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Clara Turner, Jeff Allen, Karen Chapple, and Sarah A. Smith

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About IMFG

The Institute on Municipal Finance and Governance (IMFG) is an academic research hub and non-partisan think tank based in the School of Cities at the University of Toronto.

IMFG focuses on the fiscal health and governance challenges facing large cities and city-regions. Its objective is to spark and inform public debate, and to engage the academic and policy communities around important issues of municipal finance and governance. The Institute conducts original research on issues facing cities in Canada and around the world; promotes high-level discussion among Canada's government, academic, corporate, and community leaders through conferences and roundtables; and supports graduate and post-graduate students to build Canada's cadre of municipal finance and governance experts. It is the only institute in Canada that focuses solely on municipal finance issues in large cities and city-regions.

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Land Use Planning to Mitigate Climate Change in the Greater Golden Horseshoe: An Analysis of Potential Scenarios

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Abstract

This paper assesses the potential effects of housing development on regional greenhouse gas emissions in Ontario's Greater Golden Horseshoe. Using models of different development scenarios based on household vehicle kilometres travelled and energy use, we evaluate the impacts of different forms of new housing production on greenhouse gas reduction targets and suggest housing and land use best practices and policy approaches. We model core scenarios of development from 2023 to 2030 that reflect current debates on housing development and land use planning in the region that include Build as Usual (on-going intensification); All-Sprawl (under recent policy changes); and four alternatives: Business as Usual, Moderate, Limited, and No Sprawl. Our findings suggest that aggressive intensification would reduce greenhouse gas emissions by as much as 26 percent, with particularly significant and compounding effects to be expected over the long term. We conclude that progressive land use planning and other mechanisms by the provincial, regional, and municipal orders of government that reduce the emissions generated by buildings, preserve open space that provides critical carbon sequestration, and reduce vehicle miles travelled, should be aggressively strengthened to build on progress made under the Province's *Growth Plan for the Greater Golden Horseshoe*.

Keywords: intensification, sprawl, land use planning, climate change, greenhouse gas emissions

JEL Codes: R52, R58, Q58

Land Use Planning to Mitigate Climate Change in the Greater Golden Horseshoe: An Analysis of Potential Scenarios

1. Introduction

Canada aspires to reduce its greenhouse gas (GHG) emissions by up to 45 percent of its 2005 levels by 2030, a goal that entails multiple strategies. Technology-forcing strategies, such as policies that encourage development and adoption of lower-carbon transportation options, will be fundamental in this process. Demand-side approaches that reduce emissions, such as those that minimize the use of carbon-generating transportation modes and create patterns of sustainable development, will also be crucial. Yet many Canadian municipal and regional plans do not effectively support more sustainable development, and, in effect, foster sprawl (i.e., unrestricted outward residential growth on previously undeveloped farm and natural lands, characterized by low densities and auto dependence). In fact, the Province of Ontario's recent Bill 23 and other regressive actions – including the planning of far-reaching new highways – are forcing Greater Golden Horseshoe (GGH) municipalities to return to an era of low-density, car-dependent sprawl while simultaneously weakening the promotion and requirements for infill and intensification development in built-up areas.

This report examines how Ontario is faring with reducing emissions by comparing residential development patterns under multiple scenarios, ranging from All-Sprawl outside of built-up areas to No Sprawl and all infill. We model the impacts of these different scenarios on Ontario's GHG reduction targets, based on household vehicle kilometres travelled (VKT)[1] and energy use. This scenario exercise reveals substantial variations in emissions based on different future development patterns and confirms that land use planning that supports infill development will help Ontario reduce its GHG emissions.

Next, the report examines recent growth patterns across GGH municipalities, finding variation in the extent to which cities channel development to built-up areas. Through additional research, supplemented by three interviews with current and former regional leaders, we identify the role local and regional governance has in supporting infill development, through the facilitation of land use policies and incentive programs. We conclude by suggesting steps that will help better integrate provincial land use patterns with climate goals, as well as areas for further research.

2. Background: The Greater Golden Horseshoe

The Greater Golden Horseshoe (GGH) is a region of Ontario, Canada. Covering approximately 32,000 km^2 of territory (Office of the Auditor General 2021), it wraps around Lake Ontario from Lake Erie in the southwest to Lake Huron's Georgian Bay in the north, to the Kawartha Lakes in the east. The region is home to more than a quarter of the total population of Canada, as well as Canada's largest city, Toronto. Both historically, and in the present day, the GGH has been both the population centre and the economic

1. VKT is a variable that can analyse various metrics, such as fuel efficiency, fuel consumption, environmental quality, and safety.

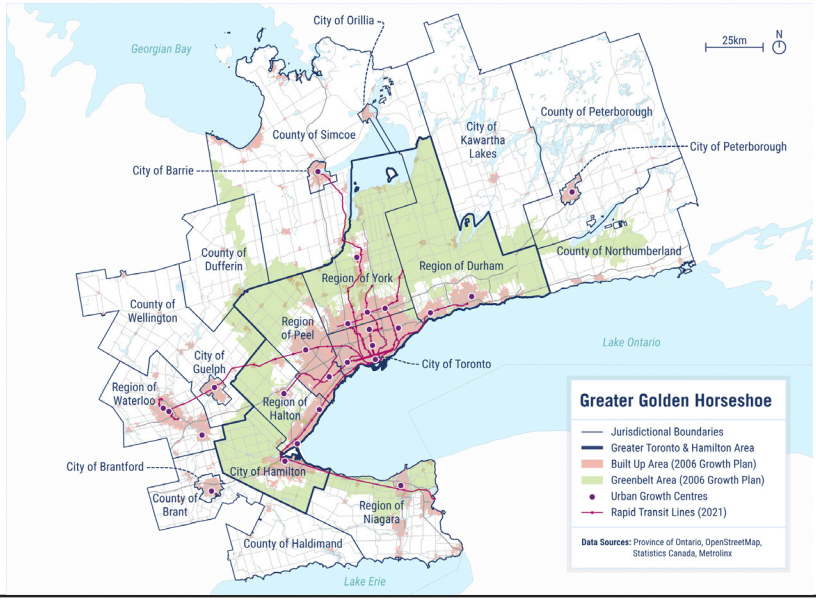
engine of Ontario: large, dynamic, and fast-growing. The area generates more than 25 percent of Canada's GDP and more than two-thirds of Ontario's GDP (Office of the Auditor General 2021). Over 4 million people work in the GGH and 9.6 million make it their home (Blais 2018; Statistics Canada 2021).

