



STANDARDS RESEARCH

# Managing Flooding and Erosion at the Watershed-Scale: Guidance to Support Governments Using Nature-Based Solutions

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## Authors

**Joanna Eyquem**, PGeo. ENV SP. CWEM. CEnv. Intact Centre on Climate Adaptation, University of Waterloo

## Project Advisory Panel

**Antoine Verville**, Metropolitan Community of Quebec, Quebec

**Christine Zimmer**, Credit Valley Conservation, Ontario

**Darwin Durnie**, Darwin Durnie Consulting Corporation

**Enda Murphy**, National Research Council Canada

**Michelle Tetreault**, Public Works Management Corp., Alberta

**Ralph Schielen**, Rijkswaterstaat, Ministry of Infrastructure and Water Management, The Netherlands

**Rehana Rajabali**, Toronto and Region Conservation Authority, Ontario

**Steve Litke**, Fraser Basin Council, British Columbia

**Kenneth Clogg-Wright**, CSA Group (Project Manager)

**Ana-Maria Tomlinson**, CSA Group

**Dragica Jeremic Nikolic**, CSA Group

**Helene Vaillancourt**, CSA Group

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**Rachel Clarke**, ACAP Cape Breton

**Guillaume Durand**, Ministère des Affaires municipales et de l'Habitation, Quebec

**Sean Ferguson**, National Research Council Canada

**Rosemarie Ferjuc**, Red Deer River Watershed Alliance

**Raelene Fewer**, Helping Nature Heal

**Mark Hartley**, Nottawasaga Valley Conservation Authority

**Steve Hounsell**, Ontario Biodiversity Council

**Jillian Hudgins**, City of Fredericton



**Fabien Hugue**, AECOM Canada  
**Zahra Jandaghian**, National Research Council Canada  
**Sean Lee**, City of Fredericton  
**Bernard McDonell**, Government of British Columbia  
**Michelle Molnar**, Municipal Natural Assets Initiative  
**Alistair Ozon**, City of Charlottetown  
**Shelley Petrie**, Greenbelt Foundation  
**Ted Preister**, Red River Basin Commission  
**Ashley Rawluk**, International Institute for Sustainable Development  
**Pablo Rodriguez**, Government of Saskatchewan  
**Lynne Roszell**, Saskatchewan Association of Watersheds  
**Namrata Shrestha**, Toronto and Region Conservation Authority  
**Barbara Veale**, Conservation Halton  
**Joshua Wiebe**, Environment and Climate Change Canada

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# Executive Summary

Flooding and erosion are natural river processes that have been, and continue to be, modified by human activity. Risks result where flooding and erosion present a danger to public safety and built infrastructure.

Historically, flood and erosion risk management techniques have relied largely on “grey” infrastructure solutions, such as flood walls, dikes, and river channel modifications, to control natural processes and reduce risk. Many of these techniques resulted in negative impacts on river ecosystems.

In contrast, nature-based solutions (NbS), such as restoring wetlands or upland forests, can be used to manage river flooding and erosion in a way that provides benefits for both people and nature. This role is specifically identified in Target 11 of the recently adopted Kunming-Montreal Global Framework Directive, which calls for parties to use NbS to restore, maintain, and enhance nature’s contributions to people, including protection from natural hazards.[1]

The role of NbS in flood and erosion risk management is increasingly recognized in Canada but it is not yet mainstream. Key needs identified in recent international and national publications include:

- Adoption of a “whole-ecosystem” approach to flood and erosion management at the watershed-scale.
- Identification and valuation of the multiple co-benefits of NbS; and
- Proactive management of natural infrastructure alongside built infrastructure, including preserving, conserving, and restoring natural assets.

The paper puts forward three recommendations to support future implementation of NbS for flood and erosion risk management by governments in Canada, supported by findings of this research report:

## 1. Development of a consistent approach to integrated watershed management.

A review of watershed management in Canadian provinces, where the majority of Canadians live, found that Ontario is the only province where watershed-scale organizations (called Conservation Authorities) have a legal mandate that combines river flood and erosion risk management (with exceptions) and nature conservation. While many provinces have developed programs to support NbS, the objectives of these programs frequently focus on habitat quality and biodiversity rather than flood and erosion risk objectives. There is opportunity to build on the existing good practice approaches identified in this report and extend them to other provinces.

## 2. Funding of watershed-scale flood and erosion strategies that address high-risk areas.

Analysis indicates that many flood and erosion risk management projects funded under the federal National Disaster Mitigation Program (NDMP) and Disaster Mitigation and Adaptation Fund (DMAF) have been led by, and undertaken within, single cities and towns. Watershed-scale organizations have only undertaken funded projects in Ontario and British Columbia. In addition, only a few projects funded under the NDMP and DMAF programs have incorporated NbS. Future funding of watershed-scale strategies should support measures, such as NbS, that address underlying causes of flood and erosion risk, while achieving multiple benefits. Indigenous governments could play a leading role in such watershed-scale approaches.

## 3. Routine consideration of NbS for river flood and erosion management.

NbS are currently an underutilized option for flood and erosion risk management in Canada. There is an opportunity to update protocols or funding procedures to promote consideration of NbS as the default solution, with grey solutions being compared and applied where technically required or more beneficial overall.

Federal, provincial, watershed-scale, and local governments (including municipal and Indigenous governments) all have roles to play in implementing the above stated recommendations. In particular, provincial governments play a key role, since they have jurisdictional responsibility for implementing flood and erosion risk management.

### **Federal government**

- Support and work with provincial governments to develop guidance for, and help fund, a nationally consistent watershed planning framework that includes agreed-upon minimum requirements for flood and erosion risk management at the watershed scale. This could be progressed through the Canadian Water Agency or through work to achieve targets set by the National Adaptation Strategy (although the strategy itself does not explicitly include watershed-scale management, several of the objectives and targets would benefit from this approach).
- Work with provincial governments to identify priority watersheds (high-risk areas or vulnerable communities) for which flood and erosion management strategies are required to be completed first (if they have not been completed already).
- Update existing federal funding programs (e.g., DMAF, Natural Infrastructure Fund) or create new funding programs to a) direct funds to projects that address flood and erosion risk at the sub-watershed / watershed-scale and b) require routine consideration of NbS as the default solution, to be combined with grey infrastructure where necessary.
- Support development and use of national guidelines and standards to support use of NbS for flood and erosion management (see Section 5.3 for discussion of specific standards).

### **Provincial governments**

- Strengthen provincial legislation and policy to support watershed-scale approaches to manage flood and erosion risk, including the use of NbS.
- Work with the federal government to develop guidance for, and help fund, a nationally consistent watershed planning framework that includes agreed-upon minimum requirements for flood and erosion risk management at the watershed scale. Provincial governments have a key role to play as watershed management (apart from international watersheds) is a provincial jurisdiction.
- Work with federal government to identify priority watersheds (high-risk areas or vulnerable communities) for which flood and erosion management strategies are required to be completed first (if they have not been completed already).
- Develop flood and erosion risk management strategies at the watershed / sub-watershed scale for prioritized high-risk areas. Update provincial funding programs to a) direct funds to projects that address flood and erosion risk at the sub-watershed / watershed-scale and b) require routine consideration of NbS as the default solution, to be combined with grey infrastructure where necessary.

### **Watershed governance organizations**

- Work to include the use of NbS for flood and erosion risk management as a watershed management objective. Ensure that the flood and erosion risk reduction benefits of NbS are documented, even when this is not the primary objective of the solution.
- Continue to use NbS for flood and erosion management as a default solution where appropriate. Work with local community groups, businesses, and governments to publicize the multiple benefits delivered.

- Work to inventory, value, and manage the services provided by natural assets within the watershed, including flood and erosion protection. Continue to protect existing natural assets and prioritize restoration efforts in areas with the highest potential benefit.
- Continue to provide technical support to local governments with flood and erosion risk management and planning / implementation of NbS projects.
- Communicate the value of natural assets and the role of NbS in flood and erosion protection to residents.

**Local governments (including municipal and Indigenous governments)**

- Work with watershed organizations to help identify, plan, and implement NbS for flood and erosion risk management.
- In the absence of a watershed governance organization, work with other local governments to help identify, plan, and implement NbS for strategic flood and erosion risk management at a watershed / sub-watershed scale.
- Consider NbS as the default solution for flood and erosion risk management, to be combined with grey infrastructure where necessary.
- Work to inventory, value and manage the services provided by natural assets, within both the local government jurisdiction and upstream watershed, including flood and erosion protection.
- Communicate the value of natural assets and the role of NbS in flood and erosion protection to residents.
- Work with private land owners / farmers who can contribute to nature-based solutions.

Future standards that could support implementation of the three recommendations are:

- A minimum framework for watershed management planning;
- A standardized approach to the strategic appraisal of river flood and erosion risk management options at the watershed-scale;
- Standards to support the identification, valuation, and management of services provided by natural assets; and
- A standardized option appraisal protocol for flood and erosion management projects, integrating the financial value of benefits and costs associated with NbS.





“Changing climatic conditions, alongside the continued degradation of these natural assets, are causing worsening river hazards in many watersheds.”

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## 1 Introduction

### 1.1 Background

Floods are the costliest natural disasters in Canada in terms of property damage [2]. Canada’s natural assets, including floodplains, wetlands, natural river channels, riparian vegetation, and upland forests, help regulate riverine flooding and erosion. However, changing climatic conditions, alongside the continued degradation of these natural assets, are causing worsening river hazards in many watersheds. In particular, more intense rainfall and drought conditions are foreseen in many locations of Canada [3], making the role that nature plays in reducing the impacts of these extreme weather events even more vital.

Nature-based solutions (NbS) are actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits [4]. NbS tackle climate change by enhancing resilience and sequestering carbon, while enhancing biodiversity and delivering a wide range of ecosystem services. In particular, NbS can be used to reduce river flood and erosion risk, as demonstrated by CSA’s recent research report “*Nature-Based Solutions for Coastal and Riverine Flood and Erosion Risk Management*” [5].

Canada’s National Adaptation Strategy, launched in November 2022, includes clear support for NbS with a bespoke objective that states “*the use of nature-based*

*solutions is accelerated to increase resilience and maximize co-benefits such as reducing stress on grey infrastructure and increasing social benefits of nature*” [6]. In addition, the newly signed Kunming-Montreal Global Biodiversity Framework includes Target 11: to “*restore, maintain and enhance nature’s contributions to people, including...protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature*” [1]. It is anticipated that Canada will update the National Biodiversity Strategy and Action Plan to align with the new framework. However, NbS are not yet used extensively by provincial and local governments as part of the routine toolbox for river flood and erosion management in Canada. Their multiple benefits are not routinely reflected in option appraisal, and grey infrastructure (engineered infrastructure composed of man-made materials) remains the default solution for many projects.

Deployment of NbS requires a strategic approach to flood and erosion management, ideally at the watershed-scale. A watershed (also often referred to as a drainage basin or river basin) is an area that drains water into a particular river or set of rivers [7], and it is the fundamental unit for managing fresh water. There is currently no national guidance or Canadian standard concerning management of flood and erosion risk at the watershed-scale.

Historically, flood and erosion risk management in Canada has focused on the community or building scale. Consequently, solutions, standards, and

guidance have also been primarily developed at the community or building scale (Figure 1). Provincial and local governments, as well as other stakeholders involved in riverine flood and erosion management, now need national actionable guidance on appraising NbS to help them mainstream these techniques, including working up to the watershed-scale.

## 1.2 Aim and Objectives

The key aim of this research report is to identify best practices and recommendations for all levels of government, specifically to support river flood and erosion management at the watershed-scale, including the use of NbS. The work builds on findings of a previous CSA Group research report, “Nature-Based Solutions for Coastal and Riverine Flood and Erosion Risk Management [5].”

Specific objectives are to:

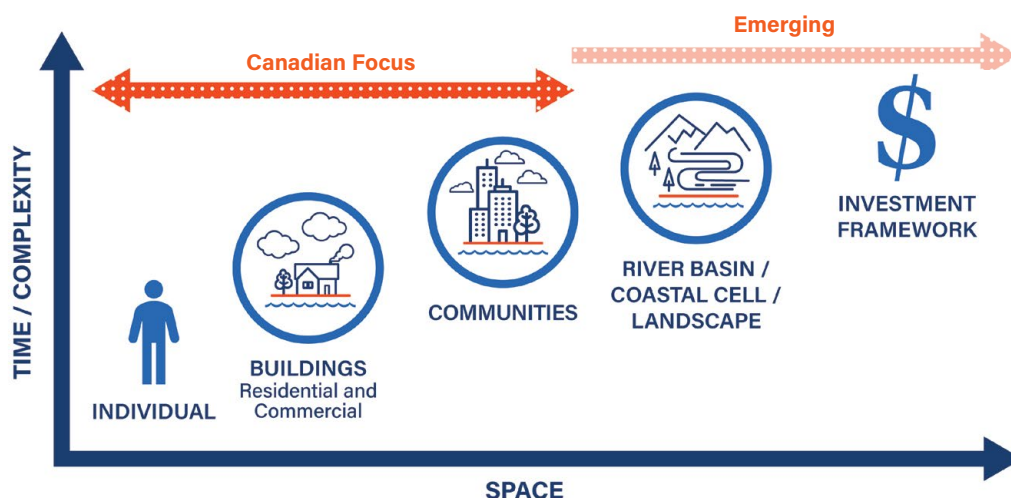
- Summarize key findings of recent research on the use of NbS in Canada for decision makers.
- Review the status of watershed management in Canadian provinces (excluding Newfoundland and Labrador).
- Analyze the scale of flood and erosion projects that have been funded by two key federal government programs: the National Disaster Mitigation Program and the Disaster Mitigation and Adaptation Fund.

