Western University
Scholarship@Western

MPA Major Research Papers | Local Government Program

7-15-2024

What line is it anyway? An appeal for policy coordination to support integrated floodplain management in Ontario

Shawna Chambers
Western University

Follow this and additional works at: https://ir.lib.uwo.ca/lgp-mrps

Part of the Public Administration Commons

Recommended Citation
Chambers, Shawna, "What line is it anyway? An appeal for policy coordination to support integrated floodplain management in Ontario" (2024). *MPA Major Research Papers*. 260.
https://ir.lib.uwo.ca/lgp-mrps/260

This Major Research Paper is brought to you for free and open access by the Local Government Program at Scholarship@Western. It has been accepted for inclusion in MPA Major Research Papers by an authorized administrator of Scholarship@Western. For more information, please contact wlswadmin@uwo.ca.

Local Government Program • Department of Political Science

What line is it anyway?
An appeal for policy coordination to support integrated floodplain management in Ontario

Subject keywords:
policy coordination, climate change, stormwater management

MPA Final Research Report

Submitted to
The Local Government Program
Department of Political Science
The University of Western Ontario

Shawna Chambers, P.Eng.
July 15, 2024

Abstract

In response to a changing climate and increasing flood damage costs, safeguarding properties from flooding has become a government priority in Ontario and throughout the world. On one side, the floodplain limit is critical to establish as a regulated area that will restrict development, and therefore, limit the potential flood damage and cost to taxpayers. On the other side, an overestimated floodplain can unnecessarily sterilize land development potential, trigger lawsuits, and increase the cost of infrastructure.

The research questions are: Why is there a lack of horizontal policy coordination at the provincial level in response to flood risk and climate change? Which policy tools can be leveraged to recognize investments in flood infrastructure and more accurately define floodplain limits? In response, this paper will review the challenges in Ontario with respect to the current floodplain management governance structure, summarize policy coordination theory to assess the challenges of establishing integrated floodplain policy, and lastly, recommend tools from policy integration and implementation theory to meet overarching provincial goals. This paper will argue that policy coordination is required to balance flood risk against uncertainty factors and that it would be beneficial for Ontario to establish an overarching multidisciplinary agency to oversee integrated floodplain management policy. This may include recognizing the benefits of structural flood controls, such as stormwater management facilities, as well as establishing a cost-risk-benefit framework to balance levels of service in response to climate change.

Acknowledgements

I wish to acknowledge the support of my City of London Stormwater Engineering colleagues who journey with me each day in discussions related to floodplain policies and who strive for continuous improvements to provide public flood protection across the city.

To Joe Lyons, Director of Local Government Program, for his patience and support throughout my time at Western University to complete the Diploma of Public Administration in 2017 and upon my return in 2022 to complete the Master of Public Administration program.

To my children, Cole and Abbie, thank you for your curiosity, joy, and for inspiring me to make the world a better place. To my husband, Kyle, for always having my back. I love you all 'past space.'

About the author

Shawna Chambers, P.Eng., is the Division Manager of Stormwater Engineering at the City of London. Ms. Chambers is a professional engineer with an undergraduate degree in Civil Engineering from the University of Waterloo, specializing in Water Resources and Environmental Engineering. Ms. Chambers received her Diploma in Public Administration from the University of Western Ontario in 2017. She has worked 17 years in municipal engineering, including 12 years in stormwater and floodplain management. Text within this report draws from Ms. Chambers practical experience as a municipal water resources engineer, manager, participant on provincial working groups, and expert witness. Project examples within this report are publicly available from the City of London's Storwmater Engineering division.

Table of Contents

List of Tables

List of Figures

1.0 Introduction

Updating floodplain mapping is important to protecting properties from flooding and ensuring public safety during significant storm events. The province of Ontario, along with many jurisdictions around the world, have been grappling with how to update flood mapping considering climate change trends of more frequent and intense rain events (Ministry of Natural Resources and Forestry (MNRF), 2020; Loschner & Nordbeck, 2020). This issue is of particular interest in urban centers where there are higher damage costs during major floods and a desire for housing intensification near watercourses and shorelines.

One of the more challenging aspects is agreeing on a level of risk that will assure the public interest. On one side, the floodplain limit is critical to establish as a regulated area that will limit development, and therefore, limit the potential flood damage and cost to taxpayers in the event of a large flood event. On the other side, an overestimated floodplain can unnecessarily sterilize land development potential and increase the cost of municipal infrastructure to convey larger flows.

Due to its complexity and number of actors involved, the literature review revealed that floodplain policy development is considered a *cross-cutting* or *wicked problem* (Peters, 2018; Candel & Biesbroek, 2016; Tosun & Lang, 2017; Nordbeck, Seher, Gruneis, Herrnegger, & Junger, 2023). Cross-cutting problems are generally identified as complex challenges that require intervention across a broad range of specializations, policy domains, and levels of government (Peters, 2018; Candel & Biesbroek, 2016; Tosun & Lang, 2017; Nordbeck, Seher, Gruneis, Herrnegger, & Junger, 2023).

The structure of this report is as follows: 1) identify issues in floodplain management in Ontario; 2) conduct a literature review of policy coordination theory; 3) test applicable theory towards the goal of implementing integrated floodplain management in the province of Ontario; and 4) recommend improvements to policy tools to ensure a more accurate representation of flood risk. This paper will argue that policy coordination and integration is required in Ontario to balance flood risk against uncertainty factors and establish a level of service for implementation.

2.0 Research Question and Strategy

The research questions being applied to the current floodplain management framework are: Why is there a lack of horizontal policy coordination at the provincial level in response to flood risk and climate change? Which policy tools can be leveraged to recognize investments in flood infrastructure and more accurately define floodplain limits? To answer the research questions, this paper will follow a deductive research process as shown in Figure 1:

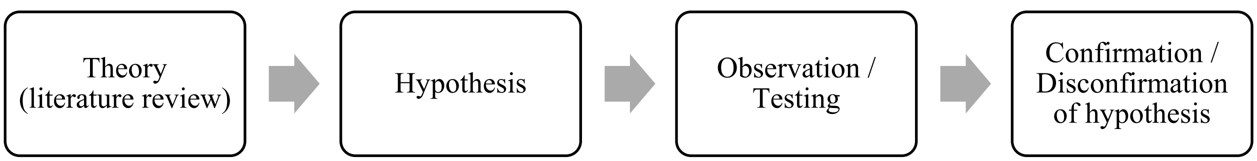

Figure 1: Deductive approach to research

The theories of policy coordination, policy integration and policy implementation were found to relate best to trying to solve what the literature defined as cross-cutting or wicked problems (Peters, 2018; Candel & Biesbroek, 2016; Tosun & Lang, 2017; Nordbeck, Seher, Gruneis, Herrnegger, & Junger, 2023). The hypothesis relates to finding a theory that will best support the research question. Namely, is there a theory that can explain why the regulatory bodies of flood and infrastructure management do not coordinate effectively.

3.0 Background

There are structural and non-structural measures to manage flood risk (Loschner & Nordbeck, 2020; McNeil, 2019). Structural measures include constructing flood control infrastructure such as floodways, dykes, dams, or ponds (Loschner & Nordbeck, 2020; McNeil, 2019). Non-structural measures include establishing floodplain limits and preventing development within the floodplain through land use policies (Loschner & Nordbeck, 2020; McNeil, 2019).

The Province of Ontario has traditionally applied policy to focus on non-structural measures in response to managing flood risk, including land use policies restricting development within a defined floodplain limit (McNeil, 2019). In 1946, Ontario enacted the *Conservation Authorities Act,* 1990 ("CA Act") following several severe flood events (Ontario, 2024; Conservation Ontario, 2024). Under the CA Act, Conservation Authorities (CAs) were established as special purpose bodies to conduct watershed management (Conservation Ontario, 2024). In 1954, Hurricane Hazel occurred which took 81 lives and caused one billion dollars in damage over the Toronto area (Ministry of Natural Resources and Forestry (MNRF), 2020). This event led to strengthening the CAs with the ability to regulate the floodplain and manage flood risk through forecasting and warning (Conservation Ontario, 2024).

On April 1, 2024, the province of Ontario released O. *Reg. 41/24: Prohibited Activities, Exemptions and Permits* to consolidate flood standards across Ontario (Sutton & Pinho, 2024). Where there were previously individual regulations for each of the 36 CAs, the new regulation confirmed the flood standard applicable to each CA (Sutton & Pinho, 2024). For example, in the Upper Thames River watershed, the flood standard is the 1937 Flood Event, equivalent to the 250-year storm frequency (Government of Ontario, 2024). A 250-year storm event has a 1 in

250 chance of occurring each year or 0.4% annually. Many of the municipalities in the Greater Toronto Area have a flood standard based on Hurricane Hazel. O.Reg. 41/24 added the requirement for CAs to develop flood mapping that is publicly available on the website and for those maps to be reviewed and updated annually if required (Sutton & Pinho, 2024).

3.1 Establishing Floodplains

Floodplain limits are generally estimated by civil engineers using modelling software and technical guidelines. Appendix A describes the general methodology of hydrologic and hydraulic modelling to establish a floodplain. This section will highlight the challenges of updating floodplain limits with current guidelines in Ontario.