The GGH is made up of 21 upper- and single-tier municipalities and 89 lower-tier municipalities with unique roles and responsibilities. For those in the two-tier system, the upper-tier delivers certain services on behalf of the lower-tier municipalities within its boundaries. The Cities of Toronto and Hamilton, in contrast, are single-tier municipalities with sole responsibility for most local services, including land use planning.

The "inner ring" municipalities are those nearest Toronto and Lake Ontario, referred to as the Greater Toronto and Hamilton Area (GTHA) (Figure 1). The inner ring is densely populated and urbanized. Its outer edges contain the majority of Ontario's Greenbelt. Established in 2005, the Greenbelt is a wide swath of open space protected from development, consisting of more than two million acres of farmlands, forests, wetlands, rivers, and lakes. The outer ring of the GGH is less densely populated but has several large cities, small towns, and rural areas.

In addition to the Greenbelt, the GGH has extensive open space, agricultural land, and natural features. These spaces play an essential role in protecting the food supply, resource-based industries, water supply, and biodiversity, and provide recreational space (Ministry of Municipal Affairs and Housing 2020).

Figure 1. Growth Plan map of the Greater Golden Horseshoe, 2006



As of 2021, the GGH contains 68 percent of Ontario's population, and 26 percent of Canada's population as of 2021 (Statistics Canada 2021). The population has grown rapidly over the past two decades and this is predicted to continue (Table 1). Just as most of Canada's recent growth has taken place in its suburbs and exurbs beyond, so has the GGH's (Gordon and Herteg 2023). Between 2006 and 2021, the GGH grew by 20 percent (adding 1.6 million residents,) and by 2050 the population is projected to increase by 5 percent, an addition of 5 million residents over 2021. Some of its municipalities, like the City of Barrie and the Regions of Durham and Halton, are projected to double or nearly double in population. Similar economic growth is projected for the region, with approximately 3 million new jobs expected to be added in the next 30 years (MMAH 2020).

3. Two Challenges: A Climate Crisis and a Housing Crisis

As the 2020s unfold, Ontario faces two major challenges: the urgent need to meet CO_2 emission reduction targets, and the development of an acute housing shortage and severe housing affordability issues across the region.

3.1 The climate crisis

Climate change poses an existential threat to humanity regardless of city, province, or country of residence. While no one is safe, people who are most vulnerable to being harmed first are those least able to protect themselves, such as individuals and families in low-income and disadvantaged communities (World Health Organization 2023). Extreme weather events and breakdowns in the ecosystems providing our food and water supplies are already occurring, and their severity will increase as temperatures continue to rise. Adaptation strategies are important, but not sufficient to address this crisis. Reducing, and then eliminating, GHG emissions is the only way to slow and stop climate change. It is imperative that public and private actors use both technology and policy to do so, immediately (Burbank 2009; Environment and Climate Change Canada 2019; NASA 2023).

> *Because we are already committed to some level of climate change, responding to climate change involves a two-pronged approach:*
>
> 1. *Reducing emissions of and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere ("mitigation");*
> 2. *Adapting to the climate change already in the pipeline ("adaptation").* (NASA, Canadian Climate Plan 2023)

Under the 2015 Paris Accord, Canada set a target for reducing GHG emissions by 40–45 percent of its 2005 levels by 2030. In 2022, the Canadian government released the *2030 Emissions Reduction Plan* to outline strategies for meeting this target (Environment and Climate Change Canada 2022). The plan includes a combination of strategies, including carbon pricing, clean fuels, and reducing emissions of methane. Of the seven sectors in Canada that produce GHG emissions, transportation and buildings produce the second- and third-most emissions, following the oil and gas sector (ECCC 2022).

Table 1. Greater Golden Horseshoe population growth, forecast, and change

Macro	Municipality	Population			
		2006	2021	2051	2021-2051 (% change)
Inner Ring (GTHA)	City of Hamilton	505,000	569,000	820,000	44
	City of Toronto	2,503,000	2,794,000	3,650,000	31
	Region of Durham	561,000	697,000	1,300,000	87
	Region of Halton	439,000	597,000	1,100,000	84
	Region of Peel	1,159,000	1,451,000	2,280,000	57
	Region of York	892,000	1,173,000	2,020,000	72
	Inner Ring (GTHA) Total	**6,060,000**	**7,282,000**	**11,170,000**	**53**
Outer Ring	City of Barrie	128,000	148,000	298,000	101
	City of Brantford	90,000	105,000	165,000	57
	City of Guelph	115,000	144,000	203,000	41
	City of Kawartha Lakes	75,000	79,000	117,000	48
	City of Orillia	30,000	33,000	49,000	48
	City of Peterborough	75,000	84,000	125,000	49
	County of Brant	34,000	39,000	59,000	51
	County of Dufferin	54,000	66,000	95,000	44
	County of Haldimand	45,000	49,000	75,000	53
	County of Northumberland	81,000	89,000	122,000	37
	County of Peterborough	58,000	64,000	82,000	28
	County of Simcoe	263,000	352,000	555,000	58
	County of Wellington	85,000	97,000	160,000	65
	Region of Niagara	427,000	478,000	674,000	41
	Region of Waterloo	478,000	587,000	923,000	57
	Outer Ring Total	**2,041,000**	**2,415,000**	**3,702,000**	**53**
Total GGH		**8,101,000**	**9,697,000**	**14,872,000**	**53**

Source: *Growth Plan for the Greater Golden Horseshoe*, 2006.
Note: Figures rounded to the nearest 100.