- Identify existing good practices and lessons learned in watershed management and use of NbS to reduce river flooding and erosion.
- Identify how the benefits of NbS can be better integrated into the appraisal of options.
- Provide guidance and recommendations for governments to improve watershed-scale management of river flood and erosion risk, including the use of NbS.
- Identify areas for future guidance and standardization to support governments managing river flood and erosion risk and using NbS at the watershed-scale.

## 1.3 Scope

This research report is scoped to the management of river flooding and erosion. Excluded from the scope are other sources of flooding and erosion, including coastal or tidal flooding and erosion, heavy rainfall flooding, groundwater flooding, ice-jam flooding, and landslides. The guidance is relevant to inhabited watersheds in the following Canadian provinces: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island. The research does not specifically address the Great Lakes, international transboundary watersheds, estuaries, or watersheds in Newfoundland and Labrador and Canadian territories (Northwest Territories, Nunavut, Yukon,) that are subject to unique challenges.

Figure 1: Focus of Flood Resilience Guidance and Standards in Canada



## 1.4 Intended Audience

This guidance is intended to be useful to a wide range of stakeholders involved in the management of river flooding and erosion, including, but not limited to:

- All levels of government;
- Watershed and river management practitioners, including Indigenous peoples (First Nations, Metis, and Inuit). This may include, but is not limited to, people working in the public sector, regional authorities, communities, governments, watershed management organizations, non-governmental organizations, and consultants;
- Project financers; and
- Others with a role in the delivery of river flood and erosion management services.

Readers are strongly recommended to consult the preceding research report “Nature-Based Solutions for Coastal and Riverine Flood and Erosion Risk Management” [5].

## 2 Methods

This guidance has been developed through a combination of desktop research and analysis and stakeholder engagement.

### 2.1 Desktop Research and Analysis

Desktop research and analysis focused on establishing current understanding and practices relating to watershed management of river flood and erosion risks and the use of NbS. Specific tasks were to:

- Summarize key findings of recent research on the use of NbS in Canada for decision makers;
- Review the status of watershed management in Canadian provinces (excluding Newfoundland and Labrador); and
- Analyze the scale of flood and erosion projects, including NbS projects, that have been funded by two key federal government programs—the National Disaster Mitigation Program and the Disaster Mitigation and Adaptation Fund—and implications for application of NbS approaches at the watershed-scale.

### 2.2 Stakeholder Engagement

Stakeholder engagement was undertaken to document, share, and collate guidance and best practices in implementing NbS for river flood and erosion risk management in Canada.

Over 40 stakeholders were engaged, contributing experiences from British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island. Additional insights were provided from the Netherlands and the United Kingdom. Participants represented a range of organizations, including governments, watershed organizations, consultants, non-governmental organizations (NGOs), and academia.

Stakeholder engagement was centred around two half-day, virtual focus groups, held in May and June 2022:

- Focus Group 1 - Taking a Watershed Approach
- Focus Group 2 - Including NbS Benefits in Options Appraisal

The focus groups were structured to stimulate discussion and collect information and feedback using a variety of methods:

- Online questionnaires sent to invitees prior to each focus group;
- Brief presentations from subject matter experts;
- Interactive polling activities; and
- Small group and plenary discussions with interactive whiteboards and note takers to capture key discussion points.

The program of each workshop is detailed in Appendix A.

Stakeholders were also invited to review and provide comments on this report.

## 3 Review of Current Understanding and Practices

### 3.1 Recent NbS Research: Key Findings for Decision Makers

This section extracts key findings of selected recent research publications that are directly relevant to the use of NbS to reduce river flooding and erosion by governments in Canada (Table 1). The findings are provided as context for the current research project. Readers are invited to consult the original reports for further details.

Common messaging from these recent key publications includes the need to:

- Adopt a “whole-ecosystem” approach to flood and erosion management that may necessarily go beyond municipal or community boundaries.

- Identify and value multiple co-benefits of NbS, in addition to the potential flood and erosion damages avoided.
- Proactively manage natural infrastructure in view of the services provided, in a similar way to built infrastructure, including preserving / conserving existing natural assets.

### 3.2 Review of Watershed Management in Canadian Provinces

#### 3.2.1 Watersheds in Canada

Canada is the second largest country in the world, with very different sized watersheds, from the very large (e.g., Great Lakes – St. Lawrence River Basin) to the very small (e.g., watersheds on Prince Edward Island).

Watersheds have been identified and mapped nationally across Canada. The Standard Drainage Area

**Table 1:** Key Findings of Relevant Research Publications

Publication	Key Findings for Decision-Makers
<b>International Guidelines on Natural and Nature-Based Features for Flood Risk Management [8]</b>	<ul style="list-style-type: none"> <li>▪ NbS can contribute to riverine flood and erosion management by:                             <ul style="list-style-type: none"> <li>▪ Storing, slowing, and reducing flood waters in the upper and middle watershed, using native vegetation where possible;</li> <li>▪ Improving connectivity of watercourses with their flood plains, creating space for water and room for the river;</li> <li>▪ Preserving or restoring sediment processes; and</li> <li>▪ Restoring lowland and river delta functions.</li> </ul> </li> <li>▪ <b>In addition to flood and erosion risk management, riverine NbS also provide a wide range of ecosystem services, including:</b> <ul style="list-style-type: none"> <li>▪ Groundwater recharge and drought amelioration;</li> <li>▪ Water quality improvement and greater freshwater availability;</li> <li>▪ Biodiversity enhancement and habitat improvement;</li> <li>▪ Improved aesthetics compared to conventional infrastructure; and</li> <li>▪ Human health, welfare, and recreational opportunities.</li> </ul> </li> <li>▪ <b>Five categories are identified for application of NbS:</b> <ul style="list-style-type: none"> <li>▪ River and floodplain management;</li> <li>▪ Vegetation management;</li> <li>▪ Rural runoff management;</li> <li>▪ Urban runoff management; and</li> <li>▪ Erosion management.</li> </ul> </li> </ul>

<p><b>Nature-Based Solutions for Coastal and Riverine Flood and Erosion Risk Management [5]</b></p>	<ul style="list-style-type: none"> <li>▪ NbS can play a much greater role in managing flood and erosion risk in Canada, and they are currently underutilized.</li> <li>▪ Flooding and erosion are fundamental to the function of natural systems. Negative consequences and risks occur where flooding and erosion intersect with vulnerable people or valued assets. Disruption of natural processes can narrow the range of options available to manage these risks.</li> <li>▪ Several guides and programs have been produced in Canada (overviewed in Appendix B of the referenced report). These outputs provide a useful basis for future national guidance but lack technical detail.</li> <li>▪ Further research needs include:             <ul style="list-style-type: none"> <li>▪ <b>Inclusion of NbS in Planning/Decision-Making Frameworks</b> –There is a need for improved planning and decision-making frameworks that incorporate NbS as tools in the portfolio of possible strategies for flood and erosion risk management.</li> <li>▪ <b>Performance Monitoring</b> – Long-term multi-year monitoring programs are needed to demonstrate performance over time and build confidence in NbS.</li> </ul> </li> </ul>
<p><b>Natural Assets Management Considerations for Engineering and Geoscience Professionals [9]</b></p>	<ul style="list-style-type: none"> <li>▪ Natural assets, such as streams, aquifers, forests, and foreshores, provide core services that local governments are commonly directly responsible for in Canada (e.g. stormwater management, drinking water filtration, and groundwater protection) as well as other benefits including recreation, climate regulation, clean air, natural habitat, and biodiversity.</li> <li>▪ Proactive management of natural assets can help local governments to:             <ul style="list-style-type: none"> <li>▪ Manage community financial and asset risk</li> <li>▪ Enhance service provisioning to communities</li> <li>▪ Partner with Indigenous communities in support of local infrastructure enhancements</li> <li>▪ Build climate resilience.</li> </ul> </li> <li>▪ Natural assets do not follow jurisdictional or ownership boundaries. Local governments must concern themselves not only with natural assets they own or manage, but also with natural assets they do not own or manage but rely on for services.</li> </ul>
<p><b>Rising Seas and Shifting Sands: Combining Natural and Grey Infrastructure to Protect Canada's Eastern and Western Coastal Communities [10]</b></p>	<ul style="list-style-type: none"> <li>▪ Canada can use NbS alongside grey infrastructure to manage flooding and erosion risk. Different measures can be combined to fulfill multiple objectives within communities.</li> <li>▪ National standards are needed to enable formalized evaluation of the multiple benefits of NbS when comparing different infrastructure options. It is recommended that this considers minimum requirements alongside regional-specific standards, together with ways to elevate and integrate the knowledge of Indigenous peoples and the financial value of benefits derived from NbS.</li> <li>▪ Flood and erosion protection measures should be subject to minimum monitoring requirements, including funding for long-term monitoring and engagement with Indigenous peoples. Monitoring should be designed to document performance against project-specific objectives.</li> <li>▪ Public-private partnerships can potentially assist in financing, delivering, monitoring, and maintaining NbS.</li> </ul>





“Although watersheds have been identified throughout Canada, the degree to which they are used as a basis for management varies significantly across the country.”

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Classification (SDAC) is Statistics Canada's official classification of drainage areas in Canada [11]. The classification identified 11 major drainage areas and 164 sub-drainage areas in Canada.

Within sub-drainage areas, smaller sub-sub-drainage areas were identified and form the basis of the National Hydrographic Network (NHN) database that is maintained by National Resources Canada. The NHN provides continuous geospatial data and basic attributes describing Canada's inland surface waters, including watershed boundaries of more than 1,382 basins covering the entire Canadian landmass [12]

The online data service, ClimateData.ca, provides over 30 pre-calculated climate indices that can be analyzed at the NHN watershed level. Data can be viewed on a map, as an interactive time series, or downloaded from the website [13].

Although watersheds have been identified throughout Canada, the degree to which they are used as a basis for management varies significantly across the country. A review of integrated watershed management approaches across Canada was undertaken by the Canadian Council of Ministers of the Environment in 2016 [14]. This review did not specifically focus on flood and erosion risk management responsibilities, and many significant changes in provincial watershed management have occurred in the six years since the review was published.

This section presents an up-to-date overview of watershed management within Canadian provinces

(excluding Newfoundland and Labrador) and the key organizations involved, with specific focus on the management of flooding and erosion risks. In particular, the following subjects have been reviewed for each province:

- Existing watershed-scale organizations;
- Mandate and authority, as defined by either legislation or a clear policy statement;
- Watershed management functions; and
- Role in flood and erosion risk management.

For further details relating to the mandate and activities of the specific watershed management organizations mentioned in this section, readers are directed to the online references provided, where they can consult the most up-to-date information.

### 3.2.2 British Columbia

There are currently no watershed-scale organizations with a legal mandate for integrated watershed management in British Columbia. However, there are several organizations that work on select aspects of watershed management or that work without a legal mandate. The key organizations are identified below.

Under the B.C. Forest and Range Practices Act (FRPA), 466 community watersheds have been designated for source water protection purposes. The FRPA sets requirements for forest company activities working within community watersheds to conserve water quality and quantity and prevent adverse cumulative hydrological effects [15].

A key charitable watershed organization within the province is the Fraser Basin Council. It is a non-profit organization that aims to advance sustainability solutions and practices in the Fraser Basin and across British Columbia. The Council's directors represent four orders of government—federal, provincial, local, and First Nations—together with the private sector and civil society. The organization works through facilitation and education, working with a vast variety of stakeholders across the province [16].

Another key organization that has no legal or policy basis but that may influence regulatory decisions is the Mackenzie River Basin Board. The board was established by the Mackenzie River Basin Transboundary Waters Master Agreement in 1997, and was signed by British Columbia, Alberta, Saskatchewan, the Northwest Territories, Yukon, and the Government of Canada [17]. The agreement commits the signatories to “work together to manage the water resources of the whole Mackenzie River Basin,” according to four guiding principles: equitable utilization, prior consultation, sustainable development, and maintenance of ecological integrity [18].

In relation to flood and erosion risk management, the provincial government provides Flood Hazard Area Land Use Management Guidelines [19] and administers funding for developing and updating flood risk assessments. However, land use regulation itself is the responsibility of local governments, or of provincial approving officers for land outside of municipal boundaries, and provincial land officers responsible for Crown land [20]. As a result, land use planning does not consistently account for flood risk within the province, as highlighted in responses to a recent survey on provincial flood preparedness [21].

The need for improved flood and erosion risk management was dramatically highlighted during the November / December 2021 floods in British Columbia—the most-costly severe weather event in the province's history [22]. A key report, developed following this flood event to improve understanding of risk and resilience in British Columbia, specifically recommends a more integrated approach to flood risk management [23].

With a view to improving watershed security, in January 2022, the provincial government issued a discussion paper on the development of a Watershed Security Strategy and Fund for public consultation. The

discussion paper suggested “reduced risks from water related hazards such as flooding and drought” as one of the elements of watershed security [24]. Work is ongoing to develop the strategy, with a launch currently planned for spring 2023 [25]. In addition, the province of British Columbia is currently gathering feedback on a proposed Flood Strategy to manage flood safety risks, which includes consideration of watershed-based approaches and emphasizes green infrastructure as a preferred option for flood mitigation where suitable [26].

### 3.2.3 Alberta

In Alberta, the Water for Life strategy has been the key strategy for managing the province's waters resources since 2003 [27]. The strategy was renewed in 2008 [28]. It identifies three geographical scales of partnerships for managing water [29]:

- Alberta Water Council (AWC) – at the province-wide scale;
- Watershed Planning and Advisory Councils (WPACs) – at the watershed-scale; and
- Watershed Stewardship Groups (WSGs) – at the local scale.

The Alberta Water Council is a not-for-profit, collaborative partnership that provides leadership, expertise, sector knowledge, and perspectives to advance the outcomes of Water for Life and other water management priorities within the province [30].

Watershed Stewardship Groups are local-community, volunteer-based partnerships that are actively engaged in environmental stewardship of their watershed [29]. These volunteer-based groups are supported by the Land Stewardship Centre [31].

