Hazard Identification Risk Assessment

2020 Vision: Year 1 Progress Report

Office of Emergency Management

July 2017

Hazard Identification Risk Assessment

2020 Vision

2020 Vision is the five-year strategic plan for The City of Toronto Office of Emergency Management (OEM) Hazard Identification and Risk Assessment (HIRA), beginning in 2016. This document identifies the primary objectives and scope for the HIRA project and defines the expected impact programs and divisions within the City of Toronto, as well as external partners and the public.

The three core themes, which form the foundation of the strategy, will be described in this document. Each will directly inform HIRA objectives based on the project work plan.

Mission

To create a framework for the development of the City of Toronto Hazard Identification Risk Assessment within the Office of Emergency Management.

The Project has a three-year timeframe and will be based on guidelines and standards provided by the Ontario Office of the Fire Marshal and Emergency Management (OFMEM), Canadian municipal policy and practice, and evidence-based research.

Purpose

Hazard Identification & Risk Assessment (HIRA) is an evaluation tool used to identify and explain the nature of the extraordinary risks facing the City of Toronto. This tool is used to assess the probability of occurrence, likely impact, and the trend of change in these hazards over time.

The outcome of HIRA is a score which can be ranked to give a relative measure of all hazards that could affect Toronto, in terms of likelihood and severity of impact.

The assessment for natural, technological and human-caused hazards for the City of Toronto is a requirement of the Emergency Management and Civil Protection Act, carried out by the Office of Emergency Management for the City of Toronto.

The assessment consists of structured interviews and an extensive research component. This effort has focused on providing an extensive body of knowledge for each hazard, with a particular focus on the City of Toronto and the GTA. This includes historic events, academic and grey literature, as well as municipal practice and Emergency Management sources.

This assessment aims to achieve the following, through annual assessment:
- Producing a stronger and more accessible evidence base for decision-makers, particularly for Emergency mitigation, planning, response and recovery.
- Inform program development at the City of Toronto, particularly for items mandated by the Emergency management and Civil Protection Act and those which improve the resilience of Toronto residents
- Improving the public's understanding of the challenges these trends and events pose to governments.

Themes

Increasing Program Quality and Effectiveness

- Theme: Inform emergency planning and mitigation measures through the integration of risk assessment

While the scale of the current analysis provides high-level information, it is not currently integrated effectively into program activities. HIRA ideally include robust, evidence-based approach, alongside interviews and spatial analysis of risk.

Utilization of collaborative approaches, alongside tools that are capable of identifying potential systematic vulnerabilities will help address this limitation. By focusing on increasing the quality of hazard-specific analysis, and building on baseline data with tools such as Geographic Information Systems (GIS), strong evidence-based research principles, and further development of vulnerability assessment and impact analysis processes in specific geographic areas of the City, a more meaningful and comprehensive product can be crafted over time. In addition, such action enables more explicit and meaningful action to be implemented by divisional and external partners to address specific risks.

Whole-of-Community Approach

- Theme: Enhance the applicability of hazard and risk profiles for mitigation efforts of City Divisions and partners

Engagement of partners in the development of risk profiles, as well as using these to inform preparedness and mitigation efforts, is best-practice in Emergency Management. Such initiatives can assist municipal organisations in better understanding the impact on neighbourhoods, organizations and infrastructure across the City.

Risk assessments performed at the scale of the whole city will characteristically lack local specificity. However, Critical infrastructure partners, organizations and community partners are often best positioned to understand the direct impacts of hazards, along with any connected or dependent processes. Involvement of such partners not only deepens the understanding and assessment of hazards and risks, but creates a platform for open dialogue and more effective mitigation efforts.

Dynamic Models and Systems of Analysis

- Theme: Increase understanding of the interdependencies of hazards and risks;

It is important to move beyond static models of system assessment, and work together to improve understandings of interdependency. Future risk assessment should endeavour to assess the interdependency and cascading impact of emergencies, and utilize a collaborative approach, alongside tools that are capable of identifying potential systematic vulnerabilities. This approach would serve the greatest benefit to mitigating risk to connected critical infrastructure.