> *Global warming can only be stopped by reducing global emissions of carbon dioxide from human fossil fuel combustion and industrial processes to zero, but even with zero emissions, the global temperature will remain essentially constant at its new warmer level. Emissions of other substances that warm the climate must also be substantially reduced.* (Environment and Climate Change Canada 2019)

In coordination with the Canadian government, individual provinces set their own targets for reducing GHG emissions by 2030. They are allowed to adjust their targets and their strategies for achieving these targets, provided that the adjustments are made public. In 2018, the Ontario provincial government's *Environmental Plan* set a target of reducing GHG emissions by 30 percent below 2005 levels by 2030, significantly less than the overall Canadian target of 40–45 percent. This plan was updated in 2022 to reflect new strategic approaches (Ministry of the Environment, Conservation and Parks 2022). Within the GGH, the municipal targets tend to be higher than those of the provincial and federal governments. The City of Toronto has set a target of 65 percent below 1990 levels by 2030, with a goal of net zero by 2040 (City of Toronto 2021). Durham Region's community GHG emissions reduction target is 80 percent below 2007 levels by 2050 (Sustainability Solutions Group 2018).

In Ontario, the three largest sources of GHG emissions are transportation (35 percent), industry (28 percent), and buildings (24 percent) (Office of the Auditor General 2021). In Canada, most transportation emissions come from light-duty passenger vehicles such as cars, SUVs, and pickup trucks, and heavy-duty freight vehicles. In recent years, Canada has seen a surge in transportation use, exhibiting a 14 percent increase in GHG emissions between 2005 and 2019 (Environment and Climate Change Canada 2021). Aviation, railways, marine transport, and pipeline transport also produce emissions, but on a smaller scale. Buildings produce emissions primarily through fossil fuel equipment (such as natural gas furnaces) used to provide heating and hot water, as well as electricity for appliances and lighting (ECCC 2022).

3.2 The housing crisis

At the same time that Ontario faces an unprecedented climate crisis and the need for quick remedial action, the Province – and particularly the GGH region – is experiencing a mounting housing affordability crisis. In 2021, the average home price in Ontario was $871,000, while the median household income was about $80,000, resulting in a 59 percent ratio of average base cost to average income level (Canada Mortgage and Housing Corporation 2022). This is considerably higher than a target affordability ratio of 37 percent calculated by the Canada Mortgage and Housing Corporation (CMHC 2022), an increase over the 30 percent target that had been the norm for decades.[2] The national housing agency estimates that Ontario needs to increase the number of units projected to be added in the next ten years by 28 percent, or 1.85 million units, to achieve an affordability ratio of 37 percent.

2. Of note, the CMHC model assumes that significant filtering will occur quickly to reach this affordability ratio – an assumption that may not play out in practice (Been et al. 2019).

In particular, purpose-built rental housing and social housing stock is lacking in Canada. Of the total 5.8 million units that CMHC concludes must be built, approximately two million need to be built specifically for the rental market (Moffatt et al. 2022). The unaffordability of Canadian rental units has increased particularly dramatically. Rents for new leases on one-bedroom apartments in Guelph (a GGH municipality) doubled in the six years between 2017 and 2023 (Moffatt et al. 2022). Social housing (i.e., housing provided at non-market rates or to populations with special needs) is also lacking. Canada's current social housing stock per capita is half of the OECD and G7 countries' average (Moffatt et al. 2022). The housing crisis is thus both an issue of market supply, with the construction of more units and purpose-built rental proposed as an approach to improve affordability, and non-market supply, given the lack of construction of below-market-rate units and social housing (Been et al. 2019). It is related also to demand, as incomes are not keeping pace with housing costs, Canada is experiencing a post-pandemic surge of immigration, and empty nesters are generally reluctant to downsize from large single-family dwellings, often due to the lack of suitable smaller units in their communities, among other reasons (Toronto City Planning 2021).

3.3 Planning for growth and building new housing: regional plans and housing development debates

Though not an independent political or statistical entity, the GGH has an award-winning inter-regional plan, *A Place to Grow* (the Growth Plan), for managing population growth and urban development, mandated under the provincial *Places to Grow Act* (2005). The Growth Plan sets policies for integrated, long-term land use, infrastructure, transportation, and environmental planning for GGH municipalities, and provides projections for population and employment growth through 2051. The most recent update of the Growth Plan was approved in 2020.

The Growth Plan is governed by ten principles describing how future development in Ontario should be shaped, covering physical development, economic development, housing development, cultural and natural resources, agriculture, infrastructure, and climate change. Among these, the plan prioritises developing higher population densities in certain areas to promote transit use, preserve natural and agriculture areas, and reduce GHGs (MMAH 2020). Its overarching goal is to reduce urban sprawl and all its attendant negative environmental, economic, and health impacts by directing growth inward to currently built-up communities while simultaneously requiring that development on greenfield lands occurs at much higher, transit-supportive densities. It was followed by a $60 billion regional transportation plan focused on providing higher-order transit to support this development concept – coordinated with the plan's focused allocation of population and jobs to those municipalities with existing and planned higher-order transit.