The 11 WPACs are stewards of the province's major watersheds. They are independent, non-profit organizations that are officially designated by Alberta Environment and Parks and have a mandate to [32] “support multi-stakeholder collaboration and community engagement within four main program areas:

- *Education and Outreach*
- *Environmental Stewardship*
- *Watershed Evaluation and Reporting*
- *Watershed Management Planning*”

The WPACs are mandated by the government to produce two key deliverables [32]:

- A State of the Watershed Report; and
- An Integrated Watershed Management Plan.

In relation to the first deliverable, a “Handbook for State of the Watershed Reporting” was published in 2008 to support WPACs and WSGs that may be undertaking similar work. The handbook mentions “floodplain presence and flooding pattern” as indicators of the condition of the watershed, whose metric is an “area of historically connected floodplain vs. area of currently connected floodplain” [33].

In relation to the second deliverable, the “Guide to Watershed Management Planning in Alberta” recognizes the role of natural systems in attenuating flooding but does not specify that flood risk management should form part of watershed management planning [34]. Flooding is considered in some of the technical reports prepared to support Integrated Watershed Management Planning, for example for the Red Deer Watershed Alliance [35].

Flood risk management is undertaken largely outside of the watershed management activities described above. The provincial government retains responsibility for flood management through the Flood Hazard Identification Program, Alberta Community Resilience Program, and specific flood mitigation studies for flood-prone watersheds [36]. Many of these studies consider the watershed-scale [37]. Upstream water storage is being pursued as a flood management strategy along the Elbow River upstream of Calgary through the construction of the Springbank Off-Stream Reservoir [38] and on the Bow River through the Modified Operations Agreement with TransAlta [39]. The provincial government also funds the Watershed Resiliency and Restoration Program, which focuses on improving natural watershed functions to build greater long-term resiliency to droughts and floods [40].

### 3.2.4 Saskatchewan

The Saskatchewan Association of Watersheds (SAW) is a non-profit umbrella organization for nine watershed groups in the province that are focused on the protection of ground and surface water [41]. These NGOs receive funding from the Saskatchewan

government for education, awareness, and coordination of program delivery but they do not address flood and erosion risk management.

The Water Security Agency (WSA) is a Crown corporation that holds core water management responsibilities in the province. The 25 Year Water Security Plan, originally released in 2012, includes several actions relating to identifying and reducing flood risk, although these actions are largely organized around communities or critical infrastructure rather than the watershed-scale [42]. With the introduction of WSA’s new Strategic Plan, launched in 2022–23, the agency is not only reviewing its Strategic Plan on an annual basis but renewing it every four years instead of five [43].

The WSA administers the Flood Damage Reduction Program (FDRP), which provides funding to local governments for flood damage reduction work across the province [44]. The agency also obtained funds under the federal government’s National Disaster Mitigation Program (NDMP) to complete a provincial-scale natural hazard risk assessment, which was published in 2018 [45]. This assessment identified high to extreme risk from convective summer storms and an increasing risk from overland flooding of both urban and rural communities in the context of climate change.

### 3.2.5 Manitoba

In Manitoba, the Watershed Planning & Programs Section of the provincial Environment, Climate and Parks Department administers and manages the Watershed Districts Program as defined by The Watershed Districts Act. Proclaimed on January 1, 2020, the Act transitioned 18 conservation districts to 14 new Watershed Districts, with boundaries aligned with natural watersheds to support integrated watershed management [46]. These newly formed Watershed Districts cover the majority of municipal Manitoba.

Watershed Districts are formed as a partnership between the province and local municipalities to “protect, restore and manage land and water resources on a watershed basis.” Each district is charged with “developing and implementing programming to improve watershed health, while four districts also have a surface water infrastructure mandate to maintain provincial waterways within their boundary” [47].





**“Manitoba reports that there are currently 26 integrated watershed management plans (IWMP) in various stages of completion, as well as one plan under renewal.”**

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Watershed Districts can also be designated as *“a Water Planning Authority for integrated watershed management planning under The Water Protection Act. They provide leadership in both the development and implementation of watershed plans, that assist in planning long-term and short-term goals and identifying priority project to improve watershed health.”* The province reports that there are currently 26 integrated watershed management plans (IWMP) in various stages of completion, as well as one plan under renewal [46]. The Watershed Districts are supported by the Manitoba Association of Watersheds (MAW) [48]. MAW delivers the GRowing Outcomes in Watersheds (GROW) Program announced by the province in 2019. The GROW and Conservation Trusts that provide funding to landowners under this program are administered by Manitoba Habitat Heritage Corporation. GROW aims to support the delivery of ecological goods and services in Manitoba. Focus areas include watershed health, management, and resiliency. Two priority outcomes of the program are watershed resilience to the impacts of climate change and improved water quality, while improved biodiversity and habitat and carbon sequestration and storage are identified as co-benefits [49].

Activities that are eligible for inclusion in a Local GROW Program include [49]:

- *“water retention*
- *wetland conservation, restoration or enhancement*
- *riparian area conservation, restoration or enhancement*

- *buffer establishment (ex: shelterbelts and multi-species buffer strips)*
- *upland area conservation, restoration, or enhancement (ex: woodlot management, grassland conservation, converting marginal cropland to grassland, and soil health improvements)”*

The Manitoba government also supports Watershed Districts through the Assurance: Watershed Ecological Goods and Services grant that is part of the Ag Action Manitoba Program. The grant facilitates *“work with farmers to implement sustainable environmental practices,”* including water retention, runoff management, and wetland restoration and enhancement [50].

Water retention studies are being undertaken in the province as a method of managing both flood and drought conditions, as well as improving water quality and achieving other watershed management objectives. When the cumulative impacts of several projects are combined, benefits can occur at both the local and the watershed-scale [51].

Although several natural infrastructure elements relating to flood and erosion risk are addressed by Watershed Districts, it is Manitoba Infrastructure that leads and retains responsibility for flood risk management projects at the provincial level [52]. Work has been conducted at the watershed-scale, such as in the Assiniboine River and Lake Manitoba Basins Flood Mitigation Study [53]. However, not all watersheds have a flood risk management strategy.

### 3.2.6 Ontario

In Ontario, Conservation Authorities promote integrated watershed management and are organized on a watershed basis. Conservation Ontario is a non-profit association that represents the 36 Conservation Authorities. Thirty-one of them operate in Ontario and five deliver programs and services in northern Ontario [54].

Conservation Authorities have a legislated mandate under the Conservation Authorities Act, originally enacted in 1946 [55]. Following severe economic and human losses due to Hurricane Hazel in 1954, Conservation Authorities were given regulatory powers within floodplains, which have since been broadened to cover regulating and permitting development within river and stream valleys, wetlands, hazard-prone areas (flooding, erosion, dynamic beaches), and geotechnically hazardous sites [55].

The core mandate of Conservation Authorities is to undertake watershed-based programs to protect people and property from flooding and other natural hazards and to conserve natural resources for economic, social, and environmental benefits [54]. Mandatory programs and services provided by Conservation Authorities are set out in Ontario Regulation 686/21 and include development of a watershed-based resource management strategy [56]. Conservation Authorities have also worked extensively with municipalities to develop sub-watershed plans for areas identified for development. Consultations on new guidance occurred in early 2022 [57].

The undertaking of watershed management planning alongside land use planning has been identified as a key factor that helps limit flood damage in Ontario. A comparison of the use of Disaster Financial Assistance Arrangements (DFAA) by provinces during the 1970–2014 period suggested the primary reason for limited use of DFAA payments in Ontario, in comparison with greater use in the Prairie provinces (Alberta, Manitoba, and Saskatchewan), was the administration of floodplain regulation by the Conservation Authorities [58]. Similarly, a study comparing Michigan and Ontario flood damages in August and September 1986 also highlighted the benefits of long-term floodplain regulation in limiting flood damages in Ontario [59].

In 2022, the Ontario government passed Bill 23, which includes significant modifications to several sections of the Conservation Authorities Act [60]. These modifications include:

- Removal of the ability of Conservation Authorities to review or comment on proposals or applications made under a prescribed Act; and
- Exemption of activities authorized under the Planning Act from the prohibitions that restrict activities and development in lands over which Conservation Authorities hold jurisdiction (including hazard lands, river and stream corridors, and shorelines).

These modifications will reduce the role that watershed-scale Conservation Authorities play in land use planning in the province.

### 3.2.7 Quebec

In 2002, the Quebec Water Policy supported reforming water governance and establishing integrated watershed management in Quebec [61]. The Water Act, enacted in 2009 and amended in 2017 and 2022, sets out the responsibility of watershed organizations (in French: *Organisme de bassin versant*) to undertake watershed planning in consultation with a variety of stakeholders [62]. The Act also introduced integrated management for the Saint Lawrence River, providing for the establishment of 12 regional consultation tables (in French: *tables de concertation régionales*). There are currently 40 legally recognized watershed organizations [63] and six regional consultation tables [64]. The *Regroupement des organismes de bassins versants du Québec (ROBVQ)* is a non-profit organization that is recognized by the Ministry of the Environment, the Fight Against Climate Change, Wildlife and Parks (MELCCFP) as being its privileged interlocutor for the implementation of integrated water management by watershed in Quebec [65].

The mandate of each watershed organization, as defined in the current reference framework, includes consulting with stakeholders, developing and implementing a water master plan, and raising awareness and promoting integrated water resource management [66]. Key issues identified and addressed in work by watershed organizations include water contamination, health of wetlands, shoreline erosion, water quality, flooding, public access to water bodies, and drinking water supply [67].



While watershed organizations are responsible for developing a water master plan, they are not responsible for managing flood and erosion risk and they do not have the authority to permit development in areas at flood or erosion risk. This limits direct integration of these activities. The 2020 provincial flood protection plan included a new flood resilience and adaptation program [68]. As part of the program, the Ministry of Municipal Affairs and Housing (Ministère des Affaires municipales et de l'Habitation) established 10 new project offices tasked with planning flood resilience interventions at the watershed-scale. Each of the new project offices must work with both a municipal round table and a civil round table in planning flood resilience interventions [69].

### 3.2.8 New Brunswick

There is currently no provincially appointed organization for integrated watershed management in New Brunswick.

Watershed management in the province is undertaken by 31 NGOs, overseeing 78% of the province [70]. The N.B. Watershed Caucus, a program led by the New Brunswick Environmental Network (NBEN), provides a forum for these watershed organizations [70]. Many of the watershed organizations have developed an integrated watershed management plan that includes actions relating to management of flooding and erosion / sedimentation using NbS. The organizations vary in terms of their objectives and the funding and resources available to implement the identified actions.

An action to develop a renewed framework for watershed-scale management of surface water quality was included in A Water Strategy for New Brunswick (2017) [71]. The province's Watershed Protection Program focuses on source water protection for communities that receive their drinking water from surface watersheds (about 40% of the population) [72].

The provincial strategy for flood risk management is set out in the New Brunswick Flood Risk Reduction Strategy (2014). In this strategy, flood mitigation is focused on risk reduction by working with communities and infrastructure owners [73]. The provincial government recently released updated coastal and inland flood risk mapping that incorporates the impacts of climate change [74], and has been working with

New Brunswick communities to undertake Climate Change Adaptation Plans [75].

The potential to use NbS to address flood and erosion risk was initially outlined in the 2016 plan, Transitioning to a Low-Carbon Economy – New Brunswick's Climate Change Action Plan. The plan includes the action to *"promote and use natural infrastructure (e.g., forests, wetlands, salt marshes, floodplains) as an important tool to buffer against climate change impacts"* (action 71) [76].

New Brunswick's new Climate Change Adaptation Plan (2022–2027) sets out 30 actions for the province, with *"preparing for climate change"* as one of the three key pillars identified. Under this pillar, biodiversity and NbS are a key area for action. The provincial government intends to continue to support NbS as an approach to adapt to climate change, including through training and capacity building. New actions identified increasing protected areas to beyond 10% of the province's land and fresh water, as well as implement a Living Shorelines program by 2026. [77].

### 3.2.9 Nova Scotia

In 2010, through Water for Life: Nova Scotia's Water Resource Management Strategy, the province committed to an approach based on integrated water management, using the watershed as a unit for analysis. The strategy identified 46 primary watersheds in the province and established a Nova Scotia Water Advisory Group (NSWAG) to support implementation of integrated water management. However, the strategy did not include actions for flood and erosion risk management [78].

The Nova Scotia Watershed Assessment Program (NSWAP) was launched in 2011 to characterize and evaluate the state of the province's watersheds according to 11 different watershed variables [79], including variables of interest to flood and erosion management. The project subdivided the primary watersheds into major and residual watersheds, as many of the streams in Nova Scotia drain directly to the ocean rather than being part of larger watershed units [80]. Phase 2 of this project, to develop watershed report cards, does not appear to have been completed to date [81]. The last progress report on the province's Water for Life strategy webpage was for 2014 [82].

Watershed management, including protection and enhancement of natural infrastructure, is undertaken by several NGOs in Nova Scotia, including the Sackville Rivers Association [83], Clean Annapolis River Project [84], and ACAP Cape Breton [85]. However, there is currently no coordinating body, and activities vary between the NGOs depending on their specific objectives and available resources.

In relation to flood and erosion risk management, the Nova Scotia Flood Mitigation Framework provides an approach based on 1) support for communities and 2) provincial leadership [86]. Work with communities is through the Flood Risk Infrastructure Investment Program (FRiIP), which provides match-funding for: [87]

- *“river training and floodway improvements*
- *floodwater containment and flood intensity mitigation*
- *studies including mapping to identify flood-prone areas and identification of potential solutions to mitigate flood impacts”*

The provincial leadership part of the Framework lists eight actions. One action is to provide scientific and geo-technical advice for coastal flood risk assessments. There is no explicit mention of the use of natural infrastructure to manage flood and erosion risk as part of the Flood Mitigation Framework, and action is not organized at the watershed-scale.

