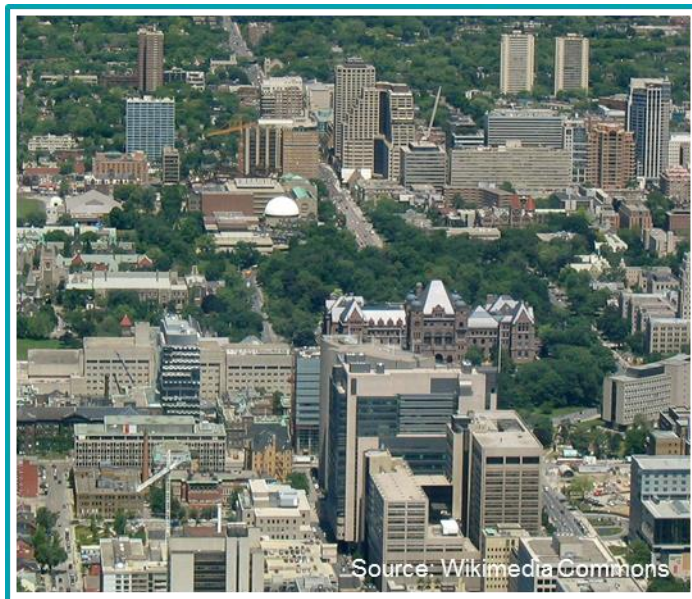


Research and Information Gathering on Climate Change Mitigation and Adaptation



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Prepared By:

environmental
studies

YORK
UNIVERSITY



ZIZZO
ALLAN
DEMARCO

OCC⁺AR
Ontario Centre for Climate Impacts
and Adaptation Resources

—  ONTARIO
CLIMATE CONSORTIUM —

 Toronto and Region
Conservation
for The Living City®

CONTRIBUTING AUTHORS

Ian McVey, Chandra Sharma,¹ Travis Allan, Joanna Kyriazis,² Al Douglas, Paul Cobb, Julie Mallette,³ Laura Taylor and Stuart Cooper⁴

1. Ontario Climate Consortium & Toronto and Region Conservation
2. Zizzo Allan DeMarco LLP
3. Ontario Centre for Climate Impacts and Adaptation Resources
4. York University, Faculty of Environmental Studies

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CONTENTS

Contributing Authors	2
Acknowledgements	2
Contents	3
Tables	4
Acronyms	5
EXECUTIVE SUMMARY	7
I. LAND-USE PLANNING AND CLIMATE CHANGE: LITERATURE-BASED LINKAGES AND CONSIDERATIONS	17
Defining Climate Change and Land-Use Planning	17
Literature Review Approach	18
Context and Linkages	19
Land-Use Planning Tools	21
Implementation Scale and Challenges	22
Barriers to Implementation	25
Considerations for Land-Use Planning	25
Summary of Key Themes and Linkages	27
II. BEST PRACTICES TO ACHIEVE CLIMATE OBJECTIVES THROUGH LAND-USE PLANNING	30
Best Practices	33
Barriers to Implementation	36
Key Information Needs	37
III. GREATER GOLDEN HORSESHOE PLANNING POLICY REVIEW	39
Comparing GGH Planning Policy Framework to Literature Review and Jurisdictional Scan ..	39
Methodology	40

GGH Planning Policy Framework Evaluation.....	42
Gaps in GGH Land-Use Planning Framework	49
IV. RECOMMENDATIONS FOR LAND-USE PLANNING AND POLICY REFORM TO COMBAT CLIMATE CHANGE IN ONTARIO.....	52
V. MONITORING PERFORMANCE OF NEW AND EXISTING POLICIES AND IMPLEMENTATION STRATEGIES.....	65
Introduction	65
Selecting Performance Metrics and Indicators.....	65
Proposed indicator Framework.....	68
Conclusion	78
VI. ENVISIONING A RESILIENT, LOW-CARBON GREATER GOLDEN HORSESHOE	79
Factors and Assumptions Influencing the Scenarios.....	79
GGH Today	81
GGH Tomorrow (2030).....	83
GGH Future (2050).....	87
VII. CONCLUSION.....	91

TABLES

Table 1: Land-use tools and instruments.....	21
Table 2: Opportunities exist at all scales for adaptation and mitigation in land-use planning	24
Table 3: Approaches to monitoring and evaluation.....	26
Table 4 Strongest linkages between climate change mitigation and adaptation to land-use planning	28
Table 5: Jurisdictions selected for best practices scan	30

Table 6: Description and evaluation of the richness of Best Practices in case studies of climate change and land-use planning	35
Table 7: Evaluation criteria.....	41
Table 8: Evaluation of PPS and Provincial Plans	44
Table 9: Evaluation of municipal official plans	46
Table 10: Municipal climate change action.....	47
Table 11: Mitigation indicators and metrics	68
Table 12: Adaptation indicators and metrics.....	73

ACRONYMS

BRT	Bus Rapid Transit
CEP	Community Energy Plan
CHP	Combined Heat and Power
DAIA	Development Approval Information Area
FCM	Federation of Canadian Municipalities
GGH	Greater Golden Horseshoe
GHG	Greenhouse Gas
GTA	Greater Toronto Area
IESO	Independent Electricity System Operator
IPCC	Intergovernmental Panel on Climate Change
LDC	Local Distribution Company
LID	Low-Impact Development
LUP	Land-Use Planning
MMAH	Ministry of Municipal Affairs and Housing
MNRF	Ministry of Natural Resources and Forestry
MOECC	Ministry of the Environment and Climate Change
MUSH	Municipalities, Universities, School Boards and Hospitals
OMB	Ontario Municipal Board

OP	Official Plan
ORMCP	Oak Ridges Moraine Conservation Plan
NEP	Niagara Escarpment Plan
PCP	Partners for Climate Protection
PPS	Provincial Policy Statement
PV	Photovoltaics
TRCA	Toronto and Region Conservation Authority

EXECUTIVE SUMMARY

This report was prepared for the Government of Ontario (the Province) to provide research and recommendations to aid the Ministry of the Environment and Climate Change, as well as other ministries and stakeholders selected by MOECC, in planning for climate change and responding to the 2015 coordinated review (2015 Coordinated Review) of the Growth Plan for the Greater Golden Horseshoe (Growth Plan), the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan (ORMCP) and the Niagara Escarpment Plan (NEP) (collectively, the Provincial Plans).

The objectives of this report are:

1. To provide the most up-to-date linkages between land-use planning (LUP) and actions to mitigate (including greenhouse gas (GHG) reductions and carbon storage and sequestration) and adapt to climate change (CC) in the Greater Golden Horseshoe (GGH).
2. To provide land-use planning best practices from leading comparable jurisdictions (city regions), including key land-use indicators, land-use planning objectives, key information needs, planning tools, policies and performance measures to mitigate and adapt to climate change.
3. To provide a comparison of best practices to Ontario's existing land-use policy framework for the GGH, including the Growth Plan, the Greenbelt Plan, the ORMCP, the NEP and the Provincial Policy Statement 2014 (PPS).
4. To provide recommendations to support climate change mitigation and adaptation on changes that may be appropriate to the Growth Plan, the Greenbelt Plan, the ORMCP and the NEP.
5. To provide recommendations on potential performance measures, indicators or other metrics, which could be used to determine whether climate change-related objectives within the Provincial Plans are being met.
6. To provide a narrative description of climate resilient and low-carbon communities to help provide a potential future vision for Ontarians.

The report proceeds in six sections. Section I summarizes findings from our literature review and explores the linkages between land-use planning and actions to mitigate and adapt to climate change in the GGH. Research reviewed indicates that there is a strong connection between where and how we live, our GHG emissions and our ability to adapt to extreme weather and other climate change impacts. In particular, land-use planning decisions will largely determine whether progress is made in two of Ontario's largest GHG-emitting sectors—transportation and buildings (which respectively account for approximately 36% and 19% of the provincial total).¹ Indeed, it is not a stretch to say that land-use planning decisions made today and into the future will determine whether Ontario meets its medium- and long-term GHG

¹ Environment Canada. National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2013. Ottawa: Minister of the Environment, 2015: 55 Table A10-13).
Web. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php. Energy-based emissions from "Commercial and Institutional" and "Residential" Stationary Combustion Sources were combined to arrive at the building-related emissions referred to here.

reduction targets. Land-use planning decisions also influence the risk and vulnerability of human settlements and ecosystems to climate change-induced extreme weather events: hazards including heat stress and extreme precipitation affect health, habitats, infrastructure and economies, all of which influence not only where we live, but our quality of life. The literature review identified the following key substantive focus areas for addressing climate change through land-use planning:

- **Action Planning.** Develop and adopt strong objectives for adaptation and mitigation and, where possible, mainstream climate change into management and decision-making. Increase collaboration between government jurisdictions both vertically (province-region-city) and horizontally (city-to-city and across provincial ministries and municipal departments).
- **Energy.** Reduce fossil fuel consumption through energy efficiency and conservation and low-carbon energy planning in aspects of infrastructure renewal and community development.
- **Research.** Collaborate and coordinate on research, including low-carbon technology, climate data, impacts and adaptation. Harness partnerships with academia and the business community.
- **Resilience.** Enhance the resilience of infrastructure, communities, natural heritage and agricultural lands. Ensure that sites and opportunities for resilience are identified and reserved.
- **Technology.** Facilitate the deployment of technologies that advance mitigation and adaptation goals in buildings, transportation and utility systems, including increasing distributed low-carbon energy supply.
- **Environmental Design.** Construct, rehabilitate and maintain green infrastructure (including urban green infrastructure and green roofs) to support infiltration and water management and reduce flood risks. Recognize additional benefits of improved building energy efficiency and reduced heat island effects.
- **Equity.** Ensure effective and ongoing public consultation to identify and prioritize areas and individuals with highest vulnerability. Recognize differing risk tolerance levels and risk perceptions.
- **Food.** Foster and support local food production and the reduction of travel distances for food. Protect and enhance agricultural lands.
- **Transportation.** Reduce car use through the development of compact, transit-oriented communities, better design of transit and urban form, and the provision of public and active transportation alternatives.
- **Urban Form.** Promote compact, mixed-use development to increase density, reduce sprawl, improve air quality and reduce transportation GHGs.

These focus areas were adopted as evaluation criteria for the policy review of the Provincial Plans discussed in Section III. The literature review also identifies the strongest linkages between land-use planning and climate change mitigation and adaptation, supporting the assessment of changes that *must* take place to achieve Ontario's climate change objectives. These linkages form the basis for the policy directions contained in Section IV.

The jurisdictional scan in Section II of this report provides an overview of best practices based on a review of comparable city regions outside of Ontario, which are considered leaders on climate change. City regions reviewed include: Calgary Region (Canada), Metro Vancouver

(Canada), Metro Chicago (USA), New York City (USA), San Francisco Bay Area (USA), Metro Atlanta (USA), Greater London (UK), Randstad (Netherlands), Metro Sydney (Australia) and Southeast Queensland (Australia). These were selected on the basis of their comparability to the GGH considering a range of factors including economic structure, governance, climate action and climate risks. While no one place can be said to have completely addressed climate change adaptation or mitigation, a variety of best practices were identified and then used to supplement and inform the report's detailed recommendations. Best practices identified include:

- **Incentives and financing.** These are often used to support energy and/or water efficiency projects in homes and businesses, but may also include disincentives to carbon emitting activities such as road pricing. Stormwater user fees are an example of adaptation-related incentives.
- **Planning policies and instruments.** These may be in the form of building regulations and land-use planning principles to both reduce GHG emissions and improve resiliency and better prepare for climate change.
- **Guidelines and toolkits.** Tools and guidelines for climate change mitigation and adaptation are often in the form of publications, visualization tools and interactive web-tools and can help decision-makers map climate change impacts and assess key risks.
- **Coordination and collaboration.** This refers to cooperation between government, business and scientific communities across departments and jurisdictions, which may involve the use of working groups and task forces specifically created to tackle climate change.
- **Natural systems.** The protection and restoration of wetlands, green spaces and urban forests to reduce flood risk, mitigate urban heat island effect, sequester carbon and provide other ecosystem services is key to addressing climate change risks through land-use planning.
- **Vulnerable populations.** The best land-use planning and climate change strategies ensure that populations with limited adaptive capacity or that are living in especially vulnerable locations are protected from the impacts of climate change.
- **Infrastructure.** Development of alternative fuel infrastructure, decentralized energy generation and stormwater management are vital to ensuring the reduction of GHGs and resiliency of built and natural systems.

The policy review in Section III of the report evaluates the current planning framework for the GGH against the key substantive focus areas and best practices identified in the literature review and jurisdictional scan. The evaluation finds that Ontario has taken important steps to integrate sustainability and conservation of natural heritage into its legislation and supporting plans and policies. However, significant work remains if the Province wishes to meet its climate change objectives and ensure that the GGH works toward, and thrives in, a low-carbon future. In particular, there is a myriad of approaches to climate change action within the GGH, suggesting that a more coordinated approach by the Province is needed to ensure equity and fairness in land-use decisions and climate change action across the region. The policy review identifies several gaps in the current GGH planning framework, which the report's final recommendations seek to address:

1. **Gap between Ontario's climate change action plan and current planning framework.** Current provincial and local plans are not aligned with the provincial climate change policy framework; therefore "mainstreaming" of climate change in planning is recommended.
2. **Gap between evidence and data.** Research useful for planning and monitoring climate change action in land-use approvals and decision-making in Ontario is lacking; therefore objective, longitudinal data collection—based on a standardized climate change performance measurement framework—and public reporting by the Province and municipalities is recommended.
3. **Gap between policies and implementation.** While policies promoting and encouraging sustainable land uses have been in place in the GGH for years, implementation of those policies through the planning and development approvals process has been less successful.
4. **Gap between energy and planning.** The drastic reduction in emissions from fossil fuel energy use required to meet Ontario's GHG targets means changes in land-use patterns and local-scale relationships are needed, especially to better facilitate low-carbon sources of heat in the building sector. Community energy planning needs to be incorporated into the planning framework.
5. **Gap between land-use designations and areas of highest vulnerability to climate impacts.** Designating zones of high vulnerability is recommended to support action in areas of highest flood risk, aging infrastructure, poor accessibility and vulnerable residents.
6. **Gap between compact urban form and environmental design.** Climate change mitigation actions are focused on compact urban form to reduce car travel and support low-carbon energy technologies, but adapting to climate change requires more space for biodiversity conservation, green infrastructure and low-impact development. Providing direction to resolve this tension is needed.
7. **Education gap.** Planners working in the GGH need education and training around climate change action in order to effectively incorporate mitigation and adaptation into planning activities.

The recommendations in Section IV address these gaps to improve the land-use planning framework in the GGH as it relates to climate change mitigation and adaptation. Based on the key linkages identified in the literature review, the best practices compiled in the jurisdictional scan, the gaps uncovered in the review of the four GGH plans and consultation with the expert advisory committee, our team distilled seven policy directions to support climate change mitigation and adaptation in the areas governed by the Provincial Plans. For each of the seven policy directions, an extensive list of detailed recommendations for specific plan amendments and implementation guidance was developed (see Appendix 4). For each policy direction below, high-priority recommendations are highlighted to illustrate changes to the Provincial Plans that could help Ontario achieve its climate change objectives.

Policy Direction 1—Mainstream climate change considerations in Ontario's land-use planning framework. Incorporate and integrate climate change mitigation and adaptation objectives and policies established by Ontario's Climate Change Strategy and the PPS into each of the covered four Provincial Plans and any municipal land-use plans governed by the Growth Plan for the Greater Golden Horseshoe.

Example high-priority recommendations:

- **The Province should incorporate quantitative and qualitative climate change-related indicators into the performance monitoring frameworks for Provincial Plans and the PPS.** Municipalities will then incorporate these performance indicators into their municipal official plan (OP) performance monitoring framework, as they are required to conform their official plans to the Growth Plan. In designing the indicators, the Province should ensure the indicators work on a municipal scale but can also easily roll up into a regional reporting scale. See Section V for a recommended climate change performance-monitoring framework developed as part of this project. (Recommendation 1.2)

- **The Province should require municipalities to develop climate change plans.** Such plans should: (a) quantify GHG emissions located within their borders; set out

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ #2 Gap between evidence and data
- ❖ # 3 Gap between policies and implementation

emissions reduction targets and timelines, including from private transportation and buildings; allocate responsibility; and develop strategies to achieve targets; and (b) identify populations, areas and infrastructure of highest climate vulnerability; set targets and timelines for reducing vulnerability; allocate responsibility; and develop strategies to achieve targets. The Province should also require municipalities to report against their plans using the climate change performance measures discussed above periodically (i.e. as part of official plan reviews). Municipalities should prepare climate change plans in coordination with official plans and strategies such as transportation plans, watershed plans, natural heritage

plans, infrastructure master/asset management plans to ensure climate change considerations are incorporated into those plans and strategies as well. (Recommendation 1.3)

Policy Direction 2—Require the development of compact, location-efficient communities (development that is a convenient distance from workplaces, amenities, stores and urban hubs; has access to and provides the densities needed to support various modes of rapid transit; enables short commute times; and contains realistic opportunities to use transit and active transportation, allowing for improved transitions between modes).

Example high-priority recommendations:

- **Stop or dramatically limit sprawl and contain the outward expansion of urban built-up area of the GGH into greenfields by taking one or more of the following approaches:**
 - Requiring the 2041 growth forecast to be accommodated within existing designated greenfield and built-up areas (i.e. no further urban expansion pending next ten year review).
 - Prohibiting any new greenfield designation.
 - Establishing clear, permanent settlement area boundaries for municipalities within the Growth Plan such that settlement areas cannot be expanded through municipal comprehensive reviews.
 - Alternatively, amending the Growth Plan to prohibit expansion of the settlement area within any municipality that has not achieved its minimum density and intensification targets.
 - Conducting or causing to be conducted a review of the metrics for what constitutes “major office” and, if supported, reducing the threshold for lands classified as “major office” under the Growth Plan to include lower area and minimum jobs thresholds.
 - Adding a definition for “major institutional” development under the Growth Plan.
 - Prohibiting any new major office/major institutional uses outside of identified intensification areas or areas with existing/planned transit (e.g. urban growth centres, major transit station areas, intensification corridors). (Recommendation 2.1)
- **Increase density targets in urban growth areas and create density targets for employment lands** that support appropriate mixed-use and transit (consider conforming to transit-supportive densities set out in the Province’s transit-supportive guidelines). (Recommendation 2.5)
- **Set minimum density targets for major transit station areas and intensification corridors** via the Growth Plan. To this end, the Province could also develop rules that substitute a provincial density permitting scheme that will achieve targets within a fixed area of major transit station areas and intensification corridors for municipalities that fail to meet their targets within a specified time period (e.g. five years). Density targets could be set and achieved in coordination with the Ministry of Transportation, GO Transit and Metrolinx. (Recommendation 2.8)

Gaps in Ontario’s Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario’s climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ # 6 Gap between compact urban form and environmental design

- **Take action on key suburban employment lands such as areas surrounding Pearson Airport, the 404/407 and Vaughan** by specifically designating them and requiring a re-urbanization strategy to retrofit these areas in a way supportive of plan objectives: for instance, supporting the development of public transit and active transportation through employment infill, mixed-use/residential infill, active transportation and a transit strategy. GO Transit, Metrolinx and local transit providers would likely be partners in carrying out this recommendation, as would municipalities. (Recommendation 2.9)
- **Amend the Growth Plan to recognize that significant concentrations of office space exist outside of the designated growth centres, and need to be integrated into transit planning.** The Province should work with local municipalities in the Greater Toronto Area (GTA) to adjust priorities and fine tune the planned roll-out of rapid transit projects to better connect to the approximately 108 million square feet of office space that are currently dependent on automobile access. Consider requiring all new free-standing offices to locate in urban growth centres, or around/along major transit stations areas or intensification corridors. (Recommendation 2.12)

Policy Direction 3—Require urban design features and the layout of major land uses (e.g. institutions, green space, commercial areas) that support higher-order transit and active transportation.

Example high-priority recommendations:

- **Clearly prioritize public and active transportation in planning and investments by adding a passenger transportation hierarchy into the Growth Plan** to guide transportation infrastructure planning and major transportation investments by municipalities, municipal planners and transportation authorities. The hierarchy would be modeled off of the hierarchy in the Big Move and would prioritize active transportation and public transportation over personal vehicular use. (Recommendation 3.1)
- **Require municipalities to develop minimum bicycling parking requirements** for residential, employment and commercial centres in new developments, clearly signaling that the Province places a priority on low-carbon active transportation. (Recommendation 3.6)

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ # 4 Gap between energy and planning
- ❖ # 6 Gap between compact urban form and environmental design

Policy Direction 4—Require, integrate and support community energy planning (including district energy, renewable energy generation and energy efficiency) into our land-use planning framework (e.g. integrated planning, codes, standards and permitting and voluntary incentives such as density bonusing and credits).

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ # 4 Gap between energy and planning

Example high-priority recommendation:

- **Require municipalities to prepare community energy plans** that promote energy conservation, the deployment of low-carbon electricity and district thermal energy, and enhance electricity system resilience to extreme weather events. The Province should also require municipalities to incorporate community energy plans into their land-use planning. (Recommendation 4.1)

Policy Direction 5—Protect and enhance green infrastructure (natural and built), through land-use planning and through the use of offsets and other crediting mechanisms that provide economic incentives for the preservation, establishment and maintenance of natural heritage features and supportive green technologies that sequester carbon and help build resilience to extreme weather.

