 2010, the First Nations governments requested that the federal government establish the Edéhzhíe NWA under the Canada Wildlife Act and WAR (NWT Environment and Natural Resources, 2023).

Designation of the Edéhzhíe as an NWA finally occurred in 2022, following a lengthy process:

- The federal government allowed for the interim protection for subsurface resources to expire in November 2010, potentially enabling the recommended area to be utilized for mining before it could be protected as an NWA (DFN, 2013).
- Following a series of legal actions, the court decided that the interim protection of the entire candidate area should remain in place until the entire NWT Protected Area Strategy process was complete (DFN, 2013).
- In 2016, the DFN and Government of Canada re-initiated work on an agreement to finalize establishment of Edéhzhíe as Canada's first Indigenous protected area and an NWA.
- In 2018, the Dehcho First Nations, in partnership with the Government of Canada, announced the establishment of the Edéhzhíe Dehcho Protected Area in the Northwest Territories under Dehcho Dene law. That same year, the Dehcho First Nations grand chief and the Government of Canada signed the Edéhzhíe Establishment Agreement, outlining the measures for which Canada and Dehcho Dene would work together to protect and preserve the area (EEA, 2018).

- In 2022, the Government of Canada designated the Edéhzhíe as an NWA (ECCC, 2022a).

The Dehcho First Nations and the Government of Canada co-manage the Edéhzhíe through a jointly appointed Edéhzhíe management board that includes members of the Dehcho First Nations, a representative from Environment and Climate Change Canada and an impartial chair. The board is consensus-based; all parties must agree on decisions and no individual party has a veto. The Dehcho First Nations play a primary role in caretaking the land, employing the Dehcho K'éhodi stewardship and Indigenous guardians program. The Indigenous guardians are the Nations' "eyes and ears" on the ground and are skilled in traditional knowledge and cultural protocols around caring for the land, while also being trained in western science to undertake ecological monitoring (ILI, 2023). Each Dehcho community has two guardians working on the land to help with youth mentoring, cultural protection, research projects, patrolling, cabin installation and ecological monitoring.

IMPACT AND OUTCOMES

The primary purpose of achieving NWA designation of the Edéhzhíe is to protect and conserve wildlife and wildlife habitat (ECCC, 2022a), which involved making trade-offs. The Edéhzhíe is only accessible to individuals exercising section 35(1) rights under the Constitution Act, 1982, and those that receive permits (ECCC, 2022a). Tourism within the boundary of the Edéhzhíe NWA was low to non-existent prior to its designation, but the designation in effect prohibits tourism as a viable economic venture (Canada Wildlife Act: Regulations Amending the Wildlife Area Regulations and the Environmental Violations Administrative Monetary Penalties Regulations, 2021). The establishment of a protected area prohibits resource extraction or surface and subsurface development on the land. By reducing the size of the protected area as originally proposed (from 25,230 km2 to 14,218 km2), the Edéhzhíe protects a majority (89 per cent) of the conservation values initially intended for protection, while excluding a large majority of the hydrocarbon and mineral potential (78 per cent).

The value of the ecological goods and services generated in the Edéhzhíe outweighs the economic output that could have been derived from the area. A strategic environmental assessment conducted for the Edéhzhíe concluded that establishing Edéhzhíe as an NWA was unlikely to result in significant adverse environmental effects, but instead likely to result in beneficial environmental and related socio-cultural components through the conservation of natural ecosystems and species, and protection of subsistence harvesting activities and traditional use by the Dehcho First Nations (SENES 2006). The socio-economic assessment conservatively estimated the current economic output of the Edéhzhíe prior to its establishment as an IPA and NWA at $1.8 to 2.8 million annually (AMEC 2008). The area provides several ecological goods and services such as nitrogen cycling, carbon sequestration and storage, air filtration, flood control, water flow mitigation and water filtration (Canada Wildlife Act: Regulations Amending the Wildlife Area Regulations and the

Environmental Violations Administrative Monetary Penalties Regulations 2021), with an estimated value 60 to 80 times the annual economic output ($108-224 million annually) (AMEC 2008). This is because the Edéhzhíe contains more wetlands and carbon sequestration potential than expected based on area alone.

Other outcomes of the initiative also provide significant value. This dynamic boreal landscape supports the headwaters that supply freshwater to the Dehcho region and is home to a high diversity of species (including species at risk), such as woodland boreal caribou, wood bison, snow geese, greater white-fronted geese and tundra swans (ECCC, 2022a). The landscape also supports several species important to Dene culture and sustenance, such as moose, white fish, lake trout and fur-bearing animals like the lynx, (ECCC, 2022b). In addition to diverse wildlife and landscape integral to Dehcho culture, protecting the Edéhzhíe supports cultural preservation. The Edéhzhíe is the "heart and soul" of the Dehcho region. Conserving the area honours the Dehcho's cultural responsibility to the land and will sustain the Dehcho way of life in the Edéhzhíe for current and future generations (ECCC, 2022b).

Edéhzhíe is the first formal Indigenous protected and conserved area designated in Canada, since the creation of the Pathway to Target 1 initiative, representing the next era of Indigenous-led conservation. Its implementation and lessons learned have been shared broadly to catalyze Indigenous-led conservation throughout the country. Although its legal status is secured and strong governance established, concerns remain regarding long-term funding to manage the area.

Table 2: Evaluation of project against eight criteria of the IUCN Global Standard for Nature-based Solutions

CRITERION	RATING	RATIONALE
1. Societal challenges	☐	Addresses several societal challenges, including climate change adaptation, loss of ecosystem integrity and biodiversity, and preserving an area of Indigenous spiritual and cultural significance.
2. Design at scale	☐	The design of the Edéhzhíe recognizes and responds to the interactions between the economy, society and ecosystems by protecting areas of high conservation value, while excluding areas of high economic potential, therefore taking into account its place with the larger landscape and socio-economic drivers of the region. Some conservation values were lost from the initial candidate protected area, but the design is large enough to minimize risk to the conservation values that were retained.
3. Biodiversity net gain	◐	Protecting areas that are fairly pristine may be less likely to achieve substantial biodiversity gains compared to other NbS actions, such as restoring degraded ecosystems or creating new ecosystems where biodiversity was not previously present. However, protecting and managing this area as an NWA also prevents biodiversity loss by providing a refuge for migratory birds and endangered species, whose habitat may be degrading elsewhere.

4. Economic feasibility	☐	Economic, socio-economic and strategic environmental assessments were undertaken to ensure the area was justified against alternative solutions and was economically viable.
5. Inclusive governance	☐	Comprehensive consultation from the federal government with First Nations and Indigenous governments was present at every step during establishment of the protected area, and the multi-stakeholder planning process ultimately led to co-governance of the designated site, with the Indigenous parties taking a lead role in strategic decisions and day-to-day management.
6. Balance trade-offs	◐	This project was able to balance the trade-offs between economic and ecological gains by reducing the size of the protected area to include areas of the highest ecological value while excluding the areas with high development and mining potential. If development were to occur in the areas excluded from the NWA, safeguards would need to be established to avoid destabilizing the intervention.
7. Adaptive management	☐	Dehcho K'éhodi stewardship and guardians programs are aligned with the values and interests of Dehcho communities and weave Indigenous knowledge systems and western science to inform management, including through collection and use of ecological monitoring data.
8. Mainstreaming & sustainability	☐	The intervention contributes to several national and international sustainability targets for human well-being, climate change and biodiversity, including Canada's Target 1 biodiversity challenge and the United Nations Declaration on the Rights of Indigenous Peoples. Being Canada's first formal IPCA that is co-governed by Dehcho First Nations and the Government of Canada supports creation of other IPCAs and mainstreaming of this approach to conservation in Canada.

BARRIERS AND ENABLERS OF SUCCESS

Maintaining political will throughout the lifespan of Edéhzhíe's implementation, managing competing interest over land uses and ensuring long-term finance for monitoring and management by Dehcho First Nations are key challenges. Efforts to overcome these challenges include having strong conservation targets that cascade down, leading to direct action, trust in a multi-stakeholder processes for protected areas planning to provide a robust justification for establishing the protected area, ensuring the protected area contains areas of high conservation value, and establishing the Edéhzhíe Trust Fund (endowment fund) to support protection and long-term management of the area. The Edéhzhíe Trust Fund was created from contributions from the federal government, Dehcho First Nations, and third-party donors. The trust fund is a vehicle that supports Dehcho First Nations to mobilize resources to manage the NWA.