However, in the new plan, *Our Climate, Our Future: Nova Scotia’s Climate Change Plan for Clean Growth*, released in December 2022, minimizing climate impacts by restoring natural areas and ecosystems is a key theme identified to help respond to climate impacts. Action 12 of the plan includes to *“strengthen and coordinate responses to coastal and inland flood risk by investing in natural flood protection”* [88].

### 3.2.10 Prince Edward Island (PEI)

Watershed management in PEI is undertaken by local watershed groups that do not have a formal mandate [89]. There are 24 watershed groups across the island, supported by the PEI Watershed Alliance [90]. Both the watershed groups and the PEI Watershed Alliance are supported by the government through the Watershed Management Fund, which is designed to support projects for watershed management planning and capacity building, pollution control, erosion

management, wildlife habitat enhancement and biodiversity, and research and outreach [91].

In terms of flood risk management, PEI is an island with small river basins of limited relief. The recent Climate Change Risk Assessment, published in 2021 and used to inform the province’s Climate Change Action Plan 2018–2023, identified coastal erosion, post-tropical storms, and heavy precipitation and inland flooding as *“high”* risks for the province [92]. The provincial government has funded mapping of coastal and inland flooding in the context of climate change; however, this is available on a community basis rather than for watersheds [93].

Flood risk management projects are not specifically listed as eligible for funding through the Watershed Management Fund, although natural infrastructure projects that may reduce downstream flood risk are supported. The Guide to Watershed Planning produced by the PEI government also does not specifically mention flood risk management, although soil erosion and sedimentation are highlighted as key issues for consideration [94]. It is worth noting that municipal land use planning is in place for only approximately 10% of PEI’s land base, with the provincial government acting as the planning authority for the remaining 90% of land area [95].

In 2020, the Government of Prince Edward Island established a \$1 million annual Climate Challenge Fund that supports NbS for flood and erosion risk management [96]. The province’s climate adaptation plan, launched in October 2022, also mentions NbS under several actions with the themes of resilient communities and natural habitat and biodiversity, but does not explicitly include a watershed approach to flood and erosion risk management [97].

### 3.2.11 Key Findings

An overview of key elements of watershed management in the Canadian provinces examined is provided in Table 2. Review focused on the use of NbS for river flood and erosion management and yielded the following key findings:

- **Legislative mandate and authority:**  
Few of the Canadian provinces have set a clear mandate for integrated watershed management. Many provincial mandates are focused on specific

problems (e.g., drinking water source protection) or specific watersheds, or their responsibilities are shared with other organizations.

- **Varied involvement in flood and erosion river management:**

Only Conservation Authorities in Ontario have a legal mandate and permitting authority (with exceptions) in relation to river flood and erosion risk management. Several watershed management organizations are indirectly involved in flood and erosion risk management, although they may be consulted.

- **Focus on NbS for different purposes:**

Many provinces have developed programs to support NbS but the objectives of these programs vary and frequently focus on habitat quality and biodiversity rather than using NbS as a means to manage flood and erosion risk.

- **Resourcing:**

While funding is provided by many provincial governments to support watershed management, the level of resourcing available varies significantly. This impacts the capacity (staff, time, money) of watershed management organizations, including the development and retention of in-house knowledge.

### 3.3 Analysis of Federally Funded Flood and Erosion Risk Management Projects

The federal government has financially supported, and continues to support, flood risk management work undertaken by provinces, territories, and communities. The two major funds are:

- The National Disaster Mitigation Program (NDMP), administered by Public Safety Canada from 2015 to 2022; and
- The Disaster Mitigation and Adaptation Fund (DMAF), administered by Infrastructure Canada, the first intake of which was in 2018.

Funding under these programs has already been allocated and project-level data is available.

This section presents an analysis of the spatial jurisdiction of the recipients to whom federal funding has been allocated for flood risk management work under the two programs. The scale at which projects themselves are being undertaken has also been analyzed for DMAF-funded projects, based on the

project descriptions that are readily available for each project. The purpose of the analysis is to establish how federal funding to date under these programs has supported watershed-scale flood and erosion management approaches, including the use of NbS.

#### 3.3.1 The National Disaster Mitigation Program (NDMP)

##### 3.3.1.1 Overview of Funding Program

The NDMP allocated funds between 2015 and 2022 to recipients to increase understanding of, and community resilience to, flood risk. Budget 2014 allocated \$200 million over five years, from 2015 to 2020. In 2020, a further \$25 million was allocated to the program over two years, beginning in fiscal year 2020–2021 and up to March 31, 2022 [98].

The analysis for this report concerns the Mitigation Contribution Component (MCC) of the NDMP, which provided financial support to provinces (up to 50%) and territories (up to 75%) for cost-shared projects in four streams of eligible activities (see Table 3) [99].

##### 3.3.1.2 Project-Level Data

Data relating to 460 projects funded under the seven annual cycles of NDMP funding was provided by Public Safety Canada for analysis and approved for release. The data provided included the project title, recipient organization, province or territory, cycle of funding, and funding stream.

No projects were funded in Quebec, as an agreement was not signed with the province. In addition, no projects were funded in Nunavut. In 2020–2021 (cycle 6), during the COVID-19 pandemic, additional funding was allocated to existing projects only. No new projects were established.

Detailed project descriptions were not provided for each project; therefore, it was not possible to isolate NDMP projects that addressed river flooding and erosion based on the data available. Several of the projects also addressed multiple types of flood risk in the same project (e.g., coastal, heavy rainfall, as well as river flooding). Therefore, the analysis includes all projects, not only those relating to river flooding and erosion. Due to the lack of project descriptions, it was also not possible to classify projects by the spatial scale of the projects themselves.

**Table 2:** Overview of Watershed Management in Canadian Provinces (excluding Newfoundland and Labrador)

Character	BC	AB	SK	MB	ON	QC	NB	NS	PEI
<b>Watershed-Scale Governance Bodies</b>	NGOs, Community watersheds (govt)	Watershed Planning and Advisory Councils (WPACs)	Watershed Associations	Watershed Districts	Conservation Authorities	Watershed Organizations (Organisations des bassins versants)	NGOs	NGOs	NGOs – Local Watershed Groups
<b>Co-ordinating Body</b>	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
<b>Website</b>	<a href="#">Fraser Basin Council</a>	<a href="#">Government of Alberta</a>	<a href="#">Saskatchewan Association of Watersheds</a>	<a href="#">Government of Manitoba</a>	<a href="#">Conservation Ontario</a>	<a href="#">ROVBQ</a>	<a href="#">Watershed Caucus</a>	<a href="#">Water for Life Strategy</a>	<a href="#">PEI Watershed Alliance</a>
<b>Number of Watershed Management Organizations</b>	Unknown	11	9	14	36	40	18	Unknown	24
<b>Formal Mandate</b>	No – Strategy in development	Yes, but shared and for certain functions	Yes, but shared and for certain functions	Yes, but shared and for certain functions	Yes, for certain functions	Yes, but shared and for certain functions	No	Yes, but not fulfilled	No – Informal
<b>Functions</b>	Varies by organization Fraser Basin Council – facilitation and education Community watersheds (466) designated to protect surface drinking water	Watershed evaluation and reporting Watershed management planning Education and outreach Environmental stewardship	Source water protection: ground and surface water	Protecting, preserving, conserving, managing, controlling, or prudently using the resources of the district	Protect people and property from flooding and other natural hazards Conserve natural resources for economic, social, and environmental benefits	Promote consultation with regional stakeholders Inform, mobilize, consult, and raise public awareness Develop a master plan for water (MPW)	Varies by organization	Varies by organization	Varies by organization
<b>Role in Flood and Erosion Risk Management</b>	Fraser Basin Council – facilitation and education	Limited role. Provincial government maintains responsibility.	No formal role. Water Security Agency is responsible.	Limited role in use of natural infrastructure to reduce flood and erosion risk through GROW program.	Part of core mandate. Authority for permitting of development (with expanded exceptions) and undertaking projects to manage flood and erosion risk.	Consultative role. MAMH Project Offices responsible for flood risk.	No formal role. Provincial government maintains responsibility.	No formal role.	Limited role in use of natural infrastructure to manage erosion risk. Riverine flood risk not identified as a key objective.
<b>Decision Making</b>	No formal authority. Adoption of own watershed management plans and action plans.	No formal authority. Adoption of Watershed Management Plans.	No formal authority.	Can carry out or support work inside and outside its boundaries to benefit core function.	Development permitting authority in hazard-prone areas (with expanded exceptions).	Adoption of Watershed Management Plans.	No formal authority. Adoption of own watershed management plans and action plans.	No formal authority. Adoption of own watershed management plans and action plans.	No formal authority. Province and municipalities retain authority.

**Table 3: Four NDMP Funding Streams**

Stream	Description
<b>Stream 1: Risk Assessments</b>	Provided funding for risk assessments that inform flood risk management. Risk assessment includes identifying flood hazards, potential impacts, and community and infrastructure vulnerabilities.
<b>Stream 2: Flood Mapping</b>	Provided funding for the production and/or updating of flood maps.
<b>Stream 3: Mitigation Planning</b>	Provided funding for the development and/or updating of mitigation plans to address flood risks.
<b>Stream 4: Investments in Non-Structural and Small-Scale Structural Mitigation Projects</b>	Provided funding for other non-structural and small-scale structural mitigation projects to address flood risk.

### 3.3.1.3 Spatial Jurisdiction of Funding Recipient Organizations

Each NDMP project was classified according to the spatial jurisdiction of the funding recipient organization, using the following classification:

- Province;
- Watershed;
- Region;
- Indigenous government; and
- City / Town.

A breakdown of the number of NDMP projects funded in each province, according to the scale of the funding recipient organization, is illustrated in Figure 2.

Analysis of the data reveals distinct differences between the provinces and territories in terms of both the number of projects funded from 2015 to 2022 and the spatial scale of the recipients leading the projects.

Over half of the projects receiving funding from the NDMP were in the province of Ontario (235 projects, 51%), with a significant number of projects in British Columbia (106 projects, 23%) and Alberta (49 projects, 11%). The remaining provinces and territories each received funding for 5% or less of the NDMP-funded projects.

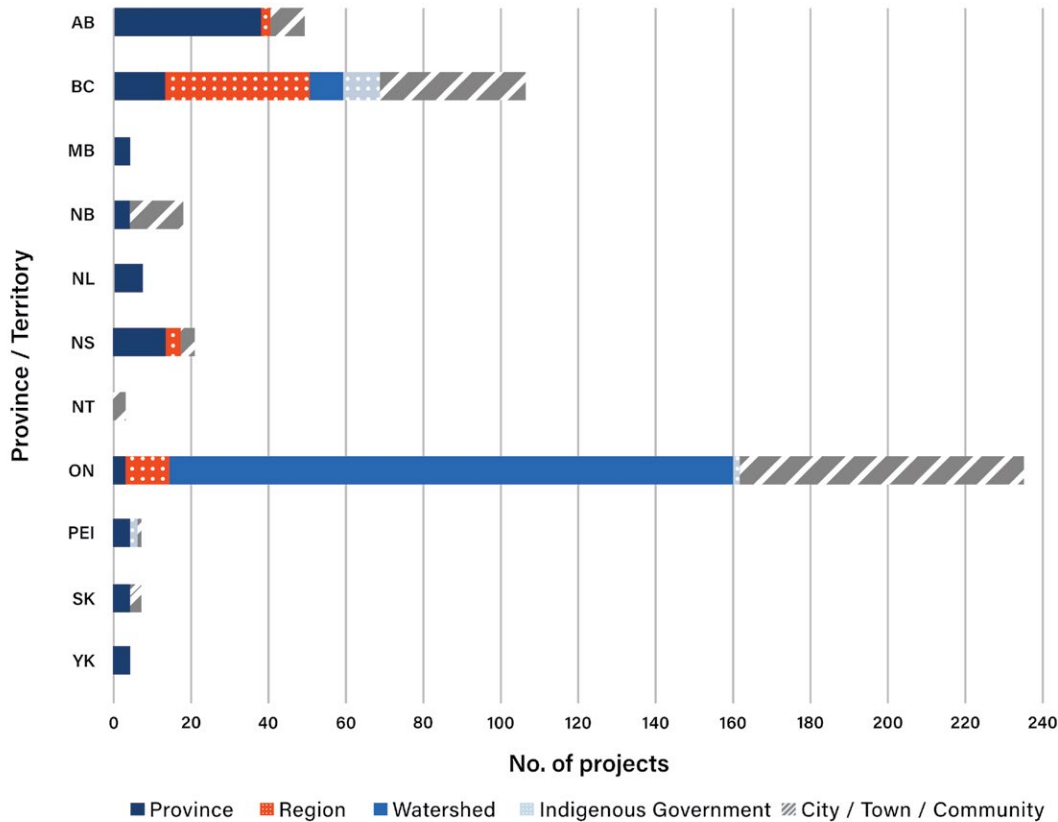
With regard to the spatial scale of funding recipients:

- The **provincial government** was the only recipient of NDMP funding in Manitoba, Yukon, and Newfoundland and Labrador. The provincial government was also the recipient for the majority of NDMP projects in Alberta, Nova Scotia, Prince Edward Island, and Saskatchewan.
- **Regional governments** were key leaders of NDMP projects in British Columbia, and led some of the projects in Ontario, Nova Scotia, and Alberta.
- **Watershed scale organizations** received funding for NDMP projects in only two provinces: Ontario and British Columbia. However, together these projects represented 34% of projects funded, 31% of which were led by Conservation Authorities in Ontario. The remaining nine projects were led by the Fraser Basin Council and the Okanagan Basin Water Board in British Columbia.
- **Indigenous governments** secured funding for 11 NDMP projects, with nine of these projects based in Prince Edward Island. It is notable that Indigenous governments also had access to alternative funding programs, such as First Nations Adapt, during the 2015–2022 time period [99].
- **Cities and towns** were the key funding recipients for NDMP projects in New Brunswick, where funds for 14 projects were secured by seven cities and towns. Many projects in Ontario and British Columbia were also led by cities and towns. In the Northwest Territories, Tuktoyaktuk and Aklavik received NDMP funding. Overall, cities and towns led 31% of the NDMP-funded projects.