Example high-priority recommendations:

- **The Province should consider boundary expansions for the Greenbelt** that would achieve climate change adaptation objectives such as green infrastructure, flood control and food security; foster connectivity; and promote mitigation of GHGs through intensification (providing a limit on sprawl) and by preserving natural heritage assets that sequester carbon. The best candidate areas for boundary expansions will be consistent with the vision and goals of the Greenbelt Plan, connect to current Greenbelt systems and complement the goals of the Growth Plan. From a climate change and flood prevention perspective, lands that are high-priority for including in expansion include:
 - Significant source water areas and urban river valleys.
 - Systems within watershed headwaters that have little Greenbelt protection.
 - Middle reach areas of river and stream systems where the headwaters and downstream areas are currently within the Greenbelt.
 - Lands identified as part of natural heritage systems and refined in watershed plans. (Recommendation 5.2)

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ #5 Gap between land-use designations and areas of highest vulnerability to climate impacts.
- ❖ #6 Gap between compact urban form and environmental design

- **Develop protections for green infrastructure in areas within the GGH but not covered by the Greenbelt Plan, ORMCP or NEP.** Identify and develop new policies (over and above the provisions in the PPS) to protect natural heritage, water resource and agricultural systems, as well as specific features such as wetlands, forests, headwaters and recharges areas and in these regions. Prioritize lands with the highest ecosystem service values. (Recommendation 5.3)

Policy Direction 6—Require improved stormwater management through protection, enhancement and/or construction of new permeable surfaces, run-off control, low-impact development (LID) and green infrastructure (including updating of provincial stormwater management standards).

Example high-priority recommendations:

- **Amend Provincial Plans to define and include as a clear objective low-impact development** that manages stormwater runoff at source and increases resilience throughout the affected watershed. (Recommendation 6.1)
- **Require planning for stormwater management to incorporate resilient, redundant and fail-safe measures** that will function effectively in a future environment of unpredictable extreme rainfall. (Recommendation 6.2)
- **Require municipalities to recover the full cost of sewage works** (as defined in the *Ontario Water Resources Act*), including long-term operations and maintenance of stormwater management facilities. (Recommendation 6.4)
- **Amend Provincial Plans to require municipalities to incorporate LID and climate change resilience into new infrastructure and urban design,** including roads and buildings, as well as retrofits. Link requirement with funding opportunities to support implementation. (Recommendation 6.8)
- **As part of any expansion of the urban boundary and any major urban redevelopment, watershed and subwatershed plans should be updated** to assess the cumulative impacts of development and climate change, in light of the most up-to-date climate science. (Recommendation 6.3)
- **Require that stormwater management plans and processes target maintenance of the natural hydrologic cycle** by managing stormwater runoff at source and preventing increases in the quantity of runoff from developed lands. Ensure that areas of the landscape that are important for the natural retention and filtration of water (e.g. wetlands) and for the

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ #5 Gap between land-use designations and areas of highest vulnerability to climate impacts.
- ❖ #6 Gap between compact urban form and environmental design

safe passage of floodwaters (e.g. floodplains) are protected, restored and enhanced to ensure their effective function. (Recommendation 6.6)

Policy Direction 7—Provide tools that encourage effective and collaborative adaptation planning by local and regional governments, including updated climate impacts research, updated floodplain mapping, future climate scenarios and requirements to develop climate change risk inventories and adaptation implementation plans.

Example high-priority recommendations:

- **Require local planning authorities to use updated mapping of hazardous (flood prone) lands and sites (including appropriate buffers) to designate appropriate zoning for these areas in municipal planning documents.** Flood hazard mapping should be extended to include urban flood zones as well as riverine flood hazards and should consider both existing and future extreme weather risks. Restrict municipalities from permitting development in “flood fringe” and “spill zone” areas (especially in light of outdated floodplain maps). Consider requiring new greenfield development and redevelopment affecting flood-prone areas to examine options for hazard

remediation. (Recommendation 7.1)

- **Provide adequate and ongoing support and funding to local planning authorities for floodplain maps to be updated** on a regular basis and in accordance with the best available information. (Recommendation 7.3)

Section V identifies a performance-measurement framework, including recommended key performance indicators, metrics and in some cases targets, which, if implemented, could support the evaluation of regional progress toward climate change objectives.

Recognizing the multiple spatial layers involved, as well as the numerous potential data points, the recommendations focus on indicators and metrics that scale effectively and, where possible, measure data important to multiple climate change mitigation and/or adaptation objectives.

Finally, Section VI ties together some of the evidence-based recommendations and indicators set out in this report through a descriptive narrative. This section describes Ontario today, Ontario in 2030 and Ontario in 2050, helping readers and policy-makers consider not just where we are, but where we could be: a region with a system for land-use planning that helps us build livable, prosperous and low-carbon municipalities that will adapt and thrive for generations to come.

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ #2 Gap between evidence and data
- ❖ #3 Gap between policies and implementation
- ❖ #7 Education gap

I. LAND-USE PLANNING AND CLIMATE CHANGE: LITERATURE-BASED LINKAGES AND CONSIDERATIONS

The objective of this literature review is to identify the linkages between climate change (mitigation and adaptation) and land-use planning at various scales, including environmental planning, resource planning and planning for infrastructure. The literature review identifies the shifts in land-use planning that need to take place to respond to climate change, typical barriers to implementation, and key information needs (i.e. indicators, thresholds, performance measures, etc.).

Defining Climate Change and Land-Use Planning

Identifying linkages between climate change and land-use planning first requires clarity on definitions. For this research, we use the Intergovernmental Panel on Climate Change (IPCC) definitions for adaptation, mitigation, and land use and land-use change:

- **Adaptation** is defined as “the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects”.²
- **Mitigation** is defined as “a human intervention to reduce the sources and enhance the sinks of greenhouse gases”.³
- **Land use and land-use change** is defined as “the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The term *land use* is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land-use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land-use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus give rise to radiative forcing and/or other impacts on climate, locally or globally”.⁴

² “Glossary.” Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Ed. C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White New York, NY: Cambridge University Press. Annex II. Web. https://ipcc-wg2.gov/AR5/images/uploads/WGIAR5-AnnexII_FINAL.pdf.

³ *Ibid.*

⁴ *Ibid.*

Literature Review Approach

The project team was asked to identify the most recent literature available from academics and think tanks that address the linkages between land-use planning and climate change. A total of 20 sources were to be identified, including a minimum of ten sources of peer-reviewed information and ten additional non-peer reviewed sources (i.e. grey literature).

The team took a three-stage approach to identifying these 20 sources, as described briefly below:

Stage 1: Identify a long list of potential references

The team developed an initial table of key words, expert sources, and known references. This list of known references was expanded through a call-for-knowledge from the project team to known networks and through the national Adaptation Community of Practice.⁵ The project team continued to expand the search using research questions to capture the widest range of appropriate sources and references.

This extensive review highlighted 140 references that examined aspects of the nexus between land-use planning and climate change response.

Stage 2: Narrow long list down to 20

After documenting the main characteristics of the long list of references described above, the project team developed a set of selection criteria to narrow it down to a final list of 20 references for further review and analysis. These criteria aimed to capture content and lessons most suitable for the GGH and objectives of the review:

- Establish a diverse array of land-use policy tools and instruments that can be leveraged for adaptation and mitigation (forward mapping).
- Establish a diverse set of actions and policies on mitigation and adaptation, each linked with land-use policy (backward mapping).
- Develop/underpin our understanding of the science (climate, social, planning) between land use and adaptation/mitigation outcomes.
- Be diverse (scale of applicability, national/international).
- Support identification of case studies and examples.
- Represent academic and grey literature.
- Be recent and relevant to GGH context.
- Support all areas of project research (does not leave gaps in knowledge).

The final list of 20 research papers was drawn from a variety of sources including national and international sources, academic and grey literature and theoretical and practical sources.

⁵ The National Adaptation Community of Practice is an online community for adaptation experts, policymakers and practitioners. The resource is facilitated by OCCIAR. The community includes a “call for knowledge” forum. There are over 300 members nationally. See www.ccadaptation.ca.

Stage 3: Review and analysis of short list of 20

After narrowing the list to the 20 publications that best reflect the selection criteria, the project team developed a report (Appendix 1) that highlights the linkages, key themes and concepts that emerged from the selected publications, as well as an annotated bibliography (Appendix 1A) that summarizes each of the articles. Notably, the project team identified three key linkages between land-use planning and climate change mitigation and three key linkages between land-use planning and climate change adaptation. This set of six core linkages provides the basis for recommendations for the Provincial Plans summarized in Section V of this report.

The following sections provide a summary of findings from the literature review report found in Appendix 1.

Context and Linkages



Image 1. View of Market Street in San Francisco, CA.

Heavily urbanized regions such as the GGH are complex areas with interdependent governance systems, ecological assets and a diverse array of climate-related vulnerabilities.⁶ Climate change translates to both significant issues and opportunities for urban regions. Collaborative, forward-looking, climate-sensitive land-use planning can help address these risks and opportunities, providing a foundation for ongoing emission reductions and increased resilience.

Land-use planning has a significant influence on the levels of GHG emissions in any given region. Urban regions account for up to 70% of global GHG emissions.⁷ GHG emissions are determined by, and stem from, a variety of urban form factors including population density, land-use mix, connectivity and accessibility.⁸ Land-use decisions and actions taken by cities can

⁶ Revi, A. et al. "Urban Areas." *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Ed. L.L. White Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea. New York, NY: Cambridge University Press, 2014. 535–612. Print.

⁷ Seto, Karen C et al. "Human Settlements, Infrastructure and Spatial Planning." *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Ed. T. Zwickel and J.C. Minx Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow. New York, NY: Cambridge University Press. 927-928. Print.

⁸ *Ibid.*

contribute 50-90% of global reductions necessary to narrow the gap between current baseline emissions and those associated with a strong chance of remaining below a 2°C global temperature rise.⁹

Historical emissions and the inability to make significant GHG reductions in the immediate term mean that we will continue to witness changes to weather and climate. The impacts of long-term changes to temperature and precipitation, weather variability and extreme weather pose risks to natural and built systems. As urban regions become home to increasing proportions of citizens, economic activity and built assets, risks and vulnerabilities associated with climate change will concentrate in these areas. For example, hazards such as heat stress and extreme precipitation can have impacts on human health in urban areas, infrastructure, ecosystems and economies. These impacts can be addressed through climate-sensitive land use and urban planning.¹⁰ Adaptation provides opportunities for both incremental and transformative development,¹¹ while successful mitigation can provide co-benefits in areas such as air quality and human health.¹²

Clearly, both mitigation and adaptation are necessary responses to climate change, and the scale of effort and change required for each is significant.¹³ There are, however, legitimate and challenging questions in assigning priority and effort that will require a strong understanding of the trade-offs and opportunities for synergy between these objectives. While a number of measures designed or conceived with either adaptation or mitigation in mind can have synergies with the other, there are potential conflicts as well. For example, many adaptation responses indicate greater need for green space, while mitigation objectives would call for greater density. Increased tree cover to reduce heat islands and other green infrastructure such as bioswales, have greater space requirements.¹⁴ It is therefore “incumbent on planners to work towards addressing” both the causes (emissions) and symptoms (impacts) of climate change.¹⁵

In addition to identifying the interrelationships between climate change adaptation, climate change mitigation and land-use planning, the literature review noted themes of limitations, complexity, governance and conflicting interests and values. The spatial scale of decision-making for these topics was also noted as a critical point of intersection. The research also identified planning tools, barriers and monitoring as important cross-cutting themes from the literature. Research results on these themes are summarized below, with additional detail and discussion about the findings in Appendix 1.

⁹ Global Commission on the Economy and Climate. New Climate Economy Technical Note: Abatement Reduction Potential. January 2015. Web. http://newclimateeconomy.report/wp-content/uploads/2015/01/NCE-technical-note-emission-reduction-potential_final.pdf Potential. January 2015.

¹⁰ Revi, A. et al. “Urban Areas.” 2014. 535–612. Print.

¹¹ *Ibid.* at 538.

¹² Seto, Karen C et al. “Human Settlements, Infrastructure and Spatial Planning.” 928.

¹³ Adger, Neil W., Irene Lorenzoni, and Karen L O'Brien. *Adapting to Climate Change: Thresholds, Values, Governance*. Ed. Neil W. Adger, Irene Lorenzoni, and Karen L O'Brien. N.p., 2009. xiv. Web.

¹⁴ Hamin, Elisabeth M., and Nicole Gurrán. “Urban Form and Climate Change: Balancing Adaptation and Mitigation in the U.S. and Australia.” *Habitat International* 33.3 (2009): 238–245. Web. 10 Jan. 2015.

¹⁵ American Planning Association. *Policy Guide on Planning and Climate Change*. N.p., 2011. 1.0. Print.

Land-Use Planning Tools

Specific land-use planning tools and implementation approaches can be effective at introducing and requiring action on climate change. Official plans, development controls, approvals, financial incentives (i.e. taxes and charges), and design guidelines are a few examples. For example, framing instruments such as planning documents, development guidelines and best practices can help establish direction, objectives and overall goals for climate change. Regulatory instruments such as defined hazard zones, permits or zoning requirements strengthen and define the land-use direction for climate change response, which can be further incentivized by financial incentives (taxes, charges).

These and other land-use planning tools and mechanisms for enacting climate change response are summarized in Table 1 below.

Table 1: Land-use tools and instruments¹⁶

Instrument category	Instrument or tool
Framing	<ul style="list-style-type: none"> • Official plans¹⁷ • Local plans on special matters¹⁸ • Collaboration / consultation
Regulatory and zoning	<ul style="list-style-type: none"> • Land subdivision and development controls¹⁹ • Delineation of hazard areas, flood plain regulation²⁰ • Limit to site cover and impervious surfaces²¹ • Development Permit Areas can flexible and site specific. Integrated with development charges. Used for water management, hazards, energy efficiency²² • Development Approval Information Areas (DAIAs). Used to require site specific impact assessment²³ • Subdivision and servicing bylaw: requiring green infrastructure²⁴ • Tree protection²⁵
Taxes and Charges	<ul style="list-style-type: none"> • Development cost charges: exemptions for certain

¹⁶ Macintosh, Andrew, Anita Foerster, and Jan McDonald. *Limp, Leap or Learn? Developing Legal Frameworks for Climate Change Adaptation Planning in Australia*. Gold Coast, Australia.: N.p., 2013. Print

¹⁷ Richardson, G.R.A., and J. Otero. *Land-use Planning Tools for Local Adaptation to Climate Change*. Ottawa, ON. Canada.: N.p., 2012. Print.

¹⁸ *Ibid.*

¹⁹ *Ibid.*

²⁰ Carlson, Deborah. *Preparing for Climate Change: An Implementation Guide for Local Governments in British Columbia*. Vancouver, B.C.: N.p., 2012. Web; Richardson, G.R.A., and J. Otero. *Land-use Planning Tools for Local Adaptation to Climate Change*. Ottawa, ON. Canada.: N.p., 2012. Print.

²¹ *Ibid.*

²² Carlson, Deborah. *Preparing for Climate Change: An Implementation Guide for Local Governments in British Columbia*. Vancouver, B.C.: N.p., 2012. Web

²³ *Ibid.*

²⁴ *Ibid.*

²⁵ *Ibid.*

	developments (e.g. low GHG) ²⁶ • Stormwater user fees
Voluntary	• Density bonuses; increased density available in exchange for adaptive/mitigative measures ²⁷ • Covenants and easements ²⁸
Information	• Run off control, landscaping ²⁹ • Design guidelines ³⁰
Liability	• Environmental review of development projects ³¹
Compulsory Acquisition	• Property purchase, designation for future acquisition ³²

Implementation Scale and Challenges

The spatial breadth and complexity of both GHG emissions sources and climate change vulnerabilities necessitates a similarly broad and complex response. Implementation of climate change responses, most notably adaptation measures, can be challenging for many reasons, including:

- Differing perceptions of risk and levels of risk tolerance
- Unknown social, environmental and economic impacts
- The potential for time delays and vague results
- The trade-offs between objectives for built and natural systems

Additional complexity appears when efforts to mitigate GHGs and adapt to climate change involve interjurisdictional and intrajurisdictional (i.e. between departments within a municipality) coordination. In this respect climate change planning is similar to, and linked with, land-use planning processes.

Table 2 demonstrates the range of land-use actions and associated planning scale. It also demonstrates that at each level of governance and at every geographic scale there are important opportunities to undertake action and demonstrate leadership on mitigation and adaptation. Some actions are most efficiently undertaken by higher-level actors (such as development of codes and standards) while others are necessarily local in nature (such as site

²⁶ *Ibid.*

²⁷ *Ibid.*

²⁸ Richardson, G.R.A., and J. Otero. *Land-use Planning Tools for Local Adaptation to Climate Change*. Ottawa, ON. Canada.: N.p., 2012. Print.

²⁹ Carlson, Deborah. *Preparing for Climate Change: An Implementation Guide for Local Governments in British Columbia*. Vancouver, B.C.: N.p., 2012. Web.


³⁰ Richardson, G.R.A., and J. Otero. *Land-use Planning Tools for Local Adaptation to Climate Change*. Ottawa, ON. Canada.: N.p., 2012. Print.

³¹ *Ibid.*

³² Macintosh, Andrew, Anita Foerster, and Jan McDonald. *Limp, Leap or Learn? Developing Legal Frameworks for Climate Change Adaptation Planning in Australia*. Gold Coast, Australia.: N.p., 2013. Print

permitting or neighbourhood design). The coordination of efforts to respond to climate change, both at policy and planning levels is critical in order to a) optimize efficiency, b) reduce policy overlap or repetitiveness, c) find efficiencies in costs, and d) match policy to proper implementation spatial scales. Climate change adaptation and mitigation also require effective governance and leadership to drive action on a topic that is publicly sensitive and has uncertain future outcomes.

Table 2: Opportunities exist at all scales for adaptation and mitigation in land-use planning³³

Geographi c Scale	Examples of actors at each scale	Areas of action		Examples		
	National	Regulations and policy development		Carbon pricing, GHG regulations		
	Bi-national agencies			Financial support for adaptation and mitigation		
	Government departments	Research and information		Improve energy efficiency standards, building energy codes		
	Government agencies	Codes, standards development		Develop and disseminate guidance on adaptation		
	Watershed agencies	Regional planning, alignment		Develop and disseminate climate data and projections		
	Conservation management agencies	Best practices summaries		Identify, protect, enhance ecosystem services		
	Counties	Education		Infrastructure planning, coordination		
	Regional municipalities	Ecosystem-based adaptation		Provide regional, downscaled climate data and projections		
	Local governments	Regionally specific research and information		Plan for alternative and public transit		
	Site		Environmental design		Adopt best practices, codes and standards	
				Infrastructure and green infrastructure design and construction		
				Conduct public engagement to identify risks, vulnerability		
				Urban and neighbourhood design for alternative transit		
				Site permitting based on low-carbon, resilient design		
Areas of action at all scales						
Leadership, coordination	Demonstration projects	Mainstream climate change	Vision targets	Incentives	Evaluate equity	Transit planning

³³ Based on American Planning Association. Policy Guide on Planning and Climate Change. 2011. Section 3.1.

Barriers to Implementation

The project team identified barriers to addressing climate change through land-use planning that stretched across facets of technology, institutions, politics, legislation and finances. Examples of barriers cited in the literature include:

- **Policy and information for planners:** The lack of a clear policy framework and insufficient spatial information related to (1) areas of high vulnerability and (2) the effectiveness of planning options to reduce vulnerability and emissions.
- **Public attitudes:** Public apathy and a misunderstanding or underestimation of risks often undermines political support for land-use planning action to address climate change.
- **Best practice guidance:** Regulatory and technical guidance on approaches to incorporate climate change into planning frameworks, most notably in the design and redesign of cities and regional urban growth centres, is lacking.
- **Linking local action to global outcome:** A lack of clarity and communication on the importance of local and regional actions for achieving national and global GHG reduction objectives.
- **Siloed implementation:** a lack of coordination horizontally (across departments/ministries) or vertically (i.e. federal → provincial → municipal) creates redundancy and inefficiency.

Considerations for Land-Use Planning

Monitoring and evaluation of both the planning effort to enact climate change responses, as well as the adaptation and mitigation responses themselves are important. Performance measurement and target-setting for mitigation (i.e. GHG emissions reduction) is more straightforward than for adaptation. The complexity of adaptation (different spatial, temporal and sectoral scales) calls for more sophisticated methods of assessing both outcomes and effectiveness. Adaptation can also take the form of improvements to capacity, which further enables adaptation planning and implementation. Since investments in improving capacity may not always be made for the primary purpose of climate change action, accurate monitoring and tracking can be difficult.

Monitoring outcomes of adaptation and mitigation responses facilitates an evaluation of effectiveness, and provides opportunities for course correction. Monitoring and evaluation thus are an integral part of iterative climate change responses.³⁴ There is no one-size-fits-all approach to monitoring and evaluation.³⁵ Rather, approaches and indicators should be selected based on needs. In some cases, success will only be assessable in retrospect.³⁶

³⁴ Turner, S et al. *A Review of the Monitoring and Evaluation Literature for Climate Change Adaptation*. Melbourne: N.p., 2014. Print.

³⁵ *Ibid.*

³⁶ Adger, Neil W., Irene Lorenzoni, and Karen L O'Brien. *Adapting to Climate Change: Thresholds, Values, Governance*. Ed. Neil W. Adger, Irene Lorenzoni, and Karen L O'Brien. N.p., 2009. Web.

