

A Climate Impact Assessment Comparative Analysis for the City of London

Final Report

February 29, 2024



Submitted to:
The City of London

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1. Executive Summary

Assessing climate risks, related impacts, and adaptive capacity is an important step to address the goal of improving the City of London resilience to climate change impacts. There are many methods available to assess climate risks, each with unique facets that address spatial and time scales, climate data certainty, adaptive capacity and perceptions of consequence. The City of London's Climate Change Discussion Primer, and subsequent Climate Change Adaptation Risk Assessment (CCARA) exemplify one such approach. A broader scale assessment of climate change risks was conducted by the Province of Ontario which also had its unique elements and approach. Comparing the 2 assessments, both in terms of process and results enables an understanding of transferrable lessons regarding the mechanics of the assessment and a comparison of risk results. This analysis compared the City of London's CCARA to the Provincial Climate Change Impact Assessment (PCCIA) in 3 main areas: the methodology, their respective risk scenarios and the risk results (PCCIA Southwest Ontario region). The comparative analysis also considered aspects of scale, resource availability, goals and budget.

Both the provincial and London assessments share the goal of documenting greatest risks and climate change impacts to key areas of importance within the areas of assessment. Importantly, the focus of the City of London's assessment work was on corporate responsibility as defined by service delivery from the City Corporation. The scope of the PCCIA covers a multitude of ecological, social and business systems across the entire province. The PCCIA's comprehensive and multi-sectoral assessment of potential climate change-related impacts aims to improve the understanding of how and where climate change impacts may occur and provides the impetus for adaptation planning and resilience action across the province.

Both assessments show that weather events posing the highest risk include extreme precipitation, flooding, sleet/ice storms and heat waves/high and extreme temperatures, both in the present time period (baseline) and in the mid-term future (2050s). It is expected that extreme heat related risks will accelerate, and that extreme precipitation will remain a consistent driver of risk in the coming decades. Winter precipitation is expected to drive more risks in the future, compared to the amount of current risks being driven by low temperature.

Public health, emergency management, general population, and Indigenous communities are subject to the highest risks at present and in the mid-term future period (2050s). Adaptive capacity analysis, conducted as part of the PCCIA, identified climate change adaptation priorities (categories/sectors with lower adaptive capacity and high or very high risk scores). Notably, current adaptation priorities for the Southwest region are: Unhoused population, Indigenous population, Indigenous cultural services, and Indigenous health care, while emerging adaptation priorities include: general population, social assistance and public administration, and Indigenous social assistance.

The importance of identifying and implementing appropriate adaptation strategies and actions was common in both assessments. The PCCIA produced an Adaptation and Resilience Best Practice (ABP) report that aims to support policy- and decision-makers in the identification and

consideration of adaptation measures that can build adaptive capacity in the businesses, communities, infrastructure, and natural systems of Ontario and reduce the potential for catastrophic losses across the province.

Comparative analysis identified 91 PCCIA adaptation best practices to be considered as a starting point for closer investigation. These ABPs could inform the selection of locally appropriate measures to assess climate risks and could be potentially relevant in informing the City of London Adaptation Plan. Consultations with the City of London staff revealed that a number of existing programs, not reflected in the 2014 CCARA and the Discussion Primer, already support similar adaptation actions and some of the ABPs are implemented by the City. Other ABPs are being considered for implementation in the future.

For several ABPs linked to People and Communities, focusing on unhoused populations, Indigenous populations, health care as well as overarching issues, a number of gaps were identified during the review of risk assessment documents as well as communication with the City staff. Importantly, this Area of Focus has the most current and emerging priorities for adaptation and risk management in light of higher risk scores and lower levels of adaptive capacity.

PCCIA information on Southwest Ontario regional risks, adaptive capacity and adaptation best practices could help the City of London further advance climate change resiliency. Results from this comparative analysis could be used in an engagement process to solicit validation and inform aspects of a City of London Climate Change Adaptation Plan. Grouping ABPs by type and/or specific areas of importance to the City could help identify and prioritize appropriate adaptation strategies. Additionally, further and deeper exploration of indirect, cascading and cross-sectoral impacts and identification of areas where impacts amplify can help prioritize resilience needs and target adaptation responses.

Other considerations for future climate change adaptation work include incorporation of the most up-to-date climate risk information into City Planning documents such as the Official Plan, the Corporate Strategic Plan, and the Corporate Asset Management Program. An inclusive approach to development of climate policy and programs, capital and operational expenditures, research and technological development would ensure good representation from, and recognition of vulnerable populations who are most risk from climate change.

2. Introduction

As a response to London's 2019 Climate Emergency Declaration, the City of London embarked on a multi-year initiative titled the Climate Emergency Action Plan (CEAP) [1] with the goals of:

- 1) Achieving net-zero community greenhouse gas emissions by 2050,
- 2) Improving the City's resilience to climate change impacts, and
- 3) Bringing everyone along (e.g., individuals, households, businesses, neighbourhoods).

A Climate Change Adaptation Risk Assessment (CCARA) for the Corporation of the City of London [2], conducted in 2014, focused on corporate responsibility and documented the Corporation's greatest climate-related risks and accompanying losses with respect to City service delivery.

The assessment was updated in 2021 with the assistance of ICLEI Canada and their Advancing Adaptation program and formed the foundation for the recently completed Discussion Primer [3] on the topic of climate adaptation. The Primer's intent is to translate corporate risks to the broader, community-wide scale, with a focus on impacts to vulnerable populations, built environment, natural environment. The Primer also presents motivation for action and provides more technical detail on the City's earlier work and informs the City of London Climate Change Adaptation Plan development.

