Ontario's Special Advisor on Flooding Report to Government

An Independent Review of the 2019 Flood Events in Ontario

A Report to the Hon. John Yakabuski, Minister of Natural Resources and Forestry

Douglas McNeil, P.Eng.
McNeil Consulting Inc. – Winnipeg, Manitoba

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Executive Summary

Ontario has a long history of taking actions to keep people and property safe from the impacts of flooding through land use planning policies and mitigative activities. The development of the modern floodplain policy in Ontario, the watershed approach, the conservation authority model, and the flood standards have been extremely effective at reducing flood risks, especially in new greenfield development areas.

However, during the spring of 2019, heavy rains paired with melting snow and a sudden temperature increase led to devastating flooding across many areas throughout northern and southern Ontario. Emergency declarations were made by 23 municipalities and one First Nation, with significant flooding impacting households, commercial properties, roads and other key infrastructure, such as bridges. Emergencies were first declared starting in early April and lasted through July in many cases. Even through the fall and heading into winter, the Great Lakes continue to experience high-water levels that have been underway since early 2017, and many people and properties continue to be at risk.

In response to these flood events, the provincial government announced that it would undertake consultation on the province's current flood mitigation and land use planning policies. Their first step was to host three regional listening sessions held by provincial leaders with municipal, Indigenous and industry leaders in Muskoka, Pembroke and Ottawa in May 2019. These sessions allowed the Province to hear directly from areas most devastated by the spring floods. Acknowledging that these sessions did not cover all areas that experienced flooding, nor provided the public with an opportunity to engage on the topic, the Province invited comments regarding flooding and suggestions to make Ontario more resilient to flooding through an online survey from May 16 to June 28, 2019.

Following this initial engagement in the spring, I was appointed by the Minister of Natural Resources and Forestry, the Honourable John Yakabuski, on July 18, 2019, to review the province's current flood management framework. In addition to considering policies and activities which influenced spring flooding, I was also asked to consider both Great Lakes and urban flooding.

As Special Advisor on Flooding, I was appointed by the government to provide expert advice to the Minister, and to make recommendations to the government on opportunities to improve the existing flood policy framework.

Despite having worked in Manitoba on flooding issues throughout my career, I was unfamiliar with the complex policy framework for flood management in Ontario.

Understanding the various roles of agencies involved, including the federal government, municipalities, conservation authorities and individual provincial ministries, along with the policies and technical guidance, was of utmost importance to the review process. The Ministry provided a number of documents to enable an understanding of the current policy framework for flood management in Ontario and a listing of the documents is included in Appendix A.

While information provided by the Ministry was helpful in providing context for my evaluation, further engagement was warranted to ensure a full review.

I first met with Minister Yakabuski to ensure a clear understanding of my mandate and the importance of this review to the people of Ontario. He underscored the devastating impacts being felt across the province from flooding and the need for the Province to help citizens and ensure their safety in the future.

Working with the Ministry, a nine-day community tour over two weeks in early September 2019 was developed to highlight the variance in issues, geographies and responsibilities. Tour stops included a mix of provincial department meetings; agency meetings; municipal and conservation authority roundtables; and guided tours of locally impacted areas. The first set of community tours took place in the Ottawa, Pembroke and North Bay areas. During the second week of my community tours, I visited Toronto, Muskoka, Cambridge and London.

I have segmented my report into six chapters: 1) Introduction; 2) The Review Process; 3) Background and the 2019 Flooding in Ontario; 4) Region Specific Situations; 5) Ontario's Approach to Managing Flood Risk; and 6) Challenges and Opportunities to Managing Flood Risk.

In Chapter 3, I wanted to set the stage and explain all of the reasons behind the 2019 flooding, such as the above average snowfall in winter 2018/19, above average snow water equivalent, low temperatures going well into the spring, and significant rainfall during snow melt.

I prepared Chapter 4 to try to provide the reader with explanations as to what happened during the flooding in each of the watersheds that I visited or heard about. Too often I heard people say they didn't understand how systems worked, or if they did, they felt that operations could have been done differently for a better result. I asked for and am grateful for the significant amount of detailed information from the various conservation authorities, municipalities, agencies and provincial departments. A lot of this information is included in this report, but was first reviewed and edited by me.

In Chapter 5, I talk about the core components of emergency management—prevention, mitigation, preparedness, response and recovery. I also identify the Acts, regulations, policies and technical guidelines regarding floods. Lastly, I write about the roles and responsibilities of provincial ministries, municipalities, conservation authorities, the federal government, and other agencies involved in flood management.

It is not hard to see that flooding, whether it is as a result of spring freshet, urban flooding or high Great Lakes water levels, is having a growing effect on Ontarians, and has reminded us that there is always room to improve. In Chapter 6, I write about the challenges and opportunities to managing flood risk, and include my numerous recommendations to the Ontario Government and recommendations to the other parties discussed in Chapter 5.

Based on an analysis of the information available for all of the systems that experienced flooding in 2019, nothing points to human error or the negligent operation of water control structures as the cause of the flooding. The sheer amount of water (snow and rainfall) on the landscape directly contributed to the flooding. Measures taken by water managers everywhere were effective in reducing the magnitude of flooding and associated damages throughout the drainage basins.

My work was supported by, and I am very much indebted to, the Ministry of Natural Resources and Forestry, which provided background materials, logistic support for meetings and tours, and facilitated the transfer of information and correspondence from the public and stakeholders related to my review.

Recommendations

Author's note: Implementation of many of the recommendations in this report are focused on agencies outside the jurisdiction or control of the Ministry of Natural Resources and Forestry (MNRF). In those cases, I would expect that the MNRF can initiate discussions with the particular agency to try and seek agreement for implementation, in full or in part.

Recommendation #1	That the MNRF proceed as expeditiously as possible to finalize its proposed regulation under the *Conservation Authorities Act* and submit it to Cabinet for approval.
Recommendation #2	That the MNRF consult with the conservation authorities on their application of the hazards-based approach and the risk-based approach to managing flooding.
Recommendation #3	That the following be incorporated into the Provincial Policy Statement: • The reference to "impacts of a changing climate" throughout the Provincial Policy Statement helps to bring it to everyone's attention and should be included in the Preamble as well. • Either in the body of the PPS or in the definitions section, reference should be made specifically to the requirement for conservation authorities to regulate development activities in hazardous lands as required in the *Conservation Authorities Act.* • That "d) Transportation and Infrastructure Corridors, Airports, Solid and Liquid Waste Management" be added to Section 3.1.5 of the Provincial Policy Statement.
Recommendation #4	That the MNRF update floodplain mapping technical and implementation guidelines recognizing new technology and approaches for flood hazard and flood risk mapping, and that the MNRF collaborate with conservation authorities on this initiative.

Recommendation #5	That the Province update its technical guides pertaining to floods and natural hazards. This should include undertaking a review of the flood event standards (e.g. 1%, Timmins storm, Hurricane Hazel), with a view to providing for current science and climate change, such as a specified minimum freeboard. This should also include reviewing the floodplain areas (floodway, floodway fringe, shoreline setbacks) as well as reviewing and updating, where appropriate, Great Lakes flood level values and shoreline erosion hazard methodologies and allowances.
Recommendation #6	That the Province establish a working group with provincial departments, conservation authorities and municipalities to prepare a multi-year approach to floodplain mapping.
Recommendation #7	That the federal government be encouraged to extend the National Disaster Mitigation Program or develop a successor program, so that municipalities, conservation authorities, and Ontario and Quebec (in consideration of the Ottawa River) can undertake or update floodplain mapping in all critical areas.
Recommendation #8	That the Province consider the establishment of a provincial Elevation Mapping Program and commit to the annual funding requirements.
Recommendation #9	That the Province consider establishing a provincial custodian for floodplain mapping information and make the necessary updates to policies, regulations and legislation.
Recommendation #10	That the Ministry of the Solicitor General implement the Auditor General's recommendations regarding a governance framework for emergency management and updating continuity of operations programs as soon as possible.
Recommendation #11	That the Province consider whether the *Emergency Management and Civil Protection Act* needs to be amended with a view to clarifying roles and responsibilities of identifying hazardous areas.

Recommendation #12	That the MNRF consider working with Conservation Ontario and the Association of Municipalities of Ontario to determine how the experience and information developed by municipalities and conservation authorities of identifying hazardous areas can be transferred to municipalities without a conservation authority.
Recommendation #13	That the Province consider legislative amendments that clarify the permissions under the *Conservation Authority Act* and the land use approvals in accordance with the *Planning Act* as they relate to development in hazardous areas.
Recommendation #14	That the Province consider new legislation to improve the existing flood policy framework by having a lead minister responsible for all flood-related policy, standards, regulations and legislation.
Recommendation #15	That the Province consider adopting legislation that will require flood risk properties to be identified in some way that is publicly accessible, at the very least on the property title, to ensure that prospective buyers are aware.
Recommendation #16	That municipalities consider utilizing local improvement charges to help finance and install (or upgrade) shoreline protection works, and if necessary, that the Province provide municipalities with enhanced authority to do so.
Recommendation #17	That the Province support municipalities and conservation authorities to ensure the conservation, restoration and creation of natural green infrastructure (i.e. wetlands, forest cover, pervious surfaces) during land use planning to reduce runoff and mitigate the impacts of flooding.
Recommendation #18	That the MNRF North Bay District facilitate a meeting between the Sturgeon-Nipissing-French watershed group and the Upper Ottawa River Watershed group to help the latter group establish a collaborative arrangement for future flood events. It is important that all parties involved in the flood be present at the meeting.

Recommendation #19	That the City of North Bay in particular, and any other municipalities in a similar situation, install appropriate treatment plant bypass piping to improve resiliency of key infrastructure and limit the impacts of flooding on this infrastructure and associated impacts to public health and safety.
Recommendation #20	That the Province, the federal government (Public Service and Procurement Canada) and the North Bay-Mattawa Conservation Authority review the Lake Nipissing Operational Guidelines.
Recommendation #21	That the MNRF establish a communication protocol to inform and involve key stakeholders (i.e. municipalities) on watershed conditions and operations throughout the fall and winter leading into and throughout the spring freshet, commencing in early 2020.
Recommendation #22	That the Ministry of Environment, Conservation and Parks (MECP) use the results of the Muskoka Watershed Conservation and Management Initiative to inform any potential future amendments to the Muskoka River Water Management Plan by working with the Ministry of Natural Resources and Forestry, and in the meantime, that the MECP consider whether to encourage the municipalities to establish a conservation authority or request the Ministry of Municipal Affairs and Housing to restrict development in the floodplains (e.g. Ministerial Order).
Recommendation #23	That Haliburton County document how their collaborative model worked for the 2019 flood and share this information with, and for the benefit of, other counties, municipalities and conservation authorities.
Recommendation #24	That provincial, federal and municipal governments work with the Essex Region Conservation Authority and the Lower Thames Valley Conservation Authority to undertake a coordinated short- and long-term strategy to address the existing and expected impacts to Chatham-Kent, Windsor-Essex and Pelee Island as a result of current and future water

	levels, flood and erosion hazards, and climate change on Lake Erie, Lake St. Clair and the Detroit River.
Recommendation #25	That the MNRF review and update the appropriate technical guides, with consideration of a new category permitting development in hazardous lands along large inland lakes, rivers and streams, and along the Great Lakes/St. Lawrence River, utilizing flood protection land forms and/or other forms of flood protection and floodproofing methods with very strict requirements and conditions. Further, consideration should be given to enshrining this concept in legislation or in a regulation along with other structural methods that are now permitted in non-hazard lands or Special Policy Areas.
Recommendation #26	That, due to the increased use of the regional flood control facilities, the MNRF review whether the Province should take steps to regulate the use of these structures or let municipalities decide their use.
Recommendation #27	That the Province create a working group of all pertinent ministries to define their respective roles as they pertain to pluvial flooding.
Recommendation #28	That the Province consider whether it should take steps to regulate drainage standards in urban areas, such as the requirement to restrict runoff flows to pre-development rates and flood protection measures for private property, and if so, what is the most appropriate legislation.
Recommendation #29	That the Ministry of Environment, Conservation and Parks reach out to the Intact Centre on Climate Adaptation, as part of their commitment to consult with the insurance and real estate industry under the 2018 Environment Plan, to work collaboratively to raise awareness among homeowners about the increasing risk of flooding and to disseminate the basement flooding protection information to homeowners.
Recommendation #30	That the Ministry of Infrastructure ensure that the Ontario Community Infrastructure Fund supports municipalities in enhancing and implementing asset management plans (which includes stormwater management and consideration of climate change adaptation and mitigation activities), which will

	help municipalities make the best possible investment decisions for their infrastructure assets.
Recommendation #31	That the Ministry of Infrastructure work specifically with the MNRF on the design of future intakes of the Green stream of the Investing in Canada Infrastructure Program to ensure flood-related projects are eligible.
Recommendation #32	That the Province continue to fund the Water Erosion Control Infrastructure program and consider adopting a multi-year budget.
Recommendation #33	That the Province continue to issue Green Bonds in 2020 and beyond to help finance extreme-weather resistant infrastructure.
Recommendation #34	That the Province continue its financial commitment and partnership arrangement with the federal government through the hydrometric network agreement.
Recommendation #35	That the Province continue to monitor the effectiveness and location of gauges to ensure that there is appropriate coverage and consider repositioning gauges if necessary.
Recommendation #36	That, where appropriate and where funding permits, the Province consider the installation of GOES telemetry at key locations where more frequent access to information is required (areas of higher risk/watersheds that react quickly to changes in precipitation or snowmelt) and where current landline telecommunication technology is less secure and not as reliable in transmitting information.
Recommendation #37	That, where appropriate and where funding permits, the Province consider the use of automated alarms at those stations in watersheds of higher risk/quick response to precipitation and snowmelt to alert when water levels have exceeded a threshold of concern.
Recommendation #38	That the Province explore whether there would be value toward additional manual snow course locations in those watersheds where snow cover and snow water content are

	factors in spring flooding, and seek to involve the citizens in the collection and reporting of that data.
Recommendation #39	That the Province explore the feasibility of remote sensing products to better estimate the spatial distribution of snow and snow patterns.
Recommendation #40	That the MNRF work with federal, provincial and local partners as well as industry toward an Open Data model where information is shared and consolidated into the existing Surface Water Monitoring Centre hydrometric monitoring database.
Recommendation #41	That the Province investigate the return on investment of utilizing the new satellite imagery and resourcing with the necessary staff additions to provide better flood forecasting and monitoring.
Recommendation #42	That the Province update the flood forecasting and warning guidelines, providing clarity on roles and responsibilities (conservation authorities, MNRF district offices, municipalities) and provide examples of the systems, from simple to complex, with recognition that each system should be designed to reflect the local watershed characteristics and resources.
Recommendation #43	That the Ministry of the Solicitor General implement emergency operations initiatives in response to the recommendations of the Auditor General as soon as possible.
Recommendation #44	That Emergency Management Ontario improve its processes for interacting with municipalities and clearly lay out the processes on their website.
Recommendation #45	That Emergency Management Ontario clearly lay out the process for municipalities to request assistance during emergencies and provide field support to help determine the assistance that is required.
Recommendation #46	That the Province have a central website for flooding issues that provides answers (for conservation authorities, municipalities and the public) to a myriad of typical and

	frequent questions, or at the very least, a link to the agency (provincial department, power company, etc.) that provides the answers to the questions.
Recommendation #47	That the Province review the funding formula for eligibility of municipalities under the Municipal Disaster Recovery Assistance program.
Recommendation #48	That the “build back better” pilot under the Municipal Disaster Recovery Assistance program move from a “pilot” to a full program. The Province should consider raising the 15% cap where it makes economic sense. The program should be tied to legislated flood protection levels and floodproofing criteria. For example, a bridge damaged by a flood can only be replaced if it is raised to the design flood.
Recommendation #49	That the Province consider including a “build back better” component under the Disaster Recovery Assistance for Ontarians program.
Recommendation #50	That the Province approach Indigenous Services Canada about expanding their disaster assistance program to include houses that are leased on First Nation reserve land by non-status individuals.
Recommendation #51	That the Disaster Recovery Assistance for Ontarians program be flexible enough to allow for removal of the structure from the floodplain (buyout) if it is the only technically and financially feasible option.
Recommendation #52	That the Province continue the dialogue with the Insurance Bureau of Canada and the federal government on the steps needed to make flood insurance more available to more Ontarians.
Recommendation #53	That the Province ensure that municipalities have all the information regarding eligible items under the Municipal Disaster Recovery Assistance program, including costs for disposal of waste materials from a flood.

Recommendation #54	That the Province consider special or expedited approvals for new or expanded landfills if significant capacity is used up from the disposal of flood-related waste materials.
Recommendation #55	That the International Joint Commission, the Ottawa River Regulation Planning Board, and Ontario Power Generation make their detailed information about their flood operations readily available on their respective websites.
Recommendation #56	That the International Joint Commission consider meeting with interested stakeholder groups and individuals to explain in considerable detail how their structures are operated.
Recommendation #57	That the International Joint Commission consider creating specific “2017 Flood” and “2019 Flood” buttons for their home webpage and populating those pages with detailed information on the floods and their operations, as well as providing direct links to related reports.
Recommendation #58	That the supporting agencies of the Ottawa River Regulation Planning Board (Canada, Ontario, Quebec and the dam operators) consider reviewing the original agreement, recommendations and guiding principles, and board policies given they are almost 40 years old.
Recommendation #59	That the supporting agencies of the Ottawa River Regulation Planning Board (Canada, Ontario, Quebec and the dam operators) consider removing “Regulation” from the title, as it implies that the Board can actually manage large floods when, in fact, they cannot because of the limited storage capacity of the generating station reservoirs, which were designed for electric power generation and not flood control.

Recommendation #60	That a communications officer be assigned to the Ottawa River Regulation Planning Board to help with messaging during flood events or any public meetings and free up the staff engineers to concentrate on their duties. At least two communications officers should be assigned as needed and well trained in the technical operations. The officers should be from another government department as opposed to Ontario Power Generation or another non-government dam owner, since the public believes the dam owners only care about generating electricity.
Recommendation #61	That a communications person with marketing experience work with the Ottawa River Regulation Planning Board to prepare more easily understood materials for publication. The approach to managing the Ottawa River by the Board is not well understood by the public or government officials. Also, the materials should not be confusing. In one example I saw, a line graph showed a water level difference of 1.0 metres but the text below it stated "> 50 cm or 20 in."
Recommendation #62	That the Ottawa River Regulation Planning Board work with Ontario Power Generation and consider installing staff gauges at critical settled locations along the river, and engage residents to read and report on these gauges. These residents have a vested interest in getting accurate information and so their "buy-in" could be to volunteer their time to provide the data.
Recommendation #63	That two municipal officials, one from the Association of Municipalities of Ontario and one from the Quebec counterpart, sit on the Ottawa River Regulation Planning Board. The intent is to provide contact persons on the Board trusted by municipalities in both provinces, and for the municipal representatives on the Board to help disseminate correct and accurate information back to municipalities. Consideration could also be given to adding municipal representatives to the Ottawa River Regulating Committee, in addition to or instead of the Board. It is recognized that the three signatories to the Agreement (Canada, Ontario and

	Quebec) would have to agree to amending the Agreement for this purpose.
Recommendation #64	That Ontario Power Generation create a dynamic illustration regarding the dry section at Deux-Rivieres that “walks” the observer through the changes in water levels during low to normal to high flows, with voice-over explanation of water level changes, and that this video be included on their website.
Recommendation #65	That Ontario Power Generation identify options to address their concern about refill dates and provide greater flexibility on how refill is determined, taking into consideration the range of potential impacts, to support potential amendment proposals to relevant Water Management Plans.
Recommendation #66	That the Province maintain, at a minimum, the current level of funding in departmental budgets and programs related to everything flood (i.e. existing approval processes and associated policies and technical requirements, floodplain mapping, maintenance of flood infrastructure, satellite imagery, etc.).

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Chapter 1

Introduction

1.1 Preface

Flooding is a natural phenomenon. In the scientific context, a natural phenomenon is something that is observed to occur or to exist without human input. But of course, there is human input in the form of activities, such as deforestation, rapid drainage of rural land, urbanization, and the existence of structures and the operational procedures of those structures. The problem with a year like 2019 is that the natural events (snow, rain, melting, wind) that caused the flooding were so much larger than what we have measured to be average, that the human inputs have had very little impact, positive or negative. The most ideal human input has been ensuring people and property are out of harm's way.

As a natural phenomenon, major storm events that contribute to significant flood events will happen again, but with climate change we can expect that they will be more frequent and/or more significant. There is no one level of government that can be expected to deal with floods before, during and after they happen, but rather every level of government (federal, provincial, municipal, county), agencies of government (conservation authorities), and every individual, has a role and responsibility.

Ontario has a long history of trying to keep people and property safe from the impacts of flooding through land use planning policies and mitigative activities.

The development of the modern floodplain policy in Ontario, the watershed approach, the conservation authority model, and the flood standards have been extremely effective at reducing flood risks, especially in new greenfield development areas. Strong provincial legislation and policy, including the *Planning Act* and the Provincial Policy Statement, the *Conservation Authorities Act*, *Lakes and Rivers Improvement Act*, and natural hazard technical guides, have collectively gone a long way to reducing and mitigating flood risks in Ontario. Historic investment in flood mitigation infrastructure, such as dams, dikes, flood channels and shoreline protection, has delivered structural solutions to reduce flood risk to existing and new developments in floodplains. This broad approach has served the province well.

While these policies and mitigative activities have made Ontario a leader across Canada, it is clear that Ontarians continue to be significantly impacted by flood events and the costs associated with these impacts continue to mount.

During the spring of 2019, heavy rains paired with melting snow and a sudden temperature increase led to devastating flooding across many areas throughout northern and southern Ontario. Emergency declarations were made by 23 municipalities and one First Nation with significant flooding impacting households, commercial properties, roads and other key infrastructure such as bridges. Emergencies were first declared starting in early April and lasting through July in many cases. Homeowners, municipal and provincial emergency response personnel, and countless volunteers including the Canadian Forces worked tirelessly for weeks defending against the high water, reminiscent of a similar scene only two years earlier.

In response to these flood events, the provincial government announced that it would be undertaking consultation on the province's current flood mitigation and land use planning policies. Their first step was to host three regional listening sessions held by provincial leaders with municipal, Indigenous and industry leaders in Muskoka, Pembroke and Ottawa, in May. These sessions allowed the Province to hear directly from areas most devastated by the spring floods. Acknowledging that these sessions did not cover all areas that experienced flooding, nor provided the public with an opportunity to engage on the topic, the Province invited comments regarding flooding and suggestions to make Ontario more resilient to flooding through an online survey from May 16 to June 28.

Following this initial engagement in the spring, I was appointed by the Minister of Natural Resources and Forestry, the Honourable John Yakabuski (Minister) on July 18, 2019, to review the Province's current flood management framework. In addition to considering policies and activities which influenced spring flooding, I was also asked to consider both Great Lakes and urban flooding.

Throughout the Great Lakes, a period of high-water levels has been underway since early 2017. Businesses, resource management, recreational activities and shipping have all been affected by unprecedented high-water levels, and many residents have been displaced from their homes, as shoreline erosion and road access affect public safety. Agricultural centres along the shore of Lake Erie have been threatened and emergency declarations continue to plague shoreline communities, in some cases built below current lake levels.

Urban flooding is becoming a more frequently occurring public safety hazard. This type of flooding occurs when excessive runoff from a storm event exceeds infrastructure capacity and capabilities, thereby increasing urban stream erosion and flooding, and potentially causing sewers to back up into basements and overflows of raw sewage into lakes and natural watercourses. In 2018, two individuals were caught in a Toronto elevator, narrowly escaping rising waters. Isolated intense storm events have caused

significant flood damages to major infrastructure in urban areas and occur with little to no warning.

It is not hard to see that flooding, whether it is as a result of spring freshet, urban flooding or high Great Lakes water levels, is having a growing effect on Ontarians, and has reminded us that there is always room to improve.

Based on an analysis of the information available for all of the systems that experienced flooding in 2019, nothing points to human error or the negligent operation of water control structures as the cause of the flooding. The sheer amount of water (snow and rainfall) on the landscape directly contributed to the flooding. Measures taken by the water managers everywhere were effective in reducing the magnitude of flooding and associated damages throughout the drainage basins.

1.2 Terms of Reference

As Special Advisor on Flooding, I was appointed by the government to provide expert advice to the Minister and to make recommendations to the government on opportunities to improve the existing flood policy framework.

Specifically, I was asked to focus my review on and provide recommendations regarding:

- Current roles and responsibilities among agencies involved in flood management;
- Increasing awareness among homeowners about the growing risk of flooding and living in flood-prone areas;
- The Province's current legislative, land use planning and flood mitigation policy framework, including guidance, approaches and opportunities for improvement;
- Potential additional mitigation approaches that could help address impacts to existing development in floodplains; and
- Opportunities to improve community resilience in the face of ongoing threats.

To conduct the work, I was tasked with reviewing and building on what was heard during the targeted listening sessions held in Muskoka, Pembroke and Ottawa in May 2019, as well as comments received through the online survey. I was also afforded the opportunity to conduct additional consultations to hear and learn about the flood experiences across many areas of Ontario.

My report, to be submitted by October 31, 2019, would draw from my personal expertise and knowledge as well as additional available resources from the Province to provide

my best advice to the government based on my review. My report and recommendations would consider the array of local issues as well as the roles played by municipal and federal governments in flood management, and ensure my recommendations could be feasibly implemented within the province.

My work was supported by the Ministry of Natural Resources and Forestry, which provided background materials and logistical support, and facilitated the transfer of information and correspondence from the public and stakeholders related to my review.

Chapter 2

The Review Process

Despite having worked in Manitoba on flooding issues throughout my career, I was unfamiliar with the complex policy framework for flood management in Ontario. Understanding the various roles of agencies involved including the federal government, municipalities, conservation authorities and individual provincial ministries as well as the policies and technical guidance was of utmost importance to the review process.

2.1 Documents and Other Information

The Ministry provided a number of documents to enable an understanding of the current policy framework for flood management. These included:

- Provincial acts, regulations and policies associated with flood management;
- Technical guidelines prepared by the Province to support municipalities and conservation authorities in managing flooding and other natural hazards;
- Information related to floodplain mapping, disaster relief, funding, insurance, and natural infrastructure; and
- Information on water management in the Muskoka River and Ottawa River watershed and Great Lakes Basin.

I was also provided with a summary of feedback received from both the spring listening sessions and the online flood survey. The Minister's office provided me with correspondence that he received that was directed at my review. A detailed listing of materials reviewed can be found in Appendix A.

2.2 Engagement and Site Tours

While information provided by the Ministry was helpful in providing context for my evaluation, further engagement was warranted to ensure a full review.

I first met with Minister Yakabuski to ensure a clear understanding of my mandate and the importance of this review to the people of Ontario. He underscored the devastating impacts being felt across the province from flooding and the need for the Province to help citizens and ensure their safety in the future.

I also met with Conservation Ontario, Ontario Power Generation, the Ministries of Environment Conservation and Parks, and Municipal Affairs and Housing to get a better understanding of their roles in water management. The purpose of these meetings was

to provide additional background and context to the current policies and responsibilities for flood management within the province.

Through these dialogues, and in reviewing the background information provided by the Ministry, I realized the importance of visiting some of the areas hardest hit by flooding. This was necessary to appreciate the diversity in geographies and issues, and to hear firsthand from people in those areas about the impacts experienced and potential solutions.

Working with the Ministry, a nine-day community tour over two weeks in early September was developed to highlight the variance in issues, geographies and responsibilities. Tour stops included a mix of:

- Agency meetings;
- Municipal and conservation authority roundtables; and
- Guided tours of locally impacted areas.

In selecting the tour locations, it was acknowledged that the size of the province and the number of communities that experienced flooding would make it impossible to visit every area that has been impacted. Representative locations were chosen to provide a mix of riverine, lake, urban and Great Lakes flooding context, with the clear understanding that impacts are being felt across the province, not just in these areas specifically. In the vast majority of cases, meeting locations were chosen within a two-hour drive of the municipalities targeted for engagement.

Participation in municipal engagement sessions targeted municipalities that:

- Declared flood-related states of emergencies in 2019;
- Represented areas that had been approved for provincial disaster recovery assistance;
- Had requested meetings with the Minister to discuss flooding and/or high-water levels;
- Had contacted the Ministry asking for an opportunity to meet with the Special Advisor; or
- Were known to have experienced major flood events in the last few years.

The first set of community tours took place in the Ottawa, Pembroke and North Bay areas.

During the two-day visit to Ottawa, I met with the Ottawa River Regulation Planning Board, the International Joint Commission, the Insurance Bureau of Canada, and the local MPP for Kanata—Carleton. I hosted a municipal roundtable meeting with Ottawa area MPPs, municipal officials and staff, and conservation authority general managers. I toured the areas of Britannia, Constance Bay, Rhoddy's Bay, Westmeath and Braeside, all significantly impacted by flooding in the spring of 2019.

In Pembroke, I held a municipal roundtable discussion with a wide area of eastern Ontario municipal officials and met with a concerned citizens group. I toured the flood-impacted areas of Pembroke, Deux-Riviere and Mattawa, and discussed the characteristics of the Ottawa River at Klock with Ontario Power Generation, which contributes to the highly complex management challenges of the river.

In North Bay, I met with the local conservation authority and hosted a roundtable meeting with local municipal officials, the MPP for Nipissing, the federal government and local First Nation representatives to discuss the challenges associated with managing the river systems in their area.

During the second week of my community tours, I visited Toronto, Muskoka, Cambridge and London.

In Toronto, I spent a day with one of the local conservation authorities. They provided me with an overview of the issues they deal with in their highly urbanized watershed, and we toured the high flood risk neighbourhood of Rockcliffe and the projects under way along the lower Don River floodplain. While in Toronto, I also hosted a day of meetings with stakeholders, agencies, ministers and MPPs. I met with the Minister of Municipal Affairs and Housing, the Hon. Steve Clark; the Minister of Environment Conservation and Parks, the Hon. Jeff Yurek; and a Greater Toronto Area MPP. I met with two branches from the Ministry of Natural Resources and Forestry—Mapping and Surface Water Monitoring as well as Emergency Management Ontario, which falls under the purview of the Office of the Fire Marshall and Emergency Management within the Ministry of the Solicitor General. I also met with representatives from the Association of Municipalities of Ontario, the City of Toronto, the Kingdom of the Netherlands, the Great Lakes St. Lawrence Collaborative, the Regional Public Works Commissioners, and the Electrical Safety Authority.

In the Muskoka area, I met with the Ministry of Natural Resources and Forestry District of Parry Sound and Bracebridge Area staff to understand their role in managing water in the Muskoka and Magnetawan watersheds, and held a municipal roundtable meeting in Huntsville with central Ontario municipal officials, the local MPP for Parry Sound—Muskoka, and a stakeholder group.

In Cambridge, I met with the Intact Centre on Climate Adaptation out of the University of Waterloo, and hosted a municipal roundtable meeting with municipal officials, area conservation authority management and local MPP staff from the surrounding area. I met with the local conservation authority, and toured flood-prone areas in and around Cambridge and Brantford.

In London, I toured the area of Port Stanley, along the shoreline of Lake Erie, to get an appreciation of the height of the lake, but unfortunately was not able to see firsthand any shoreline erosion. I met with local conservation authority staff to discuss their role in local water management and hosted a municipal roundtable with southwestern Ontario municipal officials and area conservation authority managers.

Chapter 3

Background and the 2019 Flooding in Ontario

3.1 Watershed and Meteorological Conditions leading up to the Spring Freshet

3.1.1 Flow Generating Mechanisms in Ontario

The main causes of riverine and lake flooding are snow and ice melt, intense and/or long-lasting precipitation, rain on snow, riverine ice jams, or a combination of these causes. The risk of flooding is also influenced by conditions within the drainage basin, such as pre-flood water levels, presence of snow and ice, the soil moisture content, how early and deep the frost, and land use change, including more efficient rural drainage and urbanization. Some of the largest notable floods in Ontario have occurred as a result of major rainstorms. For this reason, riverine flood hazards limits are generally defined based on the flood resulting from the actual rainfall experienced during a major rain storm, such as the Hurricane Hazel storm (1954) or the Timmins storm (1961), transposed over a specific watershed or the 100-year flood, whichever is greater.

In Ontario, streamflow regimes are generally classified as snowmelt-dominated, whereby most of the winter precipitation falls as snow and melts during the spring. Temperature affects the type of precipitation (i.e. rain versus snow), the accumulation of a snowpack, and the timing and amount of ice and snowmelt runoff, while influencing the snow water equivalent of the snowpack. Snow water equivalent defines the amount of liquid water in the snowpack that would be formed if it were completely melted. Precipitation determines the potential magnitudes of flow generated during different times of the year. The timing of high spring flows in snowmelt regimes are also affected by geographic location, whereby snowmelt occurs later further north and at higher elevations, and is affected by the size of the drainage basin and the amount of storage within the drainage basin as affected by the size and number of lakes and wetlands. In more southerly areas of the province, streamflow regimes, while influenced by snowmelt, can be less defined by it.