The Growth Plan relies on three key mechanisms, the first of which is of particular importance to this study: an intensification target that defines the percentage of future residential development that is planned to occur within the built-up area (the original target was 40 percent). The built-up area refers to land within the boundary of the developed urban area (Figure 1) and is demarcated by a boundary identified by the

Province in conjunction with GGH municipalities to reflect the extent of the built-up area as of 2006 and to measure the intensification targets in the Growth Plan (MMAH 2006).

The Growth Plan also directs growth by setting out intensification targets for strategic growth areas[3] within the built-up area, such as to designated urban growth centres, transit corridors (MMAH 2020), and major transit station areas (MTSAs). Of particular importance are the urban growth centres, which function as the dominant centres of the region, and together with MTSAs act as priority areas for employment, mixed uses, community and public spaces, and entertainment, cultural, commercial, and residential uses (MMAH 2020). Strategic growth areas all have minimum density targets, and often have building- or density-type priorities. The targets are cast in terms of people and/or jobs per hectare that municipalities should plan for.

Third, the Growth Plan establishes density targets for development that is planned to continue outside the built-up areas on lands termed designated greenfield areas.[4] The plan sets a target of 40–50 residents and/or jobs per hectare (400–500 per km^2), depending on the municipality.

However, a significant shift from the Growth Plan was introduced in November 2022, when the Ontario government passed Bill 23. Titled the *More Homes Built Faster Act*, this legislation promotes and incentivises housing development, and tasks municipalities with a lead role in facilitating new residential development. It was accompanied by various government directives, including one that assigns quotas of new housing units to be built by the major municipalities by 2030.

Moreover, Bill 23 also rolled back environmental legislation and strengthened existing Ministerial authority to override municipal authority regarding local and regional land use planning, even if opposed by the municipal council. Arguably the most regressive element of the bill was removing authority for land use planning by upper-tier municipalities (the Regions of Durham, Halton, Peel, and York), effectively delegating planning responsibilities to local municipalities (although this provision has yet to come fully into effect). Bill 23 also reduced development charge funding for infrastructure, putting fiscal pressures on municipalities. This makes development processes longer and more expensive for taxpayers, and will likely influence the ability of municipalities to support affordable housing, as well as certain services that communities have come to rely on (Durham Region 2024). These governance and funding changes, coupled with the spring 2023 announcement that the government intends to repeal the Growth Plan, will set Ontario back decades in its efforts to contain sprawl.

The changes under Bill 23 will also affect the direction of long-term development and growth strategized by municipal and regional land use plans. It also removed various requirements for public participation and the public right to appeal planning decisions.

3. Strategic growth areas are sites in nodes, corridors, and other areas identified by a municipality or the Province to be the focus for intensification and high-density mixed uses, as per the Growth Plan.

4. Designated greenfield areas are lands within urban areas that fall outside the built boundary that have been designated in an official plan for development and to accommodate forecasted growth, as per the Growth Plan.

In some cases, local efforts to maintain density requirements, direct more growth to the built-up areas, and prevent development in open space or on protected agricultural land have been overridden by the provincial government since the bill's passage.

The requirements have had an impact on 12 municipal official plans. In particular, the Province mandated that areas such as Halton Region and the City of Hamilton expand their urban areas, which includes new community and employment areas,[5] adding more than 3,350 hectares in Halton and 2,200 hectares of urban space in Hamilton (Legislative and Planning Services 2022; City of Hamilton 2022). These expansions directly removed and redesignated land from the Greenbelt, causing uproar and controversy. However, within a year, the Province tabled legislation to reverse the decision (*Planning Statute Law Amendment Act* 2023).

Despite the nuances and reversals, with few exceptions the overarching theme and stated intention of the provincial government has been to dismantle a generation of provincial legislative and policy efforts to pursue intensification and densification,[6] and promote a return to low-density, car-dependent urban sprawl. Whether or not by design, this also directly impacts the efforts to integrate growth with the regional transportation plan and to create transit-supportive densities in new greenfield development areas, while simultaneously frustrating efforts to curb GHG emissions.

4. Understanding the Relationship Between Land Use and Climate

Over the past 20 years, a significant number of studies have examined the environmental impacts of sprawl and the efficacy of different policy approaches.

4.1 The environmental impacts of sprawl are significant and long lasting

Land use and development patterns have a significant impact on the emissions of greenhouse gases that cause climate change (Van de Weghe and Kennedy 2007). The location and density of development, and the type of buildings and infrastructure, affect the level of emissions generated through several mechanisms. First, the development of undeveloped open space both releases carbon sequestered in the soil, forests, and plant life, and prevents future carbon sequestration by these resources (Andrews 2008). For this reason, infill development generates fewer GHG emissions than greenfield development, especially if development at the periphery is consuming valuable ecological resources such as forests and wetlands.

Second, smaller and denser building units require less energy than larger and more dispersed units (Andrews 2008; Norman et al. 2006). Smaller units use less energy per resident for heating and cooling, and more densely built development experiences less energy loss through the transmission and distribution of electricity (Ewing and Rong 2008).

5. The Province of Ontario made changes to the Halton Region Official Plan through Regional Official Plan Amendment 49 (Regional Municipality of Halton 2022) and to the City of Hamilton Official Plan through Official Plan Amendment 167 (City of Hamilton 2022).