In 2023, the Climate Risk Institute (CRI) and partners completed a Provincial Climate Change Impact Assessment (PCCIA) for Ontario [4]. The PCCIA is a comprehensive and multi-sectoral assessment that provides an overview of impacts that stem from a changing climate and underscores the understanding of how and where climate change may affect Ontario's economy, infrastructure, communities, public health and safety, and ecosystems. The PCCIA provides information to facilitate adaptation decisions and inform adaptation priorities across Ontario sectors and sub-regions. It establishes a foundation of impacts against which future assessments can be compared and provides a methodological model for future studies.

The City of London commissioned CRI to conduct a comparative analysis of approaches and levels of analysis for climate risk in the CCARA, the Discussion Primer that it informed, and the PCCIA. The comparative analysis looks closely at the methodology of the two assessments, respective risk scenarios and results for the Southwest Ontario region of the PCCIA and the City of London, understanding the scale, resource availability, goals and budget differences between the assessments.

This report summarizes the comparative analysis documented in detail in the comparative framework (available under separate cover) [5] and includes a summary of findings that could feed into the engagement process with London's general public to collaboratively edit the Discussion Primer and inform the development of the City of London Climate Change Adaptation Plan.

3. Comparative Framework Structure

In order to capture the essential information and to display it in a fashion for comparison, a framework was developed (Table 1). The three main areas of climate change content comparison include the following:

- Risk assessment data and methods,
- Risk scenarios, and
- Adaptation best practices (ABPs) and adaptive capacity,

Each of these 3 areas are further broken down into discrete elements as noted in Table 1. Population of the framework then helps identify differences and similarities between the 2 sets of content.

Table 1. Comparative framework elements and rationale for their inclusion.

Area of Focus	Elements	Rationale for Inclusion
Methods and Data	• Scope and Scale of Assessment • Climate Data Sources • Climate Models and Modelling Techniques • Climate Hazards • Climate Variables/Indices • Timeframes • Methods for Risk Identification • Risk Equation • Vulnerability and Exposure Elements • Socio-Economic Analysis • Spatial Analysis • Literature Review and Sources • Analysis of Compounding, Cascading and Cross-Sectoral Risks • Engagement Methods	Allowed for the identification of similarities and differences; and, Areas the City could draw focus on in the future (for future climate change risk assessment process).
Risk Scenarios	• Area of Focus (PCCIA) • Level 1 (L1) Category • Level 2 (L2) Category (if applicable) • Climate Hazard Group • Climate Hazard • Risk Scenario (PCCIA) • Inclusion of PCCIA Scenario in the City of London Work	The analysis highlighted differences in scope between provincial and London risk assessments, identifying regional PCCIA scenarios currently not included in the City of London assessments and informing areas for future risk prioritization efforts.

	• City of London Scenario (if applicable) • Notes/Findings	
Adaptation Best Practices (ABPs) and Adaptive Capacity	• Area of Focus/Cross-Sectoral Theme (PCCIA) • Level 1 Category • Type of ABP • Description of ABP • Implementation Timeline • Implementations Responsibility and Partners • Relevant Adaptive Capacity Component • Relevant Elements of Adaptive Capacity Component • Ranking of Adaptive Capacity Component • Relevant Objective and/or Action Informing City of London Adaptation Plan (if applicable) • Relevant Recommendation from City of London Risk Assessment (if applicable) • City of London Comments	Knowledge and understanding of ABPs can inform a tailored regional context of relevant adaptation best practices, implementation timelines, implementation responsibilities and partners, and relevant adaptive capacity components to use as a guiding point and benchmark when developing the Climate Change Adaptation Plan. The comparison can help identify areas/sectors that do not have ABPs outlined in existing risk assessment work and may be explored further as resources permit.

4. Data and Methods Review

Both the provincial and the City of London assessments share **the goal** of documenting greatest risks and climate change impacts to key areas of importance within the areas of assessment.

The **scope** of the Ontario PCCIA covers the entire province geographically and includes five Areas of Focus that are further subdivided into Level 1 and Level 2 categories:

- Food and Agriculture,
- Infrastructure,
- People and Communities,
- Natural Environment, and
- Business and Economy.

The City of London Climate Change Risk Assessment focused on 14 service areas for the Corporation of the City of London:

- Realty Services,
- Land Use Planning,

- Solid Waste,
- Water Supply and Distribution,
- Parks and Recreation,
- Transportation,
- Storm Water and Drainage Engineering,
- Corporate Security and Emergency Management,
- Facilities Maintenance/Buildings,
- Urban Forestry,
- London Police Services,
- Pollution Control Operations (Waste Water and Solid Waste Systems),
- London Fire Department,
- Human Health - MLHU.

These service areas overlap with some of the L1 categories assessed in the PCCIA's Infrastructure, People and Communities, Business and Economy, and Natural Environment Areas of Focus. None of the Food and Agriculture L1 or L2 categories are included in the City of London CCARA; however, the Discussion Primer for The City of London Climate Change Adaptation Plan lists impacts to agricultural production among priority impacts and issues. Additionally, the Discussion Primer lists 48 actions intended to address climate risks identified for London and improve the City's resilience to the changing climate. The actions are listed under four themes that are well aligned with PCCIA's Infrastructure, Natural Environment and People and Communities Areas of Focus:

- Built Environment,
- Natural Environment,
- People, and
- Enabling actions.

Importantly, the focus of the City of London's assessment work was inward facing which reported on climate risks to service delivery by the corporation. The PCCIA assessed risks to the external environment of the province and not risks to service delivery provided by the Ontario government. The comprehensive and multi-sectoral assessment of potential climate change-related impacts provides an understanding of how and where climate change impacts may occur and provides the impetus for adaptation planning and resilience action across the province.