The results of the analysis reflect the significant differences between provinces in terms of both their approach to watershed management and in the roles and responsibilities for flood and erosion risk management, as described in section 3.2.



**Figure 2: NDMP Projects Classified by Scale of Recipient Organization**



In particular, the findings underline the pivotal role of Conservation Authorities in undertaking and attracting investment to flood and erosion risk management at the watershed-scale in Ontario, and the lack of organizations playing a similar role in other provinces and territories.

The allocation of NDMP funding was based on evaluation of applications received, rather than on an assessment of baseline flood and erosion risk across Canada. To access funding, organizations required the necessary resources (staff, time, and knowledge) to develop a successful application. Ontario Conservation Authorities evidently were among the organizations that had these necessary resources and successfully secured funding for multiple projects. For example, over the seven-year period, the Toronto and Region

Conservation Authority secured NDMP funding for 23 projects, the Upper Thames River Conservation Authority for 16 projects, and the Credit Valley Conservation Authority for 12 projects.

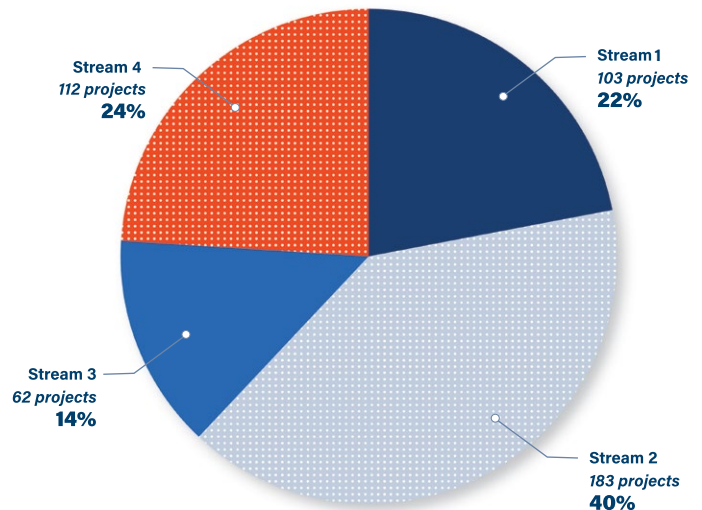
The lack of organizations undertaking a similar watershed-scale role led to fewer applications being made in other provinces and territories, and ultimately less work being funded to reduce flood and erosion risk in Canada. The evaluation of the NDMP undertaken in 2020 identified that the MCC part of the program had a budget of \$183.8 million for the period 2015–2020, but only \$94.8 million was allocated to projects in this period. The remaining funds (48%) were either reprofiled to future years of the program, reallocated to other departmental priorities, or returned to Treasury Board Secretariat [99].

The findings also highlight the significant role that cities and towns currently play in undertaking projects to address flood and erosion risk. A key issue with this arrangement in terms of managing river flooding and erosion is that the jurisdiction of cities and towns often does not encompass the watershed or sub-watershed of concern from a flood risk management perspective. While studies to understand and map flood risk may be designed to cover areas outside the jurisdiction (Stream 1 and 2 of the NDMP), mitigation planning and implementation of solutions (Stream 3 and 4 of the NDMP) are likely to be focused within the jurisdiction of the city and town. This may effectively preclude consideration of many NbS that work with natural processes at the watershed or sub-watershed scale (e.g., increasing floodwater storage upstream of a city or town by reconnecting floodplains). In addition, the potentially negative and cumulative impacts of solutions implemented by cities and towns on downstream communities may not be appropriately considered.

### 3.3.1.4 Use of Nature-based Solutions

NbS to reduce flood and erosion risk were eligible for funding under Stream 4 of the NDMP, covering non-structural and small-scale structural disaster mitigation projects. 112 projects received funding under Stream 4, accounting for 24% of the funded projects (Figure 3).

**Figure 3:** Classification by Stream of 460 NDMP Projects Funded 2015–2022



Funding allocation to NbS was not specifically tracked. The titles and descriptions of the Stream 4 projects funded between 2015 and 2022 were reviewed to identify projects that related to NbS. Following review of project titles and, where available, project descriptions, six projects were identified as relating to NbS (Table 4). Other projects may have included NbS that were not detailed in the project name or description.

**Table 4:** Details of Six NbS Projects Funded by NDMP between 2015 and 2022

Prov.	Project Name	Funding Year	Organization	Project Description (where available)
ON	Reducing Impacts of Stormwater - Green Infrastructure Promotion Program	2017-18	Upper Thames River Conservation Authority	Public education outreach program (non-structural)
ON	McKellar Ward Green Infrastructure Installation Tree Planting Project	2018-19	City of Thunder Bay	Green infrastructure installation tree planting project
ON	Saltfleet Flood and Erosion Control Wetland Mitigation Project	2019-20	Hamilton Conservation Authority	Establishment of four wetlands located in the Upper Stoney Creek and Upper Battlefield Creek watersheds. Work aims to reduce flooding in Lower Stoney Creek and Battlefield Creek for a range of storm events (2- to 100-year return period).

Prov.	Project Name	Funding Year	Organization	Project Description (where available)
ON	Wetland Enhancement Partnership within the Lake Simcoe Basin to Eliminate Chronic Community Flooding	2019–20	Lake Simcoe Region Conservation Authority	Development of a strategic wetland enhancement project to reduce flood risk. Includes a Class Environmental Assessment, public consultation, and engagement of stakeholders in the design process. Post-construction performance monitoring and operational / maintenance are also included.
ON	Greening Your Neighbourhoods Waterloo Region**	2019–20	Reep Green Solutions	Workshops to engage local residents and stakeholders in considering priority actions that could help to reduce stormwater runoff within their neighbourhood. Goal to increase uptake of green stormwater infrastructure solutions to help mitigate flood risks associated with increasingly intense precipitation events.
ON	Focus on Flooding and Reducing the Impacts of Stormwater in the Upper Thames Watershed – Phase 2	2019–20	Upper Thames River Conservation Authority	Phase 2 to further the 2017–18 funded project. Extended delivery of program and additional components to students and residents of high-risk communities. Includes a low-impact development pilot project and education programming with schools.

The six projects identified represent just over 1% of the 460 projects funded by the NDMP and 5% of Stream 4 projects. It is notable that all of the projects relating to NbS were funded in Ontario, with four of them being led by Conservation Authorities.

### 3.3.2 Disaster Mitigation and Adaptation Fund

#### 3.3.2.1 Overview of Funding Program

In 2018, the Government of Canada committed \$2 billion over 10 years to the Disaster Mitigation and Adaptation Fund (DMAF) to invest in structural and natural infrastructure projects to increase the resilience of communities that are impacted by natural disasters triggered by climate change [100]. This first intake of DMAF aimed to support “shovel-ready”, large-scale projects with total eligible costs of at least \$20 million, with match-funding being provided by applicants in most cases [101]. Funding from the first intake of the DMAF was allocated between 2018 and 2022 and is the focus of analysis presented in this section. Projects were considered for funding as part of a competitive intake process, as well as to respond to urgent and emergent situations [101].

In Budget 2021, an additional \$1.375 billion in federal funding over 12 years was announced to renew the DMAF. Starting in 2021, the DMAF funding has two streams: the small-scale project stream (projects with total eligible costs between \$1 million and \$20 million) and the large-scale project stream (projects with total eligible costs of \$20 million and above) [102]. In launching the National Adaptation Strategy, up to \$489 million in further funding was allocated to the DMAF [103].

#### 3.3.2.2 Project-Level Data

Funding from the first intake of the DMAF was allocated to 70 projects between 2018 and 2022. Project-level information relating to these projects is publicly available online as part of Infrastructure Canada’s project dataset [104]. Information provided in the dataset includes project title, ultimate recipient, location, province, and federal funding contribution.

In addition to the project dataset, news releases issued by the Government of Canada to announce each project were researched online and used to extract a brief



“Analysis of project titles and descriptions reveals that 45 of the 70 projects funded during the first intake of DMAF related directly, or in part, to reducing river flooding and erosion risks.”

description of each project. Using these project descriptions, it was possible to identify DMAF projects that addressed river flooding and erosion. Subsequently, these projects were analyzed and classified according to the spatial scale of the funding recipient(s), the spatial scale of the project itself, and the use of NbS.

### 3.3.2.3 River Flooding and Erosion Projects

DMAF funding was available for projects that reduce future climate-related risks and disasters triggered by a range of natural hazards, including, but not limited to, avalanche, drought, earthquake, erosion, extreme temperature, flood, hurricane, landslides, permafrost thaw, sea level rise, storm, tsunami, and wildland fire. Analysis of project titles and descriptions reveals that 45 of the 70 projects funded during the first intake of DMAF related directly, or in part, to reducing river flooding and erosion risks. See Figure 4. The federal funding contribution to these 45 projects was \$1.389 million.

Further analysis described in the following sections has been undertaken considering these 45 projects directly or partly related to reducing river flooding and erosion risks.

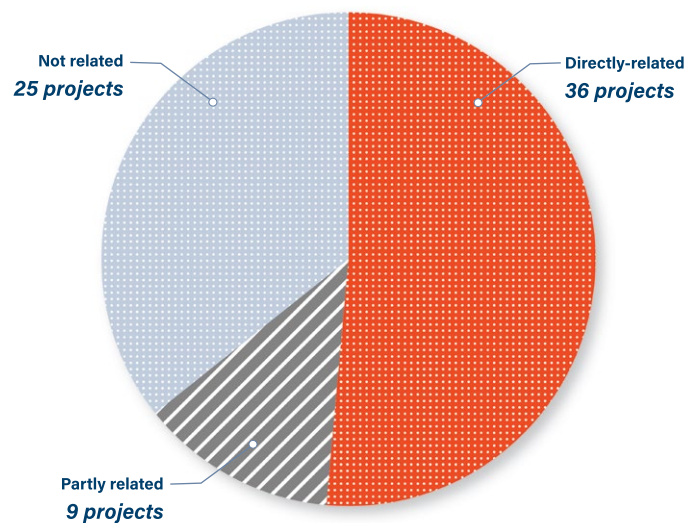
### 3.3.2.4 Spatial Jurisdiction of Funding Recipient Organizations

Each DMAF river flood and erosion project was classified according to the spatial jurisdiction of the funding recipient organization, using the following classification:

- Province;
- Watershed;
- Region;
- Indigenous government; and
- City / Town.

A breakdown of the number of DMAF projects funded in each province / territory, according to the scale of the funding recipient organization, is illustrated in Figure 5.

**Figure 4 :** Classification of 70 DMAF Projects Based on their Relationship to River Flooding and Erosion Risks [104]





**Table 5:** Details of Six DMAF River Flood and Erosion Projects Using NbS

Prov.	Project Name	Organization	Project Description
BC	Mill Creek Flood Protection	City of Kelowna	Project to increase creek capacity through rehabilitating riverbanks, upgrading drainage, and providing additional off-stream water storage areas.
BC	Cowichan Watershed Resiliency Program	Cowichan Tribes First Nation	Project to improve watershed resilience by increasing capacity to buffer drought and flooding. Focus areas include sediment management and habitat rehabilitation.
ON	Natural infrastructure enhancement and restoration of the urban forest in the York Region	York Region	Planting trees and adding natural features to improve drainage capacity during heavy rainfall events.
ON	Repair, remediate, and enhance resilience of Toronto's tree canopy and waterfront shoreline structures to protect against future flooding and storm events	Toronto and Region Conservation Authority (TRCA)	Rehabilitating shoreline infrastructure, beaches, waterfront parks, embankments, trails, and pathways. Improving the resiliency and tree canopy cover.
ON	Toronto Region Ravine Erosion Risk Management and Hazard Mitigation Project	Toronto and Region Conservation Authority (TRCA)	Management of erosion at 111 locations within the Region of Peel, York Region, and the City of Toronto over the next 10 years.
QC	Rehabilitation of natural shoreline threatened by accelerated erosion in the major waterfront parks on the Island of Montreal, in the province of Quebec	City of Montreal	Rehabilitating 10 km of shoreline using bioengineering techniques that include vegetation. Aim to better manage the impacts of erosion and protect shoreline communities and ecosystems.

The province with the most DMAF-funded projects to manage river flood and erosion risk was Ontario (17 projects). Several projects were also funded in Quebec (8 projects) and British Columbia (7 projects), with other provinces receiving funding for 5 or fewer projects. No river flood and erosion projects were funded in Nova Scotia, Nunavut, Prince Edward Island, or Yukon.

Regarding the spatial scale of funding recipients, over two-thirds of the projects were led by cities and towns. Watershed-scale organizations only received funding in Ontario, while Indigenous governments only received funding in British Columbia. In Manitoba and Newfoundland and Labrador, only the provinces received DMAF funding.