6. Intensification is the process of making existing housing developments or settlement areas higher density than their current state (converting low-density housing into high-density housing.) Densification refers to the increase of density of population, jobs, or housing.

Third, sprawl and low-density development is correlated with higher VKT by residents using personal automobiles, and consequently with greater use of gasoline and higher per capita emissions (Ewing et al. 2007; Holz-Rau and Scheiner 2019; Kissinger and Reznik 2019). It also suggests auto dependency, undermining the public transit infrastructure that is needed to reduce GHG emissions. In a case study of residential GHGs in the Toronto metropolitan area, researchers found that census tracts with the highest emissions were all located in low-density tracts; emissions were particularly high due to private auto use (Van de Weghe and Kennedy 2007). Similarly, a study of mobility choices in the GTHA found that vehicle ownership, among other factors, is associated with increased mobility emissions, while areas that have higher population density are associated with lower mobility emissions (Wang et al. 2023).

Another Canadian case study of household emissions in Edmonton found that housing unit size and the proportion of single-family detached homes, as well as neighbourhood distance from transit stations and the downtown area, were strongly positively correlated with high neighbourhood per capita emissions (Welegedara et al. 2021).

4.2 Addressing climate change requires multiple policy strategies

Because so much of human activity produces carbon emissions, reducing and eliminating these emissions requires a policy approach that involves multiple strategies across multiple sectors. For example, to reduce tailpipe emissions, policy can encourage use of low-emission or no-emission vehicles; an approach often referred to as "technology-forcing" policy. Other examples of technology-forcing policies in the transportation sector include mandating vehicle fuel economy standards or low carbon fuel use (Barbour and Deakin 2012).

Policy can also engage in demand-side intervention; that is, attempting to decrease emissions by reducing the average VKT with measures such as electrification and increased transit infrastructure. Examples of demand-side policies include disincentivising vehicle use via gasoline pricing and incentivising or facilitating public transit use by subsidising ridership and expanding infrastructure or service. Norway has been particularly successful in reducing carbon emissions produced by its transportation sector by introducing incentives and new infrastructure for electric vehicles. In 2021, two-thirds of new passenger cars sold were fully electric. The incentives were mainly composed of tax relief and reductions in road and parking fees (OECD 2022). Demand-side incentives in the GGH would include requiring denser land use to enable greater use of public and active transportation modes, lower per household energy use, and preservation of sequestered carbon in farmland and natural areas or vegetation.

A range of policy scholars argue that demand-side policies must be used in addition to technology-forcing policies if significant reductions in GHGs are to be achieved. Studying American legislation, California's Air Resources Board found that technology-forcing policies alone could only address short-term carbon reduction goals (CARB 2008). Demand-side policies are needed to meet long-term goals and prevent gains made via technology-forcing policies from being eliminated by the overall trend of rising automobile use (Boarnet 2010; Burbank 2009).

5. Methodology

Given the GGH's simultaneous environmental and housing crises, this study models the effects of intensification of housing development on the region's GHGs. This report models emissions from building operations and tailpipe emissions from VKT by non-freight vehicles. Both are sources of emissions with available, comprehensive, and fine-grained data that can be tailored to reflect the diversity in population density and urban form in the GGH. Most importantly, they are clearly connected to housing development and land use intensification, and can be actively influenced by policy change by the local, regional, and provincial orders of government.

5.1 Building the model

This study models the effects of land use intensification on GHGs from residential building operations and from personal VKT. We estimated emissions per household for those located within and outside the built boundary for the GGH's 21 upper- and single-tier municipalities (Figure 2).

The emissions per household were derived from a model developed by the Canadian Urban Institute (CUI). For this study, the CUI provided its estimates of average GHG emissions in tonnes of carbon dioxide equivalent (CO_2-eq) per year, per household, at the dissemination area (DA) level (the smallest standard geography for which most Canadian census data is disseminated). These emissions were divided into household energy emissions and emissions from household private vehicle travel.[7]

Household energy emissions describe how much carbon is emitted by the functions of a home. This can include activities such as heating and cooling, water consumption, and household waste. The way in which these activities are powered (electricity, gas, fuel) determines the emissions produced. We derived household energy emissions from three data sources:

1. The 2019 *Households and the Environment Survey* (Statistics Canada), which provides summaries of average household energy use in gigajoules by households for different unit types (e.g., single-detached, apartments).
2. Provincial energy profiles (provided by the Canada Energy Regulator), which convert energy in gigajoules per household to annual CO_2 equivalent emissions for different dwelling types, based on the energy sources of each province.
3. The 2021 *Census of Population* (Statistics Canada), which provides counts of dwelling units by type at the DA level.

Using these sources, we calculated total emissions for household energy use were calculated for each DA by multiplying the number of households living in each particular unit type by that unit type's emissions rate, and then totalling across all household types.

7. A recent study by the Smart Prosperity Institute's PLACE Centre adopts a different approach, using estimated vehicles per household with new development and loss of carbon sequestration from converted agricultural land (Helmer 2023). This model, which results in slightly lower estimates of GHG emission reduction than ours, does not account for VKT or household energy use.

Average emissions per household were calculated by dividing this total by the number of households.

Household private vehicle travel emissions provided by the CUI were based on provincial estimates of the physical flow account for GHG emissions from Statistics Canada. Provincial totals for household motor fuel use were divided by total number of households in a province, resulting in average annual GHG emissions of 5.4 tonnes of CO_2-eq (CO_2 equivalent) per household in Ontario.