The Vision

HIRA 2020 priorities:

Priority 2: Connecting

Improve understanding of complex Hazard and Risks through more focused and targeted assessment.

Priority 1: Developing

Develop a more robust HIRA methodology and framework through continuous improvement.

Priority 3: Integrating

Leverage overlapping goals and objectives within the City of Toronto, to enhance and improve multiple projects.

Priority 4: Engaging

Work with stakeholders and partners to develop and enhance the HIRA with a whole-of-society approach.

Progress to Date

| Complete | In Progress 2018 Target | Planned 2018-19 | Planned 2019-20 |

Priority 1: Developing
Develop a more robust HIRA methodology and framework through continuous improvement.

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Improve understanding of complex Hazard and Risks through more targeted and focused assessment.

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Leverage overlapping goals and objectives within the City of Toronto, to enhance and improve multiple projects.

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Work with stakeholders and partners to develop and enhance the HIRA with a whole-of-society approach.

Priority 1: Developing

Revisions to the HIRA since 2016 have focused on process improvements, such as defining service interruptions, understanding potential impact to critical infrastructure, and improving data collection and analysis. Over 480 hours of research work-hours, along with 200 hours of staff time at the Office of Emergency Management, have resulted in a well-documented and comprehensive baseline of research and analysis. This assessment is based on establishing and assessing potential capacity in response to realistic worst-case scenarios, and is supported by a combination of interviews, research and peer review with Subject Matter Experts.

This product, along with a number of supporting guides and training options, now serve to bolster institutional knowledge, guide policy, and inform plans in the Office of Emergency management and across institutional barriers.

Annual update of the HIRA product supported by the Emergency management Working Group will be sufficient to maintain this baseline.

With priority 1 addressed, June 2017 marks the beginning of phase 2 of this strategy.

Priority 2: Connecting

Objectives:

1. Improve understandings of interdependency of Critical Infrastructure
2. Further develop hazard-specific assessment in three core areas, contributing to risk mitigation measures:
    o Cyber Threat
    o Electrical Power Disruption
    o Flooding
3. Assess and improve the way in which Hazard Identification and Risk Assessment informs program areas within the Office of Emergency Management and the EMWG.

Methodology Overview

The Provincial methodology laid out by the office of the Fire Marshal and Emergency Management forms the basis for the City of Toronto HIRA. The City of Toronto methodology, including the differences between the provincial and Toronto municipal HIRA framework, is included in this section.

Standards

The overall process of risk identification, risk analysis, and risk evaluation at the City of Toronto is based on annual Hazard identification and Risk Assessment. This assessment is therefore based on a rigorous methodology, consistent with the following standards and guidelines:

- CSA Z1600-17 – Emergency and Continuity Management Program

- ISO 31000 – Risk Management Principles and Guidelines

- ISO/IEC 31010 - Risk Management - Risk Assessment Techniques

Sources and Scoring

Four main types of sources were examined in order to holistically identify hazards and risk:

- **Interviews with Subject Matter Experts** (e.g. Toronto divisional experts, RCMP, Toronto Fire, environment Canada)
- **Historical Data** (e.g. City of Toronto internal records, media reports, The Canadian Disaster Database, Environment Canada, Transport Canada, etc)
- **Global Risk Studies and Assessments** (e.g. Cambridge Centre for Risk Studies Global Report, Examples from other cities including New York and Los Angeles, Public Safety Canada, Swiss Re, World Economic Forum etc)
- **Hazard information sources** (e.g. risk specific emergency plans, Subject matter expert reports, research papers, materials from critical infrastructure partners)

This assessment produced two sets of scores for each hazard, one informed by the research component, and one based on the interview component. In cases where more than one interview was conducted, the average calculated across all interviews was used as the final score.

Peer Review

Members of the Emergency Management Working group reviewed and provided feedback on each hazard profile. This group consists of stakeholders from across City divisions identified in the City Emergency Plan as well as external partners and subject matter experts in emergency planning, mitigation, response and recovery. Each hazard profile and all hazard scores were evaluated by this group, to assess the quality and reliability of findings, and to ensure a more thorough and holistic assessment of the resilience of the City to each hazard.

