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When Creeks Spill into Cities: Flood Forecasting and Warning, and Interagency Coordination

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ABSTRACT

In July and August 2024, the Dixie-Dundas neighbourhood in the City of Mississauga, Ontario experienced two severe storm events that exceeded the 100-year storm threshold in parts of the Little Etobicoke Creek subwatershed. The neighbourhood is located within a floodplain spill area where flows from Little Etobicoke Creek overtopped its banks and spilled into the urban environment travelling along roadways and private properties creating a combination of riverine and urban flooding, resulting in significant impacts to people, infrastructure, and property.

Flood risk management in Ontario operates through a shared responsibility framework involving municipalities, conservation authorities, and the Province of Ontario. This paper presents a case study of how this framework functioned during the 2024 storm events, drawing on the experience of Toronto and Region Conservation Authority and its municipal partners. The paper describes flood conditions in the Little Etobicoke Creek subwatershed, flood and monitoring systems, flood forecasting and warning actions that were taken during the events, and post event documentation and risk reduction efforts.

The 2024 storms tested flood forecasting and warning systems, and interagency coordination under extreme rainfall conditions. Lessons from this case highlight the importance of detailed floodplain mapping, real time monitoring, clear and timely flood communications, site specific emergency planning, and sustained collaboration between conservation authorities and municipalities. The findings offer practical insights for flood management agencies managing compound flooding risks in highly urbanized watersheds.

KEYWORDS: flood forecasting and warning, shared responsibility, urban flooding, floodplain mapping, emergency response, watershed management

1 INTRODUCTION

Insured losses from weather events have been climbing for years (Web-1), and climate related infrastructure costs are expected to increase significantly without increased investment in risk reduction (Web-2). This is placing growing pressure on flood forecasting, warning, and emergency response systems, and infrastructure to achieve long term risk reduction. These challenges are particularly acute in highly urbanized watersheds (Konrad, 2003, p. 3), where intense rainfall can overwhelm the capacity of both river systems and municipal drainage infrastructure, producing both overland and basement flooding that requires rapid coordination among multiple agencies.

In Ontario, Canada, flood risk management operates through a shared responsibility framework involving municipalities, conservation authorities (CA's), the Province of Ontario, and the public. This framework, known as Ontario's flooding strategy, builds on the four core components of emergency management, namely mitigation, preparedness, response, and recovery (Ontario Ministry of Natural Resources and Forestry, 2020, p. 5). Two of the key responsibilities in this framework are to manage urban drainage infrastructure and undertake emergency response. Conservation authority responsibilities differ from that of municipalities with regards to flood risk management. CA's focus on anticipating flooding risks through riverine floodplain modelling and mapping, real-time monitoring of weather and watershed conditions, forecasting and warning of increasing flood risks, providing technical support to emergency response providers during flood events, and documenting conditions following events. Floodplain modelling and mapping services also support land development regulations, whereby land development restrictions limit the creation of additional riverine flood risk exposure. Keeping the public safe during severe storms depends on strong interagency coordination before, during, and after flood events, and this framework reinforces interagency coordination.

Toronto and Region Conservation Authority (TRCA) is one of 36 conservation authorities in Ontario (Web-3) and supports municipal partners across nine watersheds draining into Lake Ontario (Web-4). This paper presents a case study of collaborative flood risk management in the Little Etobicoke Creek subwatershed, with a focus on the Dixie Dundas neighbourhood in the City of Mississauga, one of the highest ranked riverine flood vulnerable clusters within the TRCA jurisdiction. The neighbourhood is located within a floodplain spill area of Little Etobicoke Creek and has experienced significant flooding during major summer storm events, including July 8, 2013, and two severe events in July and August 2024.

Using the 2024 storm events as a focal point, this paper describes existing flood risk conditions, floodplain mapping and watershed monitoring systems, flood forecasting and warning actions, and post event collaboration with municipal and regional partners. The objective is to illustrate how Ontario's shared responsibility model functions during extreme rainfall and highlights practical lessons for flood communications, emergency preparedness, and long-term flood mitigation planning in highly urbanized watersheds.

2 EXISTING FLOOD RISK IN LITTLE ETOBICOKE CREEK SUBWATERSHED

2.1 Dixie-Dundas Flood Vulnerable Cluster

TRCA's 2018 Flood Risk Assessment and Ranking Project identified and ranked clusters of roads and structures at risk of riverine and overland flooding across its jurisdiction (IBI Group, 2019). This study undertook detailed flood damage analysis considering expected flood depths across a spectrum of storm events allowing a consistent approach for quantifying and prioritizing flood risks between vulnerable clusters. Being able to quantify potential damages is critical for risk mitigation and remediation planning as well as emergency and disaster response planning.