The amount of snow on the ground, or the water that it contains, can often be a driver or indicator of the potential for flooding. The amount of this water that becomes runoff for the river depends on the timing and rate of snowmelt. For example, a very rapid melt of an average snowpack could lead to flooding. Conversely, a slow melt of a very heavy snow pack may not result in flooding. This becomes challenging for water managers as the impact of the snow on the river is heavily driven by the weather, which is difficult to predict. This provides a rationale as to why in some years with higher than average

snow on the ground, flooding may not be experienced, whereas years with an average snowpack significant flooding may be observed.

3.1.2 Summary of General Meteorological and Watershed Conditions

A series of noteworthy, atypical and synergistic factors contributed to the severity of the flooding in the spring of 2019. Environment and Climate Change Canada has characterized the 2018/19 winter as very long and extremely cold, including higher than normal snowfall across northern, central and eastern Ontario. Furthermore, this year's winter did not experience the one or more significant thaws that has come to characterize winters in south-central Ontario. The result was a well above average snowpack on the ground in early April, with the snowpack experiencing a rapid melt by mid-April, and a considerable depth of snowpack remaining past mid-April in those areas experiencing flooding. This melt was intensified by a series of strong large-scale storms that resulted in significant rainfall amounts in the latter portions of April, whose occurrence was widespread across the portion of the province experiencing spring flooding.

While April's temperatures in the northwest, the far north and southern Ontario were in the normal range, most of the province, including those areas that experienced the most notable flooding in the spring of 2019, also experienced temperatures 1 to 2 degrees Celsius below normal, with the greatest temperature anomalies—up to 3 degrees Celsius below normal—observed in northern Ontario. These trends towards lower than average temperatures contributed to the maintenance of widespread snowfall distributions later into the spring and extended the duration of conditions that would support frozen soils into the spring compared to an average year. The effect of these temperature and snowfall trends contributes to a greater snowpack later in the season, and frozen or partially frozen soils with a limited ability to absorb runoff water.

More specifically, across central and eastern Ontario, April experienced some extremely active weather, owing in part to a west to east jet stream pattern over southern Canadian latitudes that supported frequent weather disturbances, including above average precipitation. Above average precipitation was observed throughout the spring months of March, April and May across many of the areas affected by flooding in 2019, receiving 50 to 100 millimetres or more precipitation than on average across the three months with the latter half of April 2019 representing above average to 200% of normal values. A low-pressure system developed over the southern U.S. on April 25 and moved northeastward bringing heavy rain on April 26 to 27, focused on southwestern and central Ontario and the upper Ottawa River catchment region of Quebec, with amounts ranging from 32 to 43 millimetres. While a portion of the snowpack had or was beginning to melt by this time, the soil would have remained partly frozen and where

thawed, would have exceeded its capacity to support meltwater infiltration. A significant fraction of the rain that fell during this period would have reached surface water features that were already at or exceeding their capacity to contain water.

This rainfall contributed greatly to the flooding in the affected portions of Ontario in addition to the high-water levels experienced on the Great Lakes, in particular Lake Erie and Lake Ontario and the downstream St. Lawrence River system. The Great Lakes in particular received significant inputs of water from both sides of the border, as the U.S. tributaries experienced the wettest 12-month period on record, from May 2018 to May 2019.

In summary, key drivers leading up to the flooding of spring 2019 included: a colder than average winter without a significant winter thaw, contributing to a larger than average snow pack and higher than average snow water equivalents. These conditions were enhanced by colder than usual spring temperatures that maintained the snowpack further into the spring period than usual, and the melt of this snowpack was accelerated and exacerbated by numerous rain-on-snow events that occurred as temperatures began to rise significantly in mid-April.

3.2 Climate Change – A Recent History

It is particularly difficult to distinguish natural variability from the effects of climate change. The abundance of water in Ontario's numerous rivers and lakes, including within the Great Lakes, tends to oscillate in a cyclical fashion. Research has shown that the periods of these cyclical oscillations can be linked to changes in the global water cycle, including alignments with large scale cyclical patterns of water movement driven by oceanic (e.g. North Atlantic Multidecadal Cycle, Pacific Decadal Oscillation) and other related processes (El Nino/La Nina/Southern Oscillation). Regardless of the mechanisms, history has shown that flows and levels within Ontario's streams, rivers and lakes, including within the Great Lakes, are well established to increase and decrease over a range of temporal and spatial scales.

Recent climate change reports have suggested that Canada's climate is warming twice as fast as the global average. Temperature and precipitation are fundamental climate variables that directly affect natural and human systems. Changes in temperature can affect the timing and extent of snowpack development, soil freezing, snow and ice melt, and rainfall potential during colder seasons, as well as the timing, intensity, duration, amount and phase of precipitation events (rain vs. snow). A recently published MNRF study documenting results for the period 1980 to 2010 has confirmed a significant decreasing trend in maximum snow water equivalent of 6.4% per decade, or approximately minus 9 millimetres, across Ontario, representing a reduction of 5 to 10% of the annual precipitation in affected watersheds.

With climate change, alterations in the global water cycle are expected to bring a range of variability affected by increasing water content of the atmosphere, strengthening of climatological precipitation/evaporation patterns, a more pronounced spatial structure, and sharp gradients in precipitation change. While precipitation is generally projected to increase in the future, summer precipitation, particularly in parts of southern Canada, is projected to decrease. The most serious impacts of climate change are expected to be the changes in climate extremes. Extreme precipitation is projected to increase in the future; however, the observational record has not yet shown evidence of consistent changes in short duration, high intensity precipitation across the province.

For instance, although not backed by a wealth of empirical evidence, recent history in Ontario suggests that hydrological extremes may be increasingly affected by so-called "ninja" storms/rainfall events that are sporadically observed across the province. These rain events are not usually forecast, and are often defined by short duration, high intensity rainfall that can result in extreme rainfall amounts often over a relatively short period of time, generally distributed over a small area and not adequately captured by the rainfall gauge network. There is also growing evidence to suggest that the assumption of climate stationarity, which is fundamental to traditional flood frequency analysis, may no longer be assumed. In other words, under a changing climate, we should perhaps not be relying on hydrologic extremes that are based on an analysis of data from the past to predict the magnitude of future hydrological events, including design storms.

The changing frequency and intensity of precipitation can be expected to lead to a changing likelihood of extreme events, such as floods and droughts. Over the Great Lakes Basin, evidence suggests that climate change is leading towards an increase in precipitation. At the same time, climate change has also shown trends in increasing air temperatures and increasing lake temperatures across the basin, which naturally leads to higher rates of evaporation. These two processes act as competing forces on water levels. Higher precipitation and/or lower evaporation at times will lead to more water on the landscape and higher water levels, but at other times, higher evaporation and/or lower precipitation will lead to lower water levels. With these two competing dynamic forces at odds with each other, some have alluded to this as a "tug-of-war" between stronger climatic forces. The higher water levels in the Great Lakes in 2014 was a change from record low water levels in 2012 and 2013. It was believed to be initiated by a combination of increased precipitation, but more importantly a slowdown in the rate of evaporation triggered by the very cold winter of 2014, which was caused by a polar vortex that sent cold air southward and froze the Lakes. This reduced evaporation and increased precipitation resulted in water levels that have risen in the Great Lakes to the record extremes observed in 2017 and 2019. Climate experts believe that this swing of the pendulum, going from one extreme of low water to one of high water, is in fact a

consequence of climate change across the Great Lakes Basin and at continental scales.

Although one cannot unequivocally say that climate change is causing the flooding that has been observed over the last number of years or the last decade in Ontario, we do, however, know that water levels and flows are affected by a combination of temperature, precipitation and solar inputs that affect changes in precipitation and evaporation. Changes that have been observed at a global scale and a continental scale in North America, including changes in temperature and precipitation, are affecting water levels and flows in a way that would make them different from what would have otherwise been in the past. The potential exists that flooding may become increasingly more prevalent and the swing from wet to dry more volatile, making the flooding hazard more pronounced under a changing climate and its associated swings in variability.

Chapter 4

Region Specific Situations

The section below provides an overview of flooding that occurred in various parts of the province in 2019.

As I was not able to visit or investigate the flooding that occurred in every part of the province, the information included below provides only a partial picture of the flooding that occurred and the associated impacts. While there may be some parallels between the areas discussed below and other parts of the province, it may also be more likely that the situation in other parts of the province are equally as unique.

4.1 Flooding along the Ottawa River

4.1.1 Ottawa River Basin and Ontario Power Generation Facilities

The Ottawa River Basin is located on the border between eastern Ontario and southern Quebec, with 35% of the basin in Ontario and 65% in Quebec. The river has a length of more than 1,130 kilometres and a total basin area of 146,300 square kilometres. There are 13 principal reservoirs on the Ottawa River as defined by the Ottawa River Regulation Planning Board (i.e. > 200 million cubic metres of storage capacity). Ontario Power Generation operates three of the principal reservoirs, namely Bark Lake, Lady Evelyn Lake and Des Joachims Generating Station.

The vertical and horizontal profile of the Ottawa River varies considerably throughout the river, creating hydraulic constrictions throughout. Generally, the easiest place to create a dam and reservoir is at a natural restriction in the river or natural lake area. By selecting narrow river sections, the cost of building the dam is lower. There are also several natural shallow sections in the river. These create the rapids that many tourist companies rely on. Under high flow conditions, narrow or shallow sections of the river create natural restrictions that limit the amount of water that can pass through the section, in effect backing up the river. This is called a backwater effect. If the river flow is large enough, these natural restrictions may lead to flooding.

There is little significant storage available in the lower portion of the Ottawa River; in fact, over 60% of the basin is essentially uncontrolled due to lack of storage capability. Ontario Power Generation (OPG) operates four hydroelectric generation facilities on the lower portion of the Ottawa River, which consists of one or more dams and a powerhouse (Otto Holden, Des Joachims, Chenaux and Chats Falls). These stations operate under the authority of Water Power Leases with the Province of Ontario and with *An Act Respecting the Water Powers of the River Ottawa* (1943). During normal

flow conditions, OPG has the legal ability to raise the water level to the limit prescribed in the license for the respective facility for the purposes of power generation. Under high flow conditions, OPG operates its dams and stations to minimize the impacts of flooding and to at least do no more harm than would occur under natural conditions.

Each station has known water level impacts related to flooding thresholds. For instance, the Des Joachims Generating Station has a known backwater affect on the Town of Mattawa when the combined Otto Holden Generating Station and Mattawa River flows are greater than 2,000 cubic metres per second. The operating strategy during the freshet is predicated on ensuring that Mattawa and Pembroke should not suffer unduly during high water periods, and that a balance must be sought between flows and levels at either site, despite the fact that balancing flooding at these sites reduces depth of water or flow at the generating station and thus energy production.

Reference is often made in this section to OPG's facilities being operated as "run-of-river" facilities (i.e. facilities that have no storage capacity whatsoever and generate electricity by whatever flow is running in the river and through the generating station) during periods of flooding. Understanding what this term means conceptually is critical to understanding why water management approaches were used during periods of high flow and flood flow experienced in the spring of 2017 and 2019. OPG's facilities are not normally operated as run-of-river, nor are they classified as run-of-river facilities. It must be highlighted that, outside of high flow or flood conditions, all of OPG generating stations operate on a daily peaking cycle as peaking or cycling facilities. Ontario's Independent Electricity System Operator incentivizes power production to meet the needs of the Ontario energy market. Under normal operating conditions, outside of high flow or flooding events, OPG has significant control over the flows and levels to support power production, including daily ramping cycles that move water through the facilities in response to energy market demands, all within the licensed requirements approved for each facility. While some OPG generating stations on the Ottawa river have a minimum flow requirement, generating stations, including Otto Holden, completely shut flows off at night to store water for power production the next day. For transparency and full disclosure, the above facts must be emphasised as they can affect public perception of flow and level management regimes on the river and OPG's ability to control flooding. OPG does have a heightened level of control and storage on flows and levels on the Ottawa River when flows are considered normal outside of freshet periods. However, OPG generating stations do not have the ability to store enormous amounts of water and manipulate levels that would prevent extreme high water and flooding in conditions experienced in spring 2017 and 2019.

4.1.2 Spring Freshets – Comparison of 2019 to 2017 and 2018

4.1.2.1 Weather and Watershed Conditions

During my tour along the Ottawa River and the sessions held with municipal and other representatives along the way, there were many questions posed regarding the differences in flooding between 2017 and 2019. Others asked why flooding didn't occur in 2018, as many perceived that snow conditions were similar in 2018 to this past spring (2019) and to 2017.

Despite the occurrence of two large events in relatively close proximity to one another, the driving factors between the spring floods of 2017 and 2019 were different and impacted the basin in different ways.

4.1.2.2 Watershed Conditions in 2019

The snow on the ground as of April 1, 2019, was significantly higher than normal and higher than experienced in 2017 and 2018. Snow surveys showed the upper portion of the basin had 150 to 188% of the normal Snow Water Equivalent (SWE) for that time of year. Most of the watershed had an excess of 200 millimetres of SWE during the peak of the snowpack. The total precipitation throughout the watershed was also higher than normal, although not as high as in 2017. The accumulated April to May precipitation was approximately 125 to 175% of normal in 2019 for that time of year. While this precipitation was distributed more broadly over the basin than it was in 2017, major rainfall events coincided with the peak of the snowmelt period in 2019. Together, this led to historic flooding seen in much of the Ottawa River watershed in 2019.

The return period for the 2019 flood is estimated to be a 1:100-year to a 1:120 to 1:130-year flood depending on location and local factors affecting flows and levels.

4.1.2.3 Watershed Conditions in 2017

Leading up to the freshet of 2017, the snow conditions in the Ottawa River basin were considered to be average. A review of the 2017 winter and spring period showed a relatively average snow pack compared to 2016, in which there was not significant flooding. The major driver of this spring flood event was precipitation. In April and May of 2017, the precipitation over the entire basin totaled 257 millimetres, which is considerably higher than the 150- millimetre average (1981-2010) for those months. Local precipitation accumulation varied between 240 and 380 millimetres, with most precipitation falling in the central and southern portion of the basin. Much of this precipitation came during two events between April 30 and May 6, when 70 to 140 millimetres of rain fell on the lower unregulated portion of the basin. Receiving

approximately two months of rainfall in a period of seven days in the uncontrolled portion of the basin was the major trigger for the flood that occurred in 2017.

4.1.2.4 Watershed Conditions in 2018

In contrast, in 2018, the snow survey campaigns indicated that SWE was above normal in the Quebec region of the basin upstream of Lac des Quinze and near normal for the rest of the watershed. The month of March was slightly warmer than normal, but the month of April was much colder than normal. The cold spell persisted until the third week of April, which resulted in very little snowmelt throughout the month. As a result, the Snow Water Equivalent (SWE) in mid-late April was considerably higher than normal for that time of year. From April 20 to 24, there was a strong warming event with temperatures reaching as high as 20 degrees Celsius. This resulted in a relatively sudden snowmelt in the basin. During the period of March to May, the accumulated amount of precipitation and its distribution was approximately normal. The peak flow on the Ottawa River in 2018 occurred relatively suddenly due to the quick snow melt, but the magnitude of the peak was mitigated with the storage in the principal reservoirs and flows were only slightly above a typical year.

4.1.3 Reservoir and Station Operations in Spring 2019

At the beginning of the 2019 freshet season (the end of March), Ontario Power Generation's strategy was to continue to pass the inflow coming to its facilities in order to maintain low reservoir levels, with the exception of Bark Lake, which is the most southern principal reservoir on the watershed. Early in the week of April 15, the weather forecast showed a large precipitation event of 40 to 70 millimetres approaching for the end of the week. At this time, outflow from Lake Timiskaming and other principal reservoirs in the upper Abitibi-Timiskaming area was being decreased, as was the outflow from Otto Holden and Des Joachims.

This strategy would place water in storage as the snowmelt and a heavy rain event could significantly increase flow on the lower Ottawa River. Bark Lake was filling and expected to rise as much as 50 centimetres per day. The discharge from Bark Lake was allowed to increase as the lake level rose in order to maintain some storage space for later events. By the middle to end of April there was flooding on the Madawaska River, particularly around Kamaniskeg Lake. This was due to very high unregulated flow to Kamaniskeg Lake from the York and other rivers, and increasingly limited storage at upstream Bark Lake. Also, on April 15, the high flows prompted a strategy change at Chats Falls to begin following the high flow curve. Under high flows, the restriction upstream of the station becomes an important hydraulic control and the guide curve provides information on the relationship between Chats Lake water levels and the Chats Falls Generating Station headwater elevation. By April 21, the weather forecast,

now with a shorter lead time, had decreased (20 to 30 millimetres) and inflow being passed at Otto Holden and Des Joachims was continuing a slow build rate.

4.1.4 The May 6 Flow Increase from Otto Holden Affecting Mattawa

At the end of April, another significant rainstorm was forecast to bring up to 60 millimetres of precipitation to the upper portion of the basin. The principal reservoirs in the upper basin at the end of April were continuing to fill, and more specifically Lake Timiskaming was filling rapidly. The strategy at the Des Joachims Generating Station switched to passing inflows so that the reservoir level would not continue to rise. By the beginning of May, the flow on the lower Ottawa was expected to slowly decline; however, inflows to the upper portions of the Ottawa River were continuing to increase. Model results and inflow forecasts for May 5 continued to project that inflows within Lake Timiskaming and Otto Holden would remain well below 3,000 cubic metres per second. It was not until the following day, May 6, that conditions changed significantly, and model results projected inflows to exceed the 3,000 cubic metres per second threshold. As Lake Timiskaming was continuing to rapidly approach its maximum operating level, with significant further increases in inflows now being forecast, a strategic decision to further increase discharge from Lake Timiskaming was made. Over the course of May 6, there were two significant flow increases from the Timiskaming reservoir, one having been completed in the morning and another performed in the afternoon. This was to account for projected increases to come. The travel time from Lake Timiskaming to Otto Holden is approximately three to four hours, therefore any flow changes from Lake Timiskaming arrives at Otto Holden within a very short timeframe.

In response to the increased discharge from the Timiskaming reservoir, Otto Holden staged flow increases accordingly throughout the day to ensure that all adjustments corresponded with the changes upstream. Otto Holden performed seven flow adjustments throughout the day as inflows climbed, with the subsequent releases upstream. This was intentionally completed during daylight hours. The flow increases from the Timiskaming reservoir and Otto Holden were significant enough to result in the Ottawa River elevation rising approximately 65 centimetres within the Town of Mattawa throughout the day. Over the following five days, flows and elevations continued to increase within the upper Ottawa River basins, as the inflows and discharges at Lake Timiskaming and Otto Holden rose accordingly until they finally peaked at 3,316 cubic metres per second on May 10 and 3,355 cubic metres per second on May 11. At all times throughout freshet, flow changes were performed strategically with regard for impacted areas and ultimately, with a mindset of providing as much flood mitigation as possible. As flows stabilized and declined towards the end of May, the strategy at all Ontario Power Generation reservoirs changed to begin increasing reservoir and forebay

water levels. This allowed the flow of water on the Ottawa River to decrease more quickly than would have occurred under natural conditions. The reservoirs and forebays continued to rise to their normal operating levels, with the Des Joachims reservoir reaching its normal summer operating range in mid-June.

4.1.5 Explanation of Conditions at Des Joachims and the Dry Section at Deux-Rivieres

When Des Joachims was originally constructed, in order to maximize the potential for electricity generation, the license granted in 1946 allowed for the elevation of the water upstream of Des Joachims to be artificially elevated to the natural high-water mark. This serves as the reservoir for the Des Joachims generating station and can be used to store water for power generation or other purposes, such as flood relief. This portion of the artificially elevated water levels can be seen from the Trans-Canada Highway (Highway 17) in the vicinity of Deux-Rivieres. A review of media articles has identified the observation of the de-watered section of the reservoir in other years (including 2017), which again was a significant topic of discussion during sessions with municipal representatives.

A complicating factor for providing flood relief at the Des Joachims Generating Station is the hydraulic conditions upstream of the generating station. The Ottawa River has several reaches that are naturally shallow, narrow or have changes in gradient, which leads to the development of the rapids for which the river is famous. There is a flat shallow region between the upstream Otto Holden Generating Station and Des Joachims Generating Station. This area, around the old village of Klock several kilometres upstream of Des Joachims, is known as the Rocky Farm Rapids. This section of the river becomes an important control point under high flow conditions. The two analogies below may be useful to help the reader understand the situation:

> Analogy 1 – Multi-lane Highway
>
> Think of a multi-lane highway. If there were a two-lane highway that had no more than two lanes worth of traffic travelling across it, all cars could move uninhibited at the proper speed. During rush hours, more traffic would be trying to merge onto the highway than the two lanes could handle. As a result, traffic would be backed up. The more cars, the worse the traffic jam and the further up the highway it would extend. At Rocky Farm Rapids, not only is the river narrower but it is also shallower, which amplifies the traffic analogy, for not only is the traffic backed up in distance and extending further back, it is also as if there are multiple cars piled upon each vying to get through the traffic back-up.

Analogy 2 – Kitchen Funnel

Picture a funnel, as you would use in a kitchen. The rate the water is able to pass through the funnel is limited by the size of the narrow section of the funnel. If water is slowly poured in at a rate that the narrow section can pass, then water will not build up into the funnel. If it is poured in more quickly, the funnel will begin to fill. When the rate of flow exceeds that rate of flow at which can pass through the funnel, the water will begin to overflow as it backs up.

The rapids section at Klock has a similar impact on the Ottawa River. Where the analogies become imperfect is the fact that there is also a connection in the gradient or slope of the river. This is related to the elevation of the water downstream and the ability of the channel to pass water. During normal flow conditions, the Des Joachims reservoir can be maintained at a higher level for energy production, because the flow does not exceed the capacity of the channel and the rapids do not create an appreciable backwater effect. When the flow is high (and typically when the Des Joachims reservoir is low), the rapids become a hydraulic control and begin to cause a backwater effect creating a higher water elevation upstream at the Town of Mattawa. Even if the water level was raised at Des Joachims, it would have a muted influence at Mattawa and Otto Holden. As flow continues to increase, differences in water level between the two sites becomes larger, and the restriction at Klock becomes a more powerful control. High flow weakens but does not eliminate the influence of Des Joachims on the upstream water level.

Because of the geography of the Ottawa River, there are two distinct strategies that can be employed at Des Joachims to alleviate flooding. If the flooding is occurring mainly downstream of the station (for example due to heavy rain) and storage capacity is available, water can be retained in the reservoir to decrease the amount of water in the lower reaches of the Ottawa River. However, if the combined flow out of the Otto Holden Generating Station and the Mattawa River is greater than 2,000 cubic metres per second, the rapids at Klock can begin to create backwater flooding. This is when there is a lot of water coming from the upper portion of the Ottawa River. In these circumstances, the water level in Mattawa can be influenced but not fully controlled by the elevation at Des Joachims Generating Station. As flow increases, the reservoir at Des Joachims is maintained at a lower elevation to avoid backwater flooding. This can be achieved either by not refilling the reservoir after the winter drawdown or by releasing more water from the reservoir. A draw down must be timed to avoid releasing an amount of water that would generate or worsen flooding downstream. Typically, the Des Joachims reservoir will be refilled in two stages. The water level will be built up to a level that is known to not increase flooding in Mattawa. Once this risk subsides, the second stage begins and the reservoir is built up to its summer operating level.

In most years, including 2019, the Ottawa River tends to experience two flow peaks. The first is generated by snowmelt and rain in the lower portion of the watershed. The second occurs if/when the primary reservoirs in the upper portion of the watershed have filled and are forced to pass inflowing water downstream. In 2019, there was substantial snowmelt in the upper reservoirs leading to the second peak being larger than the first. Leading up to the first spring peak, water was slowly stored at Des Joachims Generating Station bringing the reservoir up to the first refill stage. As the second peak approached, driven by the upper reservoirs becoming full and having to pass their inflow, the elevation at Des Joachims Generating Station was held low with the goal of not subjecting the Town of Mattawa and other upstream communities to worse flooding than would have occurred under natural conditions. As upstream flow decreased toward the end of the event, Des Joachims Generating Station was filled, reducing the flow downstream.

A criticism during the 2019 flood event was that the reservoir was empty and could have been used to alleviate flooding at Pembroke. This would have made the overall impact from the event worse, as the Des Joachims reservoir has a finite storage capacity. If the Des Joachims reservoir had been at the top of its operating range, the water level in Mattawa would have been approximately half a metre higher. If the Des Joachims reservoir had been filled, the only option would have been to pass the flow coming into it, having no downstream benefit during a prolonged event. At peak flow, the Des Joachims reservoir would have filled from an empty state in less than half a day. A refill rate that could have had a meaningful impact on flooding in Pembroke could not have been sustained for the multi-week duration of the 2019 event. Therefore, using the storage capacity at Des Joachims Generating Station to alleviate downstream flooding would have had a large impact on Mattawa and provided negligible to no benefits at Pembroke.

4.2 Flooding in The North Bay-Mattawa Area

The North Bay-Mattawa area is one of the most densely populated districts in northern Ontario and is home to more than 83,000 people, with the major population centres of North Bay (51,553), Callander (3,900) and Mattawa (2,000). The region includes two distinct watersheds, the Sturgeon-Nipissing-French and the Upper Ottawa River.

4.2.1 Sturgeon-Nipissing-French Watershed

Lake Nipissing is a Provincially Significant Inland Fishery, which receives water from Lake Temagami in the north through the Sturgeon River and flows west to the Great Lakes Basin (Georgian Bay of Lake Huron) through the French River. The Lake Nipissing and French River system is part of a 19,000 square kilometre watershed. Lake Nipissing is the fourth largest inland lake in Ontario, covering over 850 square

kilometres. From it, the French River runs 105 kilometres to Georgian Bay. The headwaters of the Sturgeon River-Lake Nipissing-French River (SNF) watershed are the northern portions of the Sturgeon and Wanapitei Rivers, with the Sturgeon River watershed flowing directly into Lake Nipissing. The Wanapitei River joins the French River System in the last reach of the French River below Lake Nipissing. The SNF system is quite complicated, being comprised of several large lakes, numerous rivers and more than 40 control structures and power stations. Public Services and Procurement Canada (PSPC) operates four dams that effectively control the outflow from Lake Nipissing.

There is no Water Management Plan (WMP) in place for the SNF watershed; however, there is a WMP for the South River subwatershed, which flows into Lake Nipissing. PSPC operates the dams that effectively control the outflow from Lake Nipissing at the French River. PSPC operates the dams according to guidelines that were published in 1992. The Ministry of Natural Resources and Forestry (MNRF) supports integrated water management decisions on this watershed by holding daily or as needed calls during freshet with other dam operators, known as the "SNF Technical Committee." The MNRF also coordinates daily or as needed calls with elected or emergency management representatives from local and Indigenous communities, known as the "SNF Stakeholder Committee," to share information on water management decisions and foster a shared understanding of water-related impacts.

During freshet 2019, the Technical Committee, with consensus from the Stakeholder Committee, took the approach of incrementally increasing outflows from the French River dams in order to avoid exceeding the flood allowance on Lake Nipissing. Water was also stored in Lake Temagami's flood allowance during a time when Lake Nipissing was vulnerable to exceeding its flood allowance. The whole watershed experienced significant flooding during freshet 2019.

4.2.2 Upper Ottawa River Watershed

The Upper Ottawa River watershed's primary reservoir is Lake Temiskaming in the north. It also receives water flowing east from North Bay through the Mattawa River at Mattawa, which means "meeting of the waters" in Algonquin. The Ottawa River flows southeast to the St. Lawrence River, with many other uncontrolled inflows from Quebec and Ontario on the way down. The Mattawa River watershed typically flows into the Ottawa River at the Town of Mattawa. The lower Mattawa River portion of the watershed (below the Hurdman Dam) is hydraulically dominated by backwater effects from the Ottawa River. The Ottawa River drainage basin is 146,300 square kilometres, including regions of Ontario and Quebec. It is twice the size of New Brunswick. More

than 3,000 people live within the three municipalities and townships that border the lower Mattawa River, with 2,000 people living in the Town of Mattawa.

Water Management Plans are in place for many of the subwatersheds in the Upper Ottawa River, including Hurdman Dam, the Matabitchuan River and the Montreal River, with each flowing into the Upper Ottawa River. The Ottawa River Regulation Planning Board is responsible for water management on the Ottawa River (see more detail in Section 4.1).

4.2.3 Spring 2019 Flooding

An above average winter snowpack and slow start to the melt, with cool temperatures in the first three weeks of April, combined with substantial precipitation over the Easter weekend, resulted in substantial flooding throughout both watersheds. The April 15 snow pack readings within the region averaged 517% of the long-term average for that time of year, and water equivalence averaged 425% of the long-term average. April's precipitation was 215% of normal and May was 150.8% of normal, according to the North Bay-Mattawa Conservation Authority (NBMCA). Northern watersheds outside of NBMCA's jurisdiction, which flow into Lake Nipissing and the Ottawa River basin above Mattawa River, also experienced above average snow packs and high amounts of precipitation. Adding to the problem, the Sturgeon-Nipissing- French (SNF) watershed received between 50 to 75 millimetres more precipitation than normal in May 2019, with several large rain events causing spikes in inflows throughout the month.

On April 17, the NBMCA and MNRF North Bay District office each issued the first Flood Watch of the freshet event. The last bulletin issued by the MNRF North Bay District was issued on June 17 and expired June 21. The flood message status for all watersheds within NBMCA's jurisdiction did not return to normal until on July 2.

The Municipality of Mattawa declared a State of Emergency on May 6, 2019. The Ottawa River rose 4.25 metres between April 17 and May 11, a significant portion of which occurred within 48 hours of the Emergency Declaration due to incoming runoff water from upstream reservoirs on the Ottawa River (see explanation in Section 4.1.4). Transport Canada issued a navigational warning for the Ottawa River near Mattawa that prohibited boat travel.

On May 9, the City of North Bay undertook precautions to protect the wastewater treatment plant by installing pumping equipment and temporary piping as part of a contingency plan. In addition, a lift station bypass plan was established to provide system relief where possible in order to limit flow to the wastewater treatment plant. While it was a worst case scenario, a failure at the wastewater treatment plant could have resulted in large volumes of untreated wastewater being released onto the shores

of Lake Nipissing, damage to plant operations that would have likely led to weeks if not months of reduced wastewater treatment capabilities, sewer backups in low-lying areas of the City of North Bay, and the possible evacuation of city residents.

Nipissing First Nation experienced very high water levels and was preparing to evacuate residents if the lake level exceeded 196.59 metres. In the Jocko Point and Beaucage areas, high water levels and high winds damaged many properties. Approximately 60,000 sandbags were deployed in this area.

The Municipality of Callander and Nipissing Township all experienced very high water levels in low-lying areas along the Lake Nipissing lakeshore, impacting local businesses, roads and infrastructure.

The Municipality of West Nipissing declared a State of Emergency on May 9 due to damaging winds and damage to municipal infrastructure. All boat launches were closed until June.

Residents along the Upper French River began to see an increase in water levels, as local inflows peaked and increased discharges were made from the Chaudière Dam (together with Portage, Little Chaudière and Okikendawt Dams) to mitigate lake level rise on Lake Nipissing. On May 26, a State of Emergency was declared in the Municipality of French River, which remained in effect past June 17.

4.3 Flooding in the Muskoka River Watershed

4.3.1 Physical Characteristics and Municipal Governance

The Muskoka River watershed is located in south-central Ontario's lake and cottage country, within the southern Boreal Ecozone of the Precambrian Shield. The main population centres include Huntsville, Bracebridge and Gravenhurst. The drainage basin encompasses an area of approximately 5,100 square kilometres and extends in a southwesterly orientation for a distance of approximately 210 kilometres, descending 345 metres in elevation from the western slopes of Algonquin Provincial Park, to its mouth at Georgian Bay of Lake Huron. The watershed originates along the height of land known as the Algonquin Dome and is comprised of three drainage systems, including the North and South Branches of the Muskoka River and the Lower Muskoka subwatershed, and includes 200 lakes covering an area of approximately 78,000 hectares. The Muskoka River is comprised of 19 quaternary basins that form its subwatersheds. The three largest lakes in the watershed include Lake Rosseau, Lake Muskoka and Lake Joseph.

