

Chief Executive Officer



May 27, 2020

Patricia Koval
Member
Ontario's Advisory Panel on Climate Change

Re: TRCA Recommendations to the Advisory Panel on Ontario's Flooding Strategy

Dear Ms. Koval:

Thank you for taking the time to meet Toronto and Region Conservation Authority (TRCA) staff on March 9, 2020 to share our knowledge and expertise in supporting the creation of resilient communities, infrastructure, and housing within our jurisdiction.

On September 10, 2019, TRCA staff had the opportunity to meet with Ontario's Special Advisor on Flooding to present both the unique challenges of our highly urbanized jurisdiction, as well as our expertise in flood risk management in this context, including a tour of successfully completed and in-process flood protection projects. We were pleased to see many of TRCA's recommendations to the Special Advisor, as outlined in the attached letter of September 27, 2019, carried forward into his final report released by the Province on November 28, 2019.

The subsequent release of Ontario's Flooding Strategy on March 9, 2020 acknowledges the success of current provincial policy and the expertise of conservation authorities and municipalities in implementing provincial policy to help reduce flood risks. The structure of the report follows the components of the emergency management cycle and mirrors our own flood risk management strategies, programs and services. Many of the actions outlined in the Strategy are areas in which TRCA has already exhibited leadership.

We were also pleased to see:

- Acknowledgement of flooding as a natural process that will continue to occur;
- Recognition of the role and legacy of Conservation Authorities as essential partners in protecting people and property from flooding;
- Recognition of the need to update provincial guidelines, including the MNRF River and Stream Systems - Flooding Hazard Limit and the Great Lakes Shoreline Hazard Limit to account for both technological advancements, as well as climate change; and
- A set of Goals, Priorities, and Objectives for flood management that align with TRCA's Strategic Plan, priorities, and legislative mandate.

While it is recognized that Ontario's Flooding Strategy (the Strategy) is meant to be a high level document, our review has highlighted several areas of improvement, as noted below.

1. Further details in a workplan, including timelines, to provide certainty on the delivery of priorities and actions

While the recommendations within the Special Advisor's report were explicitly outlined, it is not easy to distinguish the roles, responsibilities, or timelines to execute and deliver the suite of actions and activities identified in the Strategy. The most important area of improvement would be to issue a follow up document that provides a workplan for the actions and activities in the Strategy in order to provide more certainty to stakeholders. As an example, our work continues to be governed by many of the guidelines and policies that were identified for updating, therefore it is critical to accelerate the timelines associated with the updating of both the policies and the technical guidelines so that they can be applied to the significant capital investments in flood and erosion risk reduction in programs such as the Disaster Mitigation and Adaptation Fund.

2. Establishing Working Groups

Responsibilities, timelines, membership, and the participation process associated with certain working groups identified in the Strategy, such as the "Urban Flooding Work Group" or "Multi-Agency Flood Mapping Technical Team", are not clear. The converse situation exists where some of the actions warrant a working group which has not been identified, such as actions and activities related to policy, legislative or regulatory matters associated with land use planning, or the task to "examine and analyze existing flood level values specified on the Great Lakes – St. Lawrence and connecting channels, considering recent high-water levels and what may be predicted under a changing climate". It is acknowledged that successful implementation of the actions within the Strategy will require the collaboration and support of several stakeholders, including conservation authorities. Therefore, it will be imperative that the working groups are resourced with the appropriate stakeholders and expertise, together with a workplan to ensure timely deliverables to advance the Strategy.

3. Highlighting the value of watershed planning and conserving natural resources to managing flood resiliency

One of the key recommendations that we provided to the Flood Advisor was to promote better integration of natural hazard, natural heritage and water resource system policies through watershed and subwatershed planning, as well as infrastructure planning in the Provincial Policy Statement. Conserving natural resources makes watersheds more resilient to the variations in precipitation patterns resulting from climate change. As such, natural hazards and natural heritage are intrinsically linked. While the Strategy does include a variety of actions related to wetlands, it could be further strengthened and enhanced about the interrelationship between natural heritage systems and natural hazards, particularly within the urban/urbanizing context.

4. Funding to support implementation

While the strategy does note the need to leverage existing funding programs for other levels of government, there are no new funding commitments outlined in the strategy. CAs have a large portfolio of purpose-built, as well as inherited, flood control structures that are approaching their end of life; significant investments will be required to upgrade, and maintain, infrastructure in a state of good repair. The strategy noted a continuation of financial support from the Water Erosion Control Infrastructure (WECI) program, however increased funding to this program is desirable in order to meet the cost-sharing requirements for other federal funding programs, such as the Disaster Mitigation and Adaptation Fund.

Funding through the federal National Disaster Mitigation Program (NDMP) has been effective at supporting flood risk reduction through multiple means and has allowed CAs to accelerate important work in flood line mapping, flood risk modeling, flood infrastructure assessments and flood forecasting and warning. TRCA secured over \$3.9 Million in NDMP funds to accelerate our program work.

Given the ample evidence of risks associated with extreme weather and climate change, funding is required to continue the important work in both the flood forecasting and warning and flood infrastructure realms. While the federal Disaster Mitigation and Adaptation Fund (DMAF) can help support projects with a capital component, important work such as the development of improved flood forecasting and warning tools and risk assessments would not qualify for DMAF funding. Many of these federal grants are matching programs. The Province could play a leadership role by supporting mechanisms for municipalities to collect dedicated funding for flood remediation and mitigation projects.

5. Priority: Updating Technical Guidelines

Given TRCA's significant experience in flood risk management which aligns with the actions and activities outlined in the Flood Strategy, we are eager to share our knowledge and technical expertise to support the Province to achieve our collective goals and objective to increase Ontario's resiliency to flooding. As discussed in our meeting on March 9th, we would recommend that a top priority would be the updates the Ministry of Natural Resources and Forestry (MNRF) Technical Guidelines related to natural hazards, including guidance to "prepare for the impacts of a changing climate" in order to be consistent with Provincial Policy Statement (PPS) 2020. With guidance developed by the Province now being referenced in section 3.1.1 Natural Hazards of the PPS, there is an urgent need to have the technical guidance updated to reflect current technology and approaches, particularly within the urban context, so as not to be a barrier for innovative solutions. While this updating process is technical in nature, these guides do influence land use planning and CA permitting decision, as such, it recommended that as noted above, a policy, planning and regulatory working group be established and integrated with the technical work. This will ensure current challenges and opportunities are considered and that any policy, legislative and regulatory changes are identified.

Specific updates relating to key technical guidelines are outlined below.

Update the Ministry of Natural Resources and Forestry (MNRF) Technical Guide (River and Stream Systems, Flood Hazard Limit) to:

- a) **Account** for technological advancements in the last 15 years, including the proliferation of two-dimensional modelling software and methodologies, as well as the use of GIS-based models and mapping outputs.
- b) **Provide** guidance, as per the commitments in "A Made-in-Ontario Environment Plan", to support the application of climate change science in decision making, including the consideration of the extreme precipitation increases expected with our changing climate in both floodplain mapping and infrastructure design.
- c) **Provide technical and policy guidance specific to flood risk in the urban context to:**
 - Resolve the reporting relationship for stormwater management and flood risk management. CAs deal with Ministry of Environment, Conservation and Parks (MECP) for stormwater management matters but deal with MNRF for flood management matters. The role of stormwater ponds in mitigating the impacts of urban development, for example, are recognized by MECP, but are not recognized as providing flood risk reduction benefits according to MNRF.
 - Take a risk-based approach to mitigate existing urban flood risk. Historically, CA efforts have been focused on delineating hazard areas. While this is important to implement land use management for new greenfield development, within the urban context it is important to

assess priorities for flood mitigation from a risk-based perspective, targeting the highest risk areas and developing solutions that fit within the urban constraints of the area.

- Reconcile growth and risk reduction goals. The Provincial Growth Plan and municipal official plans have identified areas for intensification and urban expansion. In order to accommodate the proposed growth in Ontario, impacts to flooding must be considered and managed appropriately. Many Urban Growth Centers, (e.g. Downtown Toronto, Brampton, Vaughan) are located in historic flood plains and in some cases, future urban expansions can result in increases to Regional flood flows, in turn expanding downstream flood plains. In order to protect life and property from flooding and allow for future growth, remedial measures to provide permanent flood protection need to be considered since passive approaches (e.g. moving development to other locations, expropriating land and infringing on riparian rights) may not be feasible. Currently, the methodology of utilizing remedial measures is not considered in the current MNRF Technical Guidelines (2002); however, there are examples where these types of practices have been successfully implemented in Ontario, with Provincial approval (e.g. West Donlands Flood Protection landform) with resulting benefits including acting as a catalyst for development of the Pan Am Village and major private sector redevelopments.
- d) **Update the 2009 Special Policy Area Procedures** informed by lessons learned by CAs from comprehensive updates undertaken in the last 10 years. Many SPAs were designated in the late 1980s and early 1990s. Several comprehensive updates undertaken in TRCA's jurisdiction have been completed in consultation with municipalities, the Province, and the public. These multi-year projects have provided valuable insights on improvements to processes and outcomes such as: ensuring municipal documents (Official Plans and Zoning-By-laws) reflect the current planning and policy regime; ensuring corresponding updates to municipal flood emergency response plans; and ensuring the up-front understanding of technical studies required to accompany applications to streamline submissions in the development process.

Regarding the MNRF Technical Guides for Great Lakes -St. Lawrence River Shorelines Hazards:

- a) **Update** the 100-year level for Lake Ontario to account for the high levels seen in 2017 and 2019. Data included in the 2001 Technical Guide are based on older data presented in the MNRF document, "Great Lakes System Flood Levels and Water Related Hazards" (February 1989), which includes an analysis of data ending in the year 1987. The Province should update the governing reach-by-reach 100-year lake elevations to account for more recent historical records, climate change, and the impact of Plan 2014 of the International Joint Commission. This should be done in conjunction with the expedited review of Plan 2014 by the Great Lakes Adaptive Management Committee, in order to ensure a common approach between the federal IJC initiatives and the MNRF objectives.
- b) **Include** guidance on the expected changes in shoreline erosion risk with a changing climate, as a result of updated return period lake levels, as well as the reduction in expected ice-cover under future climate scenarios.
- c) **Reconcile** the variation in determining the shoreline erosion hazard limit as currently described in the MNRF Technical Guide and regulations under Section 28 of the Conservation Authorities Act.

Update the MNRF Technical Guide River and Stream Systems: Erosion Hazard Limit to:

- a) Account for any technological advancements, include guidance on climate change and provide technical and policy guidance to erosion risk within the urban context.

6. Priority: Conservation Authorities Act and associated regulations

The Strategy acknowledges that municipalities and conservation authorities are central to the success of local flood management, having distinct delegated roles from the Province along with legislated and regulatory responsibilities. In this regard, we recommend the following related to the *Conservation Authorities Act* and associated regulations:

- a) **Support** the creation of a robust natural hazard protection and management mandatory program and services regulation under Section 21.1 (1) of the *Conservation Authorities Act* that recognizes the value of comprehensive integrated watershed management and conserving natural resources to reduce risks associated with flooding
- b) **Include** pro-active watershed and subwatershed planning, flood and erosion control, and remediation work as a mandated activity of CAs.
- c) **Recognize** within the mandatory programs and services, the role of CAs in the land use planning and environmental protection process, as linked to legislation including the *Planning Act*, *Environmental Assessment Act*, and the *Conservation Authorities Act*, in supporting the implementation of provincial policies.
- d) **Add** a clause of indemnification or statutory immunity for the good faith operation of essential flood and erosion control infrastructure and programming

Thank you once again for the opportunity to meet with you and to provide TRCA staff comments and recommendations on flood risk management and resilience in Ontario. A copy of the presentation given by Rehana Rajabali, Sameer Dhalla, Moranne McDonnell and Laurie Nelson at the meeting has also been enclosed. Should you have any questions, require clarification, or wish to meet to discuss the above remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original signed by>

John MacKenzie, M.Sc.(PI) MCIP, RPP
Chief Executive Officer

Encl.

BY E-MAIL

cc: Sameer Dhalla, Director, Engineering and Development Services
Rehana Rajabali, Senior Manager, Flood Risk Management
Laurie Nelson, Director, Policy Planning
Moranne McDonnell, Director, Restoration and Infrastructure

September 27, 2019

Mr. Doug McNeil, P.Eng.
Special Advisor on Flooding
c/o Ms. Jennifer Keyes
Manager, Water Resources Section
Ministry of Natural Resources and Forestry

VIA EMAIL

jennifer.keyes@ontario.ca

Dear Mr. McNeil:

Re: TRCA Recommendations to the Province on Flood Risk and Resilience in Ontario

Thank you for taking the time to meet Toronto and Region Conservation Authority (TRCA) staff on September 10, 2019 to discuss our roles, responsibilities, and expertise related to flooding within our jurisdiction. We appreciated the opportunity to take you on a tour of flood prone areas in our jurisdiction and to see firsthand, successfully completed, or in-process flood protection projects.

TRCA and its member municipalities have a vested interest in your work and are highly supportive of the Province's efforts to meet shared provincial and municipal objectives for addressing flood risk in Ontario's watersheds. Further to our meeting, the following recommendations were compiled by TRCA staff who oversee our response to flood events and work with municipalities, emergency services, watershed residents and the Province on matters related to flooding. These comments have also been vetted by TRCA's Senior Leadership Team involved in the implementation of adaptive "flood proofing measures" on behalf of our partners including municipalities and government agencies. We are hopeful our recommendations will inform your work.

To improve flood resilience in Ontario, we offer the following recommendations with supporting comments and rationale:

1. Acknowledge the success of current provincial policy and the expertise of conservation authorities and municipalities in implementing provincial policy to help reduce flood risks

Since the development of modern flood plain policy, the watershed approach, conservation authority model (including section 28 regulations), and Hurricane Hazel flood standard have been extremely effective at reducing flood risks in our jurisdiction, especially in new greenfield development areas. Strong provincial legislation and policy, including the *Planning Act*, Provincial Policy Statement (PPS), the *Conservation Authorities Act* (CA Act), *Environmental Assessment Act*, *Development Charges Act*, as well as supporting technical guides in hazard management, have substantially reduced flood risks in newly developed greenfield areas in our jurisdiction. In addition, the fact that section 28 permitting Regulations under the CA Act are applicable law under the *Building Code Act* has been an important mechanism in avoiding increases in flood risk for people, property and infrastructure. We would recommend your report acknowledge that the existing provincial flood risk management framework, and its implementation by municipalities and conservation authorities, has collectively gone a long way to reduce and mitigate flood risks in Ontario.

2. Strengthen and update provincial legislation, policies and guidelines

The Made-In-Ontario Environment Plan affirms the important role of conservation authorities (CAs) in the land use planning and environmental protection process. CAs provide significant support to both the Province and municipalities in the implementation of the PPS and the Provincial Plans (e.g. Growth Plan). CA core roles are linked to other legislation such as the *Planning Act* and the *Environmental Assessment Act*, where we provide one-window review of natural hazard issues related to development and infrastructure applications and relevant sections of implementation of the PPS. Additionally, the administration of TRCA's regulatory permitting responsibilities under Section 28 of the *Conservation Authorities Act* complements our delegated planning responsibilities. Furthermore, the unique watershed-based governance model of CAs that transcends municipal boundaries has enabled innovation in developing practical solutions to current and emerging issues, (e.g. flood

management, climate change, rapid urbanizing/growth), through partnerships with other CAs and municipalities. To maintain and improve on-the-ground implementation, we offer the following recommendations related to the **Provincial Policy Statement Review**:

- 2.1. **Enhance** the current policy framework to recognize the urban context, (i.e. flood vulnerable urban cores and transit lines), and provide guidance for appropriate community revitalization/redevelopment, including encouraging flood mitigation projects and remediation to provide protection to existing development, even if it is not possible to remediate the risk to the regulatory level.
- 2.2. **Promote** better integration of natural hazard, natural heritage and water resource system policies through watershed and subwatershed planning and infrastructure planning in the PPS. Conserving natural resources makes watersheds more resilient to the variations in precipitation patterns resulting from climate change. As such, natural hazards and natural heritage are intrinsically linked.
- 2.3. **Update** the Technical Guidelines to support policy interpretation and implementation to address the following: the urban context/existing development in the One-Zone Approach, safe ingress and egress standards, flood proofing standards, risk assessments criteria, and clear standards for One-Zone, Two-Zone and Special Policy Areas, as well as incorporating climate change.
- 2.4. **Update** the 2009 Special Policy Area Procedures informed by lessons learned by CAs from comprehensive updates undertaken in the last 10 years. Many SPAs were designated in the late 1980s and early 1990s. Several comprehensive updates undertaken in TRCA's jurisdiction have been completed in consultation with municipalities, the Province, and the public. These multi-year projects have provided valuable insights on improvements to processes and outcomes such as: ensuring municipal documents (Official Plans and Zoning-By-laws) reflect the current planning and policy regime; ensuring corresponding updates to municipal flood emergency response plans; and ensuring the up-front understanding of technical studies required to accompany applications to streamline submissions in the development process.

We also offer the following recommendations related to the Conservation Authorities Act and associated regulations:

- 2.5. **Support** the creation of a robust natural hazard protection and management mandatory program and services regulation under Section 21.1 (1) of the *Conservation Authorities Act* that recognizes the value of comprehensive integrated watershed management and conserving natural resources to reduce risks associated with flooding.
- 2.6. **Include** pro-active watershed and subwatershed planning, flood and erosion control, and remediation work as a core mandated activity of CAs.
- 2.7. **Recognize** as a core mandatory program and service, the role of CAs in the land use planning and environmental protection process, as linked to legislation including the *Planning Act*, *Environmental Assessment Act*, and the *Conservation Authorities Act*, in supporting the implementation of provincial policies.
- 2.8. **Add** a clause of indemnification or statutory immunity for the good faith operation of essential flood and erosion control infrastructure and programming.