KEY LESSONS LEARNED

Individuals directly involved in Edéhzhíe's planning and implementation highlight the following lessons:

- Working toward co-management is an exercise in expectations management. Government officials and Dehcho First Nations have different priorities, which required a shift from sole decision-making in how these parties would set priorities and execute activities.
- When various parties have legal or traditional interests and responsibilities to the land, establishing shared long-term outcomes is essential to work toward an agreement.
- Comprehensive Indigenous consultation and a multi-stakeholder planning process can yield solutions that benefit all stakeholders involved in establishing protected areas.
- Designation of an IPCA and NWA can be a long process, and sufficient timelines (10 to 15 years), strong governance structures and capacity are required to develop management plans, monitoring programs, training and funding mechanisms.

CASE STUDY 2: SHEPARD CONSTRUCTED WETLAND

Ralph Klein Park within the Shepard Constructed Wetland, on the southeast edge of the City of Calgary (Photo: Greg Debicki/City of Calgary with permission)

Project: Shepard Constructed Wetland, part of the Shepard Stormwater Diversion Project

Type: Type 3 (create), freshwater wetland

Location: Southeast Calgary, Alberta

Partners: City of Calgary, Western Irrigation District, Province of Alberta

Implementation Details: Scale: 230 ha; Timeframe: built between 2007 and 2009; Cost: $69 million (in 2020 dollars) for development of the wetland facility.

PROBLEM CONTEXT

As with any city urbanizing and increasing its development footprint, Calgary faced stormwater management issues in the 1980s. Back then, much of east Calgary drained naturally into the Western Headworks (WH) Canal, operated by the Province of Alberta, which supplies the Western Irrigation District's (WID) main storage reservoir, Chestermere Lake. A critical component of water supply management in a region of highly variable flows, the WID system services over 800 ranchers and four towns, increasing agricultural returns significantly (Paterson Earth & Water Consulting, 2015; Ryan, 2015). The province and WID were concerned that peak volume surges after rainfall events posed a flood risk east of Calgary and increased demands on WID infrastructure. Water quality aspects of stormwater entering the WID were also a concern to the province and WID, with high bacterial counts and nutrient loading (with attendant weed problems and noxious algal blooms) registered in Chestermere Lake linked to Calgary stormwater runoff (Ryan, 2015). The province had already imposed a moratorium on additional storm discharges into the WH Canal in 1983, which challenged the city in providing serviced land for

industrial development along the eastern fringes of Calgary. Managing increased runoff discharge from urbanization is particularly challenging in low-lying, semi-arid environments such as southern Alberta with low drainage densities and non-contributing (i.e., no surface outlet to the Bow River) surface drainage in the form of saline sloughs (seasonal swamps) and pothole wetlands that dominate the east side of the city. In 2002, the City of Calgary, Province of Alberta and WID agreed to a solution that included development of the Shepard Stormwater Diversion Project.

APPROACH

Initially conceived of in the 1980s and part of the Shepard Stormwater Diversion Project, the Shepard Constructed Wetland facility was built by the City of Calgary between 2007 and 2009 to address a key societal challenge in a locale facing rapid economic and population growth: drainage of urban stormwater runoff. At 230 hectares, the Shepard Constructed Wetland (SCW) functions both as a stormwater storage facility and a treatment wetland that naturally filters stormwater before its eventual discharge into the Bow River. The SCW is the largest constructed wetland in Canada, treating the runoff of existing and future developments on the eastern edge of Calgary. The SCW is an integral part of a large-scale drainage infrastructure project, which comprises three components: 1) a wasteway and canal that diverts excess runoff from 10,000 hectares of land during extreme events toward the SCW, 2) the SCW itself and 3) the Shepard Ditch, which takes the discharge from the SCW to the Bow River. Landscape features determined the design of the project, with existing low-lying areas — the lower reaches of the Shepard Slough Complex — incorporated as part of the SCW with alignment of the Shepard Ditch along the eastern fringes of Calgary chosen to maximize drainage from future lands in the southeast quadrant. Calgary did not consider alternatives to the SCW, but the city's 2005 Triple Bottom Line Policy would have been applied, which obliged council to consider social, economic, environmental and smart growth impacts of its decision to build the SCW as part of the broader initiative.

The SCW project figured prominently in the 2001 Intermunicipal Plan guiding subdivision and development in the Shepard Area, involving both the City of Calgary and Rocky View County. In anticipation of population growth and land-use changes in the area, the plan identifies among its objectives options for development of the SCW project and identification of servicing standards, including stormwater management. The plan highlights the Shepard Slough Complex, seasonal ponds providing waterfowl habitat and stormwater retention, and owl habitat areas (short-eared and burrowing owl) as environmentally significant features to consider in applications for redesignation, subdivision and development, with the plan positing that alterations to the Shepard Slough Complex required to build the SCW could provide "benefits for wildlife habitat and passive recreation." At the time, the city and county acknowledged that the SCW was part of a regional sub-basin, itself part of the Bow River watershed. They called for the commissioning of a regional sub-basin drainage study to assess changes in stormwater runoff associated with the land-use plan overall and not just the SCW project. Other policies supporting the

SCW included the requirement to apply a minimum setback of 30 metres from the perimeter of the SCW to protect water quality in the wetland and enhance wildlife habitat.

The City of Calgary led implementation of the SCW project, although it represented a joint effort with the WID and the province. Financing for the project stemmed from self-supported debentures, government grants and private contributions (City of Calgary, 2005), including a substantial loan from the city's Real Estate Reserve Fund. In total, the initial project cost was $69 million (2020$) or about $442,000 per hectare. The large-scale nature of the project triggered extensive engagement within the city and externally, including with the province, the WID, neighbouring municipalities and property owners in the project area (at that time rural). The City of Calgary and Rocky View County had already obtained public perspectives on the SCW back in 1998 as part of the consultations (open houses, design workshop, statutory public hearings) surrounding the 2001 Shepard Area Structure Plan, with stakeholders at that time raising concerns about goose and mosquito populations, the water table and pathway linkages, as well as the potential for the SCW to become an amenity for recreation. Stakeholders were clear on the need for the SCW and related infrastructure components, and support for the project was widespread, especially since it solved a stormwater management problem that had slowed development on Calgary's east side for more than 20 years. A project of this size tends to attract some opposition, with landowners directly affected by land expropriation for the right-of-way most strongly opposed. Public engagement practices within the city have changed since construction of the SCW, with a greater effort in external engagement with the non-profit sector and enhanced consideration of the equity dimensions of the project, were it up for decision today.

Design and construction of the SCW followed policy direction and guidance in force in the 2000s. The SCW incorporates a portion of the Shepard Slough Complex (i.e., a natural wetland) but is primarily an engineered stormwater wetland, according to classification in the city's 2004 Wetland Conservation Plan (City of Calgary, 2004). Design and construction of the SCW would have followed provisions in the City of Calgary's 2000 Stormwater Management & Design Manual, and the edition of Calgary Parks' Development Guidelines and Standard Specifications, Landscape Construction that was current then. Such provisions included maintaining base flows from the forebay to the wetland, re-creating existing plant communities, protecting any rare/unique species and using locally grown plant material to maximize rates of establishment. City policy back then outlined a range of values provided by wetlands, but the functional focus of the SCW was squarely on stormwater storage and treatment. Structurally, the SCW includes several elements: an inlet culvert, two sediment forebays, five cells with internal berms and perimeter dikes, a discharge bay, a diversion ditch in the southeast corner for surface runoff from remaining upper Shepard Slough Complex and perimeter drainage ditches and piping (ALMS, 2011). For optimum performance, cells were terraced to minimize excavation and earthworks. As for vegetation, seed mixes

varied by site zone and were subject to commercial availability, with zones comprising a wetland shelf, a littoral zone and upland grasses.

Beyond the construction phase, monitoring of the SWC project was limited. Despite policy direction in the City of Calgary's 2004 Wetland Conservation Plan on wetland monitoring programs, including landscape assessment, implementation monitoring, performance monitoring of ecological and economic values, the city focused on compliance with provincial requirements. A 10-year water quality monitoring program for the SCW was established as per the requirements of the province. Additional monitoring is currently being contemplated as part of the East Calgary Regional Drainage Study. The city also has a long-standing surface water quality monitoring program across a network of sites within the Calgary region, which monitors a suite of parameters at various outfalls into and within the Bow River, an important fish-bearing river in the province (City of Calgary, no date).

IMPACT AND OUTCOMES

The Shepard Constructed Wetland project manifested as a solution to address concerns of flooding and lack of appropriate drainage infrastructure in the east of Calgary as well as to divert negative impacts on the irrigation district outside the city. By these measures, the SCW project is a success. The wetland receives stormwater runoff from a catchment area of nearly 6,000 hectares and effectively redirects excess stormwater for natural filtration before eventual discharge to the Bow River. The SCW has a maximum storage volume of 5.2 million cubic metres of water and treats more than 50 per cent of the stormwater from Calgary's east industrial parks as well as subdivisions to the north (AECOM, 2011). Direct beneficiaries of the SCW have included residents living east of Calgary around Chestermere Lake, the City of Chestermere and surrounding area; the WID because of the reduced demands on their infrastructure; and the development community along the eastern fringes of Calgary, with way out for drainage allowing development to proceed in that area.