Research Questions

The Hazard Identification and Risk Assessment is based on four simple questions:
- What hazards exist in Toronto?
- How frequently do they occur?
- How severe can their impact be?
- Which hazards pose the greatest threat to the City and its residents?

Further to this, the HIRA research and interviews are designed to ascertain a deeper understanding to the following for every hazard:
- What hazards represent the most risk to the resilience of City of Toronto Residents?
- What is the likelihood of these events affecting Toronto within the 1, 3, and 20 years?
- Is the probability, frequency or intensity of these events increasing over time?
- Which sector, infrastructure, geographic areas, and demographic groups are more at risk?
- Are there gaps in the current mitigation, planning, preparedness, response or recovery strategies that the City of Toronto or its partners could improve upon?
- To what extent and in what ways can the risks that these events be mitigated?

Interview Questions

Preparatory Questions:

1. Have you conducted your own risk assessment (HIRA)?
2. What methodology do you use? Please share what you can.
3. Are there areas of the city or populations which are at particularly high risk for this type of hazard?
4. We would like to discuss how often this hazard occurs. How often would you say this hazard occurs within a 20 year period in the City if at all?
   a) Why did you choose that number?
   b) Do you think this number may change? How?

Standard Questions (No preparation)

1. How would you describe your organization/division's capability to cope and recover in the event of a _____emergency?
2. Describe an example of a time when your organization/division experienced an _____ emergency.
   a) Did it effect people in the City, and people your organization/division serves?
   b) Which facilities, services or technology were effected?
   c) How did your organization/division respond?
3. Is there anything your organization/division can do, or is currently doing, to help reduce or mitigate the risk of these kinds of emergencies for residents of Toronto?
   a) What are the challenges which have prevented the implementation of these? (if applicable)
4. Do you think that your organization/division is adequately aware of and/or prepared for the risks and impacts of such a hazard? Explain why.
5. Has your organization/division established working relationships or partnerships to help address

this risk? Please explain.

6. Are there any specific hazards or risks you think your organization/division should pay particular attention to that are related to _____ emergencies?

7. What is the most credible* worst case scenario you can think of for emergencies of this type occurring in or affecting the City (and requiring action on the part of your organization/division), and how would your community respond? Please describe the scenario.

*Most credible: An event that is possible and plausible to occur. Its occurrence would be the logical result of systems currently in place and not, for instance, the result of a series of freak accidents.

Event-specific Questions:

Interviewers may wish to ask questions about a specific event which has occurred. These should be asked at the end of the interview.

Examples:

- Since [*event name*], have regulations or procedures been implemented to address the risk? Have these been successful in reducing the risk? Please explain.
- How possible are such events in the future? Would such events be likely to occur at the same, or higher, magnitude?

Measuring Likelihood

Score	Category	% Chance, occurrence in any year	Description
1	Rare	<1%	Hazards with return periods >100 years.
2	Very Unlikely	1- 2%.	Occurs in the City of Toronto every 50 – 100 years. Includes hazards that have not occurred but are reported to be more likely in the near future.
3	Unlikely	2-10%	Occurs in the City of Toronto every 20 – 50 years
4	Probable	10-50%	Occurs in the City of Toronto every 5 – 20 years
5	Likely	50-100%	Occurs in the City of Toronto <5 years.
6	Almost Certain	100%	The hazard occurs annually.

Measuring of Consequence

Consequence is measured by examining each of the following consequence variables in turn. Variable scores are a maximum of 2, 3 or 4, depending on the potential for fatalities. This weighting of consequence variables was determined by the Office of the Fire Marshal and Emergency Management in their original HIRA framework and adopted for the City HIRA to ensure that scores are comparable to previous assessments, as well as assessments performed across the province.