3.1.1 Subjectivity of Floodplain models

An underlying challenge with establishing floodplain mapping is that modelling is an interpretive and often subjective practice (Ministry of Natural Resources and Forestry, 2002). An engineer requires a good understanding of the watershed to construct hydrologic and hydraulic models, but it is challenging to depict highly variable natural phenomena, such as weather, with reasonable accuracy and reliability. Ideally, models can be calibrated to the response of a watercourse through long-term flow monitoring; however, even with calibration, each storm event tends to be unique since there are seasonal fluctuations of the ground conditions and the storm events can be uniquely distributed in volume and intensity. These factors generate uncertainty in floodplain modeling results and theoretical flood risks need to be assessed critically against historical flood response, professional judgement, ground-truthing, and ideally, a cost-benefit risk assessment (Ministry of Natural Resources and Forestry, 2002).

Due to the subjective nature of modelling, government standards to inform floodplain modelling assumptions are important to provide a uniform level of service across jurisdictions.

3.1.2 Outdated provincial guidance

In Ontario, many of the assumptions used in floodplain modelling and mapping are based on government design guidelines or standards, however, the advancement of stormwater engineering since the early 2000s has exceeded the pace of guidance documents (McNeil, 2019). Specifically, the Ministry of Natural Resources and Forestry's (MNRF)'s 2002 "Technical Guide - River and Stream Systems: Flooding Hazard Limit" (the "2002 Flood Technical Guide") directs key technical assumptions inputted into modelling software that estimates flood flows for floodplain mapping. However, the guide is over 20 years old and based on information from the 1980s (McNeil, 2019). As such, it does not recognize climate change, advances in modelling software, current industry best practices, or the benefits of low-risk structural measures, such as stormwater management facilities (McNeil, 2019). The 2002 Flood Technical Guide also acknowledges the need for engineering judgment to avoid liability (Ministry of Natural Resources and Forestry, 2002):

> "The two main steps in the mapping of a flood plain are: (1) to determine the flood criteria and the corresponding flood flow; and (2) to delineate the area inundated by the flood flow. Whether the selected flood is based on a flood frequency analysis or the resultant runoff of a specified meteorologic input, there is considerable investigation necessary to develop a reasonable estimate. This is the main part of the hydrologic investigation required and should be carried out using the best techniques available. A high standard of analysis along with good engineering judgement will be required to obtain realistic results, which can be defended when legally challenged" (p. 23).

3.2 Stormwater Management

The primary objective of stormwater management (SWM) is to mimic post-development conditions to predevelopment conditions with respect to drainage on the landscape. SWM systems are considered structural flood control measures.

3.2.1 SWM ponds and New Development

The Ministry of Conservation and Parks (MECP)'s release of the 2003 "Stormwater Planning and Design Manual" (Ministry of Environment, Conservation and Parks, 2003) which initiated the widespread implementation of large storage ponds for flood and water quality control as part of all new development (McNeil, 2019). The stormwater ponds are designed by engineers and implemented through the development approvals process under the *Environmental Assessment Act, 1990, R.S.O. 1990, c. E.18* to mitigate flood risk downstream (Ministry of Environment, Conservation and Parks, 2003). Effectively, the ponds store large volumes of rainwater to mitigate downstream flood impacts by attenuating post-development flows (e.g., housing subdivisions) to pre-devleopment flow rates (e.g., greenfield farmland) (McNeil, 2019). Figure 2 depicts the considerations when designing modern SWM infrastructure.

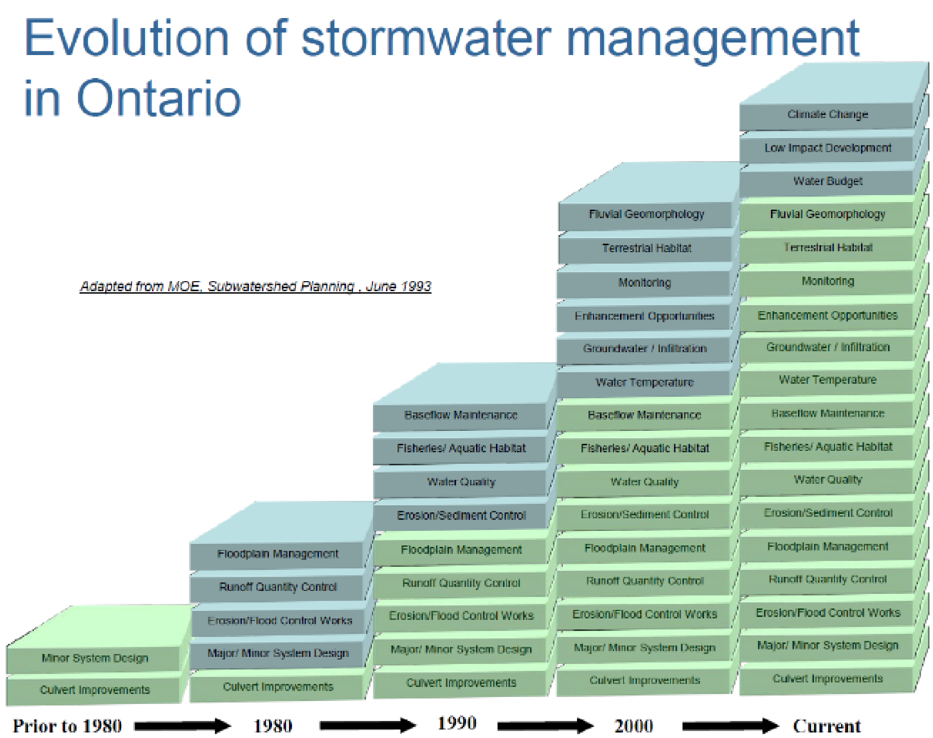

Figure 2: Evolution of stormwater management in Ontario
(from Aqufor Beech Ltd., 2019)

SWM approvals follow governance frameworks to consider both structural and environmental factors, all to ensure compliance with civil engineering standards while not causing harm to waterways that support aquatic and terrestrial wildlife. The SWM facilities store a substantial amount of floodwater and cost millions of dollars to construct and maintain. Retrofit flood control facilities may be funded through municipal property taxes, stormwater utility charge, or through senior government grants. Figure 3 illustrates the scale of a SWM pond against the size of homes servicing a local subdivision in London, Ontario.

Figure 3: Fox Hollow Subdivision Stormwater Management System in London, ON
(City of London, 2012)

3.2.2 Compliance and accountability

There have been updates made by other provincial agencies to provide technical and financial frameworks to hold local government accountable to the maintenance of stormwater infrastructure.

Environmental Compliance Approval

The construction and operation of SWM ponds are regulated by the MECP in accordance with the *Ontario Water Resources Act, R.S.O 1990, c. O.40* (OWRA). Specifically, under Section 53 of the OWRA, stormwater management facilities are considered Sewage Works and each pond constructed at the local government level is required to obtain a provincial Environmental Compliance Approval (ECA) from the MECP (Ontario, 2024).

The ECA process was streamlined in 2023 when the MECP issued each municipality a Consolidated Linear Infrastructure Environmental Compliance Approval for Stormwater Infrastructure (CLI-ECA). The CLI-ECA is a comprehensive approval for each municipality based on its inventory of storm sewers and municipal stormwater infrastructure servicing residential properties (Ministry of the Environment, Conservation and Parks, 2024). To obtain this approval, a local municipality is required to provide a complete inventory of all municipal storm sewers, residential stormwater storage ponds, and water quality treatment devices (Ministry of the Environment, Conservation and Parks, 2024).

The CLI-ECA contains terms and conditions to allow for streamlined common stormwater infrastructure as an administrative approval. Each municipality is held accountable by providing annual reporting of all new infrastructure that is constructed, watercourse monitoring results, and operations and maintenance logs. (Ministry of the Environment, Conservation and Parks, 2024).

Capital Asset Management

Infrastructure Ontario (IO) regulates planning for adequate funding for municipal infrastructure through requiring corporate assessment management plans. *O.Reg. 588/17 Asset Management Planning for Municipal Infrastructure,* 2017 was adopted by the province to require municipalities to inventory all stormwater infrastructure, including ponds, dams, dykes, storm sewers, and account for 10 years of lifecycle costs (i.e., capital cost and operations, and maintenance) (Government of Ontario, 2021). O.Reg. 588/17 also requires municipalities to describe or map the percentage of properties resilient to a 1:5 year and a 1:100-year storm event (Government of Ontario, 2021). By 2025, the regulation requires full cost-accounting of stormwater infrastructure at the local government level to represent current and proposed levels of service (Government of Ontario, 2021).

3.3 Climate Change

There is direction from the federal and provincial governments to consider climate change but there are no standards or framework to apply to floodplain modelling and mapping (McNeil, 2019). As a result, practitioners are tasked with assuming an estimated uncertainty factor that is not standardized across the province. This makes climate change assumptions in modelling and mapping difficult to defend.

3.4 Inconsistent guidelines

Without updated provincial guidance, some CAs are following the 2002 Flood technical Guide's message of applying 'good engineering judgement' and are updating their own guidelines (Ministry of Natural Resources and Forestry, 2002). A Steering Committee comprised of Ontario's largest CAs, including Toronto Region Conservation Authority, Credit Valley Conservation, and Grand River Conservation Authority, hired a consultant to develop a complement to the 2002 Flood Technical Guide, entitled "Technical Guidelines for Flood Hazard and Mapping" (March 2017) (Environmental Water Resources Group Ltd., 2017). This document states the purpose of the guide is to assist CAs and consultants to generate floodplain mapping (Environmental Water Resources Group Ltd., 2017).

The 2017 Flood Technical Guide could be considered the best available information to inform floodplain mapping in Ontario given the level of expertise that informed the document, and the reliance by the province's largest CAs. However, not all CAs have adopted this information, and it leads to inconsistent assumptions and level of service across the province.