The following table (Table 3) describes characteristics of different approaches to monitoring and evaluation:³⁷

Table 3: Approaches to monitoring and evaluation

Methodology	Approach	Key question(s)	Benefits
Input-output-outcome-based evaluations / theory-of-change	<p>Focus on effectiveness</p> <p>Elements of adaptive capacity or risk evaluated against indicators</p>	<p>Theory-of-change approach: stakeholders identify long term goals and map backwards through steps</p> <p>Indicators, thresholds, assumptions as outlines</p>	<p>Robust when dealing with complex, multi-faceted adaptation</p> <p>Iterative process</p>
Process-based evaluations		<p>Define key stages in process, document progress on implementation</p>	<p>Does not define outcomes ('what' is less important than 'how')</p> <p>Does assume linear process with stages, not always consistent with adaptation</p>
Evaluation of behavioural change		<p>Documents behaviour change</p>	<p>Influence rather than quantify impact; outcomes as behaviour change</p> <p>Can be combined with other approaches</p>
Economic evaluation	<p>Focus on economic efficiency</p>	<p>Cost-benefit or cost-effectiveness analysis</p>	<p>Standardizes outcomes in terms of dollars</p> <p>Assessment of baseline difficult</p>

The portfolio of indicators for assessing success should include both process and outcome-based indicators in order to capture the benefits of each approach,³⁸ and should reflect the

³⁷ Turner, S et al. *A Review of the Monitoring and Evaluation Literature for Climate Change Adaptation*. Melbourne: N.p., 2014. Print.

³⁸ Turner, S et al. *A Review of the Monitoring and Evaluation Literature for Climate Change Adaptation*. Melbourne: N.p., 2014. Print.; Revi, A. et al. "Urban Areas." *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Ed. L.L. White Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea. New York, NY: Cambridge University Press, 2014. 535–612. Print.

multi-faceted nature of adaptation and mitigation (importance of process and building capacity, reduction of vulnerability. Indicators should be both qualitative and quantitative.³⁹ A list of indicators and performance measurement framework addressing both mitigation and adaptation in Ontario is found in Section VI.

Summary of Key Themes and Linkages

Given the breadth and depth of both themes of land-use planning and climate change response (adaptation/mitigation), the domestic and international scholarship was extensive. Numerous observations, lessons, tools, actions and linkages were noted and, in assessing this wealth of literature, core themes were noted.

The identified themes were consistently referenced in many of the articles and reports included in the literature review. The themes serve as key substantive focus areas for achieving successful climate change response through land-use planning. In total, ten substantive focus areas were identified, as described briefly below. These are explored further in Appendix 1 and Table 7 in Section III below.

- **Action Planning.** Develop and adopt strong objectives for adaptation and mitigation and, where possible, mainstream climate change into management and decision-making. Increase collaboration between government jurisdictions both vertically (province-region-city) and horizontally (city-to-city and across provincial ministries and municipal departments).
- **Energy.** Reduce fossil fuel consumption through energy efficiency and conservation and low-carbon energy planning in aspects of infrastructure renewal and community development.
- **Research.** Collaborate and coordinate on research, including low-carbon technology, climate data, impacts and adaptation. Harness partnerships with academia and the business community.
- **Resilience.** Enhance the resilience of infrastructure, communities, natural heritage and agricultural lands. Ensure that sites and opportunities for resilience are identified and reserved.
- **Technology.** Facilitate the deployment of technologies that advance mitigation and adaptation goals in buildings, transportation and utility systems, including increasing distributed low-carbon energy supply.
- **Environmental Design.** Construct, rehabilitate and maintain green infrastructure (including urban green infrastructure and green roofs) to support infiltration and water management and reduce flood risks. Recognize additional benefits of improved building energy efficiency and reduced heat island effects.
- **Equity.** Ensure effective and ongoing public consultation to identify and prioritize areas and individuals with highest vulnerability. Recognize differing risk tolerance levels and risk perceptions.
- **Food.** Foster and support local food production and the reduction of travel distances for food. Protect and enhance agricultural lands.

³⁹ Turner, S et al. *A Review of the Monitoring and Evaluation Literature for Climate Change Adaptation*. Melbourne: N.p., 2014. Print.

- **Transportation.** Reduce car use through the development of compact, transit-oriented communities, better design of transit and urban form, and the provision of public and active transportation alternatives.
- **Urban Form.** Promote compact, mixed-use development to increase density, reduce sprawl, improve air quality and reduce transportation GHGs.

These key substantive focus areas – the basis of best practices that stem from the literature – are elaborated in relation to land-use planning and used as the evaluative criteria to analyze Ontario’s current land-use planning framework (see Section IV below). Further, specific criteria in each focus area are used as identifiers to determine whether land-use planning is aligned with climate change planning objectives.

The substantive focus areas discussed above were used to help identify the three strongest linkages between land-use planning and climate change mitigation and the three strongest linkages between land-use planning and climate change adaptation. These key linkages -- described briefly in Table 4 below - form the basis of six of the seven policy directions prescribed in Section IV below.

Table 4 Strongest linkages between climate change mitigation and adaptation to land-use planning

Action		
Strong link to mitigation	Primary mitigation benefit	Policy direction
Require the development of compact, location-efficient communities (development that is a convenient distance from workplaces, amenities, stores and urban hubs; has access to and provides the densities needed to support various modes of rapid transit; enables short commute times; and contains realistic opportunities to use transit and active transportation, allowing for improved transitions between modes).	Reduce personal vehicle reliance, reduce vehicle emissions.	#2
Require urban design features and the layout of major land uses (e.g. institutions, green space, commercial areas) that support higher-order transit and active transportation.	Reduce personal vehicle reliance, reduce vehicle emissions.	#3
Require, integrate and support community energy planning (including district energy, renewable energy generation and energy efficiency) into our land-use planning framework (e.g. integrated planning, codes, standards and permitting and voluntary incentives such as density bonusing and credits).	Reduce energy demand from buildings, improve energy efficiency, reduce energy related emissions.	#4

Strong link to adaptation	Primary adaptation benefit
Protect and enhance green infrastructure (natural and built), through land-use planning and through the use of offsets and other crediting mechanisms that provide economic incentives for the preservation, establishment and maintenance of natural heritage features and supportive green technologies that sequester carbon and help build resilience to extreme weather.	Improve resilience of ecosystems, support biodiversity. Watershed-level management of flood risks. #5
Require improved stormwater management through protection, enhancement and/or construction of new permeable surfaces, run-off control, LID and green infrastructure (including updating of provincial stormwater management standards).	Management of urban flood risks from extreme precipitation. #6
Provide tools that encourage effective and collaborative adaptation planning by local and regional governments, including updated climate impacts research, updated floodplain mapping, future climate scenarios and requirements to develop climate change risk inventories and adaptation implementation plans.	Coordination improves efficiency and effectiveness of adaptation responses. #7

II. BEST PRACTICES TO ACHIEVE CLIMATE OBJECTIVES THROUGH LAND-USE PLANNING



Image 2. View of the Thames River in London, UK.

After distilling key linkages between climate change and land-use planning from the literature review, the project team identified examples of real-world application and implementation that exemplify success in the use of planning to respond to climate change. Nations and sub-nations from around the world were scanned to identify a list of ten

jurisdictions that (1) were comparable in context to the GGH, and that (2) showcased best practices in climate change mitigation and adaptation that were identified in the literature review.

Comparability to the GGH, and relevance of best practices, was determined based on a set of evaluation criteria comprised of:

- **Economic structure:** Diversity of economic sectors and important contribution to regional and national economy.
- **Governance:** Multiple levels of governance, including local, regional, state/provincial. Bi-national management of watersheds an asset.
- **Climate leadership:** Demonstrated leadership in planning and implementation of climate mitigation and adaptation at one or more levels of governance.
- **Climate risks:** Similar climate and exposure to climate hazards.

Based on these evaluation criteria, the jurisdictions identified in Table 5 below were explored in more detail for best practices and innovative tools.

Table 5: Jurisdictions selected for best practices scan

Jurisdiction	Key points of comparability
New York, NY	<p>New York City and its five boroughs have a total population of 8.5 million and a diverse economy that is a state and national hub.</p> <p>There is significant alignment between land-use policies and climate change response through the <i>PlaNYC</i> plan. Goals include reduction of GHG emissions, sustainable transportation and resilience of urban infrastructure.</p> <p>Strong mitigation and adaptation plans at municipal and borough levels are supported by appropriate policy, standards, codes and legislation.</p>
Metro Atlanta, GA	<p>As the ninth largest metropolitan area in the US, the metro Atlanta area has an estimated population of 6.1 million and spans up to 39 counties in north Georgia.</p>

	<p>The region has a diverse economy, including service sectors (health and finance) that are comparable to the GGH, as well as agriculture, manufacturing and construction.</p> <p>As an inland metropolitan region, Atlanta faces some climate hazards similar to those faced by the GGH, including drought, heat waves and surface water flooding.</p>
London, UK	<p>London generates over 20% of the UK economy, and the London metropolitan area generates over 30%.</p> <p>The London Plan outlines a spatial development strategy and includes climate change and transport. Multiple levels of government, including city and boroughs levels, are responsible for planning and implementation.</p> <p>Greater London includes the metropolitan greenbelt, which limits development.</p> <p>Strong climate mitigation initiatives exist at the city and country level, and there are clear connections (through the Planning Policy Statement and the London Plan) between spatial planning and climate outcomes.</p>
San Francisco Bay Area, CA	<p>The Bay Area is a large, multi-city region with a diverse, growing and important economy. The population of the region is similar to the GGH and includes both urban, peri-urban and rural areas. Multiple levels of government engaged, from local to county and region to state. The local climate is temperate.</p> <p>Long range integrated transportation, land use and housing plans exist that can be referenced.</p> <p>Multiple examples of both mitigation and adaptation planning at the site, local and regional level include: better streets plan, bicycle plans, adapting to rising tides, Energy and Climate Action Plan (Oakland) and the San Francisco Climate Action Plan.</p>
Randstad Region, Netherlands	<p>A multi-city region that is home to the largest cities in the country, including Amsterdam, Rotterdam, and The Hague, Randstad is central both politically and economically to the country.</p> <p>Randstad is described by academic authors (Runhaar et al, 2009) as a leading jurisdiction with respect to spatial planning and environmental concerns. Higher-level policy is implemented at the local level, requiring strong frameworks for lower levels at the scale of implementation.</p> <p>Randstad is home to the Knowledge and Innovation Community on Climate Change Mitigation and Adaptation (part of the European Institute for Innovation and Technology). The Rotterdam Climate Initiative aligns actions of municipalities, port and the private sector.</p> <p>The Dutch National Research program <i>Climate Changes Spatial Planning</i> also contains strong resources.</p>
Chicago Metropolitan Area, IL	<p>Chicago, an important hub on the North American Great Lakes, is the third largest regional economy in the US. The Chicago metro areas include multiple adjacent counties and communities and include over 9 million people, 2.6 million of which reside in the City of Chicago.</p> <p>Alignment between environment and urban planning is described and made</p>

	<p>explicit in multiple references and plans, including <i>Adding Green to Urban Design</i>, which outlines the rationale, vision and implementation strategy for sustainable urban design. GOTO 2040 is a comprehensive regional plan.</p> <p>As a mid-continent city on the shores of the Great Lakes, Chicago has a similar climate to Toronto and faces similar climate hazards, including extreme precipitation and extreme heat events. Natural heritage and wildlife plans for the region also include provisions and plans for climate change impacts.</p>
Southeast Queensland, Australia	<p>With a total area of 22,000 km² and a population of just over 3 million, Southeast Queensland is comparable geographically and demographically to the GGH.</p> <p>It is comparable economically as well, as it has a diverse economy with strong tourism, manufacturing, food and logistics industries.</p>
Calgary, AB	<p>Calgary is engaged in planning, guided by the province-led South Saskatchewan Regional Plan under the provincial land-use Framework. Community sustainability, including mitigation and adaptation, is included at all levels.</p> <p>Key areas of comparability: an area of significant and rapid growth; challenges maintaining natural and agricultural areas while facilitating development; and adapting to climate risks, including riverine flooding.</p>
Sydney and Region, Australia	<p>Sydney, and the region, is a critical economic and population centre for the country. The region is faced with challenges similar to those faced by the GGH, including population growth and demand for housing.</p> <p>The state government has created a Metropolitan Plan for Sydney 2030, which contains nine strategic directions, each with strong linkages between land-use planning, protection of the environment and tackling climate change.</p> <p>Projects and plans include renewable energy, urban forest, natural heritage and balancing land uses on the city fringe. The regional plan creates the structure for the city corporate plan, reflecting the level of alignment.</p>
Greater Vancouver Regional District, BC	<p>The metro Vancouver area includes 22 local authorities and is a growing region with respect to the economy and population.</p> <p>Land use and climate change are aligned at various levels and this is demonstrated in, for example, the Regional Food System Strategy, Corporate Climate Action Plan and Regional Transit Plan.</p> <p>Provincial policies, including a carbon tax and GHG objectives, are linked with local initiatives. Tools such as MetroQuest are used for scenario analysis and long term spatial planning.</p>

Not surprisingly, many of the jurisdictions exemplified facets of the substantive focus areas that were uncovered during the literature review. For example, some locations have established formal partnerships with academia (relating to the Research focus area) to better understand climate risks, while others have deployed innovative technologies to curb GHG emissions (engaging the Technology and Energy focus areas).

Best Practices

As each jurisdiction was reviewed for its planning and action on climate change, a core set of best practices became apparent. In total, seven best practices were developed that envelop the climate change actions in all of the jurisdictional case studies. They include incentives and financing, planning policies and instruments, guidelines and toolkits, coordination and collaboration, natural systems, vulnerable populations and infrastructure (see Table 6, below).

A second set of criteria was then applied to gauge the richness or strength of the seven best practices. This set of criteria was comprised of:

- Spatial and jurisdictional diversity
- Presence of implementation plans
- Presence of monitoring, evaluation and performance measures
- Clear connections between land-use planning and climate change

Table 6 below lists the seven best practices, their definitions and the criteria used to evaluate their richness in all of the selected jurisdictions. In addition to the overall picture of richness, a more fulsome review of each jurisdiction under these criteria can be found in Appendix 2.

The jurisdictional review sought out examples of tools used in land-use planning that drive initiatives such as GHG reduction, improved stormwater management systems and energy efficiency. Many of the best practices address both climate change mitigation and adaptation under the themes of “climate action” (Chicago), “resilience” (NYC), “sustainability” (Atlanta, Calgary) and “combating” climate change (Sydney). These interrelations reflect the importance of both adaptation and mitigation and corroborate the existence of noteworthy synergies identified in the literature review.

Although efforts to assess and manage the consequences of climate change are increasing around the world, mitigation of GHG emissions remains the prevalent direction of climate change responses in the jurisdictions reviewed. Nearly all jurisdictions commit to GHG reduction targets and devote much attention to energy efficiency. Climate change

adaptation was also referenced in all cases, but largely focused on impacts from sea level rise, drought, flooding and heat stress. For example, “climate proofing” discourse appears in all levels of governance in the Netherlands. The City of London also devotes an entire document



Image 3. View of Manhattan in New York City.

and strategy to preparing for expected impacts entitled “The Mayor’s Climate Change Adaptation Strategy: Managing Risks and Increasing Resilience”.⁴⁰

In general, incentives and other programs to reduce energy demand and increased efficiency in building stocks were found in London, Chicago, Atlanta and San Francisco. Planning policies and instruments were applied in all jurisdictions to encourage reduced and/or efficient



Image 4. GO Train travelling on the tracks adjacent to Lower Don River near Leslieville in Toronto, Ontario.

transportation; to identify and prevent building on hazard lands; and to improve air quality. Guidelines and toolkits are present in almost all of selected jurisdictions, helping to visualize climate change impacts, predict climate change futures and lend key pieces of information to support planning (e.g. sea level rise, flood plains, heat islands, etc.). All jurisdictions likewise demonstrate coordination and collaboration with different levels of government and some have invited resident participation in the development of future climate sensitive cities and regions. The use of natural systems and

green infrastructure is a recurring theme within the various regions as they combat the threat of intense precipitation and increased heat stress in the context of climate change.

⁴⁰ Nickson, A., Woolston, H., Daniels, J., Dedring, I., Reid, K., Ranger, K., Clancy, L., Street, R., and Reeder, T. Managing Risk and Increasing Resilience. The Mayor’s Climate Change Adaptation Strategy. Greater London Authority. ISBN 978-1-84781-469-2. 2011.

Table 6: Description and evaluation of the richness of best practices in case studies of climate change and land-use planning

	Incentives and financing	Planning policies and instruments	Guidelines and toolkits	Coordination and collaboration	Natural systems	Vulnerable populations	Infrastructure
Description	Support for energy and/or water efficiency projects in homes and businesses – particularly retrofits - in the form of free services offered by city staff or subsidies and rebates for retrofitting. Also includes disincentives.	Updating building regulations and land-use planning principles to improve resiliency and better prepare for climate change.	Tools and guidelines for climate change adaptation in the form of publications, visualization tools and interactive web-tools.	Fostering cooperation between government, business and scientific communities across departments and jurisdictions. Includes working groups and task forces.	The protection and restoration of wetlands, green spaces and urban forests to reduce flood risk, mitigate urban heat island effect, sequester carbon and perform other services.	Ensuring that populations with limited capacity or those that are living in especially vulnerable locations are identified and protected from the impacts of climate change.	Development of alternative and decentralized energy infrastructure, green infrastructure stormwater management.
Spatial and Jurisdiction Diversity	Most examples are at the local scale, though there is potential for provincial use.	Yes, it is apparent at all scales.	Local and regional scales.	All scales.	Local and regional scales.	All scales.	All scales.
Presence of Implementation Plans	✓	✓✓✓	✓✓	✓	✓✓✓	✓	✓✓✓
Presence of Monitoring & Evaluation/ Performance Measures	✓	✓✓✓	✓	✓	✓✓	✓✓	✓✓✓
Clear Connection between LUP and climate change	✓✓	✓✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓✓

Barriers to Implementation

Compared to the literature review, barriers were not as apparent in the jurisdictional scan, likely reflecting the different perspective of academic and think tank report authors versus municipal employees and stakeholders describing their own programs. The vast majority of the cases examined were positive, framed as successful and discussed progress to date and future actions. The cases revealed few details about challenges that were present at different points of planning and implementation. However, the scan considered *potential* barriers as drawn from the literature review, and noted how case studies described responses to those barriers. A high-level overview of barriers and some best-practice responses to them identified in the

jurisdictional scan are described below.



Image 5. An image of the Don Valley Brickworks in Toronto, Ontario where former quarries have been converted to wetlands.

Policy and information for planners:

A lack of information to determine the value of natural assets from a climate change perspective, as well as supporting policy to protect those assets, was identified as an issue in a number of selected jurisdictions. The need for housing often encroaches on natural areas, making development a real threat. Promoting the health benefits of natural areas and marketing the flood mitigation properties of riparian areas and

wetlands have helped gain support for conservation and the re-naturalization of public urban spaces (e.g. San Francisco and Chicago). The popularity of green infrastructure also contributes to more resilient urban natural systems.

Public attitudes: Although all regions have various plans that tackle climate change mitigation and adaptation, public opposition to those responses was most apparent in Southeast Queensland, Australia. In this case, provincial governments trumped local initiatives to include recognition of sea level rise in development requests by the building community. In the end, building scenarios of sea level rise were removed from local planning guidelines. The example from Southeast Queensland also demonstrates the concept of differing perceptions of risk at the local level. In London, congestion charges for vehicle movement in the city core were initially not supported by the public, but after they were implemented public acceptance increased over time.

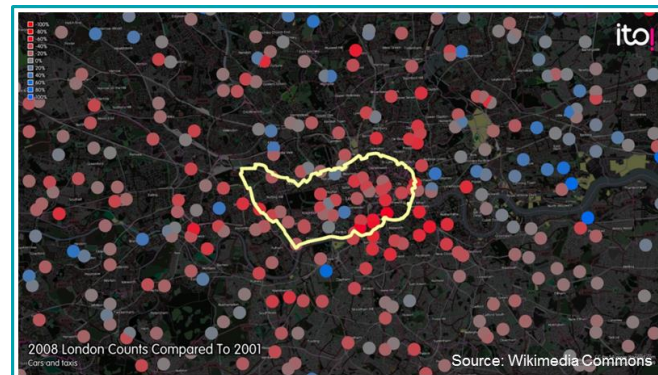


Image 6. This map shows the changes in traffic that took place in London between 2001 and 2008 (red indicates a decline in traffic while blue shows an increase.) While congestion charges were not initially supported by the public, this image indicates that traffic declined over the period studied.

Best practice guidance: Planning tools and frameworks often integrate projections of climate change; however, uncertainty associated with these projections can create challenges for local planning (for example in Southeast Queensland). Two approaches that have been successful at assisting planners and other decision makers in light of this uncertainty include taking an adaptive management approach (Chicago) and identifying historic changes and local vulnerabilities (Randstad).

Siloed implementation: Fragmented decision-making and lack of communication between levels of government can make climate change responses uncoordinated and pose unknown risks. Chicago and Calgary demonstrate the use of interdepartmental or regional boards or agencies to help oversee development and the enactment of climate change plans.

Barriers from the literature review and how those were overcome in jurisdictions around the world provide valuable considerations for the GGH context. Consideration of these challenges and actively developing solutions in advance will advance the process of climate change mitigation and adaptation in the GGH. These barriers were considered in developing the seven policy directions for provincial policy (Section IV).

Key Information Needs

Cascading alignment between provincial/state, regional and local climate change planning facilitates the development and application of objectives and targets for climate change response. Data collection and reporting are also improved by effective coordination on climate change mitigation and adaptation among regions, sectors and departments. This is especially true with GHG reduction plans, where GHGs are more easily quantifiable and summative across spatial and/or sectoral boundaries.