Our study adds regional variability using DA-level estimates of average daily VKT based on the *Transportation Tomorrow Survey*, a comprehensive survey of how GGH residents use the transportation system. Provincial-level private vehicle emissions were adjusted upward or downward in each DA, based on the assumption that daily VKT is directly proportional to fuel use and emissions over a calendar year. This was estimated first by computing a household weighted average of average daily VKT for the entire region, then generating a ratio of a DA's average VKT by this average VKT, and then multiplying this DA-level VKT ratio by the average GHG emissions rate for private transport ($\text{Transport-GHG}_{DA} = (\text{VKT}_{DA} / \text{VKT}_{Average}) * 5.4\ CO_2\text{-eq}$).

Figure 2. Average Greater Golden Horseshoe region household GHG emissions, 2021

Household CO_2eq Emissions by Region in 2021 (tonnes of CO_2eq / year)

	Region	Household Average	Total
GTHA	Region of Durham	8.85	2,151,093
	Region of York	7.15	2,796,536
	City of Toronto	3.14	3,650,659
	Region of Peel	6.34	2,857,973
	Region of Halton	7.86	1,639,385
	City of Hamilton	6.33	1,409,131
Outer Ring	County of Northumberland	10.69	399,079
	County of Peterborough	8.77	225,721
	City of Peterborough	5.05	181,809
	City of Kawartha Lakes	10.16	332,423
	County of Simcoe	10.04	1,336,319
	City of Barrie	7.85	434,009
	City of Orillia	6.59	95,018
	County of Dufferin	12.76	297,472
	County of Wellington	11.71	414,015
	City of Guelph	6.18	349,478
	Region of Waterloo	6.70	1,490,114
	County of Brant	9.48	136,075
	City of Brantford	6.74	281,055
	County of Haldimand	10.79	201,981
	Region of Niagara	6.91	1,353,261
	Overall	**6.09**	22,032,606

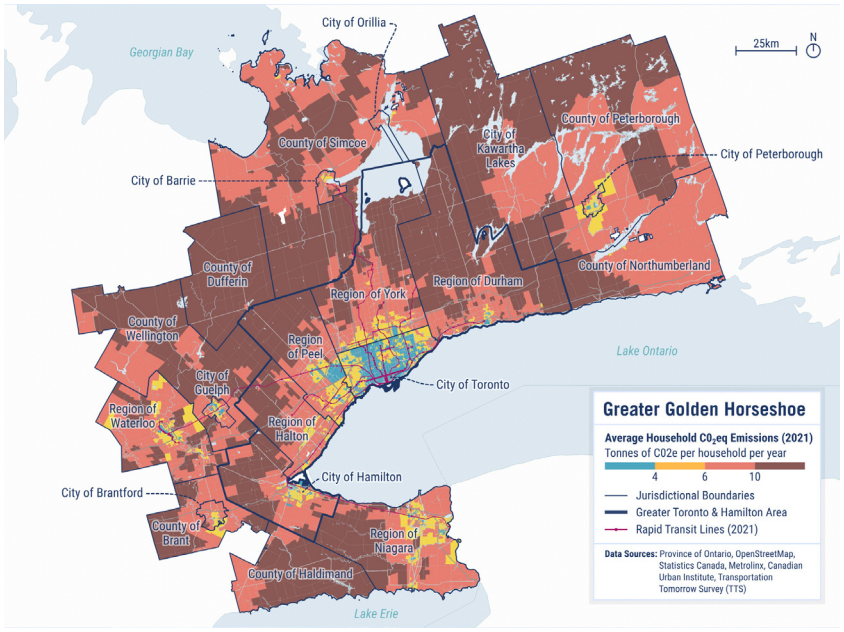
We measured overall average household emissions for each DA by totalling the average household energy and transportation-related emissions, respectively. Averages and totals were then computed for each municipality as well as for the overall region.

Neighbourhoods with denser development, fewer single-detached homes, and more alternative transportation modes (public transit, walking, cycling) generate less emissions per household. Due to longer driving distances and more detached single-family homes, rural and exurban areas generally have the highest rates of GHG emissions (Figures 2 and 3).

To model the impacts of future housing development on emissions in the GGH, we distinguished between emissions levels of households outside of the built boundary – primarily designated greenfield areas (where new housing development represents sprawl) – and inside of the built boundary (where new housing development represents intensification).

To estimate emissions due to sprawl, we assumed that new development in greenfield areas would have the same average household emissions as that between 2006 and 2021. A common way to determine how many people a space is accommodating is to compare population densities. The simplest way to measure population density is by dividing a boundary's population by the land area, producing a count of persons per

Figure 3. Average household greenhouse gas emissions by dissemination area, Greater Golden Horseshoe, 2021



km^2. We classified areas with population densities greater than 100 people per km^2 in 2021 that were located outside the built-up boundary as greenfield development that occurred in the past 15 years, and estimated their average emissions by DA. To estimate emissions of intensification, we assumed that areas experiencing development classified as intensification would have a population density of at least 5,000 people per km^2 within the built-up boundary.

Scope of this study

Estimating the effects of development on projections of future GHG emissions involves several interacting factors. In addition to tailpipe emissions and building operation emissions, a fully comprehensive model of GHG emissions would include several additional factors. These factors fall into one of two categories: either their inclusion would most likely corroborate the findings of this model and exacerbate the differences in emissions between infill development and greenfield development, or they require making complex assumptions about future development or demographic patterns. Either way, they are outside the scope of this study.

Below, we describe the additional contributing factors, as well as potential technological, demographic, and behavioural shifts that are beyond our ability to anticipate accurately in our models.