4.0 Why does it matter?

Despite the oversight, maintenance, and approvals processes required by the MECP and IO, as well as the investment to construct SWM ponds, the MNRF technical guidance does not recognize the flood control benefits of SWM ponds for establishing floodplain limits. It is argued by MNRF and some CAs that SWM facilities cannot be relied upon and pose a flood risk if they were to fail (McNeil, 2019); however, it is not considered that this risk can be mitigated by a suitable maintenance regime as required by the CLI-ECA. Overall, there should be a higher consideration for the political and legal ramifications of not recognizing stormwater management pond storage volume against the minimal risk of failure. Of interest, the 2017 Flood Technical Guide supports the inclusion of ponds to provide flood control and makes a decision on how to consider climate change by comparing 50 years of historical rain data to the flood standard (Environmental Water Resources Group Ltd., 2017).

It is important that flood risk management balances property protection, with uncertainty factors, such as climate change and establish a viable level of service since there are direct land use restrictions and infrastructure costs associated with the floodplain, specifically within the limits of the defined line on a map. Figure 4 depicts factors to consider in floodplain management when I presented to the Source to Stream conference in March 2024.

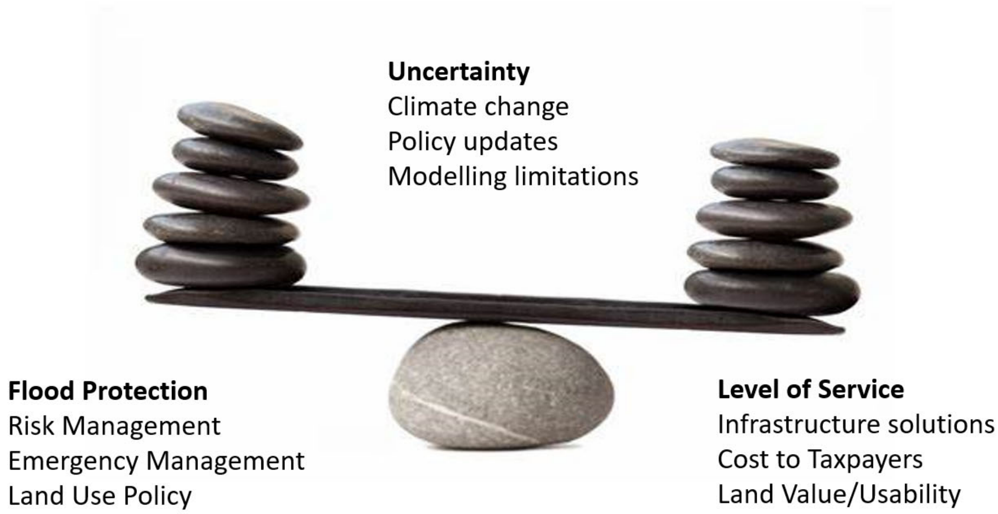

Figure 4: Balancing Act for Flood Management
(from Chambers, 2024)

Developable land footprint and infrastructure costs are two of the most significant impacts to over-estimating floodplain limits.

4.1 Development restrictions

In accordance with the PPS, new development or redevelopment is not permitted in the floodway (Ministry of Municipal Affairs and Housing (MMAH), 2020). As a result, a floodplain update can sterilize lands that may have been previously zoned for growth and development. This can limit economic development and housing units within urban centres.

In addition, any individual properties in the floodplain will not be granted a permit for a secondary dwelling unit (i.e. basement apartment) since it is considered development in the floodplain (Ministry of Municipal Affairs and Housing (MMAH), 2020). This can directly impact the viability of a new homeowner to finance mortgage payments if they had considered renting a unit within their home.

4.1.1 Impact on Housing Crisis

The Conservative party's provincial mandate is heavily focused on mitigating the housing crisis in Ontario. As of August 21, 2023, the province has assigned housing targets to 50 municipalities to meet the "More Homes, Built Faster: Ontario's Housing Supply Action Plan 2022-2023" and build 1.5 million homes by 2031 (Ministry of Municipal Affairs and Housing, 2023).

The provincial goals also include streamlining the development process to reduce the cost of housing. The province passed four bills between 2019 and 2024 to accelerate housing development in Ontario: *Bill 108 – More Homes, More Choice Act,* 2019; *Bill 229 – Protect Support and Recover from COVID-19 (Budget Measures)*, 2020; *Bill 23 – More Homes, Built Faster Act,* 2022; and as of June 6, 2024, *Bill 185 – Cutting Red Tape to Build More Homes Act,* 2024. Each bill amends sections in multiple existing acts, including the Planning Act and the CA Act. Some of the new policies touch on a complex policy framework, including land use, environmental, flood risk, and climate change policies as well as roles and responsibilities (Mitchell, Shrubsole, & Watson, 2024; Mitchell, Watson, & Shrubsole, 2022). However, none of these bills will address the current challenges of floodplain management and there will be impacts to developable land resulting from outdated technical guidance.

4.1.2 Liability and lawsuits

Lawsuits have begun to occur in Ontario after CAs conduct a floodplain update and place properties in the floodplain that were previously considered dry. In October 2020, a class action lawsuit of $1 billion dollars was launched by Oakville property owners against the province, municipalities, and CAs for increasing the floodplain limits (Lea, 2020; Dunn, 2020). The CBC article recognizes some of the impacts as, "Owners have been unable to get permits for home additions, pools or decks. As well, the claim says the properties are less valuable, with owners now obligated to tell buyers they're within a flood plain" (Dunn, 2020). In response to the Oakville lawsuit, Conservation Halton stated (Lea, 2020):

> "This claim alleges that Conservation Halton made policy, land use, and regulatory decisions which increased downstream flood risks to residents, as well as other claims," reads the statement. "These allegations are not true. Conservation Halton at all times worked within the framework of the Conservation Authorities Act and the regulations and the applicable Provincial Policy Statement as well as its own policies. These provisions were all designed to work together to protect the community from dangers to life, safety and property damage."

In accordance with the current design guidance from the province, it is possible that Conservation Halton did not consider any stormwater management ponds constructed with the new development upstream and made assumptions for climate change that may be difficult to defend. The paradox is that the MECP requires ponds provide flood storage, but the MNRF floodplain guidance does not recognize this storage. As a result, it can be argued that new development does cause flooding downstream from a land use policy perspective.

Without an updated provincial standard or guideline, it will be challenging for CAs and municipalities at the local level to justify floodplain limit updates and it could lead to many lawsuits that are technically complex or inconclusive. Professor Usman Khan, a water resources professor at York University, summarizes that "it's difficult in general to "decouple" the effects that climate change and urbanization have on flood risk. He says determining that one played more of a role than the other is challenging…there is much uncertainty in this type of analysis" (Dunn, 2020). Figure 5 illustrates an example of floodplain mapping where the yellow is the area inundated without considering the two SWM ponds, and the coral represents flooding when considering the SWM ponds. This is one example of how stormwater ponds can reduce floodplain limits if the water quantity storage is included in the modelling.

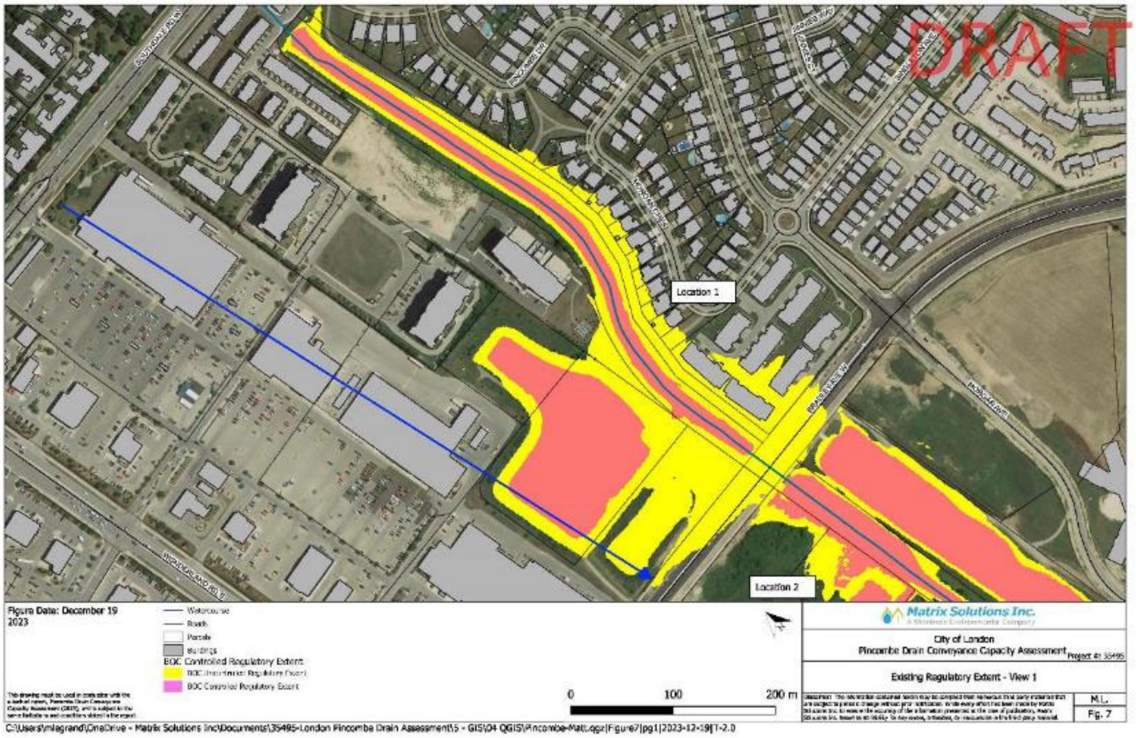

Figure 5: Floodplain with and without ponds, Pincombe Drain, London, ON
(Matrix Solutions Inc., 2024)

4.2 Unrecognized financial investments

Significant financial investments are made each year to construct stormwater ponds, culvert upgrades, bridges, and flood control infrastructure. If outdated assumptions are generating flow rates that are higher than the regulatory storm, it can increase the financial burden across the urban watershed.