Ralph Klein Park is an interpretive park associated with the SCW facility, with the constructed wetland generating recreational and educational benefits. Planning documents identified opportunities for habitat creation and passive recreation because of modifications to the Shepard Slough Complex as part of the SCW project. Indeed, recognizing the importance of wetlands and birding opportunities, the city developed a 30-hectare park, which is integrated within the SCW. The Ecosystem Services Pilot Project (Alberta Government, 2011) estimated the recreational benefits derived from people visiting the wetland complex for birding at just over $5 million per year (2020$), a value based on 114,685 visitors each spending $44 for a day trip. Since the economic modelling only considered birding activities (and not walking or scenic viewing), the recreational value of the SCW is likely higher. The SCW also offers an immersive setting for learning about species, habitats, conservation and biodiversity, fostering a deep connection to the environment. The Ralph Klein Park education centre located within the SCW

is in its 12th year of operation, with educational programs focused on wetlands, including Mud Between My Toes, Seasonal Nature Studies, Nature Walks, H2Ohh!, Marsh Madness and Wetland Wigglers for grades 1 through 12. In 2022 alone, there were over 2,500 total participants across these programs. The park's most popular program, Mud Between My Toes, is freely accessible for teachers and students because of corporate sponsorship.

Although the potential exists to manage constructed wetlands to support biodiversity and multiple bundles of ecosystem services beyond acting as stormwater infrastructure, this infrequently occurs (Alberta Government, 2011; Lee et al., 2021), and the SCW is no different. Nevertheless, some evidence indicates that these constructed wetlands do support biodiversity. The SCW is within a wetland complex located along a north-south migration route for birds and facilitates habitat for many species that do not occur in other parts of Calgary, such as the white-faced ibis, the black-crowned night heron and multiple shorebirds. Over 46 different species of birds have been identified in Ralph Klein Park (City of Calgary Parks, 2023). Additionally, results from a 2017 to 2019 citizen science effort to record amphibian presence as an indicator of biodiversity in 52 wetlands around Calgary determined that wetlands with stormwater infrastructure played a role in urban amphibian and aquatic biodiversity (City of Calgary & the Miistakis Institute, 2020). Today, the city integrates ecosystem services more clearly into decision-making, having developed a system for natural asset valuation that looks at six key ecosystem services (stormwater management, habitat, recreation, urban heat reduction, carbon storage and improved aesthetics).

Post-project followup showed unanticipated nutrient leaching from the SCW, pointing to opportunities to learn about optimization of phosphorous management as part of low-impact development practices. The field of stormwater management has evolved significantly since the wetland was built. At the time the it was built, nutrient control would not have been directly considered; now, the city is evaluating the options and various methods to better control and minimize nutrient leaching. City staff have submitted a research application to explore the causes of the problem and effective controls. Their hypothesis is that wetland vegetation harvested from other locales to construct the engineered wetland already had high phosphorous levels and is one of the main sources. Natural infrastructure, not just wetlands but also applications such as green roofs and bioretention areas, are susceptible to nutrient leaching. Experience with the SCW is driving research and innovation so future applications of nature-based solutions of this kind can avoid this unintended downside. Research pertaining to amendments that can be mixed in has recently been published.

Table 3: Evaluation of project against eight criteria of the IUCN Global Standard for Nature-based Solutions

CRITERION	RATING	RATIONALE
1. Societal challenges	☐	The intent of the Shepard Constructed Wetland and the broader drainage initiative was to address stormwater management and treatment. These factors assist with the health and well-being of people living in the region and help balance population and economic development with environmental sustainability. The SCW is a core feature of a beloved city park, although the project's recreation, education and aesthetic benefits were not forefront in decision-making on the project.
2. Design at scale	☐	The project considered its place within the larger landscape and socio-economic drivers by enhancing natural features, decreasing flood risk and improving water quality, all in the context of sub-basin drainage.
3. Biodiversity net gain	☐	This was a stormwater management project with little to no considerations for biodiversity or other ecosystem services in its design or construction. If built today, considerations for six ecosystem services would be integrated from the start, and project staff across planning areas (e.g., drainage, biodiversity, and parks and recreation) would be involved in informing project feasibility and design. The city is also currently defining a vision for caretaking natural assets, including pocket wetlands. Although not designed for this purpose, observations at the SWC have confirmed significant biodiversity richness at the site.
4. Economic feasibility	◐	The project was subject to a triple bottom line assessment, consistent with city policy at the time. Financing came from diverse sources, including debt, grants and private contributions. Direct project beneficiaries were clearly defined, as well as landowners adversely affected due to right-of-way expropriation.
5. Inclusive governance	◐	Large-scale projects such as this trigger extensive public consultation before implementation, which happened in this case. The project received endorsement from both the City of Calgary and adjacent Rocky View County and was a key feature in an intermunicipal land use plan. If the project were up for decision today, Indigenous reconciliation and equity dimensions would be an essential component.
6. Balance trade-offs	☐	The SCW and the broader Shepard Stormwater Diversion Project was an exercise in balancing trade-offs inherent in urbanization and industrial development on low-lying, semi-arid environments with low drainage densities, all while trying to comply with wetland conservation policies. Safeguards such as development setbacks around the SCW and habitat protection were encoded in policy and today are central to the way the city protects wetlands in an urbanizing environment.
7. Adaptive management	◐	A 10-year monitoring program was set up specifically for the SCW to comply with provincial water quality standards, although not necessarily to facilitate adaptive management. However, the city has developed new standards since this project, which take into consideration more adaptive management principles.

8. Mainstreaming & sustainability	◐	Lessons from implementation of SCW and other related initiatives are informing updates to the city's stormwater management strategy, which will integrate nature-based solutions. Experience from the SCW is informing new research (e.g., nutrient management) and serving as an example for other jurisdictions.

BARRIERS AND ENABLERS OF SUCCESS

As completion of the SCW project occurred several years ago, with staff most directly involved having since retired, documenting specific barriers and enablers to success is challenging. With respect to implementation barriers, the project received widespread support, although a few landowners directly affected strongly opposed it. Enablers of success included the city's capacity for self-financing such a large-scale project, access to a wetland inventory, clear policy direction and strong local government planning, including provisions for intermunicipal cooperation. What is evident is that the SCW and broader Shepard Stormwater Diversion Project in some ways were ahead of their time, contributing to the evolution of stormwater management thinking and to improvements in understanding and better managing natural assets and ecosystem services. For example, other local governments use the SCW to demonstrate the multi-functionality of constructed wetlands with stormwater management as the focal service. The following challenges remain outstanding and top of mind for the City of Calgary:

- **The business of asset management.** Historically, capacity for analyzing and designing systems for stormwater management was strong, with weaknesses in accounting for operations and maintenance. Experience has shown the need to tighten feedback loops (e.g., preventative inspections) and truly manage infrastructure as systems (e.g., use of invertebrates as health indicators) and on a life-cycle basis.
- **The need to encourage responsible innovation in the context of continuous change.** Climate change and other drivers are pushing operating conditions toward the unknown, which calls for innovation. However, a process needs to be in place to anticipate possible failure scenarios and think through actions to minimize risk or foster robust decisions. For example, for vegetation selection, it is preferable to pick flora species for drought suitability because if they can handle drought conditions, they are usually robust to extra moisture, but not the other way around.
- **A focus on improved quantification of the co-benefits that come with nature-based approaches.** The city has partnered with the Credit Valley Conservation Authority in Ontario to use their Risk and Return on Investments Tool (Credit Valley Conservation, no date). This tool informs flood risk management and can accommodate management scenarios involving nature.

KEY LESSONS LEARNED

City staff reflecting on the implementation of the SCW and future application of nature-based solutions highlight the following lessons:

- Invest in knowledge management. City staff are developing a guide based on learnings from applying the PIEVC protocol to engineering design and master planning projects for open spaces. This guide will enable efficient matching between problems identified and viable solutions and is a way to help embed climate change and nature-based solutions into planning and design processes for infrastructure.
- Contribute to standard setting and use standards when published. Calgary staff have been part of ongoing work on the design of Low Impact Development and natural asset inventory standards. Contributions to such committees enhance the practicality of standards, which then serve as tools to guide processes in other municipalities.
- Be open to communicating with, asking questions of and leaning on other municipalities for support. A lot of effort and time can be spent reinventing or redesigning when greater value could come from improving existing efforts.
- Engage the business community early. Solutions need to resonate with them while at the same time fitting the larger societal vision for community building.