Additional contributing factors:

Effects of land use conversion on carbon sequestration

Forests, soil, and plants all sequester carbon; consequently, the urban development of open spaces both releases carbon and prevents future sequestration of carbon (Andrews 2008). While it is complex to calculate the exact amount of carbon sequestration lost from sprawl, based on land use change and GHG emission factors, an estimated gross sequestration rate is 2.12 tonnes of CO_2 per hectare, per year (Helmer 2023).[8] Although this report's model does not include estimates of the effects of greenfield development versus infill development on carbon release and sequestration, it can be assumed that scenarios involving sprawl development would significantly increase emissions and decrease the capability of the region to offset emissions through naturally occurring carbon sequestration.

Effects of commercial or industrial infill development

This study does not examine the effects of commercial or industrial development. Commercial and industrial buildings generate greater emissions than residential buildings as a whole (Andrews 2008), and their location and connectivity affect transportation emissions from freight.

Effects of embodied carbon of buildings

Embodied carbon refers to the carbon emissions associated with the upstream process of manufacturing a product, including the extraction of material,

8. Based on methods used by Pasher et al. (2014).

processing, and assembly. In 2015, roughly 11 percent of global GHG emissions came from just the manufacturing or material for construction, a number that is rapidly growing (International Resource Panel 2020). Recent research suggests that a shift in new construction from mostly single-family urban form to either low-rise multi-unit or mid- and high-rise urban form would reduce emissions by approximately 30 percent in Ontario (Rankin and Saxe 2023). Research has also shown that there is a significant embodied carbon variation in the buildings we currently build; improving building design to the standard of the top 25 percent of current buildings provides another 30 percent reduction (Rankin and Saxe 2023; Yoffe et al. 2024). For example, the type of material varies in the amount of carbon produced or sequestered. Materials such as cement and steel produce between 0.47–0.60 tonnes of carbon dioxide for every tonne manufactured (Mass Timber Institute n.d.). In comparison, roughly one cubic metre of mass timber sequesters an estimated one metric tonne of carbon dioxide (Mass Timber Institute n.d.).

Projections of technological, demographic, or behavioural shifts:

Effects of potential demographic shifts in demand for housing or transportation
Changes in household size and age of residents over time, as well as the rise in remote work, are likely to affect demand for certain types of housing and modes of transportation. This study does not model how an aging Baby Boomer population, shrinking average household sizes, or societal preference shifts for housing or transportation options could affect emissions from housing or transportation.

Effects of potential changes to transportation infrastructure
This study also does not model potential changes to transportation infrastructure, generated either by increased (or decreased) demand, increased feasibility (e.g., density facilitating cost-effective public transit or active transport options), or technological development (e.g., greater adoption of, and infrastructure for, zero emission vehicles).

Effects of potential changes to energy efficiency
Canada's 2020 *National Building Code* and *National Energy Code for Buildings* establish tiers that enable residential construction to reach the net zero energy ready standard by 2030. Efficiency Canada finds that implementing those tiers, as well as an aggressive electrification standard for new homes, would cut emissions from new residential construction by about two-thirds (Lockhart and Simon 2023).

5.2 Modelling scenarios

We modelled four scenarios representing different approaches to housing development in the GGH, and their effects on Ontario's ability to limit GHG emissions and meet deadlines for carbon reduction by 2030 (Table 2). We assumed that approximately 1.1

million of the 1.5 million housing units to be developed in Ontario under Bill 23 are built within the GGH. These projected units were divided among the municipalities based on the quotas set out in Bill 23 (Appendix A). For outer ring municipalities for which no quota was set, we used either public housing pledges or calculated an estimated number of units based on projections of housing growth made by the Ontario Ministry of Municipal Affairs and Housing (Hemson Consulting 2020).

The first scenario reflects the possible development landscape as defined by Bill 23 and the 2023 update to the Provincial Planning Statement (PPS) (MMAH 2023). Under this scenario, the 1.5 million homes to be constructed are built on greenfield land, outside of the built boundary, where possible.[9] The removal of intensification targets in the PPS allows for development to occur outside the built boundary, and Bill 23's provisional authority over municipal plans precludes any attempts by municipalities to maintain their own intensification standards. As such, while this scenario represents a "worst case," it is fully permissible under the current provincial approach to land use planning and housing development.

The second scenario reflects the outcome if the housing development under Bill 23 adheres to the intensification standards set out in the 2020 Growth Plan. These intensification targets required that 50 percent of all new development in the GGH occur within the built boundary, with the exception of eight outer ring municipalities (where the target is 40 percent) or the intensification targets set out in their most recent municipal comprehensive reviews.

The third scenario reflects the outcome if intensification of new housing development increased for each municipality by 50 percent over the assigned targets from the 2020 Growth Plan. This scenario reflects comparatively lower rates of intensification for more rural municipalities, where both consumption patterns and available infrastructure could make intensification more challenging.

The fourth scenario reflects the outcome if all new development takes place within the built-up boundary, and no sprawl development occurs. Although this is aspirational, our case studies in the next section reveal that seven cities and four regions outside of Toronto have in effect seen 50 percent or more of new residential development occur within their built-up areas.

6. Findings: Land Use Intensification Significantly Lowers Household Emissions

This section first presents the results of the four scenario models, and then examines in more detail recent residential construction trends in the GTHA. Based on archival research and interviews with three regional governments, we identify land use policies that are helping certain regions and municipalities intensify.

6.1 A comparison of scenarios: from All-Sprawl to No Sprawl

Our model demonstrates a significant difference in projected annual GHG emissions in

9. The City of Toronto has no remaining greenfield land. Consequently, this scenario counts Toronto's 285,000 target units of new housing as entirely intensification development.