Given the years when the City of London CCARA and the Ontario PCCIA were released (2014 and 2023, respectively), **sources and time periods of climate data** as well as **models and modelling techniques** are different (see Table 2).

Table 2. Sources of data, time periods, models and modelling techniques

	Ontario PCCIA	2014 London CCARA	2022 Discussion Primer
Historic data and source	ECCC Climate Normals	Risk-based Adaptation to Climate Change: A Guide for Ontario Municipalities (2006), peer reviewed articles	climatedata.ca and ClimateAtlas.ca
Historic time period	1981-2010	Current time (2000)	1976-2005
Future projections and source	Fifth Coupled Model Intercomparison Project (CMIP5)	Risk-based Adaptation to Climate Change: A Guide for Ontario Municipalities (2006), peer reviewed articles	climatedata.ca and ClimateAtlas.ca
Future time period(s)	2041-2070 (2050s) 2071-2100 (2080s)	2025-2050 (mid-century)	2021-2050 (mid-century) 2051-2080 (end of century)
Climate models	AR5 ensemble of models	Canadian Global Climate Model (CGCM), with the consensus projections of the Intergovernmental Panel on Climate Change 2001 Report (TAR)	AR5 ensemble of models
Modelling technique	Delta Approach (modelling done “in house” by the project team)	Not mentioned	Bias Correction with Constructed Analogues and Quantile mapping, Version 2 (BCCAQv2)
Modelling completed	By the project team	Externally (unknown source)	Externally (Pacific Climate Impacts Consortium)

The PCCIA included eight **climate hazard** groupings, which, in some cases, included **several climate variables/indices**, making the total number of variables assessed – 15 (Table 3). The City of London CCARA and the Discussion Primer focus on eight climate hazards (Table 3) that were the basis for the risk factors for each of the impacts. Of the eight hazard groups included in the PCCIA, Temperature, Precipitation, Extreme precipitation, and Wildfire are not directly mentioned in the London assessment. At the same time, Flood, Poor air quality, and Extreme wind that are included in London CCARA are not referenced in PCCIA. There are, however, parallels/links that can be drawn between Extreme precipitation and Flooding, as well as between Wildfire and Poor air quality.

Common hazards between the two assessments (PCCIA/London CCARA) include:

- High and extreme temperature/Heatwave,

- Low temperature/Extended extreme cold,
- Winter precipitation/Intense snow and Sleet, hail, ice storms,
- Drought.

Table 3. Climate Hazard Groups and Variables included in 2014 City of London CCARA and 2023 Ontario PCCIA.

City of London CCARA Climate Hazards	Ontario PCCIA Climate Hazard Grouping	Ontario PCCIA Climate Variables/Indices
• Flood • Sleet/Hail/Ice Storms • Heat Wave • Drought • Poor Air Quality • Extreme Wind • Intense Snow • Extended Extreme Cold	• High and Extreme Temperatures • Low Temperatures • Temperatures and Growing-Related Conditions • Precipitation • Winter Precipitation • Extreme Precipitation • Drought • Wildfire	• Extreme Hot Days (> 30°C) • Degree Days < 0°C • Cold Days < -25°C • Cooling Degree Days (18°C) • Growing Degree Days (5°C) • Growing Season Length • Spring Precipitation • Summer Precipitation • Autumn Precipitation • Winter Precipitation • Winter Rain Percentage (Rain:Snow Ratio) • Extreme Precipitation (Short Duration) • Extreme Precipitation (Long Duration) • Moisture Deficit/Drought • Wildfire Index

Literature review and internal expert judgement were used in both the PCCIA and the City of London work on **climate impact identification and development of risk scenarios** from the onset. External expert judgement was used at initial stages by the London which led to impacts and risk identification, while the PCCIA applied consulting team expertise to develop and validate risk scenarios.

In the PCCIA, Area of Focus team leads and support researchers with expertise in their respectful sectors/subsectors used the 'Most Probable Worst-Case Event' to develop risk scenarios and consequences associated with each, as well as uncertainties and cross-sectoral and indirect considerations, as appropriate. Subsequent validation of risk scenarios was done through stakeholder engagement. In the City of London 2014 CCARA, the Climate Change Advisory Committee brainstormed the types of negative impacts and related corporate considerations. A review of key literature sources, and information from webinars and workshops attended by the Committee in 2022 helped to identify priority impacts, covering the themes of Natural Environment, Built Environment, and People.

Risk equations used in the PCCIA and the City of London CCARA and their main elements are listed in Table 4.

Table 4. Risk equations and component definitions.

	Ontario PCCIA	City of London CCARA and Discussion Primer
Risk equation	Risk = Frequency x Consequence x Likelihood	Risk = Likelihood of Occurrence x Severity of Consequence
Component definitions	Frequency refers to how often a climate hazard occurs. Consequence refers to the severity of the impact experienced. Likelihood refers to the probability of the impact occurring.	Likelihood refers to the climate hazard. Consequence refers to the severity of the impact experienced.
Consequence assessment elements	Impacts on Human Health and Safety (People and Communities Area of Focus) Environmental Damage (Natural Environment Area of Focus) Disruption of Services (Business and Economy Area of Focus) Financial Loss (Food and Agriculture, Infrastructure, and Business and Economy Areas of Focus).	Observations of impacts in the London area or in areas similar to London regarding human health, environment and infrastructure

Levels of **vulnerability and exposure** were not quantitatively assessed in either the PCCIA or the City of London CCARA. However, vulnerability and exposure assumptions were noted for service areas in London CCARA, where each risk scenario corresponded to an instance of exposure of a service area to a climate hazard. In the PCCIA, vulnerability and exposure-related assumptions were considered at L1/L2 granularities during the development of risk scenarios as well as during future risk scores calculation for scenarios where socio-economic changes result in changes or constraints for a L1/L2 category. In the recent work described in London's Discussion Primer, effects of climate change on vulnerable populations are noted in an additional column for each of the priority impacts statements.