Please consider the following related to the Development Charges Act:

- 2.9. In any future review of the *Development Charges Act*, continue to enable financing tools such as Area-Specific Development Charges to finance flood protection works, particularly for community revitalization and intensification areas.

3. Acknowledge the difference between greenfield flooding controls and flooding controls in historically developed areas

As discussed on site at our meeting, there is a substantial difference between managing floods in newer greenfield development and historically developed areas, some of which are now subject to intensification pressures. We recommend your report point out some of the specific challenges with managing the existing flood risk in areas developed prior to the implementation of flood plain policy and regulation in Ontario's land use policy and planning regime. We would also ask that your report please point out the need to rehabilitate, enhance or build new flood protection infrastructure, coincident with or as a catalyst to urban development. We feel that your report should also note the issues with short or smaller catchment areas in urbanized watersheds, that are characterized by a flashy flood response, and year-round risk.

4. Recognize the importance of financing retrofits and flood and erosion protection work for developed areas

Flood prone urban areas with historical development, built in areas where development would not be permitted today, along with aging infrastructure that cannot handle flows resulting in urban flooding illustrate the need for local knowledge in applying models and tools best suited to each circumstance. These areas also require special attention in terms of municipal financing tools to address historical erosion prone areas and aging infrastructure such as culverts, bridges, sewers, watermains, roadways that are flood prone. In some cases where intensification is proposed, there is a major reluctance for developers to participate in retrofitting of infrastructure and upgrades to support development.

Some of our municipal partners have used development charges to fund flood and erosion remediation and green infrastructure (e.g. Toronto Waterfront projects, the Vaughan Metropolitan Centre for the Black Creek corridor). Other partners are introducing levies to help address aging stormwater infrastructure. A sustainable funding model is needed to support the maintenance, renewal and improvement of flood mitigation and remediation measures. Development charges should be considered as part of a suite of funding options including levies, rate increases on water, stormwater, etc. to incent developers, government agencies and municipalities to address flooding issues as part of comprehensive redevelopment, intensification and community revitalization.

5. Link flood protection and remediation with major provincial infrastructure investments

In some cases, major provincial investments have been made by Metrolinx or regional transit agencies, (VIVA Rapidco, TTC etc.), in locations where flood risks, despite being known, have not been addressed. Often the budgets for projects did not include funding envelopes for such remedial works as part of the project and therefore the flood risks remain unaddressed. New highway or roadway projects should also address historical issues and lead to a net benefit where existing flood risks are present. However, in a recent case in the City of Vaughan in York Region, on the Metrolinx Barrie Go Rail Corridor near Langstaff, Metrolinx did, at the advice of agencies including TRCA, upgrade a culvert. This upgrade will reduce upstream riverine flooding and protect the rail line from future flood risks. This more recent practice should be encouraged in all provincial infrastructure projects to protect provincial investments.

6. Clarify roles and responsibilities in flood management for both riverine and urban flooding

In our jurisdiction, there have been many examples where urban flooding has resulted in major disruptions and impacts on property, businesses and people. A significant gap that exists both in terms of mapping and warning, is the area of urban (pluvial) flood risk. While this is not the mandate of CAs, the fact that CAs have delineated one type of flood risk area has created an appetite on the part of the public for similar flood risk information for urban (pluvial) flood risk. The Province could support municipalities in developing pluvial flood risk information, in providing guidance on how to incorporate climate change in infrastructure design, and in supporting flood resilient design standards, where they are not already in place, through municipal drainage bylaws and stormwater management requirements. One of the challenges in addressing pluvial flood risk is that many of these areas are not experiencing the type of development that other areas have experienced so infrastructure improvements cannot be leveraged as a condition of development through the *Planning Act* processes and or through Area-Specific Development Charges that might exist in Intensification Areas or in Greenfield Areas.

7. Update the technical guidance that governs floodplain mapping and land use management

The policy guidance and technical standards on floodplain mapping are set by the Province. The Ministry of Natural Resources and Forestry (MNRF) Technical Guide (River and Stream Systems, Flood Hazard Limit) should be updated to:

7.1 Account for technological advancements in the last 15 years, including the proliferation of two-dimensional modelling software and methodologies, as well as the use of GIS-based models and mapping outputs.

7.2 Provide guidance, as per the commitments in the Ontario Environment Plan, to support the application of climate change science in decision making, including the consideration of the extreme precipitation increases expected with our changing climate in both floodplain mapping and infrastructure design.

7.3 Provide technical and policy guidance specific to flood risk in the urban context to:

- Resolve the reporting relationship for stormwater management and flood risk management. CAs deal with Ministry of Environment, Conservation and Parks (MECP) for stormwater management matters but deal with MNRF for flood management matters. The role of stormwater ponds in mitigating the impacts of urban development, for example, are recognized by MECP, but are not recognized as providing flood risk reduction benefits according to MNRF.
- Take a risk-based approach to mitigate existing urban flood risk. Historically, CA efforts have been focused on delineating hazard areas. While this is important to implement land use management for new greenfield development, within the urban context it is important to assess priorities for flood mitigation from a risk-based perspective, targeting the highest risk areas and developing solutions that fit within the urban constraints of the area.
- Reconcile growth and risk reduction goals. The Provincial Growth Plan and municipal official plans have identified areas for intensification and urban expansion. In order to accommodate the proposed growth in Ontario, impacts to flooding must be considered and managed appropriately. Many Urban Growth Centers, (e.g. Downtown Toronto, Brampton, Vaughan) are located in historic flood plains and in some cases, future urban expansions can result in increases to Regional flood flows, in turn expanding downstream flood plains. In order to protect life and property from flooding and allow for future growth, remedial measures to provide permanent flood protection need to be considered since passive approaches (e.g. moving development to other locations, expropriating land and infringing on riparian rights) may not be feasible. Currently, the methodology of utilizing remedial measures is not considered in the current MNRF Technical Guidelines (2002); however, there are examples where these types of practices have been successfully implemented in Ontario, with Provincial approval (e.g. West Donlands Flood Protection landform) with resulting benefits including acting as a catalyst for development of the Pan Am Village and major private sector redevelopments.
- Update the 100-year level for Lake Ontario to account for the high levels seen in 2017 and 2019. Data included in the 2001 Technical Guide are based on older data presented in the MNRF document, "Great Lakes System Flood Levels and Water Related Hazards" (February 1989), which includes an analysis of data ending in the year 1987. The Province should update the governing reach-by-reach 100-year lake elevations to account for more recent historical records, climate change, and the impact of Plan 2014 of the International Joint Commission. TRCA and the City of Toronto undertook a similar analysis for the purpose of the Toronto Islands Flood Characterization and Risk Assessment Project.

8. Disseminate best practices from our jurisdiction and others across Ontario

Within our jurisdiction, TRCA has pioneered work in two-dimensional floodplain mapping, flood risk assessment, and real-time gauging for flood warning communications. The Province could support the adoption of the best practices developed by CAs across Ontario, supporting consistency in service delivery through training and knowledge transfer. Events such as the annual Provincial Flood Forecasting and Warning Committee and the MNRF Technical Transfer Workshop represent important opportunities for knowledge exchange. The Province could combine local expertise with province-wide knowledge transfer opportunities like these annual events. The Province should continue and expand these opportunities and consider making these workshops mandatory in the most vulnerable and highest risk flood prone areas of the Province.

9. Foster a culture of risk awareness and provide indemnity to conservation authorities to match the delegation of responsibilities

Many responsibilities have been delegated to, or mandated upon, CAs from the Province, including the construction and operation of flood control infrastructure and local Flood Forecasting and Warning. Unlike municipalities, who have some limited immunity from action for similar services, or the Crown, who has reduced lines of action against it, the services provided by CAs incur exposure to potentially significant liabilities. This, in turn, has a direct impact to the format and content of flood warning messages. As one measure aimed at managing potential liabilities, disclaimers and clarifications must be included in addition to critical key messages. It is recommended that a clause of indemnification or statutory immunity for the good faith operation of essential flood and erosion control infrastructure and programming be added to the *Conservation Authorities Act*.

10. Communicate risk as a high priority

Continued funding to support robust floodplain mapping should be coupled with practices and policies that make it easier to share and access risk information. TRCA has made the regulatory floodplain information publicly accessible for several years, however, the willingness of municipal partners to proactively share risk information with the public varies. Some parties are reluctant to publicize risk information if no funding for an infrastructure project is currently underway to address the risk. As highlighted by the priority of the Sendai Framework for Disaster Risk Reduction (SFDRR), understanding risk is the critical first step in reducing risk. Actively communicating risks to vulnerable communities can lessen the impact of flooding, as residents can take preparatory steps to protect themselves and their homes. The Province should explore options to strengthen requirements for the disclosure of flood risk information in real-estate transactions. CAs, including TRCA, currently offer a solicitor-realty service in this regard. Clear and current guidelines and standards for Flood Forecasting and Warning, as well as floodplain mapping, are also imperative so that municipalities and CAs can point to the fulfillment of due diligence according to standards and guidelines to protect people and property.

11. Enable and enhance CA Act Section 28 enforcement and compliance provisions

TRCA Enforcement staff have experienced many instances where flooding and erosion have been caused by illegal construction practices. This has included the filling in of flood prone valleys, the construction of impoundments, diversion of watercourses, the burial of streams, all of which have exacerbated flood risk on site and downstream. TRCA has, as part of the CA Act review, requested stronger powers on par with other provincial and municipal legislation, including the ability to impose Stop Work orders, orders to comply, and to access private property to help assess situations to avoid flood risks.

12. Modernize flood forecasting and warning measures

While Flood Forecasting and Warning measures have drastically improved in the past 60 years, significant investment is required to modernize the program and fully leverage new technologies. TRCA has been working with academic partners in these areas and leveraging National Disaster Mitigation Program (NDMP) funding where possible, but the following goals could be extended to all areas of the Province: 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, and geotargeting flood warning messages using Common Alerting Protocol format to integrate with the Alert Ready platform and mobile public safety apps.

13. Link flood and erosion control projects to required asset management plans

Municipalities are required to have asset management plans, and this presents the opportunity to link the issue of prioritizing investments to avoid major losses for assets that are in flood prone areas. The City of Toronto-TRCA Erosion Hazard Mitigation Program applies a risk-based approach to municipal infrastructure to identify opportunities where investments in infrastructure protection, (e.g., conducting works to stabilize a flood prone bridge or valley wall), could reduce risk of infrastructure failure, thus avoiding substantial costs. Such an approach should be encouraged as part of asset management work particularly in developed areas. We recommend that municipalities work with CAs to prepare such proactive risk-based plans that include preliminary costing for remediation for flood and erosion prone areas as part of their core CA mandate.

14. Continue provincial funding support for conservation authorities and cooperation between all levels of government to maximize opportunities presented by federal funding programs

CAs have a large portfolio of purpose-built, as well as inherited, flood control structures that are approaching their end of life; significant investments will be required to upgrade, and maintain, infrastructure in a state of good repair. The financial support from the Water Erosion Control Infrastructure (WECI) is an important source of funding for flood infrastructure and should be protected, at minimum, or enhanced to provide for the required infrastructure investment.

Funding through the federal NDMP has been effective at supporting flood risk reduction through multiple means and has allowed CAs to accelerate important work in flood line mapping, flood risk modeling, flood infrastructure assessments and flood forecasting and warning. The current program ends in March 2020, and the lack of funding in this area would create a problematic funding void.

Given the ample evidence of risks associated with extreme weather and climate change, funding is required to continue the important work in both the flood forecasting and warning and flood infrastructure realms. While the federal Disaster Mitigation and Adaptation Fund (DMAF) can help support projects with a capital component, important work such as the development of improved flood forecasting and warning tools and risk assessments would not qualify for DMAF funding. Many of these federal grants are matching programs. The Province could play a leadership role by supporting mechanisms for municipalities to collect dedicated funding for flood remediation and mitigation projects.

Thank you once again for the opportunity to meet with you and to provide TRCA staff comments and recommendations on flood management and resilience in Ontario. A copy of the presentation given by Rehana Rajabali, Sameer Dhalla and Laurie Nelson at the meeting has also been enclosed. Should you have any questions, require clarification, or wish to meet to discuss the above remarks, please contact the undersigned at your earliest convenience.

Sincerely,

<Original signed by>

John MacKenzie, M.Sc.(PI), MCIP, RPP
Chief Executive Officer

Encl.

BY E-MAIL

cc: Sameer Dhalla, Director, Engineering and Development Services
Rehana Rajabali, Senior Manager, Flood Risk Management
Laurie Nelson, Director, Policy Planning

Toronto and Region Conservation Authority Expertise in Climate Change

Mitigation, Adaptation, Flood and Erosion Risk Management

Presentation to: Pat Koval and Lynette Mader, Provincial Climate Change Task Force Advisory Group

Presentation Outline

1. Our role in climate resilience
2. How past decisions drive our risk
3. Global and Regional Climate Change Context
 - Warmer, Wetter, Wilder
 - How this alters the risks
4. Creating resilient communities
 - Land use planning and policy
 - Guidance on incorporating climate change into Hazard Mapping
5. Creating resilient infrastructure
6. Creating resilient housing
7. Tools for effective management of resources
8. Summary

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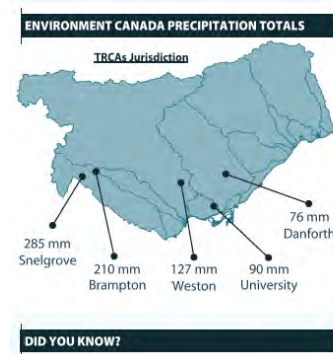
1. Our history and role in climate resilience



Toronto and Region Conservation Authority expertise and partnership in climate resilience

- TRCA has been working on climate related risks since the time of Hurricane Hazel
- TRCA hosts the Ontario Climate Consortium (OCC), established in 2011 as a centre of research and analysis expertise
- TRCA is involved in the design and implementation of programs and projects with our municipal partners (e.g. Peel Climate Change Partnership, Durham Climate Change Adaptation Program, Toronto Flood Resilience Working Group) - these include both adaptation and mitigation initiatives





Hurricane Hazel – a lesson in climate risks

Hurricane Hazel
mobilized the need for
managing Ontario's
watersheds, for the
safety of communities



Hurricane Hazel (1954)

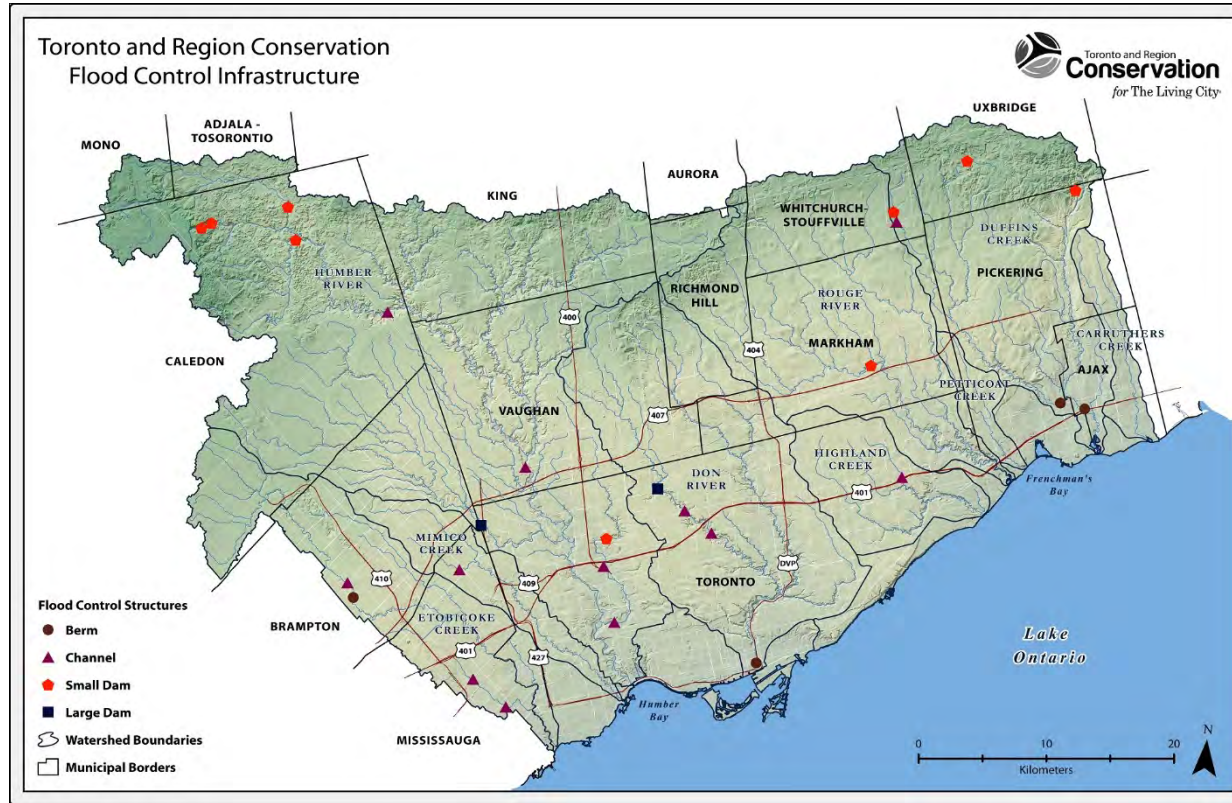


METROPOLITAN TORONTO AND REGION
CONSERVATION AUTHORITY

Post-Hazel Flood Control

- Metropolitan Toronto and Region Conservation Authority (MTRCA) was formed in 1957.
- Amendment to CA Act to acquire lands for recreation and conservation purposes and mandate for flood management
- 1959 Plan for Flood Control and Water Conservation, with three focus areas: Land Acquisition, Flood Control Infrastructure, and Land-Use Planning