CASE STUDY 3: TORONTO TREE CANOPY AND WATERFRONT SHORELINE PROJECT

Bluffer's Park (Cliffcrest). Photo: © Jason Paris

Project: The Toronto Tree Canopy and Waterfront Shoreline Project

Type: Type 3 (restore), urban forest, lake waterfront, freshwater ecosystem

Location: Toronto, Ontario

Partners: City of Toronto–led in partnership with the Toronto Region Conservation Authority (TRCA)

Implementation Details: Scale: Multi-neighbourhood scale – 900 ha, Timeframe: 2019-2025 (65 percent of projects completed as of 2022), Cost: $29 million ($2020) in capital costs.

PROBLEM CONTEXT

The City of Toronto is experiencing an increase in frequency and severity of flooding events, high lake level events and extreme weather events. In 2017, Toronto experienced a major flooding event where Lake Ontario reached the highest levels recorded since 1918, when reliable lake level records began (ILOSLRB, 2018). Record precipitation across Lake Ontario and the St. Lawrence River basin was a key driver of this extreme event (ILOSLRB, 2018). A subsequent windstorm in 2018 and even higher lake levels in 2019 caused significant erosion of the shoreline, exposing previously buried infrastructure, closing trails due to safety concerns and requiring landslide warnings to be issued for visitors to the Scarborough Bluffs, as the bluffs had already experienced dozens of landslides in 2017 (TRCA, 2019; CBC, 2017). These increasingly recurrent problems prompted city officials to adopt a new approach to protecting the Toronto shoreline from erosion and flooding, and

to building resilience for both the natural environments and culturally significant infrastructure along the historic Lake Ontario shoreline.

APPROACH

The Toronto Tree Canopy and Waterfront Shoreline Project is part of the city's new approach to shoreline protection from flooding and erosion. The project is a collaboration between the City of Toronto and the Toronto and Region Conservation Authority (TRCA) aimed at improving adaptability to increasing and intensifying weather events by repairing and enhancing the resilience of erosion control infrastructure, such as breakwater structures, artificial reefs and dynamic beaches on Toronto's shorelines. The project also expands the city's tree-planting program to increase the number of healthy trees, which provide stormwater management services by reducing peak flows and bolstering natural area restoration along the shoreline (Natural Resources Canada, 2022). The combination of both shoreline infrastructure and urban forest expansion comprises diverse nature-based solutions that the City of Toronto and TRCA are implementing to combat the damage of severe weather events to the shoreline and city at large.

This project was a response to a series of extreme events that caused severe flooding and erosion, including the 2017 high lake event, a 2018 ice and windstorm event and the 2019 high lake event Instead of simply repairing existing flood protection structures on the waterfront, the project design responded to the need to address the "new normal" of higher static lake level parameters. Built decades ago, existing structures generally include a single layer of aggregate material. In addition to building with double layers, TRCA is building new structures to a higher elevation, creating a backsplash area to reduce the impacts of wave overtopping and using larger/heavier aggregate. In some instances, TRCA is building nearshore shoals/reefs, which increase aquatic habitat and dissipate wave action before hitting the shoreline. This change in approach by the City of Toronto and TRCA took place based on these organizations' assessments of damage to existing structures and the advice of TRCA's coastal engineering consultants. The project bundles two city priorities — enhancing the urban tree canopy and mitigating flooding and erosion risk — as two distinct components: 1) tree canopy expansion and urban forestry rehabilitation and 2) shoreline restoration. The tree canopy aspect of this project builds on the 2012-22 City of Toronto's Strategic Forest Management Plan, itself building on the city's long history of improvements to tree canopy cover (City of Toronto, Parks, Forestry and Recreation, 2013). The shoreline restoration aspect of the project involves work along the coast of Lake Ontario and on the Toronto Islands.

Access to a federal grant enabled the project's expanded scope and influenced its carbon footprint. In 2019, the city secured a grant of approximately $11 million from Infrastructure Canada through the Disaster Mitigation and Adaption Fund (DMAF). This grant made it possible to expand the number of sites remediated to include 11 TRCA erosion control assets within Ashbridges Bay Park, Bluffer's Park

and Humber Bay Park East and West. Additionally, the grant made it possible to implement remedial flood protection, repairs to paths and boardwalks and erosion protection and enhancements in other popular locations including Toronto Islands, Tommy Thompson Park and the Western and Eastern Beaches. The funding also enabled the implementation of more resilient and ecologically sustainable solutions to the waterfront than would have been the case without the leveraged funds. As part of DMAF requirements, the city was obliged to undertake a project-level greenhouse gas mitigation assessment and implement related controls through procurement and other means; e.g., encouraging contractors to use lower-emitting fuels and using an electric vehicle for inspections (TRCA, 2020).

Nevertheless, the decision to integrate nature-based solutions into this project came from the City of Toronto, with the implementation for the tree canopy components led by the City of Toronto Urban Forestry section and the shoreline component led by the TRCA. Implementation of the urban forestry portion of this project will occur over the course of 10 years, to account for staffing challenges and unforeseen storm events that required the reallocation of forestry crews to address damages. TRCA works with a group called Aquatic Habitat Toronto, which provides feedback and recommendations on habitat components of shoreline projects based on the Toronto Waterfront Aquatic Habitat Restoration Strategy (RAP, 2023). This group includes representatives from the city, Waterfront Toronto, Ports Toronto, the Ministry of Natural Resources and Forestry (MNRF), Environment and Climate Change Canada (ECCC) and Fisheries and Oceans Canada. Initially scheduled for completion by 2022, the new deadline of the shoreline component is 2027, to coincide with the coming into force of new resiliency standards. The new standards include a recommendation that the 100-year flood level for Toronto Islands, which is defined as the 100-year still-water level, be increased from 75.74 to 76.05 metres IGLD85 (W.F. Baird & Associates Coastal Engineers Ltd., 2019).

Engagement on the Toronto Tree Canopy and Waterfront Shoreline project took place in a variety of ways. Internal engagement across city divisions occurred. For example, the urban forestry department collaborates with Toronto Water to deal with erosion. Additionally, a standardized system of internal notification processes and project descriptions are shared within the city and TRCA communications. Due to the nature of shorelines projects as maintenance, these activities were originally considered a repair and thus did not require public consultation. However, construction notices were put up a month in advance of project work with contact information for the public to ask questions, provide comments and gain more information about the projects along the main shoreline of Toronto (TRCA, 2023). There is further accountability in both shoreline and tree canopy components by reporting on progress to council about the ongoing work. Prior to project implementation, Indigenous Peoples were consulted about construction of the projects, with opportunities to comment on design, and continue to be updated by the TRCA on the city's behalf. Indigenous engagement is incorporated from the outset with the treaty holders. Reporting to the treaty holders occurs on an annual or semi-annual basis.

The Toronto Island project sites have extensive and continuous public participation, with engagement of residents and special interest groups as part of the Toronto Island Park Flood and Erosion Mitigation Project. This project was planned in accordance with Conservation Ontario's Class Environmental Assessment for Remedial Flood and Erosion Control Projects (amended 2013) emergency flood and control works. The purpose of this EA is to ensure long-term solutions are met when addressing emergency flooding and erosion projects and that these actions are subject to the Environmental Assessment Act (Conservation Ontario, 2013). The project engaged the community through the Class EA process conducted on Toronto Islands, with public meetings and a citizen committee as well as coordination with the Toronto Island Park Master Plan (City of Toronto, 2023).

Monitoring of the shoreline component of the project follows TRCA's standard practices. Groups within TRCA (aquatic habitat monitoring, terrestrial habitat monitoring, erosion monitoring) build off of historical monitoring data to assess how projects do over time, and in cases where there are no baseline data, crews are sent out to establish a baseline before construction begins. Monitoring programs are set up in perpetuity to monitor the status and success of projects through the TRCA's monitoring programs. Monitoring of these sites is tied to regulatory approvals and offsetting programs are in place to compensate for any habitat that may be affected by structures. The offsetting programs require creation of additional habitat if construction efforts impact existing habitat (DFO, 2019). The erosion-prevention structures built or restored as part of the project are to be reevaluated at least annually, either by foot or via drone. For newly built structures, these assessments are more frequent than annually (e.g., nearshore reefs and dynamic beaches). Additional monitoring of shoreline structures is implemented after major storm events.