Two Flood Vulnerable Clusters were identified along Little Etobicoke Creek in the City of Mississauga, between Eglinton Avenue and south of Dundas Street East. Flooding within this highly urbanized subwatershed typically occurs during the 100-year event or larger regional storms as a result of the majority of the watershed not having stormwater management controls (<22% of the urbanized area employs modern stormwater management controls (Toronto and Region Conservation Authority, 2021, p. 42). Within TRCA's jurisdiction, the 100-year event refers to the storm event with a 1% chance of occurring each year in a specific location, while the regional storm is a historical storm that is derived from the Hurricane Hazel storm that impacted Ontario in 1954. TRCA's jurisdiction encounters and has experienced both short duration intense storm events (e.g., thunderstorms), and longer large volume storm events (e.g., hurricane events).

The Dixie Dundas Flood Vulnerable Cluster is located near the intersection of Dixie Road and Dundas Street East and includes areas designated as a provincial Special Policy Area (Web-5). A Special Policy Area is a land use policy planning tool that allows a historically developed area within a floodplain to continue to exist while limiting intensification. The cluster is ranked first in flood risk within the Region of Peel and third overall across the TRCA jurisdiction. It is fully urbanized, consisting primarily of commercial and industrial land uses with adjacent high density residential areas. The combination of dense development, floodplain spill behaviour, and limited attenuation capacity makes this cluster particularly susceptible to short duration, high intensity summer storms, as demonstrated during flood events in 2013 and 2024.

2.2 Floodplain mapping

In 2015, TRCA completed an updated floodplain mapping study for the Dixie Dundas and Applewood Special Policy Area to improve characterization of flood risk within and adjacent to the SPA. The study used high resolution topographic data and two dimensional (2D) hydraulic modelling, using MIKE Flood modelling software, to assess flood behaviour under extreme storm conditions.

The analysis identified a significant floodplain spill area along Little Etobicoke Creek upstream of the Dixie Road crossing, where creek flows overtop the channel and spread laterally into surrounding urban areas. This spill mechanism increases flood exposure beyond the SPA boundaries and contributes to downstream impacts during major storm events.

Subsequent studies by the City of Mississauga extended floodplain coverage downstream into the Credit Valley Conservation Authority jurisdiction, confirming that flood impacts extend across conservation authority boundaries. The mapping results have directly informed flood forecasting and warning operations, site specific flood risk packages, land use decisions, and the development of long term flood mitigation strategies for the Dixie Dundas area (McKay & Hofbauer, 2024).

2.3 Existing flood mitigation measures and studies

Following the July 8, 2013, storm event, the City of Mississauga and TRCA initiated a series of technical studies to better understand flood mechanisms and evaluate mitigation options within the Little Etobicoke Creek subwatershed. These studies focused on areas with the highest flood risk, including the Dixie Dundas Flood Vulnerable Cluster.

TRCA developed a detailed 2D hydraulic model of Little Etobicoke Creek, and the City of Mississauga completed two Municipal Class Environmental Assessment studies examining riverine flooding associated with floodplain spill and pluvial flooding resulting from capacity exceedance of the storm sewer system. Together, these studies assessed a range of structural and non-structural mitigation options in a fully urbanized environment with limited space for large scale infrastructure.

The outcomes of these studies have informed both long term flood mitigation planning and short-term preparedness measures, including emergency response planning and enhancements to flood forecasting and warning. As of 2024, the City of Mississauga had completed an Environmental Assessment focused on reducing flood risk in the Dixie Dundas area, providing the basis for advancing future infrastructure solutions.

2.4 TRCA Monitoring and Flood Infrastructure

TRCA operates a network of precipitation and water level monitoring stations within the Little Etobicoke Creek subwatershed to support its Flood Forecasting and Warning Program. Near real time data from these stations are used to assess watershed response during storm events and to inform flood

messaging and coordination with municipal emergency response agencies. The data from this system is available to emergency management personnel and the public in real-time at 5-minute intervals (Web-6).

The monitoring network includes a stream gauge located upstream of the Dixie Dundas area and a precipitation station within the subwatershed. While these stations do not provide direct discharge measurements, they offer critical information on rainfall intensity, water level trends, and rates of rise during extreme events. This information supports situational awareness and decision making under rapidly changing conditions.

In addition to monitoring, flood control infrastructure exists along portions of Little Etobicoke Creek, including flood walls, channels, and dike systems constructed to reduce flood risk from higher frequency storm events. While these structures provided localized protection, the 2024 storm events exceeded their design capacity, reminding us that structural flood protection solutions can provide a false sense of security, and reinforcing the need for flood forecasting, emergency planning, and long term removal of risks rather than defense against risks.