Most of the implementation plans pertaining to regulations and planning principles take the form of specific strategies with targets and objectives, often aligned with higher-level plans. In the case of Calgary (and other Canadian cities), they monitor success by using the Federation of Canadian Municipalities (FCM) Partners for Climate Protection (PCP) program. The success of cooperation and collaboration may, in fact, be measured by the development of plans and other initiatives that seek action on climate change adaptation and mitigation.

Goals and strategies for improvements and maintenance of natural systems are often identified in specific plans (e.g. San Francisco Urban Forest Plan). For example, these ecosystem-based strategies can have targets for the number of trees, permeable land cover, program participation rates and the number of parks, among others. Mapping tools can help identify vulnerable populations or high-risk areas, which can enable social services, public health, municipal planners, emergency services and insurers.

Tracking and reporting on effectiveness (both mitigation and adaptation) helps to gauge the success of climate change plans and can support continuous improvement efforts. Appendix 2 provides a more comprehensive explanation of each of the seven best practices under the criteria of barriers, implementation plans, monitoring and evaluation and connection to land-use

planning. In addition, three page summaries of the climate change mitigation and adaptation activities for each jurisdiction are listed in Appendix 2.

The information on best practices, barriers, and information needs as defined in the ten leading jurisdictions around the world constitute key information for enabling climate change response through land-use planning in the GGH of Ontario. Taking lessons from the leading jurisdictions, the best practices and key information needs described in this section were considered and incorporated into the recommendations prescribed in Section IV and detailed in Appendix 4 (this is particularly the case for the implementation recommendations in Appendix 4).

III. GREATER GOLDEN HORSESHOE PLANNING POLICY REVIEW

In this section, we evaluate the land-use planning framework in the GGH in the context of lessons learned from the literature review and jurisdictional scan of current best practices to address climate change adaptation and mitigation. The literature review and jurisdictional scan identified priority policy directions and best practices regarding land-use planning and implementation tools. These sections also discussed typical barriers to implementation and identified performance measurement needs.

In this section of the report, the project team has established a set of evaluation criteria based on the lessons learned in these sections, and has applied these to a review of the following key elements of the land-use planning framework for the GGH:

- The PPS
- The Growth Plan
- The Greenbelt Plan
- The ORMCP
- The NEP
- Official plans for ten GGH municipalities
- Select provincial and municipal policy and implementation guidance documents

A detailed evaluation is presented in Appendix 3.

Having applied the evaluation criteria to the key elements of the land-use planning framework listed above, the project team has identified several gaps which are addressed with policy recommendations that are found in Section IV.

Comparing GGH Planning Policy Framework to Literature Review and Jurisdictional Scan

Land-use planning is at the centre of a broad approach to addressing climate change in Ontario. With the goal of evaluating Ontario's land-use planning framework for the GGH in the context of contemporary best practices and ideas about climate change planning, we reviewed the most recent published work on how land-use planning affects and is affected by climate change, discussed in Section I.

The literature review confirms that land-use planning is a critical policy area for reducing emissions and increasing resilience to climate change impacts. Much of the literature focuses on the role of urban regions as major contributors to GHGs and as sites of much effort to reduce emissions. Urban regions, with high population concentrations are also highly vulnerable to impacts. While there is no question that land use is a "causal factor" of GHG emissions and a way of understanding spatial climate change impacts⁴¹, planning is but one action area for addressing climate change in urban regions.

The need to see planning as one action area within a larger suite of complementary actions was borne out in the jurisdictional scan, where each of the ten jurisdictions studied are undergoing a

⁴¹ Dale, Virginia H. 'The Relationship Between Land Use Change and Climate Change.' *Ecological Applications* 7.3 (1997): 753–769., Print.

paradigm shift to mainstreaming climate action within a broad range of policy areas. The challenge is to assign relative priority for resources, with land-use planning being one area of action competing with others for regulatory decision-making priority, research and technical guidance and, of course, financing.

What are the lessons for planning in the GGH? Drawing from the literature review and jurisdictional scan, it is a challenge to make sense of how the best practices and ideas should be adopted in the GGH as sustainability and regional governance already form the foundation of land-use planning in the region. While the visibility of climate change as an issue has increased exponentially in the past few years, much of the discussion relates to broader notions of “sustainability,”⁴² which has long been incorporated into Ontario’s land-use planning framework (including watershed, ecosystem and natural heritage system planning).

The literature, both scholarly and practice-based, grapples with the multi-scalar challenges of climate change action and discussions jump through all levels of government from global agreements to nations and regions, and all geographic scales from global, to national, to regions, neighbourhoods, individual development sites, right down to the detailed mechanics of buildings. In Ontario, regional-scale planning, which mediates between larger-scale and smaller-scale issues, has long been part of our approach; yet regional coordination between municipalities is seen as an aspirational goal in other global city regions. Basic sustainability policies and regional governance are therefore not subjects for the policy review. Nonetheless, the GGH planning framework needs to draw from this foundation to increase climate change awareness and action throughout the region.

Methodology

Climate change actions in urban regions are distilled in the literature review into a list of substantive focus areas, which strongly correlate land-use planning to climate change.

The substantive focus areas are used in the policy review as evaluation criteria against which the GGH land-use planning policy framework is analyzed (see Table 7 below). Ten evaluation criteria address two themes in climate action: 1. mainstreaming, and 2. planning built and natural environments. The criteria, representing best practices in climate action, are presented as questions and are used to review of the PPS, Provincial Plans, policy guidance and official plans (see Appendix 3 for detailed discussion and review).

The first five dimensions—action planning, energy, research, resilience, and technology—characterize the paradigm shift to “mainstreaming” climate change within a broad range of government policies and priorities, in areas that are highly interrelated but not limited to land-use planning.

The second set of five criteria under “Planning built and natural environments”—environmental design (including biodiversity, green infrastructure and low impact development), equity, food, transportation and urban form—include climate change actions in areas conventionally related to land-use planning.

⁴² Wheeler, Stephen M. *Planning for Sustainability: Creating Livable, Equitable and Ecological Communities*. 2nd ed. New York: Routledge, 2013. Print.

Table 7: Evaluation criteria

Evaluation criteria	
Mainstreaming: new priorities for government to reduce emissions and adapt to changing climates	
Action planning	Is climate change part of land-use planning? Are strong objectives for climate change mitigation and adaptation set out? Does policy address: <ul style="list-style-type: none"> •Impact? •Adaptive capacity? •Vulnerability? •Integrated approaches? •Risk management?
Energy	Is reducing carbon emissions through reductions in energy use and energy efficiency the goal of planning policy?
Research	Do scientific analysis, data collection, monitoring and evaluation support land-use planning? Is education and collaboration important?
Resilience	Is resilience of infrastructure, communities, natural heritage and agricultural lands a planning goal?
Technology	Are green and alternative technologies facilitated in buildings, transportation and utility systems? Do barriers exist to implementation?
Climate change action in planning built and natural environments	
Environmental design	Do planning policies include: <ul style="list-style-type: none"> •Biodiversity? •Green infrastructure? •Low impact design? •Urban design for mitigation and adaptation?
Equity	Are environmental and social justice included? Are priorities set based on areas and individuals with highest vulnerability?
Food	Are food systems considered part of planning for climate change? Are local food protection and the protection of agricultural lands promoted?
Transportation	Is planning based on land-use patterns and infrastructure that reduces car use and ensures that public and active transportation are viable alternatives?
Urban form	Is compact, mixed-use development a planning goal?

GGH Planning Policy Framework Evaluation

A myriad of approaches to climate change action is currently being undertaken by municipalities within the GGH. Some GGH municipalities have taken great strides in making connections between their land-use planning and climate change action, drawing upon international frameworks such as ICLEI's Building Adaptive & Resilient Communities (BARC) Program framework (for adaptation) as well as national ones such as FCM's PCP program (for mitigation). Of the ten municipalities studied, Oakville has one of the more progressive approaches, detailing mitigation and adaptation actions across all areas of municipal responsibility. Oakville has a separate climate change action planning process, with an official plan playing a supporting role. In other cases, such as Caledon, the official plan is the document where processes and policies for climate change action are set out. The result is that there is a myriad of approaches to climate change action within the GGH, suggesting that a more coordinated approach by the Province is needed to ensure equity and fairness in land-use decisions and climate change action across the region.

Provincial Policy Statement

Recent changes to the PPS (2014) represent a positive step toward the coordinated provincial approach discussed above. Planning in Ontario takes its cue from the PPS. While the *Planning Act* “sets out the ground rules for land-use planning”, the PPS is the “statement of the

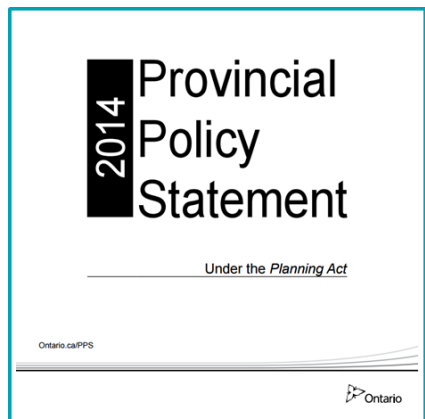


Image 7. The Provincial Policy Statement was updated by the Ministry of Municipal Affairs and Housing in 2014.

government's policies on land-use planning” and “all decisions affecting land-use planning matters ‘shall be consistent with’ the PPS”.⁴³ In practice, municipal official plans tend to closely reflect the structure and language of the PPS and so any revisions to the policy framework for the GGH begin with the *Planning Act* and PPS.

The PPS update released by the MMAH in 2014 puts new emphasis on mitigating and adapting to climate change when making planning decisions. Some key highlights related to climate change in the PPS, 2014 include requirements to:

- Consider the potential impacts of climate change (i.e. flooding caused by extreme weather events) and support efforts to reduce GHG emissions and climate change adaptation strategies.⁴⁴
- Establish more robust stormwater management requirements and encourage implementation of more green infrastructure (e.g. permeable surfaces).⁴⁵
- Support the re-use of infrastructure, and consider the full life-cycle cost of infrastructure.⁴⁶

The newly revised PPS recognizes that mitigation and adaptation strategies must be incorporated in development plans, which is a significant improvement. These revisions will

⁴³ Ontario Ministry of Municipal Affairs and Housing (MMAH). Provincial Policy Statement, 2014: Key Changes by Policy Area. 2014. Web. <http://www.mah.gov.on.ca/AssetFactory.aspx?did=10470>.

⁴⁴ *Ibid* at 3, policy 1.8.

⁴⁵ *Ibid* at 3, policies 1.6.2, 1.6.6.7.

⁴⁶ *Ibid* at 3, policies 1.6.1 and 1.6.3.

have a broad influence on land-use planning in the GGH as municipal official plans undergo statutory five-year reviews and are revised to conform to these updates.

Provincial Plans

The Provincial Plans are supportive of climate action but need updating. As discussed, the PPS and the suite of Provincial Plans governing land use in the GGH are based on an approach to sustainability, which was geared toward reducing the extent and impacts of urbanization on natural systems, especially the management of rainfall as “stormwater management systems” and related riparian habitats. In the recently released *Discussion Document for the 2015 Coordinated Review*, climate change is front and centre, with “climate change and building resilient communities” as a policy goal guiding the review. Although all of the Provincial Plans predate the Province’s climate change action plan (2007), the sustainability foundation of the plans already goes a long way to addressing climate change.



Image 8. Provincial plans reviewed in the development of this report.

The Provincial Plans together represent an integrated approach to sustainability planning—a policy approach that is exemplary in many ways of best practices found in other places—but the plans do not explicitly include climate change mitigation or adaptation policies, given that they predate the Province’s commitment to climate change action. With the exception of the NEP (from the 1970s), the plans were devised during the early 2000s, when there was a great deal of public concern for environmental issues, especially around urban sprawl. The Oak Ridges Moraine was the area of focus for the first provincial plan of this era to be adopted. But, when the plans were devised, the climate change discourse was just emerging. With the 2007 *Go Green Climate Change Action Plan*, climate change became a provincial priority, clearly identifying the Growth Plan and Greenbelt as an important part of the strategy for addressing climate change (albeit focused on mitigation).⁴⁷

Updating the plans to address climate change is an obvious next step. The Growth Plan and Greenbelt Plan together address mitigation through compact urban form and complete communities integrated with transit and natural heritage system planning. When the Growth Plan was released in 2005, it received awards from both the Canadian and American Planning Associations. At the time, it was recognized as a “landmark” plan with a “coordinated approach to sustainable growth and development, including the Greenbelt and related [Big Move]

⁴⁷ Government of Ontario. Go Green: Ontario's Action Plan on Climate Change. August 2007. Web.

infrastructure plan”. The 2015 Coordinated Review of the Provincial Plans provides a timely opportunity to make policy changes to these plans in support of climate action.

Table 8 below presents the evaluation of the PPS and Provincial Plans against the selected evaluation criteria. For the PPS and each plan, a checkmark denotes plan policies that meet the criteria and an “X” identifies gaps in policies. The gaps are discussed in detail in Appendix 3.

Table 8: Evaluation of PPS and Provincial Plans

Provincial Policy/Plan	Mainstreaming criteria	Planning built and natural environments criteria
Planning Act	<input checked="" type="checkbox"/> Climate change not identified as an area of provincial interest <input checked="" type="checkbox"/> Relationship of planning policy framework to provincial climate change action plan unclear	N/A
Provincial Policy Statement	<input checked="" type="checkbox"/> Climate change part of the policy direction for land-use planning <input checked="" type="checkbox"/> Integration of mitigation and adaptations actions with land-use policy framework is limited	<input checked="" type="checkbox"/> Strong links
Greenbelt Plan	<input checked="" type="checkbox"/> Greenbelt permanently protects agricultural and natural lands <input checked="" type="checkbox"/> Contribution to climate regulation not addressed	<input checked="" type="checkbox"/> Strong
Growth Plan	<input checked="" type="checkbox"/> Integrated approach to overall planning system	<input checked="" type="checkbox"/> Biodiversity, green infrastructure, LID and design outside of “green plans”, not addressed
Oak Ridges Moraine Conservation Plan	<input checked="" type="checkbox"/> Important contribution to climate regulation not included	<input checked="" type="checkbox"/> The basis of the ORMCP is a green infrastructure approach, whereby the natural systems collect and store water for the region <input checked="" type="checkbox"/> Language missing around green infrastructure, low impact development, and design
Niagara Escarpment Plan	<input checked="" type="checkbox"/> Contribution to climate regulation not included <input checked="" type="checkbox"/> Potential impacts to conservation and protection areas not addressed.	<input checked="" type="checkbox"/> NEP is based on limiting development to protect the “open landscape character” of the Escarpment. <input checked="" type="checkbox"/> Design considerations concern visual impact, not natural system function

Official Plans

A variety of approaches and levels of engagement with climate change adaptation and mitigation are found in the ten municipalities studied. Generally, these strongly support provincial involvement in setting appropriate minimum emissions standards and in providing guidance and resources to increase the integration of mitigation and adaptation across GGH municipalities.

The more progressive official plans are at the lower-tier level. For example, Oakville is sophisticated in its approach to climate change and provides an example of best practice that competes with any in the jurisdictional scan. Caledon's plan makes a strong link between climate action and conservation, while Ajax provides a sound, overall approach to addressing climate action throughout each policy section of its plan.

Of the single-tier city plans, Guelph's in-force official plan (reviewed) is progressive, but not as promising as the new climate change policies included in its new official plan amendment (currently under appeal at the Ontario Municipal Board (OMB)), which demonstrates quite a progressive approach, especially in energy. Hamilton's policies are reasonable but not as progressive as those found in Guelph's new OP amendment.

The upper tier plans are less successful as a whole, with Simcoe and Peterborough providing little real direction for action in their jurisdictions. Dufferin County focuses on its role as coordinator of land-use policy and discusses, in several places, the need for action, but with implementation at the local level. Niagara Region's plan makes little mention of climate change, which is surprising given the potential vulnerabilities of key economic sectors (i.e. wine production and tourism) and related landscapes within its jurisdiction. York Region's official plan reflects a progressive approach with sustainability as a cornerstone of its growth management approach.

Table 9 below presents a summary evaluation of municipal official plans against the evaluation criteria. For each plan a checkmark denotes plan policies that meet the evaluation criteria, and each "X" identifies a gap in policies. These gaps are discussed in more detail in Appendix 3.

Table 9: Evaluation of municipal official plans

Municipality	Governance structure	Official plan (date of most recent approval or consolidation)	Mainstreaming criteria	Planning built and natural environments criteria
York Region	Upper-tier	2013	<input checked="" type="checkbox"/> Climate change context for planning and in policies throughout the OP	<input checked="" type="checkbox"/> Strong
Niagara Region	Upper-tier	2014	<input checked="" type="checkbox"/> Climate change not part of vision and limited in OP	<input checked="" type="checkbox"/> Limited
Dufferin County	Upper-tier	2014 (draft)	<input checked="" type="checkbox"/> Climate change context for planning and in policies throughout the OP	<input checked="" type="checkbox"/> Limited
Peterborough County	Upper-tier	2014	<input checked="" type="checkbox"/> Criteria not strongly addressed	<input checked="" type="checkbox"/> Not strongly addressed
Simcoe County	Upper-tier	2007	<input checked="" type="checkbox"/> Criteria not strongly addressed	<input checked="" type="checkbox"/> Not strongly addressed
City of Guelph	Single-tier	2014*	<input checked="" type="checkbox"/> Climate change context for planning and in some policies	<input checked="" type="checkbox"/> Limited
City of Hamilton	Single-tier	2014	<input checked="" type="checkbox"/> Climate change not part of vision but addressed in some policies	<input checked="" type="checkbox"/> Strong
Town of Ajax	Lower-tier (Durham Region)	2012	<input checked="" type="checkbox"/> Climate change context for planning and in policies throughout the OP	<input checked="" type="checkbox"/> Strong
Town of Caledon	Lower-tier (Peel Region)	2014	<input checked="" type="checkbox"/> Climate change context for planning and in policies throughout the OP	<input checked="" type="checkbox"/> Strong
Town of Oakville	Lower-tier (Halton Region)	2014	<input checked="" type="checkbox"/> Climate change as context for planning and in policies throughout the OP	<input checked="" type="checkbox"/> Strong

*City of Guelph OPA 48 includes new policies for climate change but is under appeal at the OMB.

Table 10: Municipal climate change action

Municipality	Climate Change Action Plan or Strategy?	Emissions Inventory?	Community Energy Initiatives	Related framework*	Other Municipal Climate Change-related Strategies
York	No	(lower-tier Vaughan and Newmarket)	No	PCP	York Region Sustainability Strategy: Towards a Sustainable Region (2007) New Communities Guidelines (2013)
Niagara	Yes	Yes	No	PCP	Adapting to Climate Change: Challenges for Niagara (2012)
Simcoe County	No	No	No	(not ICLEI or PCP)	No
Peterborough (County)	No	No	Yes	PCP (not ICLEI)	Greater Peterborough Area Climate Change Scoping Document (2013)
Dufferin County	No	No	No	(not ICLEI or PCP)	No
Hamilton	Yes	Yes	No	ICLEI/PCP	Climate Change Vulnerability Background Study (2004) Hamilton Climate Action Charter (2011)
Guelph	No	Yes	Yes	ICLEI, PCP	Community Energy Plan (2007)
Caledon	Yes	Yes	No	PCP	Peel Climate Strategy (2011)
Oakville	Yes	Yes	(in process)	ICLEI PCP	Climate Change Primer (2014) Environmental Strategic Plan (2011) State of the Environment Report (annual) Community Sustainability Plan (2014)
Ajax	No	Yes	(Downtown)	ICLEI (Durham Region, PCP)	Integrated Community Sustainability Plan (2014)

*Source: ICLEI (International Local Governments for Sustainability), FCM PCP program and municipal website.

Policy Direction and Guidance

The PPS states, “[g]uidance material and technical criteria may be issued from time to time to assist planning authorities and decision-makers with implementing the policies of the Provincial Policy Statement. Information, technical criteria and approaches outlined in guidance material are meant to support but not add to or detract from the policies of the Provincial Policy Statement”.⁴⁸

The project team compiled and reviewed a list of guidance documents produced by provincial ministries, conservation authorities and regional and local municipalities to guide municipal land-use policy-making and development review. The full list of documents consulted can be found in Appendix 3. A summary discussion addressing some of the key findings from select documents reviewed is provided below.

The project team started with the overarching provincial climate change planning documents. The Province introduced its approach to climate change in 2007 with the *Go Green: Ontario's Action Plan on Climate Change*. It has since been followed by the *Climate Ready: Ontario's Adaptation Strategy and Action Plan* in 2011. Together, these meet the “mainstreaming” goals of the evaluation criteria. Action planning, energy, research, resilience and technology are all addressed by these plans and strategies. The challenge is to clarify the relationship between provincial action plans and strategies and the land-use planning framework.

The project team reviewed guidance documents addressing planning in the Lake Simcoe watershed, including the Lake Simcoe Climate Change Adaptation Strategy (Draft, 2013) and Lake Simcoe Protection Plan in 2009, and found them to be aligned with the “paradigm shift” evaluative criteria, particularly relating to climate adaptation. In taking a watershed scale approach, these documents address and support protection of the natural heritage system and the resilience benefits that the system confers.

The guidance for environmental assessments does not meet many of the evaluation criteria, either for the overall recognition of the paradigm shift, or planning the built and natural environment. Given that environmental assessments at the municipal level often are undertaken for infrastructure projects to facilitate growth and development, a solid understanding of how alternatives should be evaluated against mitigation and adaptation criteria are missing. Similarly, municipal asset management plans need to be considered in light of adaptation especially, as set out in *Building Together: Guide for Municipal Asset Management Plans* (2012).