Socio-economic considerations were an important component of the Ontario PCCIA and included twelve socio-economic metrics and indicators that were grouped under three main categories:

- Demographics (population, population density, households, and household size),
- Housing (housing stock),

- Economics (GDP, industry output, employment, employment rate, wages, low income measure after tax, and investment in construction capital formation).

The socio-economic profile was developed using Shared Socio-economic Pathway 2 (SSP2) that balances socio-economic challenges for adaptation and mitigation. The profile creates the backdrop against which climate change unfolds and informs other considerations and pressures alongside climate change.

Socio-economic analysis was not included in the 2014 City of London Risk Assessment; however, in the recent work (i.e., the Discussion Primer) four objectives and 24 actions were identified under the People theme, that incorporated socio-economic considerations (e.g., for vulnerable populations).

Spatial analysis of risks was not performed in the City of London risk assessment work, which could be explained by the geographic scale of the assessment and the (lack of) availability of relevant climate and other data at that scale. In the PCCIA, risk scores for L2 categories were observed with a spatial resolution of 10x10 km for all time periods. They were then further rolled up to regional and provincial scales, representing the scalability of the assessment.

Literature review was a key component in the development of risk scenarios for the PCCIA and was complemented by expert judgement of the project team and validation by stakeholders. The strength of evidence was evaluated to indicate the availability of sources of information and the extent to which information has high quality data to inform risk scoring. Criteria were developed to evaluate the strength of evidence (low, medium or high) in the PCCIA and similarly, the City of London Climate Change Adaptation Committee (CCAC) conducted a review of literature sources related to climate trends, impacts, and adaptation approaches for the City of London and other municipalities in the region. The literature review was complemented by expert interviews and workshops. Assessment of the strength of evidence provided by literature was not conducted.

In the Ontario PCCIA **cross-sectoral analyses** were conducted to represent the inherent connectedness of systems in society and complex interactions between the Areas of Focus. The cross-sectoral analyses (for Food security, Water security, Energy security, Human health, safety and well-being, and Community function) centered on human populations and impacts were viewed through an equity lens which highlighted unique factors or populations that may be disproportionately impacted. The City of London 2014 CCARA did not assess compounding, cascading, or cross-sectoral risks; however, recent work (i.e., the Discussion Primer) identified cascading effects as one of the topics to monitor. Specifically, the work on the development of the impact statements mentions the need to study the interdependence between infrastructure systems to minimize cascading effects of climate change (e.g., damage to one system impacts another system causing a domino effect).

Engagement activities over the course of the Ontario PCCIA focused primarily on validation and gathering feedback on key elements (i.e., methods and outputs) of the assessment. The primary goals of the City of London engagement were to inform the development of actions and recommendations to address climate change adaptation in London.

The Ontario PCCIA held engagement activities over the course of the assessment, with four virtual sessions hosted to a) review the methodological framework; b) validate current risks and vulnerabilities and gather insights on decision support systems; 3) validate future risks and vulnerabilities; d) review cross-sectoral impacts. In addition to these sessions, attended by experts from each of the regions and Areas of Focus as well as the Impact Assessment Inter-Ministerial Committee (IAIC) and Ontario Ministry of Environment, Conservation and Parks (MECP), the consulting team hosted webinars, surveys, virtual workshops, virtual meetings with Indigenous organizations, the IAIC/MECP staff, and maintained ongoing communication via email.

Engagement methods used in the City of London risk assessment work (2014 to present) included interviews with key operations staff and senior management, and workshops with community groups. The Discussion Primer will be provided for further public review and input (via workshops and online comments, including the notion of an Indigenous-focused opportunity) with a Final Adaptation Plan anticipated by the end of 2024.

5. Risk Scenarios Analysis

Climate impact identification and development of risk scenarios for both the PCCIA and the City of London CCARA included literature review and internal expert judgement.

The Climate Change Adaptation Committee formed by the City of London in 2012 identified and evaluated climate change risks to service delivery by the City Corporation, determined options for managing those risks, and made strategic recommendations intended to effectively and efficiently minimize the risks.

Recent work on the development of the Discussion Primer is based on the 2014 CCARA and expands the focus to the community level, proposing a set of actions by the community which are intended to address the climate risks identified for London and improve the City's resilience. The actions will be discussed and refined by partners, collaborators, and community members and will lead to the preparation of a Climate Change Adaptation Plan for the City of London.

In the PCCIA, an extensive literature review was undertaken to a) identify possible impacts to each L1 and L2 category, now and in the future, b) identify a risk scenario and the consequences associated with that scenario, c) determine any assumptions or uncertainties in information based on literature, and d) document indirect and cross-sectoral considerations for qualitative characterization. Risk scenarios were developed using the Most Probable Worst-Case Event (MPWCE) concept. MPWCE considers the most severe possible outcome that can reasonably be expected to occur based on a specific interaction between the climate variable and L1 or L2 category.