The Muskoka River watershed is a complex, cascading system. There are a series of notable constrictions or pinch points that impede the flow of water and cause water to back up, creating what is referred to as a backwater effect, as affected by the hydraulic conditions. (As described in an analogy in Section 4.1.5, think of it like a funnel, where discharging a large volume of water is limited by the narrowest and/or shallowest point in the river. Putting water into the funnel at a larger volume than can pass through the tip of the funnel causes it to rise up the funnel and overflow.) Lake Muskoka is the last major lake in the system before water enters the Moon and Musquash rivers that flow into Georgian Bay, which represents the outlet of the funnel. All water from both branches of the Muskoka River and Lakes Rosseau and Joseph flow into Lake Muskoka, and the only outflow for Lake Muskoka is through the two dams at Bala. The MNRF Bala dams control the water levels on Lake Muskoka; however, during periods of high flows and levels, a difference in water levels develops between Lake Muskoka and what is known locally as Bala Bay. This is caused by three constrictions at Bala Park Island and Wanilah Island that restrict flow into Bala Bay, affecting how much water can be discharged from the Bala dams. During periods of flooding, a significant difference in water surface elevation (≥1 metre) is observed between Bala Bay and Lake Muskoka, which further exacerbates efforts to move water through the dams at Bala.

Muskoka is governed by a two-tier municipal system with the District Municipality of Muskoka as the regional municipality forming the upper-tier, working with the six area municipalities including the Towns of Bracebridge, Huntsville and Gravenhurst, and the Townships of Lake of Bays, Georgian Bay and Muskoka Lakes making up the lower tier. The drainage basin also includes components of other municipalities including the Township of Algonquin Highlands and Haliburton County, among slivers of others. Of the approximate 150,000 people populating the watershed, approximately 58% are seasonal residents according to the 2011 Canadian census. The majority of the big three lakes—Muskoka, Joseph and Rosseau—are located within the Township of Muskoka Lakes. The Wahta Mohawk and Moose Deer Point First Nations are also located within Muskoka's boundaries.

There is extensive development with high value infrastructure within the main Muskoka Lakes (Lake Muskoka, Lake Rosseau, Lake Joseph, etc.) spread over approximately 14,000 lake lots, including 5,300-5,500 boathouses, greater than 6,500 docks, and approximately 41 marinas and 131 resorts.

4.3.2 Water Management Structures and Operations

There are 42 water management structures within the Muskoka River drainage basin, including dams and/or dam-powerhouse combinations in addition to three navigation locks. The MNRF operates 29 of these structures, all of which are manually operated

using stop logs or valves. Most MNRF dams were originally constructed to facilitate the transport of logs to sawmills, divert water to power the mills, and aid in commercial navigation. Over the intervening years, the operations emphasis of the dams has transitioned from commerce and transportation to the provision of a balance of social/recreational, environmental and economic interests.

It must be emphasised that dams in central Ontario, including those in the Muskoka River watershed, are not flood control structures. Flood control structures require a large lake or reservoir and associated drawdown capacity to store or hold back flood waters. Analyses have confirmed that lakes in the Muskoka River watershed that are regulated by dams have a limited capacity to drawdown water to affect flooding, and during periods of large volume rapid runoff, the available drawdown capacity is insufficient to reduce peak flood water levels. In this sense, the greater the magnitude of the flood event, the less ability the MNRF has on affecting or mitigating flooding through operation of its dams. Once the dams are fully open, the MNRF does not have the ability to increase the rate of flow, as it is then based on the amount of water in the system and the natural rate of flow and elevation as it moves through the wide-open dam sluice ways.

To the extent possible, the MNRF operates dams to maintain water levels within the ranges identified in the established dam operating plan. For the Muskoka River, these ranges were formalized in the Muskoka River Water Management Plan in 2006. The range of operations is based on a range of factors, including recreational and environmental considerations. The plan applies to normal water conditions, while there is recognition that unusually high rainfall or snowmelt can result in high water and flooding. Water Management Plans can help regulate flows to ensure that one activity does not take primacy over another (e.g. waterpower generation over recreational use); however, they do not and cannot prevent flooding. The goal of water management planning, in the context of Section 23 of the *Lakes and Rivers Improvement Act*, is to contribute to the environmental, social and economic well being of the people of Ontario through the sustainable development of waterpower resources, and to manage these resources in an ecologically sustainable way for the benefit of present and future generations. The management of floods and flooding is not explicitly a goal of water management planning, and Water Management Plans are not designed to manage floods.

4.3.3 Land Use Planning and Flood-prone Development in the Muskoka River Watershed

Floodplain mapping for most of the area was originally completed in the late 1980s and early 1990s under the Canada-Ontario Flood Damage Reduction Program (FDRP).

Areas mapped include the Big East River in Huntsville and the Muskoka River, including the major lakes in the Muskoka River Watershed. This exercise identified that a considerable number of cottages and associated docks and boathouses were located within the floodplain of rivers and lakes. In the intervening time since these studies were undertaken, development in the area, particularly related to recreational properties, has increased dramatically.

Recommendations included in FDRP mapping reports from the late 1980s and early 1990s include vertical water levels and horizontal setback criteria to give potential developers a choice in floodproofing criteria: either 1) build dwellings above a minimum vertical water level described in a table; or 2) build dwellings beyond a horizontal setback, also described in a table within the report. Further, this included recommendations that no encroachment be allowed where the depth of flooding during the regulatory event would exceed 1.0 metres, and no encroachment be allowed within 20 metres of either riverbank. More explicitly, the FDRP program, which focused on the identification of high flood risk designated areas in the province, included strong policies to encourage the authority, where the zoning authority is neither provincial or federal, to impose land use restrictions that will prohibit all further projects in a designated area that are vulnerable to flood damage. Furthermore, assistance under any federal or provincial disaster assistance program shall not extend to costs or losses incurred as a result of a flood with respect to any project commenced or any moveable property placed within an area after its designation or interim designation as a flood risk area.

The District Municipality of Muskoka is in the process of updating its floodplain mapping using matched funding from the Federal National Disaster Mitigation Program. It must be emphasised that such mapping only adds value when used to inform development, with the intention of keeping people and property out of the floodplain. The available information suggests that land use planning and development approvals have not been proceeding in this fashion, particularly within the Township of Muskoka Lakes, which has seen significant numbers of boathouses constructed every year. For instance, between 2013 and 2016, the Township of Muskoka Lakes issued building permits for 267 new boathouses with a total value of construction of $46,263,584. As boathouses are situated atop the water, at or near the high-water mark, boathouses are always within the floodplain (or floodway) and add to the impacts during a high-water event.

There is significant concern that the construction of new boathouses within Muskoka Lakes are being approved without regard for the potential damage from flood and ice heaving. Designs presented to Council include first floor plans with utility rooms, games rooms, elevators and washrooms, which are much more than a basic boathouse, and there appears to be no direction or regard for incorporating floodproofing measures into the construction plans. As these structures continue to be built in harm’s way, flooding

and ice damage will only increase as will costs associated with the inevitable damage from these natural phenomena. It is unreasonable to expect that water levels can be controlled within a finite range and be kept below the damage level of docks and boathouses, or other structures, when dealing with a large river system with limited means to mitigate the magnitude and extent of flooding. With a changing climate, damages to these boathouses and other infrastructure in the floodplain as a result of flooding and ice movement will continue to occur, and most likely at increased frequency. It is not a question of if these lakes and river systems will flood again, it is only a question of when.

4.3.4 Spring 2019 Watershed Conditions, Flood Mechanisms and Water Management Activities

The Muskoka River Watershed has experienced flooding on numerous occasions in the past, including in 1976, 1980, 1985, 1998, 2008, 2013 and most recently, in 2019. Throughout the winter, MNRF staff monitor snowpack across the Muskoka River watershed to determine snow depths and snow water equivalents at which time they also evaluate soil conditions. During winter/spring 2018/2019, as in other years, the MNRF monitored the snowpack beginning in December and over the winter. In anticipation of the snowmelt and spring rainfall, the MNRF commenced the drawdown of lakes within the watershed in late fall 2018 and continued through the winter to help mitigate runoff. At this time, the MNRF took an aggressive approach, targeting the lower limit of the operating zone for the lakes.

Over the winter, the MNRF continued to monitor weather conditions. To help mitigate the anticipated spring runoff, the MNRF continued to draw down water levels at the dams. There were several rain events that caused water levels to rise over the winter period and the MNRF took measures to continue the drawdown. Lake Muskoka was drawn down to one of its lowest levels in preparation for the rain, snowmelt and warmer weather expected through April. Complaints from the public about low water levels were received in late March 2019.

By mid-March, the amount of water contained within a snowpack in the Muskoka River watershed was on average 171 millimetres, which is above average for this time of year but not as high as in some prior years. It is important to highlight that above average snow water equivalent does not mean flooding will occur and is one of many factors that water managers must consider when making decisions related to water management. By the beginning of April, the snow water equivalent in the snowpack had increased to 192 millimetres, representing 208% of average, with an average snowpack depth of 66 centimetres and depths exceeding 80 centimetres in the upper headwaters of the watershed within Algonquin Provincial Park. The snow survey conducted on April 15

showed that the snowpack depth had been reduced by approximately one-third (to 43 centimetres) with an average snow water equivalent of 134 millimetres, representing 148.5% of the historic average.

The Muskoka Airport weather station received 129.5 millimetres of precipitation in the month of April, exceeding the monthly average by 164%. Temperatures in April were lower than the long-term average for the month, affected by values considerably lower than average for a little over the first half of the month. Notable increases in maximum temperature on April 7 (12.2 degrees Celsius) and April 12 (14.5 degrees Celsius) accompanied by overnight temperatures above 0 degrees Celsius were important in increasing runoff and sustaining snowmelt and runoff generation. Water levels on Lake Muskoka began to rise on April 7 with the warmer weather and melting snow, as runoff entered the river system. (Once inflows to the lakes are more than the maximum capacity of the dams, with all logs out, water levels will rise.)

From April 10 through April 23, daily average temperatures exceeding 5 degrees Celsius and maximum temperatures ranging from 8.3 to 17.2 degrees Celsius, combined with overnight temperatures above 0 degrees Celsius, were important in sustaining runoff increases, particularly when combined with the 114 millimetres of rainfall that was recorded in the latter half of the month. The existing snowpack and associated snow water equivalents present at the middle of the month, combined with the significant rain on snow, moved considerable water volumes to rivers and lakes draining these areas. On April 17, Parry Sound District MNRF issued a Flood Watch that was upgraded to a Flood Warning on April 19, given the significant rainfall (60 to 70 millimetres), temperature increases and snowmelt that had occurred in the intervening period. Between April 7 and April 28, water levels on Lake Muskoka rose by 1.59 metres, eventually peaking on May 3. Flows in the north and south branches of the Muskoka River peaked on April 26 and April 29, experiencing the highest flows on record.

Actions taken to operate the dams in spring 2019 were consistent with the Muskoka River Water Management Plan, including specific triggers to further draw down water levels when snow water content is high. Specifically, March 15 and April 1 are the key dates identified in the plan.

4.4 Flooding in the Magnetawan River Watershed

The Magnetawan River watershed is situated immediately north of the Muskoka River watershed and also experienced significant flooding in spring 2019. While measured snowpack and snow water equivalent values in the Magnetawan basin were lower than in the Muskoka watershed, they remained considerably higher than average at 260% of normal (for snow water equivalent) in the upper portion of the watershed at the

beginning of April. While the Magnetawan River is less developed than the Muskoka River watershed, defined areas of the Township of Armour, the Township of Ryerson, and the Village of Burks Falls were significantly affected by flooding in the spring of 2019. The small village of Katrine, one of the areas hardest hit in the Township of Armour, is built on a floodplain at the mouth of Doe Lake, where approximately 50 homes were flooded.

4.5 Flooding in the County of Haliburton

The County of Haliburton includes the headwaters of the Trent Severn Waterway (TSW) system, which controls water flows and levels for more than 18,000 square kilometres of the Trent Severn Watersheds. The Trent River basin encompasses 218 lakes in the Haliburton Highlands region, 37 of which are directly controlled by TSW dams. There are some 600 named lakes in Haliburton County with significant waterfront property ownership, including a notable number of water-access only properties.

Watersheds represented in Haliburton County include—the Black River watershed that flows south and west to the Muskokas; the Burnt River watershed; the Gull River watershed (which encompasses the Burnt River system); and the Nogies Creek, Eels and Jack Lake watershed.

As experienced in other regions of Ontario, Haliburton County has been experiencing significant flooding, most notably in 2013, 2016, 2017 and 2019. Declarations of Emergency were declared in 2013, 2017 and 2019, with near misses in 2016 and 2018.

4.6 Flooding along Lake Ontario and the St. Lawrence River

4.6.1 Flooding Conditions in 2019

Following an extended period of below average water levels from 1999 to about 2013, all Great Lake water levels were well above their average in 2019. Lake Superior, Lake St. Clair, Lake Erie and Lake Ontario all exceeded record highs in May, while Lake Huron rose to within one centimetre of the previous record in July.

Significant precipitation and snowmelt around the Lake Ontario basin, combined with record inflows from Lake Erie, set a new record for total water inflows, or supply, to Lake Ontario for the month of May, exceeding the previous record set in 2017. Total inflows in May 2019 were the second highest inflows of any month of the year dating back to 1900. Total inflows to Lake Ontario in June were the second highest on record. From January to June 2019, the six-month combined total inflows were the wettest January to June period on record due to a combination of record inflows from Lake Erie and wet conditions on and around Lake Ontario itself. Downstream of the lake, flows

from the Ottawa River emptying into the lower St. Lawrence River also set a new record high during the spring freshet 2019. The flows in May 2019 exceeded the previous monthly record in 1974 by more than 1,000 cubic metres per second.

As described by the International Joint Commission's (IJC) International Lake Ontario-St. Lawrence Board, Lake Ontario was caught between a flooding Lake Erie upstream and a flooded lower St. Lawrence River downstream. Upstream, Lake Erie water levels were exceeding historic record highs by the beginning of May. Downstream, several months of wet weather followed by heavy rains and snowmelt over late April and early May caused record Ottawa River flows, resulting in severe flooding along the Ottawa and lower St. Lawrence River. This combination of record high inflows from Lake Erie and above average precipitation across the Lake Ontario and Ottawa River basins was the main driver of Lake Ontario-St. Lawrence record high water levels in 2019. Lake Ontario water levels ultimately reached 75.92 metres in early June, exceeding the record daily peak of 75.88 metres reached previously in late May 2017.

Water levels of Lake Ontario change in response to the difference between the supply (total inflow) it receives and its outflow. While outflows are controlled by the Moses-Saunders Dam, inflows are uncontrolled. While the IJC's Plan 2014, brought into effect in 2017, regulates flows through the Moses-Saunders Dam (outflows), inflows are uncontrolled. While increasing outflows through the Moses-Saunders dam can help reduce water levels in Lake Ontario, the amount of control this structure has over water levels in Lake Ontario is very limited, as there are physical limits to the amount of water that can be released. Larger releases, while they may reduce flooding in Lake Ontario, can have drastic impacts downstream. Increasing outflows enough to reduce flood levels in Lake Ontario by one centimetre in a week will result in increasing flood levels below the dam in Montreal by 10 centimetres.

Throughout April and May 2019, the IJC's International Lake Ontario-St. Lawrence Board continued to regulate Lake Ontario outflows by the maximum flow limits prescribed by Plan 2014. In June, as Ottawa River flows began to moderate below their record highs, the Board rapidly increased outflows from the Moses-Saunders Dam to provide relief from shoreline flooding on Lake Ontario. Outflows were ultimately increased to the maximum sustained flow on record, as the Board was now undertaking major deviations from the plan to provide relief from shoreline flooding on Lake Ontario. These outflows reached 10,400 cubic metres per second, equivalent to the record high outflows released for several weeks in the summer of 2017. These major deviations of flow are significant departures from the outflows prescribed in Plan 2014; however, the IJC was doing so in response to extremely high Lake Ontario levels and in accordance with IJC policies. In Ontario, flooding occurred around Lake Erie, Lake Ontario and the upper St. Lawrence River, especially during periods of active weather.

From media reports, Prince Edward County, the Bay of Quinte, Toronto Island, Municipality of Clarington, Brighton, and the Thousand Islands shoreline area in the upper river, among other areas, experienced flooding.

4.6.2 Comparison to Flooding Conditions in 2017

The causes of record high Lake Ontario water levels in 2017 and regulation of outflows under Plan 2014 were studied and reported on by the Board (see the IJC report titled: "Observed Conditions and Regulated Outflows in 2017," May 25, 2018, https://ijc.org/sites/default/files/2018-08/ILOSLRB_FloodReport2017.pdf). The Board attributed the extreme high levels mainly to record precipitation received across the Lake Ontario-St. Lawrence River basin, noting that wet weather was also experienced upstream in the Lake Erie watershed. Lake Ontario water levels rose rapidly, setting record highs by the end of May. In response, in all but three weeks of the year, outflows from the lake were determined by either the maximum flow limits set by Plan 2014 or by deviations from Plan 2014. The Board concluded that Plan 2014 did not cause the high levels in 2017 or contribute to them in any significant way.

Flooding in 2017, among other impacts, were reported on by the IJC's Great Lakes-St. Lawrence River Adaptive Management Committee as part of their ongoing evaluation of the IJC's regulation of lake outflows in the Great Lakes (see the IJC report titled: "Summary of 2017 Great Lakes Basin Conditions and Water Level Impacts to Support Ongoing Regulation Plan Evaluation," November 13, 2018, https://ijc.org/sites/default/files/2018-11/GLAM_2017_MainReport_FINAL-20181129_2.pdf). The Committee evaluated the impacts on multiple interests, including flooding, from a variety of sources. They noted, however, that much of the quantitative economic and environmental data was not available at the time of reporting.

Impacts to coastal properties in 2017 were reported as widespread, with reports of flooded homes, roads, driveways, trails, lawns, emergency response, and extensive sandbagging efforts to protect houses and properties. In Ontario, flooding of residential property and buildings along the Lake Ontario shoreline was observed with particularly hard-hit areas including portions of Toronto Island, Clarington, Brighton, and Prince Edward County. On the upper St. Lawrence River, shoreline flooding was observed particularly in the Thousand Islands area. From the IJC's report, Figure 5-25 highlights the percent of shoreline survey respondents that indicated flooding impacts. In Ontario, along the lake shoreline, a local State of Emergency was declared for a portion of the Municipality of Clarington shoreline as well as all of Prince Edward County. The Mohawks of the Bay of Quinte also declared an emergency for their territory in response to high water levels.

4.7 Flooding along Lake Erie and Lake St. Clair Shorelines

Since March 2019, water levels in Lake Erie and Lake St. Clair have remained above locally determined Flood Watch thresholds, with monthly mean lake levels in Lake Erie and Lake St. Clair reaching all time highs in July 2019. Lake Erie is approximately 84 centimetres above long-term monthly average lake levels (or 13 centimetres above previous highs in 1986 and 35 centimetres higher than July 2018). Lake St. Clair is approximately 86 centimetres above long-term monthly average lake levels. This is 10 centimetres above previous 1986 highs and 35 centimetres higher than July 2018.

These record levels have resulted in the Windsor Essex region being under an Extended Flood Watch for more than six months. Similarly, the Lower Thames Valley Conservation Authority has issued 50 flood bulletins (Watershed Conditions Statements/Flood Watches/Flood Warnings) warning shoreline residents of potential flood events so far this year (2019).

Portions of Essex Region, in the Southeast Leamington area between Hillman Marsh and Point Pelee, lie behind earthen dikes built in the late 1800s that have been “spot-repaired” sporadically over time as emergencies required. Approximately 400 homes and 2,100 hectares of farmland are, in some instances, 3 to 3.35 metres below Lake Erie water levels.

While lake levels are currently undergoing seasonal decline, they remain above previous 1986 record levels, meaning these declines have not resulted in any reduction in the level of flood/erosion risk in the region. Making matters worse, fall rain events, wind and winter ice is expected to result in further flooding and erosion.

4.7.1 2019 Flooding

Flooding and erosion along the Lake Erie shoreline resulting from high water levels has had, and in most cases continues to have, significant impacts on residents, businesses and infrastructure.

Three sections of roads have been closed along Lake Erie in Chatham-Kent (total length of road closed is 9.6 kilometres). Similarly, LaSalle and Kingsville have closed sections of road due to high water levels.

High water levels have closed marinas in Windsor and Lakeshore, closed waterfront trails in Windsor, and closed sections of the Holiday Beach Conservation Area and Tremblay Beach Conservation Area.

Residents along the Lake Erie Shoreline between Point Pelee National Park and the Town of Wheatley experienced 10 flood events between March 2019 and August 2019.

This area was developed on a naturally eroding clay shoreline. Therefore, even without the existing development, they would continue to erode. Under the current condition (high lake level), wave action is causing erosion at the shore. Under low lake levels, the erosion is happening on the clay bottom as the waves attack the surf zone.

Shoreline protection structures (sheet pile walls and armour stone breakwalls/revetments) have been used in some areas to try and slow down erosion rates in front of the shoreline protection. However, these structures do not stop erosion of the lake bottom in front of the structures, which results in a deeper and deeper nearshore lake bottom slope. This has allowed larger waves and waves with greater energy to impact the shoreline. In the end, the shoreline protection constructed to reduce the hazard is progressively making it worse. As a result, the flood hazards are getting worse with each passing storm.

Numerous homes and properties have suffered and continue to suffer from flooding with limited access into and out of the community. Some of these areas are not municipally serviced and are sitting in water, which results in failing septic systems, mould and related health and safety and structural concerns, in addition to the physical and mental health effects associated with these conditions.

Current high water conditions have caused significant damage across the shoreline. High waters have also prevented many repairs leaving existing development exposed to both erosion and flood hazards.

With high water levels, lake waves have created a 100+ metre breach in Hillman Marsh Barrier Beach, posing significant risk to inland dikes, which are now exposed to direct wave attack. The inland dikes are now holding back high water levels and over an extended period of time, which they were not constructed to withstand. Inland communities protected by the flood protection dike are also at risk of flooding under this condition.

The Marentette breakwater breached and exposed the interior dikes to open lake wave conditions, which this system was not designed to withstand. Some nominal repairs have proceeded through the provisions of the *Drainage Act,* but these repairs are essentially a temporary fix.

Large blocks of peat continue to be eroded out of the marsh areas in Leamington and Rondeau Bay, with the most recent evidence of this occurring in late summer 2019.

Due to sediment balance issues—a result of shoreline hardening—the barrier beach that forms the southwestern barrier within Rondeau Bay has now been removed for approximately 100 metres. This allows Lake Erie waves to enter Rondeau Bay, putting

the low-lying community of Shrewsbury and 470 homes at risk. Continuing and long-term future flooding is anticipated based on present conditions and climate change forecasts.

A State of Emergency was declared along Erie Shore Drive on August 27, 2019, due to significant flooding caused by high winds (peaked at 35 kilometres per hour) and rain. There are 123 homes at risk along Erie Shore Drive, with 35% being permanent residents. The event resulted in significant damage to 12 homes, the roadway, supporting slope, drain and three breakwalls.

A voluntary evacuation took place in a localized area of Erie Shore Drive, comprising 50 homes. Electricity and natural gas services were shut off where there was a safety risk. The water pressure in the water main (under Erie Shore Drive) that provides drinking water to the community of Erieau was reduced due to fears of failure. In the short time period during and around the event, the municipality shored up the roadway and drainage works.

4.7.2 Erosion

While the flood issues are significant, they cannot be isolated from erosion on the Great Lakes. Many of the areas with the highest flood risks also feature a significant long-term erosion rate. This includes Marentette to Wheatley and Erie Shore Drive and many high bluff areas. In keeping with the 1990s Technical Guide, new development has been allowed to be located as close as possible to shoreline hazards, once the landward limit of the erosion hazard is applied. However, due to climate change, the risk profile is changing. Reductions in lake ice have already and will continue to expose the shorelines to higher amounts of wave energy/erosion. Landowners who thought they were 100 years away from erosion hazards might now only be 50 years away, and significant lengths of municipal infrastructure (roads and utilities) are at risk of failure.

Shoreline erosion on Pelee Island is particularly concerning because it has washed out sections of roadway that provide ingress/egress for residents. Bluff failures have occurred in 2019 related to the erosive effects of the high waters. These failures have impacted existing development with at least one home within 1.5 metres from the precipice. These types of failures are expected soon even as water recedes in the region, as the erosive effects have already occurred at the toe of these bluffs.

The Municipality of Chatham-Kent has closed a significant portion of Talbot Trail (West) (length of road closed is 3.8 kilometres). The road was closed due to erosion on the south side of the road (rotational failure). The solution will require a high level of investment estimated at $640 million up front and $12 million per year in maintenance costs.

4.7.3 Recent Severe Rain Events

Risks of flooding in southwestern Ontario are not only a result of high lake levels.

In September 2016, Windsor, Tecumseh and Lakeshore were impacted by a severe and isolated rain event that tracked from the northwest, dumping over 200 millimetres of rainfall in six hours, causing flooding in thousands of urban area basements.

In August 2017, a similar system tracked out of the southwest that formed two distinct storms dumped 146 millimetres of rainfall in less than three hours, which followed a 100-millimetre rainfall earlier. The storm total of 246 millimetres in less than six hours surpasses all accepted design standards. This event exceeded $300 million in insurable losses.

Because both Essex Region and Lower Thames Valley are low lying, high lake/river levels mean that water from stormwater and drainage systems has no place to go.

For example, 30,000 residents living in parts of the Town of Lakeshore, the Town of Tecumseh and the City of Windsor are fully urbanised centres that exist within Lake St. Clair's historic flood extent. Pumping systems that provide for drainage are now regularly overcome by rainfalls that exceed acceptable design standards. These areas have protection systems to prevent lake flooding (either berms or pumping schemes); however, record lake level elevations are challenging the existing protection systems. Any measurable rainfall, such as those events that happened in 2016 and 2017, will cause significant flooding, especially in the urban centres.

4.8 Other Notable Recent Flooding Events

While flooding in spring 2019 resulted in significant damages to many parts of Ontario, several other recent flood events were also brought to my attention during the review. I've noted some of these other recent flood events in this section for the purpose of demonstrating that the flooding that occurred in 2019 does not appear to be an isolated event. Again, this section is not meant to provide an exhaustive account of notable flooding events in Ontario's recent history— an account of that nature was outside the scope of my assignment. However, I felt it important to include some of these events to help demonstrate that flooding is a common occurrence in Ontario and something that can occur at any time of the year.

4.8.1 Recent Flood Events in the City of Toronto

Over 2.7 million people live in the City of Toronto with nearly six million people living in the Greater Toronto Area (GTA). While 2019 was not a significant year for flooding in

Toronto when compared to other areas, significant events and associated impacts have occurred there in the past and are worth noting as part of this report.

With drainage areas ranging from 38 square kilometres for the Carruthers Creek to 900 square kilometres for the Humber River, watersheds within the City of Toronto tend to be relatively small. These small drainage areas, with short stream lengths and highly urbanized (impervious) surfaces, leave little lead time between rainfall and flood impacts. Year-round flood threats include ice jams in the winter, snowmelt in spring, unpredictable thunderstorms in the summer, and hurricane remnants in the fall.

While land use planning has effectively reduced risk in greenfield areas, many neighbourhoods were historically settled near rivers prior to floodplain management. Examples include old downtowns in Brampton, Bolton, Unionville and Stouffville. There are 41 Flood Vulnerable Clusters (areas where there is a high concentration of buildings in the floodplain) within the jurisdictional area managed by the Toronto and Region Conservation Authority (TRCA) alone.

The most severe flooding on record in Ontario occurred in October 1954, when Hurricane Hazel passed over the Toronto area. Eighty-one lives were lost and damages were estimated at $25 million (in 1954 dollars). TRCA's recent Flood Risk Assessment study estimates that if Hurricane Hazel were to occur today, it could result in almost $3 billion in property damages, business disruption and population displacement. While Hurricane Hazel-type storms remain a possibility that must be prepared for, recent events have shown that significant damages and disruption can also occur from significantly smaller events.

On July 8, 2013, a severe thunderstorm dropped more than 120 millimetres of rain over parts of the GTA during the afternoon rush hour, causing roughly $1 billion in insurable losses and stranding thousands of commuters, including over 1,400 passengers who needed to be rescued from a GO train marooned in floodwaters from the nearby Don River.

In the spring of 2017, water levels in Lake Ontario reached levels higher than ever recorded. The impact was significant on Toronto Islands, home to over 800 residents, almost 30 businesses and two schools. The islands' parks experienced significant shoreline erosion, damage and debris accumulation. Direct and indirect damages to the City of Toronto due to the closing of Toronto Island Park were estimated to be $8 million for the 2017 event. In 2019, water levels rose even higher than in 2017, though preventative measures helped to keep the islands open. In 2019, the newly reached record levels were maintained for nearly four weeks. A full accounting of damages from the 2019 levels is still underway.

On August 8, 2018, a highly localized “ninja” storm dumped over 100 millimetres of rain in less than two hours. This storm was not forecast and was so localized that its track evaded detection by TRCA’s real-time precipitation gauges. Flows in Black Creek in the Rockcliffe neighbourhood, a highly flood vulnerable area, rose over two metres in 75 minutes, spilling into nearby properties and stranding two men in an elevator when they attempted to retrieve their vehicles from underground parking. They were rescued by first responders just in time.

On March 15, 2019, as late winter rainfall and snowmelt raised flows in rivers, an ice jam developed in the Town of Caledon, spilling into the Bolton Core neighbourhood. As floodwaters rose through the evening, over 80 homes were evacuated, of which 30 experienced direct flood impacts. The jammed ice had to be manually removed using excavators.

4.8.2 Recent Flood Events in the Grand River Watershed

The Grand River lies at the heart of one of the fastest growing regions in Ontario; however, the watershed faces challenges brought on by intensive population growth, extensive agriculture and climate change. Warmer air and water temperatures, bigger rainstorms and dramatic changes in weather patterns pose new challenges in managing floods, improving water quality and securing water supplies for municipalities, farmers, industry and the natural environment.

Flooding in the Grand River watershed has many causes including:

- Rapid snowmelt over a short period of time;
- Combined rainfall and snowmelt;
- Localized ice jam flooding;
- Moderate rainfall on saturated or frozen ground;
- Extreme localized rain (severe cellular storms, convective thunderstorms or lake breeze events);
- Severe widespread rain (tropical storm remnants or large low pressure systems); and
- Lake Erie surge (shoreline).

While there is seasonality associated with certain types of flooding in the watershed, the risk of riverine flooding remains relatively consistent throughout the year. Compounding challenges associated with riverine flooding, Lake Erie presents additional challenges through lake surge flooding, shoreline erosion and the influence of lake breezes (wind blowing from the water to the shore).

Large floods tend to happen on a cyclical basis in the watershed and trends show they occur in clusters. Data indicates there were clusters of large floods in the late 1940s, mid-1970s, early 2000s, late 2000s, and more recently 2017 and 2018.

In June of 2017, an unforecasted rainfall event caused significant flooding in the communities of Grand Valley, Drayton, West Montrose, Conestogo Cambridge-Preston and Glen Morris. More than 125 millimetres of rain fell across the northern portion of the watershed in the span of a few hours, resulting in the highest flows seen in the Grand River through Cambridge since the May 1974 benchmark flood event. Reports (unconfirmed) of several million dollars in damage resulted from this event.

The highest single-day rainfall event ever recorded in the Grand River watershed occurred in February 2018 and resulted in near floods of record that were further complicated by major ice jams in multiple communities. More than 5,000 residents in Brantford were evacuated due to overtopping of the dike system due to ice jams in that community. Dams owned and managed by the Grand River Conservation Authority helped reduce flows in the order of 40 to 50% downstream of the major reservoirs; however, significant transportation disruptions (road/bridge closures) still occurred due to ice impact. Municipal flood damages in Cambridge and Brantford associated with this event were reported to be in excess of $5 million. Damage incurred by individual property owners and businesses is unknown.

Snowmelt and ice jams in February 2019 resulted in the second highest community ice jam (West Montrose) identified in records dating back to 1967. This event was only exceeded by an event in February 1981.

Chapter 5

Ontario's Approach to Managing Flood Risk

Ontario's current approach to managing risks associated with flooding is based on the five core components of emergency management: 1) Prevention; 2) Mitigation; 3) Preparedness; 4) Response; and 5) Recovery. Management is achieved through the use of a series of provincial acts, regulations, policies and technical guides that are implemented through partnerships with a number of provincial ministries, municipalities, First Nations and conservation authorities.

The objectives with this approach are to save lives and money, protect property, public health and the environment, maintain economic stability, help assure the continuance of critical infrastructure, and reduce social disruption associated with emergencies.

5.1 The Five Core Components of Emergency Management

5.1.1 Prevention

Prevention includes actions taken to prevent flood-related emergencies or disasters from occurring, and includes land use planning and regulatory restrictions to keep development out of the floodplains and other hazardous areas. While we cannot prevent flooding from occurring, keeping people and property out of flood-prone areas helps ensure naturally occurring flood events do not result in local emergencies.

As an overall principle for flood management, the MNRF prioritizes the use of non-structural and land use planning measures as its preferred approach to manage flood risks. This includes the identification of hazardous areas, including floodplains. Municipalities can then plan to prohibit/limit activities, including development, in these areas. The main legislative tools used to support this approach include the *Planning Act* together with the Provincial Policy Statement and the *Conservation Authorities Act*.