2.5 Emergency planning

Conservation authority flood forecasting and warning data along with mapping supports municipal emergency response during riverine flood events. Little Etobicoke Creek responds rapidly to rainfall leading to very small flood warning lead times. Site specific planning is critical to minimizing emergency response actions once flooding is expected.

In response to the high risk ranking of the Dixie Dundas Flood Vulnerable Cluster, TRCA worked with the City of Mississauga and the Region of Peel to develop a Site Specific Flood Risk Package for this area. The package provides location specific flood hazard information, identifies vulnerable infrastructure and properties, and supports municipal decision making during flood events, including road closures, evacuations, and resource deployment.

This site specific approach strengthened coordination between TRCA and municipal emergency management agencies and played an important role in informing response actions during the 2024 storm events. It also provided a foundation for post event updates to emergency planning and preparedness within the subwatershed.

3 SUMMARY OF 2024 FLOODING EVENTS

The summer of 2024 presented exceptionally challenging hydrometeorological conditions across the Toronto and Region Conservation Authority jurisdiction, culminating in two severe rainfall events that stress-tested flood forecasting, warning, and municipal emergency response systems. Antecedent wet conditions amplified the impacts of the first storm event, which occurred on July 16.

Rainfall totals in June and July far exceeded long term averages, resulting in saturated soils across southern Ontario prior to the July 16 event. Over 100 mm of rain in June and 215 mm in July were recorded at Environment Canada's Toronto Pearson Airport weather station —well above the monthly average of approximately 75 mm for each month (Web-7). The July total exceeded the previous monthly record set in October 1954 during Hurricane Hazel (Web-7). Rainfall from the remnants of Hurricane Beryl on July 10–11, and multiple thunderstorms between July 12–15 saturated soils across southern Ontario and the GTA, which reduced infiltration capacity and increased runoff potential prior to the July 16 event.

On July 16, sustained heavy rainfall occurred for 3–4 hours, with the most intense precipitation affecting Mississauga and Toronto. Rainfall totals across TRCA watersheds ranged from 8 mm to 102 mm,

with intensities between 5 mm/hr and 58 mm/hr, highest in the western and southern areas. Storm return period analysis showed significant variation, with the largest return period recorded in the Little Etobicoke Creek sub-watershed, slightly exceeding the 100-year storm threshold.

3.1 Flood forecasting and warning actions during the July 16, 2024, event

During the July 16 storm, TRCA actively monitored watershed and weather conditions in accordance with internal procedures and Provincial guidelines for flood event messaging (Toronto and Region Conservation Authority, 2025, pp. 11-13). Flood messaging was escalated as conditions and weather forecasts deteriorated. A Flood Watch was issued at 9:30 AM, followed by a Flood Warning at 11:30 AM as rainfall intensities increased and water levels rose rapidly across multiple watersheds. A Flood Watch is issued when flooding is possible and is intended to advise municipalities, emergency services, and individuals in flood vulnerable areas to prepare for possible flooding impacts, while a Flood Warning indicates that flooding is imminent or already occurring, and is the highest level of messaging. Flood messages were distributed through established channels to municipal partners, emergency response agencies, media, and the public.

The escalation to Flood Warning coincided with TRCA activating its emergency storm event procedures. These procedures were guided by Emergency Management Ontario's Incident Management System (IMS), a standardized framework used by TRCA to support municipal coordination of emergency response actions (Web-8). In addition, TRCA engaged in direct communications with affected municipalities and agencies. These direct phone communications with municipal emergency management and transportation agencies supported real time coordination of response actions during the rapidly developing event.

3.2 Flood impacts during the July 16, 2024, event

Flood impacts during the July 16 event reflected the combined effects of riverine flooding and exceedance of urban drainage systems. Within the City of Mississauga, water levels along Little Etobicoke Creek rose rapidly and overtopped channel banks within one and a half hours of the onset of rain, resulting in a major floodplain spill near the Dixie Road and Dundas Street East intersection. Floodwater extended beyond the regulated floodplain, impacting roads, commercial and industrial properties, and adjacent residential areas within the Dixie Dundas Flood Vulnerable Cluster.

Impacts included significant flooding at the Tyndall Seniors Residence, where emergency evacuations were required (Web-9). Flooding patterns observed during the event were consistent with previous floodplain mapping and hydraulic modelling, validating existing risk assessments. Additional impacts occurred across the City of Toronto, including flooding of major transportation corridors such as the Don Valley Parkway (web-10), further demonstrating the vulnerability of highly urbanized systems under extreme rainfall conditions.

3.3 August 17, 2024, storm event and comparative impacts

A second severe rainfall event occurred on August 17, 2024, approximately one month after the July storm. Slow moving thunderstorms produced intense short duration rainfall, with peak totals exceeding those observed on July 16, 2024, with 136 mm of rainfall. Flooding again affected the Dixie Dundas Flood Vulnerable Cluster, with floodplain spill behaviour similar to that observed during the earlier event.