Risk scenarios were developed for each L1 or L2 category, representing a primary or secondary branch of an Area of Focus, for applicable regions within the province. Based on the PCCIA's wide scope, more than 580 risk scenarios were developed and analyzed for the Southwest

region. Risk scores were assigned for current, mid-century (2050s) and end of century (2080s) time periods. Risk scores were produced for each unique interaction (e.g., one climate variable and its associated risk scenario for a particular Level 2 category and provincial region) to assess climate change impacts. Every risk score was then compared, evaluated, normalized and added, or 'rolled-up', to produce a representative risk profile for a Level 2 category, then a Level 1 category, then an entire Area of Focus, and finally across an entire geographic region. Depending on the Area of Focus, different themes or combinations of themes were used to assess impact consequences in relation to a single risk scenario. Consequences were assessed based on consideration of one or more of the following categories: impacts to human health and safety, environmental damage, disruption of services and financial loss.

In the CCARA, corporate considerations were identified and then were used as a starting point to guide a more detailed investigation and analysis of risk for the City of London. The impacts were assigned to service areas and risk scores were calculated. Risk scores were assigned for all 8-climate hazard/risk events for all impacted service types for both present (2000s) and mid-century (2025-2050s) time periods. Under each service area, and for all climate hazards, high level risk scenarios were developed for the three focus areas: health, environment, and infrastructure, resulting in a combined total of 224 risk scenarios for the present and mid-term future time periods.

The City of London CCARA used a common **risk equation**: Risk = Likelihood of Occurrence x Severity of Consequence, in which likelihood refers to the climate hazard and consequence refers to the severity of the impact experienced. In the PCCIA, an additional element was added to the equation: Risk = Frequency x Consequence x Likelihood. A climate risk reported through the PCCIA can therefore be interpreted as a function of the frequency of a climate variable occurring now and/or in the future, the consequence(s) of its impact on the Area of Focus component, and the likelihood of it leading to the identified impact.

The City of London CCARA states that **weather events posing the highest risk** include flooding, sleet/ice storms and heat waves, both at present and in the mid-term future. Results for the Southwest region presented in the PCCIA show that extreme precipitation events, drought, high and extreme temperatures, and low temperature drive the largest number of High and Very High risks. It is expected that extreme heat related risks will accelerate, and that extreme precipitation will remain a consistent driver of risk in the coming decades. Drought conditions will persist as a major driver, but the rate of increase in high temperatures and extreme precipitation impacts is expected to make up a larger portion of the highest risks in this region. Winter precipitation (e.g. Rain to Snow Ratio) is expected to drive more risks in the future, compared to the amount of current risks being driven by low temperature (e.g. Extreme Cold Days).

The 2014 City of London risk assessment found that all service areas and services delivered by the City are subject to the risk of impacts from climate change, both presently and in the mid-term future (2050s); however, none of the risks were deemed severe enough to demand

immediate adaptation activities. Little change was noted with respect to the impacts on the various service areas between the present and mid-term future periods.

Health, Emergency Management and Pollution Control service areas are the most exposed to the risks of climate change, according to the 2014 risk assessment. The highest climate-related risks in Southwest region of the PCCIA are experienced by Indigenous communities, general population, and fauna. City of London service areas of and PCCIA Level 1 categories with the highest risk scores for the current and future time periods are shown in Table 5.

Table 5. City of London service areas and PCCIA Level 1 categories with the highest risk scores for the current and future (2050s) time periods

City of London Service Area		PCCIA Level 1 Category	
Current Score ≥ 10 / $\geq 12^*$	Future Score ≥ 10 / $\geq 12^* / \geq 14^\diamond$	Current High (8) / Very High* (16) Score	Future High (8) / Very High* (16) Score
- Human Health - MLHU * - London Fire Department - Pollution Control Operations - London Police Services - Urban Forestry - Facilities Maintenance/ Buildings - Corporate Security and Emergency Management - Storm Water and Drainage Engineering - Transportation - Parks and Recreation - Water Supply and Distribution	- Human Health - MLHU $^\diamond$ - London Fire Department $^\diamond$ - Pollution Control Operations * - London Police Services $^\diamond$ - Urban Forestry * - Facilities Maintenance/ Buildings * - Corporate Security and Emergency Management * - Storm Water and Drainage Engineering * - Transportation * - Parks and Recreation * - Water Supply and Distribution * - Solid Waste	- Healthcare - Population - Indigenous Communities - Stormwater Management - Fauna - Forestry, fishing and hunting economies - Field Crops - Fruits and Vegetables	- Healthcare - Population* - Social Assistance and Public Administration - Indigenous Communities* - Buildings - Stormwater Management - Transportation - Utilities - Fauna* - Flora - Aquatic Ecosystem - Terrestrial Ecosystem - Ecosystem Cultural Services - Provisioning Services - Regulating Services - Forestry, fishing and hunting economies - Arts, Entertainment and Recreation - Financial and Insurance

			• Field Crops • Fruits and Vegetables • Livestock
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A subset of PCCIA risk scenarios corresponding to service areas identified in the City of London CCARA and themes included in the Discussion Primer provide details on relevant Areas of Focus, L1/L2 categories, climate hazards and climate hazard groups as well as scenario assumptions. Corresponding London risk scenarios are included, and considerations are provided for cases where no matching scenarios are present in the City of London CCARA.

Specific combinations of L1/L2 categories and climate hazards in risk scenarios not included in the City of London work are provided in Table 6.