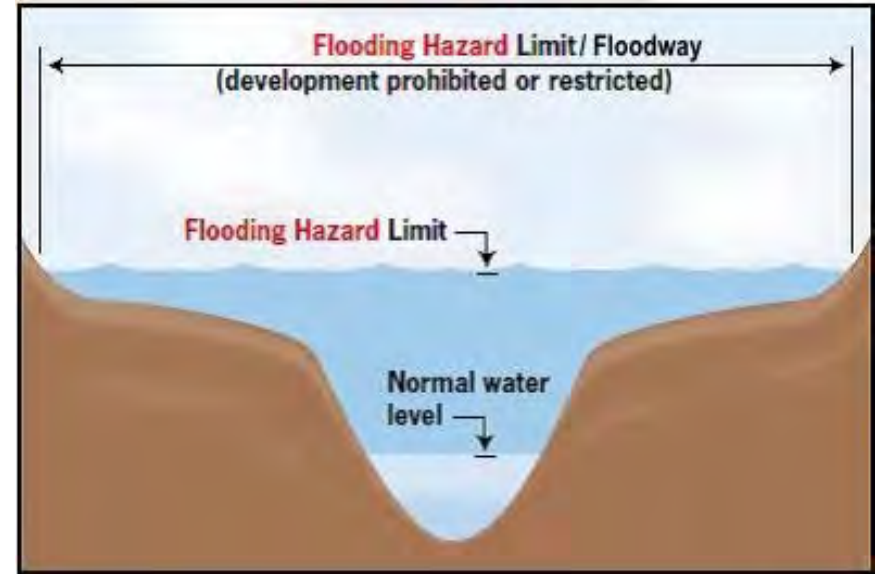
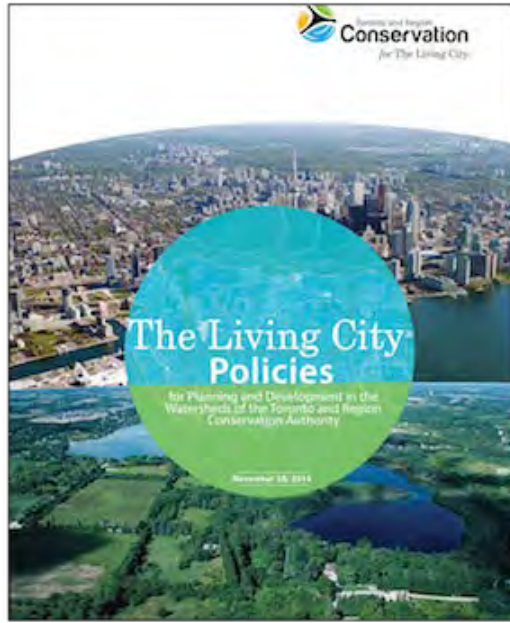
Land Acquisition & Flood Control Infrastructure



- Jurisdiction of flood plain land to Authorities
- Conservation Authorities involved in flood control structures



Many built 50 years ago, others were inherited mill dams

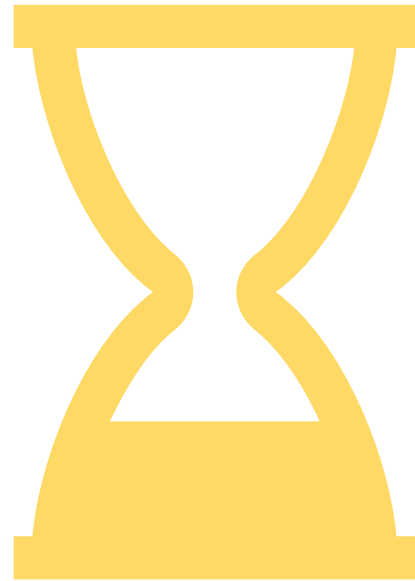


Land Use Planning

Resilience is a partnership

- Province: Funding, policy guidance, MNRF direct responsibilities for the flood hazard
- Federal government: Funding, policy guidance, weather warnings (Environment Canada)
- Conservation Authorities: development and infrastructure plan review, permitting, flood forecasting and warning (as delegated from the province), etc.
- Municipalities: Primary responsibility for all types of emergency response, including flooding (under Emergency Management and Civil Protection Act); storm drainage infrastructure and urban (pluvial) flooding, *Planning Act*
- Individuals: Personal preparedness and property-level measures

2. Historic Decisions Affecting Present-Day Development



Factors Increasing Risks

Historic infilling

- Garbage dumped in ravines
- Unengineered fill dumped on top
- Houses built on slopes made of unconsolidated fill
- Communities built in flood-prone areas



Factors Increasing Risks

Loss of natural cover and increase of impervious surfaces

- Increase of surface and water temperatures and increase surface water runoff directly into watercourses – before modern stormwater management



Factors Increasing Risks

Minimal Setbacks

- Homes built too close to the top of slope



Factors Increasing Risks

Climate Change

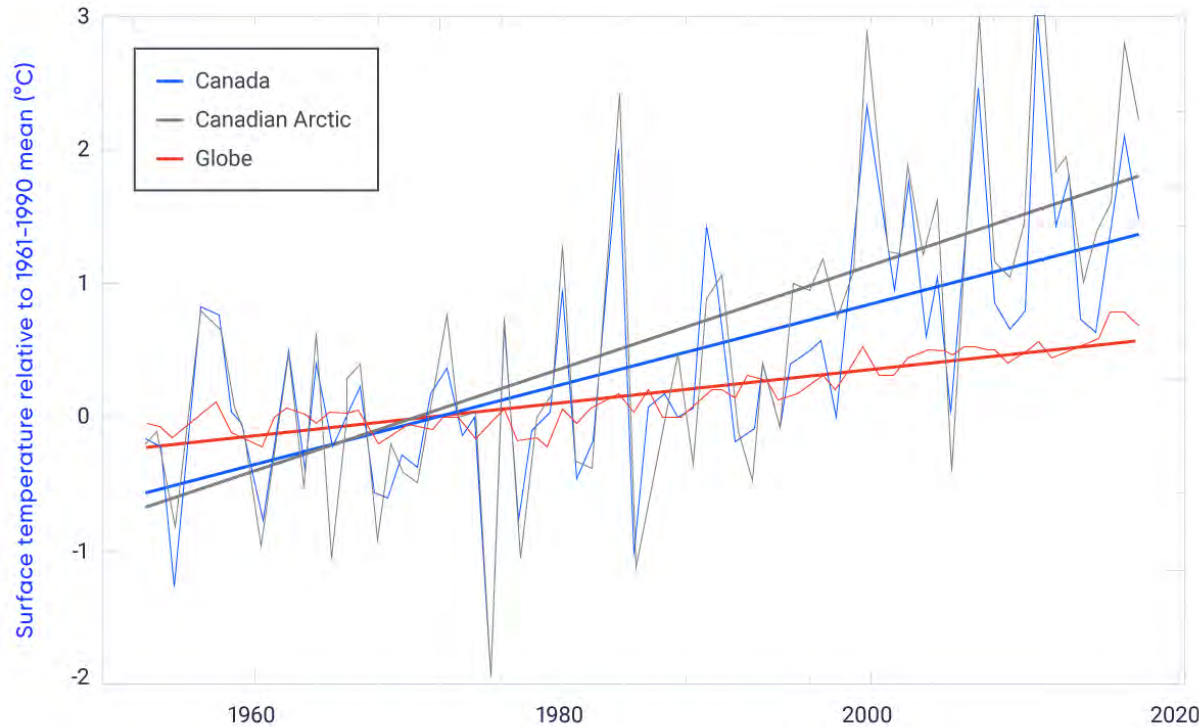
- Increased precipitation events (frequency & degree)
- Record high lake levels



3. The Climate Change Context



Canada is Warming Faster Than the World



From the 2019 Canada's Changing Climate Report:

Headline Finding:

The rate of surface warming for Canada is more than twice the rate of surface warming for the globe.

Meanwhile, the rate of warming for the Canadian Arctic is about three times the global rate.

How has the Climate Changed in Canada?

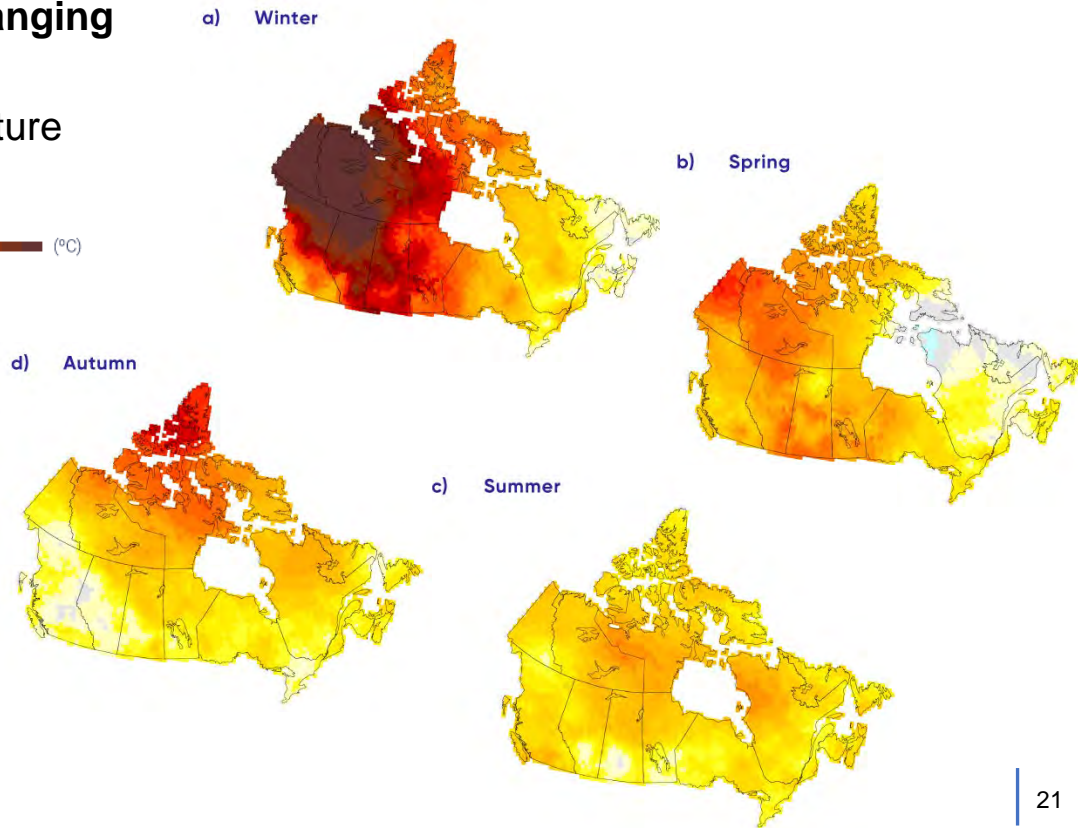
From the 2019 Canada's Changing Climate Report:

Changes in seasonal temperature across Canada (1948-2016)



Headline Finding:

Between 1948 and 2016, the best estimate of mean annual temperature increase is 1.7°C for Canada as a whole and 2.3°C for northern Canada



How has the Climate Changed in Canada?

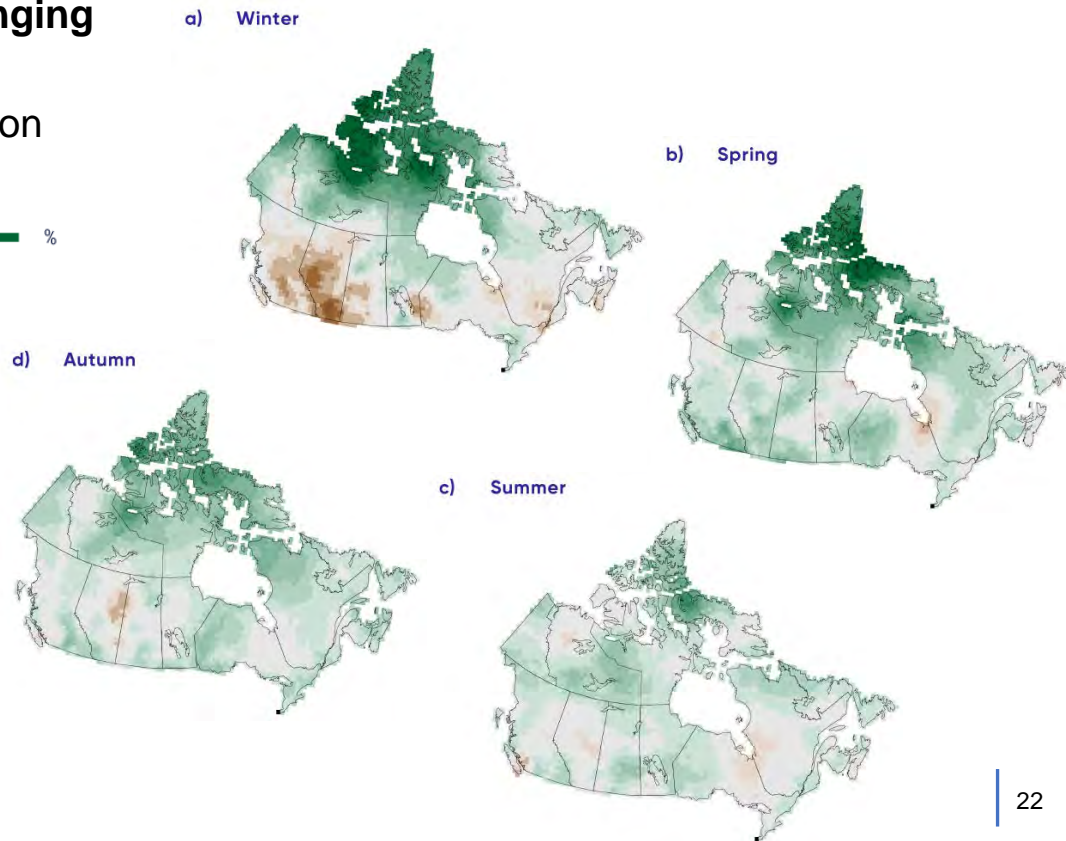
From the 2019 Canada's Changing Climate Report:

Changes in seasonal precipitation across Canada (1948-2012)



Headline Finding:

There is medium confidence that annual mean precipitation has increased, on average, in Canada, with larger percentage increases in northern Canada



Climate Change Impacts in Canada

From the 2019 report on Canada's Top Climate Change Risks

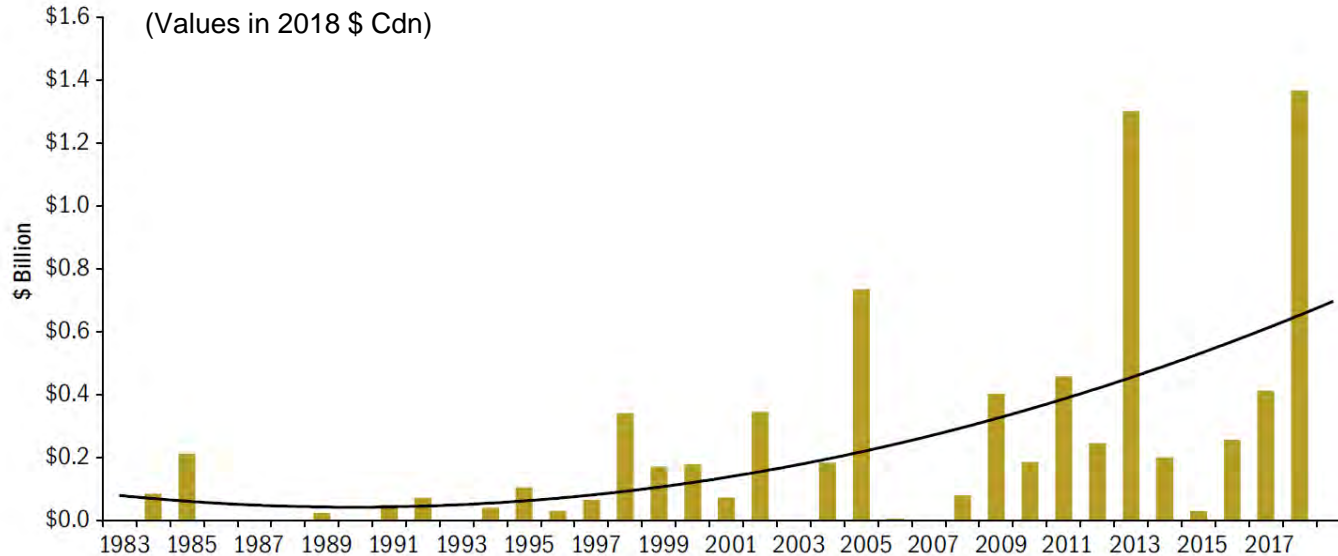


Top 12 Risks:

- Agriculture and Food
- Coastal Communities
- Ecosystems
- Fisheries
- Forestry
- Geopolitical Dynamics
- Governance and Capacity
- Human Health and Wellness
- Indigenous Ways of Life
- Northern Communities
- Physical Infrastructure
- Water

Insured Losses in Ontario

Due to Large Catastrophic Events ($\geq \$25$ million)



Source of data: Insurance Bureau of Canada Facts Book, CatIQ, PCS, Swiss Re, Munich Re, and Deloitte

Large catastrophic losses include damage due to wind, water, ice, snow, hail, fire, lightning and earthquakes.