4.2.1 Senior Government Funding

In Canada, the federal agencies provide funding transfers to provinces and territories to conduct floodplain mapping studies or to construct infrastructure to protect people from flooding. Municipalities leverage property tax, development charges, or stormwater utility fees to finance stormwater management or structural flood improvements. Appendix B details the Disaster Mitigation Adaptation Fund (DMAF) and the Natural Disaster Mitigation Fund

(DMAF) as two federal funding streams that co-finance with the province and municipalities for structural and non-structural flood management.

Politically, it is remarkable that the infrastructure constructed through government funding programs will not be recognized within the flood model under current design guidelines. For example, Figure 6 below shows a section of the West London Dyke in London, Ontario (City of London, 2008). The federal government is funding $10 million (40% of the $25 million dollar project) through the Disaster Mitigation Adaptation Fund (DMAF) (City of London, 2020) and the provincial government is providing funding through the Water and Erosion Control Infrastructure (WECI) fund (City of London, 2020). Under current MNRF guidelines, this structural dyke will provide no additional land use permissions to properties protected by the dyke and the neighbourhood will continue to be considered floodplain (McNeil, 2019).

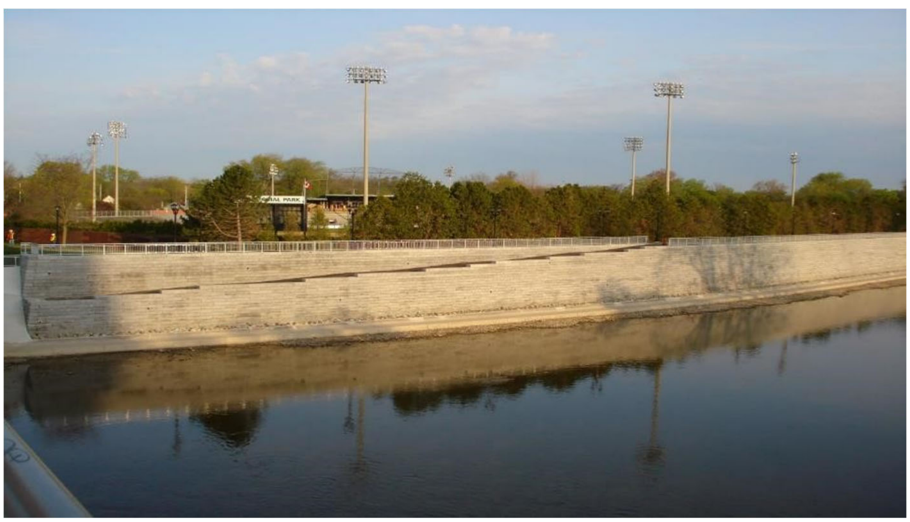

Figure 6: Disaster Mitigation Adaptation Fund project: West London Dyke
(City of London, 2008)

4.2.2 Higher Costs for Municipal Taxpayers

Overestimated floodplains trigger larger infrastructure to convey higher flow rates and it can limit the ability to finance infrastructure improvements, since the higher costs will apply to all structures along the watercourse, from upstream to downstream. New SWM ponds are funded by growth, however, for storm sewer and culvert improvements in the built area, some municipalities fund infrastructure improvements through property taxes while others have adopted a stormwater utility fee to enhance funding streams. These additional costs directly impact budgets and the ability of the municipality to maintain a level of service.

5.0 Focusing Event

In spring 2019, Ontario experienced heavy rains during snow melt conditions that led to 23 municipalities and one First Nation declaring a state of emergency across (McNeil, 2019). In reference to Kingdon's Multiple Streams Framework, the widespread flooding served as a 'focusing event' for the policy problem stream (Hoefer, 2022) that led to the province evaluating the current state of flood management and to produce an updated flood strategy within one year. On March 9, 2020, the province released an updated flood strategy identifying five priorities and eight actions to improve Ontario's flood response (Ministry of Natural Resources and Forestry (MNRF), 2020). See Figure 7.

Figure 7: Ontario's Flood Strategy (from Dungavell, 2024)

The updated flood strategy prioritized the importance of understanding flood risk, strengthening the governance structure, as well as enhancing preparedness, emergency response and funding to reduce risks (MNRF, 2020). The flood strategy identifies roles and responsibilities of current actors involved in the four pillars of flood management: mitigation, preparedness, response, and recovery as shown in Figure 8 (MNRF, 2020).

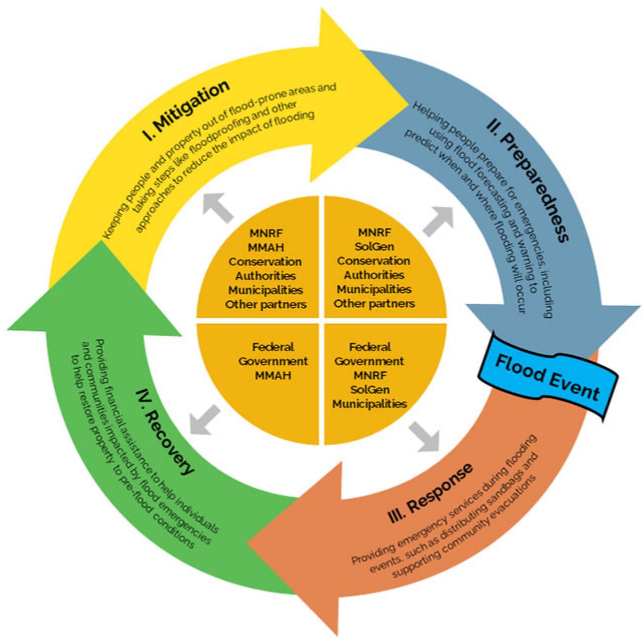

Figure 8: Four pillars of emergency management (MNRF, 2020)

The 2020 Ontario Flood Strategy confirms the lead agency in mitigation and preparedness is the MNRF with support from the Ministry of Municipal Affairs and Housing (MMAH), CAs, and municipalities (MNRF, 2020). The federal government notably only has a role in financing response and recovery (Ministry of Natural Resources and Forestry (MNRF), 2020). See Appendix C for more information on roles and responsibilities of key actors.

On March 9, 2020, the policy window opened with policy streams and political streams ready to take a detailed look at floodplain management in Ontario (Hoefer, 2022).

Unfortunately, the COVID-19 pandemic began later that month and the political stream quickly shifted to manage public health amid the worldwide heath crisis. However, by fall 2020, the Ministry of Natural Resources and Forestry (MNRF) did initiate a Technical Working Group comprised of task teams to tackle the recommendation of the flood strategy (Stainton & Noyes, 2024). MNRF invited CAs, the Association of Municipalities of Ontario (AMO), and federal agencies to participate in the working group to tackle the priority of enhancing flood mapping (Stainton & Noyes, 2024).

While the MNRF started the process to update the 2002 Flood Technical Guide in 2020, updates to the technical guide are outstanding as of July 2024. The MNRF's "Technical Bulletin – Flooding Hazards: Data Survey and Mapping Specifications" was finalized in December 2023 (Stainton & Noyes, 2024). This document only provides guidance on how to gather survey data and physically map the flood but does not provide updates on the assumptions to generate flow rates within a hydrologic model. The updates to the 2002 Flood Technical Guide have many outstanding items to discuss before it can be released (Stainton & Noyes, 2024) and the fact remains, that initiating the update was long overdue when it started in 2020.

The research question remains: Why has there been a lack of horizontal coordination at the provincial level in response to flood risk and climate change? Which policy tools can be leveraged to recognize investments in flood infrastructure and more accurately define floodplain limits?

6.0 Literature Review

The goal of the literature review was to find theories to explain the challenges of realizing integrated floodplain policy that incorporates structural and non-structural flood controls. The literature review started by researching journal articles related to policy coordination. This search led to information on theories related to challenges and possible solutions to policy implementation as well as coordination of environmental problems through policy integration.

Key theories emerged from the literature review, including, Guy B. Peters on Policy Coordination (Peters, 2018), Matland's theory on Policy Implementation (Matland, 1995), and Candel & Bessbrook and Tosun & Lang's theories on Policy Integration (Candel & Biesbroek, 2016; Biesbroek, 2021; Tosun & Lang, 2017) and Hudson, Hunter and Peckham's paper on closing the policy implementation gap (Hudson, Hunter, & Peckham, 2019). In addition, a case study from Switzerland is included as an example of successful floodplain integration (Loschner & Nordbeck, 2020).

A combination of these theories is assessed to answer the research questions. It is notable that theory on solving cross-cutting or wicked problems through policy integration appears to be more prevalent in Europe. The leading articles on policy coordination and policy integration during the literature review originated from Europe, except for Matland from the United States.

6.1 Policy Coordination

Peters (2018) asserts the importance of coordination as part of effective policy design to achieve common goals and address more complex or cross-cutting problems. Peters (2018) identifies *strategic coordination* as most advantageous to achieve larger government goals, such as adaptation to climate change, which involves multiple government agencies at varying horizontal and vertical levels (Peters, 2018). One of the primary challenges to strategic coordination is that it requires proactive, predictive thinking rather than reactive coordination between agencies (Peters, 2018).