Table 6. PCCIA L1/L2 categories and climate hazards/variables not included in the City of London work

Level 1/Level 2 Category	Climate Hazard/Variable
Natural Environment Area of Focus	
Clear Open Water	Cooling Degree Days
Bog	Cooling Degree Days; Moisture Deficit/Drought
Deciduous Forest	Moisture Deficit/Drought
Pollination	Growing Degree Days
Fauna	Wildfire
Waterfowl	Growing Degree Days
Migratory Songbirds	Growing Season Length
Infrastructure Area of Focus	
Air Transportation (Transportation)	Extreme Precipitation Event (shorter term), Extreme Hot Days
Rail (Transportation)	Extreme Precipitation Event (shorter term), Extreme Hot Days
Telecommunications (Utilities)	Extreme Precipitation Event (shorter term), Mean Winter Precipitation
Business and Economy Area of Focus	
Accommodation and Food Services	Extreme Heat, Higher Average Temperatures, Drought, Extreme Precipitation and Wildfire
Arts, Entertainment and Recreation	Extreme Heat, Higher Average Temperatures, Drought, Extreme Precipitation and Wildfire
Monetary, Credit, Securities, Funds and other Financial Vehicles	Extreme Heat, Extreme Precipitation and Wildfire
Insurance Carriers and Related Activities	Extreme Heat, Extreme Precipitation and Wildfire
Information and Cultural Industries	Extreme Heat, Extreme Precipitation, Wildfire
Manufacturing	Extreme Heat, Extreme Precipitation, and Drought
Retail Trade	Extreme Heat, Growing Degree Days, and Extreme Precipitation

Electrical Power Generation	Extreme Heat, changing Growing Degree Days, Mean and Extreme Precipitation, Drought and Wildfire
Electrical Power Transmission, Control and Distribution	Extreme Heat, changing Growing Degree Days, Mean and Extreme Precipitation, Drought and Wildfire
Natural Gas Distribution	Extreme Heat, changing Growing Degree Days, Mean and Extreme Precipitation, Drought and Wildfire
Air Transportation (Transportation Economy)	Extreme Heat, Extreme Hot Days, Higher Average Temperatures, Extreme Precipitation Event (shorter term), Mean Winter Precipitation
Rail (Transportation Economy)	Extreme Heat, Extreme Hot Days, Higher Average Temperatures, Extreme Precipitation Event (shorter term), Extreme Hot Days
Telecommunications (Utility Services)	Extreme Heat, Extreme Hot Days, Higher Average Temperatures, Extreme Precipitation Event (shorter term), Mean Winter Precipitation
People and Communities Area of Focus	
General Population	Wildfire

Specific rationales and assumptions for **vulnerability and exposure** were developed and considered for each Area of Focus, and, in some cases, Level 1 and Level 2 categories during the development of risk scenarios in the PCCIA. Additionally, where socio-economic changes constrain or put pressures on specific Level 2 categories, thus increasing vulnerability, future scores were changed to reflect worsening conditions or increased exposure. In the CCARA, exposure was noted for each service area and each weather event/hazard. Higher risk scores are indicative of existing exposure and sensitivity to changing climate conditions. Building off the results from the CCARA, the Discussion Primer identified 25 impact statements that were used to comment on the effects of climate change on vulnerable populations in London.

Indirect and cascading impacts identified within each Area of Focus informed the themes of the **cross-sectoral analysis** in the PCCIA: food security, energy security, water security, human health, safety and well-being, and community function. The assessment applied a people-centric approach and an equity lens to ensure consistent framing of the cascading impacts across every cross-sectoral theme and Area of Focus. Although compounding, cascading, or cross-sectoral risks were not assessed in the 2014 CCARA, the more recent Discussion Primer identified cascading effects as one of the key topics to monitor in the future. A cross-sectoral assessment of climate change impacts and identification of areas where impacts cascade or amplify, can help further prioritize resilience needs and target adaptation responses.

6. Adaptive Capacity and Adaptation Best Practices Analysis

Within the framework of the PCCIA, the capacity to adapt to current and projected climate risks was explored through an **adaptive capacity** assessment. Adaptive capacity is defined as a way to measure inherent adaptability in a system, organization, or industry, in other words, the

ability to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Regional adaptive capacity was assessed for each region through the analysis of:

- **Technology**, described as the availability of technological resources (including hard technologies, practices and planning) that can build resilience into the practices assessed.
- **Resource Availability**, described as the capacity of an organization, industry, or system to apply and/or redistribute financial, human, and natural resources where and when needed.
- **Complexity**, described as the number of stakeholders or decision-makers present at a regional level. The capacity to make decisions and change course at the regional level can be inversely correlated to the number of decision-makers/stakeholders.

Characterization and scoring were based on literature review, engagement and expert experience. For the Southwest region, Technology, Resource Availability, and Complexity components were scored High, High, and Medium, respectively.

Adaptive capacity was also assessed for L1 categories at the provincial level, after which climate change **adaptation priorities** were identified and defined as any Level 1 category in a given region that receives an adaptive capacity rating of Medium or lower and exhibits a risk score of High or Very high.

Current adaptation priorities identified for the Southwest region include: Unhoused population, Indigenous population, Indigenous cultural services, and Indigenous health care.

Emerging adaptation priorities identified for the Southwest region by mid-century include: General population, Social assistance and public administration, and Indigenous social assistance.

No formal assessment of adaptive capacity is referenced in the 2014 CCARA or the Discussion Primer; however, both documents stress the need to take appropriate measures to respond to the impacts of climate change and prioritize adaptive actions to achieve the most effective and affordable response. References to London's location in proximity to cutting edge educational and research institutions that can provide ground-breaking innovative data and propose solutions provide, albeit not directly, some context for the City's adaptive capacity.

The PCCIA applied adaptive capacity results to help guide the identification of areas of research for **adaptation best practices (ABPs)**. The list of ABPs provided in Ontario Provincial Climate Change Impact Assessment Adaptation Best Practices Report [5] is aimed to support policy- and decision-makers in the identification and consideration of adaptation measures that can build adaptive capacity in the businesses, communities, infrastructure, and natural systems of Ontario and reduce the potential for catastrophic losses across the province.