All urban forestry projects in the City of Toronto have monitoring built in, and the Toronto Tree Canopy and Waterfront Shoreline project is no exception. Planting sites are monitored for three to four years after being planted. This monitoring is usually done by contractors and is included as part of their contracts. Once trees pass their "warranty" period (when contractors no longer monitor), internal staff monitor the sites annually. Planting sites are generally considered to be stable after five years and are "free to grow" after that time, although sites may be monitored after five- or 10-year intervals if needed. Sustainability standards and indicators of urban forest success are highlighted in the City of Toronto's Strategic Forest Management Plan (2013).

IMPACT AND OUTCOMES

Staff most directly involved in the implementation and planning of this project contend that final project results will far exceed what was originally planned in 2018. Increased aquatic habitat from the shoreline work, the increase in forest management work, invasive species removal, hazard tree removal and replanting, which has increased health and resiliency of the urban forest, in combination

with the aesthetic and health benefits provided by new amenities in public parks, means that the benefits of this project are far-reaching across various social and ecological values.

Trade-offs made along the way included the prioritization of some sites due to unexpected damage from surprise storm events as well as delayed construction and implementation due to a Class EA taking place on the Toronto Islands. This delay was necessary to ensure that the public was adequately consulted on actions taken on the Toronto Islands, that Indigenous communities and treaty holders were adequately engaged and that the procedures and planning principles of the Class EA were followed.

The benefits to people in the Toronto area from the project are numerous. Restoration of infrastructure along the shoreline provides value to residents of the Toronto waterfront region as well as waterfront users at large by increasing its safe use through bank stabilization. Several of the sites restored through this project are in popular parks, such as Bluffers Park, which sees thousands of users in the summer (TRCA, 2021). Furthermore, funding of this project has enabled the city to hire contractors to implement the work, creating employment opportunities in the city.

Although the project is reactive, it established a framework for a more robust set of standards for resiliency that enhance terrestrial and aquatic habitats. This framework has the potential to be applied to future projects and applications for funding to incorporate nature-based solutions. The City of Toronto and TRCA participated in the Great Lakes–St. Lawrence River Adaptive Management (GLAM) Committee and demonstrated that this project can be used as an example for how new standards of higher static lake levels and increased resiliency thresholds can be applied in cities along the shores of the Great Lakes.

Table 4: Evaluation of project against eight criteria of the IUCN Global Standard for Nature-based Solutions

CRITERION	RATING	RATIONALE
1. Societal challenges	☐	Addresses societal challenges such as public health and well-being (safe access to nature/natural spaces, shoreline parks), increase in urban forest (increases green spaces in city/urban forest canopy).
2. Design at scale	☐	The project considered its place within the larger landscape by increasing aquatic and terrestrial habitat where possible and by minimizing GHG emissions from construction activities through strategic measures.
3. Biodiversity net gain	◐	While some biodiversity loss occurs through armouring shorelines in areas where environmental conditions are not conducive to NbS, biodiversity offsetting is used by creating or enhancing fish habitat such as coastal reefs. This project will increase the urban forest canopy of the City of Toronto by an additional 30,000 trees beyond the city's normal planting strategy.

4. Economic feasibility	◐	This project was justified against available alternative solutions. However, without federal funding through the DMAF program, the scope and scale of this project would not have been possible. Establishes a budgetary standard for future NbS.
5. Inclusive governance	☐	The shoreline remediation projects engage Indigenous rights holders. Community engagement occurred through public engagement practices (signage, meetings) during implementation.
6. Balance trade-offs	◐	The project was able to balance trade-offs within the physical limitations of the project. Because of environmental conditions (southeast-facing shoreline, extreme winds with gusts exceeding 100 km/hr during storm events, substantial waves) some shoreline hardening was required but at sites with more favourable environmental conditions NbS were implemented.
7. Adaptive management	☐	The scope, scale and standards of this project have changed since the project's original design in 2018 to account for new data from extreme weather events and new standards. Monitoring is ongoing to ensure shoreline structures are stable and/or functioning correctly (e.g., dynamic beaches) as well as monitoring newly planted urban forest sites.
8. Mainstreaming & sustainability	☐	This project was used to inform the Great Lakes–St. Lawrence River Adaptive Management (GLAM) Committee as an example of how new standards of higher static lake levels and increased resiliency thresholds can be applied through robust, resilient structural improvements as well as terrestrial and aquatic habitat improvements in other shoreline cities.

BARRIERS AND ENABLERS OF SUCCESS

One of the biggest barriers to success for this project related to the limitations and delays that occurred because of the COVID-19 pandemic. Supply chain disruptions, staffing shortages and significant increase in costs occurred and continue to be challenges that are dealt with and learned from on an ongoing basis. Unexpected, intense storm events also occurred, so forestry crews were diverted to work on reducing the impact of storms, which took them away from rehabilitation and tree-planting work.

The implementation of nature-based solutions was somewhat limited by the physical conditions of the shoreline on Lake Ontario. The shoreline is southeast facing and, during storm events, can experience sustained winds over 80 km/hr with gusts exceeding 100 km/hr as well as substantial waves. These coastal conditions limit the kind of infrastructure used along this shoreline. In comparison, the shores of the Toronto Island sites can accommodate more diverse nature-based solutions.

The City of Toronto attributes the success of this project largely to two factors: 1) the ability to develop more robust and resilient shoreline infrastructure and tree-planting/forest-management practices due to the funding provided through the DMAF program and 2) the long-established strong collaboration and partnership with the TRCA that enabled swift and effective action in the face of emergency actions from unexpected storm events while informing project work with extensive

knowledge and expertise in ecology, hydrology and best practices in erosion control and aquatic and terrestrial habitat monitoring.

KEY LESSONS LEARNED

People directly involved in the project's planning and implementation highlight the following lessons:

- The budgetary changes demonstrate what additional robust work can be done when there is funding available.
- Because this project was reactive, cities should move toward a more proactive approach to prevent unexpected expenditures. By implementing robust and resilient infrastructure before major storm events occur, municipalities can prevent future extreme expenditures.
- This project demonstrated vulnerabilities in existing structures because some structures that were vulnerable to high lake events were resilient to wind damage, while others that were resilient to high lake event structures sustained significant damage from wind. This informs future prioritization of projects, considering that what looks vulnerable might not be and vice versa.

CASE STUDY 4: CAMPBELL CREEK DAM REMOVAL PROJECT

Demolition of the Campbell Creek Dam. (Photo: Nathan Wilbur/Atlantic Salmon Federation with permission)

Project: Campbell Creek Dam removal to restore fish passage for Atlantic Salmon and other native fish on this tributary to the Nashwaak River.

Type: Type 3 (restore), freshwater ecosystem

Location: Marysville, a suburb of Fredericton, New Brunswick

Partners: Maliseet Nation Conservation Council (lead), Nashwaak Watershed Association, Atlantic Salmon Federation, Saint Mary's First Nation, Fredericton City Council

Implementation Details: Scale: Tributary scale – 3,300 ha, Timelines: 2016-2021, Cost: $824,000 (2020$) for implementation.

PROBLEM CONTEXT

The Campbell Creek Dam was built in 1919 to provide water for the cotton mill in Marysville, New Brunswick, and was the largest operating dam of its kind in the Atlantic provinces prior to the mill's closure in the 1970s. Indigenous and conservation organizations have long recognized that the dam creates negative environmental impacts, most notably acting as a barrier to the upstream passage of native fish species, including sea-run brook trout, alewives, blueback herring, sea lamprey, American eel, and Atlantic salmon. All of these fish species are culturally important to local First Nations and ecologically important through the delivery of marine-derived nutrients upstream. In addition, American eel is considered threatened and Atlantic salmon is considered endangered by the

Committee on the Status of Endangered Wildlife in Canada, although the decision to list these species under the Species at Risk Act is still under review (COSEWIC 2012, Hudgins 2018). The dam's interference with the natural flow of the creek as well as periodic flushing of headpond water and sediment through a malfunctioning sluice gate have also given rise to concerns about effects on water quality and temperatures that could be detrimental to downstream habitats, exacerbating warming water temperatures associated with long-term regional climate change that are detrimental to fish. Beyond these ecological issues, municipal concerns about the physical deterioration of the city-owned dam led to a geotechnical assessment in 2014. It found the structure to be a public safety liability, providing an added incentive for dam removal.

Notably, other organizations had previously contemplated dam removal but did not follow through to implementation. For example, a resource development company evaluated dam removal as part of potential fish habitat compensation measures associated with a mining project. The option was ultimately rejected as too small a project to meet the "harmful alteration, disruption and destruction" compensation requirements for a mining project of the scale being undertaken (Stantec 2013). Although the dam removal project was the wrong scale for this purpose, it was the right scale for local fish populations and surrounding communities.