Costs include damage of personal and commercial property, and automobiles, excluding adjustment expenses.

Recent Severe Weather Events

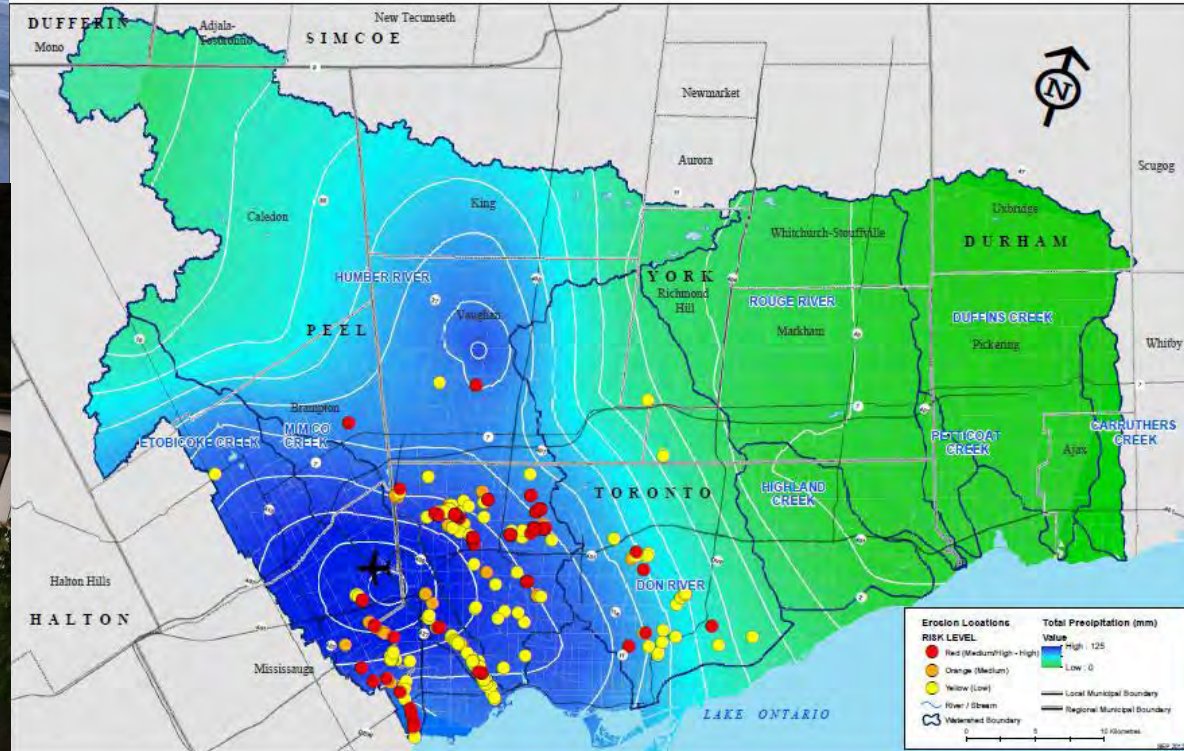




July 8, 2013



- 140 mm in 2-3 hours
- Flooding, power outages, damages to infrastructure, major erosion across jurisdiction
- Significant impact to public & private property



2018 Several Storm Events



Date	Rainfall (mm)	Hours	Description
Jan 22	55	48	5 Year - on frozen ground
Feb 19	32	48	Late winter rainfall event
Apr 04	29	24	Spring rainfall event
Apr 13	81	72	2 x 2 Year - on frozen ground
Jun 01	26	1	Cloudburst event
Jul 05	64	4	5 Year - very intense (Upper Humber)
Jul 16	75	8	25 Year - Rouge watershed
Jul 29	43	1.5	2 Year - very intense (Upper Don)
Aug 08	73	12	25 Year - Downtown flooding
Aug 17	52	24	5 Year - Upper Humber
Aug 21	40	12	2 Year - Downtown
Sep 10	34	24	Fall rainfall event
Total Severe Weather Events: 12			

January 11, 2020

- 60-96 mm of rainfall across entire TRCA jurisdiction in 30 hours
- Triggered erosion issues across jurisdiction



Facing Upstream

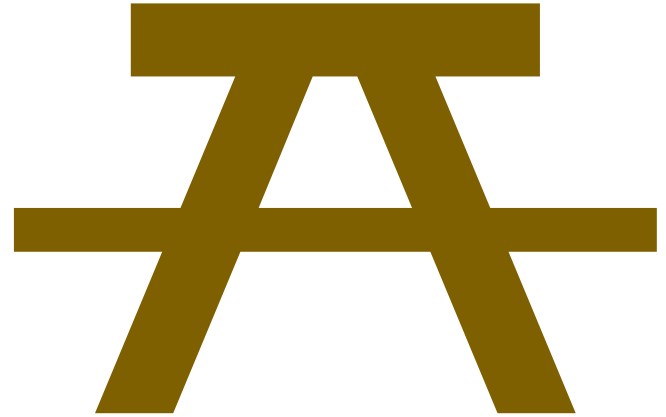


Facing Downstream



Photos show approximately 33 m of asphalt road washed out into the Humber River at the Toronto Zoo (cutting transportation, damaged infrastructure)

4. Developing Resilient Communities



PREVENTION & MITIGATION

Limiting exposure to risk:

- Implementing TRCA's regulations and policies

Reducing risk:

- Operating a flood forecasting and warning program
- Maintaining flood control infrastructure
- Creating a flood protection strategy for vulnerable areas
- Implementing remedial works projects

Understanding the risks:

- Climate, geology, watershed response and potential for climate change

Documenting the risks:

- Floodplain mapping, identification of flood vulnerable areas

RECOVERY

- Flood event documentation and lessons learned
- Storm analysis

Flood Risk Management

PREVENTION & MITIGATION

PREPAREDNESS

- TRCA's Flood Contingency Plan
- Emergency Plans
- Emergency Operations Centre
- Training
- Public Education

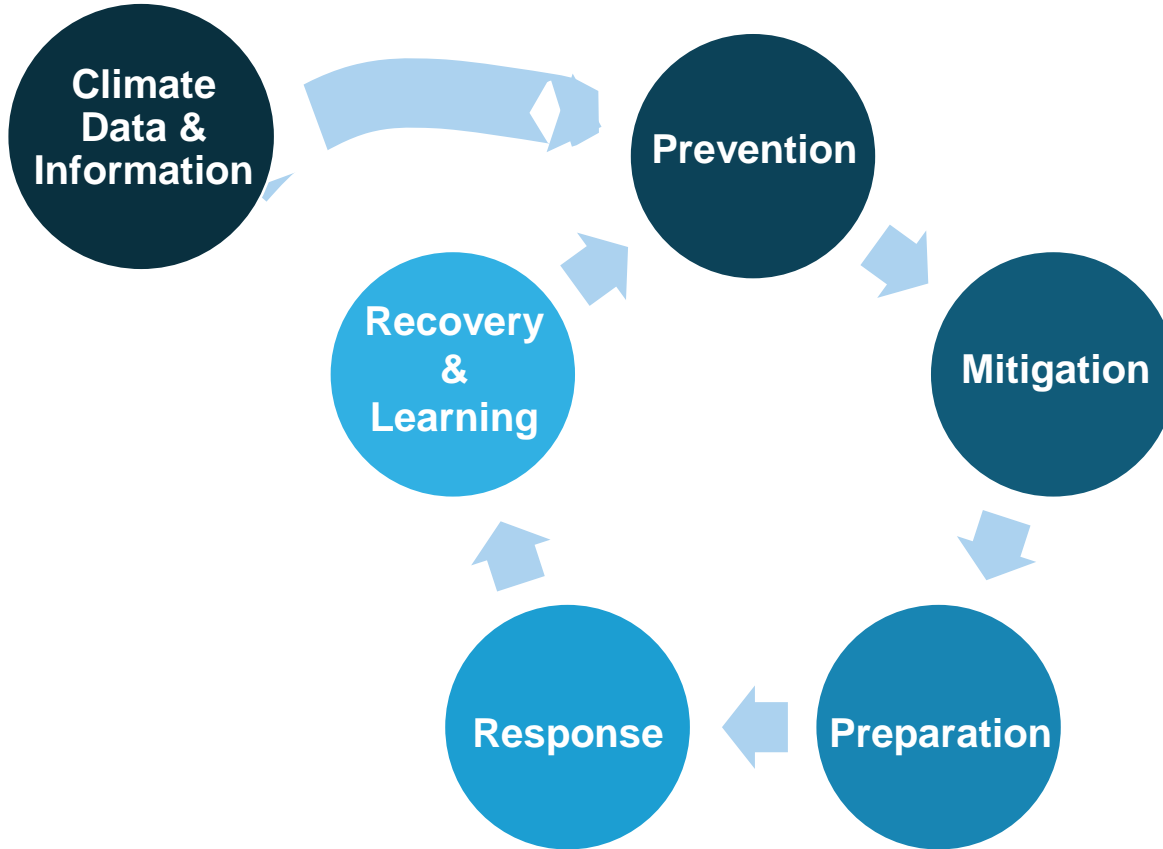
RESPONSE

- Provide Flood Forecasting and Warning (issuing flood messages)
- Operate flood control infrastructure
- Communicate information and advice
- Data management

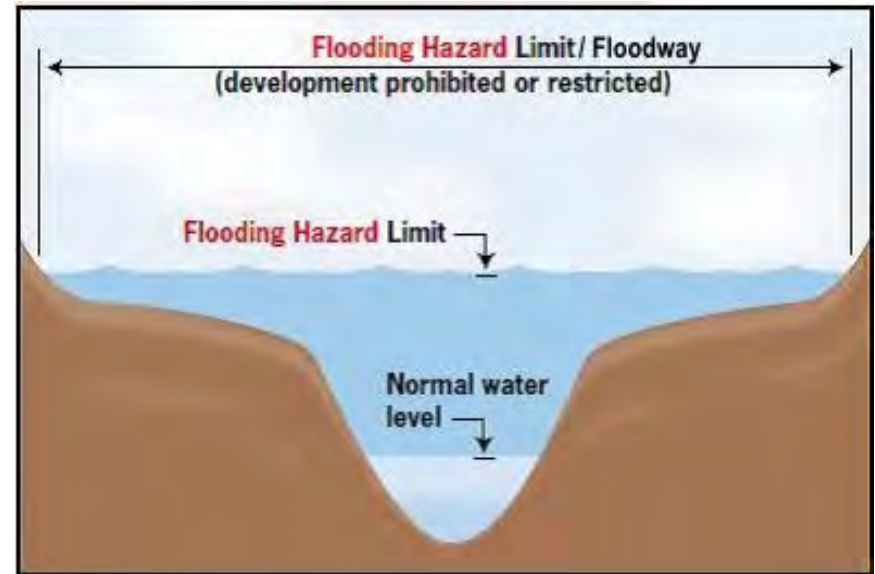
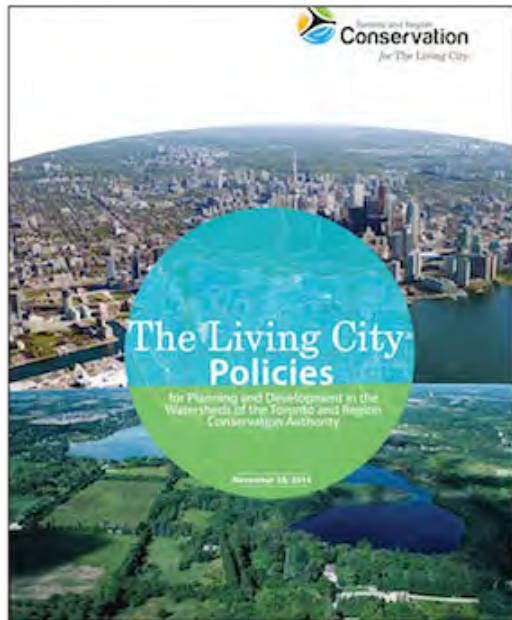
RECOVERY

RESPONSE

Climate Change is a modifier



Identifying and mapping hazards are key to resilient communities



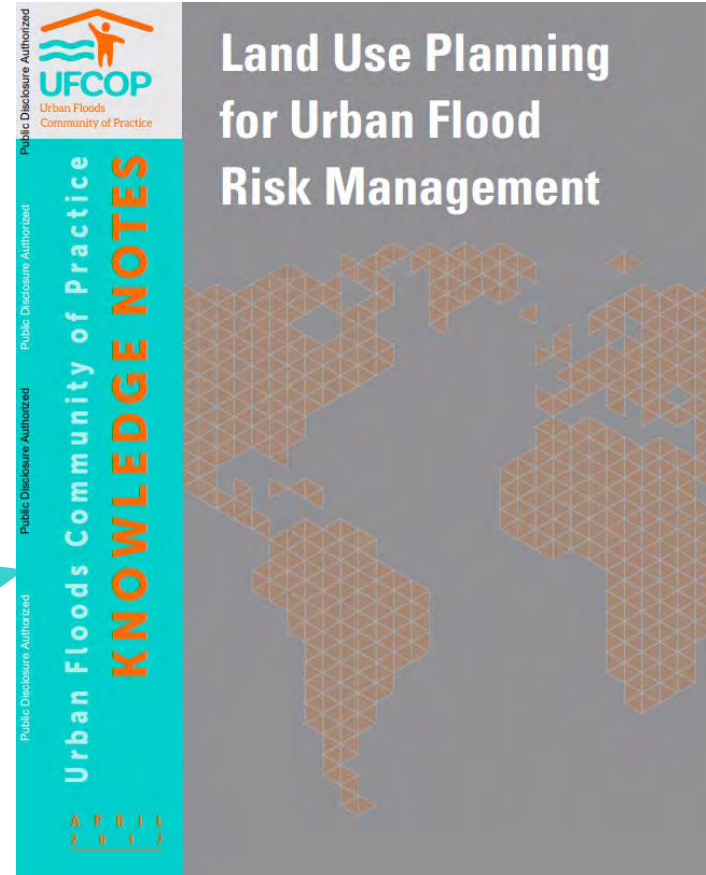
Conservation Authorities..
Making 'Room for the River' for over 60 years...



al Acquisition Site
roperty
Target System
al Target System
ea
area
ing Area
elt

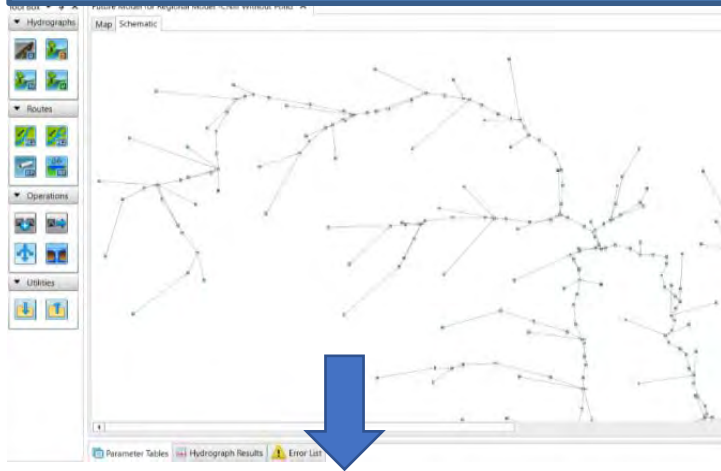
- Coordination of flood risk in multiple sectors that involve land development (critical infrastructure and utilities, open space, and housing)
- Coordination of flood risk at multiple scales, from local plans for specific communities to multijurisdictional watershed planning
- A safe, productive, and livable urban environment at lower cost as compared to using structural systems

Land use planning is a critical component of an integrated approach to flood risk management. The Sendai Framework for Disaster Risk Reduction 2015–2030 underscores the importance of land use planning and policy to address underlying disaster risk drivers, which include unplanned and rapid urbanization, poor land management, and weak regulation of and incentives for private disaster risk reduction investment (UNISDR 2015). Global networks through initiatives such as the ICLEI Resilient Cities, the UNISDR Making Cities Resilient, the Rockefeller Foundation's 100RC, and the C40 Cities have put flood risk concerns on many a city council's agenda. Cities across the globe are gearing up to address flood risks through land use planning; many are in initial stages of lobbying for commitment, and many have made significant strides in risk assessment. But the adoption of land use planning for flood risk management remains challenging.