A list of adaptation best practices was assembled in the Ontario PCCIA to inform actions to increase regional and/or sectoral resilience to climate change. ABPs were developed through a variety of methodologies, including engagement with subject matter experts through a series of workshops, research and literature review conducted by the consulting team.

The City of London CCARA points out the importance of identifying and implementing appropriate adaptation strategies and actions. A discussion of possible solutions to climate change impacts resulted in a list of recommended actions for corporate-wide and service area consideration.

The Discussion Primer references previous work in the preparation of the CEAP, London's existing adaptation actions, and adaptation actions from peer municipal jurisdictions that were used to develop a vision for the Adaptation Plan, including objectives and themes. 48 actions that will move London closer to achieving the vision are listed under four themes (see Section 4) categorized into seven priority areas:

- Integrate climate change thinking and response;
- Protect public health and safety;
- Minimize the risk to buildings and property;
- Strengthen infrastructure resilience;
- Enhance biodiversity and ecosystem functions;
- Reduce community service disruptions; and
- Build community resilience.

Review of the PCCIA ABPs and adaptive capacity identified 91 practices that include municipalities in the list of partners responsible for implementation and can inform the City of London's Adaptation Plan. The included best practices can be considered as a starting point for closer investigation to select locally and contextually appropriate measures to address climate risks.

The comparative analysis included Adaptation Best Practices that are either overarching or linked to one of the cross-sectoral themes or Areas of Focus and fall into one or more of the following categories:

- Projects or Programs (projects or longer-term programs that support Ontario stakeholders and rights holders in adoption of adaptation measures);
- Policy and Regulation (a set of policies, regulations or plans used to support decision-making and/or operational regulations);
- Research and Development (science-based opportunities primarily focused on expanding knowledge through research and development);
- Investment and Incentives (investment into existing or new programs, and development of incentive programs and opportunities).

Each ABP was matched with a relevant element of adaptive capacity components for the Southwest region, with rankings of the components provided.

The list of best practices is intended to be considered as a starting point for closer investigation to select locally appropriate measures to assess climate risks. To that end, for each ABP, the framework lists a relevant Objective or Action from the Discussion Primer informing the City of London's Adaptation Plan and a relevant recommendation from the City of London CCARA.

Most of the listed ABPs have a corresponding objective, action or recommendation identified in the City of London documents that were reviewed. In a number of cases actions and recommendations provide broad guidance (e.g., "Continue to undertake and, where possible, increase actions that address both adaptation and mitigation measures.") that applies to multiple ABPs.

Notably, several ABPs in People and Communities, Business and Economy, Infrastructure, and Food and Agriculture Areas of Focus and Water Security cross-sectoral theme do not have relating objectives, actions or recommendations in the City of London risk assessment documents that were reviewed (Table 7).

For ABPs linked to People and Communities, focusing on unhoused populations, Indigenous populations, health care as well as overarching issues, a number of gaps were identified during the review of risk assessment documents as well as communication from the City staff. Importantly, this Area of Focus has the most current and emerging priorities for adaptation and risk management in light of higher risk scores and lower levels of adaptive capacity.

Consultations with the City of London staff revealed that a number of existing programs, not reflected in the 2014 CCARA and the Discussion Primer, already support similar adaptation actions and some of the ABPs are implemented by the City. For other ABPs listed in Table 7, considerations for their inclusion into the future adaptation plan are in place.

Table 7. PCCIA Adaptation Best Practices not explicitly addressed in the City of London 2014 CCARA and Discussion Primer.

Adaptation Best Practice	Area of Focus/ Cross-sectoral Theme	Level 1 Category (if applicable)	Comments
Create a provincial governing body to represent water management in Ontario	Water security	n/a	Beyond the scope of just one municipality (City of London).
Explore and apply recommended practices for managed aquifer recharge	Water security	n/a	London does not rely on groundwater as a potable water source, so the importance of this is diminished in a purely London context (City of London).
Implement Policy Changes laid out in the Update of Ontario's Water Quantity Management Framework	Water security	n/a	Could be considered for further investigation (CRI).

Decouple drinking water and stormwater fees	Infrastructure	Stormwater management	London has an existing stormwater rate reduction program that provides discounted stormwater charges for properties that demonstrate that the runoff coefficient of the property is less than the City Design & Specification Standard for the Land Use/Zoning (City of London).
Integrate a gender lens into climate change adaptation and capacity building	People and Communities	Overarching	Could be considered for further investigation (CRI).
Facilitate opportunities for volunteers to train in disaster management	People and Communities	General Population	Could be considered for further investigation (CRI).
Develop Government policy to maintain affordable housing markets in Ontario	People and Communities	Unhoused Population	There is crossover here with current initiatives to support and build affordable housing. Collaboration with internal City staff in Planning and Economic Development is required moving forward on this (City of London).
Fund and support the development of programs to prevent people from becoming unhoused	People and Communities	Unhoused Population	There is crossover here with current initiatives to support and build affordable housing. Collaboration with internal City staff in Planning and Economic Development is required moving forward on this (City of London).
Encourage the use of technology to increase capacity to respond to climate-related health crises	People and Communities	Health Care	Could be considered for further investigation (CRI).
Reframe adaptation policy to be Indigenous-led and culturally appropriate for Indigenous communities	People and Communities	Indigenous Communities	This will be a significant focus of engagement and consultation on the adaptation plan (City of London).
Develop financial instruments to promote investment in climate resilience	Business and Economy	Overarching	The CEAP-proposed business case put forward as part of the ongoing Multi-Year Budget deliberations includes additional support of this nature (City of London).