In a coordinated policy framework, the benefits can include avoiding duplication of services; reducing contradictions in policies; being flexible to changing demands in society; being able to better manage complex cross-cutting problems; and, to appear more competent to the public (Peters, 2018).

6.2 Challenges with coordination

In general, coordination is becoming more challenging due to a greater number of cross-cutting issues in society, wherein the complexity warrants a multidisciplinary response (Candel & Biesbroek, 2016; Tosun & Lang, 2017; Peters, 2018). Peters identifies seven specific constraints to coordination: specialization, beliefs and ideologies, power, performance management, turf, politics, and accountability (Peters, 2018). Of these, specialization, beliefs and ideologies, and politics apply most to the constraints of floodplain policy coordination.

6.2.1 Specialization - New Public Management

Not surprisingly, the benefits of coordination are generally challenged by the propensity of government agencies to operate in "silos" (Peters, 2018; Tosun & Lang, 2017; Candel & Biesbroek, 2016). Several authors note that New Public Management (NPM) during the 1980s exacerbated silos by focusing on *specialization* within agencies to meet specific goals and targets (Tosun & Lang, 2017; Candel & Biesbroek, 2016; Peters, 2018). While specialization is important to solving specific challenges, it is also the "antithesis to coordination" (Peters, 2018, p. 4) when there is an increase of specialized agencies vying to achieve individual goals. NPM has not focused on horizontal coordination as much as vertical alignment, which has created competition between horizontal actors and sometimes, a fight for financial and staff resources to achieve individualized agency objectives rather than collective public goals (Peters, 2018).

6.2.2 Belief and Ideology

With specialization comes the related challenge of "*beliefs and ideologies*" where "specialized organizations in government will be popular primarily by individuals with a belief in the mission of the organization ideology within the organization can be reinforced by professional training and the tendency of professionals to have a particular conception of policy problems and the possible solution to those problems" (Peters, 2018, p. 5). This barrier also resonates strongly with the challenges of integrated floodplain management, given that the policies are led and developed by specialized technical staff.

6.2.3 Politics

Prioritizing updates to floodplain policies typical require a large flood to provide a "focusing event" to encourage politicians to commit adequate resources to invest in flood risk studies, mapping, and infrastructure. The politics of flooding have a limited "stickiness" (Biesbroek, 2021) in that flooding tends to be a priority when it is flooding but then forgotten a short time afterwards when the impacts of flooding are removed. "Politicians react to demand for action by producing action. They do not pause to consider the feasibility of policy implementation." (Matland, 1995, p. 156). For example, the 2020 Ontario Flood Strategy did not assign additional resources to the MNRF to complete the 2002 Flood Technical Guide update (Stainton & Noyes, 2024).

6.3 Achieving coordination

Peters identifies networks, collaboration, and hierarchical tools as means to achieve coordination (Peters, 2018). Firstly, the importance of networks of committed civil servants is an important component of bottom-up coordination as well as coordinating ideas (Peters, 2018).

Peters stresses the need for "committed and capable individuals" who are willing to work together to support the structures and frameworks of the policy development (Peters, 2018, p. 6). Similarly, to address the "policy implementation gap" of cross-cutting problems, Hudson, Hunter and Peckham offer the importance of an "implementation entrepreneur" as "crucial in determining acceptance and receptivity" to policy implementation (Hudson, Hunter, & Peckham, 2019). "Such actors appear to have a unique identity, indeed certain innate personality characteristics. These are said to include being: highly intuitive, critical analytical thinkers, instigators of constructive social action, well-integrated personalities; highly developed egos; high level of leadership and above average creative potential" (Hudson, Hunter, & Peckham, 2019, p. 7).

Peters also recommends that hierarchical tools can be leveraged by actors from the center of government such as "superministries" to extend across service areas and specialty agencies (Peters, 2018, p. 7).

6.3.1 Policy Integration

Candel and Biesbroek's (2016) theories of *policy integration* are directly related to challenges with environmental and climate change policies where attempts in the European Union have been ongoing for integrated floodplain management (Russel, et al., 2020; Loschner & Nordbeck, 2020; Biesbroek, 2021; Tosun & Lang, 2017) Candel and Biesbroek (2016) identify a framework of four dimensions of integration including: (1) policy frame, (2) subsystem involvement, (3) policy goals, and (4) policy instruments.

The first dimension of policy integration is the *Policy Frame*, defined as "the problem definition and governance understanding that is dominant among the governance system's macropolitical venues and decision-makers…the absence of a policy frame that fosters a common governance approach can pose serious risks" (Candel & Biesbroek, 2016, p. 218). "Sociopolitical mechanisms" influencing the policy frames include "focusing events, policy entrepreneurship, and interest mobilization" (Candel & Biesbroek, 2016, p. 218). For collaboration, Peters also suggests that ideas can be coordinated by "reframing" (Peters, 2018, p. 6). Reframing involves developing a policy frame that is agreed upon by multiple actors through collaboration, however, "resolving coordination problems through collaboration or reframing can be very difficult and time consuming. There are often deeply embedded ideas about policy that must be reconciled across actors" (Peters, 2018, p. 6).

The second dimension is *Subsystem Involvement* or the "range of actors and institutions involved in the governance of a particular cross-cutting policy problem. The rise of a cross-cutting problem on the political agenda is often followed by an increase in the number of subsystems that are formally or informally involved" (Candel & Biesbroek, 2016, p. 218).

The third dimension is *Policy Goals* referring "to the explicit adoption of a specific concern within the policies and strategies of a governance system, including its subsystems, with the aim of addressing the concern" (Candel & Biesbroek, 2016, p. 220).

The fourth dimension is *Policy instruments* which relate to the tools implemented by government agencies to achieve the policy objectives (Candel & Biesbroek, 2016). In the case of floodplain management this would include flood mapping, land use planning, technical guides, and emergency management preparedness.

6.3.2 Policy Implementation

In 1995, Richard E. Matland identifies that there have been traditionally "two schools of thought" with respect to policy implementation: top-down and bottom-up (Matland, 1995, pp. 145-146). Matland synthesizes the literature related to policy implementation research prepared up until 1995 and suggests an ambiguity-conflict model to consider a combination of the two schools shown in Figure 9 (Matland, 1995).

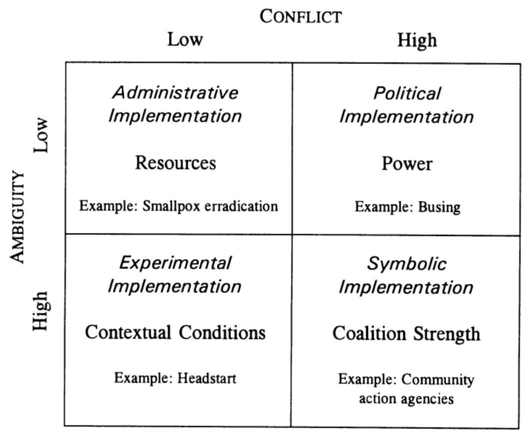

Figure 9: Ambiguity-Conflict Matrix: Policy Implementation Processes
(Matland, 1995, p. 160)

Policy ambiguity is either ambiguity of goals or ambiguity of means, “in designing a policy, goal conflict and ambiguity often are negatively correlated. One of the ways to limit conflict is through ambiguity. The clearer goals are, the more likely they are to lead to conflict” (Matland, 1995, p. 157). Furthermore, “The intensity of conflict increases with an increase in incompatibility of concerns, and with an increase in the perceived stakes for each actor. The more important a decision is, the more aggressive behavior will be” (Matland, 1995, pp. 156-157). In the case of floodplain mapping, the goal is clear but there is an incompatibility of concerns between the MNRF and CAs versus the municipalities implementing the policies.

Matland’s model recommends that high ambiguity and high conflict problems are best resolved through *Symbolic Implementation* where the key organization concept would be coalition or collaborative strength (Hudson, Hunter, & Peckham, 2019; Matland, 1995). Symbolic implementation requires top-down and bottom-up integration. There will be differing perspectives of how to achieve the desired goals and “competition ensues over the correct vision” (Matland, 1995, p. 168). Symbolic implementation differs from political implementation because the microlevel or bottom-up actors ultimately implement the policy decisions (Matland, 1995).

Matland's theory supports Peters recommendation for coordination between horizontal and vertical agencies as necessary to policy implementation (Peters, 2018). However, Matland offers additional insight to why top-down actors may not wish to engage with bottom-up actors as follows:

"One argues from a normative perspective that local service deliverers have expertise and knowledge of the true problems; therefore, they are in a better position to propose purposeful policy. Top-down models, however, see local actors as impediments to successful implementation, agents whose shirking behavior needs to be controlled. The second variant argues from a positive perspective that discretion for street-level bureaucrats is inevitably so great that it is simply unrealistic to expect policy designers to be able to control the actions of these agents. That service deliverers determine policy is a major tenet of bottom-up models" (Matland, 1995, p. 148).

The importance of bottom-up actors is also supported by Hudson, Hunter & Peckam who state, "one of the salient features of many policies – especially those requiring face-to-face contact with the public – is that "lower level" staff have considerable contact with outside bodies and often enjoy discretionary powers which accord them de facto autonomy from their managers. Although many of the decisions of these actors may seem small individually, in aggregate they may radically reshape strategic policy intention" (Hudson, Hunter, & Peckham, 2019, p. 3).

To Peters' note on specialization, Matland notes that professions are likely to contribute most significantly to the task of problem solving. However, there will be competing recommendations to solve the problem and the professional coalitions will likely resort to resolving disagreements by using more political tools of "coercion or bargaining" and less use of "problem solving or persuasion" (Matland, 1995, p. 169).