Ontario's housing strategy does not consider climate change as an issue for affordable housing. *Building Foundations: Building Futures, Ontario's Long-Term Affordable Housing Strategy* is dated quite recently, in 2013, and so it is surprising. At a minimum, the link between affordable housing and the vulnerability of lower-income residents should be addressed and discussed. Affordable housing should not be built in areas of high climate change impact. We recommend that a land-use designation for areas of high climate change vulnerability be included in the PPS for just this reason.

⁴⁸ Ontario Ministry of Municipal Affairs and Housing (MMAH). Provincial Policy Statement, 2014. 2014: 3. Web. <http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463>.

Two existing “reference manuals” are of key importance to climate change action. The Ontario Ministry of Natural Resources and Forestry’s *Natural Heritage Reference Manual* (2010) and the MOECC’s *Stormwater Management Planning and Design Manual* (2003) (Stormwater Manual) are both used extensively by planners to prepare and evaluate policies and development proposals. The Natural Heritage Reference Manual is very comprehensive and is consistent with many of the recommendations made by the project team in Section IV. Similarly, the Stormwater Manual lays out the reasons why stormwater needs to be managed in a preventative manner at the site-level. The disconnect appears to be in the enforcement of these guidelines in the development review process.

The Toronto and Region Conservation Authority’s (TRCA) *Living Cities Policies*, 2014, is, in our opinion, the benchmark for linking climate change and land-use planning, this conclusion was reached after the project team reviewed at least 200 documents on climate change, most of which have been produced in the last ten years. The TRCA has “regulatory jurisdiction over nine watersheds” and the most urbanized areas of the GGH. The TRCA’s mandate is “to undertake watershed planning and management programs that prevent, eliminate, or reduce the risk to life and property from flood hazards and erosion hazards, as well as encourage the conservation and restoration of natural resources”.⁴⁹ The TRCA’s mandate mirrors some of the more important climate change action areas identified in this project. The TRCA also has an advocacy role as “a public commenting body, watershed resource management agency, service provider”⁵⁰ and because of this wide approach, its work addresses all of the evaluation criteria.

With respect to the full suite of guidance documents reviewed, the project team has found that the large volume of information, and its fragmentation across numerous documents, is likely to be overwhelming for municipal planners and other staff. The many different bits and pieces tend to be targeted toward the responsibility of specific policy areas and/or the responsibility of different actors but may actually be working against the need for a more integrated approach to climate change action (and land-use planning, generally).

Gaps in GGH Land-Use Planning Framework

The policy review concludes that there are seven gaps in the current planning framework related to action planning, research, implementation, energy, vulnerability and compact form versus environmental design and education.

1. Gap between Ontario’s climate change action plan and current land-use planning framework

What emerged from the review was a lack of a unified approach to climate action across the GGH.

The “Action Planning” set of evaluation criteria was one of the most useful in the review as it enabled us to consider how climate change action is generally reflected in policy documents. There is a myriad of approaches to climate change action with no clear direction.

⁴⁹ Toronto and Region Conservation Authority (TRCA). The Living City: Policies for Planning and Development in the Watersheds of Toronto and Region Conservation Authority. November 2014: s. 3.1.
Web. <http://www.trca.on.ca/dotAsset/200582.pdf>.

⁵⁰ *Ibid* at 39.

A key decision to be made by the Province is the relationship between the provincial climate change action strategy and the Planning Act and PPS. Given that climate change actions are required across all sectors of the economy and society, we believe the Province's climate change action strategy acts as an umbrella policy direction and the *Planning Act* and PPS deal with land-use aspects of climate change mitigation and adaptation. The relationship between climate change action plans is more acute at the local municipal level, where some municipalities have already approved climate change action plans: the relationship between such action plans and official plans in development review is unclear.

While the provincial GHG reductions targets are arguably aligned with what the literature suggests is necessary to address climate change, the radical action needed to achieve these targets is not currently reflected in the GGH land-use planning framework.

2. Gap between evidence and data

The lack of evidence to support climate action emerged as a significant barrier. Each provincial plan includes a policy regarding monitoring of performance measures. Official plan policies refer to the need for data to be provided by the Province to support monitoring but longitudinal data, in many cases, does not seem to exist, or at least downscaled climate data and projections useful to local municipalities does not exist. Reducing emissions requires the ability to track success in reductions and improving stormwater management requires forecasts of extremes in water flow and the ability to monitor and respond. Adaptation actions require solid research; up-to-date, dependable data and technical information are required to support action planning, especially for stormwater management.

3. Gap between policies and implementation

While policies promoting and encouraging sustainable land uses have been in place in the GGH for years, implementation of those policies through the planning and development approvals process is uneven.

Weak policy language leaves much to interpretation and negotiation in the development process. The choice of language in the PPS and official plans purposefully distinguishes between types of policies in terms of implementation. As the PPS states, "There is some discretion when applying a policy with enabling or supportive language [for instance the words 'should', 'promote', and 'encourage' are enabling] in contrast to a policy with a directive, limitation or prohibition [e.g., the phrase 'shall not be permitted' is prohibitive with little room for discretion on the part of planners and decision-makers in the process]".⁵¹ In practice, if a planning matter has not been set out in the PPS as being a provincial interest, it is difficult to defend and implement at the local level. If, at the local level, climate action is only "encouraged" or "promoted", then there is a high likelihood that an uninspired proponent will not meet the spirit of the policy, compared to a policy where action is "required".

Funding for infrastructure, especially transit, occurs outside of the planning process. Provision of transit infrastructure, and active transportation infrastructure, require investment and coordination. The gap between policies and implementation is a funding one, which is strongly identified as an area of concern in the literature.

⁵¹ MMAH. PPS, 2014: 2. Web. <http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463>.

4. Gap between energy and planning

Land-use decisions affect the use of energy in a given community. The planning policy framework encourages “energy conservation”, including energy reduction through transit use and active transportation, green building practices, inclusion of renewables and district energy in development, and reduction of trip distance through compact urban form. The potential for linking energy reduction to land-use planning decisions is exemplified by Guelph’s Community Energy Plan, where integrated approaches to various types of land-use designations, seems to be a way forward for upper- and single-tier communities across the GGH.

5. Gap between land-use designations and areas of highest vulnerability to climate impacts

Addressing climate vulnerability and building resilience is described in the literature and best practices in other jurisdictions as “climate proofing”. “Special policy areas” in Ontario often identify where historic settlement in floodplains are still important urban areas where revitalization is in the public interest, despite flood risk. While new or intensified development is not permitted in these areas, there is no requirement to assess the risk and vulnerability of these areas under future climate scenarios and develop “climate proofing” strategies. Indeed, assessments of vulnerability to climate impacts are not well addressed in the existing planning framework.

6. Gap between compact urban form and environmental design

Trade-offs between mitigation and adaptation emerge where compact urban form is at odds with best practices in environmental design. On one hand, planning policies should support compact urban form to reduce car travel. On the other hand, policies to protect natural heritage systems and agricultural lands are foundational to climate regulation, not only at the scale of the urban region, but in terms of localized flooding and microclimate moderation of urban heat island effects. Indeed, moving to a system where water, wastewater and stormwater management depend on green infrastructure rather than engineering solutions is needed. For example, when “leapfrog development” is permitted to occur outside of intensification areas and beyond the Greenbelt area, the Greenbelt Plan (or at least the planning framework that permits leapfrog development) is criticized for extending the commuting distance between communities on either side—increasing the potential for emissions, in spite of the Greenbelt’s important role in climate regulation and urban containment. Similarly, intensification proposals in urban areas may assume that achieving higher densities is a greater policy concern than, say, space-intensive stormwater management. The planning policy framework does not provide guidance to balance the tension between compact form and greater space for green design.

7. Education gap

Mainstreaming climate change in the GGH planning framework will not occur until planners are educated about climate change and their role in mitigation and adaptation action. Planners are leaders in public education and consultation, can be influential in their municipalities and are well positioned to be champions of climate action.

In conclusion, land-use planning is one area of action required as part of mainstreaming climate change across all aspects of provincial and municipal responsibilities. We have used the main substantive focus areas identified in the literature to evaluate the existing policy framework in the GGH. While much has already been done, we have identified gaps in the policy framework and offer recommendations in the next section to address them.

IV. RECOMMENDATIONS FOR LAND-USE PLANNING AND POLICY REFORM TO COMBAT CLIMATE CHANGE IN ONTARIO

This report proposes a variety of recommendations to reduce GHG emissions and encourage adaptation through land-use planning tools available to Ontario. These recommendations draw on the key linkages between land-use planning and climate change identified in the literature review (Section I), the best practices compiled in the jurisdictional scan (Section II) and the major gaps in Ontario's current planning framework uncovered in the policy and plan review (Section III). Following identification of key linkages, best practices and gaps, a central challenge was applying lessons that were either theoretical or based on other jurisdictions to the specific policy framework in the area governed by the Provincial Plans.



Figure 1: Hierarchy of recommendations

The project team first identified seven policy directions that show the most potential to effectively achieve Ontario's climate objectives and support climate change mitigation and adaptation in the areas governed by the Provincial Plans. Policy recommendations were chosen to represent high-level goals based on literature, other jurisdictions and gaps, and to provide a framework for more detailed, specific recommendations. For each of the seven policy directions, the project team then developed an extensive list of detailed recommendations. Recommendations are subdivided into specific plan amendments, which focus on changes to the wording of the Provincial Plans and their enabling statutes and implementation recommendations, which provide a broad range of related actions, policy changes and tools that could support the applicable policy direction. The full list of recommendations, along with data relevant to implementation including related Provincial Plan sections, other applicable legislation and policy, relevant actors and other policy objectives addressed (based on the substantive focus areas set out in Section I) are provided in Appendix 4.

This section highlights the highest priority recommendations, based on their potential to achieve Ontario's climate change objectives, considering the barriers and gaps in Ontario's current planning framework they intend to address, and demonstrating how best practices from other jurisdictions could be applied in the Ontario context.

Policy Direction 1—Mainstream climate change considerations in Ontario's land-use planning framework. Incorporate and integrate climate change mitigation and adaptation objectives and policies established by Ontario's Climate Change Strategy and the PPS into each of the covered four Provincial Plans and any municipal land-use plans governed by the Growth Plan for the Greater Golden Horseshoe.

The literature review identified *action planning* as a key focus area for addressing climate change through land-use planning. Developing and adopting strong objectives for adaptation and mitigation and, where possible, mainstreaming climate change into management and decision-making at all levels of government are important steps in achieving improved climate change outcomes.

As discussed in Section III, regulatory and technical guidance from the provincial government on incorporating climate change into planning frameworks would motivate further action and help identify synergies between mitigation and adaptation goals. The recommendations under this policy direction therefore encourage the Province and municipalities to set clear climate change objectives in their policies and planning documents, including the *Planning Act*, the Provincial Plans, existing municipal plans and new municipal climate change plans. In doing so, these recommendations also address the major gap between Ontario's climate change action plan and current planning framework identified in our policy review.

Recommendations under this policy direction seek to overcome barriers relating to policy and information for planners and siloed implementation and address the education gap experienced by many Ontario planners by prescribing a clear policy framework, detailed climate change guidance, outreach and training to municipalities, and the facilitation of resource-pooling and information-sharing through communication and linking initiatives. Recommendations also incorporate best practices of increasing collaboration between government jurisdictions both vertically (province-region-city) and horizontally (city-to-city and across provincial ministries and municipal departments), as well as considering infrastructure and vulnerable populations in climate change planning, risk assessment and asset management.

The highest priority recommendations under this policy direction are as follows:

- **The Province should incorporate quantitative and qualitative climate change-related indicators into the performance-monitoring frameworks for Provincial Plans and the PPS.** Municipalities will then incorporate these performance indicators into their municipal official plan performance-monitoring framework, as they are required to conform their official plans to the Growth Plan. In designing the indicators, the Province should ensure the indicators work on a municipal scale but can also easily roll up into a regional reporting scale. See Section V for a recommended climate change performance-monitoring framework developed as part of this project. (Recommendation 1.2)

- **The Province should require municipalities to develop climate change plans.** Such plans should: (a) quantify GHG emissions located within their borders; set out

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ #2 Gap between evidence and data
- ❖ #3 Gap between policies and implementation

emissions reduction targets and timelines, including from private transportation and buildings; allocate responsibility; and develop strategies to achieve targets; and (b) identify populations, areas and infrastructure of highest climate vulnerability; set targets and timelines for reducing vulnerability; allocate responsibility; and develop strategies to achieve targets. The Province should also require municipalities to report against their plans using the climate change performance measures discussed above periodically (i.e. as part of official plan reviews). Municipalities should prepare climate change plans in coordination with official plans and strategies such as transportation plans, watershed plans, natural heritage

plans, infrastructure master/asset management plans to ensure climate change considerations are incorporated into those plans and strategies as well. (Recommendation 1.3)

Policy Direction 2—Require the development of compact, location-efficient communities (development that is a convenient distance from workplaces, amenities, stores and urban hubs; has access to and provides the densities needed to support various modes of rapid transit; enables short commute times; and contains realistic opportunities to use transit and active transportation, allowing for improved transitions between modes).

Because of the important role played by transportation and urban form in Ontario's GHG emission profile, both were identified as priority areas of focus in achieving climate change objectives through land-use planning. Indeed, reducing personal vehicle use through the development of compact, mixed-use, location-efficient communities can significantly increase density, reduce sprawl, improve air quality and reduce transportation GHGs.

Fixing the GGH's snarled traffic and high vehicular GHG emissions will not be easy. A major barrier to progress under this policy direction is public attitudes (as identified in Sections I and II) and a historical prioritization of personal vehicular transportation over other modes. Other barriers include a lack of clarity and communication on the importance of local and regional actions for achieving national and global GHG reduction objectives, the cost and time associated with planning and building transportation infrastructure and the fact that a great deal of residential and employment lands have already been developed without any meaningful access to higher-order transportation or active transportation opportunities—all in the context of enormous growth in some key areas.

A special concern that arose out of our expert consultations is the status of concentrated employment lands with no convenient access to higher-order transit:

“The suburban municipalities, often referred to as ‘the 905’, (33% of the region) have enjoyed the greatest amount of growth in the region over the past 20 years. This submarket is characterized by concentrations of office space located in industrial/office parks, such as Meadowvale, Airport Corporate Centre, the Burlington-Oakville corridor, and the 407/404 cluster. Taken as a whole, the clusters of office space in these highway-dependent locations now collectively exceed the size of the Financial Core. These clusters enjoy few of the value-added amenities of the Financial Core, and to a lesser extent the Toronto transit-oriented, and Toronto non-transit, submarkets. The location of 66-million ft² of office space in this submarket (more than Calgary and Edmonton combined), accommodating in excess of 325,000 office workers, is the single largest contributor to congestion on GTA highways.”⁵²

Encouraging compact development is also an important tool in protecting green spaces and green infrastructure generally from being lost to sprawl, an objective that is fundamental to meeting Ontario's climate change adaptation objectives. As we note in Section I, however, compact, intensified development can also conflict with adaptation objectives, particularly if it is located in areas of high flood risk or if it is designed and located without adequate attention to key green infrastructure, such as permeable surfaces, bioswales and adequate shade.

Recommendations related to this section include a variety of ideas designed to approach transportation-related emissions from as many angles and incorporating as many best practices from other jurisdictions as possible. They are targeted at halting sprawl and increasing intensification, which will help create the densities required for transit, while also reducing the distance over which people and goods need to move. Many of the implementation recommendations associated with these policies incorporate best practices identified in Section II, including incentives and financing such as development charges and property taxes, as well as coordination and collaboration with other actors such as the development industry and local planning authorities.

The highest priority recommendations under this policy direction are as follows:

- **Stop or dramatically limit sprawl and contain the outward expansion of urban built-up area of the GGH into greenfields by taking one or more of the following approaches:**
 - Requiring the 2041 growth forecast to be accommodated within existing designated greenfield and built-up areas (i.e. no further urban expansion pending next ten year review).
 - Prohibiting any new greenfield designation.
 - Establishing clear, permanent settlement area boundaries for municipalities within the Growth Plan area such that settlement areas cannot be expanded through municipal comprehensive reviews.

⁵² Canadian Urban Institute. The New Geography of Office Location and the Consequences of Business as Usual in the GTA. March 2011: 5. Web. <http://www.toronto.ca/legdocs/mmis/2012/pg/bgrd/backgroundfile-43264.pdf>

- Alternatively, amending the Growth Plan to prohibit expansion of the settlement area within any municipality that has not achieved its (increased) minimum density and intensification targets.
- Conducting or causing to be conducted a review of the metrics for what constitutes “major office” and, if supported, reducing the threshold for lands classified as “major office” under the Growth Plan to include lower area and minimum jobs thresholds.
- Adding a definition for “major institutional” development under the Growth Plan.
- Prohibiting any new major office/major institutional uses outside identified intensification areas or areas with existing/planned transit (e.g. urban growth centres, major transit station areas, intensification corridors). (Recommendation 2.1)

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ # 6 Gap between compact urban form and environmental design

- **Increase density targets in urban growth areas and create density targets for employment lands** that support appropriate mixed-use and transit (consider conforming to transit-supportive densities set out in the Province's transit-supportive guidelines). (Recommendation 2.5)

- **Set minimum density targets for major transit station areas and intensification corridors** via the Growth Plan. To this end, the Province could also develop rules that substitute a provincial density permitting scheme that will achieve targets within a fixed

Strategies Legend	Transit service type	Suggested minimum density
Green Action	Basic Transit Service (One bus every 20-30 minutes)	22 units per ha / 50 residents & jobs combined
Applicable Community Scale	Frequent Transit Service (One Bus every 10-15 minutes)	37 units per ha / 80 residents & jobs combined
Small	Very Frequent Bus Service (One bus every 5 minutes with potential for LRT or BRT)	45 units per ha / 100 residents & jobs combined
Mid-size	Dedicated Rapid Transit (LRT/BRT)	72 units per ha / 160 residents & jobs combined
Large	Subway	90 units per ha / 200 residents & jobs combined
Big City		
Planning Scale		
Site		
District		
Municipal		
Regional		

The table above illustrates suggested minimum density thresholds for areas within a 5-10 minute walk of transit capable of supporting different types and levels of transit service. The thresholds presented are a guide and not to be applied as standards. Other factors such as the design of streets and open spaces, building characteristics, levels of feeder service, travel time, range of densities across the network and mix of uses can also have a significant impact on transit ridership. Mobility hubs and major transit station areas may require higher minimum densities.

Figure 2: Minimum transit-supportive densities (adapted from MTO's Transit –Supportive Guidelines, 2012)

area of major transit station areas and intensification corridors for municipalities that fail to meet their targets within a specified time period (e.g. five years). Density targets could be set and achieved in coordination with the Ministry of Transportation, GO Transit and Metrolinx. This recommendation is vital to ensuring the Province receives value for its large

transit investments, since achieving sufficient density is a major factor in determining the utilization of higher-order transportation assets. (Recommendation 2.8)

- **Take action on key suburban employment lands such as areas surrounding Pearson Airport, the 404/407 and Vaughan** by specifically designating them and requiring a re-urbanization strategy to retrofit these areas in a way supportive of plan objectives: for instance, supporting the development of public transit and active transportation through employment infill, mixed-use/residential infill, active transportation and a transit strategy. GO Transit, Metrolinx and local transit providers would likely be partners in carrying out this recommendation, as would municipalities. (Recommendation 2.9)
- **Amend the Growth Plan to recognize that significant concentrations of office space exist outside of the designated growth centres, and need to be integrated into transit planning.** The Province should work with local municipalities in the GTA to adjust priorities and fine-tune the planned roll-out of rapid transit projects to better connect to the approximately 108 million square feet of office space that are currently dependent on automobile access. Consider also requiring all new free-standing offices to locate in urban growth centres, or around/along major transit stations areas or intensification corridors. (Recommendation 2.12)

Policy Direction 3—Encourage urban design features and the layout of major land uses (e.g. institutions, green space, commercial areas) that support higher-order transit and active transportation.

Because of the large impact of transportation-related emissions on Ontario's GHG profile, prioritizing public transit and active transportation is an important tools to achieve climate change mitigation objectives through land-use planning. Our literature review and jurisdictional scan indicated that improved urban design is a key component of creating effective, usable higher-order public transportation and active transportation systems (see Table 4 in Section I above).

Barriers to increasing the modal share of higher-order transit, walking and cycling include negative public attitudes and low political support, as well as a lack of best practices guidance, which has historically led to planning focused primarily on personal vehicular use, which locks in high transportation-related GHG emissions. Recommendations in this section include providing strong, unequivocal guidance that we need to plan for and prioritize low-GHG emitting higher-order and active transportation if Ontario is ever going to successfully reduce its transportation-related emissions.

Recommendations also draw on our findings from the jurisdictional scan to integrate best practices from comparable jurisdictions. While many readers may be familiar with the extraordinarily efficient and convenient cycling infrastructure in Northern European active transportation hubs like Amsterdam and Copenhagen, they may not be aware that a number of North American cities have also made significant investments in cycling infrastructure and

comfortable, convenient transit stations (see for example, our profile of Calgary). We recommend that Ontario adopt some of the best practices these jurisdictions have put into place: for instance, by focusing on infrastructure that enhances the comfort, safety and efficiency of higher order and active transit and using fiscal tools such as parking fees and road pricing to support better urban design outcomes, such as well maintained stations and bicycle paths and bicycle parking facilities.