Apply a climate lens to government decision-making, and ensure integration of Indigenous perspectives	Food and Agriculture	Overarching	London has established a Climate Lens Framework which supports the integration of climate change considerations into decision-making enterprise-wide. The Framework is evolving and has room for improvement, including further consideration of Indigenous perspectives (City of London).
Fund a knowledge transfer and sharing program for practical adaptation and best management practice sharing with Indigenous knowledge at its core	Food and Agriculture	Overarching	This appears to be a provincial effort with limited municipal responsibility (City of London).

7. Summary of Findings and Suggestions for Improvements

The comparative analysis of the Ontario Provincial Climate Change Impact Assessment and City of London climate change risk assessments has provided several insights on methodological approaches, data availability, development of risk scenarios, risk evaluation as well as levels of adaptive capacity and relevant adaptation best practices.

Important **areas of alignment** between the provincial and the City of London risk assessments include:

- The common goal of documenting greatest risks and climate change impacts to key areas of importance within the areas of assessment.
- The shared conclusion that climate change impacts are already affecting Ontarians/Londoners and include recent events such as flooding, heat waves, and unusually high climate variability and extremes.
- The understanding that strong action is needed to reduce the impacts resulting from climate change in order to protect critical infrastructure, systems and communities from experiencing catastrophic failures and losses.
- The importance of a broad, multi-disciplinary response approach to identified vulnerabilities and proactive implementation of strategies to address climate change risks and avoid/minimize the extent of damage and costs.

Keeping in mind the timing, scale and resource availability between the assessments, a number of **areas of discrepancy** were identified:

- The scale and scope of the Provincial and City of London risk assessments reflects varying priorities and areas of focus as well as time periods, climate variables and hazards of importance as well as resultant risk scenarios.

- Given the years when the City of London CCARA and The Ontario PCCIA were released (2014 and 2023, respectively) and technological advancements that have taken place over this time, climate models and modelling techniques used in the assessments are different.
- The risk equation used in the provincial assessment includes three elements, in contrast to two elements used in the City of London CCARA. In addition to the likelihood/frequency of the climate hazard and the severity of consequence, the PCCIA factors in the likelihood of the impact occurring.
- Importantly, the PCCIA assigned impact consequence scores based on the consideration of one (rarely two) elements per Area of Focus (impacts on human health and safety, environmental damage, disruption of services, or financial loss) while the CCARA considered observations on human health, environment and infrastructure for each service area.
- Engagement activities over the course of the Ontario PCCIA focused primarily on validation and gathering feedback on key elements (methods and outputs) of the assessment. The primary goals of the City of London engagement were to inform the development of actions and recommendations to address climate change adaptation in London.
- Socio-economic, spatial, cross-sectoral and adaptive capacity analyses were included in the PCCIA but fell outside the scope of the London CCARA.

Taking into account review findings, some **considerations for future climate change adaptation work** could include:

- Leveraging PCCIA information on Southwest region risks, adaptive capacity and adaptation best practices at the scale that aligns with the City of London needs and existing practices and measures.
- Presenting/incorporating results of the comparative analysis during the engagement process to inform the development of the City of London Climate Change Adaptation Plan. Specifically, grouping ABPs by type and/or specific areas of importance to City of London could help identify and prioritize appropriate adaptation strategies.
- Further and deeper exploration of indirect, cascading and cross-sectoral impacts and identification of areas where impacts cascade or amplify can help prioritize resilience needs and target adaptation responses.
- Ensuring the incorporation of the most up-to-date climate risk information into the Official Plan, the Corporate Strategic Plan, the Corporate Asset Management Program, and other documents and tools developed and used by London to plan for the future.
- Ensuring the inclusion of perspectives of all parties and aspects in society, incorporation of Indigenous knowledge and experience during the development and implementation of policies and programs, capital and operational expenditures, research and technological development.

- Regular communication and coordination of activities across a complex corporation with diverse interests, service areas, and resources are needed to ensure the sustainability of service delivery, minimized disruption and reduction of unnecessary expenses.

8. References

1. City of London. (2022). Climate Emergency Action Plan. Available at <https://getinvolved.london.ca/12452/widgets/49288/documents/85827>
2. City of London. (2014). Climate Change Adaptation Risk Assessment Report: 2014.
3. City of London and ICLEI. (2024). Discussion Primer - Developing London's Climate Change Adaptation Plan. [Not publicly released at the time of the completion of this report]
4. Climate Risk Institute. (2023). Ontario Provincial Climate Change Impact Assessment Technical Report. Report prepared by the Climate Risk Institute, Dillon Consulting, ESSA Technologies Ltd., Kennedy Consulting and Seton Stiebert for the Ontario Ministry of Environment, Conservation and Parks. Available at: <https://www.ontario.ca/page/ontario-provincial-climate-change-impact-assessment>
5. Climate Risk Institute. (2024). Comparative Framework for Climate Change Risk Assessment Analysis.
6. Climate Risk Institute. (2023). Ontario Provincial Climate Change Impact Assessment Adaptation Best Practices Report. Report prepared by the Climate Risk Institute, Dillon Consulting, ESSA Technologies Ltd., Kennedy Consulting and Seton Stiebert for the Ontario Ministry of Environment, Conservation and Parks. Available at: [https://municipalengineers.on.ca/files/news-information/Climate Resilience Reports/PCCIA%20Adaption%20Best%20Practices%20Jan%202023.pdf](https://municipalengineers.on.ca/files/news-information/Climate%20Resilience%20Reports/PCCIA%20Adaption%20Best%20Practices%20Jan%202023.pdf)