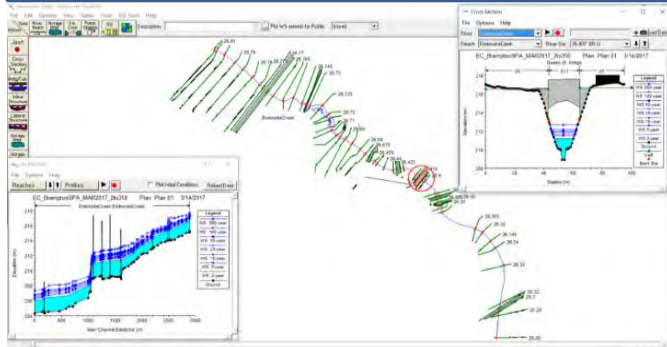


Technical foundation for floodplain mapping

Hydrologic Modeling



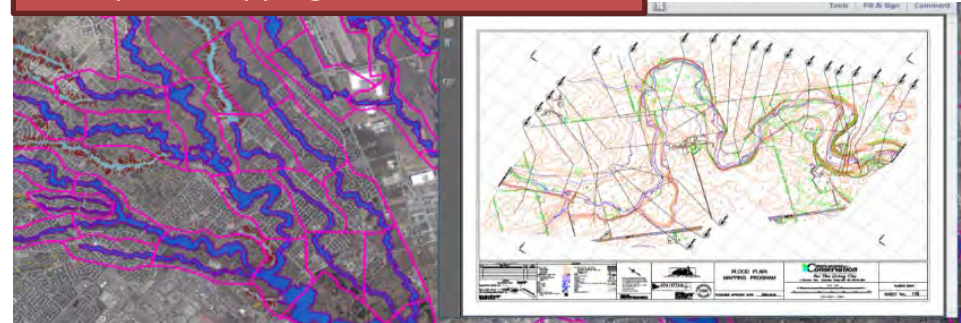
Hydraulic Modeling



Stormwater Management Criteria

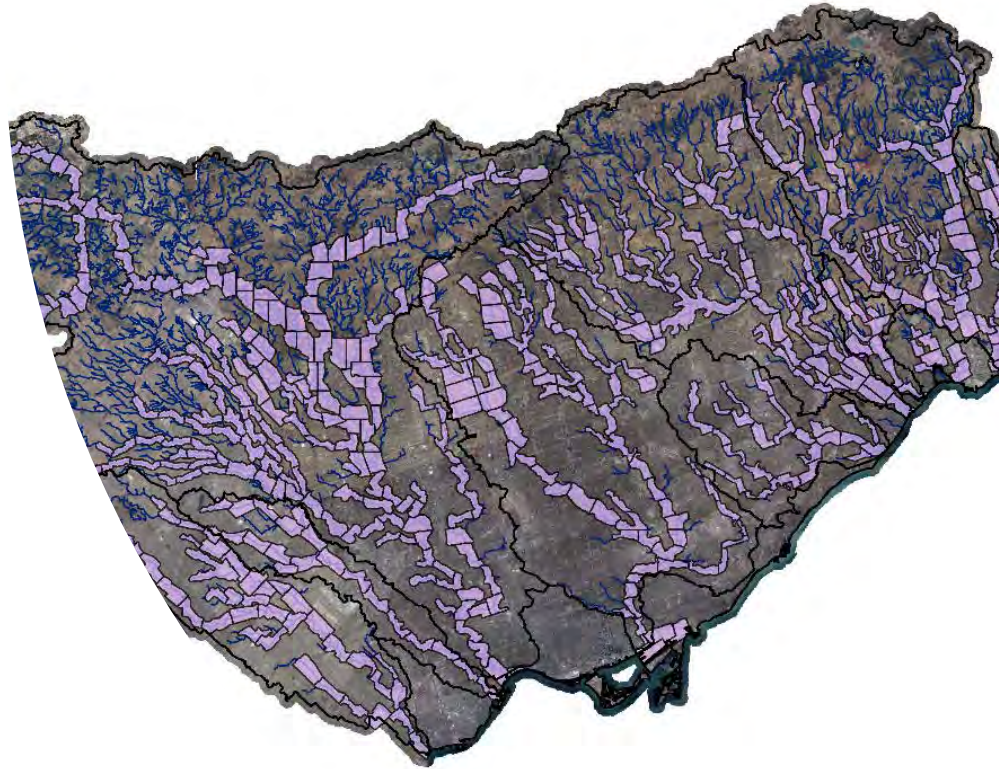


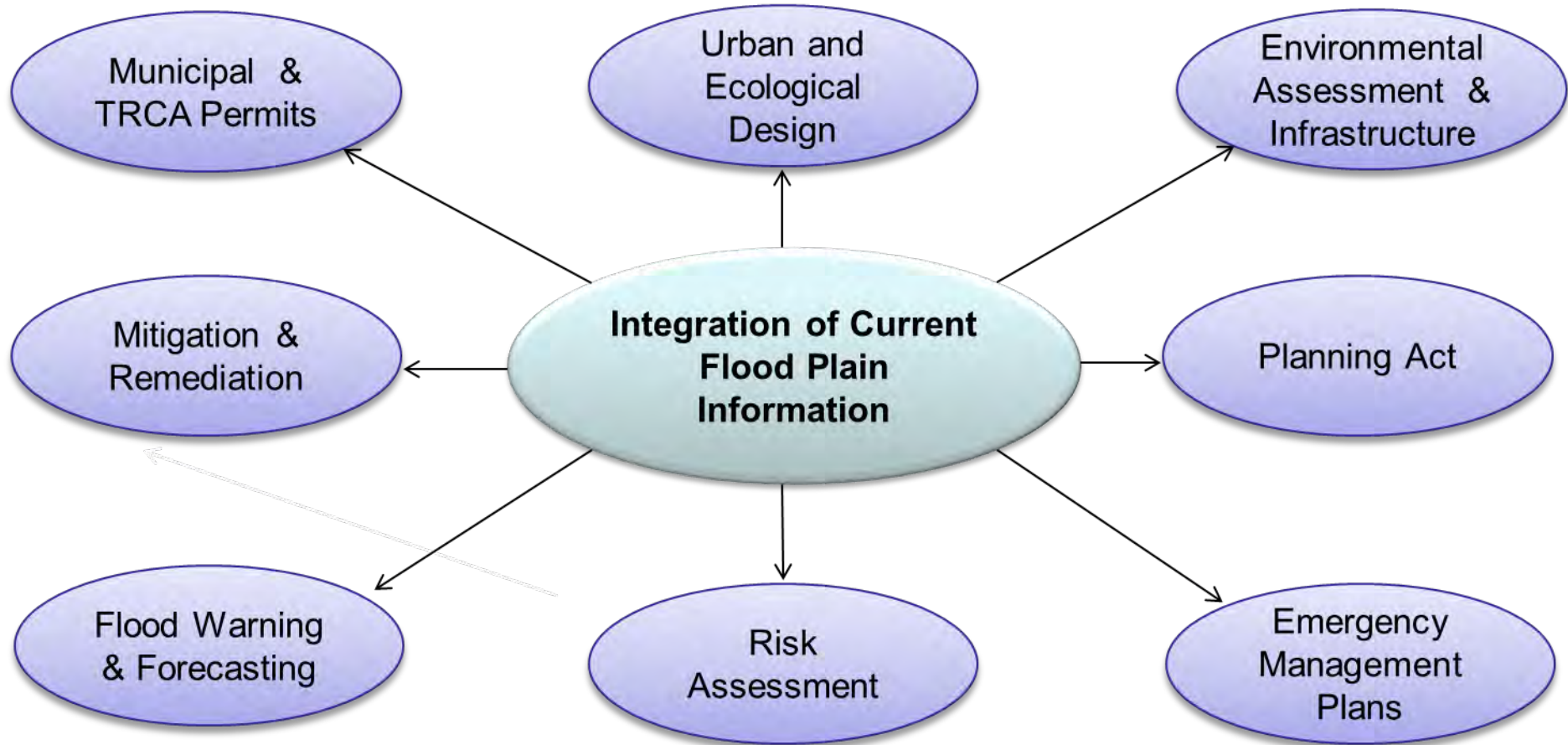
Floodplain Mapping



Floodplain Mapping

- TRCA:
 - Over 15,000 ha of engineered floodplain maps (547 mapsheets)
 - 9 different watersheds (and thus hydrology models)
 - Most maps were less than 15 years old anyway – after all NDMP updates complete, all will be within 7-8 years
- Conservation Authority Average:
 - 72 percent of floodplain maps are outdated
 - 44 percent of these are in high risk areas







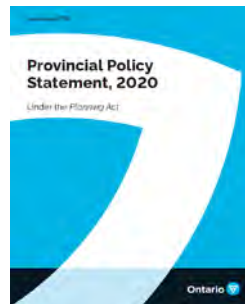
Preserving and Protecting
our Environment for
Future Generations

A Made-in-Ontario Environment Plan



Ministry of the Environment,
Conservation and Parks

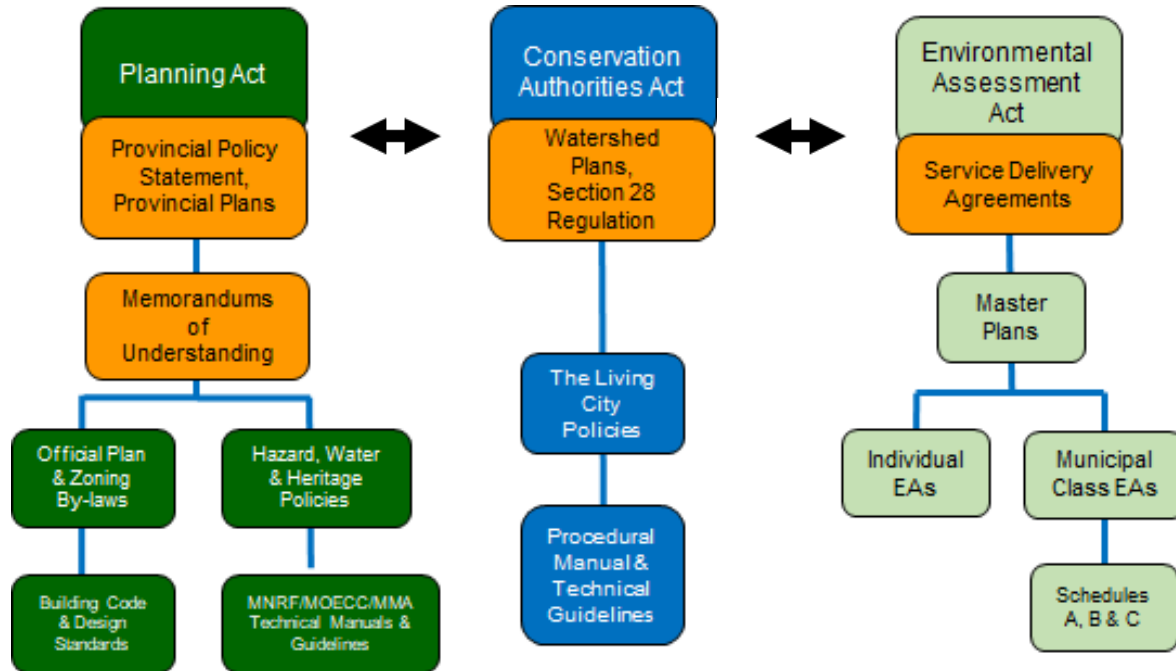
Ontario

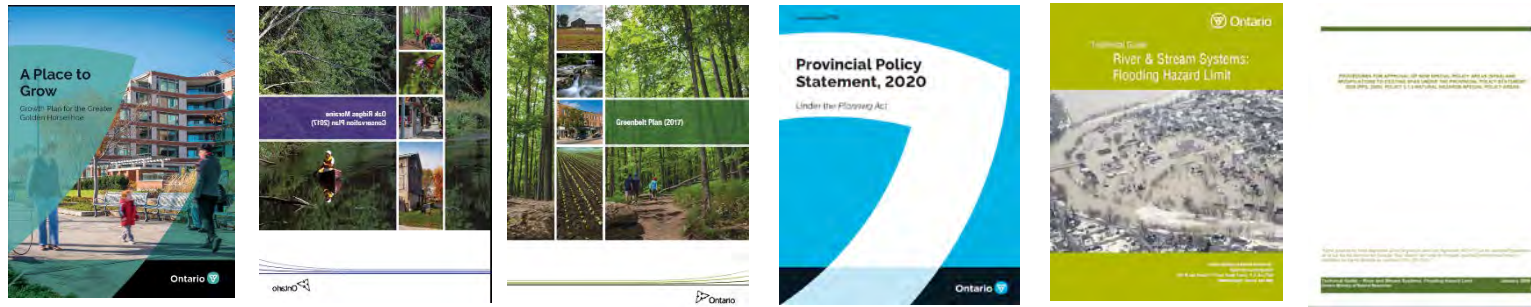


Effective hazard risk management
requires supportive policy
guidance...



TRCA Plan Review Roles & Responsibilities





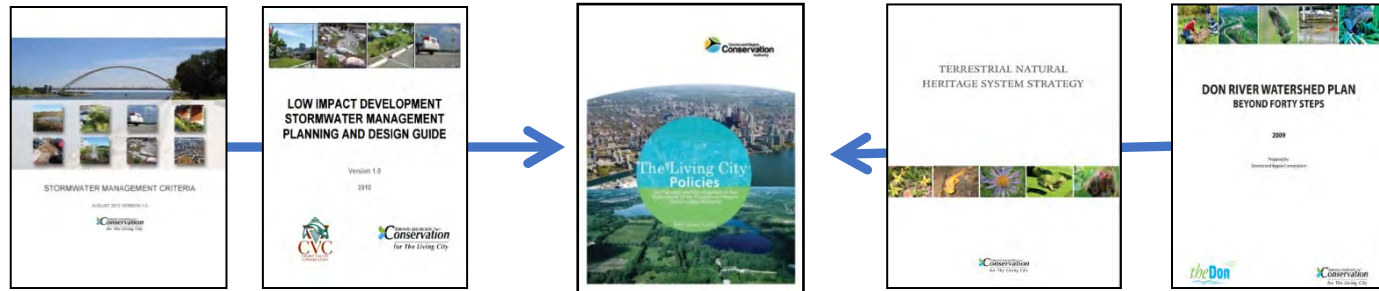
Provincial Plans, Policies & Technical Guidelines



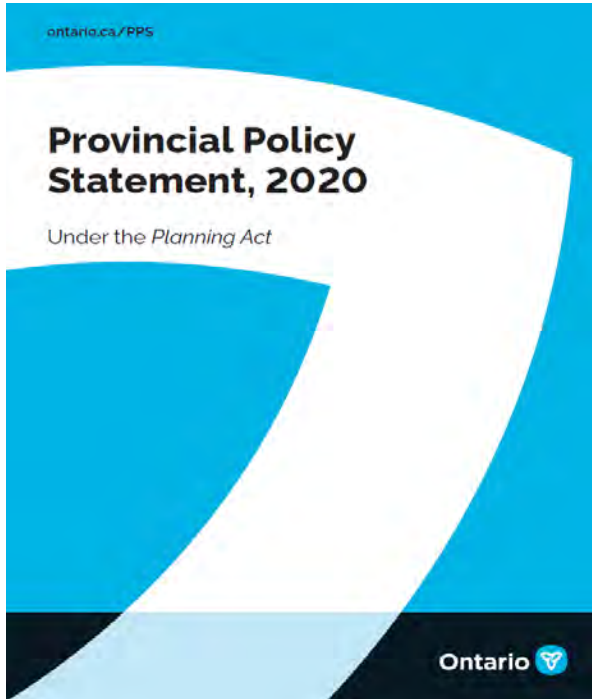
Municipal plan input, development and environmental assessment review,
permitting and compliance, policy analysis,
technical expertise & advice



Conservation Authority Watershed Plans, Policies & Technical Guidelines



Section 3.0 Protecting Public Health and Safety



- Mitigating potential risk to public health or safety of property damage from natural hazards, including the risks that may be associated with the impacts of a changing climate, will require **the Province, planning authorities, and conservation authorities** to work together.
- Development shall generally be directed, in accordance with **guidance developed by the Province** (as amended from time to time), to areas outside of...

River & Stream Systems: Flooding Hazard Limit



Updated guidance on hazard limits needed from the Province

- Updates needed:
- Guidance on how to incorporate climate change
- Better guidance on the urban context
 - How to account for impacts of urbanization on existing floodlines
 - Maintenance of infrastructure
- Technological advancements in the last 15 years:
 - 2D Modelling
 - GIS based models and outputs
 - Identification of spill areas, through the above

Erosion Risk Management Program

- A recognized need for remediation and construction of erosion control structures
- Monitoring of areas affected by flooding, erosion, and or slope instability
- Study and investigation of erosion hazards within TRCA's watersheds
- Working with municipalities, regions, and federal government





Resilient Communities

- The Erosion Risk Management Program (ERMP) works to create erosion control structures that reduce risk and hazards
- Protection of public green space and recreational resources, such as trails

A portion of the Humber Trail was rebuilt and protected with a vegetated rock revetment. Works also improved habitat quality for endangered Redside Dace.