The highest priority recommendations under this policy direction are as follows:

- **Clearly prioritize public and active transportation in planning and investments by adding a passenger transportation hierarchy into the Growth Plan** to guide transportation infrastructure planning and major transportation investments by municipalities, municipal planners and transportation authorities. The hierarchy could be modeled off of the hierarchy in the Big Move and should prioritize active transportation and public transportation over personal vehicular use. (Recommendation 3.1)
- **Require municipalities to develop minimum bicycling parking requirements** for residential, employment and commercial centres in new developments, clearly signaling that the Province places a priority on low-carbon active transportation. (Recommendation 3.6)

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ # 4 Gap between energy and planning
- ❖ # 6 Gap between compact urban form and environmental design

Policy Direction 4—Require, integrate and support community energy planning (including district energy, renewable energy generation and energy efficiency) into our land-use planning framework (e.g. integrated planning, codes, standards and permitting and voluntary incentives such as density bonusing and credits).

The literature review (Section I) identified energy and technology as key focus areas for addressing Ontario's climate change objectives. Emissions from energy use, including for heating and cooling buildings, make up a large part of Ontario's climate change emissions profile. Inefficient energy use (particularly fossil fuel energy use) can also have serious air quality issues, which represent a major adaptation risk. Reducing fossil fuel consumption through energy efficiency and low-carbon energy planning and facilitating the deployment of technologies that advance mitigation and adaptation goals in buildings, transportation and utility systems are vital to building a clean energy future. Significant work is required, however: our policy review highlighted a gap between energy and planning and indicated that community energy planning needs to be better integrated into Ontario's broader land-use planning framework.

In each of these cases, land-use planning can play a key role in helping Ontario meet its climate change objectives of reducing GHGs emissions from energy generation and use, and increasing resilience to energy price shocks and air quality issues. Some opportunities already being used to reduce the impact of energy use on a community scale include integrated community energy planning, district energy programs and greater use of local renewable energy generation and passive heating.

One of the main barriers to progress on community energy use in Ontario relates to siloed implementation of energy policies and planning. Traditionally, energy planning has been seen as the responsibility of utilities, the provincial government and various regulatory bodies and/or Crown corporations, while many important opportunities, such as district energy and community energy planning, require significant municipal involvement to succeed, because they are so tied to the spatial layout of users. Another challenge is one of know-how: many municipal planners are not yet experienced at integrating energy use and renewable energy opportunities into planning decisions.

Recommendations to support better community energy planning under this policy direction seek

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ # 4 Gap between energy and planning

to overcome barriers and articulate best practices for covered municipalities, including coordination and collaboration with renewable energy developers, making use of incentives such as density bonusing and credits, and focusing on infrastructure that improves energy efficiency and ensures electric vehicle readiness.

The highest priority recommendation under this policy direction is as follows:

- **Require municipalities to prepare community energy plans (CEPs)** that promote energy conservation, the deployment of low-carbon electricity and district thermal energy and enhance electricity system resilience to extreme

weather events. The Province should also require municipalities to incorporate CEPs into their land-use planning. (Recommendation 4.1)

Policy Direction 5—Protect and enhance green infrastructure (natural and built), through land-use planning and through the use of offsets and other crediting mechanisms that provide economic incentives for the preservation, establishment and maintenance of natural heritage features and supportive green technologies that sequester carbon and help build resilience to extreme weather.

“Green infrastructure” is defined in the PPS as “natural and humanmade elements that provide ecological and hydrological functions and processes. Green infrastructure can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and

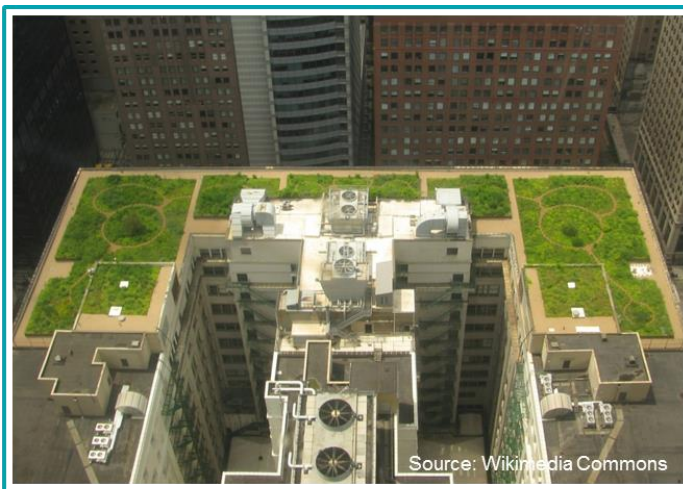


Image 10. Example of green roof on Chicago City Hall.

green roofs.” Our literature review identifies *resilience* as a key focus area for climate change planning and indicates that protecting and increasing green infrastructure can play a key role in climate change adaptation (for example, by supporting flood stormwater management, improving resilience of natural heritage and agricultural lands, supporting biodiversity and cooling cities in the summer). Green infrastructure can also include the provision of mitigation related actions, such as carbon sequestration in forests and green roofs.

Barriers to the effective implementation of green infrastructure include informational barriers and best practices guidance. For instance, Ontario planners may lack familiarity with green infrastructure and the value of ecological and hydrological functions and processes. They may also need further guidance regarding which areas are most vulnerable and which types of natural systems are most effective at reducing emissions. Moreover, the costs and benefits of green infrastructure are poorly understood compared to the well-known costs and benefits of development—which results in a tendency to favour development.

The best practices engaged in the recommendations under this policy direction include a focus on natural systems, such as policy amendments that seek to enhance protection and encourage re-naturalization of key natural heritage and water resources. Incentives and financing mechanisms are also proposed, including crediting mechanisms and tax breaks that incentivize the preservation and re-naturalization of certain types of land such as marginal farmland and key waterways.

The highest priority recommendations under this policy direction are as follows:

- **The Province should consider boundary expansions for the Greenbelt** that would achieve climate change adaptation objectives such as green infrastructure, flood control and food security; foster connectivity; and promote mitigation of GHGs through intensification (providing a limit on sprawl) and by preserving natural heritage assets that sequester carbon. The best candidate areas for boundary expansions will be consistent with the vision and goals of the Greenbelt Plan, connect to current Greenbelt systems and complement the goals of the Growth Plan. From a climate change and flood prevention perspective, lands that are high-priority for including in expansion include:
 - Significant source water areas and urban river valleys.
 - Systems within watershed headwaters that have little Greenbelt protection.
 - Middle reach areas of river and stream systems where the headwaters and downstream areas are currently within the Greenbelt; and
 - Lands identified as part of natural heritage systems and refined in watershed plans. (Recommendation 5.2)
- **Develop protections for green infrastructure in areas within the GGH but not covered by the Greenbelt Plan, ORMCP or NEP.** Identify and develop new policies (over and above the provisions in the PPS) to protect natural heritage, water resource and agricultural systems, as well as specific features such as wetlands, forests, headwaters and recharges areas and in these regions. Prioritize lands with the highest ecosystem service values. (Recommendation 5.3)

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ #5 Gap between land-use designations and areas of highest vulnerability to climate impacts.
- ❖ #6 Gap between compact urban form and environmental design

Policy Direction 6—Require improved stormwater management through protection, enhancement and/or construction of new permeable surfaces, run-off control, low-impact development (LID) and green infrastructure (including updating of provincial stormwater management standards).

Because of climate change's potentially profound impact on flooding in municipalities across the globe, our jurisdictional scan indicated that climate change leaders across the world are taking dramatic action to improve stormwater management. Such improvements are made not just by investing in traditional stormwater infrastructure, but also by managing water onsite, through LID and through more adaptive infrastructure design. Indeed, our literature review identified *environmental design* as a key focus area in climate change planning, including constructing,

rehabilitating and maintaining green infrastructure and LID to support infiltration and water management and reduce flood risks.

Some of the barriers to improved stormwater management are similar to those relating to green infrastructure. Policymakers and planners may lack of experience with tools like LID at the regulatory level and are unclear with respect to its potential effectiveness in reducing climate change vulnerability. In fact, one of the greatest barriers to LID is the uncertainty of its reliability and ability to withhold larger storm events, particularly because the functionality of LID depends on the substrate upon which it is constructed. Best practices guidance is also needed from the Province and other jurisdictions.

In general, recommendations in this section focus on providing the tools and requirements to explore and encourage the use of LID and green infrastructure to manage water onsite. They incorporate best practices relating to natural systems, ensuring the protection of landscapes that are important for water retention and the safe passage of floodwaters. They also hone in on infrastructure and vulnerable populations, requiring that LID and climate change resilience are incorporated into new infrastructure and assessing risks to and impacts in highly vulnerable and populated areas. Finally, the recommendations also engage best practices relating to incentives and financing, encouraging municipalities to recover costs of sewage works and develop stormwater rate systems.

The highest priority recommendations under this policy direction are as follows:

- **Amend Provincial Plans to define and include as a clear objective low-impact development** that manages stormwater runoff at source and increases resilience throughout the affected watershed. (Recommendation 6.1)
- **Require planning for stormwater management to incorporate resilient, redundant and fail-safe measures** that will function effectively in a future environment of unpredictable extreme rainfall. (Recommendation 6.2)
- **Require municipalities to recover the full cost of sewage works** (as defined in the *Ontario Water Resources Act*), including long-term operations and maintenance of stormwater management facilities. (Recommendation 6.4)
- **Amend Provincial Plans to require municipalities to incorporate LID and climate change resilience into new infrastructure and urban design**, including roads and buildings, as well as retrofits. Link requirement with funding opportunities to support implementation. (Recommendation 6.8)
- **As part of any expansion of the urban boundary and any major urban redevelopment, watershed and subwatershed plans should be updated** to assess the cumulative impacts of development and climate change, in light of the most up-to-date climate science. (Recommendation 6.3)
- **Require that stormwater management plans and processes target maintenance of the natural hydrologic cycle** by managing stormwater runoff at source and preventing

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ # 3 Gap between policies and implementation
- ❖ #5 Gap between land-use designations and areas of highest vulnerability to climate impacts.
- ❖ #6 Gap between compact urban form and environmental design

increases in the quantity of runoff from developed lands. Ensure that areas of the landscape that are important for the natural retention and filtration of water (e.g. wetlands) and for the safe passage of floodwaters (e.g. floodplains) are protected, restored and enhanced to ensure their effective function. (Recommendation 6.6)

Policy Direction 7—Provide tools that encourage effective and collaborative adaptation planning by local and regional governments, including updated climate impacts research, updated floodplain mapping, future climate scenarios and requirements to develop climate change risk inventories and adaptation implementation plans.

A key theme from our overview of Ontario's planning framework, as well as the literature review is that, to be effective, climate change adaptation planning must be integrated, involving actors ranging from provincial policymakers and regulators across ministries, municipal planners and conservation authorities—all of whom have an important role to play in identifying risks and opportunities associated with adaptation. The literature review identified *research* as a key focus area at the intersection of climate change and planning. A barrier common to many best practice jurisdictions around the world is getting the right people and information to the right places and avoiding siloed implementation of policies and practices. Specifically, the complex multi-departmental nature of climate change risks, as well as the difficulty in locating sufficiently granular climate change adaptation data can challenge even the most committed municipalities.

In light of this, the recommendations focus on collaborative research and information-gathering to address the gap between evidence and data identified in our policy review, combine regional oversight with on-the-ground know-how, and ensure that the research necessary for planning and monitoring climate change action in land-use approvals and decision-making is collected and shared. They promote the use of educational outreach and new technologies, and incorporate best practices related to guidelines and toolkits such as updating technical guidance on flood hazard management. Informed by leading jurisdictions, the recommendations pay special attention to vulnerable populations, prioritizing the most critical areas for updating floodplain maps and restricting municipalities from permitting development in high risk zones.

The highest priority recommendations under this policy direction are as follows:

Gaps in Ontario's Current Framework Addressed by Recommendations:

- ❖ #1 Gap between Ontario's climate change action plan and current planning framework
- ❖ #2 Gap between evidence and data
- ❖ #3 Gap between policies and implementation
- ❖ #7 Education gap

- **Require local planning authorities to use updated mapping of hazardous (flood-prone) lands and sites (including appropriate buffers) to designate appropriate zoning for these areas in municipal planning documents.** Flood hazard mapping should be extended to include urban flood zones as well as riverine flood hazards and should consider

both existing and future extreme weather risks. Restrict municipalities from permitting development in “flood fringe” and “spill zone” areas (especially in light of outdated floodplain maps). Consider requiring new greenfield development and redevelopment affecting flood-prone areas to examine options for hazard remediation. (Recommendation 7.1)

- **Provide adequate and ongoing support and funding to local planning authorities for floodplain maps to be updated** on a regular basis and in accordance with the best available information. (Recommendation 7.3)

V. MONITORING PERFORMANCE OF NEW AND EXISTING POLICIES AND IMPLEMENTATION STRATEGIES

Introduction

Building on the findings established in the literature review, jurisdictional scan and Ontario policy review, indicators and metrics are suggested to help the Province and GGH municipalities understand whether climate change adaptation and mitigation actions within the realm of land-use planning are achieving desired outcomes. These indicators help to contextualize priority policy directions by identifying critical performance areas in which progress needs to take place to transition to low-carbon climate resilience in the GGH. The team also identified thresholds or targets associated with metrics where there was support from the literature reviewed.

Selecting Performance Metrics and Indicators

Prior to identifying appropriate indicators, metrics and potential thresholds, the project team sought to establish a clear understanding of the language used to define indicators, metrics, indicators and thresholds. The following concepts are used in the context of this section:

1. **Indicators:** Key variables that represent the relationship between land-use planning and climate change mitigation and adaptation. The main function of indicators is the representation of information regarding the complex interrelationship between land-use planning and climate change. They decrease the number of parameters that are necessary to present the relationship, and thus simplify the communication of results to users.⁵³
2. **Metrics:** The outcome(s) that will be reported to define performance in an indicator. Metrics can be quantitative or qualitative. An example of a metric for the indicator “personal vehicle demand” may be vehicle kilometres travelled per capita.
3. **Thresholds/targets:** The performance within a given metric that must be met or exceeded for the desired end-state or goal (i.e. low-carbon climate resilience) to be realized/manifested.

There are a number of approaches that could be used to develop indicators. The two main approaches identified through the literature are:

1. **Process-based:** indicators that evaluate the implementation of an enabling environment needed to achieve low-carbon climate resilient outcomes (i.e. # of municipalities that have implemented a CEP). These indicators seek to measure progress along an agreed course of action and chart progress toward desired outcomes. This is an upstream approach in that it provides enhanced capacity to manage outcomes.

⁵³ OECD, OECD Environmental Indicators: Development, Measurement and Use (Paris, OECD, 2003).

2. **Outcome-based:** indicators that monitor the effectiveness of policies and activities toward an explicit outcome/action (e.g. increased drainage capacity to cope with more intense precipitation events). This is a downstream approach in that it focuses on an assessment of actual results achieved as a result of policy implementation.

The team has focused on identifying outcome-based indicators in the proposed framework, with some exceptions. This is because most government policy objectives and targets are outcome-based (i.e. reductions in GHG emissions), and therefore it may be possible to link climate change objectives with objectives in other areas (i.e. transit investment – [Metrolinx Big Move Goals and objectives](#)), furthering the objective of “mainstreaming” climate change action across government.

Research to-date identified that there are hundreds of potential performance indicators and metrics that could be used to help indicate whether land-use planning and development are aligned with climate change mitigation and adaptation. The research also identified numerous challenges in monitoring performance, particularly with respect to climate adaptation (see call out box below).

Challenges with monitoring progress on climate change adaptation

The challenges with monitoring climate progress are particularly notable with respect to adaptation because it is difficult to determine in advance what good adaptation looks like. Unlike mitigation, where indicators and metrics can be clearly linked to targeted reductions in GHG emissions, adaptation has no prescribed target. There is also significant uncertainty about the scale, timing and spatial nature of climate change in the region, making it challenging to identify a clear link between action and outcome.

Adaptation-related activities have many different goals, including: building resilience and adaptive capacity; reducing the loss of assets associated with extreme weather; improving risk management processes; and delivering sector-specific adaptation measures alongside economic development goals such as poverty reduction and food security. This diversity of goals results in an overwhelming number of metrics for assessing results.

Added to this are the typical performance measurement challenges associated with data gaps (spatial and temporal), data quality and the time and costs associated with obtaining data.

In response to these challenges, an approach is to focus on process-based assessments of capacity and awareness raising.* However, a future comprehensive assessment should also include outcome-based indicators to facilitate an understanding of how adaptation policy is resulting in reduced risk and vulnerability.

Data availability and reliability is another challenge. The indicators and metrics identified by the project team draw data from a wide range of sources, all with varying degrees of reliability and availability. Many of the applicable data sources are not available on an annual basis (i.e. Transportation Tomorrow Survey is conducted every five years, as is Statistics Canada's Census).

The team first identified a comprehensive view of the potential landscape of indicators and metrics, and then sought to narrow down the list through consultation internally and with our external advisors. Synergies between indicators were identified so that the chosen set of performance indicators and metrics promote multiple climate benefits (i.e. mixed-use development promotes reduced vehicle kilometres travelled while also creating conditions supportive of alternative distributed energy systems).

The land-use and climate performance-measurement framework developed for this project is organized to reflect the seven policy directions discussed in Section IV above. The framework consists of seven categories, 16 indicators and 30 metrics. This set is chosen to be a manageable group that captures policy priorities at the regional scale while also being flexible enough to be translated down to the municipal, district and neighbourhood scales.

The following tables present a the performance measurement framework developed for this project.

Proposed indicator framework

Table 11: Mitigation indicators and metrics

Policy direction	Indicator	Metric	Example of where metric has been used	Potential target/threshold	Rationale/intent	Data source(s) and gaps
#1 Mainstream climate change considerations in Ontario's land-use planning framework	Land-use planning-related GHG emissions	Total and per capita GHGs produced by buildings and on-road personal vehicle transportation sources in the GGH	Metro Vancouver regional growth strategy – Baseline Annual Report	Align with Ontario provincial GHG reduction target for 2050 (35Mt total)	Assuming 18-20 million people in Ontario by 2050, per capita emissions should be less than 2 tonnes.	Environment Canada National Inventory Report for provincial-level data; lack of local and regional level data
	#2 Require the development of compact, location-efficient communities	Intensification	# of residents per hectare in the GGH (developable area density)	Neptis Foundation, Growing Pains Report	40-100	Consistent with New Climate Economy report figures for “semi-constrained cities” ⁵⁴
		% of residential and employment growth occurring within built boundary of municipalities	Metro Vancouver regional growth strategy – Baseline Annual Report	100% ⁵⁵	Counteracting sprawl by building within urban boundary is consistent with literature	Statistics Canada Census (for population); satellite imagery (for urban built-up area)

⁵⁴ Todd Litman, Analysis of Public Policies that Unintentionally Encourage and Subsidize Urban Sprawl (Victoria: Victoria Transport Policy Institute, 2015) 7.

⁵⁵ Chris Bataille et. al., Final Technical Report: The capacity for integrated community energy solutions policies to reduce urban greenhouse gas emissions (Vancouver: MK Jaccard and Associates Inc., 2010) 53.

Policy direction	Indicator	Metric	Example of where metric has been used	Potential target/threshold	Rationale/intent	Data source(s) and gaps
		% of all residential units located within urban growth centres and transit corridors	Metro Vancouver regional growth strategy – Baseline Annual Report	Minimum 25% by 2050 ⁵⁶	By concentrating housing in transit-supportive areas, investments in the network are best leveraged to reduce transportation GHGs	Property assessment data; Real Estate Search Corporation
		% of new commercial/institutional floor space located in transit-accessible areas	Growth Plan performance indicators	100% ⁵⁷	Focusing employment growth in transit-accessible areas will incentivize shift away from personal automobile	Property assessment data; Real Estate Search Corporation
	Mixed-use development	Diversity of residential, commercial and retail land uses within a given urban district - Simpson diversity index	Growth Plan performance indicators	N/A – No thresholds identified through research	Mixed-use development supports mobility alternatives	Municipal Property Assessment Corporation
		Mix of housing types across the GGH (detached house; attached house; apartments)	Growth Plan performance indicators	Approximately equal portions of detached, attached (i.e. townhouses and row houses), and multi-family residential units ⁵⁸	Greater mix of housing away from detached single-family homes enables increased density, which supports transit and energy efficiency	Statistics Canada National Household Survey
#3 Require urban design features that support higher-order transit	Personal vehicle demand	Volume of fuel sold for on-road transportation	Metro Vancouver regional growth strategy – Baseline Annual Report	N/A – No thresholds identified through research	Proxy metric for on-road GHG emissions	Statistics Canada data available at provincial level; it is unclear how regional level

⁵⁶ Consistent with Metro Vancouver target of 27% by 2040; recognizes that GGH currently lags Metro Vancouver in this area.

⁵⁷ 100% of growth within existing urban boundary aligns with findings of Jaccard (2010) aggressive scenario for the GTA. Bataille et. al. 55.

⁵⁸ Todd Litman, Analysis of Public Policies that Unintentionally Encourage and Subsidize Urban Sprawl (Victoria: Victoria Transport Policy Institute, 2015) 7.