6.4 Case Study – Switzerland's Flood Management Policies

Nordbeck and Loschner authored an important case study that applies policy coordination to flood risk in Switzerland (Loschner & Nordbeck, 2020). Fortuitously, this research article provides an illustration of policy coordination that is based on the theories of Candel and Biesbroek (2016), Peters (2018), and Tosun and Lang (2017) (see Figure 10).

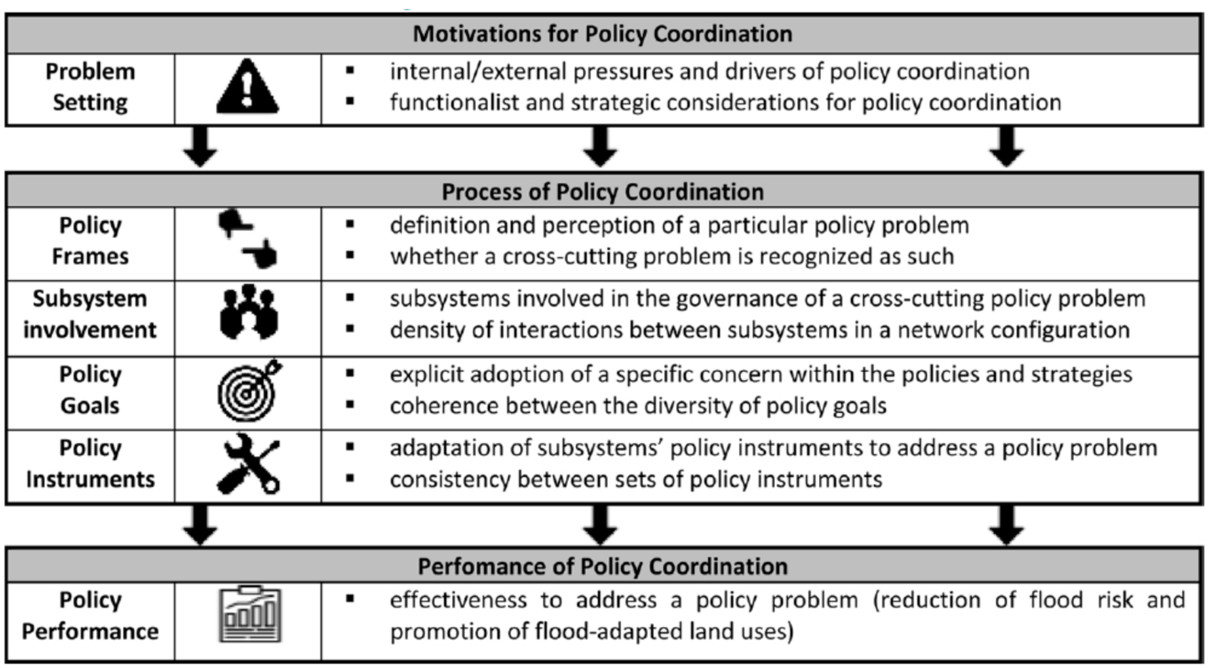

Figure 10: Analytical dimensions of policy coordination
(from Loschner & Nordbeck, 2020, p. 3)

There are four phases noted by Loschner & Nordbeck (2020) in Switzerland's evolution of floodplain policies with respect to the dimensions of policy coordination (Table 1 and 2). Phase III reasonably describes the current state of Ontario policies now and Phase IV effectively describes where Ontario would seek to evolve. Tables 1 and 2 summarize the policy frame, subsystem involvement, policy goals, and policy instruments identified by Candel and Biesbroek (2016).

Table 1: Switzerland's Floodplain Policies in Phase III (Loschner & Nordbeck, 2020, p. 6)

Phase III: Flood-adapted land use (after 1987)	
Policy Frame	• there is no absolute protection against floods • flood risks are dynamic i.a. due to possible climate influences and land development
Subsystem Involvement	• policy sectors: in particular hydraulic engineering and spatial planning • non-state actors, including insurance sector and affected residents
Policy Goals	• differentiate flood protection objectives and reduce hazard potential • prevent land development in hazard areas and mitigate accumulation in damage potential
Policy Instruments	• cantonal and municipal land use plans (in consideration of hazard maps) • flood retention measures and flood spillways • development of boundary-spanning platforms and cross-sectoral administrative units

Table 2: Switzerland's Floodplain Policies in Phase IV (Loschner & Nordbeck, 2020, p. 7)

Phase IV: Planning for flood overload (after 2005)	
Policy Frame	• flood overload and failure of flood defences results in high losses in extreme events • damage potential is increasing in protected areas and low-hazard zones
Subsystem Involvement	• policy sectors: hydraulic engineering and spatial planning • non-state actors, in particular affected residents and other stakeholders
Policy Goals	• accommodate excess floods and prevent failure of protective structures • maintain existing security levels and mitigate new risks
Policy Instruments	• robust protective systems incl. flood spillways and corridors for extreme runoff • risk-based spatial planning incl. planning measures in all hazard areas

In Phase III, Ontario has similar policies in place through the MMAH's PPS to preclude land development in hazard areas and MNRF's *Lakes and Rivers Improvement Act,* 1990 and the CA Act to protect properties from flooding and include floodplain mapping and flood retention measures. In Phase IV, there is an additional recognition that extreme events are going to occur and that there is a need to construct "robust protective systems" as well as conduct "risk-based spatial planning" (Loschner & Nordbeck, 2020).

In Switzerland's evolution between Phase III and Phase IV, the Swiss Federal Council founded the National Platform for Natural Hazards (PLANAT), "consisting of 18 specialists from different administrative levels and policy sectors, the extra-parliamentary commission sets strategic priorities for an intersectoral, whole-of-society approach in risk management" (Loschner & Nordbeck, 2020, p. 6). PLANAT has a shared policy frame of advancing integrated floodplain management. This approach follows Peters' recommendation to create "superministries" (Peters, 2018, p. 7), and "interdepartmental plans, task forces, regulatory impact assessments, funding participants, and monitoring of the participation process" (Tosun & Lang, 2017, p. 77), and "creation of an overarching inter-agency review teams" (Candel & Biesbroek, 2016, p. 233).

7.0 Analysis

Floodplain policy is a cross-cutting issue with many areas of tension on technical and administrative sides to resolve between key actors. This section will apply policy coordination theory to respond to the research questions.

7.1 Why isn't there policy coordination?

First, this section will aim to explain "why is there a lack of horizontal coordination at the provincial level in response to flood risk and climate change?"

7.1.1 Specialized agencies

Floodplain policy would be considered to involve high ambiguity and high conflict in Matland's model since it is a technical issue with actors who hold professional values and allegiances, involves specialized top and bottom level stakeholders, and there are unclear policies that are open to judgement and interpretation (Matland, 1995).

Specialized agencies, such as the MNRF and the CAs seem to be making technical and conservative decisions about structural flood controls in flood mapping, without considering the checks and balances from other provincial agencies such as the MECP and IO. This resonates with Matland's critique of top-down approaches where there is an "emphasis on clarity, rule promulgation, and monitoring…making independent decisions based on merit and technical criteria, free from political influence. It is, however, rarely possible to separate politics from administration. Attempts to insulate an inherently political subject matter from politics do not necessarily lead to apolitical actions. They instead may lead directly to policy failure" (Matland, 1995, p. 148). The MNRF and CAs do not seem to be considering the costs, land implications, and politics of not including senior level government-funded infrastructure or making a decision about risk for climate change. It feels like the MNRF and CAs are making policies in a political vacuum.

7.1.2 Beliefs and Ideology

Challenges arise between the provincial agencies, municipalities, CAs, and land developers due to differing beliefs and ideologies. The province desires to achieve over-arching goals through establishing policies, acts, and compliance instruments, all to work towards implementation and encourage consistency with local actors. Municipalities must balance implementation of multiple competing policies to support economic development, environmental conservation, budgets, and social implications within a policy framework primarily governed by the province. Conservation Authorities are focused predominantly on environmental conservation and hazard management. Land developers are focused on optimizing the yield of housing units in accordance with a profitable business case. The competing sets of priorities can lead to direct conflicts at the implementation scale when it relates to floodplain management (McNeil, 2019).

7.1.3 Differing Goals of Top and Bottom Actors

To address the competing ideologies, policy integration and coordination policies stress the importance of top-down and bottom-up actors working together to achieve policy implementation (Matland, 1995; Candel & Biesbroek, 2016; Tosun & Lang, 2017; Biesbroek, 2021; Loschner & Nordbeck, 2020). Bottom-up actors, such as local municipalities, may be the key to successful policy implementation if the province can provide enough controls to comfortably maintain control over level of service. The CLI-ECA is one example of how the MECP created additional compliance requirements for local municipalities to ensure provincial monitoring tools, in return for streamlined approvals of SWM infrastructure. However, MECP's compliance activities may not resonate with MNRF since SWM facility infrastructure remains outside of its control to manage.

Large municipalities exhibit multidisciplinary collaboration given that there are many competing goal objectives at the municipal level over the more singular goals by the specialty provincial agencies. Municipalities are forever "creatures of the province" that are tasked with multiple roles delegated by the province. These roles include but are not limited to the municipality as: the planning authority over development applications managed by MMAH; constructor of flood protection infrastructure with MECP and MNRF approvals; maintaining CLI-ECA reporting requirements to the MECP; producing inventories and budgets to produce asset management plans for IO; and in preparing emergency response plans to flood events to the Ministry of the Solicitor General (Ministry of Municipal Affairs and Housing (MMAH), 2020; McNeil, 2019; Ministry of Environment, Conservation and Parks, 2003).