Before



Rotary Peace Park

- Cost of works: \$1.7M
- 160 m long armourstone revetment to protect frequently used recreational path
- Completed in July 2019

Yellow Creek Trail Emergency Works

- Cost of works: \$750,000
- 90 m armoustone retaining wall as well as riffle and plunge pool sequences
- Completed in December 2019



Before



During

Resilient Communities

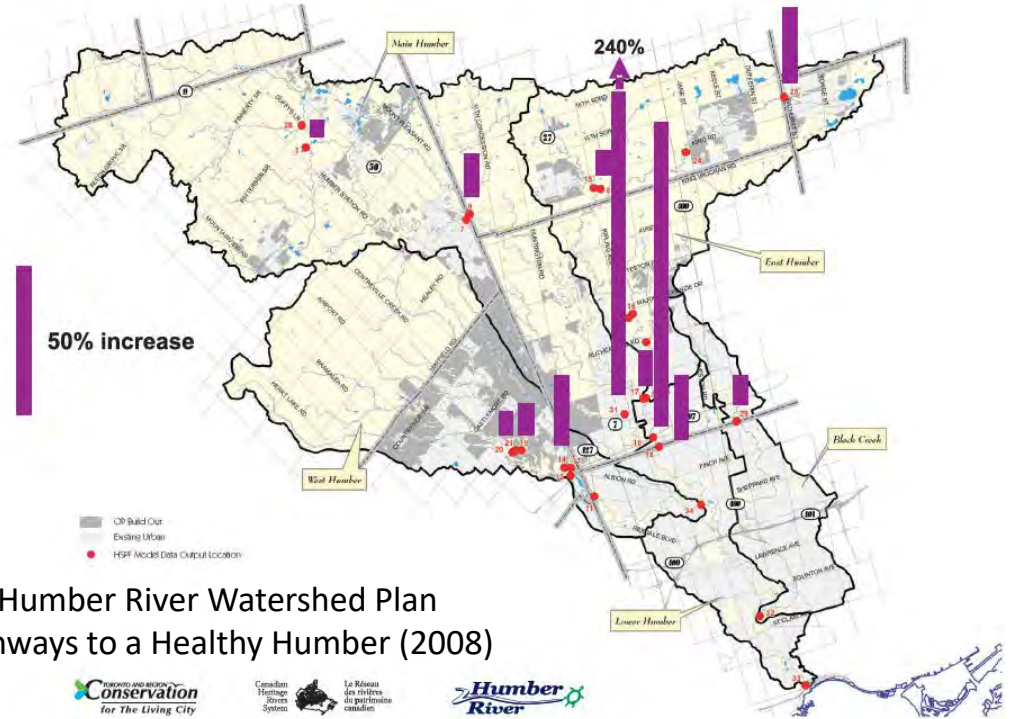


- The Restoration and Resource Management programs restore hydrology and natural cover within and adjacent to the Natural Heritage System
- Improves climate change resiliency by creating a more robust natural heritage system that mitigates flood and temperature events through improved natural cover and water storage

Knowledge & Data

- Conducting geotechnical & geomorphic assessments to determine long-term risk
- Municipal and Regional strategies to manage assets and risk

Figure 4-1: Change in erosion potential – approved official plan build-out (Scenario 2)



5. Developing Resilient Housing

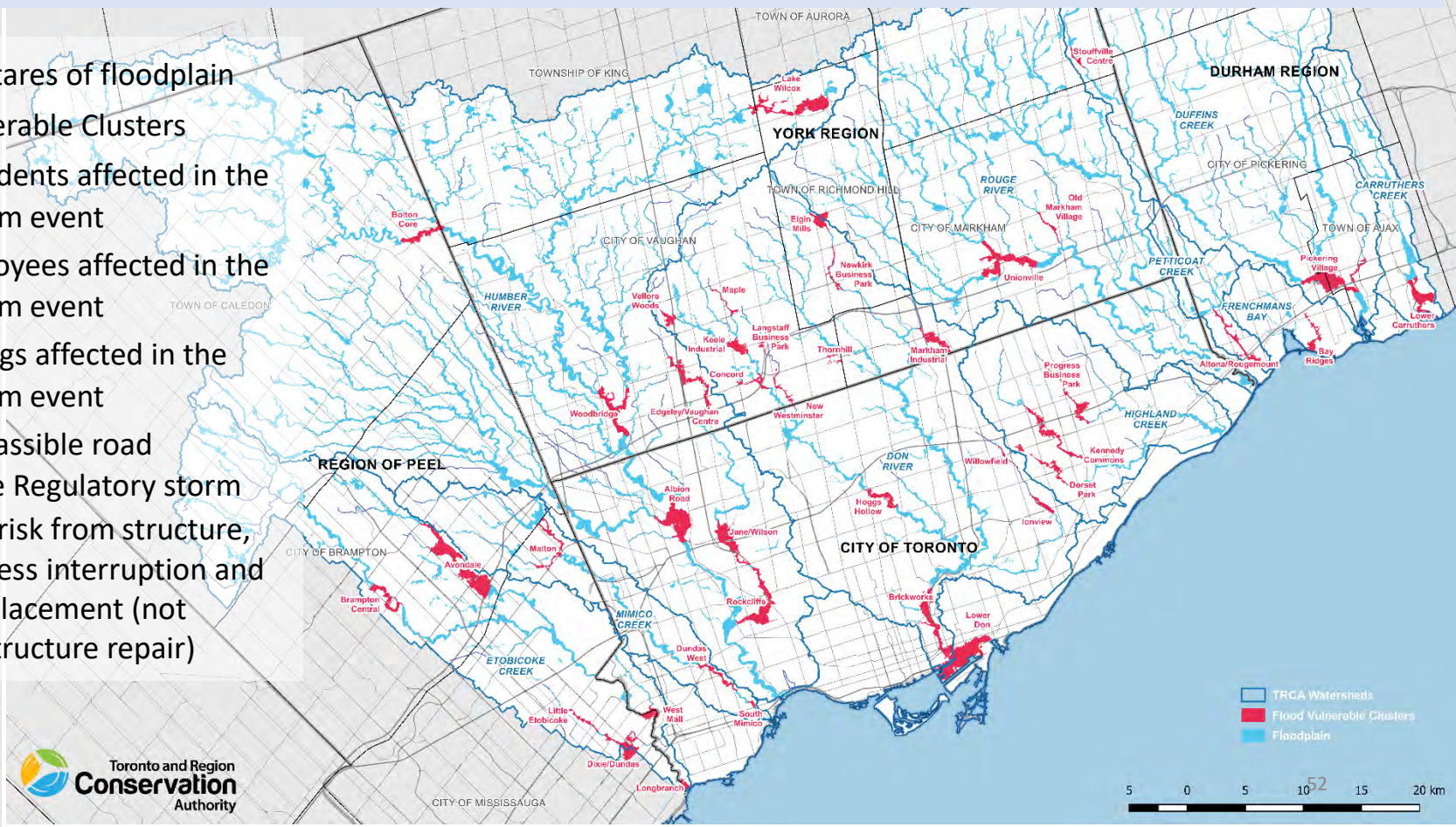


Presentation to Toronto Real Estate Board - shifting perceptions around climate risk



What about areas settled prior to land-use planning?

- >14,000 Hectares of floodplain
- 41 Flood-Vulnerable Clusters
- >43,000 Residents affected in the Regulatory storm event
- >41,000 Employees affected in the Regulatory storm event
- >9,900 Buildings affected in the Regulatory storm event
- 195km of Impassible road segments in the Regulatory storm
- ~\$3 Billion in risk from structure, contents, business interruption and population displacement (not counting infrastructure repair)



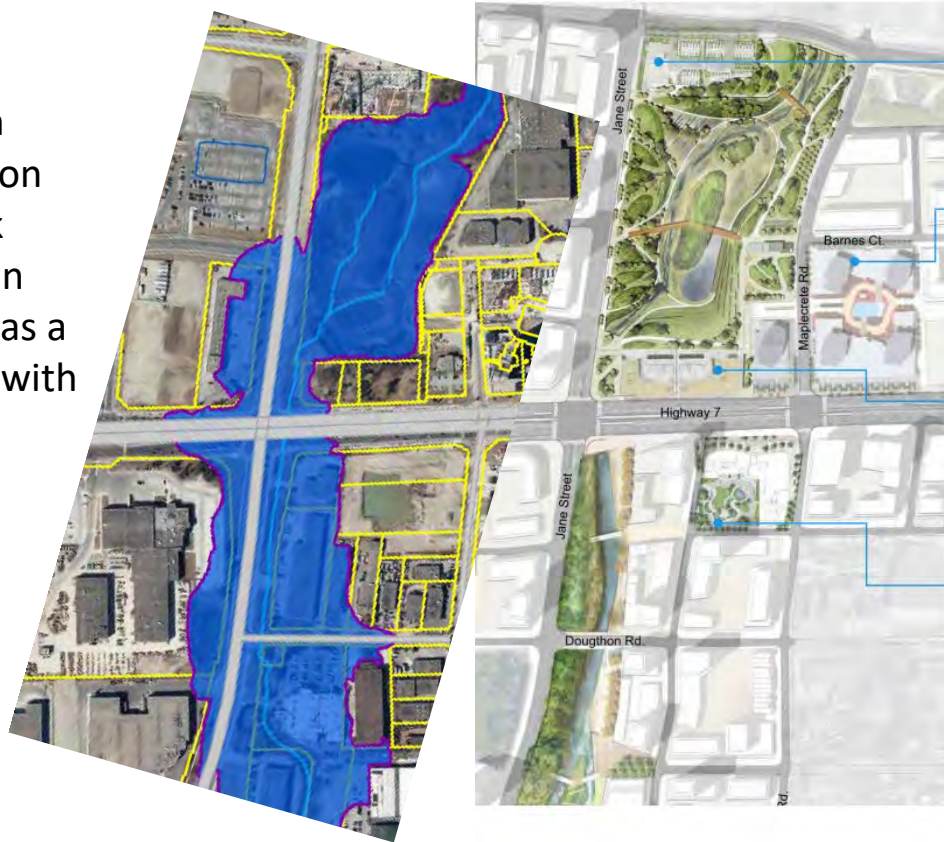
tion Studies

Study Yonge Street and Food Vulnerable Area Segment

-
- The map displays the Greater Toronto Area (GTA) with various municipalities outlined. Special Policy Areas are highlighted in red, and Flood-Vulnerable Clusters are highlighted in orange. The map includes labels for Brampton, Mississauga, and Toronto, and a legend in the bottom right corner.
- Legend:**
- Special Policy Areas (Red)
 - Flood-Vulnerable Clusters (Orange)

Vaughan Central/Edgeley

- Ranked 14th in TRCA Jurisdiction in terms of risk
- Slated for urban intensification as a growth centre with a new subway station
- Black Creek Renewal Environmental Assessment approved



Adjacent Development Activity

THE MET

572 residential units
1,104 new residents*
2018 (estimated)

EXPO CITY

1,935 residential units
3,735 new residents*
Phase 1 Towers 1 + 2 – 2016
Phase 2 Towers 3 + 4 – 2019 (estimated)
Phase 3 Tower 5 – 2023 (estimated)

ZZEN / MIDVALE

837 residential units
(proposed)
1,615 new residents*
2019/2020 (estimated)

COSMOS

833 residential units
(proposed)
1,608 new residents*
2019/2020 (estimated)

Private development concepts shown are renderings only and subject to Council approval

*estimated

West Don Flood Protection Landform

- Flood protection landforms (FPL) address deficiencies of structural measures to permanently eliminate flooding
- Relatively new concept currently unique to the Lower Don within TRCA's watershed
- Engineered to withstand all forms of failure and essentially forms part of the surrounding landscape due to sheer size of the measure



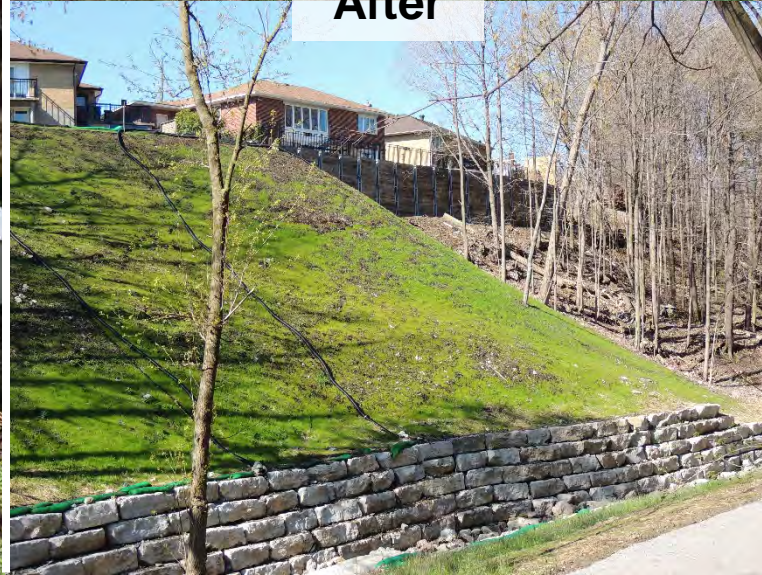
Jennifer Court & Whitburn Crescent



Before



After



- Cost of works: \$3.5M
- Includes 100+ m of armourstone retaining walls
- Completed in 2018

12-14 Appletree Crt



Before



After

- Cost of works: \$1.3M
- Amourstone wall and rubble fill buttress
- Completed in May 2018

Toronto Community Housing Building

- Toe protection in Humber River for TCH by 1025 Scarlett Road
- Cost of works: \$1.3M
- 160 m long vegetated buttress
- Completed in 2018



Before

An aerial photograph showing a multi-story brick apartment building situated on a grassy hill overlooking the Humber River. The riverbank is natural and somewhat eroded, with some trees and a small playground area visible near the building.



After

An aerial photograph showing the same building and riverbank area after construction. A long, straight, light-colored stone or concrete toe protection structure has been installed along the riverbank, extending from the building towards the river.



Before

A ground-level photograph of the riverbank. The river is in the foreground, and the brick building is visible on the opposite bank. The bank is covered in trees and vegetation, and the water appears slightly turbulent.



After

A ground-level photograph of the riverbank after the work. The river is in the foreground, and the brick building is visible on the opposite bank. The bank is now covered in a dense layer of green vegetation, and the water appears calmer.

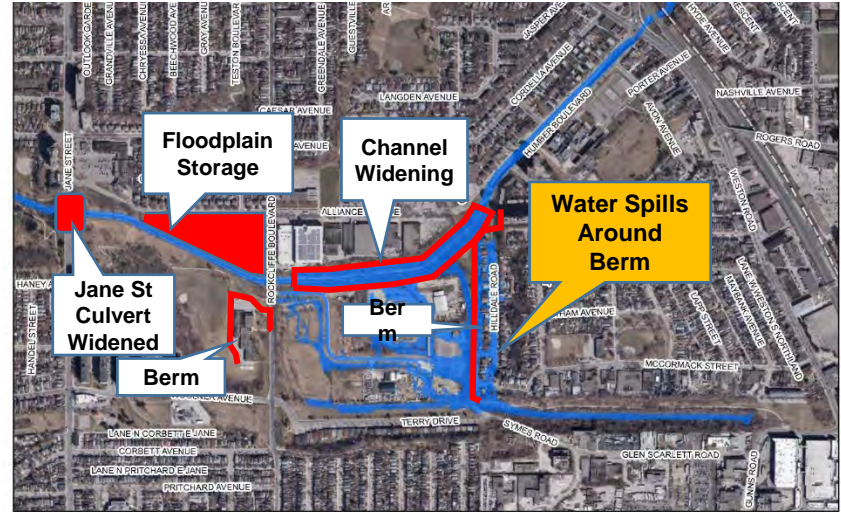
6. Developing Resilient Infrastructure



Rockcliffe Flood Remediation and Transportation Feasibility Study

Objectives:

- Expand flood remediation to protect more properties from frequent flooding.
- Establish a flood protection level of service For example, no flooding in the 100-year storm.
- Ensure flood remediation solutions consider impacts to private property, local drainage, utilities, transportation projects and traffic needs.
- Identify short and long term actions that prioritizes flood remediation at vulnerable areas first



2014 EA Preferred Alternative With New Modelling

into
er
our



Provincial Policy guidance needed for climate change considerations in Infrastructure Design



Regional Infrastructure Monitoring & Protection

- Regional partnerships formed to help with **long-term management** and **remediation** of erosion affecting regional infrastructure
- TRCA formalized monitoring parameters to establish baseline conditions and to **ensure long term protection**
- Protection against erosion along ravines & watercourses
- Risk-based, annual inspection schedule
- Current partnerships with Peel and York Region





York Region

- The **Infrastructure Hazard Monitoring Program** is a joint program between TRCA and York Region
- Assess any risk to exposed/buried infrastructure
- TRCA formed a partnership with Region of York in 2011; since then:
 - An average of 200 high risk sites **monitored** each year
 - An average of 5 sites **remediated** each year
 - Over 600 m of infrastructure **protected**
 - Over 900 m of valley & shoreline **stabilized**



Channel realignments and restoration can help fortify channels by directing water naturally and buffering high flows



Pomona Creek

- An undermined drainage pipe beneath a public trail
- Failing gabion basket wasn't providing protection
- New vegetated buttresses help to buffer flooding and high flow rates
- Weeping tiles within the bank improve drainage
- Native trees/shrubs planted to stabilize slope

Peel Region

- Since 2017:
 - Over 500 sites **monitored** each year
 - An average of 2 sites **remediated** each year
 - **Over 150 m of infrastructure protected**
 - Over 500 m of valley & shoreline **stabilized**
- TRCA works with Region of Peel of address sites of high risk and vulnerability





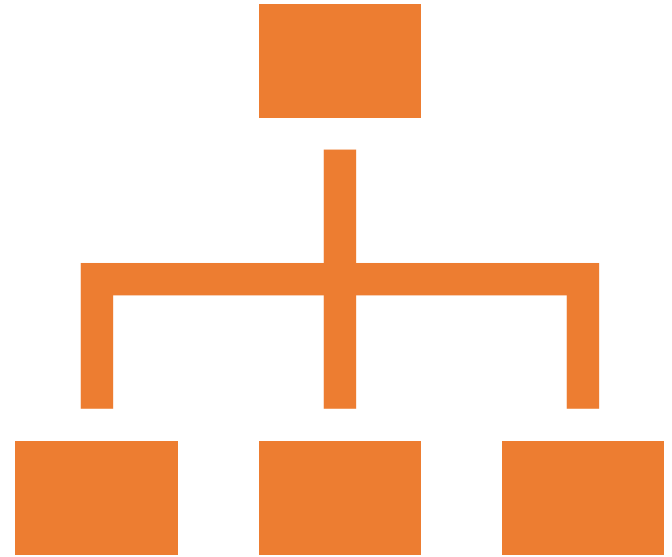
Damaged infrastructure cannot properly manage changes in discharge and flow, putting infrastructure and watercourse banks at further risk