Policy direction	Indicator	Metric	Example of where metric has been used	Potential target/threshold	Rationale/intent	Data source(s) and gaps
and active transportation						data would be compiled
		Vehicle ownership per 1000 residents	ISO 37120:2014	200-300 ⁵⁹	Vehicle ownership is strongly correlated with use, and also relates to impermeable parking land use	Transportation Tomorrow Survey data
		Auto mode share	Metrolinx Big Move Baseline Monitoring Report	<50% ⁶⁰	Increasing non-automotive mode share reduces fuel use and GHGs	Transportation Tomorrow Survey data
	Public transit	Kilometres of high-capacity public transport per 100,000 residents	ISO 37120:2014 Metrolinx Big Move Baseline Monitoring Report	N/A – No thresholds identified through research	High-capacity public transit creates alternatives to personal vehicles	Metrolinx data
		Annual number of public transit trips per capita	Metrolinx Big Move Baseline Monitoring Report ImagineCalgary Plan	N/A – No thresholds identified through research	High-capacity public transit creates alternatives to personal vehicles	Metrolinx data
#4 - Require, integrate and	CEPs	# of GGH single or upper-tier municipalities that have established CEPs	British Columbia Community Energy and	N/A – No thresholds identified through research	CEPs support energy conservation and deployment of	Municipal survey

⁵⁹ Todd Litman, Analysis of Public Policies that Unintentionally Encourage and Subsidize Urban Sprawl (Victoria: Victoria Transport Policy Institute, 2015) 7.

⁶⁰ Metro Vancouver's Translink Regional Transportation Strategy headline target is for at least 50% non-auto mode share.

Policy direction	Indicator	Metric	Example of where metric has been used	Potential target/threshold	Rationale/intent	Data source(s) and gaps
support community energy planning into our land-use planning framework	Low-carbon distributed energy generation		Emissions Inventory Initiative		low-carbon energy sources	
		Total amount of distribution-level low-carbon electricity (renewable and district energy) generated within municipal boundaries as a portion of total municipal electricity consumption	ISO 37120:2014 ImagineCalgary Plan	No specific thresholds identified. Suggest that electricity target be set as a % of peak demand	Local energy generation reduces line losses, and thus increases efficiency. Local generation also enhances resilience to grid disruption from extreme weather events. Burlington targets 3.5% of peak electrical demand being met by local sustainable generation by 2031. ⁶¹	Independent Electricity System Operator (IESO) data available at the transmission-level; however distribution-level data is a challenge (local distribution companies (LDCs) may track this data)
		Total amount of low-carbon heat (renewable and district energy) generated within municipal boundaries as a portion of total municipal heat consumption	ISO 37120:2014	Heat target requires research/data on renewable potential share of supply Areas with a heat density of 0.93 kWh/ft ² or with linear heat demand of 9146 kWh/ft can be economically	Heat is currently generated almost exclusively from natural gas combustion in non-district energy applications	No data on regional renewable heat generation currently exists

⁶¹ City of Burlington, Community Energy Plan (Burlington: City of Burlington, 2014).

Policy direction	Indicator	Metric	Example of where metric has been used	Potential target/threshold	Rationale/intent	Data source(s) and gaps
				served by district heating ⁶²		
		# of dwellings/non-residential floor space served by district energy systems	Metro Vancouver regional growth strategy – Baseline Annual Report	N/A – No thresholds identified through research	Neighbourhood-scale energy distribution systems can be more efficient than individual building energy systems by aggregating the heating load requirements of a dense cluster of buildings	Data is not currently available
	Building sector energy use	total and per capita CO ₂ equivalent emissions from residential energy use	Architecture 2030 Challenge for Planning	N/A – No thresholds identified through research	50% reduction in CO ₂ from existing buildings by 2030	Natural Resources Canada – Comprehensive Energy Use Database
		total and per \$GDP CO ₂ equivalent emissions from commercial/institutional energy use, by upper tier municipality or GGH average	Architecture 2030 Challenge for Planning	N/A – No thresholds identified through research	50% reduction in CO ₂ from existing buildings by 2030	Natural Resources Canada – Comprehensive Energy Use Database

⁶² Michael King, Community Energy: Planning Development and Delivery (Westborough: International District Energy Association, 2012).

Table 12: Adaptation indicators and metrics

Policy direction	Indicator	Metric	Examples of where this indicator/metric has been used	Potential Target/Threshold	Rationale/Intent	Data source(s)
#5 - Protect and enhance green infrastructure through land-use planning and through the use of offsets and other crediting	Natural cover	# of hectares of protected natural area and % of total GGH regional land base that is protected natural area	Metro Vancouver regional growth strategy – Baseline Annual Report	minimum of 30 per cent, and preferably 50 per cent or more, of watershed areas ⁶³	Protected natural areas provide stormwater infiltration and groundwater recharge; also support urban containment	Provincial government; conservation authorities; municipalities
		% urban forest cover within the built boundary of urban areas in the GGH	City of Vancouver Climate Adaptation Strategy	40% tree canopy cover ⁶⁴	Urban forests mitigate urban heat island impacts and control stormwater run-off	Municipal urban forestry departments; remote sensing data
	Local food supply	Total area of agricultural lands in the GGH	TRCA Living City Report Card	Near term: no loss of farmland in the GGH Long term: A greater than 5% increase in agricultural land	Local agricultural production fosters resilience to price spikes related to extreme weather events (i.e. persistent drought, flooding) Thresholds drawn from TRCA Living City Report Card (2011) ⁶⁵	Statistics Canada; Ontario Ministry of Agriculture, Food and Rural Affairs

⁶³ Graham Bryan and Brian Henshaw (eds.), How Much Habitat is Enough? 3rd Edition (Toronto: Environment Canada, 2013).

⁶⁴ City of Toronto, Every Tree Counts: A Portrait of Toronto's Urban (Toronto: City of Toronto, 2013) 15.

⁶⁵ Toronto and Region Conservation Authority, The Living City Report Card: An assessment of the environmental health of the Greater Toronto Area (Toronto: Toronto and Region Conservation Authority, 2011).

Policy direction	Indicator	Metric	Examples of where this indicator/metric has been used	Potential Target/Threshold	Rationale/Intent	Data source(s)
		Total agricultural area within GGH urban boundaries (i.e. community gardens and urban farms)	ImagineCalgary Plan	NA – No thresholds identified through research (although research suggests that City of Toronto could produce 10% of the fresh vegetables currently consumed) ⁶⁶	Urban agriculture creates resilience by reducing stormwater run-off and heat island impacts Urban agriculture provides opportunities for organic waste diversion and reduced food kilometres travelled	Municipalities – Parks and recreation departments
#6 - Require improved stormwater management through protection, enhancement and/or construction of new permeable	Municipal stormwater management	% GGH urban areas with adequate stormwater management controls (i.e. designed for both water quantity and quality control)	TRCA Living City Report Card	2016: Urban area with stormwater management increases to 35% Long term: Greater than 80% of urban areas have stormwater management ⁶⁷	Effective stormwater management controls reduce the potential for surface water flooding associated with extreme precipitation events	Conservation authorities

⁶⁶ Joseph Nasr et. al., Scaling up Urban Agriculture in Toronto: Building the Infrastructure (Toronto: Metcalf Foundation, 2010).

⁶⁷ Toronto and Region Conservation Authority, The Living City Report Card: An assessment of the environmental health of the Greater Toronto Area (Toronto: Toronto and Region Conservation Authority, 2011) 28-29.

Policy direction	Indicator	Metric	Examples of where this indicator/metric has been used	Potential Target/Threshold	Rationale/Intent	Data source(s)
surfaces, run-off control and LID	Permeability of urban area	% of permeable surfaces within serviced urban boundary	City of Vancouver Climate Adaptation Strategy	Urbanizing watersheds should maintain less than 10% impervious land cover Already urbanized watersheds should strive for 25-30% impervious land cover ⁶⁸	Permeability of the urban area affects the amount and speed of surface water run-off, and thereby erosion and flooding Increased permeability will enhance urban resilience to extreme precipitation events	Aerial photographs and satellite imagery
	Implementation of property-level green infrastructure solutions	Area (ft ²) of green or white roofs in the GGH (or by upper tier municipality)	City of Vancouver Climate Adaptation Strategy	20% of flat roof area appears to be a feasible mid-term target given experience elsewhere ⁶⁹	Green roofs provide multiple benefits, including mitigation of urban heat island effect, retention of stormwater and enhanced energy efficiency	Aerial photographs; municipal building permitting agencies
#7 - Provide tools that encourage effective and collaborative adaptation planning by local and regional governments,	Flood risk management	# of flood vulnerable clusters	TRCA Living City Report Card	2016: No increase in the # of flood-vulnerable clusters; reduction in the number of structures at risk Long term: >30% reduction in # of flood-vulnerable clusters (in	Flood vulnerable clusters represent concentrated areas of people and property at-risk during extreme weather events	Conservation authorities; provincial government
		# of people living in flood vulnerable areas	City of Vancouver Climate Adaptation Strategy			

⁶⁸ Graham Bryan and Brian Henshaw (eds.) 47.

⁶⁹ Washington DC set a target for 20% of all roofs by 2020; Basel Switzerland has achieved 23% of flat roof area with green roofs.

Policy direction	Indicator	Metric	Examples of where this indicator/metric has been used	Potential Target/Threshold	Rationale/Intent	Data source(s)
including updated climate impacts research, updated floodplain mapping, future climate scenarios and requirements to develop climate change risk inventories and adaptation implementation plans		\$ value of property at-risk in flood vulnerable areas	City of Vancouver Climate Adaptation Strategy	TRCA jurisdiction); reduction in the number of structures at risk ⁷⁰		
	Critical services and emergency preparedness	% of municipalities, universities, school boards and hospitals (MUSH) sector facilities with back-up power sufficient to remain functional over and above life safety requirements	City of Vancouver Climate Adaptation Strategy	N/A – No specific thresholds identified through research	Continued operation of critical services during extreme weather events reduces vulnerability and supports recovery, particularly of vulnerable populations	Periodic survey/audit of public sector building asset managers
		Capacity of municipal cooling centres in the GGH (# of people that	City of Vancouver Climate Adaptation Strategy	N/A – No specific thresholds identified through research	Reduces risk to vulnerable populations during extreme heat events	Municipal public health departments

⁷⁰ Toronto and Region Conservation Authority, The Living City Report Card: An assessment of the environmental health of the Greater Toronto Area (Toronto: Toronto and Region Conservation Authority, 2011, 28-29) .

Policy direction	Indicator	Metric	Examples of where this indicator/metric has been used	Potential Target/Threshold	Rationale/Intent	Data source(s)
		could be accommodated)				
	Integrated watershed management	# of the GGH covered by completed watershed plans	Greenbelt performance indicators	N/A – No specific thresholds identified through research	Green plans encourage watershed planning and management to protect water resources	Conservation authorities

Conclusion

The list of indicators covers a wide spectrum of land-use-related issues, all of which contribute to the overall transition toward low-carbon climate resilience. Progress against this entire suite of metrics will be required for the GGH to reach low-carbon climate resilience.

Assuming that the MOECC agrees with this, or a revised, performance measurement framework, establishing baseline performance across the full suite of indicators and metrics is a critically important next step. Once baseline performance has been established across the full suite, or a sub-set of priority indicators and metrics, monitoring change over time can help guide refinement of existing policies, and the development of new complementary policies. Also important is the establishment of goals and objectives that align with the performance measurement framework. Currently the Province has a headline GHG reduction target, but little in the way of subsidiary sector-by-sector goals and objectives that would help demonstrate whether and how this headline target will be achieved. Goals and objectives in the realm of adaptation are also lacking. Having established baseline performance and a set of goals and objectives that align with the overall policy direction (i.e. low-carbon climate resilience), ongoing reporting on progress is enabled.

VI. ENVISIONING A RESILIENT, LOW-CARBON GREATER GOLDEN HORSESHOE

This section presents a summary of the evidence-based narrative on low-carbon resilient urban development that is found in Appendix 5. The more detailed appendix is visually enhanced with photos to demonstrate the concepts described, and also contains best practice case study examples drawn from local, national and international jurisdictions. The narrative aligns with the policy directions identified in the literature review, incorporates best practice examples that emerged out of the jurisdictional scan and integrates the indicators and metrics identified in Section V. Furthermore, the project team strove to incorporate the policy recommendations summarized in Section IV (and elaborated on in Appendix 4).

The purpose of this narrative is to communicate a vision of what the GGH might look like as progress is made toward low-carbon climate resilience through provincial and municipal land-use planning policy. In taking a broad regional approach, the narrative attempts to address the variety of land-use planning contexts present in the GGH, albeit focused on development in the urban and newly urbanizing portions of the region where the concentration of people and built infrastructure translates into both high levels of GHG emissions and vulnerability to extreme weather events.

The narrative is organized into three timeframes that are meant to demonstrate progress in the GGH toward climate change goals. We start in the present day, and describe the contemporary situation with regard to land-use planning, carbon emissions and climate resilience. The picture presented isn't rosy, but glimmers of hope are found. We then move forward in time to 2030 and 2050 and articulate a positive vision of the GGH moving forward along a low-carbon climate resilient urban development pathway. While the future vision presented could be described as overly optimistic, the aim of this section of the report is to provide a hopeful, and ideally achievable, vision that demonstrates the role that land-use planning can play in moving us collectively toward a prosperous low-carbon resilient future.

Factors and Assumptions Influencing the Scenarios

The GGH faces unprecedented challenges in the years to 2030 and beyond. Population growth, combined with the need to reduce GHG emissions and adapt to an increasingly volatile climate, will present new challenges to provincial and regional governments. These trends and the influence they have on the narrative scenarios are briefly discussed below. Note that these are but a few of the factors that will influence how the region develops in the coming decades.

Population growth - By 2030 there will be at least another billion people on the planet. Projections for the GGH show population growing to nearly 12 million people by 2031 and 13.5 million by 2041.⁷¹ This growth is based on a number of assumptions, including high levels of immigration and increased life expectancies.

Economic growth - The performance and structure of the global economy, and by extension the GGH economy, over the period to 2050 and beyond is a hugely important factor in how the response to climate change shapes up. Strong economic performance provides financial capacity to invest in low-carbon infrastructure, but also entails higher levels of GHG emissions in the absence of a decoupling of economic growth from emissions.

Electricity supply and demand – The role of distributed renewable energy generation is an unknown, particularly in light of provincial plans to refurbish the nuclear fleet at Darlington and Bruce. Another unknown is the rate of electric vehicle adoption by GGH residents and its impact on electricity demand.

Direct climate change impacts (i.e. climate change predictions for Southern Ontario) - The most important factor shaping the future of the GGH is what happens to the climate itself. While there are many details that are uncertain, we know that over the medium and long-term temperatures will rise, the frequency of storms will increase and rainfall patterns will shift. Impacts related to these changes are highly uncertain and will influence the actions taken by the Province and municipalities.

Public attitudes and political will toward climate change - The science of climate change has moved firmly into the mainstream media across the world. It is likely to stay there as the direct impacts of climate change – and the ability of models to project/predict these impacts – increase. The key question is whether governments, and the publics they represent, are willing to make the revolutionary changes in their economic and social systems required to stimulate the deep reductions that are needed to avoid significant temperature increases.

Technological development - The rate of technological innovation is impossible to predict and will have an important influence on the nature of our response to climate change mitigation and adaptation. Smart grid and electric vehicles are two examples of where the pace of technological development could greatly influence climate change responses.

⁷¹ Hemson Consulting Ltd., Greater Golden Horseshoe Growth Forecasts to 2041: Technical Report (November 2012) Addendum (Toronto: Hemson Consulting Ltd, 2013).

GGH Today

The year is 2015 and the GGH is one of the fastest growing urban agglomerations in North America. Total population in the region is closing in on 9 million and is projected to grow to more than 11 million by 2031.

While many indicators suggest that the GGH is set for a bright and prosperous future, there are nonetheless some dark clouds on the horizon when viewed from a climate change perspective. Urban development patterns have created communities that are highly dependent on fossil fuels for mobility, heating and to a lesser extent electricity demand, meaning that per capita GHG emissions are far above the global average and as a result the Province is not on track to meet its emission reduction targets given current policy. These communities are also supported by aging 'grey' infrastructure systems (i.e. traditional infrastructure such as conventional pipe drainage and water treatment systems) that are not designed to address current climate conditions, nor the more extreme conditions forecasted for the region in the decades to come.

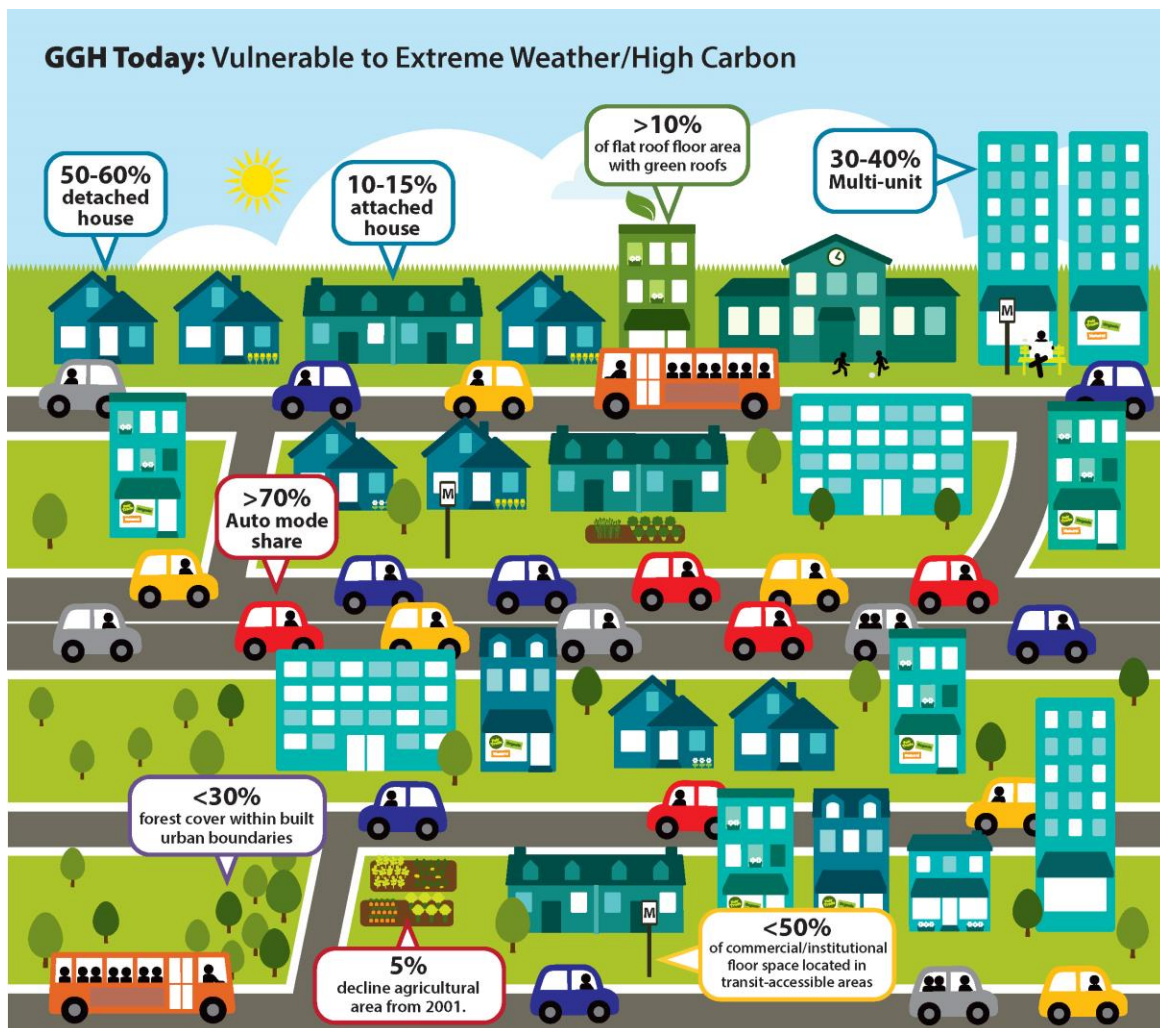


Figure 3: Graphic summary of GGH Today scenario

Summary of Key Mitigation-Related Points from the GGH Today Scenario

Urban Development Patterns

In spite of the residential condominium boom in the City of Toronto, in the region as a whole the vast majority of new residents added between 2001 and 2011 were housed in auto-dependent greenfield areas.⁷²

A similar situation exists in the commercial building sector. Historically, the region's office space was concentrated in the downtown Toronto core, or directly on subway lines;⁷³ however, today, the majority of the region's office space is located beyond the reach of higher-order transit, meaning that a large number of commuters have no realistic options to use modes with lower GHG emissions (see Figure 3).

Transportation

To say that investment in public transportation infrastructure has lagged growth is an understatement. Compared to other Canadian urban regions such as Greater Vancouver and the Calgary Region, the GGH has seen relatively little investment in new rapid transit lines over the past ten years.⁷⁴ Transportation-related GHGs are the largest and fastest growing source of emissions in the region.

As a result of underinvestment and sprawling urban development patterns, the personal automobile is used for 80% of all trips in the region.⁷⁵ Given current trends, total personal vehicle kilometres travelled in the region are projected to increase by approximately 50% by 2030, resulting in increasing levels of transportation-related GHG emissions.

Buildings

Sprawling development has also influenced the growth of building sector GHG emissions in the region. The dispersed layout of buildings on the landscape makes the development of distributed low-carbon energy solutions such as combined heat and power (CHP) and district energy infeasible. As a result, building heating needs are met by natural gas delivered through the distribution network. In spite of building efficiency improvements, overall emissions have risen in this sector since 1990.

⁷² Marcy Burchfield and Anna Kramer, *Growing Pains – Understanding the New Reality of Population and Dwelling Patterns in the Toronto and Vancouver Regions* (Toronto: The Neptis Foundation, 2015).

⁷³ Canadian Urban Institute, *The New Geography of Office Location and the Consequences of Business as Usual in the GTA* (Toronto: Canadian Urban Institute, 2011) 1.

⁷⁴ Cherise Burda and Geoffrey Singer, *Fast Cities: A comparison of rapid transit in major Canadian cities* (Toronto: Pembina Institute, 2014).