The concept of top-down actors at the province aiming to maintain controls or "checks and balances" is challenging for local government as it generates barriers to implementation and reduces the capacity of local and provincial staff to make meaningful change. Further, it can be challenging for municipalities to communicate vertically how multiple specialized policies across horizontal provincial agencies are impacting the implementation of water resources infrastructure and how this also impacts floodplain mapping, municipal budgets, and housing supply.

7.2 Which policy tools can be leveraged to improve policy coordination?

In light of the challenges to policy coordination, "which policy tools can be leveraged to better recognize investments in flood infrastructure and more accurately define floodplain limits to support over-arching provincial goals?" The recommendations for policy coordination are as follows:

7.2.1 Common policy frame and goals

In Ontario's current governance framework, success may lie in horizontal agencies establishing a common frame and overarching goals. This may entail each agency working on different but complimentary policies on variable timelines, to work towards bringing these policies together cohesively (Candel & Biesbroek, 2016). For example, MMAH's goal of improving housing opportunities and streamlining development process would complement MNRF's floodplain policy updates if the connection could be made with MECP's SWM infrastructure policies and IO's asset management plans. "The challenge then is to overcome the asynchronous nature of most integration processes by investing sufficient capacity and resources, including will, into synchronization efforts" (Candel & Biesbroek, 2016, p. 227).

7.2.2 Overarching Inter-agency

Matland's Symbolic Implementation literature and Switzerland's case study would lead us to believe that the convergence of top-down and bottom-up actors will be necessary to achieve successful integrated floodplain management (Matland, 1995; Loschner & Nordbeck, 2020). To organize these actors, the literature stresses the importance of networks and collaboration brought together by "implementation entrepreneurs" (Hudson, Hunter, & Peckham, 2019) and "overarching inter-agency review teams" (Candel & Biesbroek, 2016). Switzerland's PLANAT and successful evolution from Phase III to Phase IV into integrated floodplain management provide inspiration and insights that could be applied to Ontario.

7.2.3 Future of Enhanced Local Governments

Realistically, the MNRF does not have the capacity to ensure compliance of infrastructure or floodplain mapping in Ontario (McNeil, 2019) and the CAs are financed by more than 50% by municipalities (Conservation Ontario, 2024). Since 1954, the CAs role in floodplain management has been to map and regulate the floodplain limits within subwatersheds. The CA floodplain mapping services are valuable for municipalities that do have technical staff experienced in water resources, however, local governments in larger urban centres are evolving to create stormwater engineering divisions to oversee the development application process and capital projects. In general, local governments are evolving into more powerful and important city-regions as economic development and social centres (Gertler, 2016).

Gertler states, “there are many aspects of economic change in the contemporary era which make cities more – not less – important sites of production, distribution, and innovation. A central paradox of our age is that, as economic processes move increasingly to a global scale of operation, the centrality of the local is not diminished but is in fact enhanced” (Gertler, 2016, p. 120). The technical capacity of large urban municipalities could be equal to or greater than the MNRF or CAs to address urban flood management. As the sophistication of cities evolve, the efforts of the province to exert control over local governments through compliance measures could become obsolete to reduce red tape.

8.0 Conclusions

In reviewing theory of policy coordination, policy integration and policy implementation, it was considered that the primary constraints to coordination between horizontal provincial agencies was due to specialization of provincial agencies, including MNRF, MMAH, MECP, and IO. In contrast to the beliefs and ideologies of specialized provincial agencies, municipalities must make decisions in a multidisciplinary framework, which causes conflict between provincial and local actors. The municipal government must consider multiple roles during policy implementation and as a result, collaboration between top and bottom actors becomes challenging.

In response to the policy coordination challenges, the policy tools that may be successful to implement include creating a common policy frame and overarching goals for the provincial policy makers to achieve collaborative provincial goals. In addition, the implementation of a coordinated inter-agency that can manage the cross-cutting problems associated with structural and non-structural flood controls is recommended to facilitate a common policy frame that would include top-down and bottom-up actors. The interagency needs to be populated by implementation entrepreneurs who are eager to make positive changes to achieve integrated floodplain management.

Ultimately, considering the politics, investments, flood risk, climate change and compliance by municipalities across the province to a consistent level of service, are important to applying a balanced approach to floodplain management. This may include recognizing the benefits of structural flood controls, such as stormwater management facilities, as well as establishing a cost-risk-benefit framework to balance levels of service in response to climate change. "The appropriate balance will depend on a number of factors but political and professional judgements are required to make the correct decision on coordination" (Peters, 2018, p. 10).

9.0 References

Aqufor Beech Ltd. (2019). *Stormwater Management Master Plan: Stormwater Management Policy Review.* Guelph: City of Waterloo. Retrieved from https://www.waterloo.ca/en/government/resources/Documents/Cityadministration/SWMP/Appendix-A-policy-review.pdf

Biesbroek, R. (2021). Policy integration and climate change adaptation. *Current Opinion in Environmental Sustainability, 52*, 75-81. doi:10.1016/j.cosust.2021.07.003

Candel, J. J., & Biesbroek, R. (2016). Toward a processual understanding of policy integration. *Policy Sciences, 49*(3), 211-231. doi:10.1007/s11077-016-9248-y

Chambers, S. (2024). What line is it anyway? Stormwater infrastrucure and Climate Change in Floodplain Mapping. *Source to Stream Conference.* Brampton, ON: City of London.

City of London. (2008). *West London Dyke.* London, ON: Photo from Stormwater Engineering Division.

City of London. (2012). *Fox Hollow Stormwater Management Facility.* London, ON: Photo from Stormwater Engineering Division.

City of London. (2020, July 14). *Upper Thames River Conservation Authority and City of London Flood Protection Projects: West London Dyke Phase 7.* Retrieved from Civic Works Committee: https://pub-london.escribemeetings.com/filestream.ashx?DocumentId=73459

Conservation Ontario. (2024). *About Conservation Authorities*. Retrieved from Conservation Ontario: https://conservationontario.ca/conservation-authorities/about-conservation-authorities

Dungavell, J. (2024). Ontario Flooding Strategy Implementation. *Canadian Water Resources Association Flooding Workshop 2024.* Oakville: Ministry of Natural Resources and Forestry.

Dunn, T. (2020, October 9). *$1B class-action claim alleges Oakville property owners at flood risk due to 'over-development'*. Retrieved from CBC News: https://www.cbc.ca/news/canada/toronto/1b-class-action-claim-alleges-oakville-property-owners-at-flood-risk-due-to-over-development-1.5755264

Environmental Water Resources Group Ltd. (2017). *Technical Guidelines for Flood Hazard Mapping.* Toronto. Retrieved from https://trca.ca/app/uploads/2018/10/Technical-Guidelines-For-Flood-Hazard-Mapping-March-2017-Final.pdf

Gertler, D. A. (2016). *Growing Urban Economies: Innovation Greativity and Governance in Canadian City-Regions.* Toronto: University of Toronto Press.

Government of Ontario. (2021, March 15). *O.Reg. 588/17: Asset Management Planning for Municipal Infrastructure*. Retrieved from E-laws: https://www.ontario.ca/laws/regulation/170588

Government of Ontario. (2024, February 16). *O.Reg. 41/24: Prohibited Activities, Exemptions, and Permits*. Retrieved from E-laws: https://www.ontario.ca/laws/regulation/r24041

Hoefer, R. (2022). The Multiple Streams Framework: Understanding and Applying the Problems, Policies, and Politics Approach. *Journal of Policy Practice and Research, 3*, 1-5. doi:10.1007/s42972-022-00049-2

Housing, Infrastructure, and Communities Canada (HICC). (2023, 09 18). *Disaster Mitigation and Adaptation Fund: Overview*. Retrieved from Government of Canada: https://www.infrastructure.gc.ca/dmaf-faac/index-eng.html

Hudson, B., Hunter, D., & Peckham, S. (2019). Policy failure and the policy implementation gap: can policy support programs help? *Policy Design and Practice, 2*(1), 1-14. doi:10.1080/25741292.2018.1540378

Lea, D. (2020, October 8). *Class Action lawsuit proposed against Town of Oakville and others seeking nearly $1 billion in damages*. Retrieved from Inside Halton: https://www.insidehalton.com/news/class-action-lawsuit-proposed-against-the-town-of-oakville-and-others-seeking-nearly-1-billion/article_801e7b5e-1fd0-5859-9993-501137e6f081.html

Loschner, L., & Nordbeck, R. (2020). Switzerland's transition from flood defence to flood-adapted land use- A policy coordination perspective. *Land Use Policy, 95*. doi:https://doi.org/10.1016/j.landusepol.2019.02.032

Matland, R. E. (1995, April). Synthesizing the Implementation Literature: The Ambiguity-Conflict Model of Policy Implementation. *Journal of Public Administration Research and Theory, 5*(2), 145-174. Retrieved from https://www.jstor.org/stable/1181674

Matrix Solutions Inc. (2024). *Pincombe Drain Urban Waterways Assessment.* London, ON: Prepared for City of London.