5.1.2 Mitigation

Mitigation includes actions taken to reduce the effects of flooding, and includes the use of structural measures and floodproofing standards to protect development. Structural measures can include dams, dikes, channels, diversions and other flood control works. Floodproofing standards can include a combination of measures incorporated into the basic design and/or construction of buildings, structures or properties to reduce or eliminate flooding hazards, wave uprush and other water-related hazards, such as constructing the lowest occupancy floor of dwellings, water shut off and electrical control panel above the design flood level, and having water resistant electrical systems.

5.1.3 Preparedness

Preparedness includes the use of flood forecasting and warning to assess the potential for flooding, predict when and where flooding will occur, and help ensure an effective response (e.g. any required evacuations or mitigative activities).

The Province conducts flood forecasting and warning via the MNRF's Surface Water Monitoring Centre, which monitors weather, rainfall and stream flows, and provides advisories and a suite of products and tools (e.g. weather panels, snow survey reports) to conservation authorities (CAs), municipalities and MNRF district offices on flood potential. The monitoring of flood conditions occurs seven days a week, and the Province is able to contact CAs and other stakeholders immediately with updates.

Local scale flood forecasting and warning is provided by MNRF district offices and conservation authorities. Many of the CAs conduct more detailed flood forecasting and warning for their respective jurisdictions.

5.1.4 Response

Response includes actions taken to respond to flood emergency, such as the use of emergency services (e.g. providing sandbags, community evacuations, etc.) to protect people and property during flood events. Response can also include training for emergency response staff and meeting with stakeholders/partners to ensure an effective response. It also includes providing logistical support and social and health services.

The *Emergency Management and Civil Protection Act* (EMCPA) establishes Ontario's legal basis and framework for managing emergencies (see Section 5.2.4). It does this by defining the authority, responsibilities and safeguards accorded to provincial ministries, municipalities and specific individual appointments, such as the Commissioner of Emergency Management.

5.1.5 Recovery

Recovery includes actions taken to recover from a flood emergency, such as the use of disaster financial assistance to restore property to pre-flood conditions.

Provincially, financial assistance is delivered through two programs—the Disaster Recovery Assistance for Ontarians (DRAO) program for homeowners, tenants, small owner-operator businesses and farms, and not-for-profit organizations; and the Municipal Disaster Recovery Assistance (MDRA) program for municipalities. These programs provide funds for eligible expenses following a natural disaster to help Ontarians and municipalities recover from extraordinary costs. The DRAO program

covers 90% of eligible costs (subject to a $500 deductible and a cap of $250,000). Since the program launched in 2016, it has been activated for 28 events in 68 municipalities, with $11 million in assistance paid. The MDRA program is based on a sliding-scale cost-sharing formula. Since the program launched in 2016, it has been activated for 16 municipalities, with assistance payments of $4 million.

Municipalities can access the MDRA program when eligible disaster-related costs reach 3% of the municipality's Own Purpose Taxation levy. Due to the eligibility threshold based on municipal financial capacity, the program is accessed most frequently by small municipalities with a correspondingly small tax base.

The federal government provides funding to provinces and territories for disaster response and recovery costs under its Disaster Financial Assistance Arrangements (DFAA) program. Under this program, the federal government shares costs with provinces and territories based on a sliding-scale per capita formula. Ontario, as the largest province, has the highest threshold for federal funding and consequently is eligible for the DFAA much less frequently than most other provinces. Based on the current formula (which is adjusted for inflation each year), Ontario could access federal funding under DFAA only in the event of a disaster costing the province in excess of $46.2 million.

Ontario has only qualified for DFAA three times in the relatively recent past—for the 1998 ice storm, the 2004 Peterborough flood and the 2013 ice storm. As a result, disaster financial assistance costs associated with recovery are funded almost entirely by provincial coffers, although the overall financial burden for disasters is borne to a great extent by municipalities and property owners as well.

5.2 Acts, Regulations, Policies and Technical Guides

Ontario's preventative approach of directing development away from floodplains and other hazardous areas is highly effective in preventing property damage. Property damage associated with the same storm event are often exponentially lower in Ontario than they are in Great Lakes states, with the differences in losses primarily attributed to differences in floodplain management policies and approaches.

Provincial policies have been shown to reduce capital and operating costs associated with managing flooding and other natural hazards, reducing pressure on provincial and municipal infrastructure debts. The existing policies have been estimated to reduce costs associated with ongoing flood and natural hazard management, including costs associated with the operation and maintenance of flood and erosion control infrastructure by 20 to 80% depending on differences in urban density and property values.

These policies have been credited with keeping losses associated with flooding in Ontario lower than losses seen in other Canadian provinces. Responsibility for keeping development out of floodplains is a shared responsibility between municipalities (enforced through municipal planning) and conservation authorities (enforced through regulations made under Section 28 of the *Conservation Authorities Act*).

These policies will be increasingly valuable in protecting Ontarians from flooding and other natural hazards. Losses associated with flooding and other natural hazards continue to increase because of increasing property values and income levels, urbanization, ongoing loss of wetlands and other green infrastructure, and the increasing frequency and intensity of extreme rainfall events. As these losses rise, so does the value of Ontario's floodplain and broader hazard management policies.

5.2.1 The Planning Act and the Provincial Policy Statement

The *Planning Act* and the Provincial Policy Statement (PPS) are the primary provincial tools used to guide local land use planning decisions made by municipalities in Ontario. The PPS is the primary provincial land use policy document guiding municipal decision-making. The *Planning Act* requires that decisions on land use planning matters be "consistent with" the PPS, and the PPS policies provide the foundation for regulating development.

Municipalities are the primary implementers of the PPS through incorporation of policies into their local official plans, zoning by-laws and other planning-related decisions.

The PPS is administered by the Ministry of Municipal Affairs and Housing (MMAH), and provides policy direction on matters of provincial interest related to land use planning and development, sets the policy foundation for regulating the development and use of land, and supports the provincial goal of enhancing the quality of life of all Ontarians. The focus of the PPS is on guiding municipal decision making regarding new development and redevelopment.

While this Act and Policy is led by MMAH, the MNRF has the lead in developing the natural hazard policies, including policy direction related to flooding/flood hazards, in Section 3.0 of the PPS. The MNRF works with partners and experts in the development of these policies, which are reviewed every 10 years. These policies require municipalities to identify areas subject to natural hazards in order to consider public safety when planning for new development. To support implementation of policies in the PPS, subject area specific guidance is developed by ministries having the lead for those specific policies in collaboration with other applicable ministries. A series of natural hazard technical guides have been developed by the MNRF to support

implementation of Section 3.0 of the PPS, and are further outlined in Section 5.2.6 below.

The Ministry of Municipal Affairs and Housing conducted consultations from July 22 to October 21, 2019, on proposed changes to the Provincial Policy Statement (PPS) to help increase the supply of housing, support jobs and reduce barriers and costs in the land use planning system (see the Ontario Government website at https://ero.ontario.ca/notice/019-0279 and titled: "Provincial Policy Statement Review – Proposed Policies"). Specifically related to flooding, the proposed policies would enhance direction to prepare for impacts of a changing climate; enhance stormwater management policies to protect water and support climate resiliency; and maintain current policies related to natural and human-made hazards, which directs development away from hazardous areas including flood-prone areas in order to protect public health and safety. Given the direct correlation between the policies in Section 3.0 of the PPS and the Special Advisor on Flooding review, a placeholder was put on these policies in the draft PPS being consulted, until the government has an opportunity to consider the recommendations made in relation to potential policy changes.

5.2.2 The Conservation Authorities Act

The purpose of the *Conservation Authorities Act* is to provide for the organization and delivery of programs and services that further the conservation, restoration, development and management of natural resources in watersheds in Ontario through the establishment of conservation authorities (CAs) organized on a watershed scale. A CA is a municipal public sector organization whose governing structure of members (similar to a Board of Directors) are appointed representatives from the municipalities that established or may have joined the CA and who mostly fund the CA. Many members, for reasons of fiscal accountability, are elected municipal officials. A CA provides programs and services in local resource management within its jurisdiction to both the Province and municipalities.

In 1956, in response to severe economic and human losses associated with Hurricane Hazel (1954), amendments to the *Conservation Authorities Act* empowered CAs to make regulations to prohibit filling in floodplains. These regulations were broadened in 1960 to prohibit or regulate the placing or dumping of fill in defined areas where, in the opinion of the CA, the control of flooding, pollution or the conservation of land may be affected. In 1968, amendments to the *Conservation Authorities Act* further extended the regulations to prohibit or control construction and alteration to waterways. In 1983, the Minister of Natural Resources delegated to CAs the commenting responsibilities for floodplain management matters. CAs would have the authority to review planning

documents and provide comments to federal, provincial ministries and agencies, municipalities and private landowners, including developers.

In 1988, the Minister delegated commenting responsibilities to CAs for matters related to flooding, erosion and dynamic beaches along the shoreline of the Great Lakes/St. Lawrence River System.

In 1995, the Minister confirmed CAs as lead commenting agencies for riverine erosion, slope and soil instability matters, such as areas of high water tables, organic or peat soils, and Leda or sensitive (unstable) marine clay soils.

The regulatory scope of CAs was broadened again in 1998, giving them the authority to regulate development activities adjacent to Great Lakes shorelines, interconnecting channels and inland lakes, and the authority to regulate activities that may interfere with the hydrologic function of wetlands.

With the advent of the provincial One Window Planning Service, an agreement was developed in 2001 with the MNRF, MMAH and Conservation Ontario to define the roles and relationships between CAs, the MNRF and MMAH in planning for implementation of CA delegated responsibilities under this system. The Agreement focuses on MNRF delegated responsibilities to CAs for the PPS Section 3.1 – Natural Hazard Policies. The CA delegated role does not extend to other portions of the PPS unless specifically delegated in writing by the Province. CAs, as public bodies under the *Planning Act*, can comment on official plans or development applications on other portions of the PPS but not with the same authority as the delegated commenting role.

Each of Ontario's 36 conservation authorities currently administer an individual conservation authority "Development and Interference" regulation approved by the Minister of Natural Resources and Forestry, conforming to the requirements prescribed under Ontario Regulation 97/04 – Content of Conservation Authority Regulations Under Section 28 (1) of the Act: Development, Interference with Wetlands and Alterations to Shorelines and Watercourses. A key provincial responsibility that CAs have within their jurisdiction is the regulatory authority under Section 28 of the *Conservation Authorities Act*—the regulating of development and activities through the permitting process in hazard-prone areas set out in regulation for purposes of public safety and natural hazard management. These regulations are a critical component of Ontario's broader natural hazard management framework and are designed to achieve the following policy objectives:

- Preventing loss of life, minimizing property damage and social disruption;

- Reducing public and private expenditure for emergency operation, evacuation, restoration and protection measures;
- Regulating development which, singularly or collectively, impact upon existing flood levels, and increasing potential risks to upstream and downstream landowners;
- Control interference with natural storage areas such as wetlands;
- Conserving land through the control of development on existing or potentially unstable valley slopes or shoreline bluffs; and
- Controlling development impacts as they relate to pollution (including erosion & sedimentation) or other degradation of existing and water resources, including groundwater.

Section (4) of the regulation requires that CAs geographically describe the hazardous lands and areas susceptible to flooding based on the design flood event that is applicable (i.e. Hurricane Hazel, the Timmins event, the 100 year, etc.), and details of rain intensity, duration and impacted area are included in an appendix. This geographical description of the regulatory limits can include reference to maps filed at the head office and the regulations specific to each CA identifies that, where there is a conflict in the description of areas identified in maps, the text description of the regulated areas prevails. Floodplain and other hazard mapping and related studies provide a support for implementing the conservation authority regulations under the *Conservation Authorities Act* and for the conservation authority commenting role on official plan review activities delegated under the *Planning Act*.

Conservation authority activities are funded through a combination of shared provincial and municipal funding, municipal levy and self-financing. Floodplain mapping and technical studies for delineation of hazard areas for municipal planning (not the authority regulations) are among the items eligible for the cost-shared provincial and municipal funding.

The MNRF continues as lead administrative ministry having overall government responsibility for natural hazard management policies/programs.

The MNRF has proposed changes to regulations administered by CAs and the public was consulted between April 5 and May 21, 2019. The following excerpts are from the Ontario Government's website titled: "Focusing conservation authority development permits on the protection of people and property" (refer to https://ero.ontario.ca/notice/013-4992).

The MNRF is proposing a regulation that outlines how conservation authorities permit development and other activities for impacts to the control of natural hazards and public safety. The proposed regulation will make rules for development in hazardous areas more consistent to support faster, more predictable and less costly approvals.

Prohibited activities set out in the un-proclaimed provisions of Section 28 of the *Conservation Authorities Act* as amended by Schedule 4 of the *Building Better Communities and Conserving Watersheds Act*, 2017 include:

- Development in areas related to natural hazards such as floodplains, shorelines, wetlands and hazardous lands (i.e. lands that could be unsafe for development because of naturally occurring processes associated with flooding, erosion, dynamic beaches or unstable soil or bedrock); and
- Interference with or alterations to a watercourse or wetland.

The Ministry is proposing to create a regulation further defining the ability of a conservation authority to regulate prohibited development and other activities for impacts to natural hazards, including flooding and to public safety.

The Ministry is proposing to consolidate and harmonize the existing 36 individual conservation authority-approved regulations into one Minister of Natural Resources and Forestry approved regulation to help ensure consistency in requirements across all conservation authorities while still allowing for local flexibility based on differences in risks posed by flooding and other natural hazards.

Of note, the Ministry is also proposing under this regulation to:

- Allow conservation authorities to exempt low-risk development activities from requiring a permit provided in accordance with conservation authority policies;
- Require conservation authorities to develop, consult on, make publicly available and periodically review internal policies that guide permitting decisions; and
- Require conservation authorities to notify the public of changes to mapped regulated areas such as floodplains or wetland boundaries.

Ensuring conservation authority permitting decisions focus and deliver on their core mandate of protecting people and property from flooding and other natural hazards is part of the government's Made-in-Ontario Environment Plan to help communities and families prepare and respond to climate change. The proposed changes will also provide the business sector with a clear and consistent

regulatory environment in which to operate and will help to make approval processes faster, more predictable and less costly.

As more extreme weather events occur that threaten homes, businesses and infrastructure, it's important to ensure conservation authorities deliver on their core mandate for protecting people and property from flooding and other natural hazards. Improving the efficiency and effectiveness of these regulations is a critical component of this government's strategy for strengthening Ontario's resiliency to extreme weather events.

The MNRF believe this regulation is a critical component of Ontario's approach to reducing risks posed by flooding and other natural hazards and strengthening Ontario's resiliency to extreme weather events.

At the same time as the MNRF public review period for proposed changes to regulations, the Ministry of the Environment, Conservation and Parks consulted with the public on proposed amendments to the *Conservation Authorities Act*, which, if passed, would help conservation authorities focus and deliver on their core mandate, and improve governance. More information can be found on the Ontario Government's website titled: "Modernizing conservation authority operations - Conservation Authorities Act" (refer to https://ero.ontario.ca/notice/013-5018).

One of the stated areas of focus for conservation authorities will be providing programs and services related to managing risks posed by natural hazards, including flooding. The specific programs and services to be provided by conservation authorities related to flooding and other natural hazards are set to be outlined in regulation.

5.2.3 Lakes and Rivers Improvement Act and Water Management Planning

The *Lakes and Rivers Improvement Act* (LRIA) provides the Minister of Natural Resources and Forestry with the legislative authority to govern the design, construction, operation, maintenance and safety of dams in Ontario. The *Lakes and Rivers Improvement Act* and Ontario Regulation 454/96 require dam owners to obtain approval from the MNRF for the construction of new dams, certain repairs and alterations to existing dams, and certain water crossings and channelization works.

The *Lakes and Rivers Improvement Act* Administrative Guide and supporting technical bulletins and best management practices have been prepared to provide direction to MNRF staff responsible for application review and approval, and guidance to applicants who are seeking approval under the LRIA.

Normal operating ranges for dams authorized under the LRIA are described in Water Management Plans or site-specific operating plans for dams located outside the geographical boundary of a water management plan.

The LRIA was amended in 2002 to create a regulatory framework for existing dam operations. The amendments established the statutory authority for the Minister of Natural Resources and Forestry to order an owner of an existing dam to prepare or amend a management plan for the operation and maintenance of the dam, consistent with Minister approved guidelines.

To implement this legislative amendment, the Water Management Planning Guidelines for Waterpower 2002 (WMPG) were approved by the Minister of Natural Resources and Forestry. The goal of water management planning was to contribute to the environmental, social and economic well-being of the people of Ontario through the sustainable development of waterpower resources, by managing these resources in an ecologically sustainable way. The WMPGs established a planning process for defining goals, objectives, scope and criteria for the preparation of Water Management Plans (WMP). WMPs are owned by the primary waterpower producer and must be prepared with the input of stakeholders along the river to which it is situated.

Existing waterpower facilities on rivers in provincial jurisdiction were ordered to prepare plans for the management of flows and levels at their generating stations. In some instances, owners of non-power producing water control structures within the same river were required to participate in water management planning for rivers in which their dams were situated, if their dams were integral to the regulation of flows and levels.

“Complex” WMPs were generally prepared for rivers with multiple waterpower facilities or control structures with significant control over water levels and flows. Complex plans typically had more than one plan proponent (dam owner or waterpower facility owner) and/or significant competing interests.

“Simplified” WMPs were prepared for sections of rivers where there were one or more waterpower facilities or water control structures that generally had limited control of water levels and flows.

WMPs describe the normal range of operating conditions, defined in terms of seasonal flows and levels for each dam within a WMP. The provisions of a WMP do not apply in the event of a declared flood, low water condition or emergency situation.

In 2016, the Ministry approved the Maintaining Water Management Plans Technical Bulletin, which replaces the 2002 Water Management Planning Guidelines and its appendices.

5.2.4 The Emergency Management and Civil Protection Act

The overall legal framework for emergency management in Ontario is addressed primarily in the *Emergency Management and Civil Protection Act*, which, along with powers contained in other ministry-specific legislation, allows the government to take necessary steps to deal with a provincial emergency or any emergency in the province. The purpose of the legislation is to promote the public good by protecting the health, safety and welfare of the people of Ontario in times of emergencies.

Ontario Regulation 380/04 establishes the minimum standards for emergency management programs required by municipalities and provincial ministries and supports the requirement in the Act for mandatory emergency management programs.

The Act and Regulation require provincial ministries to develop an emergency management program consisting of:

- An emergency plan;
- Training programs and exercises for public servants;
- Public education on risks to public safety and on public preparedness for emergencies;
- Any other element required by the standards for emergency management programs;
- Identify and assess the various hazards and risks to public safety that would result in an emergency, and identify the facilities and infrastructure that are at risk of being affected by emergencies; and
- Develop a continuity of operations plan.

The Act and Regulation require municipal programs to address two core components of emergency management—preparedness and response:

- Appoint an Emergency Management Program Committee;
- Develop an Emergency Response Plan for types of emergencies assigned pursuant to Order-in-Council 1157/2009, conduct a Hazard Identification Risk Assessment, and identify critical infrastructure;
- Identify an Emergency Operations Centre;
- Appoint an information officer and conduct public education;
- Conduct training for the Community Emergency Management Coordinator (CEMC), Alternate CEMC, and Emergency Control Group;

- Conduct an exercise for the Emergency Control Group to test Emergency Operations Centre protocols, procedures and response plans; and
- Undertake an annual review of the Emergency Management program.

5.2.5 The Environmental Assessment Act

The environmental assessment (EA) process is established to ensure that governments and public bodies consider potential environmental effects before an infrastructure project begins. Consideration of impacts in and around hazardous lands is primarily through the Provincial Policy Statement and permissions issued under the *Conservation Authorities Act*.

In this context, the Provincial Policy Statement is a planning tool which applies only to "new development" proposals that require approval under the *Planning Act*, and from an infrastructure lens, applies only to infrastructure that forms the foundation for development. Permits issued under the *Conservation Authorities Act* apply to both new development and alteration to existing development, as well as the placement of fill, in defined areas of regulatory control.

Flood mitigation activities that fall outside the scope of these two legislative authorities may be subject to the *Environment Assessment Act*, either as an individual EA or a streamlined EA through the Conservation Authority Class EA for Remedial Flood and Erosion Control Projects or the Class EA for Municipal Infrastructure Projects. Class Environmental Assessments set out a standardized planning process for classes or groups of activities. It applies to projects that are carried out routinely and have predictable environmental effects that can be readily managed. An evaluation of activities under the EA process provides an opportunity for the MNRF to review proposed infrastructure activities, such as flood protection works, including the creation or maintenance of a berm or dike. Various infrastructure works proposed through this process may also be subject to additional approval requirements, such as under the *Lakes and Rivers Improvement Act* (LRIA) or the *Public Lands Act* (PLA) or subject to Ministry of Environment, Conservation and Parks permissions, such as Environmental Compliance Approvals for any discharges to the air, land or water under the *Environmental Protection Act*, or a Permit to Take Water under the *Ontario Water Resources Act*.

5.2.6 Natural Hazard Technical Guides

To support municipal implementation of the natural hazard policies of Section 3.1 of the PPS, a series of natural hazard technical guides were developed and approved by the MNRF. These documents also assist in the municipal land use planning approval

process and in explaining, or if necessary, defending technical methodologies when challenged.

The Province strongly discourages deviations from technical guidance; however, because technical guidance is not in regulation, the MNRF cannot ensure municipal compliance with provincial policy and can only point to technical guidance for direction on the appropriate use of policies, methods and protocols.

The natural hazards technical guides are represented by the following documents:

I. Understanding Natural Hazards (2001), which provides the planning concepts to address natural hazards.

II. Technical Guide – River & Stream Systems: Flooding Hazard Limit (2002), which documents standardized approaches to manage flood susceptible lands across the province. It outlines the three flood event standards used in Ontario and outlines hydrologic and hydraulic work needed to conduct floodplain analysis and delineate flood-prone areas.

III. Procedures for Approval of New Special Policy Areas (SPAs) and Modifications to Existing SPAs Under the Provincial Policy Statement, 2005 (PPS, 2005), Policy 3.1.3 – Natural Hazards – Special Policy Areas. The procedural document that supersedes and replaces the information in Part B of Appendix 5 of the Technical Guide – River & Streams: Flooding Hazard Limit (2002).

IV. Technical Guide – River & Stream Systems: Erosion Hazard Limit (2002) which has the purpose of providing a consistent and standardized procedure for the identification and management of riverine erosion hazards in Ontario.

V. Great Lakes-St. Lawrence River Shorelines: Flooding, Erosion and Dynamic Beaches (2001), which focuses on documenting standardized approaches to shoreline management and land use planning and management to address shoreline flooding, erosion and dynamic beaches, with a focus on the need to better understand the system, particularly its formation, evolution and potential impacts.

VI. Technical Guide for Large Inland Lakes Shorelines: Flooding, Erosion and Dynamic Beaches (1996), which addresses effective shoreline management and land use management approach for addressing shoreline natural hazards.

VII. Hazardous Sites – Technical Guide (1996), which provides technical support in identifying areas of unstable soils, including sensitive marine clays and organic soils as well as unstable bedrock, including karst bedrock.

5.3 Organizational Roles and Responsibilities

In Canada, flood management is the responsibility of the provinces and territories, and is often delegated to municipalities through legislation. Therefore, most flood management activities including mapping, planning, preparation, response and recovery are executed at the local rather than provincial, territorial or federal levels. The management of flooding hazards, including the prevention and mitigation of impacts, is a coordinated approach by the province, municipalities and conservation authorities. The federal government can become involved if federal disaster assistance is triggered. Management is achieved through a series of provincial acts, regulations, policies, and technical guides (see Section 5.2), which together enable local decision making to protect people and property from the impacts of flooding. These individual tools are managed by various agencies in the province based on expertise, creating a network of policies which together implement the flood management program.

5.3.1 Ministry of Natural Resources and Forestry

Since 1975 and re-affirmed by Order-in-Council 1157/2009 of the *Emergency Management and Civil Protection Act*, the MNRF is the provincial lead for seven hazards, including floods.

While the MNRF plays a major role in flood response and response support, the MNRF's current approach focuses on prevention—keeping people out of harm's way and minimizing loss of human life, injury, damage to property and the environment, and mitigation of economic and social disruption through a range of legislative, policy and technical mechanisms. As part of this approach, regulatory and land use restrictions are developed by the MNRF and put in place by municipalities through the Provincial Policy Statement (PPS) land use planning policies, with their implementation supported by a series of technical guidelines produced by the MNRF. Also, under the *Planning Act*, conservation authorities have a delegated responsibility through the MNRF to provide plan input on matters of provincial interest relating to Section 3.1 of the PPS focusing on the Official Plan and Official Plan Amendment stages as well as site plan applications, on a site-by-site basis. In combination, these actions work to prevent new or intensified development in areas prone to flooding and other natural hazards, and regulate activities that can create or increase hazards (e.g. alterations to watercourses and wetlands). The MNRF does not have its own piece of legislation to implement the hazard program and uses a series of tools to enable flood management. These program tools include:

- The *Planning Act* and Provincial Policy Statement (see Section 5.2.1 above);
- The *Conservation Authorities Act* (see Section 5.2.2 above);

- Natural Hazard Technical Guides (see Section 5.2.6 above);
- Mapping and Geomatics Services (see Section 5.3.1.1 below); and
- Flood Forecasting and Warning Services (see Section 5.3.1.2 below).

5.3.1.1 Mapping and Geomatics Services

Geospatial data is critical to flood mapping as it serves as authoritative data for the entire flood mapping process. The two main types of geospatial datasets used in flood mapping are: 1) Imagery, for two-dimensional feature positions (e.g. roads, rivers and buildings); and 2) Elevation, for three dimensional heights (e.g. height of riverbank, height of road).

The Mapping and Geomatics Services Section (MGSS) of the Mapping and Information Resources Branch in the MNRF is responsible for capturing, creating and maintaining Ontario's foundation geospatial data/base data for government, academia and the general public.

The MGSS acquires, maintains and distributes authoritative, open, provincial-scale geospatial data by coordinating provincial acquisition projects (imagery, elevation, LiDAR, bathymetry, roads, water, wetlands, etc.); developing mapping guidelines and standards; providing leadership and guidance in the management of geospatial data; establishing data sharing agreements and funding partnerships between local, provincial and national agencies; and making data discoverable and accessible as Open Data.

Besides its responsibilities for provincial-scale mapping and MNRF geomatics, the MGSS also coordinates the Land Information Ontario program (LIO) on behalf of all Ontario ministries. LIO improves geospatial service delivery for Ontario Public Service (OPS) ministries and partners by:

- Coordinating governance for collective decision making and leadership;
- Engaging with geospatial communities to identify needs;
- Delivering services and products that meet common needs and realize collective benefits; and
- Sharing geospatial knowledge to establish and review best practices.

LIO's core principles include the value of collaboration for geospatial data and services and the principle of "do once, use many times." A good example of this is the LIO Imagery Program, which acquires high-resolution imagery for the provincial government

and numerous partners across the private, public and academic sectors. The success of the LIO Imagery Program is defined by:

- Leveraging internal and external partnerships across multiple sectors;
- Meeting multiple business needs;
- Achieving financial cost sharing; and
- Establishing a predictable, 5-year imagery acquisition cycle.

5.3.1.2 Flood Forecasting and Warning Services

Flood forecasting and warning services are delivered by the MNRF through its Surface Water Monitoring Centre (SWMC) in cooperation with conservation authorities where they have been established and local MNRF district offices, which provide local level expertise and information through flood warning and watch messages to municipal responders.

The ability to provide this service rests with information provided through the hydrometric network, a federal/provincial partnership, and its 600 gauges across the province, more heavily concentrated in those watersheds of greatest population and therefore greatest risk of harm.

The agreement requires a monetary investment by the Province, most recently in the amount of $4.6M for 2019/20. It is expected that the cost of the agreement will increase at an annual inflationary rate of 2% per year. The agreement ensures that the gauges are monitored and maintained to provide the “eyes on the ground” toward flood forecasting.

While there are a number of recommendations in Section 6.3 to improve preparedness, the SWMC advises that it is committed to and continues to learn from each event, and has undertaken numerous steps toward continuous improvement. These actions include:

- Implemented a new Kisters WISKI data environment and developed multiple new products for scripting custom products to improve operations.
- Developed a new early warning system for static (calm) water levels on the Great Lakes and consolidated working relationships with federal government for Great Lakes Briefing products.
- Developed new tools for communicating Ottawa River Secretariat forecasts to conservation authorities and district offices of the Ministry of Natural Resources and Forestry.

- Initiated updates to provincial flood forecasting and warning guidelines (scheduled for completion in 2020).
- Sponsored transfer payment funding to multiple conservation authorities for new flood communication tools on the Ottawa River, GAWSER snowmelt modelling routine in WISKI, and HEC-HMS model development. The Province can evaluate and use these products now that they have been developed.
- Sponsored multiple knowledge transfer and training sessions for internal and external clients—After Action reviews, modelling and technology transfer, flood forecasting and warning community workshops, annual internal training, and collaboration with hydrometric network partners.
- Restructured business practices with Water Surveys Canada to improve field responses to gauge maintenance and field measurements for record events.
- Implementing a new communications plan, including webpage refreshes and web usage statistics.

5.3.1.3 Remote Sensing Science Group

The hub of remote sensing expertise in the provincial government is housed within the MNRF's Provincial Services Division (PSD), Science and Research Branch (SRB), Forest Resource Inventory (FRI) Unit. The Remote Sensing Science Group is primarily focused on Provincial Land Cover and Disturbance mapping and, as provincial data custodians, they support a wide range of users and applications. They also possess the skills and experience necessary to support Emergency Management Near Real Time image processing, interpretation, automation and publishing. Operationally, to support provincial emergency management flooding efforts, the Remote Sensing Science Group works closely with the Surface Water Monitoring Centre and Natural Resources Canada's (NRCan) Canada Centre for Remote Sensing and Emergency Geomatics Services Offices.

Two remote sensing products are primarily used by the group—the Canadian Space Agency's RADARSAT-2 and NASA's MODIS. These products provide more spatial information on water, ice and watershed conditions, information between stream gauges, information in remote areas, quantify conditions that cannot be determined from stream gauges, and are used to assess risk, inform flood messaging and emergency operations. They add to the body of knowledge available about flood, ice and more, and supplement human efforts on the ground (i.e. reconnaissance flights, snow surveys, ice observations). In short, these products help to make better, more informed decisions about a flood.

RADARSAT imagery allows for the accurate mapping of ice conditions through inclement weather and night time hours (as opposed to major limitations with optical imagery and local reconnaissance flights). With frequent revisit times, RADARSAT images can be acquired several times per week for each river, which improves the ability for the early detection of ice jamming.

RADARSAT is also used to provide near real time flood maps and information (extent, severity and progression); greatly improves situational awareness during flood events; facilitates better decision making and flood forecasting; creates documentation and increases knowledge that supports future flood management; and supports the development of accurate floodplain maps.

MODIS Optical Imagery is used to monitor river ice breakup in Ontario's far north coastal rivers. Acquisition, interpretation and communication used to be an entirely manual process; however, in-house tool enhancements from 2016 to 2019 have resulted in an entirely automated process.

The Canadian Space Agency is replacing the RADARSAT-2 satellite with three small identical satellites under the RADARSAT Constellation Mission (RCM), which were launched on June 12, 2019. The RCM will capture images of the earth's water, land, ice and atmosphere during the day and night and in all types of weather, including heavy cloud cover, smoke and haze, which is a huge improvement in optical products. The new RADARSAT Constellation will provide near real time data for all of Ontario and provide more information to support the assessment of flood risk, effective flood messaging and emergency operations.

5.3.2 Ministry of Municipal Affairs and Housing

The Ministry of Municipal Affairs and Housing (MMAH), in their role as lead agency for the administration of the *Planning Act* and the Provincial Policy Statement (PPS), plays a critical role in supporting the MNRF through inclusion of hazard policies in the PPS for new development and redevelopment, as previously discussed in Section 5.2.1 above.

MMAH also delivers the Disaster Recovery Assistance for Ontarians (DRAO) program (for private property owners) and at the municipal level, the Municipal Disaster Recovery Assistance (MDRA) program for eligible expenses following a natural disaster (see Section 5.1.5 above).

In addition to these programs, and in response to flooding in the spring of 2019, MMAH created a $1 million pilot project designed to help municipalities repair flood damaged roads, bridges and other infrastructure to a higher standard, meaning they can better withstand extreme weather. As part of a $1 million pilot project, the Province will

provide municipalities that qualify for MDRA funding with up to 15% above the estimated cost of rebuilding damaged public infrastructure to make it more resilient to extreme weather. Examples include raising roads to provide better protection from overland flow of water, improving the columns or footings of bridges, or increasing the size of ditches and catch basins to increase their capacity to hold water. Communities that were affected by spring flooding that occurred after March 1, 2019, are eligible for the enhanced funding under the pilot.