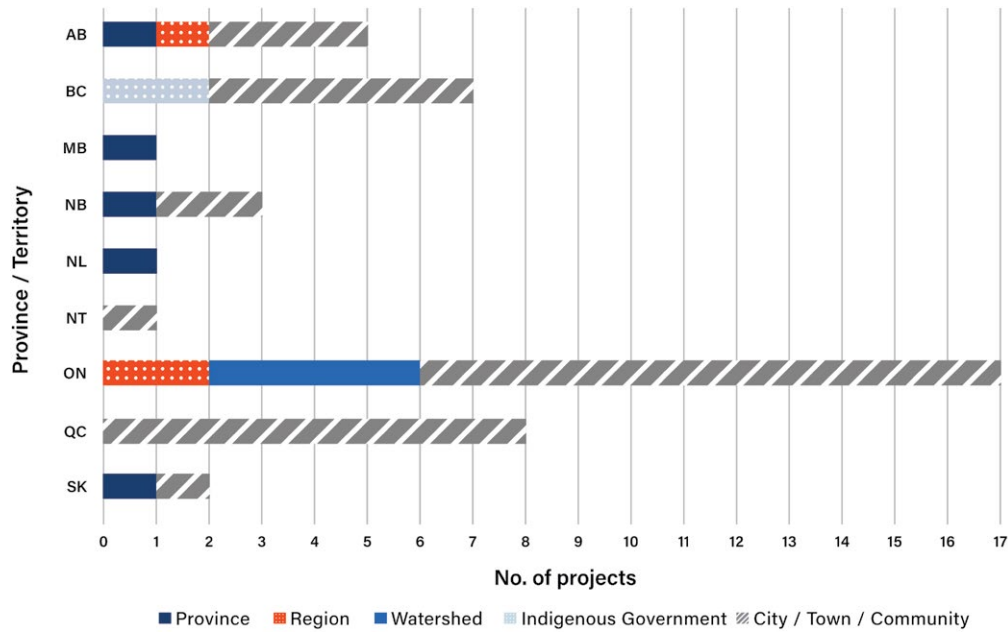
### 3.3.2.5 Spatial Jurisdiction of Projects

Based on project descriptions, each DMAF river flood and erosion project was classified according to the spatial jurisdiction of project implementation, using the following classification:

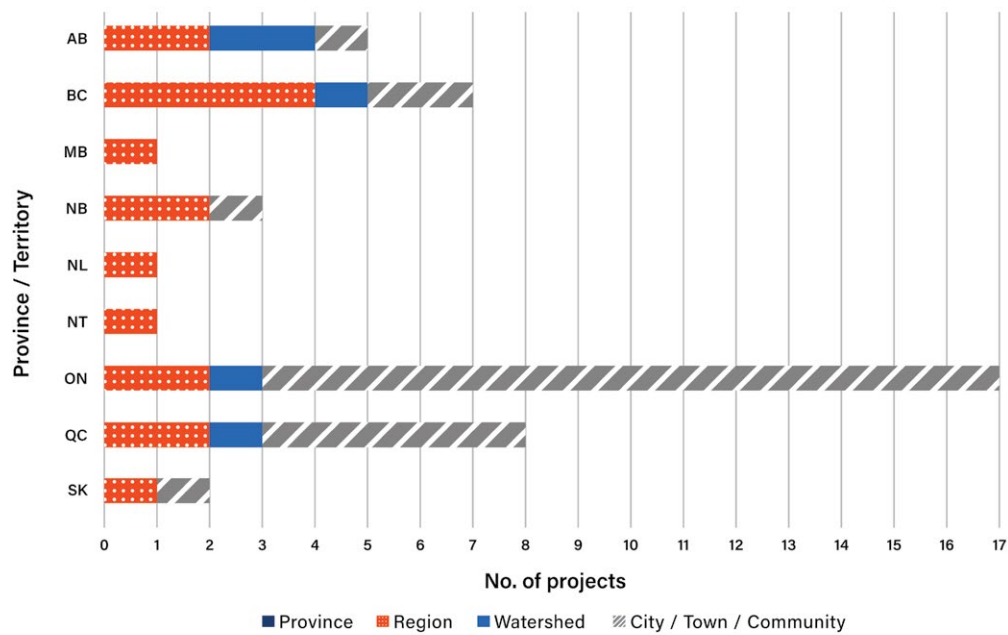
- Province;
- Region;
- Watershed; and
- City / Town / Community.

A breakdown of the number of DMAF projects funded in each province / territory, according to the scale of the project, is illustrated in Figure 6. No projects were funded at the provincial scale.

**Figure 5: DMAF River Flood and Erosion Projects Classified by Scale of Recipient Organization [104]**



**Figure 6: DMAF River Flood and Erosion Projects Classified by Scale of Project [104]**



Over half the projects involved managing river flood and erosion risk at the city / town / community scale, while just over one-third of projects worked at the regional scale, benefitting more than one community. In a number of cases, this was a result of collaboration between communities to develop some of the projects, with one of the communities acting as the funding recipient. A number of projects at the regional scale also involved provincial-led works to improve the climate resilience of public infrastructure (e.g., road corridors). Only five projects aimed to reduce flood and erosion risk working at a watershed-scale. These project were in Alberta, British Columbia, Ontario, and Quebec.

### 3.3.2.6 Use of Nature-based Solutions

The 2018 DMAF application guide stated that the fund's key objective was *"strengthening the resilience of Canadian communities through investments in large-scale infrastructure projects, including natural infrastructure projects"* [105].

Eligible investments for infrastructure projects under the DMAF included [105]:

- *"New construction of public infrastructure including natural infrastructure"*
- *Modification and/or reinforcement including rehabilitation and expansion of existing public infrastructure including natural infrastructure*
- *Land acquisition costs for land to be used as natural infrastructure."*

Merit criteria used to evaluate full applications also promoted use of natural infrastructure in projects proposed for DMAF funding:

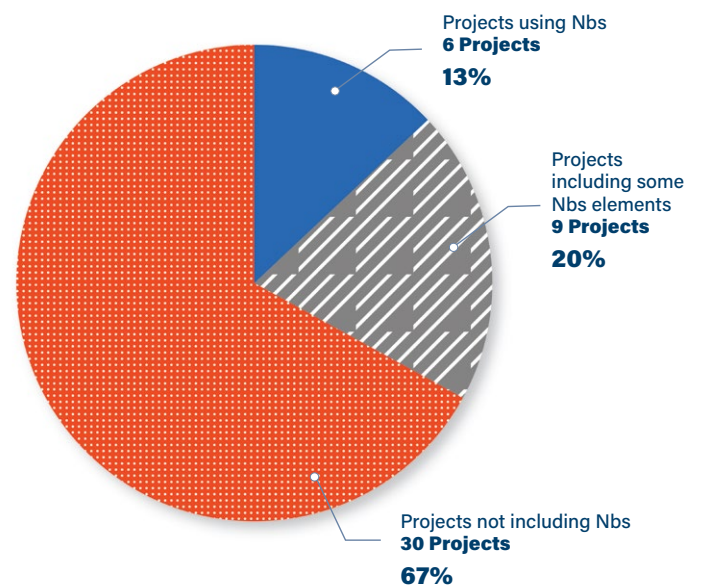
- **Criteria 4:** Promote use of innovation - including consideration of natural infrastructure, innovative technologies and/or global best practices
- **Criteria 10:** Consideration of infrastructure solutions that provide additional benefits to the community such as cultural and environmental value.

Funding allocation to NbS was not specifically tracked. The titles and descriptions of the 45 river flood and erosion projects were reviewed to identify projects that implemented NbS. Six projects were identified as using

NbS. A further nine projects were identified as incorporating NbS as part of the overall project works, although a significant part of the works concerned grey infrastructure (Figure 7).

The projects using NbS to manage river flood and erosion risk were led by a range of funding recipients, including an Indigenous government, a region, a Conservation Authority, and two cities (Table 5). Projects including NbS as part of the proposed works were also led by cities and one municipal district (Table 6).

**Figure 7: DMAF River Flood and Erosion Projects and NbS [104]**



### 3.3.3 Key Findings

Based on the analysis of projects funded under the NDMP and DMAF programs, the following overall conclusions can be drawn:

- Many federally funded flood and erosion risk management projects were led by, and undertaken within the jurisdiction of, single cities and towns. It may not be possible to effectively use NbS to reduce flood and erosion risk at the community scale (e.g., interventions upstream may be excluded). Similarly, potentially negative downstream impacts may not be fully considered.

- While a significant number of funded projects were undertaken by organizations working at a watershed-scale, these organizations are located only in Ontario and British Columbia. Conservation Authorities have played a major role in Ontario in securing federal funding for, and completing, projects to understand and reduce flooding and erosion. There has effectively been a positive feedback loop in place. Additional funds to further reduce flood and erosion risks have been secured in the province that already has the most robust approach to watershed management. The Fraser Basin Council has undertaken a similar but less pronounced role in British Columbia. The lack of organizations undertaking a similar watershed-scale role has historically led to fewer applications for federal funding being made in other provinces and territories, and ultimately less work being completed to reduce flood and erosion risk.
- NbS accounted for a minority of projects funded under the NDMP and DMAF (first intake) programs. A greater number of projects incorporating NbS were funded through the DMAF, as the application process actively encouraged natural infrastructure to be considered.
- Indigenous governments can play a role securing funding for and leading watershed-scale approaches employing NbS to reduce river flooding and erosion.

**Table 5:** Details of Six DMAF River Flood and Erosion Projects Using NbS

Prov.	Project Name	Organization	Project Description
BC	Mill Creek Flood Protection	City of Kelowna	Project to increase creek capacity through rehabilitating riverbanks, upgrading drainage, and providing additional off-stream water storage areas.
BC	Cowichan Watershed Resiliency Program	Cowichan Tribes First Nation	Project to improve watershed resilience by increasing capacity to buffer drought and flooding. Focus areas include sediment management and habitat rehabilitation.
ON	Natural infrastructure enhancement and restoration of the urban forest in the York Region	York Region	Planting trees and adding natural features to improve drainage capacity during heavy rainfall events.
ON	Repair, remediate, and enhance resilience of Toronto's tree canopy and waterfront shoreline structures to protect against future flooding and storm events	Toronto and Region Conservation Authority (TRCA)	Rehabilitating shoreline infrastructure, beaches, waterfront parks, embankments, trails, and pathways. Improving the resiliency and tree canopy cover.
ON	Toronto Region Ravine Erosion Risk Management and Hazard Mitigation Project	Toronto and Region Conservation Authority (TRCA)	Management of erosion at 111 locations within the Region of Peel, York Region, and the City of Toronto over the next 10 years.
QC	Rehabilitation of natural shoreline threatened by accelerated erosion in the major waterfront parks on the Island of Montreal, in the province of Quebec	City of Montreal	Rehabilitating 10 km of shoreline using bioengineering techniques that include vegetation. Aim to better manage the impacts of erosion and protect shoreline communities and ecosystems.



**Table 6:** Details of Nine DMAF River Flood and Erosion Projects that Include NbS elements

Prov.	Project Name	Organization	Project Description
AB	Bow Valley Mountain Creeks Flood Mitigation	Municipal District of Bighorn No. 8	Includes re-vegetation and bio-engineering work to control erosion problems.
BC	Coastal flood protection for the cities of Surrey and Delta, and the Semiahmoo First Nation	City of Surrey	Includes establishing a riverfront park on the Nicomekl River with natural flood-attenuating features.
BC	Grand Forks and Regional District of Kootenay Boundary Flood Mitigation	City of Grand Forks,	Includes re-establishing a natural floodplain in North Ruckle and building new retention ponds in South Ruckle.
NB	Multiple Natural and Structural Infrastructure Projects to Adapt to Pluvial and Fluvial Flood Events in Fredericton	City of Fredericton	Includes works to create and expand wetland areas to improve local resilience to flooding.
NT	Flood Hazard Mitigation for the Yellowknife Region	City of Yellowknife	Includes investing in natural infrastructure to reduce the risk of flooding in the community.
ON	Implementing Vaughan Stormwater Flood Mitigation projects	City of Vaughan	Includes projects that will improve water quality, increase floodplain storage, and create wetlands.
ON	Kitchener Stormwater Network Adaptation	City of Kitchener	Includes work to redesign a natural channel to help manage heavy rainfalls.
QC	Wabassee Creek Watershed	City of Gatineau	Includes work to rehabilitate three natural assets in the Wabassee Creek watershed.
QC	Protection and resilience increase against flooding in Pierrefonds-Roxboro	City of Montreal	Includes work toward creating the largest urban park in Canadian history, including wetland enhancement to support ecosystems and improve local flood resilience.

## 4 Good Practices and Opportunities for Improvement

NbS could play a greater role in managing river flood and erosion risk in Canada, while delivering multiple benefits. However, a watershed approach is key to facilitate both the identification and implementation of these type of solutions. This section presents key findings of focus groups to identify current good practices, lessons learnt, opportunities, and recommendations to better integrate NbS into flood and erosion management at the watershed scale in Canada.

### 4.1 Towards a Watershed Approach for NbS

The first of the two focus groups “Towards a Watershed Approach” was held on May 30, 2022. Key findings are summarized below and additional details are included in Appendix A.

#### 4.1.1 Perceptions of Watershed Management

As highlighted through the literature review in section 3.2, approaches to watershed management vary significantly across Canadian provinces. This is also reflected in the stakeholder perceptions.

Figure 8 illustrates the scores out of 10 assigned by 25 stakeholders regarding their perception of watershed management in their province. While personal perceptions within the same province are different and the number of viewpoints is limited, the results still indicate perceived strengths in watershed management in Ontario, Alberta, and Manitoba, and relative weakness in British Columbia and Nova Scotia.