McNeil, D. (2019). *An Independent Review of the 2019 Flood Events in Ontario.* Winnipeg: McNeil Consulting Inc. Retrieved from https://files.ontario.ca/mnrf-english-ontario-special-advisor-on-flooding-report-2019-11-25.pdf

Ministry of Environment, Conservation and Parks. (2003, March). *Stormwater Management Planning and Design Manual.* Retrieved from Government of Ontario: https://www.ontario.ca/document/stormwater-management-planning-and-design-manual-0

Ministry of Municipal Affairs and Housing (MMAH). (2020, May 1). *Provincial Policy Statement.* Retrieved from Government of Ontario: https://files.ontario.ca/mmah-provincial-policy-statement-2020-accessible-final-en-2020-02-14.pdf

Ministry of Municipal Affairs and Housing. (2023, August 21). *Ontario Providing New Tools to Municipalities to Build More Homes Faster*. Retrieved from Government of Ontario Newsroom: https://news.ontario.ca/en/backgrounder/1003396/ontario-providing-new-tools-to-municipalities-to-build-more-homes-sooner

Ministry of Natural Resources and Forestry (MNRF). (2020, March 09). *Protecting People and Property: Ontario's Flooding Strategy.* Retrieved from Government of Ontario: https://www.ontario.ca/page/protecting-people-property-ontarios-flooding-strategy

Ministry of Natural Resources and Forestry. (2002). *Technical Guide - River & Stream Systems: Flood Hazard Limit.* Retrieved from St. Clair Region Conservation Authority: https://www.scrca.on.ca/wp-content/uploads/2018/09/MNR-Technical-Guide-River-and-Stream-Erosion-Hazard.pdf

Ministry of the Environment, Conservation and Parks. (2024, June 13). *Municipal Consolidated Linear Infrastructure Environmental Compliance Approvals*. Retrieved from Government of Ontario: https://www.ontario.ca/page/municipal-consolidated-linear-infrastructure-environmental-compliance-approvals

Mitchell, B., Shrubsole, D., & Watson, N. (2024). New Policy and regulatory reforms for Ontario Conservation Authorities. *Canadian Water Resources Journal, 49*(2), 1-7. doi:10.1080/07011784.2024.2370199

Nordbeck, R., Seher, W., Gruneis, H., Herrnegger, M., & Junger, L. (2023). Conflicting and complementary policy goals as sectoral integration challenge: an analysis of sectoral interplay in flood risk management. *Policy Sciences, 56*, 595-612. doi:10.1007/s11077-023-09503-8

Ontario. (2024, June 6). *Conservation Authorities Act, R.S.O. 1990, c. C.27.* Retrieved from E-laws: https://www.ontario.ca/laws/statute/90c27

Ontario. (2024, April 01). *Ontario Water Resources Act, R.S.O. 1990, c.O.40.* Retrieved from E-Laws: https://www.ontario.ca/laws/statute/90o40#BK86

Peters, B. G. (2018). The challenge of policy coordination. *Policy Design and Practice, 1*(1), 1-11. doi:10.1080/25741292.2018.1437946

Public Safety Canada (PSC). (2023, 08 25). *National Disaster Mitigation Program (NDMP).* Retrieved from Government of Canada: https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgtn/ndmp/index-en.aspx

Russel, D., Castellari, S., Capriolo, A., Dessai, S., Hilden, M., Jensen, A., . . . Troltzsch, J.

(2020). Policy Coordination for National Climate Change Adaptation in Europe: All Process, but Little Power. *Sustainability, 12*(5393), 1-18. doi:10.3390/su12135393

Stainton, R., & Noyes, I. (2024). Provincial Flood Hazard Technical Guide Updates - Current Status and Future Plans. *Canadian Water Resources Association Flooding Workshop 2024.* Oakville: Ministry of Natural Resources and Forestry.

Sutton, K., & Pinho, P. (2024, April 10). *Amendments to Ontario's Conservation Authorities Act: Effective April 1, 2024*. Retrieved from McMillan LLP: https://mcmillan.ca/insights/amendments-to-ontarios-conservation-authorities-act-effective-april-1-2024/

Tosun, J., & Lang, A. (2017). Policy integration: mapping the different concepts. *Policy Studies, 38*(6), 553-570. doi:10.1080/01442872.2017.1339239

Appendix A: General methodology to estimate floodplain limits

Hydrologic and hydraulic modeling software is the primary tool used by engineers to generate flow rates and floodplain limits for a watercourse. A simulated storm event is used as a key input into the *hydrologic model* to generate the rainfall over a simulated watershed. The storm frequencies are assessed using regression statistical analysis of historic rainfall data to generate intensity duration frequency ("IDF") curves representing rainfall in mm/hour. The IDF curve is the industry standard to use when designing storm sewers or modeling watersheds. For example, in Ontario, the minimum standard for storm sewer/drainage design is a 2-year storm event and the minimum flood standard event is a 100-year storm event.

The hydrologic model inputs include information to represent the ground conditions of the watershed over which the rain is falling (i.e. land area, imperviousness, land slope, soil conditions, distance to inlets). The hydrologic model then simulates how the ground conditions respond to the rainfall and the model outputs flow rates of stormwater runoff for each land area inputted into the model. The runoff flow rates from the hydrologic model are then inputted or transferred over into a *hydraulic model.* The hydraulic model is effectively a geometric representation of the watercourse and its adjacent lands. The hydraulic model is generated by inputting survey data of the cross-sectional elevations of the watercourse and is supplemented by topographic elevation information.

Appendix B: Federal Government Funding Programs

B1. Disaster Mitigation Adaptation Fund (DMAF)

As of June 20, 2024, Infrastructure Canada was renamed to Housing, Infrastructure and Communities Canada (HICC) (Housing, Infrastructure, and Communities Canada (HICC), 2023). The HICC offers cost-shared funding with provincial and local governments for climate change adaptation through the Disaster Mitigation Adaptation Fund (DMAF). In 2018, the federal government committed "$2 billion over 10 years to invest in structural and natural infrastructure projects to increase the resilience of communities that are impacted by natural disasters triggered by climate change" and added another $1.375 billion in 2021 over 12 years to enhance the DMAF (HICC, 2023). The DMAF focuses on implementation of large infrastructure construction projects such as structures that would mitigate flood risk including structural dykes, dams, and flood walls.

B2. National Disaster Mitigation Program (NDMP)

Between 2015 and 2022, Public Safety Canada administered the National Disaster Mitigation Program (NDMP) as a funding source to identify increasing costs and risks associated with flooding in a changing climate (Public Safety Canada (PSC), 2023). The federal funding is provided under a cost-sharing arrangements with provincial, local governments, and public sector bodies, such as Conservation Authorities. There was $200 million dollars in funding between from 2015 to 2020 and an additional $20 million from 2021 until March 31, 2022 (PSC, 2023). The funding focused on technical studies as eligible projects fell into one of four streams: risk assessments, flood mapping, mitigation planning, and investments in non-structural small scale structure mitigation projects (PSC, 2023). Unlike the DMAF that is focused on construction, the investments through the NDMP were engineering or technical studies to assess flood risk and could also support modelling to support floodplain mapping.

PSC also administers the federal flood disaster assistance payments and Emergency Preparedness Program with $4.5 million in funding to help provinces with emergency preparedness.

Appendix C: Lead Agency Roles and Responsibilities

C1. Ministry of Natural Resources and Forestry (MNRF)

The MNRF is the lead agency responsible for mitigation and preparedness, including floodplain mapping, flood hazard management, and flood forecasting and warning (Ministry of Natural Resources and Forestry (MNRF), 2020). The MNRF uses the tools of the *Planning Act R.S.O. 1990, c.P.13*, the *Conservation Authorities Act R.S.O. 1990, c.C.27*, the Natural Hazard Technical Guides, mapping, and geomatics services to implement the flood hazard mapping program (McNeil, 2019). The MNRF also administers the *Lakes and Rivers Improvement Act, R.S.O. 1990, c. L.3* to approve flood control structures including, dykes, dams, and obstructions in watercourses that may modify riverine flood limits (McNeil, 2019).

C2. Ministry of Municipal Affairs and Housing (MMAH)

The Ministry of Municipal Affairs and Housing (MMAH) administers the *Planning Act,* 1990 and the *Provincial Policy Statement* (PPS). The PPS includes hazard policies for new development and redevelopment and defines the floodplain, floodway, flood fringe, two-zone concept, special policy areas as well as structural and non-structural flood protection (Ministry of Municipal Affairs and Housing (MMAH), 2020).

Section 3.1 Natural Hazards of the PPS (Ministry of Municipal Affairs and Housing (MMAH), 2020) directs development or redevelopment outside of flood hazards and broadly recommends planning authorities to prepare for climate change. Development may occur in the flood fringe, where there are lower depths and velocities, subject to provision of floodproofing and safe access in accordance with the MNRF policies. A two-zone concept is defined where a flood way and flood fringe are formally assigned. Special Policy Areas are identified to acknowledge areas that exist within the floodplain and may be permitted to allow for continued economic vitality of the area (Ministry of Municipal Affairs and Housing (MMAH), 2020).

C3. Conservation Authorities

Between 2019 and 2023, the province reviewed the roles and responsibilities of CAs and multiple new regulations were released. Following this review, the CAs retained authority to regulate and update floodplains but were given no additional funding or updated guidance documents from the province (Mitchell, Shrubsole, & Watson, 2024). While CAs are delegated to act on behalf of MNRF for hazard management, the funding structure does not reflect provincial support. On average, funding to local CAs is reliant on municipal levies (53%), self-generated revenues (35%), with limited funding from provincial (8%) and federal grants (4%) (Conservation Ontario, 2024).

C4. Local Government

Municipalities are “creatures of the province” and are tasked with implementing flood risk management through its roles as 1) the planning authority over development applications managed by MMAH, 2) constructors of flood protection infrastructure through MECP and MNRF, 3) maintaining its CLI-ECA reporting requirements to the MECP, 4) inventories and budgets to product the Asset Management Plan for IO, or 5) in preparing emergency response plans to flood events (Ministry of Municipal Affairs and Housing (MMAH), 2020; McNeil, 2019; Ministry of Environment, Conservation and Parks, 2003).