5.3.3 Ministry of Environment, Conservation and Parks

The Ministry of Environment, Conservation and Parks (MECP), with priority on protection of public safety and the environment, is the provincial lead for a number of water-related initiatives including:

- Protecting the Great Lakes;
- Protecting waterways and inland waters;
- Ensuring sustainable water use and water security for future generations;
- Providing provincial oversight of municipal and private wastewater and stormwater; and
- Enhancing data, information and knowledge sharing.

MECP also has overall responsibility for the *Conservation Authorities Act* and non-natural hazard related programs and services developed and delivered by CAs.

Ontario's 2018 Environment Plan outlines the government's intention to undertake a comprehensive, multi-sectoral assessment of climate change-related impacts, including vulnerabilities, risks and opportunities, to help provide a detailed understanding of how and where climate change will affect Ontario's economy, infrastructure, communities, public health and safety and ecosystems, and what the likely challenges and opportunities associated with those impacts would be. The draft plan commits to working with industry, such as real estate and insurance, to raise awareness among homeowners about the increasing risk of flooding as more frequent extreme weather events are being experienced. This initiative is also being led by MECP.

MECP develops municipal guidance documents to support stormwater management planning and design, which assists municipalities in developing stormwater servicing master plans as well as planning for infrastructure that provide protection of public safety and the environment.

5.3.4 Ministry of Infrastructure

The Ministry of Infrastructure's connection to flood management and prevention is:

- MOI is responsible for making recommendations on priorities for infrastructure and effective coordination of infrastructure across provincial ministries within the government.
- MOI works with partner ministries and Infrastructure Ontario to design, implement and administer public infrastructure programs.
- MOI manages the Asset Management Planning for Municipal Infrastructure Regulation, O. Reg. 588/17, which guides asset management and provides tools and support for municipalities in Ontario to meet their current and future infrastructure needs (see https://www.ontario.ca/page/municipal-asset-management-planning).
- MOI leads the design and implementation of federal-provincial infrastructure programs, working with partner ministries and the federal government.

Resilient infrastructure that helps communities cope with the intensifying effects of climate change and floods has become a key area for targeted investment for MOI in recent years.

MOI administers the Ontario Community Infrastructure Fund (OCIF) which, since 2014, has provided application- and predictable formula-based funding to help build and repair core infrastructure (e.g. road, bridge, water, wastewater infrastructure) in more than 420 small, rural and northern communities. The Province is currently reviewing the design of the OCIF to ensure that it continues to support municipalities to improve and implement asset management plans.

The Green stream of the Investing in Canada Infrastructure Program (ICIP) consists of up to $7.12 billion in combined federal ($2.85 billion), provincial ($2.3 billion), and other partner ($1.92 billion) funding for projects that improve outcomes under one of the three federal sub-streams—Climate Change Mitigation, Environmental Quality, and Disaster Mitigation.

MOI launched the first intake of the Green stream on October 25, 2019 (see https://news.ontario.ca/moi/en/2019/10/ontario-investing-in-green-infrastructure-to-help-smaller-communities.html). The focus of this first intake is to address critical health and safety issues in small municipalities and First Nations communities with populations under 100,000 for water, wastewater and stormwater infrastructure.

MOI will be working with other government departments, including the MNRF, to design additional intakes of the Green stream that could support innovative natural infrastructure and green technology solutions to address current and future challenges in environmental quality, climate change and disaster mitigation.

5.3.5 Office of the Fire Marshall and Emergency Management (Ministry of the Solicitor General)

The Office of the Fire Marshall and Emergency Management, Emergency Management Branch—better known as Emergency Management Ontario (EMO)—is the overall provincial emergency management organization and is responsible for monitoring, coordinating and assisting in the development and implementation of effective emergency management programs throughout Ontario, and for the coordination of these programs with the federal government. In fulfilling this special coordination role, EMO coordinates the provincial emergency response through the Provincial Emergency Operations Centre, when required; provides advice and assistance to communities and ministries in all areas of emergency management; and maintains two provincial level emergency response plans—the Provincial Nuclear Emergency Response Plan and the Provincial Emergency Response Plan (PERP).

The PERP is the plan that is used to coordinate overall provincial emergency response and outlines how EMO and the ministries respond to widespread or large-scale emergencies.

Key initiatives of EMO related to flooding include hosting an annual flood and forest fire symposium, publishing and holding workshops on Hazard Identification and Risk Assessment; conducting a review of national and international best practices to evolve the program; updating the Provincial Emergency Response Plan; and updating the Incident Management System.

For flood events, the Provincial Emergency Operations Centre (PEOC) outreaches to Community Emergency Management Coordinators potentially impacted by flooding to determine anticipated resource requests; develops GIS mapping and incident information products for situational awareness; deploys field officers to provide advice to municipalities and liaise between the PEOC and on-site responders; and develops and circulates flood resource materials (lists of flood-related resources and materials and a Flood Recovery Guide).

5.3.6 Municipalities

In the MNRF technical guides, municipalities are delegated the responsibility under the *Emergency Management and Civil Protection Act* of identifying areas subject to natural

hazards and to develop management plans (i.e. flood contingency plans) to limit exposure to public health and safety risks. This includes identifying floodplains in municipal plans and incorporating policies to address new development consistent with the PPS policy. It is up to the municipality to determine how best to achieve this requirement and the use of floodplain mapping is one tool available to demonstrate hazard areas. Municipalities can choose to involve their conservation authority in preparing floodplain mapping on the municipality's behalf, but are not required to do so.

Any updated or new mapping is generally funded on an as-needed priority basis by municipalities, or through proponent driven development applications. Neither the MNRF nor the Province provides funding for new or updated flood hazard mapping, nor approves new or updated mapping; however, the Province has provided small transfer payments for pilot projects related to mapping technologies in the last few years.

Maps are retained at the municipality and are used for specific land use planning purposes. It is up to the municipality to update their maps when required, which usually is development driven, including updates or amendments to official plans. The MNRF does not track or monitor the development of mapping locally and cannot report on its status or progress.

Municipalities are responsible for municipal stormwater management (e.g. planning, standards, design, establishment, operation and maintenance). Municipal stormwater management deals with the component of the urban surface runoff that is or would be collected by means of separate municipal storm sewers and, in some areas, by combined sewers.

Municipal stormwater management can include green infrastructure that captures (partially or fully) where snow melts or rain falls, reducing stormwater runoff that enters municipal storm sewers.

Municipalities also have an important role for managing surface runoff in rural areas. They, along with landowners, have responsibility for municipal drains that drain and convey surface runoff under the *Drainage Act*. Tile drains, which are important to agricultural productivity, collect and convey surface runoff to natural waterways directly or indirectly via municipal drains. Surface runoff from municipal roads are also conveyed and release to natural waterways. The cumulative drainage of the vast rural areas and rapid conveyance contributes to downstream urban (fluvial) flooding risk.

In emergencies, municipalities undertake first response activities and are responsible for recovery efforts in their jurisdiction.

5.3.7 Conservation Authorities

Conservation authorities are public sector bodies established by municipalities through the *Conservation Authorities Act* (see Section 5.2.2. above) that deliver programs and services, and regulate development and activities set out in regulations within their jurisdiction through a permitting process if the development may impact the control of natural hazards, including riverine and shoreline flooding, or if activities interfere with a watercourse or wetland. Conservation authorities also have a delegated role from the MNRF in reviewing municipal planning documents and applications under the *Planning Act* for consistency with the natural hazard policies in the PPS, including how the development may impact the control of natural hazards. These responsibilities include policy interpretation and the transfer of data, information and science to municipalities. The delineation of hazard areas through mapping and supporting hydrologic/hydraulic studies provides important information and science to support these delegated responsibilities. Regulatory mapping may be updated by a conservation authority from time to time, sometimes when municipalities update their official plans and their floodplain mapping or, as a requirement of a permit application, a proponent may be required to update authority regulatory mapping.

Where they have been established, conservation authorities are delegated with the responsibility for flood forecasting and warning. Where no CA exists, the local MNRF district is responsible. Supporting both CAs and MNRF districts is the MNRF's Surface Water Monitoring Centre, whose main function is to monitor water flows and levels, assess conditions across the province, and provide communications and ongoing knowledge of the provincial flood potential. The scope and complexity of a flood forecasting and warning program for a particular jurisdiction is contingent on a variety of considerations, including the level of risk within flood-prone areas. Some conservation authorities may operate and maintain an additional network of streamflow, snowpack, rain gauges and climate stations throughout their geographical jurisdictions that can also serve as data inputs to their hydrologic models to address the specific needs within their jurisdiction.

5.3.8 The Federal Government

Water management and flood hazard management more specifically are not referenced in the Canadian *Constitution Act*. Provincial water management authority is derived from the authority to legislate over property and civil rights, over matters of local and private nature, over local works and over natural resources. Some federal departments such as Natural Resources Canada (NRCan) also have a role in flooding and other natural hazards. NRCan monitors natural hazards (including flooding and landslides) and provides information about hazards events, as well as information to help

Canadians understand and prepare for natural hazards, and to reduce the losses from hazards events. NRCan develops and distributes geospatial data, topographic and geoscience maps, images and scientific publications associated with flooding and landslides. (See also the discussion on remote sensing in Section 5.3.1.3.)

Public Safety Canada administers the Disaster Financial Assistance Arrangements (DFAA) program, which reimburses provincial and territorial governments for eligible disaster response and recovery costs.

With flooding being the single largest draw on DFAA, NRCan initiated the Federal Flood Mapping Guidelines Series (in partnership with Public Safety Canada) to provide critical support to areas in Canada that didn't necessarily have robust guidance related to floodplain mapping. While well intentioned, this initiative has added to confusion in Ontario, with practitioners not necessarily understanding that Ontario's existing guides take precedence.

Public Safety Canada also provides funding for cost-shared projects related to the management of flooding and other natural hazards through programs like the National Disaster Mitigation Program (NDMP) and Infrastructure Canada provides funding through the Disaster Mitigation and Adaptation Fund (DMAF). Flood-related infrastructure projects may also be eligible for funding under the Investing in Canada Infrastructure Program (ICIP) under the Green stream administered jointly by Infrastructure Canada and Ontario.

5.3.9 Other Agencies

5.3.9.1 International Joint Commission

Canada and the United States are parties to the Boundary Waters Treaty of 1909 (the Treaty), under which the International Joint Commission (IJC) is created. Under the Treaty, IJC has the jurisdiction over cases involving the use, obstruction or diversion of boundary waters shared between Canada and the U.S. For instance, the regulation of water flow through the Moses-Saunders Dam on the St. Lawrence River fall under the jurisdiction of the IJC.

Ontario works closely with the IJC and federal, state and provincial governments to ensure Great Lakes regulation strategies account for sustainable water resources management. While Ontario is not responsible for managing outflows from the Great Lakes, the Province does have responsibilities for lands, tourism, land use planning, water use and natural hazard management (erosion, flooding), all of which are affected by water levels and flows.

The MNRF advises the International Joint Commission through IJC Boards of Control and short-term task forces and studies.

5.3.9.2 Ottawa River Regulation Planning Board

In 1983, Canada, Quebec and Ontario approved the Agreement Respecting Ottawa River Basin Regulation. Under its terms, a board was constituted to plan and recommend regulation policies and criteria leading to integrated management of the 13 principal reservoirs of the basin, taking into account flood protection, hydroelectric power production and other interests. Supported by a Regulating Committee composed of the four agencies that own and operate the reservoirs and Secretariat, the Ottawa River Regulation Planning Board endeavours to ensure that the integrated management of the reservoirs provides as much protection as possible (the generating stations on the main stem of the Ottawa River were not designed for flood protection) against flooding along the Ottawa River and its tributaries, and along its channels in the Montréal region. The term "integrated management" means that the four principal dam operators in the basin operate their facilities with knowledge of what the other operators are doing and the consequences of operational decisions elsewhere in the Ottawa River basin.

The Board consists of seven members, each with an alternate, who represent Canada (three members), Ontario (two members), and Quebec (two members). The two Ontario agencies represented include the MNRF (co-chair of the board) and Ontario Power Generation (OPG).

On the Ottawa River, the responsibility and authority to manage dams in accordance with established operating plans rest with dam owners (e.g. Hydro-Québec, Ontario Power Generation and the federal government through Public Services and Procurement Canada). The Ministry's application of the *Lakes and Rivers Improvement Act* on existing Ottawa River facilities is limited to reviews and approval of repairs/upgrades per associated work permits.

5.3.9.3 Ontario Power Generation

Ontario Power Generation (OPG) has been of member of the Ottawa River Regulation Planning Board (ORRPB) since its inception and is a full member of the Ottawa River Regulating Committee (ORRC) of the ORRPB. As part of the Regulating Committee, OPG collaborates with other operators of principal reservoirs to optimize the use of the storage they manage in view of reducing the river flows downstream, thereby minimizing flooding. In the spring, OPG and other operators follow river condition forecasts provided through the Regulating Committee very closely in order to make appropriate decisions at their facilities.

As agreed by Canada, Ontario and Quebec, the Board is the administrative and policy branch of the organization and the Regulating Committee and Secretariat are the operational arms. The purpose of the ORRPB and ORRC is to ensure integrated management, or the collaborative management, of the 13 principal reservoirs of the Ottawa River to minimize the impact of flooding and droughts along the Ottawa River. The original language in the ORPPB/ORRC agreement from the early 1980s states that the goal of the integrated management is to "provide protection against flooding." The term "protection" is a misnomer, as the location of existing reservoirs and their physical storage capacity does not provide the ability to fully protect against flooding. Integrated management on the Ottawa River does not prevent the impact of flooding, but reduces the impact of flooding to the greatest extent possible given physical constraints.

Integrated management does not mean that the ORRPB or ORRC dictate or control flows in the river. Instead, the ORRPB mandate is to ensure that all operators are sharing information and forecasts when making decisions and that all decisions are made with the full knowledge of what other operators are doing. Being involved in the management of the principal reservoirs in the Ottawa River basin, OPG communicates and exchanges information at least daily with other members of the Regulating Committee (Hydro-Québec, Québec and Canada) throughout the spring flood season to assess together current and forecast river conditions, and what actions may be required to minimize flood impacts.

The daily process starts with the ORRC members examining the current water level and flow conditions at their facilities and submitting hydrometric data and initial reservoir release decisions. Hydro-Quebec produces a hydrological forecast of inflows along the river, which is shared with the Secretariat and ORRC members. This information is used as input to the reservoir routing model for forecasting flows and levels throughout the river system to aid ORRC members in planning operations (i.e. storage/discharge decisions). Members of the ORRC review the results and discuss the current operational strategy on a conference call. If at this time OPG decides it best to modify their reservoir operation strategy, they will inform the ORRC and the reservoir routing model will be modified to examine the impact of the change in this decision. This process will occur until a final strategy is established. At all times, OPG is responsible for the operation and strategy relating to its facilities. The ORRPB/ORRS/ORRC structure ensures that the operators' decisions are transparent, consistent and share a common understanding of the watershed conditions with other members.

Chapter 6

Challenges and Opportunities to Managing Flood Risk

Although Ontario has a well-established approach to managing flood risk, the reality is that there have been significant property and casualty losses associated with extreme weather events in the past several years. According to Canada's Parliamentary Budget Officer, the estimated annual DFAA costs resulting from floods are the largest of the weather events (others being hurricanes, convective storms and winter storms) representing 75% of all weather-related expenditures (refer to https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/2016/DFAA/DFAA_EN.pdf).

The public should understand that the risk of flooding cannot be eliminated, but it can be reduced. There are considerable challenges to managing flooding especially when governments are having fiscal challenges. However, there are many opportunities to improve on the current approaches to managing flood risk.

6.1 Prevention

6.1.1 Gaps in Policy and Technical Guidance

Components of the current technical guides and associated standards are outdated and need to be updated to reflect emerging environmental concerns and new land use policies.

Beginning in 2016, the MNRF initiated work to better understand and start to address current gaps in policy, and document issues and concerns with technical guidance, including many of the components highlighted in sections below. In some circumstances, specific conservation authorities have developed and adopted their own policies and technical guides which may not be consistent with MNRF's guidance or the Provincial Policy Statement (PPS).

This section is included specifically to highlight the gaps in policy and technical guidance. Subsequent sections get into more detail and result in specific recommendations.

6.1.1.1 Lack of Guidance for Considering Climate Change

Changes made to the PPS in 2014 direct municipalities to consider the potential impacts of climate change that may increase the risk associated with flooding and other natural hazards. Furthermore, draft proposed edits to the PPS released for consultation

in 2019 suggest the need for municipalities to “prepare for the impacts of a changing climate” (see Section 5.2.1).

Climate change has the potential to alter watershed hydrology, such that existing hydrologic procedures, analyses and modelling may require adjustments or adaptations to adequately represent the range of potential hydrologic effects and to support modelling of affected flows and levels using hydraulic analyses to inform floodplain mapping. The MNRF’s Technical Guide – River & Stream Systems: Flooding Hazard Limit, which is used to help implement the PPS, was approved in 2002 and does not include the latest information on climate change. In recent years, there have been substantive changes in technology and an enhanced understanding of climate change considerations with regards to hydrologic modelling and associated influences on the hydraulic analyses required to develop floodplain mapping.

Existing policies and technical guidelines provide very little guidance on how to incorporate climate change consideration into planning and permitting decisions. Background work to derive options for integrating climate change considerations into the MNRF’s technical guidance has been ongoing since 2016 and would be integral to an update of the flooding technical guidance.

In 2017, the MNRF commissioned a study that produced a report titled: “Flooding Hazard Climate Change Advisory and Option Report.” The report identified ways in which climate change considerations can be integrated into the Technical Guide - River and Stream Systems: Flood Hazard Limit. Deliverables from this project will make significant contributions to ensuring that a range of options for addressing climate change and climate change adaptation that are consistent with provincial policy are available for consideration as the MNRF works towards enhancing implementation of Ontario’s existing flood hazard policies, while best addressing future climate considerations.

The MNRF (Water Resources Section) currently sits on the Steering Committee of a Natural Resources Canada funded study that will develop climate change information on future ice conditions and storm extremes for use in coastal infrastructure development, policies, programs and practices on the Great Lakes. Findings and data generated by this study will help inform updates to the MNRF’s technical guidance for the Great Lakes and connecting channels related to flooding, erosion and dynamic beach. Recent high levels and associated erosion on Lake Erie and Lake Ontario (specific areas of focus for the study), make the results of this study particularly timely.

6.1.1.2 Climate Change Resiliency of Existing Flood Standards

Flood standards specified in the MNRF's technical guidance for rivers and streams are based on the greater of the 100-year flood (which forms the minimum standard), floods produced by a specified meteorological event (e.g. Hurricane Hazel or Timmins Storm) or an observed flood greater than the 100-year flood level. Presently, little guidance exists for developing future climate informed flood standards, particularly for river and streams. While some have suggested incorporating arbitrary freeboard in floodplain mapping to account for uncertainty as a qualitative approach for assessing the uncertainties of flood impacts from climate change, little substantive information is available in the published literature, or in use by other jurisdictions to support this approach from a scientific perspective. Acknowledging this gap, the Flooding Hazard Climate Change Advisory and Options Report commissioned by the MNRF in 2017 also included considerations of a range of options for integrating climate change considerations to inform Ontario's flood standards.

6.1.1.3 Outdated Guidance on Floodproofing Standards

Floodproofing standards are currently addressed in the MNRF's Technical Guide – River & Stream Systems: Flooding Hazard Limit. Floodproofing information and standards identified therein are based on science and approaches from the 1980s. Floodproofing as addressed in the Technical Guide includes considerations of types of floodproofing, sound engineering practice related to construction and structural integrity, vehicular access considerations, and additional aspects related to flooding as a threat to life, including general rules regarding independent and combined functions of depth and velocity to support safe access and egress, and safe movement for most individuals in flood waters.

Work is wrapping up on an investigation and synthesis of current best practices, procedures, methodologies and technical considerations related to the field of floodproofing to protect people and property from flooding related natural hazards. This includes an evaluation of guidance presented in "Appendix 6 – Floodproofing" of the MNRF's Technical Guide – River & Stream Systems: Flooding Hazard Limit in the context of current and up-to-date protocols, procedures, methodologies and technical considerations. The evaluation will further include flooding as a threat to life to identify gaps and/or areas in the Technical Guide to highlight where the currency of the existing document would benefit from modifications and/or updates. A key deliverable is the development of considerations outlining appropriate options for updating the floodproofing guidance to support a revised Appendix 6.

Based on findings of background research and evaluation relative to the existing Technical Guide, the MNRF is considering producing a report proposing technical

information requirements, specifications and standards related to floodproofing to enhance the currency of techniques and technical considerations, and promote consistency in the application of floodproofing measures across the province.

This floodproofing review has implications for other MNRF natural hazard technical guides that refer to floodproofing (i.e. Great Lakes St. Lawrence flooding, erosion and dynamic beach) and has linkages to aspects of other policies and legislation such as the Ontario Building Code and the PPS documentation. Endorsement of newer methods could provide an additional range of options for Ontarians to manage and mitigate the impacts of flooding on dwellings.

6.1.1.4 Outdated Guidance on Hydrologic and Hydraulic Modelling

The hydrology and hydraulic chapters of the Technical Guide – River & Stream Systems: Flooding Hazard Limit are considerably dated. This includes reference to obsolete modelling software and to a lesser extent, standard practices.

The MNRF has completed initial research to identify methods and options for updating the sections associated with hydrology and hydraulics in the Technical Guide to account for technological and methodological advancements. With regards to hydrologic modelling, this includes an assessment of technologies and modelling protocols, practices and platforms for informing water level computations and flood line delineation, addressing the types of hydrologic models, model selection and calibration.

With regards to hydraulics, efforts included analyses to support improving the suitability of hydraulic analyses for estimating water levels throughout a wide range of rivers and river characteristics within Ontario. This involved guidance around choosing a hydraulic modelling technique, and direction around the use and applicability of 2-dimensional (2D) modelling, including guidance and standards for its use and interpretation. Guidance and requirements related to hydraulic model calibration, testing and sensitivity analysis were included, as were additional guidance on evaluating uncertainty in model parameters and the resulting impacts on model simulations and the associated range of error in modelled results.

While the above focus is on the riverine flooding guidance, the Great Lakes St. Lawrence and Large Inland Lakes guidance suffers from similar issues. Less effort has been placed on these documents.

6.1.1.5 Outdated Guidance on Surveying and Mapping Standards

In 1986, the MNRF adopted flood-related survey and mapping standards based on guidelines developed by the federal government under the cost shared Federal/Provincial Flood Damage Reduction Program, which ran from 1977 to 1992.

In 2002, to support municipal implementation of the PPS, the MNRF consolidated, developed and approved a series of natural hazards technical guides including the Technical Guide – River & Stream Systems: Flooding Hazard Limit.

In the Flooding Hazard Limit Guide, there is a placeholder: Section J, “Surveys and Mapping”, for new provincial direction on mapping standards and techniques.

Given the MNRF 1986 guidance is out of date, current mapping practice by municipalities and conservation authorities is to use best professional engineering judgement. Substantive advancements continue to be made rapidly in surveying and mapping standards and data acquisition, including in the areas of remote sensing, geomatics and mapping technologies and practices as discussed in other sections of this report.

With the recent release of the Federal Geomatics Guidelines for Flood Mapping, as part of the Federal Flood Mapping Guidelines Series, there is an opportunity to glean information from this document which may serve Ontario well and align, where suitable, the geospatial data requirements for flood modelling and mapping (go to https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgtn/ndmp/fldpln-mppng-en.aspx).

Updated standards are required to ensure consistency and adequacy of floodplain mapping across the province. The MNRF commissioned a review of jurisdictional surveying and mapping standards for flood mapping in 2016 and is in the process of evaluating options for updates to the appendix. A document titled: “Survey and Mapping Specifications and Standards Report” produced in 2018 for the MNRF was reviewed internally by the Ontario Public Service Elevation Coordination and Consultation Committee. This Committee brings together elevation experts from all relevant ministries and partner agencies to provide coordination and expertise on elevation data-related projects, acquisitions and issues. Feedback, technical comments and edits provided by this group are being incorporated into a final draft document, including considerations noted above related to the federal geomatics guidelines.

6.1.1.6 Other Policy or Technical Gaps

Other gaps in provincial policies and technical guidelines include:

- Lack of policy direction/technical guidance regarding drought. While the topic of drought is outside the scope of this review, it needs to be considered in the context of lowering reservoirs to capture more water and reduce the impacts of flooding, and whether a subsequent drought will prevent the reservoir from being refilled.
- Direction around the use of 2-dimensional (2D) and/or combined 1-dimensional/2-dimensional (1D/2D) hydraulic models. For example, is it necessary to consider floodplain storage in flood hazard mapping, and if so, which is the appropriate model.

Filling some of these gaps could help streamline approval processes by providing greater clarity and certainty around how to address these issues.

6.1.1.7 Limited Training, Outreach and Awareness

Limited provincial resources are currently directed towards training, outreach and awareness of the MNRF's policies, technical standards and guidelines. Such outreach is typically limited to ad hoc requests for presentations to various groups or events (e.g. annual conferences, workshops).

Limited training, outreach and awareness can contribute to misunderstanding, competing interpretations, and a lack of clarity and consistency in standards and policy requirements. Some stakeholders, including the Association of Municipalities of Ontario, have requested increased training and outreach with municipalities, developers and conservation authorities on the basis that it would help ensure services were undertaken more consistently across the province.

6.1.2 Policies, Standards, Regulations and Legislation

In her 2017 report, Ontario's Auditor General raised the following concerns:

> "The provincial emergency management program does not focus on all five components of emergency management: prevention, mitigation, preparedness, response and recovery. Currently, the focus of the emergency management program in Ontario is mainly on only two of the five components—preparedness and response—with the Ministry of Municipal Affairs also undertaking activities related to recovery through the disaster financial assistance programs", (2017 Annual Report Volume 1, Office of the Auditor General of Ontario,

http://www.auditor.on.ca/en/content/annualreports/arreports/en17/v1_304en17.pdf).

While these concerns apply to the province's overall approach to emergency management, they may also apply to the province's approach to flooding.

Prevention-based approaches have been repeatedly shown to be more effective in reducing the impacts of flooding and other natural hazards. As outlined within the five core components of emergency management, flood prevention relies on the use of non-structural measures, such as land use planning and permitting and building controls to keep people and property out of hazardous areas. In Ontario, land use restrictions are put in place by municipalities to prevent new or intensified development in areas prone to flooding and other natural hazards. Land use restrictions are also put in place by conservation authorities who are required to regulate development (in areas prone to natural hazards) for impacts to the control of natural hazards as set out in regulation (i.e. flooding and erosion) and for interference with a watercourse or a wetland.

While regulations and land use restrictions have been in place for a few decades in Ontario, concerns have been raised noting that these policies and associated technical requirements may not be adequately enforced and too easily ignored in response to the financial incentives or other incentives (such as infill development in historic communities) that encourage new and intensified development in or adjacent to flood-prone areas. These incentives often encourage greater reliance on tools contained within other core components of the emergency management framework, such as the use of mitigation measures (e.g. flood protection berms, floodproofing), preparedness systems (e.g. flood warning systems), and response (e.g. temporary sandbag dikes) and recovery programs (e.g. disaster assistance and/or insurance) that do not require strict adherence to a prevention-first approach to managing the impacts of flooding.

Clearly, more focus on prevention is needed, and strengthening existing policies and standards by enshrining them in legislation (or by regulation) is required.

As mentioned in Section 5.2.2, the MNRF is proposing a regulation under the *Conservation Authorities Act* that outlines how conservation authorities regulate development and other activities for impacts to the control of natural hazards and public safety. The proposed regulation will make rules for development in hazardous areas more consistent to support faster, more predictable and less costly approvals.

Recommendation #1

That the MNRF proceed as expeditiously as possible to finalize its proposed regulation under the *Conservation Authorities Act* and submit it to Cabinet for approval.

6.1.2.1 Consideration of Risk in Floodplain Management Policies

There are two main approaches to managing flooding and other natural hazards: a hazards-based approach and a risk-based approach.

A hazards-based approach focuses on determining where hazards exist and then taking steps to prevent activities from occurring in those areas. A risk-based approach focuses on determining the risks posed by natural hazards, and then taking steps to further reduce those risks to acceptable levels. In the case of flooding, a hazards-based approach seeks to delineate the floodplain and prevent development from occurring within it. A risk-based approach seeks to identify the risks associated with development in a floodplain and find ways to reduce those risks through enhanced floodproofing, flood forecasting and warning, and other measures. Adopting a risk-based approach allows individuals to proceed with a given activity (e.g. development within a floodplain) provided that sufficient measures can be put in place to keep risks as low as reasonably achievable.

While there is some support for a risk-based approach, developing and successfully rolling out a risk-based planning and/or permitting framework would be a complex and resource-intensive task requiring new provincial policy direction in several areas including defining acceptable levels of risk.

The MNRF's current approach to managing flooding and other natural hazards straddles these two approaches by taking a hazards-based approach to limiting new development and taking a risked-based approach to reduce risks associated with existing development located in hazardous areas (e.g. as with Special Policy Areas). Risk-based flexibility is also provided for development in the flood fringe in areas where the two-zone concept is applied, subject to floodproofing consistent with MNRF standards. This seems to be at odds with what some conservation authorities believe, as they have advocated for taking a risk-based approach to mitigate urban food risk. They recommend that the Province contemplate how to incorporate a consideration of risk when updating floodplain implementation guidelines.

Recommendation #2

That the MNRF consult with the conservation authorities on their application of the hazards-based approach and the risk-based approach to managing flooding.

6.1.2.2 Provincial Policy Statement Review – Proposed Policies

Overall, I am in agreement with the existing polices under the Provincial Policy Statement (PPS) Review, in particular with Section 3.0 Protecting Public Health and Safety. This Special Advisor on Flooding report covers some of the content in the PPS Review, which is based on my review of a considerable amount of background information, what I heard while meeting with municipalities and conservation authorities, and from submissions received by municipalities, CAs and other agencies. The proposed PPS policies are supported by some of the recommendations I've made in this report, such as the need for updated technical guidelines; entrenching elements of the technical guides (such as standards) in legislation; and reviewing and updating the MNRF's technical guides to support the use of flood protection landforms.

Recommendation #3

That the following be incorporated into the Provincial Policy Statement:

- The reference to "impacts of a changing climate" throughout the Provincial Policy Statement helps to bring it to everyone's attention and should be included in the Preamble as well.
- Either in the body of the PPS or in the definitions section, reference should be made specifically to the requirement for conservation authorities to regulate development activities in hazardous lands as required in the *Conservation Authorities Act.*
- That "d) Transportation and Infrastructure Corridors, Airports, Solid and Liquid Waste Management" be added to Section 3.1.5 of the Provincial Policy Statement.

6.1.3 Floodplain and Flood Risk Mapping

Having accurate floodplain maps help communities make efficient and effective planning decisions. The Office of the Auditor General suggests that up-to-date floodplain maps would allow municipalities to better plan for future growth in areas of low flood risk, and build infrastructure and resiliency in high-risk flood areas.

6.1.3.1 Limitations of Existing Geomatic Data and Mapping

The management of floodplains and other hazardous areas begins with their identification. Knowing the location of these areas can help streamline approval decisions and ensure areas not subject to flooding and other natural hazards can be developed.

Several issues exist associated with data and mapping used to delineate floodplains and other areas. CAs report that a large percentage of their floodplain mapping require some form of an update. This takes into consideration all elements of floodplain mapping, including the age, limitations and accuracy—not just the currency of existing mapping alone. It is important to note that particularly in areas of the province where development pressures are low, age of mapping is not necessarily an indicator that mapping is out-of-date or "outdated."

6.1.3.2 Updates to Floodplain Data and Mapping

The cost of updating floodplain mapping can be prohibitive to municipalities and CAs, as it requires high resolution elevation data.

Recent base data acquisitions funded by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and in partnership with the MNRF, including the use of Light Detection and Ranging (LiDAR) technology, have significantly reduced the cost burden to CAs and municipalities associated with base data acquisition, particularly in south-central and southwestern Ontario.

Considerable work has been undertaken by municipalities and conservation authorities in the province over the last several years to update floodplain mapping with matched federal funding provided through the federal government's competitive, merit-based National Disaster Mitigation Program (NDMP). Flood mapping was a specific funding stream of NDMP. Under NDMP, only applications related to the municipal land use planning and mitigation were eligible, and projects related to CA regulatory limit mapping to support the implementation of conservation authority regulations made under the *Conservation Authorities Act* were not eligible. The Province included a specific requirement for conservation authority proposals— that municipal support for the project be demonstrated through a letter of support from the affected municipality or municipalities (including regional governments). Furthermore, if the conservation authority planned to use a municipal levy to cover project costs, that the letter of support must also reference the municipalities support for the levy funding mechanism. By way of the letter of support, municipalities were also required to commit to the flood mapping being integrated into Official Plans to guide future development outside of flood-prone areas.

From 2015 to 2019, municipalities and conservation authorities received approximately $9 million towards updating flood maps across Ontario, for a total investment of at least $18 million in flood mapping.