APPROACH

Removal of the Campbell Creek Dam to restore the natural hydrology of the creek addressed multiple societal challenges linked to species health, water quality, broader climate change resilience and particularly public safety, providing strong rationale for moving forward with implementation planning.

Removal of the dam was ultimately championed by a coalition led by First Nations (primarily the Maliseet Nation Conservation Council) and conservation partners that first met in 2016 to begin planning after accidental draining of the dam's headpond due to the malfunctioning sluice gate noted earlier appeared to provide a window of opportunity for removal. Restoring fish access to clean cold water is a strategic priority for all organizations in the partnership and is a stated objective in the Nashwaak Watershed Association's Watershed Action Plan. The governance model for this project — a working group, where all partners met at least monthly — was effective to discuss the project, build trust, maintain momentum and ensure long-term sustainability of the project. Project partners also undertook participatory engagement with both the adjacent Saint Mary's First Nation community and the City of Fredericton through public presentations and feedback sessions, which took place in a virtual format due to the COVID-19 pandemic. Despite an overwhelming show of partner and public support, lack of funding continued to pose an obstacle to implementation.

This partnership applied for a major grant through Fisheries and Oceans Canada's Canada Nature Fund for Aquatic Species at Risk and secured approximately $600,000 in 2016 over four years. Along with the strong show of public support,

securing this funding was essential in catalyzing buy-in from the City of Fredericton to provide municipal approval of the project and additional support. Added funds from WWF Canada and the Atlantic Salmon Conservation Foundation also helped get the project off the ground, resulting in a total project budget of $770,000 in 2016 (or $824,000 in 2020$).

Preliminary work included an assessment of alternatives by the Nashwaak Watershed Association, which concluded that dam removal was the best approach to addressing these challenges because it met all objectives, was a tried-and-true method frequently implemented by one of the project partners, the Atlantic Salmon Federation, in neighbouring Maine, and was considered to require less long-term maintenance as natural self-sustaining watershed processes return (Hudgins 2018). In contrast, grey alternatives, such as installation of a fish ladder to provide passage, would require longer-term maintenance and would not address issues of ecosystem function, public safety or water quality. Implementation began with comprehensive baseline site assessments and monitoring starting in 2016 and carried out by partners and participants from First Nations communities, some of which were employed through DFO's Aboriginal Fisheries Strategy program. Baseline assessments examined:

- Eco-hydrological baseline assessment methods: Baseline assessments of the ecology and hydrology of the project area were assembled from multiple sources, including field work by the Nashwaak Watershed Association as well as by the University of New Brunswick and Canadian Rivers Institute from 2016 through 2018. These assessments included measures related to stream geomorphology, hydrology, ecology and water quality, with details on parameters measured and methods documented in Hudgins (2018). This information fed into planning for physical dam removal as well as habitat restoration, and also provided a reference point for comparison to post-project monitoring to evaluate effectiveness for the intended goals of improving watershed function, water quality and fish habitat and populations.
- Socio-cultural baseline assessment methods: The socio-cultural baseline was established by project leads in partnership with the New Brunswick Department of Tourism, Heritage and Culture. Activities included archaeological investigations of the dam itself via test pitting as a historical artifact, due to its age, excavations of the surrounding sites to search for other elements of cultural importance, and ethnographic research in nearby First Nations communities to understand historical significance of the site, fish species and the dam itself. One of the outcomes of the ethnographic research was identification of the Wolastoqey place name for the creek, Pahkwapskw, embodying Indigenous relationships with areas stretching back into the deep past (City of Fredericton 2022). The information from these investigations confirmed that dam removal activities could proceed as planned and documented important cultural context that fed into public communications and interpretive signage associated with the project.

- Planning for the dam removal was carried out by an engineering firm, taking into account the outcomes of baseline assessments. Dam removal occurred in the summer of 2021 so as not to overlap with the timing of critical spawning periods for resident fish based on ecological and Indigenous knowledge and according to federal regulations. Removal began with notching the dam with heavy machinery to allow headpond waters to drain, followed by demolition of the dam infrastructure, redistribution and burying of concrete debris adjacent to the streambed and reconstruction of the stream channel, including placement of in-stream boulders to facilitate fish passage up a steeper section of the restored stream channel. Because of ongoing access and public safety at the work site, the majority of the dam removal process was implemented by engineering and construction contractors with oversight by the project partners and without direct community involvement. However, community members participated in riparian restoration of the former headpond footprint through tree planting and staking, which occurred in tandem with dam-removal activities. Once physical works were completed, heavy machinery was removed, and the site was restored through infilling and planting to cover up vehicle tracks in the process. The implementation phase unfolded largely as planned.
- Select monitoring activities continued through the removal and are intended to be maintained for at least five years after removal concluded to document ecosystem response and alert partners to the potential need for further maintenance or reconfiguration of the site. Post-project monitoring takes place over an area extending above the former dam site down to the mouth of the stream entering the Nashwaak River for the following indicators related to (Hudgins 2018):
- Stream hydrology: By evaluating changes in the longitudinal profile to document vertical and horizontal channel adjustments, changes in slope and changes in pools and riffles; changes in stream stage and discharge using level loggers and flow measurements; and evaluation of changes in sediment movement and substrate size.
- Ecology: By evaluating changes in fish and benthic macroinvertebrate distributions using eDNA, electrofishing and Canadian Aquatic Biomonitoring Network (CABIN) surveys for benthic macroinvertebrates (BMI); survival, regrowth and composition of riparian plant community; presence and extent of invasive species; and presence of terrestrial species (focused on species at risk).
- Water quality: By evaluating changes in physical and chemical parameters, including temperature (via long-term temperature loggers), as well as monthly field probe and grab samples.

IMPACT AND OUTCOMES

Partners and community members consider the project widely successful. Persistence through funding and implementation challenges, a strong foundation

of trust and collaboration across a diverse coalition of committed partner organizations made implementation a reality after many years of contemplating dam removal.

According to a representative of the Maliseet Nation Conservation Council and other project stakeholders at the time of the project's implementation, key social and cultural outcomes from this project included:

- Providing an opportunity for nearby First Nations communities to reconnect with a site in their traditional territory by learning about the site through ethnographic and archaeological investigations and through supporting reconciliation via the removal of a structure considered by some to be a symbol of colonialism.
- Raising awareness about the significance of the site to the broader public through public outreach during project planning as well as the development of interpretive signage about the dam in collaboration with an Indigenous carver.
- Building a local knowledge base for dam removal implementation that can be applied to other dam removal projects in the region or across Canada, which often require similar considerations.

Based on interviews with key project stakeholders and available literature, the expected ecological project outcomes are listed below.

- Rapid improvements in water quality and stream temperatures around the dam site.
- Rapid improvements in the flow of cleaner, colder water downstream into the Nashwaak River that will create a cold-water refuge there, which fish in the larger river will now also be able to access.
- More gradual reconfiguration and stabilization of more natural stream channel structure and hydrology.
- Eventual recolonization by key migratory fish species above the site of the former dam contingent on the gradual stabilization of the stream channel. Because rates of recolonization are expected to vary by species, monitoring is tracking recolonization by both fast and slower colonizers:
    - Some species like alewife and blueback herring are expected to return more quickly.
    - Others like salmon are expected to return more slowly and may also be harder to detect due to their ephemeral use of small creeks like this one for spawning and as a thermal refuge during warm water events. Fortunately, the eDNA component of the post-project monitoring program is sensitive enough to detect even small numbers of fish upstream of the former dam site when upstream migration does occur.
    - At the time of writing, less than two years following dam removal, no key fish species of interest have yet been detected above the site of the former dam.

Post-project followup showed unanticipated damage to project structures, but project partners are taking a "wait and see" approach prior to undertaking further works. Structural elements of the restored site such as boulders were washed away in a high-flow event over the winter following installation, potentially affecting fish passability of the steep gradient or "drop" in the restored streambed during low-flow periods. Although this could be corrected through further work to create step pools across the drop, partners have elected to wait and see if the evolving hydrology and sediment movement of the stream will self-correct this issue over time. Adult fish are still expected to be able to bypass this area during critical spawning periods, which tend to coincide with high flows.