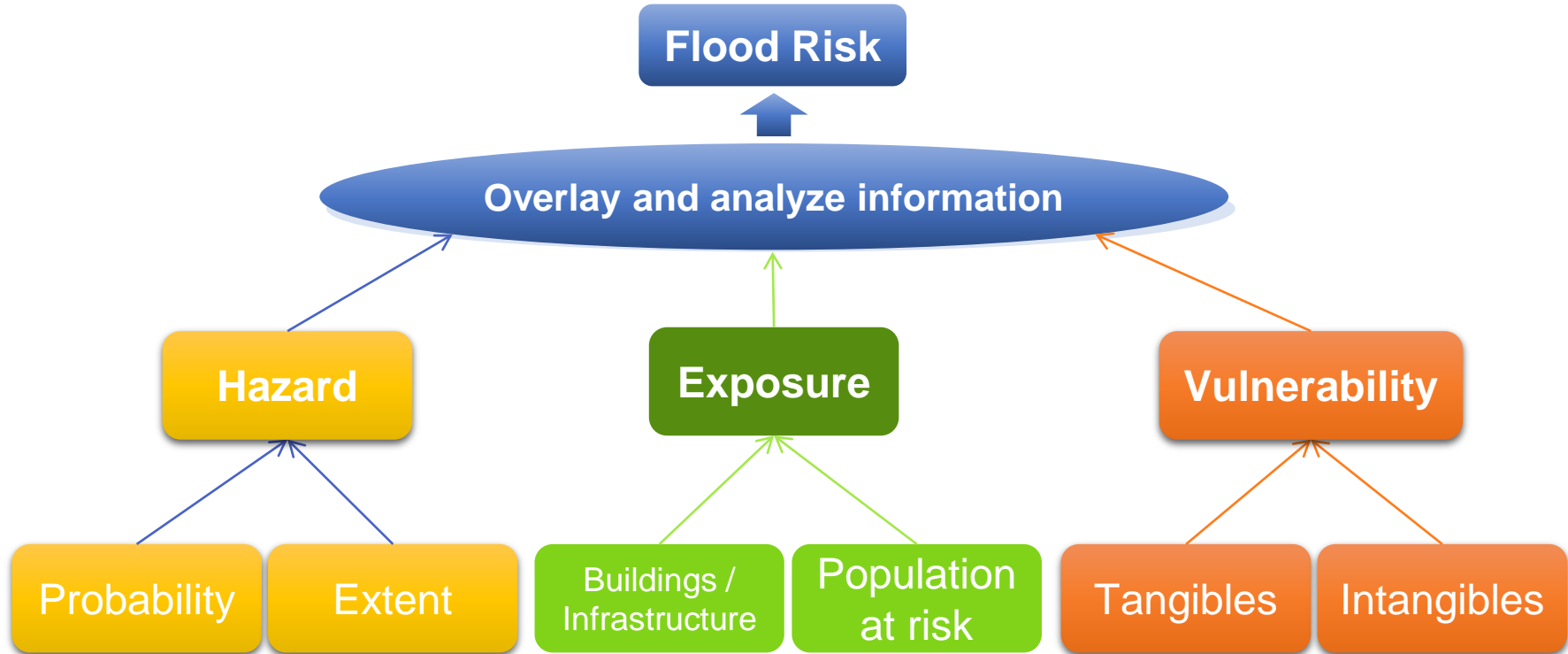
Centennial Park

- Outfall repair & bank stabilization

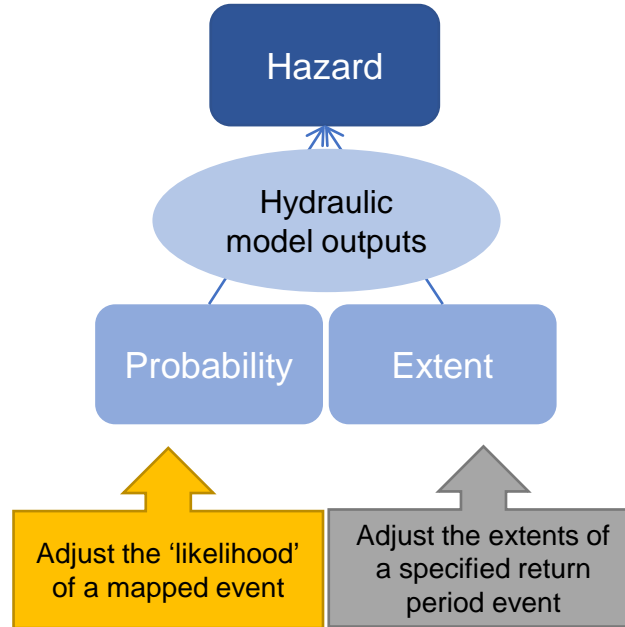
7. Tools for Proactive & Efficient Resources Management



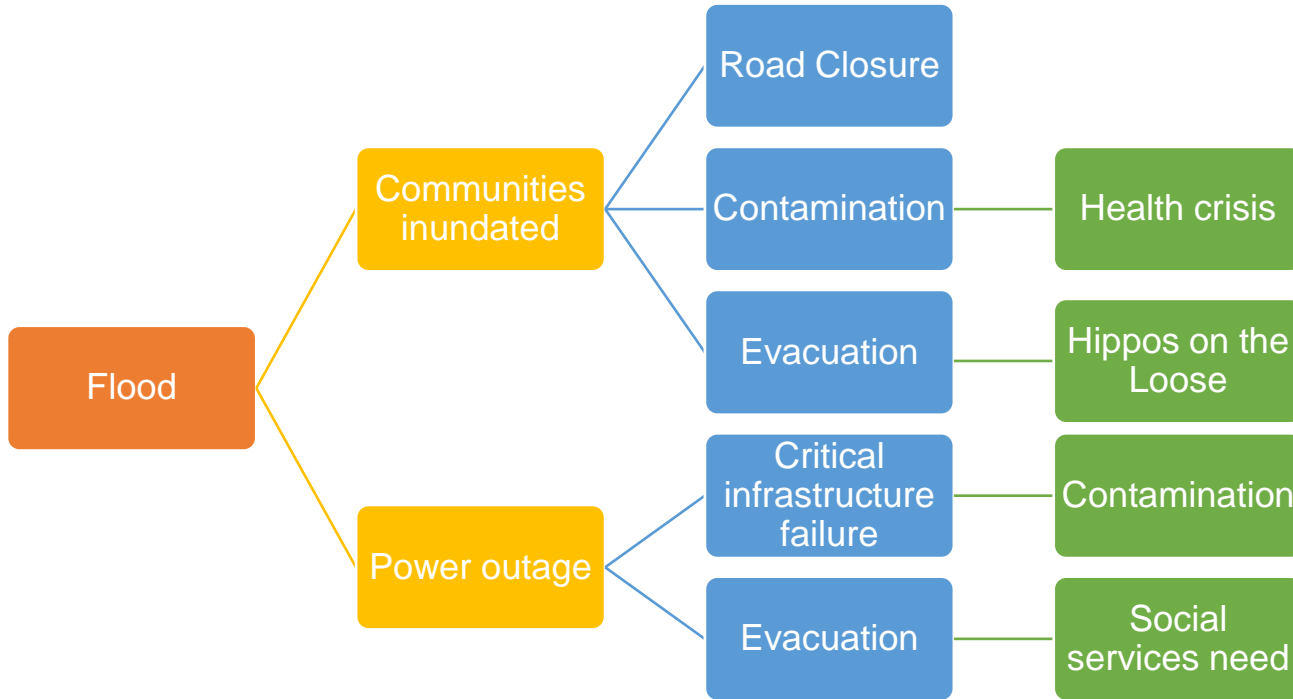
Flood Risk Assessment and Ranking Project



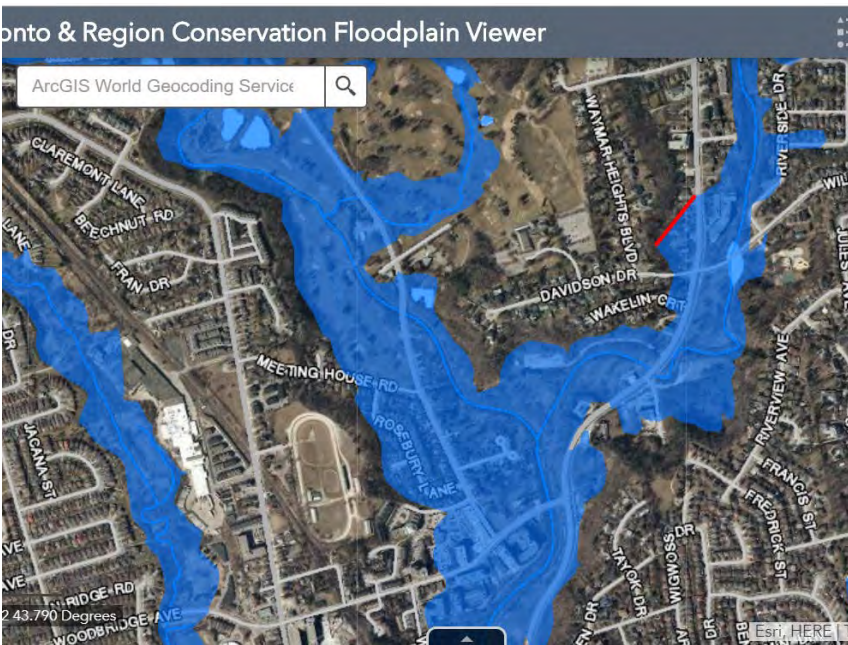
Future work: Incorporating Climate Change into Hazard Estimates



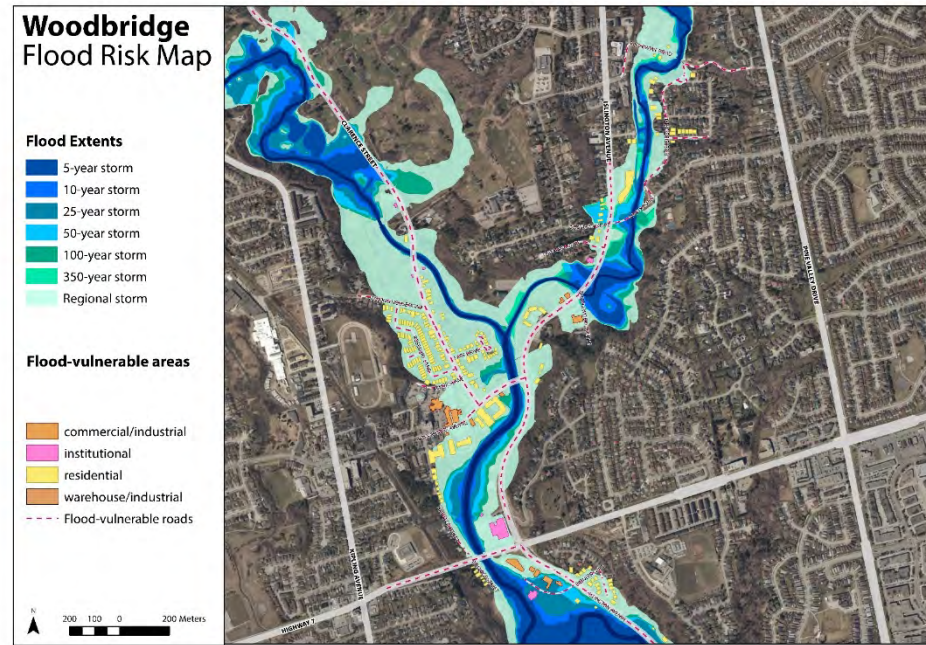
Assessments that capture interdependencies and impacts



Generic information already available



More granular risk information proposed



Flood Risk Outreach

- Neighbourhood specific web content with risk maps
- Informational letters
- Site-specific public open houses

Flood Forecasting Decision Support System

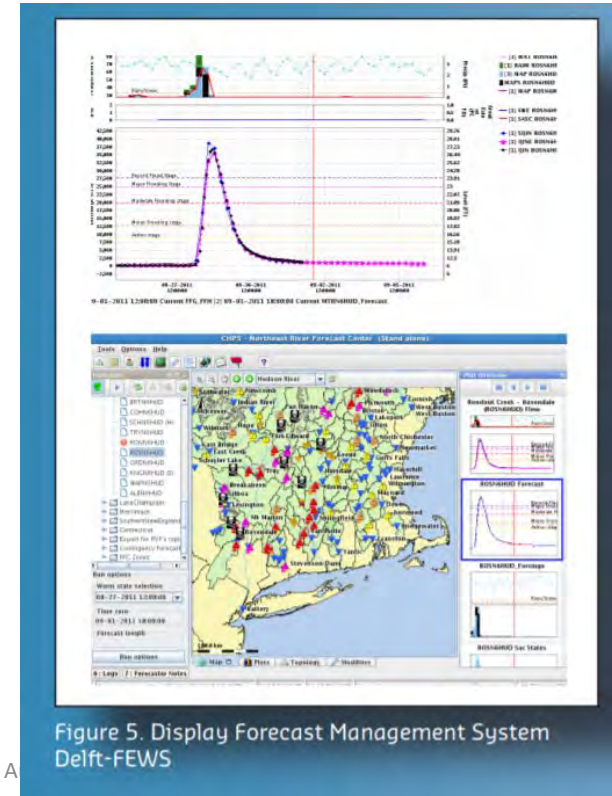
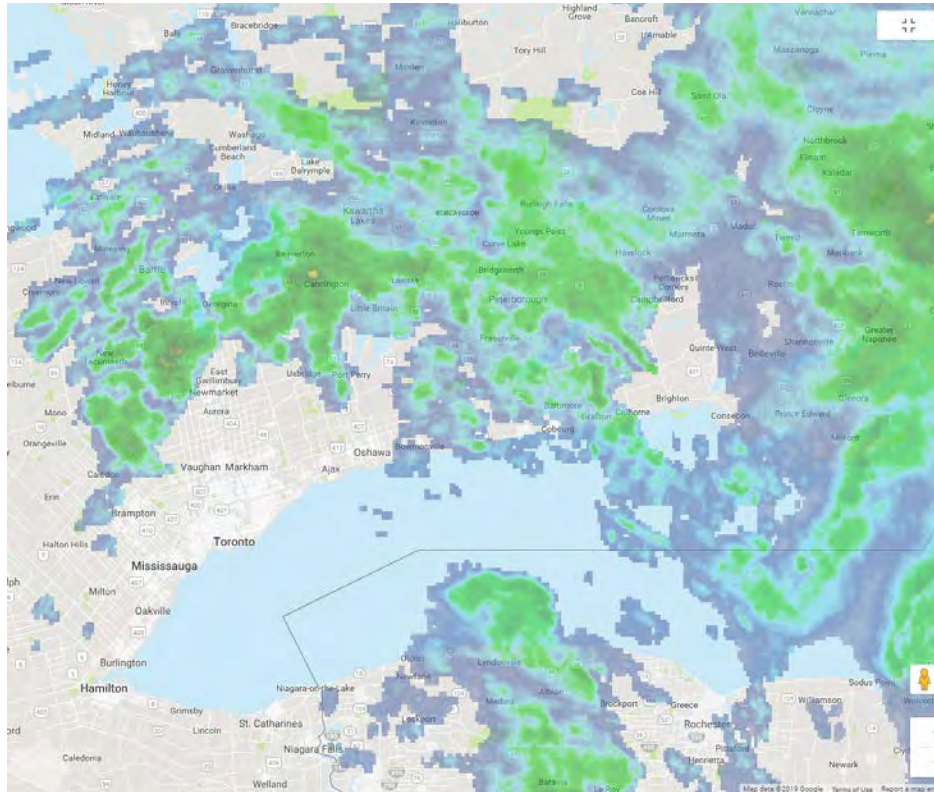
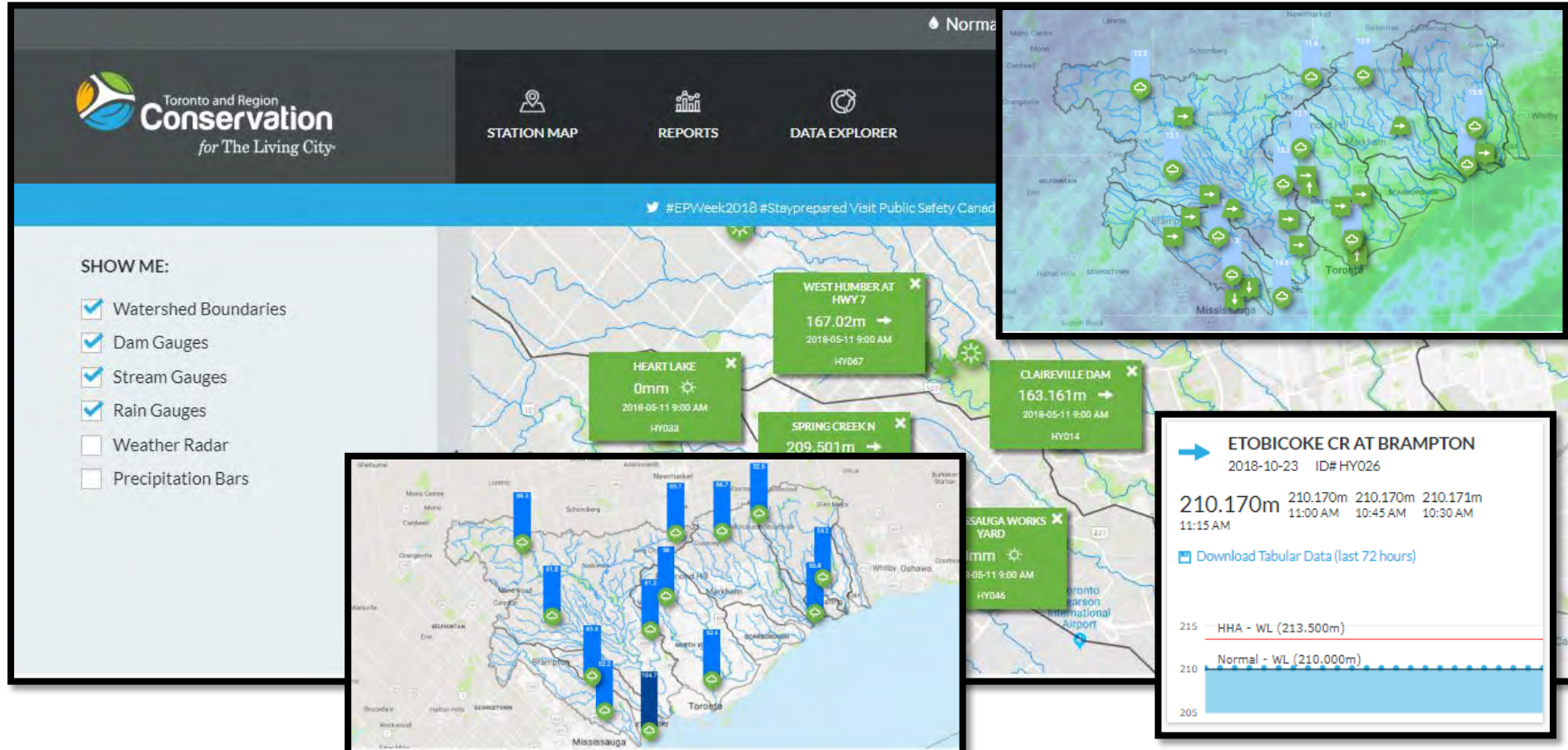


Figure 5. Display Forecast Management System Delft-FEWS

TRCA's Flood Monitoring Website

Beta.trcagauging.ca



Address or place



Site-Specific Response Plans & Tools

Flood Level (return period in years)

0 2 5 10 25

Toronto and Region Conservation Authority

-79.389 43.736 Degrees



Desktop Analysis of Existing Data

- Future Erosion Hazard Mitigation Strategy (FEHMS)
- Identifies areas with increased risk of slope failure using multiple data sets
- Aids in prioritization of mitigation work
- Reduces slope failure through prevention
 - Remediating area before a failure happens
 - Lower costs overall



Future Erosion Hazard Mitigation Strategy (FEHMS)

Identify areas that have increased risk of slope failure for carrying out proactive mitigation works.