Across all five NDMP intakes and all four funding streams, a total of $40.58 million in federal funding was secured by Ontario applicants. Including applicant matched funding, this means that no less than $81 million in total funding has been secured for flood-related initiatives through all five intakes of NDMP.

6.1.3.3 Expanding Regulatory Flood Lines

Many factors can contribute to the expansion of regulatory flood lines. These lines are dynamic in nature and can expand and move as development in the watershed changes, altering rainfall-runoff characteristics and associated flood generation. Land use change can contribute to larger amounts of water being more quickly delivered to streams and rivers. The larger volume of water in rivers and streams acts to expand flood lines, covering larger areas of land adjoining streams and rivers with water under the flood standard. In addition, acquisition of new and more accurate survey and mapping data combined with revised hydrologic and hydraulic modelling can result in considerable differences in the extent of regulatory flood lines between current and updated flood hazard mapping, particularly when based on full build-out projections related to a 20-year official plan.

Regulatory flood lines and associated floodplains are expanding or are expected to expand, bringing more existing development, and areas targeted for new development, into flood-prone areas. This can be particularly true in areas using a 1:100-year storm event to delineate regulatory flood lines; however, areas currently using a 1:250-year storm event (e.g. areas within the Upper Thames River watershed) are also finding significant expansions in regulatory flood lines. Areas using a regional regulatory storm (i.e. Hurricane Hazel or the Timmins Storm) are less likely to see significant increases in the size of regulated floodplains as these events have higher return periods (lower chance of occurring).

Regulatory flood lines and floodplain mapping should be updated along with updates to municipal official plans. It is important that flood hazard identification incorporated into municipal planning documents, through mapping or otherwise, reflect a full build-out condition of the upstream watershed based on the current official plan. This level of rigour is intended to provide people and property downstream a level of assurance that flood hazards are accounted for, and that the influence of future land development on flooding is considered. As this mapping is used by municipalities for land use planning purposes, mapping is generally current until the next Official Plan update and based on a (+/-) 20-year planning horizon.

Many areas of southern and southwestern Ontario have experienced and continue to experience rapid urban development. Many municipalities have been highlighting the need to update flood hazard mapping to capture the effects of land use development occurring since mapping was last completed and to use the most current data and technologies (i.e. LiDAR, 2D hydraulic modelling where appropriate, etc.).

Expansion of regulatory flood lines can be a concern for municipalities, developers and existing homeowners regarding the impacts of expanded lines on future growth opportunities, the ability to invest in and protect existing homes, and property values. To date, 73 flood mapping projects across southern Ontario have been funded by the federal National Disaster Mitigation Program (NDMP) with the aim of updating existing floodplain mapping across more than 30 municipalities. These studies could result in expanded regulatory flood lines, and associated concerns from the development community and others regarding the potential impacts of updated flood lines on existing and planned development within these municipalities.

Increased urbanization, exacerbated by the influences of a changing climate, can create a situation whereby areas that were considered to be outside of the floodplain, and managed and developed without specific consideration of the flood hazard, may be subject to a greater flood hazard and associated flood inundation. To better understand how this issue is being addressed internationally to provide context on how Ontario may approach them in the future, the MNRF commissioned a jurisdictional analysis of expanding floodplains in a policy and planning context. A scan of the literature conducted early in the project revealed that most jurisdictions have moved beyond a regulatory hazard-based approach to defining and managing regulatory flood lines, and instead now focus on managing floods in-line with a risk-based approach. Most international jurisdictions, rather than using a single likelihood of flood hazard to define flood lines and the flooding hazard limit, have transitioned to consideration of multiple likelihoods, and also of the number and type of exposed elements in the floodplain.

The project therefore focused on considerations for supporting the adoption of a risk-based management approach for riverine and lake flooding in Ontario, including approaches and opportunities for managing changing flood lines, with a view to understanding and managing flood risks in the context of Ontario's policy and planning landscape.

6.1.3.4 Technical Guidance That Governs Floodplain Mapping

While the Mapping and Geomatics Services Section of the Mapping and Information Resources Branch of the MNRF has been able to provide guidance on LiDAR acquisitions and the management of legacy datasets to other provincial agencies, recent projects under the National Disaster Mitigation Program (NDMP) have supported

LiDAR acquisitions by municipalities and CAs on a project-by-project basis. Ontario does not have defined flood survey and mapping guidance or standards available to support consistent survey data acquisition and mapping by conservation authorities, municipalities and developers. Updated technical guidance is needed to determine what level of detail is required for floodplain mapping and how these expectations may differ in rural or urban areas.

This lack of coordination has led to gaps in coverage for many areas of the province; duplication of effort; inconsistent data standards and data access; and increased costs.

Technology, tools and approaches to deliver modern digital floodplain mapping have changed since the most recent update of floodplain mapping technical and implementation guidelines was last completed in 2002. Work recently commissioned by the MNRF to develop surveying and mapping specifications, and standards for flood hazard mapping (in support of an update to the natural hazard technical guides), will make considerable headway in advancing mapping consistency across the province.

A couple of conservation authorities have reported that new technologies and approaches have been piloted or developed amongst the conservation authority community along with CA guidelines for developing new digital floodplain mapping. Case studies and CA guidelines can be provided by the CA community to assist the Province with assessing the new approaches and developing the new provincial guidelines for hazard and flood risk mapping. They have even offered secondments of CA personnel to the MNRF to help transfer knowledge and experience, and to create a collaborative approach to updating the technical guidelines.

Recommendation #4

That the MNRF update floodplain mapping technical and implementation guidelines recognizing new technology and approaches for flood hazard and flood risk mapping, and that the MNRF collaborate with conservation authorities on this initiative.

Recommendation #5

That the Province update its technical guides pertaining to floods and natural hazards. This should include undertaking a review of the flood event standards (e.g. 1%, Timmins storm, Hurricane Hazel), with a view to providing for current science and climate change, such as a specified minimum freeboard. This should also include reviewing the floodplain areas (floodway, floodway fringe, shoreline setbacks) as well as reviewing and updating, where appropriate, Great Lakes flood level values and shoreline erosion hazard methodologies and allowances.

6.1.3.5 Costs Associated with Updating Floodplain Mapping

In 2013, Conservation Ontario estimated that a one-time investment of $24.8 million was required to update floodplain mapping and modelling in Ontario for areas where CAs have been established. A study on floodplain mapping commissioned by Public Safety Canada estimated that the costs of mapping currently unmapped floodplains in Ontario could be as high as $119.6 million (2014). More recently, in 2017, Conservation Ontario estimated the cost of an update being approximately $136 million; however, it is not clear if this cost only includes areas of the province where conservation authorities have been created.

The National Disaster Mitigation Program (NDMP) was an effective federal program that provided 50% funding to complete updated floodplain mapping. That program ends in March 2020. Either a new federal or provincial, or combination of a federal/provincial program could provide the necessary funding.

The federal government continues to advocate and encourage adaptation and preparedness for climate variability. One of the most practical adaptations is emergency preparedness and response plans, which help make communities more resilient to climate change. Floodplain mapping and the associated models supporting floodplain mapping are fundamental to the creation of effective emergency preparedness plans for floods. A case could be made to the federal government to fund the creation of modern digital floodplain mapping as adaptation and preparedness for climate change and severe weather events.

It has been suggested that the Province discuss the opportunity to take a strategic, multi-year, multi-agency planning approach to an extended program, in order to address known gaps in floodplain mapping. As currently established, the National Disaster Mitigation Program (NDMP) is based on interested parties applying for funding. It has also been suggested that the Province advocate to the federal government for continued funding of the NDMP or development of a successor program, recommending the end date of the program be extended for 10 years, from March 2020 to March 2030. As such, the federal government investment in floodplain mapping would help achieve its goal of encouraging adaptation in preparation for climate change and extreme weather events.

Recommendation #6

That the Province establish a working group with provincial departments, conservation authorities and municipalities to prepare a multi-year approach to floodplain mapping.

Recommendation #7

That the federal government be encouraged to extend the National Disaster Mitigation Program or develop a successor program, so that municipalities, conservation authorities, and Ontario and Quebec (in consideration of the Ottawa River) can undertake or update floodplain mapping in all critical areas.

6.1.3.6 Proposed Elevation Mapping Program

Regardless of whether the federal government extends the NDMP, there is a need to establish an Elevation Mapping Program within the MNRF's Mapping and Geomatics Services Section. This program will ensure more complete coverage of the province; centrally manage a cross-agency funding model; leverage existing multi-ministry governance and budgeting capacity of the Land Information Ontario (LIO) program; reduce total costs and bureaucracy for all provincial agencies; consider cross-discipline business requirements; allow for consistent standards to be collected; align with other provincial, state and national elevation programs (Manitoba, Quebec and New Brunswick, Canada and the United States); centrally manage elevation data procurement, quality control, data management and data distribution; and leverage staff knowledge and skills to address future changes in acquisition requirements and technology (e.g. bathymetric LiDAR).

Establishing an Elevation Mapping Program will align with current government priorities:

- Ontario's Open Data Directive by maximizing access to government data;
- Ontario's Data Integration Initiative by supporting standards for data management, and releasing non-sensitive government data to promote transparency, spur innovation and economic growth; and
- Ontario's Digital and Data Task Force driving innovation using emerging data technologies.

This program would require net-new annual funding for data acquisition and for data storage and distribution.

Recommendation #8

That the Province consider the establishment of a provincial Elevation Mapping Program and commit to the annual funding requirements.

6.1.3.7 Provincial Custodian for Floodplain Mapping Information

LiDAR data is a modern approach and an important component of producing floodplain maps. It is expensive but can be affordable if two or more agencies team up to acquire the data. The Mapping and Geomatics Services Section (MGSS) of the Mapping and Information Resources Branch of the MNRF has a multi-year program for planned topographic LiDAR data acquisitions within southern Ontario. The program is intended to assist with identification of priority areas for future data collection, and to reduce duplication of effort by identifying where data may have already been collected or is planned to be collected by other government agencies.

Engagement with municipal, conservation authorities, and provincial and federal agencies has identified that flood mapping information (geospatial data, reports, and flood maps) created through the historic Federal Damage Reduction Program (FDRP) and National Disaster Mitigation Program (NDMP) projects are not seamlessly and centrally managed or accessible. On the latter point, some mapping has been acquired on the vendor's condition of restricted access only by the client.

The lack of a consolidated data management solution for flood mapping data is resulting in: 1) inability for provincial programs to incorporate data into their operations, including emergency management and response; 2) increased risk of data loss; 3) inconsistent data standards; and 4) inability to reference the data for LiDAR acquisition planning. Accordingly, there is a need to identify a provincial custodian for flood mapping information in order to clarify data ownership; determine requirements for data management, storage and access; and leverage Land Information Ontario's existing geospatial infrastructure to support data maintenance, access and dissemination at minimized costs.

If a single provincial custodian is to be established, consideration would need to be made for ownership (intellectual property) of the flood mapping information, as it is mainly held by municipalities. Policy, regulations and legislation would likely need to be updated to identify a requirement for all provincial agencies to provide flood mapping information up to the provincial custodian. Some municipalities and CAs are moving to new Open Data standards and publishing regulatory flood lines on their websites. Policy, regulations and legislation would also likely need to be updated to require that floodplain maps produced at the local level are provided to and integrated into a common provincial floodplain map repository.

Recommendation #9

That the Province consider establishing a provincial custodian for floodplain mapping information and make the necessary updates to policies, regulations and legislation.

6.1.4 Roles and Responsibilities

Several different agencies share roles and responsibilities for the management of flooding and other natural hazards. The reality is that some prevention, mitigation, preparedness and response roles have to be shared between municipalities and multiple ministries by nature of the services they provide.

However, it was pointed out at some of the municipal engagement sessions, that when roles and responsibilities are shared amongst several different agencies, it diffuses control, expertise, and ultimate decision-making and accountability among the agencies.

6.1.4.1 Unclear Roles in Emergency Management

Chapter 3 of the 2017 Auditor General's Annual report raised concerns regarding the current governance structure for emergency management noting that:

> "The current governance structure for emergency management in Ontario is not effective for overseeing a province-wide program. Oversight of emergency management in Ontario is the responsibility of the Cabinet Committee on Emergency Management. However, this committee has not met for several years. Concerns about the overall oversight of emergency management in the province were brought to the government's attention as far back as 2005 in an internal review report, Emergency Management Processes in the Ontario Public Service. The report concluded: At the enterprise level, processes are not currently sufficient to ensure that Ontarians and the resources of the Province are adequately protected against emergencies and disasters." (2017 Annual Report Volume 1, Office of the Auditor General of Ontario, http://www.auditor.on.ca/en/content/annualreports/arreports/en17/v1_304en17.pdf).

While the report focused on the broader umbrella of emergency management, similar concerns could apply specifically to the management of flooding and other natural hazards.

The Office of the Fire Marshall and Emergency Management (OFMEM) within the Ministry of the Solicitor General is taking action to address the Auditor General's

recommendations and other reviews. Following is a summary of some of the initiatives planned or currently underway:

- AG recommendation to strengthen Emergency Management and Oversight – Emergency Management Ontario (EMO) will establish inter-ministerial and a multi-level governance framework (e.g. Cabinet Committee on Emergency Management) to support decision-making, collaboration and information sharing.
- AG recommendation to update all risk assessments and response plans – EMO to review existing provincial risk assessments and the provincial emergency response plan; and re-establish province-wide Continuity of Operations Program and directly support development of municipal continuity programs.

Recommendation #10

That the Ministry of the Solicitor General implement the Auditor General's recommendations regarding a governance framework for emergency management and updating continuity of operations programs as soon as possible

6.1.4.2 Unclear Roles and Responsibilities for Identifying Hazardous Areas

While the MNRF generally takes the position that municipalities are exclusively responsible for identifying hazardous areas, provincial policy is unclear and at times contradictory, and has created some confusion over who is responsible for identifying hazardous areas.

The Emergency Management and Civil Protection Act, 2009 (EMCPA) requires both provincial ministries and municipalities to identify and assess the various hazards and risks to public safety that could give rise to emergencies.

> Section 2.1(3) regarding municipalities states: "In developing its emergency management program, every municipality shall identify and assess the various hazards and risks to public safety that could give rise to emergencies and identify the facilities and other elements of the infrastructure that are at risk of being affected by emergencies." 2002, c.14, s.4.
>
> Section 5.1(2) regarding provincial ministries states: "In developing an emergency management program, every minister of the Crown and every designated agency, board, commission and other branch of government shall identify and assess the various hazards and risks to public safety that could give rise to emergencies and identify the facilities and other elements of the

infrastructure for which the minister or agency, board, commission or branch is responsible that are at risk of being affected by emergencies."

Provincial guidelines direct municipalities to identify floodplains and other hazardous lands to incorporate these areas into their Official Plans, plan amendments, zoning bylaws and associated approvals. Municipal planning authorities, under Section 3 of the PPS (2014), are to direct development to areas outside of hazardous lands (including the floodplain identified by the limit of the flooding hazard). As per the preface of the MNRF's Technical Guide – River and Stream Systems: Flooding Hazard Limit (2002), the Province has empowered municipalities to assume responsibilities for the management of flood risk areas, and the associated liability and the risk relative to planning for new land uses in and around these areas.

Conservation authorities also invest with provincial and municipal funding in identifying hazardous areas for carrying out their delegated role in reviewing municipal planning documents for consistency with the PPS and to support administering their regulation. While the MNRF is responsible for identifying hazardous areas in areas where no municipalities or CAs have been established, some municipalities advocate that this responsibility should extend to any area where a CA has not been established and that expecting municipalities to identify hazardous areas places an unrealistic burden on small, rural municipalities.

Municipalities can choose to rely on the services of CAs to undertake floodplain mapping but are not required to do so. While some municipalities and conservation authorities partner together to create maps, others do not. In these cases, municipalities contract consulting engineering firms to complete the floodplain mapping work, as do CAs in some instances.

Recommendation #11

That the Province consider whether the *Emergency Management and Civil Protection Act* needs to be amended with a view to clarifying roles and responsibilities of identifying hazardous areas.

Recommendation #12

That the MNRF consider working with Conservation Ontario and the Association of Municipalities of Ontario to determine how the experience and information developed by municipalities and conservation authorities of identifying hazardous areas can be transferred to municipalities without a conservation authority.

6.1.4.3 Conflicting Policy Direction and Technical Advice

Shared roles and responsibilities can lead to conflicts over provincial policy direction when multiple agencies have differing perspectives on a given issue, and where other agencies are creating and disseminating guidance materials that are not consistent with MNRF endorsed policy or technical guidelines.

The MNRF provides policy direction and technical guidelines to municipalities and conservation authorities to support their planning and regulatory roles. Many CAs have their own policies in place that, at times, are used to supersede or are seen to contradict provincial policy and technical guidelines.

Some conservation authorities and municipalities view technical guidance provided by the MNRF as simply guidance to be used by engineers and other professionals to help guide their decisions, and allowing them to apply their own policies or professional judgement to decide.

Additional technical guidelines concerning the management of flooding and other natural hazards, although not necessarily provincially endorsed are also prepared and released by academia, the Standards Council of Canada, and the National Research Council.

There is no specific recommendation to deal with this issue as other recommendations provided in this report, such as enshrining flood hazard policies and technical standards in legislation, if adopted, should take care of the conflicting policy direction and technical advice.

6.1.4.4 Conflicts Between Planning and Permitting Decisions

While municipal planning and conservation authority permitting processes are related, they are distinct processes with distinct requirements.

Differences between planning and permitting requirements were noted by some stakeholders as causing conflicts between regulatory and municipal planning decisions. Some stakeholders commenting during the review questioned the ability of a CA to refuse an approval for projects previously approved under the *Planning Act*. Similar concerns have been raised regarding the pressures placed on municipalities, the Province and CAs in balancing growth and the management of hazards, particularly in municipalities with very specific growth targets.

Recommendation #13

That the Province consider legislative amendments that clarify the permissions under the *Conservation Authority Act* and the land use approvals in accordance with the *Planning Act* as they relate to development in hazardous areas.

6.1.4.5 Perceived Conflicts of Interest

Municipalities are ultimately responsible for making local planning decisions. Some stakeholders have raised concerns that this creates a conflict of interest for municipalities, as there is a perceived financial incentive not to limit development in areas prone to flooding and other natural hazards, despite potential future recovery and relief costs.

Some sectors have raised concerns that members of a conservation authority, who are primarily municipal officials, were pressured to approve projects that are deemed to be "in the interest of" municipalities, and that the lack of clarity and consistency in requirements made it difficult for a CA to say no to proposals that member municipalities want, particularly if they feel as though that decision may risk future funding.

Again, there is no specific recommendation to deal with this issue as other recommendations provided in this report, such as enshrining flood hazard policies and technical standards in legislation, if adopted, should take care of the perceived conflict of interest.

6.1.4.6 Role of the Provincial One Window Planning Service

The provincial One Window Planning Service is the organizational structure and process established to support the move to a policy-led land use planning system. It entails the Ministry of Municipal Affairs and Housing (MMAH), in consultation with partner ministries and, where applicable, conservation authorities under their MNRF delegated role, providing municipalities, planning boards, development applicants and the public with "one-stop" access for provincial land use planning services, with a focus on where MMAH exercises its statutory functions under the *Planning Act*.

Under the provincial One Window Protocol and an associated memorandum of understanding, MMAH consults with conservation authorities regarding natural hazard impacts of policy and development proposals for which it is the decision maker. Where no conservation authority has been established, the MNRF undertakes this review. Municipal planning documents approved by MMAH include all upper-tier and single-tier Official Plans (OPs), and some upper-tier and single-tier Official Plan Amendments

(OPAs). MMAH is also the decision-maker for applications from territory without municipal organization where there is no planning board. Under the provincial One Window Protocol, the Minister of Municipal Affairs and Housing is the only provincial minister who can appeal municipal planning decisions to the Local Planning Appeal Tribunal. In some circumstances, public bodies, including conservation authorities, that provided comments before a municipal decision was made can also appeal municipal planning decisions.

6.1.4.7 The Federal Government

The release of the Federal Flood Mapping Guideline Series has created confusion on the flood modelling and mapping landscape of Ontario and other provinces/territories, related to roles and responsibilities between the provinces and the federal government. The incorrect assumption among some practitioners is that the federal "guidelines" supersede those of the province. However, this series of federal documents does not replace or supersede any provincial legislation, technical standards, policy or assigned roles and responsibilities of provincial and municipal governments and their agencies in natural hazard management and mitigation. The development and implementation of flood management legislation, regulation, standards, policy and flood mitigation measures is primarily a provincial/territorial responsibility.

The federal government may intend these federal guidelines as a basis for further specification as defined by a province. However, Ontario already has its "specifications" and will adopt what is pertinent to the province, through any subsequent updates that the MNRF makes to existing guidance. The overall confusion which seems to be exacerbated by each subsequent federal guideline release has resulted in engineering staff in MNRF's regional offices needing to reaffirm the precedence of the MNRF's natural hazard technical guides when working with proponents and consultants.

6.1.4.8 Provincial Watchdog

In many jurisdictions, there is a "provincial watchdog" role by a minister over a specific subject, area or discipline. The Ontario *Great Lakes Protection Act* legislative framework is a good example of what new legislation could be considered by the Province to improve the existing flood policy framework. As examples, the legislation could:

- Establish a lead minister for all flood related policy, standards, regulations and legislation.

- Establish the Minister of Natural Resources and Forestry, as the lead Minister given that the MNRF is already lead administrative ministry having overall government responsibility for hazard management policies/ programs.
- Direct that the Minister of Natural Resources and Forestry to work with the ministers responsible for the other Acts that touch on flooding (as identified in Section 5.2) on issues raised above and re-listed here:
    - Clarifying roles in emergency management;
    - Clarifying roles and responsibilities for identifying hazardous areas;
    - Clarifying policies;
    - Clarifying technical advice;
    - Eliminating conflicts between planning and permitting decisions;
    - Eliminating conflicts of interest;
    - Reviewing the role of the provincial One Window Planning Service and the appeal mechanism; and
    - Reinforcing that provincial guides, standards, etc., take precedence.
- Provide the lead minister with the authority to amend flood hazard related planning policies.
- Provide the lead minister with the authority to direct public bodies (including other ministries, municipalities, CAs, etc.) to carry out defined actions.

Recommendation #14

That the Province consider new legislation to improve the existing flood policy framework by having a lead minister responsible for all flood-related policy, standards, regulations and legislation.

6.1.4.9 Lack of Awareness of Property Owners

Often when floodplain properties are sold the seller isn't aware of, or doesn't openly disclose, the fact that the property is located in the floodplain nor the risk of flooding that is associated with the property. Disclosure is not required during real estate transactions. However, it was reported that financial institutions are now looking at the risk of providing mortgages to flood risk properties, and some real estate agents are disclosing the risk to protect their own liability. Even if this was being done everywhere,

it is too late in the process and potential home buyers should know up front before making an offer and applying for a mortgage.

Recommendation #15

That the Province consider adopting legislation that will require flood risk properties to be identified in some way that is publicly accessible, at the very least on the property title, to ensure that prospective buyers are aware.

6.2 Mitigation

As Ontario metropolitan areas continue to grow, they face increasing pressures to develop—by growing outward, through the construction of new communities at the urban fringe, and growing upward, by accommodating more residents in existing urban areas. Provincial policies such as those contained within "Growth Plan for the Greater Golden Horseshoe" (2006) as well as within the Provincial Policy Statement, include density targets and other policies designed to limit outward growth and the creation of urban sprawl, and to promote greater densification and infill development within existing built-up areas.

Across larger scales, limiting sprawl helps to mitigate increased flooding caused by development by maintaining natural and pervious surfaces within a watershed that help to reduce and slow stormwater runoff. At the same time, targets for increased densification and infill development places additional pressure on municipalities to utilize currently undeveloped areas in existing settlement areas, including floodplains and other hazardous areas, and increase densities in already developed areas that are located in hazardous areas due to historic settlement patterns, such as designated Special Policy Areas. In some instances, urban areas targeted for further intensification and growth may be partially, or wholly, within flood-prone areas.

6.2.1 Great Lakes/St. Lawrence River Shorelines

As discussed in Sections 4.6 and 4.7, the shorelines of the Great Lakes and the St. Lawrence River have and continue to be significantly impacted by very high lake levels and erosion.

It would be ideal if everyone lived, carried on a business or installed infrastructure (roads, water, sewer, etc.) far away from the edge of the shoreline, as shoreline erosion is a natural event, and occurs under both high and low water situations and in between. However, legacy development and conversions of quaint little cottages into primary residences has resulted in a very large number of properties being at risk. This is

exacerbated by the fact that there are neighborhoods with ground elevations below the shoreline and the current lake level.

Mitigation of shoreline erosion is a very complicated challenge. For areas of intense development, the common mitigation option is shoreline protection, such as dikes, erosion protection and shoreline stabilization. There are many different examples of these structures that exist today and some are more resilient than others. Of course, removing or moving structures further away from the shoreline is another option.

These mitigative measures are extremely expensive and sometimes can't protect to the water levels seen recently. Property owners are responsible for covering the cost of these works on private property, which is the same in many jurisdictions across Canada.

In Ontario (and similarly in other jurisdictions), municipalities may consider using local improvement charges (see Ontario Regulation 586/06 under the Municipal Act, 2001) to: first, assist with the construction and financing of a shoreline protection project for a group of private property owners (that may provide economy of scale for the design and construction of the works); and second, imposing a local improvement charge which may help make the financial commitment of the overall cost of the shoreline protection works on their property easier for the private property owner by spreading it out over 20 years or more.

Further, in the case of low-lying neighborhoods inland that rely on the protection works, the municipality could consider if charges might be included as part of the calculation of a larger benefitting area and therefore the cost of the works might be spread out among all benefitting properties, and not just the properties along the shoreline.

In my review of Ontario statutes, I discovered a piece of older legislation that is not currently used titled: *The Shoreline Property Assistance Act*. Under this legislation, the province may offer a Shoreline Property Assistance Program under which municipalities may issue debentures (subsequently purchased by the Treasurer of Ontario) to fund loans to private property owners to construct works such as retaining walls, dikes, breakwaters, groynes, cribs and other structures for the rehabilitation or protection of shorelines, including repairs and improvements to existing works. The funds may also be used by private property owners for raising, relocation or repairs to buildings. The Shoreline Property Assistance Program was cancelled by the Province in 2010 and not currently available to municipalities.

Municipalities may still consider offering loans to private property owners. One municipality in southwestern Ontario, the Town of Essex, has recently approved a new loan program for shoreline residents.

Recommendation #16

That municipalities consider utilizing local improvement charges to help finance and install (or upgrade) shoreline protection works, and if necessary, that the Province provide municipalities with enhanced authority to do so.

6.2.2 Ottawa River

6.2.2.1 Meteorological and Hydrological Conditions

The meteorological and hydrological conditions during the spring freshet period in the Ottawa River basin can vary widely and the inability to forecast, with any precision, mid-to-long term conditions presents an ongoing challenge. The storage capacity within the basin is finite and the goal of integrated management of the reservoirs is to effectively apply the use of reservoir storage to reduce downstream flows at the most critical periods of spring flooding. The appropriate use of the available storage is typically applied by reducing reservoir discharges during the periods when flows from the uncontrolled sectors of the basin are high (first peak) and then increasing discharges as this flow in the lower tributaries begins to decrease. The challenge then becomes one of increasing reservoir discharges, to prevent overfilling the storage reservoirs, but at the same time not causing downstream flow to exceed the initial peak.

Due to the topography of the Ottawa River basin, the use of reservoir storage in the upper part of the river has an exaggerated effect on reducing the first peak in the upper sections of the river (Mattawa-Pembroke) because of their proximity to the reservoirs. In years where the spring runoff in Abitibi-Timiskaming greatly exceeds the storage capacity of the principal reservoirs, a second peak along the lower river reach can occur. The area of the highest constriction on the river is below Pembroke in the Westmeath/Lac Coulonge area, and the effective use of reservoir storage in the Abitibi-Timiskaming area can be seen by two peaks that are close in size but both significantly lowered due to the use of reservoir storage. The basin topography and use of reservoir storage then often results in a second peak that is lower in the southern sections of the basin but higher in the more northerly sectors even though under natural conditions, without reservoir storage, the first peak would have been higher throughout. These are broad operational strategies that are impacted by the specific meteorological and hydrological conditions that vary significantly from year to year.

The uncontrolled/unregulated portion of the drainage basin contributed significantly to the flooding in both the 2017 and 2019 floods. For instance, in 2019, the Water Survey of Canada streamflow gauge on the Petawawa River, in operation since 1915, experienced its highest flow on record in April 2019, with a peak flow 46% higher than

its previous historic peak value recorded in April 1995. An analysis of flood magnitudes in the absence of existing water management structures and reservoirs (which regulate the other 40% of the drainage basin) was undertaken by the Ottawa River Regulation Planning Board following the 2017 flood. For example, results showed that under the 2017 flood at Lac Deschenes, water levels would have been approximately one metre higher had there been no dams or reservoirs within the Ottawa River drainage basin.

6.2.2.2 Existing Development in the Floodplain and Floodway

Many areas affected by flooding in 2019 (and 2017) were legacy development or development that predates Ontario's floodplain planning policies. Some of the more significantly affected areas in the vicinity of Westmeath, Rhoddy's Bay, Braeside and Constance Bay, among other areas, are generally situated within the floodplain of the Ottawa River under the 1% flood (pursuant to mapping prepared under the Canada-Ontario Flood Damage Reduction Program during the 1980s and early 1990s) and updated mapping completed by the municipalities and or a conservation authority (where available). Many of these areas are also mapped to be in the floodway, where flood depths exceed one metre and/or flow velocities above one metre per second can create significant hazards for developments.

Many of the dwellings that dot the landscape along the Ottawa River in the above noted villages and hamlets were once modest camps that were transitioned into seasonal cottages, and now many exist as permanent year-round residences. Significant investments have been made to these residences throughout the years; however, for the most part they are not flood proofed to the flood standard (1% flood).

While clearly unfortunate, it was not a surprise to see in person that many of the areas affected by flooding were very close to the river and there was a relatively small difference in elevation between the foundations (main floors) of many residences and the elevation of the river under normal water conditions in early September 2019. A tour of some areas provided evidence that some property owners were already in the process of raising their residences to a higher level and possibly some included moving their structures further from the river's edge.

Recommendations in other sections of this report can also apply to this section on the Ottawa River.

6.2.3 Riverine, Lake

6.2.3.1 Maintaining Wetlands and Pervious Surfaces

Estimates suggest that 68% of the wetlands originally present in southern Ontario were lost by the early 1980s (State of Ontario's Biodiversity Report, 2010). An additional 4% has been lost since this time (State of Ontario's Biodiversity Report, 2015). However, a recent assessment has shown that the rate of loss appears to be decreasing (State of Ontario's Biodiversity Report, 2015). While land conversion is the primary cause of wetland loss in southern Ontario, pollution, invasive species, alteration to natural water levels, and climate change also pose serious threats.

Ontario's Great Lakes coastal wetlands have experienced similar historical losses and degradation over the past 200 years. It is estimated that by 1984, 35% of wetlands along the Canadian shores of Lakes Erie, Ontario and St. Clair had been lost, with the greatest losses occurring between Toronto and the Niagara River. Loss and degradation continue today, largely resulting from shoreline alteration, water level control, nutrient and sediment loading, invasive species, dredging and development. Upstream land use practices also have an impact, particularly through runoff from urban and industrial development, agricultural lands and impervious surfaces. Despite some localized loss and degradation, wetlands in the northern part of Ontario (Hudson Bay Lowlands and Ontario Shield ecozones) remain largely intact.

Wetlands act as natural stormwater management ponds, slowing the speed of flood waters and storing large quantities of surface water. Maintaining, restoring or constructing wetlands can be a cost-effective way of reducing flood risks and associated costs. A study commissioned in part by the MNRF in 2017 found that maintaining wetlands can reduce flood damages and costs by 29% in rural areas and by 38% in urban areas. The Insurance Bureau of Canada (IBC) has also recently issued a report documenting the ability of wetlands to reduce flood damages, and promoting wetlands and other natural infrastructure as "a viable alternative to grey infrastructure option[s] for flood mitigation" and "a cost-effective way to mitigate material financial losses that would otherwise result from flooding." (Combatting Canada's Rising Flood Costs, September, 2018: http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf).

Recommendation #17

That the Province support municipalities and conservation authorities to ensure the conservation, restoration and creation of natural green infrastructure (i.e. wetlands, forest cover, pervious surfaces) during land use planning to reduce runoff and mitigate the impacts of flooding.

6.2.3.2 North Bay/Mattawa Area

As discussed in Section 4.2, there are two distinct watersheds in the MNRF North Bay District—the Sturgeon-Nipissing-French and the Upper Ottawa River. In the engagement session, it was quite apparent from representatives from both areas, that each area had their own distinct experience through the spring freshet.