Table 5: Evaluation of project against eight criteria of the IUCN Global Standard for Nature-based Solutions

CRITERION	RATING	RATIONALE
1. Societal challenges	☐	Removal of the Campbell Creek Dam to restore the natural hydrology of the creek is expected to address multiple societal challenges for the aquatic ecosystem (through restoration of more natural stream conditions and fish passage above the former dam site), water quality (through restoration of natural flows), broader climate change resilience (through elimination of the former dam reservoir, which acted as a heat sink and contributed to warmer downstream temperatures), and particularly public safety (by removal of unstable infrastructure).
2. Design at scale	◐	The project took into account its place and influence in the larger landscape through considering upstream access benefits as well as downstream hydrological benefits of improved flows and water quality, but did not significantly incorporate risk identification and management beyond the project site.
3. Biodiversity net gain	◐	Robust monitoring program in place to track recovery of the aquatic ecosystem across multiple species groups. Key benchmarks in this case would be recovery of riparian vegetation and the presence of native fish species and their spawning activities above the former dam site as a measure of restored connectivity. Note that although benefits to fish species are anticipated, post-project monitoring to date suggests that they have not yet been realized.
4. Economic feasibility	◐	Strong and diversified financial and personnel resources drawn from multiple supporting partners were put in place to support implementation of this project. However, this did not include funding for long-term monitoring, which is common for this type of project-based grant funding. Partners are seeking other grants to support this work, and the existing strong partnership networks are likely to make this easier.
5. Inclusive governance	☐	Removal of the dam was ultimately championed by a coalition of First Nations, conservation partners and a municipal government and followed up with broader engagement through consultations with both citizens of the adjacent Saint Mary's First Nation and the City of Fredericton. Interviews with key stakeholders indicate that concerns brought forward through consultation were considered in project design, but documentation of the consultation and design process was not available to confirm.

6. Balance trade-offs	☐	Trade-offs among potential project alternatives were considered in a pre-project baseline assessment report, and measures were taken to implement environmental safeguards throughout the project as required by local regulations (e.g., timing the removal to avoid spawning season of fish downstream).
7. Adaptive management	◐	Robust monitoring program in place to track project outcomes and inform the need for future interventions at the site, with ongoing meetings by partners to review progress, although funding for future monitoring has yet to be secured.
8. Mainstreaming & sustainability	◐	Public communication assets, including photos and a video, were produced to raise awareness of project benefits and implementation. As monitoring is ongoing, lessons learned have not been shared broadly to date for mainstreaming (though participation in this case study is a start).

BARRIERS AND ENABLERS OF SUCCESS

Key project challenges included strong opposition from a minority of landowners in the area who stood to lose the recreational benefits of the headpond when the dam was drained, a common occurrence in these types of projects. This was overcome through enabling factors of a committed and enduring partnership, cultivation of an overwhelming show of public support from the broader community and persistent efforts at engagement or accommodations to keep moving forward.

KEY LESSONS LEARNED

People directly involved in the project's planning and implementation highlight the following lessons:

- Work to build a strong, diverse and persistent partnership that includes Indigenous and non-Indigenous participants who meet regularly and be able to demonstrate overwhelming community support before proceeding with implementation planning to maximize the likelihood of success.
- Leverage partnerships and networks to secure funding through diverse sources, which helps to open doors, generate buy-in and overall smooth the pathway to implementation.
- Benefit from the experiences of partners carrying out similar projects elsewhere.
- Manage expectations about how quickly the ecosystem will be able to recover, and celebrate early wins from those species and environmental indicators that are expected to respond more quickly.

CONCLUSIONS

Key takeaways

- Use of the IUCN Global Standard for NbS or similar guidance can improve project concepts and support the generation of multiple benefits for people and nature.
- Context is important in shaping NbS effectiveness. Normative (e.g., policy frameworks) and organizational structures influence project design, including extent of their inclusiveness, consideration of trade-offs, economic feasibility and monitoring practices. Organizational culture regarding learning influences adaptive management and the uptake of lessons from implementation.
- Factors that get NbS projects started include legal drivers (e.g., public safety) and the availability of seed funding. Timing is also important and predictable municipal planning processes provide windows of opportunity to instigate the incorporation of nature-based approaches. Further, access to technical resources (e.g., ecosystem service assessments) equip NbS champions with information to make a case to decision-makers.
- Factors that sustain implementation include strong leadership, partnerships, a shared vision over the outcome and reporting on implementation progress.
- For NbS projects to gain credibility as cost-effective alternatives to conventional development or conservation, transparency regarding the benefits claimed is essential. This elevates the importance of sustained monitoring that integrates social and environmental metrics and of adaptive management.

Although intended as a self-assessment tool, the IUCN Global Standard for NbS provided a useful framework to structure case studies and compare across them. A likely key benefit of using the global standard to inform the design and planning of NbS at the project level is the awareness raised of the components that "good" NbS projects entail in order to generate multiple benefits. In this way, projects that are driven by the need to provide services to human communities (e.g., the Toronto Tree Canopy and Waterfront Shoreline Project and the Shepard Constructed Wetland) can strengthen biodiversity aspects. Conversely, projects that are biodiversity/conservation-driven can look for opportunities to extend the benefits toward socio-cultural domains (e.g., Edéhzhíe and Campbell Creek Dam Removal). Thinking more holistically at the conceptual stage can help strengthen or forge new partnerships and unlock unconventional sources of funding. For example, having Indigenous partners in the Campbell Creek Dam Removal project integrated a cultural dimension that otherwise would not have been present and the project

team was able to secure funding that was preferentially allocated to Indigenous Peoples.

At the same time, context matters greatly in determining the specific structures and provisions needed to support NbS implementation. Organizational structures, including legal requirements, policies and planning processes, have the potential to influence NbS implementation at the project level. Case studies led by municipalities (e.g., Toronto and Calgary) are good examples of this, as the extent of their inclusiveness, consideration of trade-offs, economic feasibility and monitoring practices were influenced by existing organizational standards and ways of working. The opportunity also exists for experience with NbS projects to feed back into local and regional policies, strategies and standards, scaling up benefits of project-level implementation. However, in order to harness lessons from NbS implementation, attention to knowledge management is essential, and this relates to organizational culture regarding learning. At the project level, proponents would benefit from horizon scanning and networking to make a project concept more effective by learning from similar interventions. For example, the Atlantic Salmon Federation has gained significant experience in dam removal, which other groups in the region can benefit from if they can access project documentation (e.g., final project report that will be submitted to the City of Fredericton and DFO) and/or practitioners who worked on the project. Organizations working at the cityscape or landscape level or regionally can think beyond the site level (e.g., urban parks as a network of good habitat patches, with bioswales and green medians as corridors), reflect on synergies across NbS projects and identify positive cumulative effects of their NbS interventions.

The case studies illustrate a range of factors that catalyze or instigate NbS projects, and other factors that sustain the momentum for NbS implementation. Factors that get NbS projects started include legal drivers, such as public safety, liability and compliance with species at risk legislation. Having seed funding in place to attract other partners to get on board with the project has also proven to be catalytic. Municipal planning processes and strategies and vehicles for multi-jurisdictional collaboration provide entry points for applying novel approaches to environmental and land management. If these processes have predictable time frames (e.g., for updates), they can become windows of opportunity to instigate approaches centred on NbS. Technical resources, such as ecological and socio-economic assessments of value streams present on land areas, equip proponents with the data and rationale on why the intervention is important. Having robust quantitative information is especially salient for decision-makers. The case of Edéhzhíe is worth highlighting in this context. Supplementing Indigenous knowledge on the importance of the area with assessments underpinned by western science redoubled the justification for protecting the area. Factors that help sustain projects through implementation ups and downs include strong leadership, partnerships that help extend capacity (human and financial), a shared vision for the outcome to serve as a touchstone and reporting on implementation progress. On this last

point, leaning on a pre- and post-monitoring program that integrates indicators of implementation, effectiveness and status and trends monitoring generates evidence to satisfy stakeholders' expectations to see NbS results quickly and over time, as ecosystems recover or human communities are buffered from climate change impacts, for example.

The importance of investing in assessing NbS effectiveness and using the data for adaptive management cannot be overstated. These case studies largely relied on stakeholder assertions to report on expected impact and outcomes of the NbS projects. However, for NbS projects to gain credibility as cost-effective alternatives to conventional development or conservation, transparency in the benefits claimed is essential. This elevates the importance of sustained monitoring that integrates social and environmental metrics. Indeed, in the spirit of NbS, monitoring frameworks should clearly chart a path between ecosystem services and human well-being. Robust monitoring not only yields evidence to secure additional funding but also informs course corrections within the project and decisions of others contemplating the same types of projects in similar contexts. Enabling collation of the results of NbS projects and making these accessible through a digital portal is a worthy role of knowledge brokers and researchers supporting taking NbS to scale.