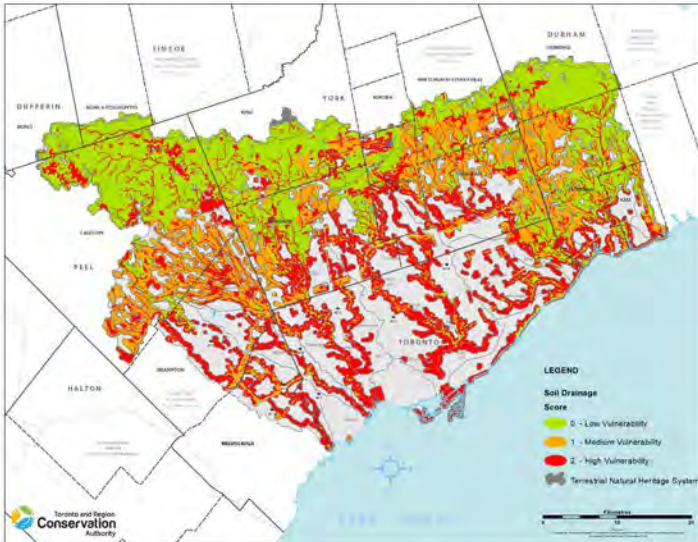
- Capital works coordination
 - Multiple risks mitigated under one project (e.g. risk to houses, water infrastructure, trails)
 - Multiple users of the same construction access road (consecutively)
 - Leaving access roads for City departments to access existing assets (e.g. sanitary crossings)
 - Converting access roads into future trails
 - Invasive species removal / native plantings on private lands



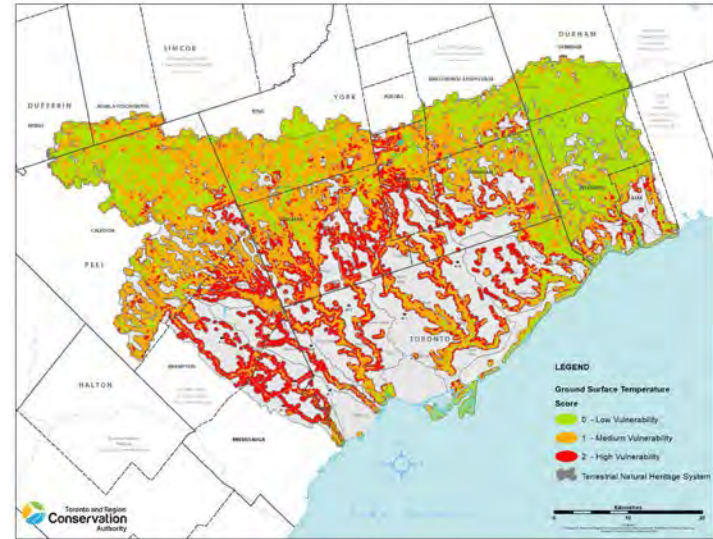
Climate Vulnerable Assessments

- Identifies relative degree of vulnerability within natural heritage system
- Informs where natural cover and wetland restoration projects could be located to mitigate vulnerability and benefit local communities

Soil drainage vulnerability scores



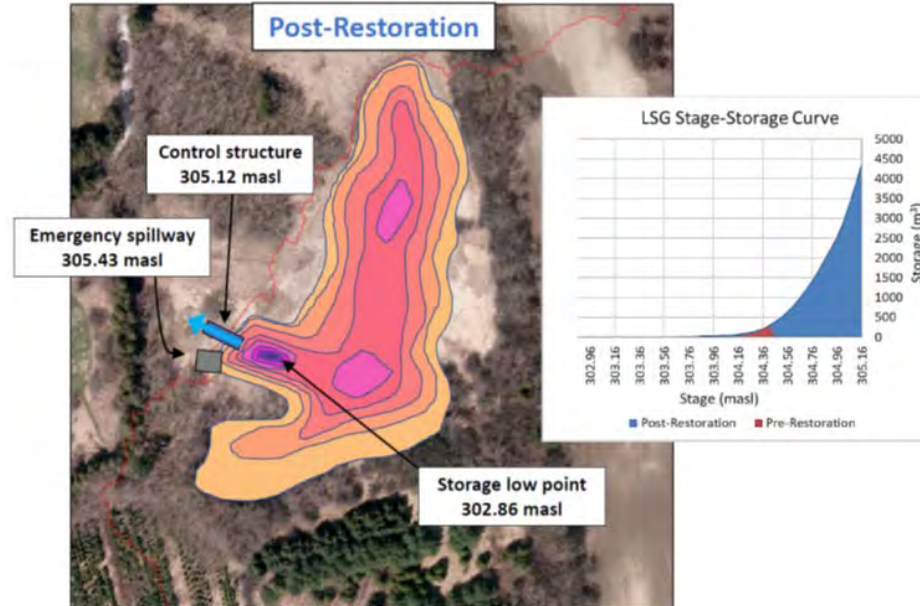
Ground surface temperatures vulnerability scores



Strategic Wetland Restoration

- Research had shown that Restored Wetland can reduce downstream flooding
- Lake St. George Wetland (annual averages)
 - Increased water storage volume by 2313%
 - Decreased maximum outflow rate by 73%
 - Improved deep percolation by 569%
 - Removed 66% more total phosphorous
 - Removed 81% more total suspended solids

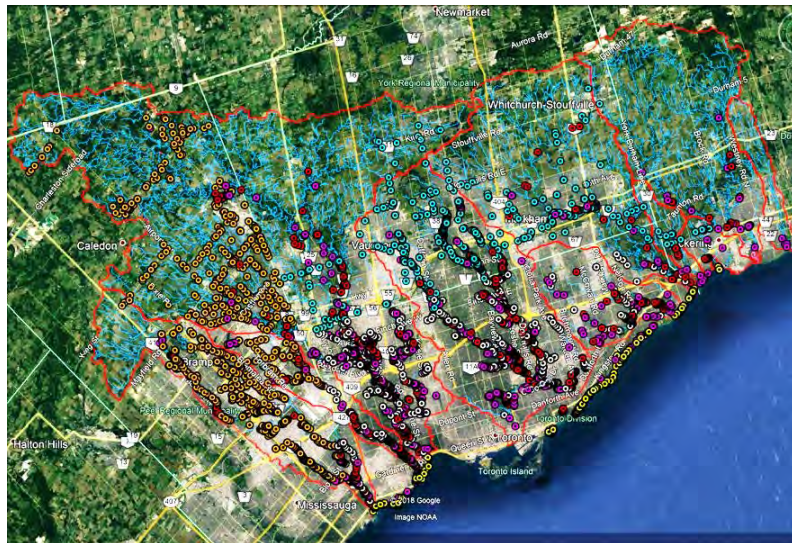
Key Performance Indicator	Pre-Restoration	Post-Restoration	Change	Change (%)
Annual average storage volume (m ³)	93	2244	2151	+2313%
Maximum storage volume (m ³)	290	8397	8107	+2796%
Total ET loss (mm)	420	434	13	+3%
Total surface outflow (1000 m ³)	26.5	18.2	-8.2	-31%
Total surface outflow (mm)	279	192	-86	-31%
Maximum outflow rate (m ³ /s)	0.46	0.13	-0.33	-73%
Total deep percolation (mm)	26	177	150	+569%
Total loss [ET + deep perc.] (mm)	447	610	163	+37%





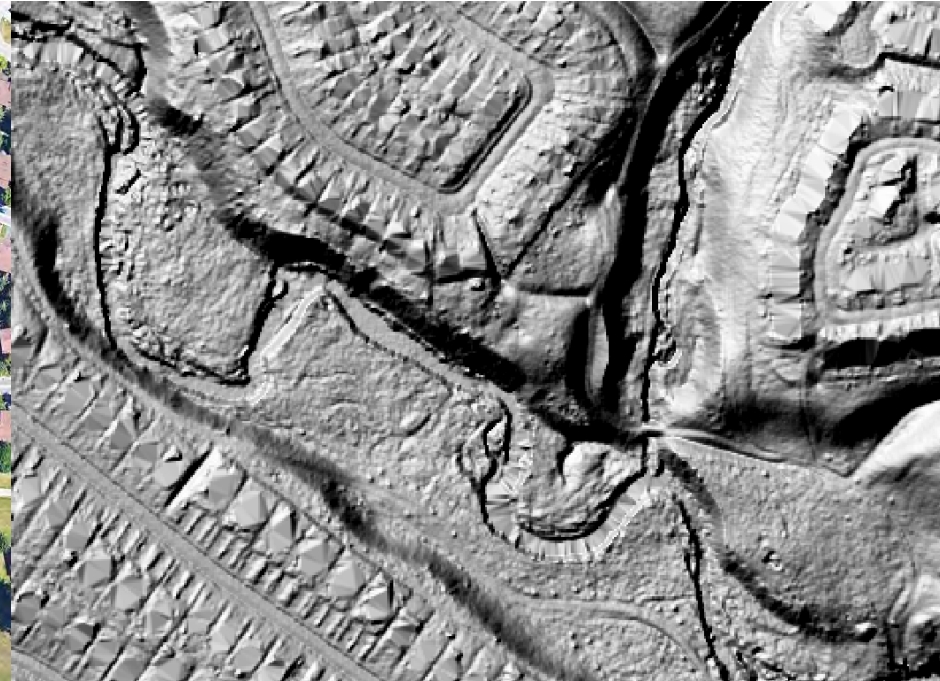
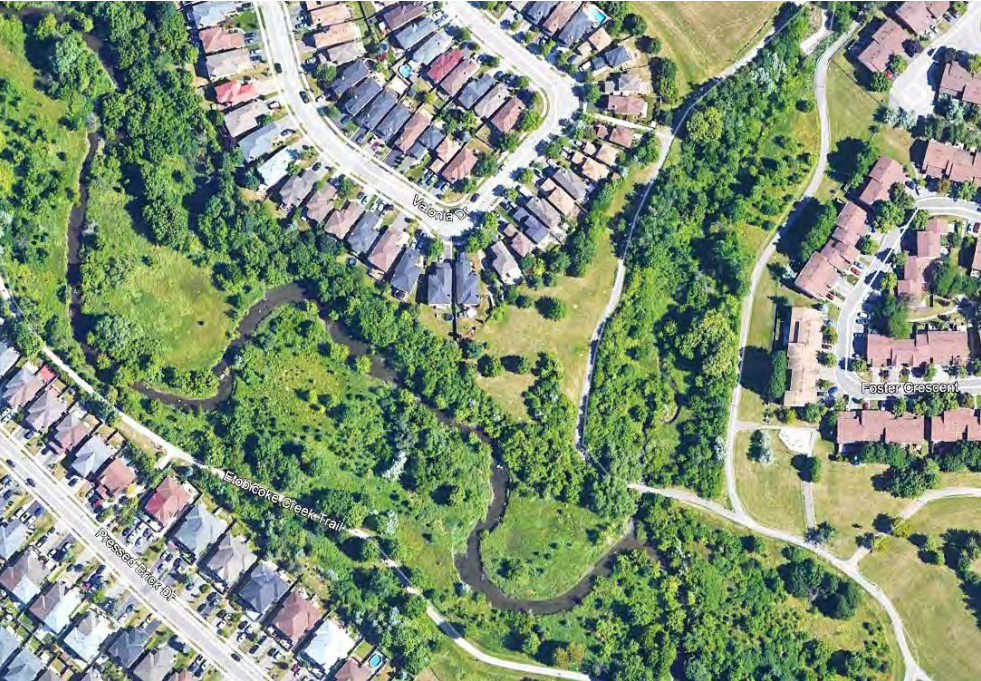
Real-Time Monitoring of Events

- Flood Risk Analysis Network (FRANK)
- Analyzes real-time stream and rain gauge data
- Determines which watercourses & reaches were affected
- Deploy inspection staff to quantify condition and/or movement



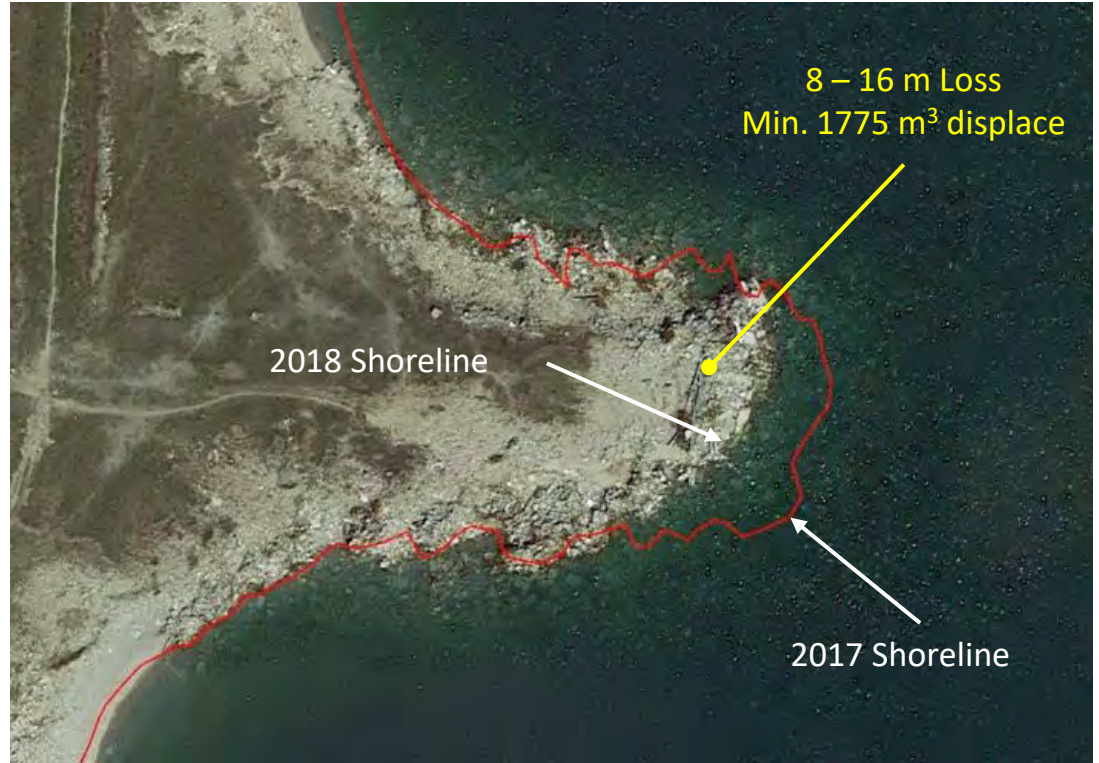
FRANK flags area
at risk
during/after an
event so that
TRCA knows
which structures
to inspect

Light Detection and Ranging (LiDAR) Analysis



Remotely Piloted Aircrafts (RPA)

- Changes the way we track and monitor erosion
- Monitoring of waterfront land will be safer, more accurate, and detailed



Remotely Piloted Aircrafts (RPA)

- 3D imagery to help document conditions and visualize solutions

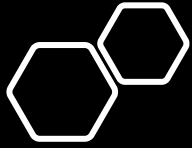


Coherence needed from
upper levels of government
on risk and vulnerability
assessment methods



Continued investment needed
in risk-reduction projects and
programs and the tools that
enable them





In Summary

- Conservation Authorities have been partners in building resilient communities, housing, and infrastructure since our inception
- We have specialized expertise in flood and erosion risk management, in climate change adaptation analysis, and in driving implementation of mitigation practices
- There are several recommendations on provincial policy guidance needed to support climate resilient communities, housing, and infrastructure – many of these have been identified in the report by Ontario's Special Advisor on Flooding
- The continued provision and partnership around funding opportunities like the National Disaster Mitigation Program, the Disaster Mitigation and Adaptation Fund, and Green Infrastructure Fund are critical