In general, there was much more collaboration between all interested parties in the Sturgeon-Nipissing-French area, and although difficult decisions needed to be made regarding what area would see more water and when, at the end of the day everyone had the opportunity for input, everyone was well informed of the situations in the entire watershed, and everyone signed off on the final decisions. This resulted in a successful outcome in the sense that they did the best they possibly could in a bad situation.

Recommendation #18

That the MNRF North Bay District facilitate a meeting between the Sturgeon-Nipissing-French watershed group and the Upper Ottawa River Watershed group to help the latter group establish a collaborative arrangement for future flood events. It is important that all parties involved in the flood be present at the meeting.

Also as discussed in Section 4.2, the City of North Bay undertook a contingency plan to protect the wastewater treatment plant. However, if Lake Nipissing had reached a critical elevation, the wastewater treatment capabilities would have been severely limited, and there was no ability to bypass the plant and temporarily discharge (during the extreme flood event scenario) directly to the lake, which meant that a huge area of the City of North Bay would experience sewer backup and a few thousand residents would have needed to be evacuated.

Recommendation #19

That the City of North Bay in particular, and any other municipalities in a similar situation, install appropriate treatment plant bypass piping to improve resiliency of key infrastructure and limit the impacts of flooding on this infrastructure and associated impacts to public health and safety.

Based on their experience with the 2019 flood, but also events in previous years, the North Bay/Mattawa session participants suggested that the Lake Nipissing operational guidelines be reviewed.

Recommendation #20

That the Province, the federal government (Public Service and Procurement Canada) and the North Bay-Mattawa Conservation Authority review the Lake Nipissing Operational Guidelines.

6.2.3.3 The Muskoka/Magnetawan Rivers/Lakes

The Muskoka and Magnetawan Rivers are both complex systems with many factors impacting water levels, including physical geography, rainfall, snowpack and temperatures. They are both cascading systems and both originate on the western slopes of Algonquin Provincial Park. Dam operations are guided by the Muskoka Water Management Plan and Dam Operations Manual, and the Magnetawan Dam Operations Manual. There are no conservation authorities in either watershed, meaning the MNRF Parry Sound District Office and other dam owners are responsible for water management operations.

The public and residents have high expectations that the dam operations will maintain relatively static water levels and prevent floods. However, the dams are not flood control structures and have very limited capacity to store or hold back flood waters, as they have little to no lake or reservoir capacity. As a result, in a large volume, rapid runoff flood, the dams have limited capacity to reduce peak water levels. The greater the flood event, the less ability the MNRF/dam operators have to mitigate the impacts.

The dams were originally constructed to facilitate the transport of logs to sawmills and aid in commercial navigation. Over time, the operational emphasis has evolved from commerce and transportation to the provision of a balance of social/recreational, environmental and economic interests. To meet these interests, and to the extent possible, the MNRF operates the dams to maintain water levels within ranges identified in the established dam operating plan. These plans were formalized in the Water

Management Plans, and are based on normal conditions. The general public and stakeholders have been critical of how the dams are operated, not only with high water conditions but low water conditions as well.

Recommendation #21

That the MNRF establish a communication protocol to inform and involve key stakeholders (i.e. municipalities) on watershed conditions and operations throughout the fall and winter leading into and throughout the spring freshet, commencing in early 2020.

While there is growing development along the shorelines within the Magnetawan River watershed, there is significant development along the shorelines within the Muskoka River watershed. Accordingly, there is keen interest from local stakeholders and municipalities in the Muskoka River Water Management Plan.

In August 2018, the Province announced a $5 million Muskoka Watershed Conservation and Management Initiative to better identify risks and issues facing the Muskoka Region. The government also committed to matching tax-deductible donations up to an additional $5 million. By protecting this particular watershed and working with the local community, this initiative will help the Province develop a comprehensive approach to watershed management, which can inform current actions and future development.

On August 7, 2019, the Minister of Environment, Conservation and Parks announced the appointment of nine members to the Muskoka Watershed Advisory Group. The Advisory Group is tasked with providing advice and recommendations to the Minister on measures to protect the health of the watershed and support the economic growth in the region. An effective watershed management approach is important to the residents of the Muskoka, especially as the watershed faces pressures and stresses from increased development, increasing contaminants and nutrient loads, and intense and frequent flooding caused by extreme weather events.

Recommendation #22

That the Ministry of Environment, Conservation and Parks (MECP) use the results of the Muskoka Watershed Conservation and Management Initiative to inform any potential future amendments to the Muskoka River Water Management Plan by working with the Ministry of Natural Resources and Forestry, and in the meantime, that the MECP consider whether to encourage the municipalities to establish a conservation authority or request the Ministry of Municipal Affairs and Housing to restrict development in the floodplains (e.g. Ministerial Order).

6.2.3.4 County of Haliburton/Trent Severn Waterway

Haliburton County is a large geographic area with multiple municipalities and infrastructure jurisdictions, including the Trent Severn Waterway (Parks Canada), the Province of Ontario (Ministry of Transportation, MNRF), the Crowe Valley Conservation Authority, the County of Haliburton, and the four local municipalities of Algonquin Highlands (Dysart et al, Highlands East and Minden Hills). This situation is somewhat unique with the number of watersheds and federal dams.

Six watersheds are represented in Haliburton County, but the majority of the County is located outside the jurisdiction of a conservation authority. The municipality of Highlands East is located within the jurisdiction of the Crowe Valley Conservation Authority.

Water originating in Haliburton County supplies water to the Trent Severn Canal but also for 47 downstream drinking water systems for communities such as Bobcaygeon Fenelon Falls, Lindsay, Peterborough and Trenton. There are 28 Trent-Severn Waterway (TSW) controlled dams above the village of Minden and the agency leads its own processes associated with dam operations and water level management. During high water conditions and flooding, TSW convenes conference calls to advise the MNRF and conservation authorities of current and predicted short-term dam operations strategies. Within the area, the MNRF operates four dams with specific operation plans, but these are operated in conjunction and collaboration with TSW operations.

As a result of the Haliburton County experiences with flooding over the last few years, there are now regular “spring freshet” conference calls held by staff of the MNRF and Trent-Severn Waterway, along with elected officials and administrative officials from emergency services, public works, etc. This collaboration has been reported as a success for helping disseminate information to the front-line people working to combat the flooding impacts, including municipal staff, conservation authority staff and the public.

A collaborative agency called the Upper Trent Water Management Partnership (UTWMP) was formed among the municipalities of Algonquin Highlands, Dysart et al, Minden Hills, Highlands East, North Kawartha, Trent Lakes, and the Coalition for Equitable Water Flow. The mission of UTWMP is to speak as a single voice for all stakeholders on water management issues affecting the reservoir and flow-through lakes, and to provide local water management leadership.

The County has partnered with Trent Severn Waterway, Kawartha Region Conservation Authority, Ganaraska Region Conservation Authority, and the Upper Trent Water Management Partnership to form a steering committee to oversee the completion of LiDAR, hydrology and mapping.

The County was successful in receiving National Disaster Mitigation Program (NDMP) funding for airborne LiDAR survey data for the Burnt and Gull River Watersheds; however, additional funding to complete data analysis, hydrologic and hydraulic models and floodplain maps was denied as this work wouldn't be complete before the program end date of March 2020. It is the intent of the County to apply for funding to complete this work if the program is extended.

Recommendation #23

That Haliburton County document how their collaborative model worked for the 2019 flood and share this information with, and for the benefit of, other counties, municipalities and conservation authorities.

6.2.3.5 Southwestern Ontario

As mentioned in Section 6.2.1 above, the shorelines of the Great Lakes and the St. Lawrence River have and continue to be significantly impacted by very high lake levels and erosion. The focus in that section is mainly on mitigation methods using typical infrastructure solutions and associated funding mechanisms. However, municipalities are looking for bigger picture solutions as they acknowledge that these are not affordable.

The municipalities and conservation authorities in southwestern Ontario held a Roundtable Information meeting on September 19, 2019, in London, Ontario. The meeting was attended (in person or by phone) by municipalities (Chatham-Kent, Leamington, Windsor, Essex, Kingsville. Tecumseh, Pelee Island, Amherstburg, LaSalle, Elgin), conservation authorities (Lower Thames, Essex Region, St. Clair Region, and Kettle Creek), provincial departments, federal departments, the Great

Lakes St. Lawrence Collaborative and Zuzek, Inc. (consultant). A summary from the meeting resulted in the following statements:

> High water levels and floods of 2019 must be viewed as a warning/wake up call. Change is needed – maintaining the status quo in policy and practice cannot continue. Municipalities cannot afford the infrastructure problems our current development approach creates, let alone future costs associated with climate change. There is an opportunity for the Provincial Government to work with Conservation Authorities and the Federal Government to lead a revolution on shoreline management. The shorelines, the ecosystems they support, the biodiversity, and ecosystem goods and services are simply too valuable to treat them like undeveloped subdivisions.

The Roundtable also resulted in a number of recommendations, some of which have been captured in other areas of this report, but I am highlighting one here:

Recommendation #24

That the provincial, federal and municipal governments work with the Essex Region Conservation Authority and the Lower Thames Valley Conservation Authority to undertake a coordinated short- and long-term strategy to address the existing and expected impacts to Chatham-Kent, Windsor-Essex and Pelee Island as a result of current and future water levels, flood and erosion hazards, and climate change on Lake Erie, Lake St. Clair and the Detroit River.

6.2.3.6 Flood Protection Land Forms

Some municipalities are considering the use of “flood protection landforms” to open hazardous areas up to new or intensified development. This is the approach currently being taken by the City of Toronto to open lands east of the Don River to development—a $1.25 billion development project supported by all three levels of government. The approach taken was permitted as a “one-off” and represents a considerable deviation from the MNRF’s natural hazard technical guides and the Provincial Policy Statement, as documented in a protocol signed by the City of Toronto, the Ministry of Municipal Affairs and Housing and the MNRF.

Existing ministry policies do not support using flood protection landforms to open new areas for development. Specifically, the MNRF’s Technical Guide – River and Stream Systems: Flooding Hazard Limit (2002) does not support the use of flood protection landforms (e.g. berms, dikes, flood walls, and other such structural methods) as permanent flood control structures or to facilitate development in hazardous areas.

Flood protection landforms can result in increases in upstream flood levels, increases in downstream flows and increases in downstream velocities. The construction of flood protection landforms can create new or aggravate existing hazards and would therefore not be consistent with Section 3.0 of the Provincial Policy Statement. Flood protection landforms and other structural measures can be overtopped making flooding worse, and they often inspire a false sense of security thereby encouraging further development in hazardous areas. Structural measures are associated with high costs, during construction and in perpetuity afterwards. Inspection, certification, maintenance, operation and repair are ongoing, often unaffordable for local communities. New construction adds to the existing municipal infrastructure deficit.

Increasing development pressures and high-profile projects, such as the Lower Don Development project, is forcing the Ministry to defend its current approach to hazard management and how best to balance the use of prevention versus protection to manage flooding and other natural hazards.

While prevention-based approaches have been repeatedly shown to be more effective in reducing the impacts of flooding and other natural hazards, flood protection landforms do have a role to play in certain situations, and the approach taken to develop the lower Don area is an excellent example. The value of the proposed real estate development has justified the great expense of ensuring that all the issues and concerns of a permanent landform and the intense development behind it in the floodplain were appropriately dealt with, including being adaptive to climate change by building higher than the design flood. While flooding will always be potentially a risk, the risk has been reduced.

There is a strong possibility that the protocol for the lower Don area and the City of Toronto's flood protection infrastructure projects will set a precedent for other areas in the province. To ensure that developers, municipalities and conservation authorities adhere to strict requirements and conditions to permit such a development in the hazard lands, this new category, the requirements and conditions should all be enshrined in legislation (regulation).

Recommendation #25

That the MNRF review and update the appropriate technical guides, with consideration of a new category permitting development in hazardous lands along large inland lakes, rivers and streams, and along the Great Lakes/St. Lawrence River, utilizing flood protection land forms and/or other forms of flood protection and floodproofing methods with very strict requirements and conditions. Further, consideration should be given to enshrining this concept in legislation or in a regulation along with other structural methods that are now permitted in non-hazard lands or Special Policy Areas.

6.2.4 Urban/Flash Flooding (Pluvial Flooding)

There are many examples of pluvial flooding in urban areas that have resulted in major disruptions of service and significant impacts on property, businesses, homes and people.

This type of flooding occurs during heavy rainfall events independent of an overflowing river or stream. The ground cannot absorb the water as quickly as it falls, especially in urban areas with a lot of hard surfaces like pavement. Drainage systems (such as human-made and natural channels, roadways, storm and combined sewers) can quickly become overwhelmed, causing water to pond in parking lots, flow into streets and nearby homes and structures, or back up into basements.

Floodplain mapping is not really practical, as overland and sewer flooding can occur anywhere in the urban area. This is partly because of the spatial variability of the “eye” of the rainstorm, but also due to the local topography, unique development (legacy and new), and the type of drainage systems in each neighborhood.

Challenges with pluvial flooding include increased imperviousness over time; inadequate surface drainage plan; private property being lower than the streets (either the grade at the house or reverse slope driveways); reliance on storms sewers that are designed for smaller rainstorm events; sedimentation of channels and sewers; blocked culverts or curb inlets; inflow and infiltration; sewer and channel design capacity limitations in older neighborhoods; deteriorated sewers; reduced sewer or wastewater treatment plant capacity due to high water levels in the receiving stream (and lack of proper gates); and failures of pumping stations or wastewater treatment plants.

There is a substantial difference between managing floods in newer greenfield development and historically developed areas, and some of the latter areas are subject to intensification or infill development pressures. In the greenfield areas, non-structural

and structural mitigation methods, including green infrastructure, can be incorporated as part of the development. In older areas, municipalities are faced with significant costs to rehabilitate, enhance or build new flood protection infrastructure for drainage systems. There are also challenges for municipalities when a newer greenfield development must utilize an existing drainage system downstream through an existing development.

Stormwater management in Canada has been evolving over the years, and system components are not only dealing with the quantity of stormwater but the quality as well (pollution reduction and erosion protection). Installation of regional stormwater management (retention or detention) ponds or linear naturalized channels has achieved both objectives, although quality improvement to a lesser degree.

6.2.4.1 Use of Regional Flood Control Facilities

Development practices are also changing and exposing potential regulatory gaps.

Stormwater management facilities are regulated in Ontario by the Ministry of Environment, Conservation and Parks (MECP). Under the *Environmental Protection Act,* an approval is issued for the purpose of stormwater management works to provide for an enhanced level of water quality control, erosion protection, and attenuation of post-development storm flows up to and including the 100-year storm event. Regional Flood Control Facilities (RFCFs) are increasingly being constructed in some areas to help mitigate flooding in urban areas. RFCFs are stormwater management ponds that are designed to control flooding associated with much larger regional storm events (e.g. Hurricane Hazel for GTA communities) exceeding the 1% storm and well above and beyond the capacity of traditional stormwater management (SWM) ponds.

While traditional SWM ponds are considered to pose a relatively low risk to downstream landowners, the risks associated with the increased use of RFCFs are largely unknown, and they are not regulated by the MNRF. RFCFs retain significant volumes of stormwater runoff and could cause significant flood damages if they were to fail, raising concerns that the use of these facilities creates new, or aggravates existing, flood hazards, particularly when built immediately upstream of residential areas.

Due to their design, RFCFs function more like dams than traditional SWM ponds (i.e. they provide flood control function). Unlike dams, there are no provincially approved structural design standards for RFCFs.

The construction of these structures can be viewed as creating new hazards and thereby conflicting with provincial policy direction which states that “planning for stormwater management shall not increase the risks to human health and safety and property damage.” In addition, the MNRF’s Technical Guide specifies that stormwater

management facilities are not to be used to provide any reduction in flood flows, and accounting for their storage in flood hazard mapping artificially reduces the extent of regulatory flood lines and is non-compliant with the MNRFs Technical Guide.

While many of these RFCFs are being constructed to support greenfield development, they are also being used in existing developments, often in highly urbanized landscapes. In some instances, RFCFs are being constructed for the purpose reducing flood flows and freeing up flood hazard lands for intensified development by artificially reducing the size of floodplains (i.e. redrawing flood lines) downstream of RFCFs, through amendments to existing flood hazard maps (i.e. floodplain maps) used to guide land use planning decisions. The MNRF views this as putting people and property in harm's way and contrary to the MNRF's Technical Guide and the Provincial Policy Statement (PPS).

While the construction of these structures has been limited, they are becoming more common (more than 50 of these structures within 46 Ontario communities) as determined by a study commissioned by the MNRF. Apparently, many of them are being built larger than their original design specifications with the aim of holding back even larger volumes of water. A prevalent perception observed when collecting data for the study was that RFCFs protect downstream landowners and these larger ponds contribute to safety rather than increased risk. The study documented that one-third of the RFCFs examined represented an increased risk to downstream communities in the event of a failure. Furthermore, the risks and consequences of failure of these facilities is not typically a design consideration. Important factors determining risk of RFCFs included the size of the pond and the embankment height, with the most influential factor in determining the risks of these facilities being the pond configuration and landscape setting (e.g. elevation of pond relative to downstream receptors) specifically in relation to populated areas.

Recommendation #26

That, due to the increased use of the regional flood control facilities, the MNRF review whether the Province should take steps to regulate the use of these structures or let municipalities decide their use.

The above issue raises the point that there is a lack of clarity around the MNRF's role in urban flooding. To date, the MNRF's focus has been on flooding from waterbodies (rivers, streams and lakes), suggesting that "urban flooding"—owing to its linkage with stormwater management and development infrastructure—should be borne by ministries with mandates related to those components (i.e. MECP, MOI, MMAH, etc.).

Recommendation #27

That the Province create a working group of all pertinent ministries to define their respective roles as they pertain to pluvial flooding.

6.2.4.2 Municipal By-laws – Pre-development Rates of Runoff

One of the methods to reduce the impact of intense rainstorm events on drainage systems is to limit new development to “pre-development” rates of stormwater runoff. All the new hard surface means that rain or snowmelt water will runoff at a much greater rate than previous agricultural use or natural habitat. By limiting the runoff to the pre-development rate, the drainage system downstream will see no more water after development than before development.

For a new subdivision, restricting to pre-development rates may be achieved with a combination of conventional stormwater management techniques (i.e. dry or wet pond) and other low impact development practices. For multi-residential or commercial situations, such as a high-rise tower or shopping mall, detention of the stormwater can be achieved by on-site storage (roof-top, underground tank, open retention basin or parking lot storage) and/or by using permeable surfaces.

6.2.4.3 Municipal By-laws – Flood Protection Measures for Private Property

Flood protection of private property is not just a municipal responsibility but also a property owner responsibility. We put locks on our doors because we can’t expect that the police service will protect our houses from intruders. Neither can we expect that the drainage system will protect us from all storm events. Accordingly, residents and other property owners have a responsibility to protect from pluvial flooding by the installation of backwater valves, sump pits and pumps, sealing doors and windows, disconnecting downspouts from the sanitary sewer, and building up the earth around the foundation and window wells, etc.

Recommendation #28

That the Province consider whether it should take steps to regulate drainage standards in urban areas, such as the requirement to restrict runoff flows to pre-development rates and flood protection measures for private property, and if so, what is the most appropriate legislation.

6.2.4.4 Intact Centre on Climate Adaptation

The Intact Centre on Climate Adaptation (Intact Centre) is an applied research centre with a national focus located within the Faculty of Environment at the University of Waterloo. The Intact Centre was founded with a gift from the Intact Financial Corporation. The Intact Centre works with homeowners, communities, governments and businesses to identify the impacts of extreme weather and climate change, and to develop the practical tools needed to help communities adapt to these changes and minimize impacts.

A particular focus of the Intact Centre over the last three years has been the development and testing of a variety of tools that have advanced flood risk reduction in Canada. From 2016 to 2018, the Intact Centre's Home Flood Protection Program developed a home flood risk assessment tool and assessor training program, and delivered over 500 flood risk assessments to residents in Ontario and Saskatchewan. Learnings from the program delivery contributed to the publication of a national guideline for basement flooding protection (CSA Z800-18) in 2018. Additionally, in April 2019, a report titled: "Water on the Rise: Protecting Canadian Homes from the Growing Threat of Flooding" was released by the Intact Centre summarizing the top flood risks associated with residential homes and the best practices for motivating action in order to reduce risk.

The Intact Centre is committed to working with municipal and provincial governments to educate residents. The Intact Centre has also published several other reports on flooding, all of which can be found on their website (https://www.intactcentreclimateadaptation.ca).

Recommendation #29

That the Ministry of Environment, Conservation and Parks reach out to the Intact Centre for Climate Adaptation, as part of their commitment to consult with the insurance and real estate industry under the 2018 Environment Plan, to work collaboratively to raise awareness among homeowners about the increasing risk of flooding and to disseminate the basement flooding protection information to homeowners.

6.2.5 Funding for Permanent Works

Following significant events, there is always a demand for funding for more permanent works (infrastructure such as a dam, bridge, shoreline protection work, erosion control infrastructure, etc. that will be designed, used and remain in place over the long term)

by local officials and the general public. Given the financial pressures that governments are facing currently, a potential immediate source would be existing programs, such as the Ontario Community Infrastructure Fund (OCIF) program, the Federal Investing in Canada Infrastructure Program (ICIP), the Ontario Water Erosion Control Infrastructure (WECI) program, and the Ontario Financing Authority green bond program.

Recommendation #30

That the Ministry of Infrastructure ensure that the Ontario Community Infrastructure Fund supports municipalities in enhancing and implementing asset management plans (which includes stormwater management and consideration of climate change adaptation and mitigation activities), which will help municipalities make the best possible investment decisions for their infrastructure assets.

Recommendation #31

That the Ministry of Infrastructure work specifically with the MNRF on the design of future intakes of the Green stream of the Investing in Canada Infrastructure Program to ensure flood-related projects are eligible.

The Province's Water Erosion Control Infrastructure (WECI) program is an effective provincial-municipal cost-share program for maintenance of water control infrastructure that reduces flooding, mitigates flood damages and disruption to the economy. Currently, the program is funded through the MNRF capital program budget on a fiscal year basis, and it is suggested that a multi-year budget be established for some larger maintenance projects that may span many years to provide flexibility for future potential fluctuations in funding requests.

Recommendation #32

That the Province continue to fund the Water Erosion Control Infrastructure program and consider adopting a multi-year budget.

The Ontario Financing Authority runs a green bond program that includes five categories— Clean Transportation; Energy Efficiency and Conservation; Clean Energy and Technology; Forestry, Agriculture and Land Management; and Climate Adaption and Resilience. Under the last category, the following projects will generally be considered eligible—flood protection and stormwater management; extreme weather resistant infrastructure and municipal infrastructure for clean and/or drinking water;

wastewater treatment; sustainable urban drainage systems; and other forms of flooding mitigation. (See more details at www.ofina.on.ca/greenbonds.)

Recommendation #33

That the Province continue to issue Green Bonds in 2020 and beyond to help finance extreme-weather resistant infrastructure.

6.3 Preparedness

6.3.1 Monitoring and Data Management

6.3.1.1 The Hydrometric Agreement

There is always an argument for better hydrometric data; however, the fiscal realities likely mean that there will be no significant increase in funding for the hydrometric network.

Recommendation #34

That the Province continue its financial commitment and partnership arrangement with the federal government through the hydrometric network agreement.

Recommendation #35

That the Province continue to monitor the effectiveness and location of gauges to ensure that there is appropriate coverage and consider repositioning gauges if necessary.

Recommendation #36

That, where appropriate and where funding permits, the Province consider the installation of GOES telemetry at key locations where more frequent access to information is required (areas of higher risk/watersheds that react quickly to changes in precipitation or snowmelt) and where current landline telecommunication technology is less secure and not as reliable in transmitting information.

Recommendation #37

That, where appropriate and where funding permits, the Province consider the use of automated alarms at those stations in watersheds of higher risk/quick response to precipitation and snowmelt to alert when water levels have exceeded a threshold of concern.

6.3.1.2 Climate (Weather) Monitoring

While there is heavy reliance on the hydrometric network, it is recognized that weather "inputs" are critical to understanding and predicting events. Citizen science is an effective tool in gaining additional precipitation information (such as through the Community Collaborative Rain, Hail and Snow Network or CoCoRAHS), typically at a lower cost and at low risk.

Recommendation #38

That the Province explore whether there would be value toward additional manual snow course locations in those watersheds where snow cover and snow water content are factors in spring flooding, and seek to involve the citizens in the collection and reporting of that data.

Recommendation #39

That the Province explore the feasibility of remote sensing products to better estimate the spatial distribution of snow and snow patterns.

6.3.1.3 Data Management

Beyond the MNRF, there are a number of other organizations or agencies that collect or have data that would be beneficial toward enhancing flood forecasting.

Recommendation #40

That the MNRF work with federal, provincial and local partners as well as industry toward an Open Data model where information is shared and consolidated into the existing Surface Water Monitoring Centre (SWMC) hydrometric monitoring database.

6.3.1.4 Satellite Remote Sensing

Although currently operationally working in an emergency management environment, the MNRF's Remote Sensing Science Group is not an emergency management tasked group. The recent launch of the three RADARSAT Constellation Mission satellites highlights a significant opportunity to improve flood and ice monitoring, but will require additional provincial resources to coordinate, process, interpret and disseminate information in near real time. The portfolio of satellite imagery products and services the Remote Sensing Science Group supports to aid the emergency management products and services is growing year upon year.

Currently the Remote Sensing group supports emergency management flood monitoring only during the spring flooding season.

Additional remote sensing satellite monitoring opportunities (e.g. snow extent and snow water equivalent) remain unexplored/unexploited provincially due to resourcing.

Recommendation #41

That the Province investigate the return on investment of utilizing the new satellite imagery and resourcing with the necessary staff additions to provide better flood forecasting and monitoring.

6.3.2 Flood Forecasting and Warning

Flood forecasting and warning plays an important role in achieving the provincial objective of reducing risk to life and reducing property damages. It is particularly important to residents located in a floodplain where permanent mitigation works do not exist. The flood forecasting and warning system is very reliant on the provincial hydrometric network (stream gauges), from which the data is used to make decisions of when to issue flood warnings, operate infrastructure (such as dams), and provide real-time status reports on flooding on different reaches of a river. The stream gauge networks also provide an important history of flooding.

Flood forecasting and warning requires integration with municipal emergency response. However, there is inconsistent resourcing for flood forecasting and warning across the province. Conservation authorities are not present in all areas of the province. In areas without conservation authorities, flood forecasting and warning is the responsibility of the local MNRF district office. Not all conservation authorities and districts are consistently equipped or resourced in order to provide flood forecasting and warning services.

Updated floodplain mapping provides the opportunity to produce new products to aid in flood forecasting and warning, and emergency response. Floodplain maps can provide a fundamental base for designing and developing response plans for a range of floods. Updated hydrology modelling for floodplain mapping can be leveraged to create new up-to-date flood forecasting models. Flood forecasting and warning systems can be designed to reflect the local watershed characteristics and be risk-based. More sophisticated complex warning systems can be implemented where the risk is highest, and less complex systems where there is lower risk and more lead time.

An ideal system would include developing real-time flood forecasting models that merge hourly forecasts with radar and real-time gauge data, the use of machine learning algorithms for data assimilation, and ensemble forecasting for areas where flood vulnerability has been identified. Flood messages should target people within affected geographic areas and consider the use of Common Alerting Protocol – Canadian Profile format. This would increase coordination, interoperability and efficiency between agencies. Over the long term, this could integrate with the Canadian Alert Ready platform and mobile telephone public safety apps.

Recommendation #42

That the Province update the flood forecasting and warning guidelines, providing clarity on roles and responsibilities (conservation authorities, MNRF district offices, municipalities) and provide examples of the systems, from simple to complex, with recognition that each system should be designed to reflect the local watershed characteristics and resources.

6.4 Emergency Response

6.4.1 Emergency Operations

As first discussed above in Section 6.1.4.1, Chapter 3 of the 2017 Auditor General's report raised concerns regarding the current governance structure for emergency management in Ontario.

The Office of the Fire Marshall and Emergency Management (OFMEM) within the Ministry of the Solicitor General, is taking action to address the Auditor General recommendations and other reviews. The following are two additional initiatives planned or currently underway that will improve emergency operations around floods:

1) AG recommendation to enhance Emergency Management program capacity – Emergency Management Ontario (EMO) to enhance readiness for large-scale

emergencies; adopt and meet international/national best practices; mandate use of the Incident Management System; and enter into mutual assistance agreements with neighbouring jurisdictions.

2) AG recommendation to increase support to municipalities and emergency management partners – EMO to enable the Provincial Emergency Operations Centre (PEOC) to more quickly deploy resources to supplement local capacity; implement emergency management software to support provincial-municipal information and resource sharing; enhance capacity to deploy humanitarian aid; and implement emergency management supply chain/logistics program.

Recommendation #43

That the Ministry of the Solicitor General implement emergency operations initiatives in response to the recommendations of the Auditor General as soon as possible.

During my engagement sessions, I did receive a lot of feedback from municipalities about improvements they would like to see implemented by EMO. In short, once they declare an emergency and request assistance from the Province, they want the Province to be more involved in coordinating a response and ensuring that the municipality has access to the resources and expertise it needs. Municipalities also request that the Province condense their requirements for reporting during an event, as it distracts from the actions needed to fight a flood, including reducing the amount of paperwork and daily reporting during a flood to multiple people at EMO.

Recommendation #44

That Emergency Management Ontario improve its processes for interacting with municipalities and clearly lay out the processes on their website.

Another complaint of municipalities was how the Canadian Forces (CF) were deployed. Municipalities do not understand the process as to how the Province engages the CF, and more importantly what activities the CF are approved to implement. In one municipality, the CF was distributing potable water when the municipality needed their help building sandbag dikes.

However, the focus should be on how the municipalities ask for assistance with specific needs rather than how to ask for a specific group's assistance. The Province should determine best how to support the request and whether it can be done without federal support.

Recommendation #45

That Emergency Management Ontario clearly lay out the process for municipalities to request assistance during emergencies and provide field support to help determine the assistance that is required.

6.4.2 Communications

A better job could be done with communication and information dissemination before, during and after a flood, but most critically during a flood. Municipalities and residents demand good information so they can make informed decisions. Timely information is also key, such as forecast peak water levels, to allow appropriate preparations to be made to protect people and property.

Many smaller municipalities and CAs don't have the resources to hire technical and communications specialists (either full-time or part-time) to answer public inquiries during a flood event. They get questions such as: "Who do I approach to ask for assistance with sandbagging?" or "What is the forecast peak water level at X location?" or "How do I build a sandbag dike?"

Recommendation #46

That the Province have a central website for flooding issues that provides answers (for conservation authorities, municipalities and the public) to a myriad of typical and frequent questions, or at the very least, a link to the agency (provincial department, power company, etc.) that provides the answers to the questions.

6.5 Recovery

6.5.1 Compensation for Damages and Rebuilding

6.5.1.1 Compensation Programs

In many of the municipal engagement sessions, many smaller municipalities advised me that achieving the damage threshold of 3% of their total own purpose taxation (revenue) to be eligible for financial assistance is difficult. Further, if a municipality did not meet the 3% threshold, they were also excluded from the "build back better" pilot.

Recommendation #47

That the Province review the funding formula for eligibility of municipalities under the Municipal Disaster Recovery Assistance program.

As discussed in Section 5.3.2, partly in response to flooding in spring 2019, the Ministry of Municipal Affairs and Housing created a $1 million pilot project designed to help municipalities repair flood damaged roads, bridges and other infrastructure to a higher standard so they can better withstand extreme weather. As part of a $1 million pilot project, the province will provide municipalities that qualify for MDRA funding with up to 15% above the estimated cost of rebuilding damaged public infrastructure to make it more resilient to extreme weather. This is a very important program, as the investment to "build back better" will reduce flood damage in future events and therefore provides a return on the investment.

Recommendation #48

That the "build back better" pilot under the Municipal Disaster Recovery Assistance program move from a "pilot" to a full program. The Province should consider raising the 15% cap where it makes economic sense. The program should be tied to legislated flood protection levels and floodproofing criteria. For example, a bridge damaged by a flood can only be replaced if it is raised to the design flood.

There is no "build back better" component under the Disaster Recovery Assistance for Ontarians (DRAO) program. Under that program, assistance is based on the cost of returning a property to a functional level, which includes meeting building code requirements. Eligible costs may include floodproofing as required to obtain a building permit. Under the applicable provisions of the *Building Code Act*, the municipality must not issue a building permit in a regulated flood zone unless the conservation authority (or the MNRF in areas with no CA) has issued the required permit, which would include floodproofing requirements. DRAO does not cover floodproofing that is not required to obtain a building permit.

However, in municipal engagement sessions I heard several stories of individuals who repaired their houses after the 2017 flood only to be flooded again in the 2019 flood, and who claimed that had they been able to "build back better" after the 2017 flood that their damages in 2019 would have been eliminated or reduced. It is not clear if the damages were caused by flooding that exceeded the design flood or designated flood protection level for the area.