⁷⁵ Ministry of Municipal Affairs and Housing, *Performance Indicators for the Growth Plan for the Greater Golden Horseshoe*, 2006 (Government of Ontario, 2014) 30.

Summary of Key Adaptation-Related Points from the GGH Today Scenario

Green Infrastructure and LID

Urban areas in the GGH are characterized by high levels of impervious landscapes that create high levels of stormwater run-off during extreme precipitation events. This leaves residents at-risk from surface water flooding, as municipal sewer systems are overwhelmed. In addition to exacerbating flooding risk, concrete- and asphalt-covered landscapes absorb heat, which leads to urban heat islands that create risks for vulnerable citizens.

Although new and innovative ways to control stormwater runoff are being implemented, regulatory barriers prevent wide uptake of innovative source and conveyance control measures that reduce or reuse stormwater volumes. GGH municipalities are attempting to reduce sewer overflows by separating combined sewers, expanding treatment capacity and storage within the sewer system, or by replacing broken pipes. This infrastructure investment adds billions to the capital spending needs of regional municipalities, which are burdened with infrastructure deficits of a similar scale in other areas such as public transportation.

Urban Forests and Regional Natural Heritage Systems

Municipalities have begun to transition from protecting natural features in isolation to identifying connected natural systems within their official plans and implementing policies to help protect them. Although there has been increased protection for natural systems within GGH municipal official plans and by-laws, provincial policy and investment in the protection of natural systems has typically focused on non-urban landscapes, such as the Greenbelt, Oak Ridges Moraine and Niagara Escarpment.

Food Systems

Urban sprawl in the region has also consumed valuable agricultural land, as well as forests and wetlands, at the periphery. In a world of relatively affordable food, the loss of agricultural land doesn't directly impact residents currently; however, in a future likely characterized by widespread food supply disruptions, there is increasing concern that the paving over of prime agricultural land is creating future vulnerabilities for the region. Local food movements have developed in the region, but remain relatively nascent.

GGH Tomorrow (2030)

It is the year 2030, and the GGH is now home to 11 million people. As a result of big moves made in the mid to late 2010s to: (1) increase the density targets for designated greenfield areas and urban growth areas; (2) cease designating new greenfield areas for urban development; and (3) ban municipalities from expanding their settlement area, the gross population density of the region (developable area density) is much higher and supportive of low-carbon mobility. Energy systems are transforming as well, particularly with respect to heat demand and supply. Therefore, building sector GHG emissions are on the decline in spite of

increases in the number of residential dwellings and in commercial/institutional building floor space.

Green infrastructure, from large forests and wetlands to urban street trees and backyard gardens, is now recognized as a critical aspect of the landscape and managed in an integrated manner to help ensure the climate adaptation-related benefits it provides are fully realized and distributed across all communities. As a result of these changes, the GGH is now fully in-transition toward low-carbon resilience.

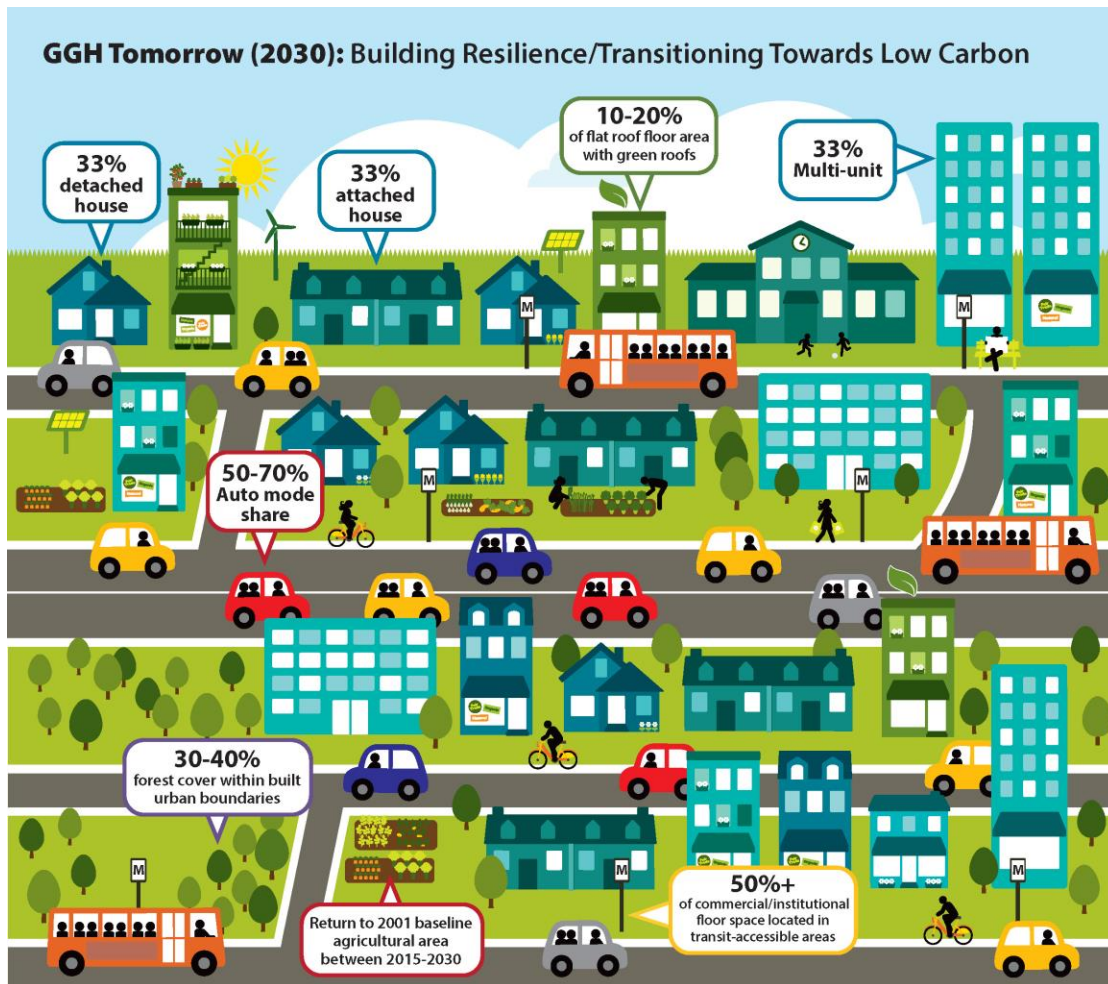


Figure 4: Graphic summary of GGH Tomorrow scenario

Summary of Key Mitigation-Related Points from the GGH Tomorrow Scenario

Urban Development Patterns

With the 2015 Coordinated Review of the GGH's land-use planning framework, it became clear to policymakers that there was a disconnect between the amount of greenfield land designated for expansion under the Growth Plan and the need to mitigate and adapt to climate change in the region.

As a result of new provincial policy, 100% of new residential units in the region are now constructed within the built boundary of municipalities. The mix of new housing units has also changed, with an even split of single-detached, attached and multi-unit buildings.

Changes to the Ontario Building Code and the *Planning Act* in the late 2010's removed barriers to infill development and, as a result, development in the built-up portions of the region is primarily mixed-use in nature and occurs in two types: (1) as infill development (i.e. secondary suites, laneway houses) in identified urban growth centres; and (2) as redevelopment along newly developed transit corridors.

As a result of the 2015 Coordinated Review of the regional land-use planning framework, the Province amended the Growth Plan to require that all new development in the commercial and institutional building sector be located in urban growth centres and transit station areas. The Growth Plan also designated key suburban employment lands (e.g. Pearson Airport, 404/407, Vaughn Corporate Centre) and required area municipalities to develop re-urbanization strategies to retrofit these areas to increase land-use efficiency and support alternative low-carbon transportation modes.

Transportation

Public transportation connections to high employment areas were also improved by the provincial decision to expand the use of dedicated lanes for bus rapid transit (BRT) on the provincial highway network.

New developments are required to explicitly plan for linkages to higher-order transit and active transportation routes with the same emphasis as they previously planned for automobile access and parking. Transit investment in these growth centres and station areas is financed to a large degree by value capture tools that levy funds from new development (i.e. development charges) to support repayment of debt used to fund rapid transit infrastructure.

The high-density, mixed-use neighbourhoods, supported by the realization of Metrolinx's Big Move investment strategy, have helped to shift large numbers of people out of personal automobiles. Automobile mode share is now approaching 70% and vehicle ownership rates have approached the levels common in most European cities in the 2010's (i.e. 200-300 vehicles per 1000 residents).

While auto mode share has declined, due to population growth the total personal vehicle kilometres travelled in the region remain close to 2015 levels. However, as fuel prices and the penetration of electrical vehicles increases, overall GHG emissions from transportation in the region have started to decline.

Buildings

The building sector is in transition as well. This was catalyzed by the 2018 agreement of all GGH municipalities to sign on collectively to the Architecture 2030 Challenge, which asks signatories to commit to reducing fossil fuel energy consumption in all buildings and achieve a 50% reduction compared to the 2018 baseline by 2030.

Energy used in the region comes from a wider range of sources than in 2015. Rooftop solar photovoltaics (PV) reached grid parity in the GGH in 2025, prompting a dramatic increase in the uptake in household and commercial rooftop solar. There is now 10,000 MW of distributed solar capacity on the provincial electricity grid, much of it located in the GGH.

While natural gas is still part of the electricity generation mix, much of this capacity is now in the form of CHP. By 2030, the GGH has 1000 MW of installed CHP capacity, a significant portion of which is situated in public sector buildings such as colleges, universities, hospitals, nursing homes and other government buildings. Renewable biogas CHP systems are also increasingly prevalent, making up 20% of total CHP capacity in the region (i.e. 200 MW).

It is also more common for homes, businesses and public institutions to be heated using low-carbon energy sources such as district CHP systems, heat pumps and solar thermal technologies. By 2030, 10% of heat demand in the building sector (residential, commercial and institutional) was supplied from low-carbon sources. The development of these heat technologies was spurred by financial incentives created as part of the Province's 2015 climate change strategy, as well as mandatory connection policies at the municipal level. But by 2023, these incentives were no longer necessary as natural gas price spikes made it cost-effective for households to install alternative renewable heating sources to reduce their reliance on costly and GHG-emitting heating fuels.

Summary of Key Adaptation-Related Points from the GGH Tomorrow Scenario

Green Infrastructure and LID

Across the GGH, infrastructure is now understood as comprising both the built and natural environments (i.e. grey and green infrastructure). The definition of infrastructure has been extended to include broader living and engineered green infrastructure.

As a result of Ontario Building Code revisions in the early 2020s, all new and significantly renovated residential, commercial and institutional buildings with flat roofs are required to install green roofs on half of available roof space (with the other half requiring solar PV or solar thermal generation). Green roofs have reduced the urban heat island and heat stress on residents, and lowered energy consumption.

All municipalities have developed Stormwater Management Master Plans and are in the process of implementing LID measures in new and retrofit developments. Stormwater fee systems have been implemented in all GGH municipalities. As a result, more rainfall is managed onsite, municipalities save money on their built infrastructure maintenance and the public has a greater understanding of its role in stormwater management.

Stormwater ponds are considered the last line of defense for flood control and applied only after all source control and conveyance options for stormwater management through engineered and natural green infrastructure have been exhausted.

Urban Forests and Regional Natural Heritage Protection

With the Greenbelt expansion as part of the 2015 Coordinated Review, new rural and urban Greenbelt lands have been identified and are being protected to enhance food and water sources as well as terrestrial and aquatic ecosystem processes. Natural cover within the Greenbelt is increasing as a result of afforestation stimulated by the provincial cap-and-trade and related offset program.

Food Systems

With greenfield development pressures having eased, total rural agricultural land area in the region is similar to what it was in the 2010's. Land devoted to urban agricultural production is increasing, enabled partly by increasing densities, which have opened up an increasing number of vacant sites for small-scale agricultural development as well as green rooftop agriculture.

GGH Future (2050)

It is the year 2050 and the GGH has undergone a paradigm shift compared to 2015. We have successfully met our GHG reduction targets and now consider ourselves fully transitioned to low-carbon climate resilience. The GGH's population now sits at roughly 14 million people.

As a result of massive public transportation investments in the 2030 to 2050 period, and revolutionary shifts in the way energy is generated and consumed within the building sector, the GGH has achieved deep cuts in its GHG emissions aligned with the Province-wide target of 80% below 1990 levels. Climate resilience has been enhanced by a decades-long re-engineering of urban infrastructure systems from grey to green, which has enabled residents to cope with rising temperatures and increasing extreme weather events.

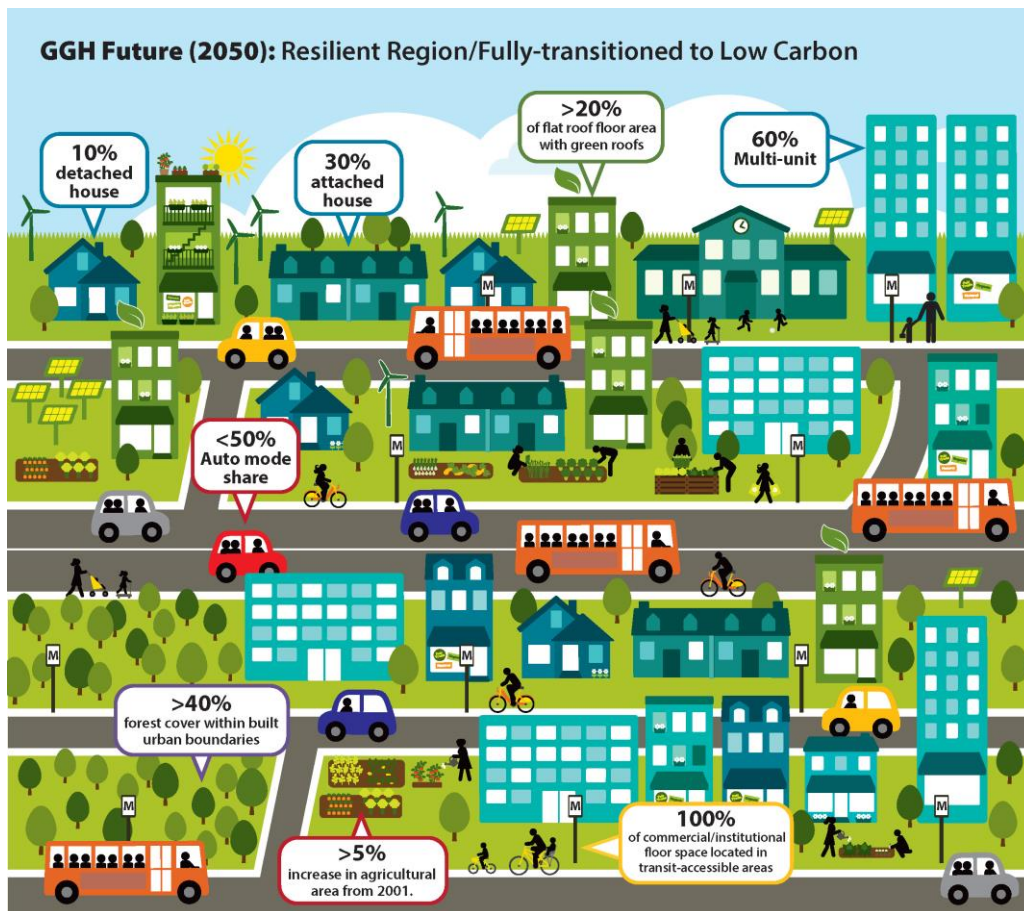


Figure 5: Graphic summary of GGH Future scenario

Summary of Key Mitigation-Related Points from GGH Future Scenario

Urban Development Patterns

Gross population densities (“developable densities”) have continued to increase in the region, with mid-rise, mixed-use infill development having been the key enabling strategy. The overall stock of housing in the region is much different than in the 2010’s, with a close to even mix of detached, semi-detached and multi-unit residential available. Some outlying suburban subdivisions have been abandoned due to the high costs of living associated with transportation and utilities provision.

While public transportation investments have connected large portions of the previously auto-dependent commercial building floor space to rapid transit, there were inevitably some dead and dying malls and office parks as a result of the decline in automobile usage. Many of these underutilized areas are now part of a suburban re-engineering project across the GGH to re-green expansive surface parking spaces and increase the amount of natural cover and peri-urban agricultural land.

Transportation

Long and medium length trips in the GGH are now predominantly provided by mass transit options. Short trips are, weather permitted, undertaken predominately by active transportation modes, and planning prioritizes these modes over personal vehicular uses. Automobile mode share is now below 50% and falling, and car share electric vehicles account for most of the vehicle kilometres traveled.

Buildings

Cost declines for solar PV technology mean that most unobstructed rooftops in the region have a system installed (of those that don't have green roofs installed). Solar PV now generates as much as 15% of total electricity annually, and close to 80% of peak demand during hot summer days. As a result of this surge in solar PV capacity, the GGH's electricity supply reached 100% low-carbon by 2046, four years ahead of a joint pledge made by mayors of the region's municipalities in 2017. These municipalities have successfully implemented their community energy plans, and, as a result, now generate a considerable portion of the energy used within their boundaries.

District heating networks are commonplace, as a result of public sector investment in district heating networks centred on MUSH sector "nodes" such as social housing developments, academic institutions, hospitals and other public buildings, as well as private developers installing heat networks in new developments.

In suburban areas that lack the density to support installation of district heating networks, homes are heated using micro-scale renewable technologies at the site/lot scale. Rooftop solar thermal and heat pump technologies take centre stage in suburban areas, providing hot water and heat that supply close to half of household needs.

Summary of Key Adaptation-Related Points from the GGH Future Scenario

Green Infrastructure and LID

The region has shifted philosophically from a focus on grey infrastructure to green infrastructure. Municipal planning and finance incorporates green infrastructure into service delivery planning and capital investment decision-making. There is now a high degree of integration and coordination of green infrastructure policies across sectors and levels of government. Collaborative adaptation planning occurs at the local and regional levels, especially as it relates to integrated watershed management, risk and emergency preparedness.

Everyone plays a part in implementing green infrastructure. Homeowners retrofit their houses with green roofs and gardens; community groups get together to set up community gardens or allotments; developers design new sites and buildings that include parks, bioswales and rain gardens; infrastructure service providers use green infrastructure to manage flooding and extreme heat in a changing climate; and governments include it as a key component of their master planning.

All development and redevelopment proposals are required to include high degrees of permeable surfacing, and to have systems in place to harvest, store and use rainwater on-site for irrigation and other non-potable uses. As a result, Ontario leads the world in the percentage of Zero Runoff developed area. Moreover, the capital and operating costs of stormwater management infrastructure has decreased considerably and is now within the financial means of municipalities in the region.

Urban Forest and Regional Natural Heritage Protection

Areas of natural heritage, water resource and agricultural systems are conserved throughout the entire GGH (not just the areas covered by the Greenbelt Plan, the ORMCP and the NEP), and they are managed as a connected, contiguous system (not fragmented and preserved in isolation) so as to build a more resilient and functioning ecosystem.

The urban forest is uniformly distributed across the urban landscape, with all residents benefiting equally from the services it provides. Homes and businesses lie within a vibrant urban forest that is healthy, diverse and abundant in all parts of the region. Treed environments are valued as an integral part of vibrant, livable and sustainable communities.

Natural cover in the landscape is restored to have adequate size and configuration to support and enhance the physical, hydrological and biological processes of the ecosystem. A mix of living and engineered green infrastructure complements the larger natural cover. The overall ecosystem is resilient and able to respond to stresses and adapt to changes.

Municipalities protect natural hydrological systems, maintaining or returning the natural hydrology to streams, forests and wetlands, and maintaining spaces for floods and water retention. Floodplains have been mapped and do not expand with each new development. Mitigation measures have been put in place to minimize risk to life and property within floodplains.

Development is avoided in floodplains and these areas are kept or returned to their natural state. As a result, they function to store and gradually release flood flows, which replenish floodplains and bordering wetlands with sediment and other nutrients. More improvements to the fish communities are realized, with additional historical fish species returning. Floodplains are multifunctional green spaces that combine recreation and biodiversity with floodwater storage.

Food Systems

Food security has continued to improve in the region. Planning policies encourage and incorporate urban food production through the creation of allotments, community farms and gardens, and inclusion of fruit trees and bushes in urban design. Ontario's food and beverage processing sector expands with the increase in food supply, increasing jobs in the domestic and export food processing sector.

VII. CONCLUSION

The project team's assessment of current linkages between climate change adaptation and mitigation and land-use planning in the areas covered by the Provincial Plans confirms that changing how and where we live, work and play is vital to the Province's ability to meet its climate change objectives. A fundamental pre-condition to success, from both a climate change mitigation and adaptation perspective, is that outward urban expansion cease. This supports the drive towards compact communities that create viable low-carbon alternatives to the personal automobile for mobility, as well as supporting the preservation and restoration of natural areas and agricultural lands that are important for region-wide resilience.

Our assessment and jurisdictional scan show that, in many ways, Ontario and some of its municipalities and conservation authorities have been leaders on sustainability, but there is still much to be done. In particular, the Province should focus on providing specific, action-oriented and mandatory direction to municipalities and other planning stakeholders within the area covered by the Provincial Plans that creates consistency and clearly requires conformity with provincial climate change objectives. This is particularly urgent in light of the mounting costs of extreme weather on public and private property and the long-term impacts of land-use policies, which often take many years to fully implement under Ontario's current land-use planning system.

The policy and implementation recommendations and complementary performance indicators proposed by this report have been selected to assist the Province in making the changes needed to achieve progress on some of Ontario's most significant GHG emission sources—transportation and buildings. They will not all be easy to implement, but the alternative, failing to take real action on land-use planning and climate change, will be much more expensive and disruptive to our society and economy in the long run.