APPENDIX 1: INTERVIEW GUIDE FOR CASE STUDY DEVELOPMENT

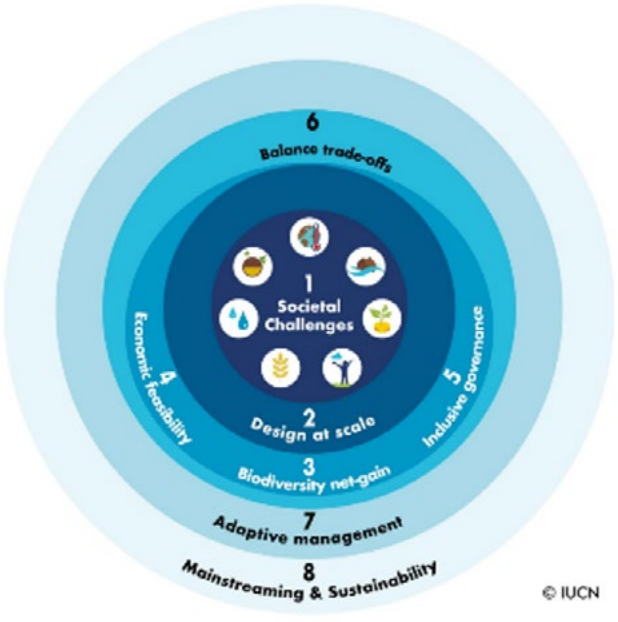
BACKGROUND

Target audiences: For internal use by DSF (primary) and to share with ENGOs advocating for nature-based solutions in Canada (secondary)

Questions these case studies should answer: How inclusive have the decision-making processes surrounding NbS implementation been, particularly regarding rights holders? How effective are selected NbS projects at achieving their focal ecosystem service and expected co-benefits over time? What factors during design and planning, implementation and post-implementation enabled NbS effectiveness? The collective case studies should answer the question: How effective is the IUCN Global Standard for Nature-based Solutions to predict high-quality NbS implementation at the project level?

Framework: We will be using the criteria in the IUCN Global Standard to structure the case study analysis. The big question we are pursuing is: Are these projects successful in maintaining ecological integrity and equitable in their process and distribution of benefits?

Implicit in this IUCN's eight interrelated criteria is a results chain (at least this is one interpretation): IF a nature-based solution responds to key societal challenges [1], matches the scale of the problem [2], acknowledges and balances trade-offs [6], is cost effective [3] and has inclusive governance [5] AND includes provisions for adaptive management [7] and policy integration [8], THEN it will ensure net ecosystem gain [3] and social equity [5] over the long term.



INTERVIEW QUESTIONS

Start with welcome/introductions, reminder of how the interview will be used; ask for consent to record and for the use of quotes (just in case we need them).

Project context

Q1. The concept of nature-based solutions (i.e., actions that protect, create, sustainably manage or restore an ecosystem in order to address societal challenges while simultaneously providing human well-being and biodiversity benefits) is relatively new. To your knowledge, was the focus on harnessing nature or naturalized systems as a way to generate benefits to people and biodiversity intentional? [1]

Tip: Many of these projects were developed before NbS were popular. The goal here is to try and tease out whether the project had these objectives in mind (could be ecosystem-based approaches) and whether these benefits and services were considered in project planning.

Q2. Tell me about how the project came about. What motivated you/your organization to embark on the project/initiative? What problems or challenges were you addressing? [1], [2]

Tip: It's less important to focus on what the project/initiative is or was than to try to uncover why it was pursued and what the intentions were. When covering drivers/ motivating factors listen for socio-ecological context (i.e., societal challenges, drivers of change).

Project planning

Q3: How did you decide on the NbS implemented? What other options did you consider? What trade-offs did you need to make? [2], [4], [6]

*Tip: We want to understand things like what steps they took to make a decision, what criteria they used (e.g., highest benefit cost ratio, compliance with policy directive, widespread support, drive for innovation), why this solution was *the* one chosen in response to the challenge.*

Q4. Who was involved in deciding on the NbS implemented? What internal and external engagement took place to make the decision? [5]

Tip: We want to understand how inclusive the decision-making process was. It's possible that the decision on this intervention took place within the context of a broader planning process (i.e., the NbS was an element of a bigger initiative). We want to know about the extent to which Indigenous rights were considered (for non-Indigenous projects). Probe that, either now or later on, depending on how the flow of the conversation goes. Would external engagement look different today, in the context of commitments to reconciliation with Indigenous Peoples?

Project implementation and monitoring

Q5. Did project implementation proceed as planned? What challenges did you encounter along the way, and how did you overcome them? If the project/ initiative is ongoing, what new challenges have come up and what are you doing in response?

Tip: Listen for gaps related to 1) data and knowledge; 2) skills and competencies; 3) leadership; 4) inclusivity and community roles; 5) norms both social and political (policies, standards); 6) collaboration/networks; 7) trade-offs and 8) innovation. Look at Excel inventory and ask about the challenges that have been highlighted for your project, for further probing. Also, try to reflect back to them what the key challenges were: Was it a governance challenge, management challenge, performance challenge, collaboration/partnership challenge, extreme event/climate change impact, surprises they could not have anticipated, etc.

Q6. What role did monitoring play in your NbS project? [7]

Tip: Listen for/probe the type of monitoring employed (implementation or effectiveness), for how they used monitoring data for decision-making, learning and reporting, who did the monitoring. Did they course-correct based on evidence from monitoring? If you have good documentation on monitoring, you can focus on specific questions that linger for you based on what you have read.

Project impact

Q7. What are or have been the project's successes? What goals were met/not met? [3], [5]

Tip: Summarize these specific successes and goals met and ask for confirmation/ validation from the key informant. If not offered as part of their answers, make sure to ask about 1) biodiversity benefits, enhancements in ecosystem services and the expected co-benefits over time and 2) human-centred outcomes (e.g., homes protected from flooding). If we don't have this already, ask about project reports, evaluations documenting project impact. Look at Excel inventory and ask about results we are most unclear/uncertain about.

Q8. Who has benefited most from the project? In what ways? [5]

Tip: This gets at whether benefits from the project were equitable. It would be nice to hear "nature benefitted" too. There may have been unanticipated impacts too. Try to probe this.

Q9. What are some of the key factors that contributed to your project's success? Walk us through a timeline, or the sequence of events, leading up to specific results.

Tip: Listen for policy or regulatory drivers; market/social demand; capacity and/or experience with specific tools/methods / approaches; key partnerships; inclusive planning process; the solution matched the scale of the problem.

Future outlook

Q10. What are the outstanding gaps or challenges that still need to be addressed? What needs to be done next to amplify the benefits generated from the project? To ensure long-term benefits? [8]

Tip: This is a "pathway" question. Here is where the respondent can elaborate on any gaps/challenges/barriers to help us to identify any necessary steps in a proposed path forward.

Q11: What two to three pieces of advice or lessons learned do you have for others (other sectors, organizations) trying to achieve similar goals?

Tip: Focus on ways benefits could be enhanced/transfer and upscale NbS, including pathways for learning from the project to inform design of others and key information gaps.

Q12: Do you have any suggestions for additional sources of information we should be consulting and people to talk to? If applicable, do you have any internal documentation that is not publicly available about the project that you have permission to share?

Tip: Key is to gain planning information that often isn't publicly available. In the interview (especially with municipal governments), suggest you may be willing to sign a confidentiality agreement. For people to consult, suggest decision-makers/catalysts for project implementation not be identified publicly.

APPENDIX 2: LIST OF INTERVIEW PARTICIPANTS

CASE STUDY 1

- Lindsay Armer, manager, Conservation Partnerships and Protected Areas, Canadian Wildlife Service, Northern Region, Environment and Climate Change Canada, Edéhzhíe Management Board Member.
- Daniel Slavik, section head of Conservation Partnerships and Protected Areas, Canadian Wildlife Service, Northern Region, Environment and Climate Change Canada.
- Olaf Jensen, director of the Protected Areas Program, Canadian Wildlife Service, Environment and Climate Change Canada.

CASE STUDY 2

- Bert van Duin, drainage technical lead, City of Calgary.
- Jillian Curley, corporate environmental specialist – climate change adaptation, City of Calgary.
- Trina Vickery, supervisor, parks programs, Recreation and Social Programs, City of Calgary.

CASE STUDY 3

- Emilio Borges, project lead, City of Toronto.
- Jet Taylor, manager, capital and special projects, Toronto and Region Conservation Authority.
- Raymond Vendrig, manager, urban forestry, City of Toronto.

CASE STUDY 4

- Jillian Hudgins, environmental strategist, City of Fredericton (project coordinator for Nashwaak Watershed Association at the time of project implementation).
- Natalie Deseta, environmental coordinator, Province of New Brunswick (project coordinator for Nashwaak Watershed Association at the time of project implementation).
- Nathan Wilbur, executive director of regional programs, Atlantic Salmon Federation.
- Kaleb Zelman, biologist at Fisheries and Oceans Canada (formerly project lead with the Maliseet Nation Conservation Council).

APPENDIX 3: REFERENCES

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