#### 4.1.2 Current Implementation of NbS for Flood and Erosion Management

There was clear consensus among stakeholders that Conservation Authorities in Ontario are leading the way in terms of both watershed management and the use of NbS for flood and erosion risk management in Canada. It was highlighted that, since Conservation Authorities have responsibility for flood and erosion risk management, as well as conservation/restoration and environmental monitoring, they are well positioned to integrate NbS into flood and erosion risk management. The Toronto and Region Conservation Authority and Credit Valley Conservation are particularly well-established and have developed best practice guidance in many areas relating to NbS. Watershed organizations in other provinces were also cited for their work with

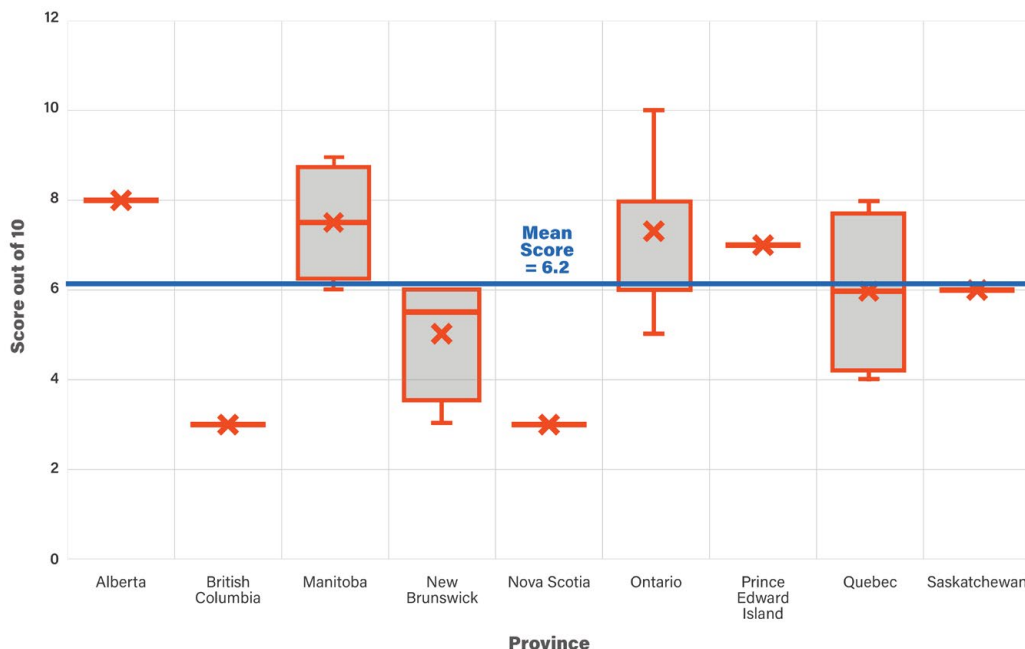
NbS, including Fraser Basin Council (BC), Bow River Basin Council (AB), and the PEI Watershed Alliance. However, these organizations do not have the same legislated mandate as Conservation Authorities.

At the provincial scale, the establishment of the Watershed Districts Program by the Government of Manitoba was identified as supportive to the implementation of NbS, although the transition from municipal to watershed-based management is ongoing.

The importance of local government leadership was underlined by several participants, both in terms of managing flooding within a watershed context and in implementing NbS. Examples cited included the City of Calgary’s Riparian Strategy and Action Plan and work to value natural assets, as well as the early integration of “freedom space” for the Coaticook River into land use planning by the MRC of Coaticook in Quebec.

NGOs and consultants are also actively supporting implementation of NbS on the ground. These actions are not necessarily part of overall watershed strategies and are being implemented to achieve multiple benefits, including, but not limited to, reducing flood and erosion risk. Examples cited by participants included:

**Figure 8:** Perceptions of Watershed Management in Canadian Provinces (excluding Newfoundland and Labrador)





“Many tools are used to compare and assess river management options in Canada. There is currently no standardized approach.”

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- ALUS, working with landowners to implement NbS on farmland;
- MNAI, working with municipalities to inventory, value, and effectively manage their existing natural assets;
- Ducks Unlimited, working to restore and enhance wetlands in multiple provinces;
- WWF Canada, working to increase resiliency using NbS in the Saint John Watershed;
- NbS projects led by the Transcoastal Adaptations Centre for Nature-based Solutions in Nova Scotia; and
- Forests Ontario, working with landowners and Conservation Authorities to strategically restore forests at a landscape and watershed-scale.

### 4.1.3 Lessons Learned Working at the Watershed-Scale

The following lessons learned provide a summary of the outputs of small group discussions between stakeholders.

#### 1. A coordinated, multi-stakeholder watershed approach is best practice

Flood and erosion management is best approached as part of integrated watershed management, which considers many other inter-related watershed functions and uses. Participants highlighted the value of coordination, close working relationships, and collaboration between watershed management organizations and communities. This was perceived as a key benefit of partnerships already established

between Conservation Authorities and municipalities. It is particularly important because of the need to consider natural river systems in flood and erosion management. These natural river systems do not follow jurisdictional boundaries.

#### 2. Supportive policy and legislative powers facilitate good decisions

Strong land use planning or zoning rules help to support use of NbS and management of at-risk areas. It was perceived that, in many cases, the key challenges are not technical understanding but political support for appropriate long-term management. For example, it is desirable to avoid development in zones at flood and erosion risk but these zones remain subject to development pressure. The importance of creating alternative purposes or uses for high-risk areas, using NbS, to lessen this pressure was highlighted. NbS can also provide benefits as part of solutions to retreat development from high-risk areas. In either case, land rights were identified as being able to influence land use and activities that can be undertaken in high-risk areas.

#### 3. Whole-life cost-benefit analysis supports better decision making

It is important to demonstrate, compare, and communicate the value of different NbS and grey infrastructure solutions for flood and risk management. Stakeholders are already implementing triple-bottom line approaches to compare options. Cost-benefit analysis can be used to demonstrate where hard engineering options are not the best

solution and where retreat from high-risk areas of the floodplain is more beneficial overall. It was also highlighted that NbS can reduce long-term maintenance commitments, especially where grey infrastructure is obsolete.

#### **4. A solid technical understanding is required as a basis for river flood and erosion management**

Solid technical understanding is a prerequisite for appropriate flood and erosion management. Technical understanding of how NbS can be used to reduce flood and erosion and the level of service achievable was perceived as lacking. Appropriate data collection is critical, including ongoing watershed monitoring and project-based monitoring of NbS.

#### **5. One size does not fit all in watershed management**

Canadian watersheds are diverse in terms of their spatial scale, key functions, and stakeholders. As such, watershed management approaches need to be flexible to enable regional application.

#### **6. An adaptive approach is needed**

It is not possible to foresee all future drivers of watershed management. Watershed approaches need to be adaptive in the context of ongoing social, economic, and environmental change.

### **4.1.4 Recommendations to Better Integrate NbS and Flood and Erosion Management at a Watershed-Scale**

#### **Extend Watershed Management to All Provinces**

There was consensus that a watershed management approach, similar to that originally developed in Ontario, should be applied to other provinces. Federal and provincial governments should develop and fund a nationally consistent watershed planning framework that has agreed minimum requirements and is flexible enough to address local watershed needs. A national approach should build on established guidance and best practices, particularly from Ontario (e.g., Provincial Policy Statement, Natural Heritage Reference Manual). The Canadian Water Agency was suggested as a potential vehicle for watershed-based governance [106]. This approach provides opportunities to engage with Indigenous communities and governments who are already working with NbS. The National Adaptation

Strategy [107] was mentioned as another initiative that would benefit from watershed management, with a need to also manage future drought conditions. Consultation in British Columbia on a Watershed Security Strategy and Fund was seen as a potential catalyst in that province.

#### **Develop Flood and Erosion Risk Management Strategies for Watersheds on a Prioritized Basis**

It was recommended that flood risk management strategies be developed for all watersheds, starting with those most at-risk. These strategies should involve coordination between all levels of government to prioritize strategic action based on risk.

#### **Standardize Valuation and Management of Natural Assets**

It was recommended that standards and guidelines are prepared to support valuing of ecosystem services provided by NbS and existing natural assets. This is needed to compare NbS to traditional solutions and to demonstrate and communicate benefits to watershed users. This can build on existing standard development for natural asset inventory. Such standards would also be useful in identifying appropriate compensation or incentives for “non-use”, prescribed beneficial uses of land, or opportunities that could be realized as part of managed retreat.

#### **Require Consideration of NbS as the Default Solution**

Protocols or funding procedures should be updated to promote consideration of NbS as the default solution, with grey solutions being compared and applied where technically required or more beneficial.

#### **Provide Additional Incentives for NbS on Private Lands**

It was recommended that additional incentives be developed to increase use of NbS or protection of existing natural assets on private lands. This may include tax incentives, project financing conditions, or green loans.

#### **Facilitate Sharing of Data and Best Practices**

Networks are required to facilitate communication and data sharing between communities within a watershed, between watersheds, and between provinces. There is currently limited exchange between watershed organizations in different provinces.



## 4.2 Including NbS Benefits in Options Appraisal

The benefits of NbS are currently not adequately addressed in options appraisal approaches in Canada. The second of the two focus groups, “Including NbS Benefits in Options Appraisal,” was held on June 14, 2022. Key findings are summarized below and additional details are included in Appendix A.

### 4.2.1 Current Options Appraisal Approaches and Tools

Many tools are used to compare and assess river management options in Canada. There is currently no standardized approach, with common approaches including:

- Multi-criteria analysis (largely qualitative assessment);
- Evaluation against specific performance objectives;
- Return on investment (often based on avoiding damages); and
- Cost-benefit analysis (largely quantitative assessment of tangible and intangible benefits/costs).

Approaches are usually tailored to the specific project objectives, and approaches may be combined to capture and evaluate different outcomes.

Canadian-specific federal or provincial protocols used to appraise river flood and erosion management options include:

- Application of Infrastructure Canada’s Climate Lens (includes Greenhouse Gas Mitigation Assessment and Climate Change Resilience Assessment) [108];
- Evaluation against Disaster Mitigation and Adaptation Fund application criteria [109]; and
- Legally required Environment Impact Assessment procedures (vary by province and territory).

Tools to support options appraisal have also been developed by other Canadian organizations. Cited examples are briefly profiled below.

### Sustainable Asset Valuation (SAVi)

SAVi is an assessment methodology that aims to help governments and investors steer capital toward sustainable infrastructure [110]. The International Institute for Sustainable Development (IISD) and MAVA Foundation built SAVi to identify and value the costs of risks, as well as the costs of externalities, of infrastructure projects, portfolios, and policies. SAVi is a simulation methodology that combines the outputs of systems dynamics simulation with project finance modelling. It is customized to each asset, portfolio, or policy, and it can be specifically tailored for nature-based infrastructure [111]. In Canada, the tool has been used to estimate the value of ecosystem and infrastructure services provided by Pelly’s Lake and Stephenfield Reservoir in Manitoba and to assess the required costs of providing these services with built or updated infrastructure [112]. The tool is not available for use by organizations themselves; rather the IISD team seeks to work with partners to customize the tool to each case [113].

### Class Environmental Assessment for Remedial Flood and Erosion Control Projects

Environment Assessment in Ontario includes several approved Class Environmental Assessments (Class EAs) that set out a standardized planning process for classes or groups of activities [114]. A Class EA for Remedial Flood and Erosion Control Projects was developed by Ontario’s Conservation Authorities and coordinated by Conservation Ontario. The Class EA sets out a planning and design process that ensures that environmental effects are considered when undertaking remedial flood and erosion control projects [115]. The Class EA documents requirements relating to option appraisal, including identifying alternative methods, selecting a preferred alternative, and determining the net impacts of the preferred alternative.

### Risk and Return on Investment Tool (RROIT)

The RROIT was developed by Credit Valley Conservation and partners to support decision makers in selecting cost-effective measures to reduce flood and erosion risks [116]. The tool can be used to:

- *“Quantify potential direct and indirect damages in dollars from flooding and erosion under different climate scenarios.*

- *Compare the effectiveness of different stormwater management solutions, including natural assets, land acquisition in the floodplain, low impact development, and grey infrastructure.*
- *Perform financial assessments of the return on investment for each solution (and combinations) to help make cost-effective decisions and reduce risk.*

The tool is not yet available for use by organizations themselves but those interested in using it are invited to reach out to Credit Valley Conservation for further details [116].

#### **4.2.2 Accounting for NbS Benefits in Options Appraisal**

NbS can deliver multiple benefits that are not typically provided by hard “grey” protection measures [117, 118]. Such benefits are often referred to as “ecosystem goods and services” that provide benefits to people. These goods and services often do not have a direct monetary market value and are therefore more difficult to integrate into options appraisal in financial terms.

Feedback from participants suggest that NbS are being considered as options for flood and erosion management but not routinely or in a way that enables all of the benefits to be evaluated. Flood and erosion control benefits are typically quantified by calculating the cost of damages avoided over time. Other ecosystem goods and services are often, but not always, considered in the appraisal of river flood and erosion management options. When ecosystem goods and services are considered, qualitative or semi-quantitative methods, including ranking and scoring, are often used, with some stakeholders undertaking economic valuation.

For example, the DMAF 2021 application process requires applicants to calculate economic benefits as a Return on Investment (ROI), based on a ratio between avoided damages and the cost of the project. Project co-benefits, including greenhouse gas reduction and ecosystem services, do not factor into the ROI calculation and are to be described qualitatively under a separate merit criterion [109].

However, ecosystem services, such as water quality, carbon sequestration and storage, and biodiversity and habitats may also be quantifiable in terms of both

predicted changes and their monetary value. Both quantitative and qualitative approaches may be used to appraise impacts as part of option appraisal (Table 7). Economic valuation of NbS solutions can employ a variety of methods, including estimation of costs to replace the service using a grey infrastructure solution, revealed preference, and statement preference methods [118]. Benefit transfer methods that are less resource and time intensive may also be used where “broad brush” analysis is sufficient. Semi-quantitative or qualitative approaches may be suitable to reflect cultural ecosystem services perceived to be less robustly quantifiable, such as recreation or aesthetics. Methods to assess or quantify changes in ecosystem service provision may also be useful as part of performance monitoring once a solution has been implemented.

Increasingly, modelling tools are available to help evaluate changes in ecosystem goods and services that may be associated with coastal management options. The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) tool, developed by the Natural Capital Project, is a suite of open-source tools that helps users explore how changes in ecosystems may lead to changes in benefits to people [119]. Several modules are available, including urban flood risk mitigation, sediment retention, urban stormwater retention, habitat quality, and carbon [120].