The close succession of the July and August storms reduced recovery capacity and amplified cumulative impacts. Together, the events highlighted the vulnerability of highly urbanized watersheds to both sustained wet periods and intense convective storms and provided an opportunity to evaluate the consistency of flood response actions and communication strategies under repeated extreme conditions.

4 POST EVENT ACTIVITIES AND MULTI-AGENCY COLLABORATION

4.1 TRCA Flood Communications

Flood messaging is a core component of TRCA's Flood Forecasting and Warning Program and a primary mechanism for communicating flood risk to municipalities, emergency response providers, media, and the public. Following the July and August 2024 storm events, post event discussions with municipal partners and elected officials identified opportunities to improve the accessibility and immediacy of flood message communications, particularly for residents in high risk areas.

In response, TRCA expanded its public flood message distribution to include text message notifications in addition to emails, and then promoted the new notification option using a combination of social media advertising and messaging during public meetings. This enhancement was added to better align with how residents access time sensitive information and to complement existing communication channels. By the end of 2025, public subscription to flood messages had increased, by approximately 130%, indicating improved reach and uptake of flood warning information. TRCA also worked with municipal partners to display flood messages directly on municipal websites to reinforce consistent messaging across jurisdictions.

4.2 Municipal collaboration

The 2024 storm events required close coordination between TRCA and municipal partners across the response phase of emergency management. Following the events, TRCA staff coordinated post event data collection, including documentation of high water marks and verification of monitoring records, to support flood analysis and validation of existing flood models.

TRCA also engaged with municipal staff through technical meetings, site visits, and debriefing sessions to review flood response actions, identify priority impact locations, and discuss opportunities for improvement. These collaborative efforts supported a shared understanding of flood mechanisms and response challenges and informed future mitigation and preparedness priorities.

4.3 Preparedness and updates to emergency planning

Post event reviews emphasized the importance of preparedness and continuous improvement in emergency planning. TRCA supported municipal emergency management activities, including training exercises and debriefing sessions, to evaluate communication pathways and interagency coordination during fast developing flood events.

A key outcome of these efforts was the updating of the Dixie Dundas Site Specific Flood Risk Package to incorporate lessons learned from the 2024 flood events. Flood risk mapping and emergency planning were also expanded to include a second Flood Vulnerable Cluster within the Little Etobicoke Creek subwatershed that experienced significant impacts during the storms. These updates strengthen the ability to respond quickly during future events in the communities.

4.4 Future flood mitigation projects

Advancing long term flood mitigation projects remains a priority following the 2024 storm events. TRCA continues to work with municipal, provincial, and federal partners to support flood mitigation planning and to pursue external funding opportunities. While federal and provincial programs have enabled progress on floodplain mapping and infrastructure projects, competition for funding and complex implementation timelines remain ongoing challenges.

Within the Dixie Dundas area, collaboration with the City of Mississauga and the Region of Peel is focused on identifying phased mitigation solutions that provide the greatest flood risk reduction within feasible timeframes. These efforts highlight the importance of sustained interagency collaboration and long term investment in flood mitigation to address increasing risks associated with extreme rainfall and urbanization.

5 CONCLUSION

The July and August 2024 storm events in the Little Etobicoke Creek subwatershed illustrate the increasing complexity of flood risk management in highly urbanized watersheds under extreme rainfall conditions. Flooding in the Dixie Dundas neighbourhood resulted from the combined effects of riverine overflow and the exceedance of urban drainage systems, reinforcing the need for coordinated approaches that extend beyond individual jurisdictions and infrastructure systems.

This case study demonstrates how Ontario's shared responsibility framework for flood risk management functions in practice during severe events. Conservation authorities contribute impartial science based expertise through floodplain mapping, monitoring, and flood forecasting and warning, while municipalities lead emergency response and recovery activities. The 2024 events highlighted the importance of timely escalation of flood messaging, established communication pathways, and strong interagency relationships developed in advance of extreme events.

Post event learning and adaptation following the 2024 storms strengthened preparedness through updated emergency planning, improved flood communications, and continued collaboration on flood mitigation planning. At the same time, the events underscored ongoing challenges related to the pace of and complexity of implementing large scale mitigation projects in built up environments.

As extreme rainfall events become more frequent and intense, the experience from the Dixie Dundas neighbourhood highlights the value of detailed floodplain mapping, real time monitoring, and sustained collaboration as foundational elements of flood resilience. While the institutional context in Ontario is specific, the lessons from this case study are broadly applicable to other jurisdictions managing compound flooding risks in urban watersheds.

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