The consequence variables included in the analysis are as follows:

- Fatalities
- Injuries
- Evacuation
- Property Damage

- Critical Infrastructure Service Impact
- Environmental Damage
- Business / Financial Impact
- Psychosocial Impact

Sub-category	Score		Description. Could result in the following:
FATALITIES	0	None	No fatalities
	1	Minor	<5 fatalities
	2	Moderate	5-10 fatalities
	3	Severe	10-50 fatalities
	4	Catastrophic	>50 fatalities
INJURIES	0	None	No injuries.
	1	Minor	<25 people
	2	Moderate	25-100 people
	3	Severe	>100 people
EVACUATION: Evacuation, shelter-in-place or stranded.	0	None	None
	1	Minor	<100 people
	2	Moderate	100-500 people
	3	Severe	>500 people
PROPERTY DAMAGE	0	None	No property damage within the community.
	1	Minor	Minor and mostly cosmetic damage.
	2	Moderate	Localized severe damage (a few buildings destroyed).
	3	Severe	Widespread severe damage (buildings destroyed).
CRITICAL INFRASTRUTURE SERVICE IMPACT	0	None	No critical infrastructure services disrupted
	1	Minor	1 critical infrastructure service.
	2	Moderate	2-3 critical infrastructure services.
	3	Severe	>3 critical infrastructure services.
ENVIRONMENTAL DAMAGE	0	None	No environmental damage.
	1	Minor	Localized and reversible damage. Clean up possible.
	2	Moderate	Major but reversible damage. Full clean up difficult.
	3	Severe	Severe, irreversible environmental damage. Full clean up not possible.
BUSINESS / FINANCIAL IMPACT	0	None	No business/financial activity disruption.
	1	Moderate	Losses for a few businesses **and** a financial impact for the city.
	2	Severe	Losses for an industry and/or a severe lasting financial impact for the city.
PSYCHOSOCIAL IMPACT: eg. mass panic, self-evacuation	0	None	No significant psychosocial impacts.
	1	Moderate	Significant but localized psychosocial impacts.
	2	Severe	Widespread psychosocial impact.

The scores for each consequence are then added together to create a total consequence score, and a consequence level is determined according to thresholds defined in the table below:

Scoring Thresholds	Consequence	Description
1 - 4	1	Minor
5 - 6	2	Slight
7 - 8	3	Moderate
9 - 10	4	Severe
11 - 12	5	Very Severe
13+	6	Catastrophic

Understanding Risk Trends

The change variable inflates the overall risk score to account for trends in either frequency or vulnerability that are anticipated to increase the risk beyond the capability of current planning assumptions of existing initiatives. This includes prevention, mitigation, preparedness, response and recovery capabilities, and with adequate consideration of the time and resources needed to implement preventative or adaptive measures. The variables that could contribute to a high change score are as follows:

Change in Frequency

1	Are the number of reported occurrences of the hazard increasing? For reference: Please specify over what period of time, specifically (1 year? 20 years?)
2	Is human activity likely to lead to more interaction with the hazard or an increase in frequency?
	e.g. population expansion, altering of drainage flow patterns, business activity
3	Is there an environmental reason why the frequency of this hazard may increase?
4	Are there policy and/or governance factors, such as land-use management or emergency response capacity, which could lead to an increase in frequency?

Answer YES to 2 or more questions: score = 2. Otherwise: score = 1.

Change in Vulnerability

1	Is the percentage of the population vulnerable to this hazard increasing?
2	Has critical infrastructure or delivery system vulnerability increased over the last 3 years? e.g. 'just-in-time' delivery systems or reliance on frequent restocking, aging infrastructure
3	Has the readiness or ability of agencies to respond to or recover from to this hazard decreased? e.g. From changes to policies, procedures, programs (including funding) or regulations etc
4	Do current prevention/mitigation measures have a reduced capacity to address the likely impact of this hazard, over the last 3 years? e.g. Stagnation of policy, ineffective 'improvements', changes to design standards etc

Answer YES to 2 or more questions: score = 2. Otherwise: score = 1.

Total:

Changing Risk = Change in Frequency + Change in Vulnerability   (Therefore, total Score can be either 2, 3 or 4)

Total Hazard Score

Once a value is determined for each of the three components of the standard risk equation, these are multiplied to produce a final score: **Risk = Frequency X Consequence X Changing risk**

The resulting value falls into the following thresholds/categories for risk

<=20 VERY LOW	21-40 LOW	41-60 MODERATE	61-80 HIGH	81-100 VERY HIGH	>100 EXTREME