A key issue identified during the focus group was the need to appraise strategic approaches to flood and erosion risk management at the watershed-scale in order to guide more local level interventions on the ground. This is an approach similar to Catchment Flood Management Planning undertaken in the United Kingdom [121]. Options appraisal on a project-specific basis can otherwise often overlook the incremental benefits (or adverse impacts) of multiple actions / interventions within a watershed.

#### **4.2.3 Support for Standardization of Option Appraisal**

As part of the June 14, 2022 focus group, participants were asked if they would welcome development of a standardized option appraisal protocol for flood and erosion management projects to include the benefits / costs associated with ecosystem goods and services. The majority of participants replied “yes”.

**Table 7:** Examples of Methods, Indicators, and Lessons Learned in Assessing Changes in Ecosystem Goods and Services

Impact	Methods, Indicators, and Values Used	Lessons Learned
<b>Water quality</b>	<ul style="list-style-type: none"> <li>Use of bespoke software (InVEST)</li> <li>Change in, or replacement value of, water treatment costs</li> <li>Change in water quality indicators (applying established standards)</li> <li>Visual indicators of water quality (turbidity, algal blooms) that may be obtained using earth observation techniques</li> </ul>	<ul style="list-style-type: none"> <li>Established standard protocols are available</li> <li>Can be difficult to address variability over space and time</li> </ul>
<b>Carbon sequestration and storage</b>	<ul style="list-style-type: none"> <li>Use of bespoke software (InVEST)</li> <li>Social value of carbon</li> <li>Change in soils and vegetation and impact on carbon flux and storage</li> <li>Calculation of embedded carbon in “grey” infrastructure protection measures</li> </ul>	<ul style="list-style-type: none"> <li>No standardized method available</li> <li>Time lag in carbon sequestration needs to be accounted for</li> <li>Calculations should be based on local data</li> </ul>
<b>Biodiversity and habitats</b>	<ul style="list-style-type: none"> <li>Use of bespoke software (InVEST, iTree)</li> <li>Use of traditional ecological knowledge / participative mapping to obtain baseline</li> <li>Change in species diversity / species at risk / invasive species</li> <li>Change in land use area of different habitats (using GIS)</li> </ul>	<ul style="list-style-type: none"> <li>Different tools may be suited to different habitats</li> <li>High-resolution mapping can be obtained using drones</li> <li>The value of habitat connectivity is difficult to capture</li> </ul>

Many of those who replied “not sure” indicated in more detailed comments that they were open to standardization as long as there was appropriate consultation in developing the standard and flexibility in applying methods suited to the local context.

## 5 Conclusions and Recommendations

### 5.1 Three Key Conclusions

Drawing together the findings of the research and stakeholder engagement undertaken through this project, the following three key conclusions can be drawn:

- Canada already has good practice approaches for watershed management** that support implementation of NbS for flood and erosion risk management. These approaches need to be strengthened and supported in Ontario and extended to other provinces.
- Funding for river flood and erosion risk management needs to be directed to watershed-scale strategies** that address

prioritized high-risk areas or projects that have been identified by such strategies. This approach would support meaningful appraisal and implementation of measures (including NbS) that address underlying causes of flooding and erosion while achieving multiple benefits.

- NbS need to be considered for river flood and erosion management with the same rigour as grey infrastructure solutions.** This includes routine appraisal of NbS alongside a full range of grey infrastructure solutions.

### 5.2 Recommended Actions for Governments

Federal, provincial, watershed-scale, and local governments (including municipal and Indigenous governments) all have roles to play in implementing the above recommendations. In particular, provincial governments play a key role, since they have jurisdictional responsibility for implementing flood and erosion risk management.

The actions that different levels of government can take in using NbS to reduce flood and erosion risk are outlined in Table 8.

**Table 8: Roles of Governments in Using NbS for Flood and Erosion Risk Management at the Watershed Scale**

Government	Recommended Actions
<p><b>Federal government</b></p>	<p>Support and work with provincial governments to develop guidance for, and help fund, a nationally consistent watershed planning framework that includes agreed-upon minimum requirements for flood and erosion risk management at the watershed scale. This could be progressed through the Canadian Water Agency or through work to achieve targets set by the National Adaptation Strategy (although the strategy itself does not explicitly include watershed-scale management, several of the objectives and targets would benefit from this approach).</p> <p>Work with provincial governments to identify priority watersheds (high-risk areas or vulnerable communities) for which flood and erosion management strategies are required to be completed first (if they have not been completed already).</p> <p>Update existing federal funding programs (e.g., DMAF, Natural Infrastructure Fund) or create new funding programs to a) direct funds to projects that address flood and erosion risk at the sub-watershed / watershed-scale and b) require routine consideration of NbS as the default solution, to be combined with grey infrastructure where necessary.</p> <p>Support development and use of national guidelines and standards to support use of NbS for flood and erosion management (see Section 5.3 for discussion of specific standards).</p>
<p><b>Provincial governments</b></p>	<p>Strengthen provincial legislation and policy to support watershed-scale approaches to manage flood and erosion risk, including the use of NbS.</p> <p>Work with the federal government to develop guidance for, and help fund, a nationally consistent watershed planning framework that includes agreed-upon minimum requirements for flood and erosion risk management at the watershed scale. Provincial governments have a key role to play as watershed management (apart from international watersheds) is a provincial jurisdiction.</p> <p>Work with federal government to identify priority watersheds (high-risk areas or vulnerable communities) for which flood and erosion management strategies are required to be completed first (if they have not been completed already).</p> <p>Develop flood and erosion risk management strategies at the watershed / sub-watershed scale for prioritized high-risk areas. Update provincial funding programs to a) direct funds to projects that address flood and erosion risk at the sub-watershed / watershed-scale and b) require routine consideration of NbS as the default solution, to be combined with grey infrastructure where necessary.</p>
<p><b>Watershed governance organizations</b></p>	<p>Work to include the use of NbS for flood and erosion risk management as a watershed management objective. Ensure that the flood and erosion risk reduction benefits of NbS are documented, even when this is not the primary objective of the solution.</p> <p>Continue to use NbS for flood and erosion management as a default solution where appropriate. Work with local community groups, businesses, and governments to publicize the multiple benefits delivered.</p> <p>Work to inventory, value, and manage the services provided by natural assets within the watershed, including flood and erosion protection. Continue to protect existing natural assets and prioritize restoration efforts in areas with the highest potential benefit.</p> <p>Continue to provide technical support to local governments with flood and erosion risk management and planning / implementation of NbS projects.</p> <p>Communicate the value of natural assets and the role of NbS in flood and erosion protection to residents.</p>



Government	Recommended Actions
<b>Local governments (including municipal and Indigenous governments)</b>	<p>Work with watershed organizations to help identify, plan, and implement NbS for flood and erosion risk management.</p> <p>In the absence of a watershed governance organization, work with other local governments to help identify, plan, and implement NbS for strategic flood and erosion risk management at a watershed / sub-watershed scale.</p> <p>Consider NbS as the default solution for flood and erosion risk management, to be combined with grey infrastructure where necessary.</p> <p>Work to inventory, value, and manage the services provided by natural assets, within both the local government jurisdiction and upstream watershed, including flood and erosion protection.</p> <p>Communicate the value of natural assets and the role of NbS in flood and erosion protection to residents.</p> <p>Work with private land owners / farmers who can contribute to nature-based solutions.</p>

### 5.3 Recommendations for Guidance and Standardization

Potential opportunities for further national guidance and standardization that have been identified as part of this research project are outlined in Table 9, together with specific considerations and recommendations drawn from this research project.

**Table 9:** Potential New National Guidance and Standards

Potential National Guidance / Standard	Considerations and Recommendations
<b>Minimum framework for watershed management planning</b>	<ul style="list-style-type: none"> <li>Opportunity to build on Canadian provinces and international jurisdictions that already have standardized watershed management planning.</li> <li>To include, but not be limited to, flood and erosion risk management.</li> <li>Requires buy-in from provincial governments to be useful; potential role for the Canadian Water Agency.</li> </ul>
<b>Standard for strategic appraisal of river flood and erosion risk management options</b>	<ul style="list-style-type: none"> <li>Standard would be applicable at a watershed- / sub-watershed-scale.</li> <li>Opportunity to build from Canadian provinces and international jurisdictions that already have standardized strategic flood and erosion risk management.</li> <li>Opportunity to build on the CSA W211:21 Management standard for stormwater systems [122].</li> <li>Recommended to include NbS as the default solution, to be combined with grey infrastructure where necessary.</li> </ul>
<b>Standards to support the identification, valuation, and management of services provided by natural assets</b>	<ul style="list-style-type: none"> <li>First standard on “Specifications for Natural Asset Inventories,” CSA W218 under development [123].</li> <li>Additional standard needs may include a) condition assessment, b) valuation, c) risk, and d) integration in asset management planning.</li> <li>Standards relating to valuation require integration with the work of the Canadian Public Sector Accounting Board to enable financial value to be reported in financial statements.</li> <li>Standards could inform standardized project option appraisal and be used by various levels of government.</li> <li>Opportunity to tie to targets recently agreed-upon under the Global Biodiversity Framework.</li> </ul>
<b>Standard option appraisal protocol for flood and erosion management projects</b>	<ul style="list-style-type: none"> <li>Standard would specifically integrate the financial value of benefits and costs associated with NbS and consider the watershed context.</li> <li>Opportunity to build on existing methods and international jurisdictions that already have standardized option appraisal protocols.</li> <li>Would be useful to several funding programs to ensure allocation of funds to achieve maximum benefits (including, but not limited to, flood and erosion risk management benefits).</li> </ul>

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# Appendix A – Focus Group Structure

This appendix provides an overview of the two workshops held in May and June 2022. Each of the workshops was attended by over 35 subject matter experts from across Canada. Attendees are recognized in the acknowledgements list at the beginning of this report.

**Table A.1:** Goals and Content Output of Focus Group #1: Taking a Watershed Approach

<b>Date:</b>	<b>Monday, May 30, 2022, 12-3pm EDT</b>
<b>Goals:</b>	<ul style="list-style-type: none"> <li>▪ Review the use of nature-based solutions for river flood and erosion risk management and their use in Canada.</li> <li>▪ Capture subject matter expertise regarding how nature-based solutions are currently being implemented, considering the watershed-scale to manage flooding and erosion.</li> <li>▪ Inform guidance and standards development for governments (local, provincial and federal) and communities to help scale-up implementation of nature-based solutions.</li> </ul>
<b>Content:</b>	<p><b>Pre-workshop questionnaire</b> (via MS Forms)</p> <p><b>Polling activities</b> (via Mentimeter)</p> <p><b>Presentations:</b></p> <ul style="list-style-type: none"> <li>▪ Nature-Based Solutions for River Flood and Erosion Risk Management (Enda Murphy, National Research Council of Canada).</li> <li>▪ Overview of Watershed Management in Canada – research results to date (Joanna Eyquem, Intact Centre on Climate Adaptation).</li> <li>▪ Practical Tips on Using NbS to Manage Flooding and Erosion – Learning from The Netherlands (Ralph Schielen, Rijkswaterstaat / Delft University of Technology)</li> </ul> <p><b>Small-group, virtual whiteboard sessions:</b></p> <ol style="list-style-type: none"> <li>1. Current use of nature-based solutions for riverine flood and erosion management</li> <li>2. Lessons learnt across Canada working at the watershed scale</li> <li>3. Opportunities and recommendations to integrate NbS and flood and erosion management at the watershed-scale</li> </ol> <p><b>Review and Structured Plenary Discussion</b></p> <ul style="list-style-type: none"> <li>▪ How can local governments and communities work more effectively together to implement NbS at the watershed scale?</li> <li>▪ Is payment for ecosystem services helping to implement NbS in your province? Who is doing this?</li> <li>▪ Are additional national standards or guidance required to strengthen watershed approaches? What would be most useful?</li> </ul>

**Table A.2:** Goals and Content Output of Focus Group #2: Including NbS Benefits in Options Appraisal

<b>Date:</b>	<b>Tuesday, June 14, 2022, 12-3pm EDT</b>
<b>Goals:</b>	<ul style="list-style-type: none"> <li>▪ Identify option appraisal tools currently applied across Canada to plan and design river flood and erosion management infrastructure, and how they incorporate Nature-based Solutions (NbS).</li> <li>▪ Capture subject matter expertise regarding how costs and benefits relating to NbS are being / can be better addressed in the riverine environment.</li> <li>▪ Inform guidance and standards development for options appraisal that specifically includes NbS co-benefits.</li> </ul>
<b>Content:</b>	<p><b>Pre-workshop questionnaire</b> (via MS Forms)</p> <p><b>Polling activities</b> (via Mentimeter)</p> <p><b>Presentations:</b></p> <ul style="list-style-type: none"> <li>▪ Overview of Approaches to Include NbS Benefits (Joanna Eyquem, Intact Centre on Climate Adaptation).</li> <li>▪ Evolution of flood and erosion risk management in Quebec City- opportunities for NbS (Antoine Verville, CMQuébec)</li> </ul> <p><b>Small-group, virtual whiteboard sessions:</b></p> <ol style="list-style-type: none"> <li>1. Current practices in option appraisal of NbS for river flood and erosion management</li> <li>2. Methods of better incorporating NbS benefits in Canada             <ul style="list-style-type: none"> <li>▪ Advantages and disadvantages of methods for different benefits</li> <li>▪ Lessons learnt</li> </ul> </li> </ol> <p><b>Review and Structured Plenary Discussion</b></p> <ul style="list-style-type: none"> <li>▪ Wider economic and accounting context</li> <li>▪ Roles and responsibilities</li> </ul>



## CSA Group Research

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In order to encourage the use of consensus-based standards solutions to promote safety and encourage innovation, CSA Group supports and conducts research in areas that address new or emerging industries, as well as topics and issues that impact a broad base of current and potential stakeholders. The output of our research programs will support the development of future standards solutions, provide interim guidance to industries on the development and adoption of new technologies, and help to demonstrate our on-going commitment to building a better, safer, more sustainable world.