Recommendation #49

That the Province consider including a “build back better” component under the Disaster Recovery Assistance for Ontarians program.

At another municipal engagement session, I was advised that a home on leased land on a First Nation reserve and leased by a “non-status” person is not eligible under either the federal or provincial disaster assistance programs. The DRAO does not have any eligibility restrictions on leased land except if it is on First Nation reserve land. Indigenous Services Canada offers disaster assistance programs on First Nation reserves but only “status” residents are eligible. There are two possible ways to address this—the federal government could expand its program to include non-status individuals leasing on reserve land, or the province could expand its program to include reserve land. There would be a number of considerations that would come into play with the latter, including that provincial planning and building regulation policies do not apply on reserve land.

Recommendation #50

That the Province approach Indigenous Services Canada about expanding their disaster assistance program to include houses that are leased on First Nation reserve land by non-status individuals.

6.5.1.2 Relocation and Buyouts

A number of individuals and groups who participated in the review were interested in a buyout program being made available to residents living in floodplains whose homes were severely damaged by the 2019 flood events.

Buyouts can be beneficial when it is anticipated that the cost of more frequent emergency response activities and disaster assistance costs will outweigh the cost of providing those homeowners with fair market value for their homes. Also, buyouts are sometimes necessary when it is not technically feasible to meet floodproofing criteria, although this situation is not common. These programs can be highly contentious depending on how market value is determined and whether these programs are optional or forced onto residents in high-risk areas.

Recommendation #51

That the Disaster Recovery Assistance for Ontarians program be flexible enough to allow for removal of the structure from the floodplain (buyout) if it is the only technically and financially feasible option.

6.5.2 Insurance

Section 5.1.5 discussed that financial assistance for most flooding events in Ontario is largely provided by the Province or costs are borne by the property owner.

The flooding costs borne by property owners in Ontario are due to the limited insurability of flood risk areas. However, insured catastrophic losses in Canada (mostly related to water damage) are significantly increasing. Accordingly, the Insurance Bureau of Canada has been conducting research and producing reports on this issue.

> "Overland flood insurance is available from a number of insurance companies active in the Ontario marketplace, however it is not available for high-risk properties, or if it is available, it is prohibitively expensive or available with a limited cap, and as a consequence virtually all high-risk zones remain uninsured or underinsured. Overland flood insurance premiums for high risk flood zones can average over $10,000, while the average premium for all other perils combined in these areas is in the order of $1,000."[1]

> "The limited insurability of flood risk places the burden for post disaster reconstruction and recovery on homeowners and taxpayers who are funding disaster relief spending from federal and provincial governments."[2]

[1] Insurance Bureau of Canada (2019). Options for Managing Flood Costs of Canada's Highest Risk Residential Properties: A report of the National Working Group on Financial Risk of Flooding. June 2019, http://assets.ibc.ca/Documents/Studies/IBC-Flood-Options-Paper-EN.pdf.

[2] IBC (2015) The financial management of flood risk - An international review: Lessons learned from flood management programs in G8 countries, http://assets.ibc.ca/Documents/Natural%20Disasters/The_Financial_Management_of_Flood_Risk.pdf.

> "Currently, for every dollar of insured losses borne by insurers in Canada, three to four dollars are borne by governments and home and business owners."[3]

Although the market is now starting to change, residential coverage for overland flooding has historically not been available in Canada on the basis that it lacks economic viability. However, this is starting to change.

> "As of spring 2019, 16 insurers offer overland flood products available to approximately 77% of Canadian property owners, with approximately 34% of Canadians having at least some insurance for overland flood risk."[1]

Residential insurance for overland (pluvial and fluvial) flooding started to become available in Canada in 2015. The emergence of private flood insurance represents a significant redistribution of the financial risks associated with flooding. Despite significant costs to governments (who are typically compelled to provide disaster relief to flooded areas), individual private home and business owners also bear significant costs as disaster relief in Ontario is limited and only covers costs for the restoring "essential property" to a basic standard, up to a limit. Insurance will help to pool individual costs across broader society (who in the future will manage their own financial risks through flood insurance). Further on the concept of pooling costs, the Insurance Bureau of Canada recently released a report in June 2019 titled: "Options for Managing Flood Costs of Canada's Highest Risk Residential Properties" (http://assets.ibc.ca/Documents/Studies/IBC-Flood-Options-Paper-EN.pdf) with input from a members of a private-public sector working group on financial management of flood risk. The report focuses on ways to better manage costs of overland flooding for high risk properties across Canada and advances three potential options: 1) Pure Market Solution: risk borne by homeowners; 2) Evolved Status Quo: risk borne by blend of homeowners and governments; and 3) Create a High-Risk Flood Insurance Pool. Option 3, the creation of a high-risk insurance pool for properties otherwise not able to access affordable flood insurance to cover losses and which would include capping or subsidizing premiums, was advanced as a preferred option. Work is continuing on this option; however, it is postulated that this "pool" could be capitalized through a fund

[3] IBC, INTACT, etc. (2018). Combatting Canada's Rising Flood Costs: Natural Infrastructure is an underutilized option, http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf.

contributed by governments, and then be supported by insurance premiums paid into the pool and levies assessed on all homeowners or municipal rate payers.

There may be opportunities for the Province and the federal government to work with the insurance market to make flood insurance more available to more Ontarians (and Canadians) through increased investments in the identification and management of flood risks. Effective hazard maps are a pre-condition for establishing an effective flood insurance program. The risks associated with offering flood insurance cannot be adequately assessed without accurate, up-to-date mapping.

Recommendation #52

That the Province continue the dialogue with the Insurance Bureau of Canada and the federal government on the steps needed to make flood insurance more available to more Ontarians.

6.5.3 Waste Materials and Landfills

Smaller municipalities raised the issue of how the significant waste materials from a flood can negatively impact the capacity of a local landfill. Used dirty sandbags, flooded contents from a house or cottage (such as furniture, appliances, etc.) and if the house or cottage is destroyed, all the material from the structure's demolition, can quickly use up landfill capacity. These municipalities claim that even if the waste can be accepted at an alternative landfill, it would most likely have to be hauled further away and the costs of hauling were a concern. And finally, municipalities expressed concern over the time period for the permitting process for establishing a new landfill (or expanding an existing landfill), which may exceed the time remaining before an existing landfill has reached capacity.

Disposal costs are in fact eligible costs under the Municipal Disaster Recovery Assistance (MDRA) program, but there has to be an actual cost incurred by the municipality. For example, if the municipality uses a private landfill and pays the tipping fees, those would be eligible. If the municipality does more runs with their garbage trucks, the overtime costs and additional fuel costs, etc., would be eligible. However, the MDRA is oriented to actual paid expenditures, meaning if a municipality has their own small landfill, there is nothing in the MDRA program to compensate them for the "room" or capacity of the landfill that is used up from flood-related waste materials and reduces the future lifespan of the landfill site, because there is no "out-of-pocket" cost incurred.

Recommendation #53

That the Province ensure that municipalities have all the information regarding eligible items under the Municipal Disaster Recovery Assistance program, including costs for disposal of waste materials from a flood.

Recommendation #54

That the Province consider special or expedited approvals for new or expanded landfills if significant capacity is used up from the disposal of flood-related waste materials.

Chapter 7

Recommendations to External Agencies

Implementation of the following recommendations are focused on agencies outside the jurisdiction or control of the Ministry of Natural Resources and Forestry (MNRF). In those cases, I would expect that the MNRF can initiate discussions with the particular agency to try and seek agreement for implementation of a recommendation, in full or in part.

All three agencies below provided me with a considerable amount of material either in written form or in PowerPoint presentations, including very descriptive pictures, graphs and charts, during the review. A lot of the information is technical, but goes into considerable detail about their operations before, during and after the flood, including decisions that were made. Some of this information has already been presented to citizens in public meetings.

Recommendation #55

That the International Joint Commission, the Ottawa River Regulation Planning Board, and Ontario Power Generation make their detailed information about their flood operations readily available on their respective websites.

7.1 International Joint Commission

Part of the general public and some stakeholder groups seem to misunderstand how the structures on the St. Lawrence River work and what effect the operation of those structures has during extreme floods. In particular, some believe that the International Joint Commission's (IJC) operation of the structures has a negative impact on Lake Ontario or even Ottawa River flooding. However, it is important to understand that while the IJC's responsibilities include the regulation of outflows at the Moses-Saunders Dam on the St. Lawrence River, they cannot fully regulate the water levels of Lake Ontario and the St. Lawrence River, and they have absolutely no bearing on flows of the Ottawa River. The Moses-Saunders Dam can allow for a higher outflow of waters from Lake Ontario to the St. Lawrence River than the natural conditions before its construction, and the 2017 and 2019 flood peaks on Lake Ontario were lower than those that would have occurred under natural conditions (refer to IJC's website at www.ijc.org for more information).

The IJC has a tremendous amount of good information on their website, but unless you know what you are looking for, it is hard to navigate and you can spend a lot of time

searching through reports to find specific information. The general public should have easy direct access to current issues such as the floods of 2017 and 2019. Having a "2017 Flood" button on the main webpage with links to related reports would be helpful, but illustrations on the Great Lakes -St. Lawrence River system or how the operation of their structures impacted water levels in 2017 should be pulled out of the reports and be prominent on the "2017 Flood" page. For example, Figures 2-1 and 2-2 of the IJC report titled: "Summary of 2017 Great Lakes Basin Conditions and Water Level Impacts to Support Ongoing Regulation Plan Evaluation," November 13, 2018 (https://ijc.org/sites/default/files/2018-11/GLAM_2017_MainReport_FINAL-20181129_2.pdf), are excellent illustrations of the Great Lakes St. Lawrence River system. Figure 2.6 of the IJC report titled: "Observed Conditions and Regulated Outflows in 2017," May 25, 2018 (https://ijc.org/sites/default/files/2018-08/ILOSLRB_FloodReport2017.pdf) is an excellent illustration of the water surface profile of Lake Ontario and the St. Lawrence River showing the effects that a release of water needed to achieve a one centimetre drop over a period of one week on Lake Ontario would have on water levels at critical areas of the St. Lawrence River, such as Montreal. There are probably many other illustrations that could be pulled from the reports and prominently displayed.

Recommendation #56

That the International Joint Commission consider meeting with interested stakeholder groups and individuals to explain in considerable detail how their structures are operated.

Recommendation #57

That the International Joint Commission consider creating specific "2017 Flood" and "2019 Flood" buttons for their home webpage and populating those pages with detailed information on the floods and their operations, as well as providing direct links to related reports.

7.2 Ottawa River Regulation Planning Board

Likewise, with the Ottawa River Regulation Planning Board (ORRPB), the general public and stakeholder groups misunderstand how water control structures on the Ottawa River are operated and what effect the operation of those structures has during extreme floods. A common complaint was that the information was too technical for the general public. As a result of the flooding damages in 2017 and 2019, residents

questioned whether more can be done to better plan for and reduce the impacts of flooding in the future.

On July 11, 2019, the Hon. John Yakabuski, Minister of Natural Resources and Forestry, sent a letter to his provincial and federal counterparts requesting their support in conducting an independent review of how the Ottawa River system is managed. The letter requested each counterpart to name an individual within their respective ministries that the MNRF could work with to set out the specific details of the review.

The ORRPB suggested that it may be time to review the actual 1983 Agreement that governs the Board and their roles and responsibilities to determine if the conclusions from 1980 still hold true almost 40 years later. The review could repeat the original process of studying the coordination between generation station operators and exploring reservoir expansion and related costs.

Recommendation #58

That the supporting agencies of the Ottawa River Regulation Planning Board (Canada, Ontario, Quebec and the dam operators) consider reviewing the original agreement, recommendations and guiding principles, and board policies given they are almost 40 years old.

Recommendation #59

That the supporting agencies of the Ottawa River Regulation Planning Board (Canada, Ontario, Quebec and the dam operators) consider removing “Regulation” from the title, as it implies that the Board can actually manage large floods when, in fact, they cannot because of the limited storage capacity of the generating station reservoirs, which were designed for electric power generation and not flood control.

Recommendation #60

That a communications officer be assigned to the Ottawa River Regulation Planning Board to help with messaging during flood events or any public meetings and free up the staff engineers to concentrate on their duties. At least two communications officers should be assigned as needed and well trained in the technical operations. The officers should be from another government department as opposed to Ontario Power Generation or another non-government dam owner, since the public believes the dam owners only care about generating electricity.

Recommendation #61

That a communications person with marketing experience work with the Ottawa River Regulation Planning Board to prepare more easily understood materials for publication. The approach to managing the Ottawa River by the Board is not well understood by the public or government officials. Also, the materials should not be confusing. In one example I saw, a line graph showed a water level difference of 1.0 metres but the text below it stated "> 50 cm or 20 in.

Hydrological forecasts should include better information about water levels all along the Ottawa River. People rarely care about flows, but they want to know what level the river will rise to, so they can prepare accordingly. Most of the information is right at or near a hydro structure, but there are a lot of houses and cottages along the river in between the gauges. Since this is a complicated river, it is recognised that it is difficult to interpolate between two gauges (it's not a straight-line relationship).

Recommendation #62

That the Ottawa River Regulation Planning Board work with Ontario Power Generation and consider installing staff gauges at critical settled locations along the river, and engage residents to read and report on these gauges. These residents have a vested interest in getting accurate information and so their "buy-in" could be to volunteer their time to provide the data.

Recommendation #63

That two municipal officials, one from the Association of Municipalities of Ontario and one from the Quebec counterpart, sit on the Ottawa River Regulation Planning Board. The intent is to provide contact persons on the Board trusted by municipalities in both provinces, and for the municipal representatives on the Board to help disseminate correct and accurate information back to municipalities. Consideration could also be given to adding municipal representatives to the Ottawa River Regulating Committee, in addition to or instead of the Board. It is recognized that the three signatories to the Agreement (Canada, Ontario and Quebec) would have to agree to amending the Agreement for this purpose.

7.3 Ontario Power Generation

As with the above two agencies, the general public and stakeholder groups do not understand how the Ontario Power Generation (OPG) stations work and what effect the operation of those power generating structures has during extreme floods. I included considerable discussion and explanation on the issues that were raised by stakeholders about the Ottawa River in Section 4.1.

Further to that, I must emphasize that while Ontario has many different waterpower producers operating throughout the province, my focus on OPG has been in relation to their operations on the Ottawa River, as they are the only Ontario-based waterpower provider operating on the Ottawa River proper. The recommendations below may also be relevant to other waterpower producers operating throughout Ontario.

Regarding Section 4.1.5, Explanation of Conditions at Des Joachims and the Dry Section at Deux-Rivieres, OPG had originally provided me with two diagrams showing operating levels during normal and high flow conditions to try and illustrate the situation. However, I did not include the diagrams in this report, as I think they would confuse the reader. What would greatly assist the reader would be additional illustrations of how the river goes through the changes from normal to high and back to normal conditions.

Recommendation #64

That Ontario Power Generation create a dynamic illustration regarding the dry section at Deux-Rivieres that “walks” the observer through the changes in water levels during low to normal to high flows, with voice-over explanation of water level changes, and that this video be included on their website.

I also discussed the issues in the upper Ottawa River watershed (Mattawa) in Section 4.2 and recommended a more collaborative approach with better communication in Section 6.2.3.2, which OPG supports.

OPG has made several recommendations to me on other matters and most are covered in other sections of this report.

One operational recommendation that OPG has raised that could reduce flooding impact would be a change of the reservoir refill date in the Water Management Plans for each power dam. It is suggested that the refill date be flexible depending on the watershed conditions, such as size and speed of the freshet in the region. Water Management Plans were not designed to manage floods. Balancing the constraints of the plan with the potential for flooding can sometimes be challenging. The Victoria Day refill constraints have been set primarily for recreational purposes; however, they cause

water management staff to make a trade-off between flood resilience and recreation. The refill date should not be based on a set trigger (or series of potential triggers), but allowed to be based on the unique conditions of each given year.

Recommendation #65

That Ontario Power Generation identify options to address their concern about refill dates and provide greater flexibility on how refill is determined, taking into consideration the range of potential impacts, to support potential amendment proposals to relevant Water Management Plans.

Chapter 8

Fiscal Pressures and Capacity Issues

The efficiency and effectiveness of the existing approval processes and associated policies and technical requirements could be limited by Ontario's overall fiscal reality and capacity issues facing provincial ministries, municipalities, and conservation authorities.

8.1 Ontario's Deficit

Ontario's deficit was estimated to be as high as $15 billion in 2018 leading to the government committing to taking necessary steps towards restoring Ontario's fiscal health. Ontario's deficit places pressure on the Province to further reduce costs and promote economic growth to help balance the budget and sustainably fund essential public services for current and future generations.

8.2 The Ministry of Natural Resources and Forestry Capacity

Some stakeholders and other groups have raised concerns regarding the capacity of the MNRF to support approval processes and associated policies and technical requirements.

The MNRF has not assessed internal capacity needs required to support provincial natural hazard management policies and programs or assessed how such programs are resourced in other jurisdictions. The Environmental Commissioner of Ontario has also raised concerns that reductions in budgets, staffing and in-house expertise has hampered the effectiveness of the MNRF.

8.3 Conservation Authority Capacity

Many MNRF policies and programs associated with protecting Ontarians from flooding and other natural hazards are delivered by conservation authorities. Reliance on conservation authorities to administer permit applications and decisions, and to comment on municipal planning policies reduces costs for the MNRF but increases costs for conservation authorities and the municipalities that fund them.

Capacity levels among conservation authorities are very diverse with annual budgets ranging from less than $1 million to more than $100 million. This divergence in capacity affects the extent to which any given conservation authority can support hazard management policy objectives. Increases to conservation authority roles and responsibilities disproportionately impact smaller conservation authorities with limited

tax bases within their jurisdictions to support program and service delivery. Conservation Ontario and municipalities have repeatedly requested increases to provincial funding levels to conservation authorities, which have not been increased in over 20 years, and this year they have requested that the 2018 funding level be reinstated.

8.4 Municipal Capacity

The MNRF relies on municipalities to implement natural hazard policies contained within the Provincial Policy Statement (PPS).

As with conservation authorities, capacity levels among municipalities are also quite diverse. Small, rural municipalities typically have a much smaller tax base than larger urban municipalities, and may be less able to support the effective management of flooding and other natural hazards.

Some municipalities rely on conservation authorities to support the management of flooding and other natural hazards, and would not have the resources to take on these responsibilities.

Recommendation #66

That the Province maintain, at a minimum, the current level of funding in departmental budgets and programs related to everything flood (i.e. existing approval processes and associated policies and technical requirements, floodplain mapping, maintenance of flood infrastructure, satellite imagery, etc.).

Appendix A – List of Documents Reviewed

A number of reports and additional background information was reviewed in developing recommendations included in this report, many of which were provided by stakeholders and individuals via email or during in-person meetings. A listing of publicly available documents received and reviewed has been provided below.

Information on current flood-related initiatives being undertaken by the Province of Ontario

- A Made-in-Ontario Environment Plan
- ERO#013-4992: Focusing conservation authority development permits on the protection of people and property
- ERO#019-0279: Provincial Policy Statement Review – Proposed Policies
- The Municipal Disaster Recovery Assistance (MDRA) pilot program (news release)
- Provincial Flooding Task Force (news release)
- Helping Protect the Muskoka Watershed (news release)

Information on the International Joint Commission

- Lake Ontario – St. Lawrence River Plan 2014
- IJC GLAM (2017) Great Lakes Basin Conditions and Water Level Impacts to Support Ongoing Regulation Plan Evaluation

Provincial acts, regulations and policies associated with flood management

- Provincial Policy Statement 2014
- The Planning Act (1990)
- Ontario Regulation 97/04 – Content of Conservation Authority Regulations Under Section 28 (1) of the Act: Development, Interference with Wetlands and Alterations to Shorelines and Watercourses

Technical guidelines prepared by the province to support municipalities and conservation authorities in managing flooding and other natural hazards

- Understanding Natural Hazards (2001)
- Special Policy Areas Technical Guide (2009)
- Technical Guide for Large Inland Lakes (1996)
- Hazardous Sites Technical Guide (1996)
- Technical Guide - River and Stream Systems: Erosion Hazard Limit (2002)
- Technical Guide - River & Stream Systems: Flooding Hazard Limit (2002)
- Great Lakes-St. Lawrence River System Tech Guide (2001)

Information on federal funding programs

- National Disaster Mitigation Program

Studies, reports and presentations prepared by non-OPS entities

- Intact Centre (2018) After the Flood: The Impact of Climate Change on Mental Health and Lost Time from Work
- Intact Centre (2018) Too Small to Fail: Protecting Canadian Communities from Floods
- Muir, Robert J. (2018) Reducing Flood Risk from Flood Plain to Floor Drain: Developing a Canadian Standard for Design Standard Adaptation in Existing Communities
- Ganaraska Region Conservation Authority. March 2015. Metadata Inventory of Existing Conservation Authority Flood Mapping
- Intact Centre (2016) Climate Change and the Preparedness of Canadian Provinces and Yukon to Limit Potential Flood Damage
- Insurance Bureau of Canada (2015) The Financial Management of Flood Risk
- Insurance Bureau of Canada (2018) Combatting Canada's Rising Flood Costs: Natural Infrastructure is an Underutilized Option
- Conservation Ontario (2013) Dodging the Perfect Storm: Conservation Ontario's Business Case for Strategic Reinvestment in Ontario's Flood Management Programs, Services and Structures
- Ontario (2008) Provincial-Municipal Fiscal and Service Delivery Review: Facing the Future Together
- Making the Most of Floodplain Buyouts
- Kenosha County Fox River Floodplain Acquisition Program
- Are Floodplain Buyouts A Smart Investment for Municipalities?
- Urban Flood Homeowners Hazard Perception & Climate Change (2009)
- Urban Flood Resilience in Ontario – Ready Set Rain (2019)
- Canadian Voices on Changing Flood Risk, 2017

Information provided to the Special Advisor during the community tour, section 1

- Limits to the Regulation of the Ottawa River – 2019 Spring Flood Overview (ORRPB)
- Agreement Respecting Ottawa River Basin Regulation, 1994 (ORRPB)
- Recommendations and Guiding Principles, 1989 (ORRPB)
- Board Policies, 1990 (ORRPB)
- The Quebec government unveils its flood action plan (news release)
- 18 homes evacuated as Ottawa River floods, Chaudiere Bridge closing due to 'high water levels' (news article)
- Some in flooded Quebec town angry new dike will block their waterfront views (news article)
- Longitudinal Profile of the Lower Ottawa River
- Ottawa River Nomination Document – Chapter 3 – Natural Heritage Values
- Britannia's berm faces its greatest test yet (news article)
- Floods: Critical berm in Britannia showing signs of leaking (news article)
- Flooding adds urgency to disaster planning and damage mitigation (news article)
- Under water, again (news article)
- Flood Warning – Ottawa River-Arnprior to L'Original (news release)
- Ottawa River Flood Activation Area Map (Alfred and Plantagenet)

- Ottawa River Flood Activation Area Map (Champlain)
- Ottawa River Flood Activation Area Map (Clarence-Rockland)
- Ottawa River Flood Activation Area Map (City of Ottawa, east)
- Ottawa River Flood Activation Area Map (City of Ottawa, west)
- Lanark County Flood Activation Area Map
- This new mapping tool helped Ottawa handle 2019 floods (news article)
- Ottawa River Flood Risk Map – Constance Bay – Map 25
- Ottawa River Flood Risk Map – Constance Bay – Map 31
- Ottawa River Flood Risk Map – Constance Bay – Map 32
- Ottawa River Flood Risk Map – Constance Bay – Map 33
- Ottawa River Flood Risk Map – Constance Bay – Map 34
- Townships of McNab/Braeside and Horton declare states of emergency due to flooding (news article)
- 'You guys are responsible': Anger, frustration in Westmeath at flood meeting (news article)
- 'The 500-year flood': Dozens forced from homes in Whitewater Region (news article)
- Westmeath Spatial Context Map – 1/2
- Westmeath Spatial Context Map – 2/2
- Residents displaced from nearly 40 properties in Laurentian Valley (news article – Pembroke Observer)
- Update on the current state of flooding in County of Renfrew (news article)
- Renfrew County Flood Activation Area Map
- County of Hastings Flood Activation Area Map – Municipality of Hastings Highlands
- District of Nipissing Flood Activation Area Map – Town of Mattawa
- High and dry – the maddening story of the upper Ottawa River (news article)
- Flood damage in the millions – Backer (news article)
- Flooding's worst still to come (news article)
- OPG gives reasons for high water levels near Mattawa (news article)
- North Bay-Mattawa Conservation Authority Jurisdictional Map
- District of Nipissing Flood Activation Area Map – Town of Mattawa
- Municipality of French River Flood Activation Area Map
- French River state of emergency, province needs more flood funding (news article)
- Several areas in northeastern Ontario declare a state of emergency (news article)

Information provided to the Special Advisor during the community tour, section 2

- After the flood: can Toronto Islands be saved from the next disaster? (news article)
- Environmental Impact of 2017 – Flooding At Toronto Islands (news article)
- Humber River flood waters force 200 people from their homes in Bolton (news article)
- Major Flooding: Rising flood waters force residents from homes in Caledon (news article)
- Members of Ontario's Muskoka Watershed Advisory Group (OPS news release)
- Ontario Helping Protect the Muskoka Watershed (OPS news release)
- Ontario Takes Next Steps to Protect Muskoka Watershed (OPS news release)

- District of Parry Sound Flood Activation Area Map
- District of Muskoka Flood Activation Area Map
- Drone footage shows extent of flooding in Ontario cottage country as further rain looms (news article)
- Kingdom of the Netherlands Water Management
- Great Lakes Action Plan, Full Report
- Great Lakes Action Plan, Summary
- Work on Brantford dike to resume on August 19 (news release)
- Preparing for Flooding – A Guide for Residents of Ayr
- City proceeding with dike land expropriation (news article)
- Ice jam, rain forecast has Chatham bracing for possible widespread flooding (news article)
- Helping Canadians Adapt to Extreme Weather
- Agriculture minister visits flood damage in Chatham-Kent (news article)
- Chatham-Kent mayor declares localized state of emergency amid flood fears (news article)
- Lake Erie Shoreline (news article)
- Erosion, flooding trigger revision of Erie shoreline development policy (news article)
- New floodplain map may stall south London development (news article)
- Strong winds could bring more flooding to Erie Shore Drive (news article)

Appendix B – Community Tours

Community tours were held from September 4 – 14, 2019. The tour was broken into two sessions as noted below. The sessions were designed to allow municipal leaders and other stakeholders to share their experiences with flooding and their ideas as to how the province can be better prepared in the future.

Feedback provided during the tour was used to assist in developing recommendations. Of note, both sessions included engagement sessions (held in groups), targeted engagement session (one-on-one meetings), and area-specific tours to help gain a complete understanding of the issues and impacts Ontarians are facing as a result of this spring's flooding.

Community Tour Session #1 – Eastern Ontario

- Wednesday September 4, 2019 – Ottawa (*targeted session and tour*)
    - Britannia
- Thursday September 5, 2019 – Ottawa (*engagement session and tour*)
    - Constance Bay, Braeside, Rhoddy's Bay and Westmeath
- Friday September 6, 2019 – Pembroke (*engagement session and tour*)
    - Pembroke, Deux Rivieres, Klock and Mattawa
- Saturday September 7, 2019 – North Bay (*engagement session*)

Community Tour Session #2 – Central and Southwestern Ontario

- Tuesday September 10, 2019 – Toronto (*targeted meeting and tour*)
    - Rockcliffe neighbourhood and Port Lands
- Wednesday September 11, 2019 – Huntsville (*engagement session and tour*)
    - Bracebridge
- Thursday September 12, 2019 – Toronto (*targeted sessions*)
- Friday September 13, 2019 – Cambridge (*engagement session and tour*)
    - Cambridge Flood Walls, Brantford Flood Works and Eagle Place
- Saturday September 14, 2019 – London (*engagement session*)

Appendix C – Engagement Session Participation

The following is a list of organizations that participated in Regional Engagement Sessions.

Thursday September 5, 2019 – Ottawa Engagement Session
City of Clarence-Rockland
City of Ottawa
MPP, Carlton
MPP, Constance Bay / Kanata-Carlton
Mississippi Valley Conservation Authority
Rideau Valley Conservation Authority
South Nation Region Conservation Authority
Town of Mississippi Mills
Township of Champlain
Township of Alfred and Plantagenet

Friday September 6, 2019 – Pembroke Engagement Session
City of Pembroke
Municipality of Hastings Highlands
MP, Renfrew–Nipissing–Pembroke
Town of Arnprior
Town of Deep River
Township of Admaston/Bromley
Township of Brudenell, Lyndoch and Raglan
Township of Greater Madawaska
Township of Laurentian Valley
Township of Madawaska Valley
Township of McNab/Braeside
Township of North Algona Wilberforce
Township of Whitewater Region

Saturday September 7, 2019 – North Bay Engagement Session
City of North Bay
City of Temiskaming Shores
MPP, Nipissing
Municipality of East Ferris
Municipality of French River
Nipissing First Nation
North Bay-Mattawa Conservation Authority
Public Services and Procurement Canada

Town of Mattawa
Township of Chisholm
Township of Mattawan

Wednesday September 11, 2019 – Huntsville Engagement Session
Armour Township
MPP, Parry Sound-Muskoka
Muskoka Watershed Advisory Group
Muskoka Watershed Council
Town of Bracebridge
Town of Gravenhurst
Town of Huntsville
Town of Lake of Bays
Town of Muskoka Lakes
Township of Algonquin Highlands
Ryerson Township
Village of Burk's Falls

Friday September 13, 2019 – Cambridge Engagement Session
City of Brantford
City of Cambridge
City of Kitchener
City of St. Catharines
County of Brant
Grand River Conservation Authority
Halton Region Conservation Authority
MPP, Cambridge (Office of)
MPP, Haldimand-Norfolk (Office of)
Region of Waterloo

Saturday September 14, 2019 – London Engagement Session
City of Sarnia
County of Essex
Essex Region Conservation Authority
Lower Thames Valley Conservation Authority
Municipality of Chatham-Kent
Town of Essex
Town of Kingsville
Township of Pelee
St. Clair Region Conservation Authority

Upper Thames River Conservation Authority

The following is a list of the individuals and groups who met directly with the Special Advisor.

Wednesday September 4, 2019
Ottawa River Regulation and Planning Board

Thursday September 5, 2019
Insurance Bureau of Canada
International Joint Commission

Friday September 6, 2019
Westmeath Citizens Group

Saturday September 7, 2019
North Bay-Mattawa Conservation Authority

Tuesday September 10, 2019
Toronto and Region Conservation Authority

Thursday September 12, 2019
Association of Municipalities of Ontario
City of Toronto
Electrical Safety Authority
Emergency Management Ontario
Great Lakes Collaborative
Kingdom of the Netherlands
MPP Lindsey Park, Durham
Regional Public Works Commissioners of Ontario

Friday September 13, 2019
Intact Centre on Climate Adaptation
Grand River Conservation Authority

Saturday September 14, 2019
Upper Thames River Conservation Authority

Appendix D – Written Submissions to the Special Advisor on Flooding

Written submissions were also received from a number of different groups over the course of the review. The submissions covered an array of issues including introductory comments, follow up materials, invitations/requests to meet with Mr. McNeil, detailed comments about flooding, water management and recent flood experiences or ideas of recommendations that should be put forward to government.

The list below identifies who submitted comments. A number of submissions were also received from members of the public whose names are not included below.

- Aquanty Inc.
- Association of Municipalities of Ontario
- Blue Mountain Watershed Trust
- Boating Ontario Association
- Central Lake Ontario Conservation Authority
- Cheryl Gallant, MP Renfrew-Nipissing-Pembroke
- City of Ottawa
- Community Living Upper Ottawa Valley
- Conservation Ontario
- County of Essex
- Electrical Safety Authority
- Emergency Management Ontario
- Great Lakes Collaborative
- Insurance Brokers Association of Ontario
- International Joint Commission
- International Joint Commission, Great Lakes-St. Lawrence Adaptative Management Committee
- Kingdom of the Netherlands
- Marit Stiles, MPP, Davenport
- McMaster University
- Ministry of the Environment, Conservation and Parks
- Ministry of Infrastructure
- Ministry of Municipal Affairs and Housing
- Ministry of Natural Resources and Forestry
- Municipality of Chatham-Kent
- Municipality of Clarington
- Municipality of Leamington
- Muskoka Lakes Association

- Muskoka Watershed Council
- North Bay-Mattawa Conservation Authority
- Ontario Association of Home Inspectors
- Ontario Power Generation
- Ottawa River Regulation Planning Board
- Regional Public Works Commissioners of Ontario
- Toronto and Region Conservation Authority
- Township of Champlain
- Township of Laurentian Valley
- Township of Madawaska Valley
- Upper Thames River Conservation Authority
- Upper Trent Water Management Partnership
- Westmeath Citizens Group
- World Wildlife Fund