Table 2: Five scenarios of intensification percentage in the Greater Golden Horseshoe used for modelling household-level GHG emissions

Macro	Municipality	Bill 23 Housing Quota	Zero intensification[i] (%))	Build as usual[ii] (%)	Growth Plan/ PPS[iii] (%)	50% increase[iv] (%)	No sprawl (%)
Inner Ring (GTHA)	City of Hamilton	47,000	0	56	50	75	100
	City of Toronto	285,000	100	100	100	100	100
	Region of Durham	84,000	0	66	50	75	100
	Region of Halton	83,000	0	44	50	75	100
	Region of Peel	246,000	0	53	50	75	100
	Region of York	125,000	0	44	50	75	100
Outer Ring	City of Barrie	23,000	0	67	50	75	100
	City of Brantford	10,000	0	53	50	75	100
	City of Guelph	18,000	0	63	50	75	100
	City of Kawartha Lakes*	8,000	0	90	30	65	100
	City of Orillia	7,000	0	56	50	75	100
	City of Peterborough	5,110	0	62	50	75	100
	County of Brant	3,050	0	23	15	58	100
	County of Dufferin	3,860	0	43	40	70	100
	County of Haldimand	2,720	0	30	32	66	100
	County of Northumberland	3,910	0	39	40	70	100
	County of Peterborough	9,640	0	17	40	70	100
	County of Simcoe	28,240	0	32	32	66	100
	County of Wellington	8,020	0	25	20	60	100
	Region of Niagara	19,000	0	54	50	75	100
	Region of Waterloo	70,000	0	69	50	75	100

[i] Zero intensification (worst case). [ii] Build as usual (same growth as 2006–2021). [iii] Growth Plan, 2020 Provincial Policy Statement (moderate). [iv] 50% increase in Growth Plan intensification

***Note:** Our calculations found the City of Kawartha Lakes had a recent dwelling growth of 90 percent intensification within the built boundary, while population growth saw only 35 percent intensification; nearly equal with the City of Toronto, but its geography, typology, and qualities differ significantly. While it is difficult to justify the precise reason, we think this deviation is because there was a large amount of population growth in rural and cottage areas where older cottages have become year-round homes..

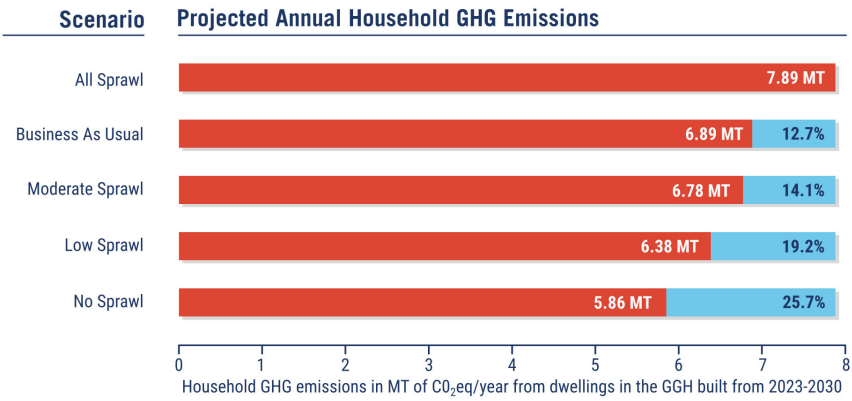
scenarios that encourage intensification and limit sprawl. Under the "worst case" All-Sprawl scenario, new housing is projected to generate approximately 7.89 megatonnes of GHG emissions per household annually (Figure 4). Under a "business as usual" scenario, reflecting the intensification targets of the 2020 Growth Plan, this figure would drop to 6.89 megatonnes of GHG emissions, a decrease of 12.7 percent over the current situation; a "moderate" sprawl scenario is quite similar, with a drop to 6.78 megatonnes and a decrease of 14.1 percent. A "limited sprawl" scenario, in which municipalities reduce sprawl by half of their 2020 targets, sees a further reduction of 19.2 percent. In a hypothetical situation in which all development takes place within the built boundary, annual household greenhouse gas emissions would be reduced by more than 25 percent.

Construction trends in the recent past are undoubtedly the best predictor of future trends over the short-term. Residential production trends from 2006–2021 have included some intensification accompanied by substantial greenfield development (Gordon and Herteg 2023). If the region continues to build as usual, it will see a 12.4 percent reduction in GHG emissions, quite similar to the moderate sprawl scenario.[10]

6.2 Compounding effects

The estimated positive environmental impacts of increasing intensification in the GGH are likely to be conservative. Municipalities with more dense development had lower

Figure 4: Scenario results – total projected annual household greenhouse gas emissions



Data Sources: Province of Ontario, Statistics Canada, Canadian Urban Institute, Transportation Tomorrow Survey (2021)

10. For comparison, looking at all of Canada, the recent SMART Centre report estimates a reduction of 15.6 percent under a "strong policies to reduce sprawl" scenario (Helmer 2023).

average levels of GHG emissions per household, both in units built in greenfield areas (sprawl) and units built within the built-up boundary (intensification). In scenarios where municipalities direct and see a greater proportion of units as intensification, rather than sprawl, their GHG emissions per household estimate would be expected to decrease as the area within the built boundary becomes more densely developed, public transit and active transport modes become more feasible for more households, and distances between jobs and housing decrease.

6.3 Addressing sprawl in the Canadian context

Some Canadian municipalities and regions have been more successful than others at reducing their GHG emissions. Many regional plans include land use strategies, such as intensification and directing housing and population growth to built-up areas, or designating urban growth centres and transit corridors, intended to aid in mitigating sprawl. Some municipalities and regions offer incentives for development in these areas.

While municipal and regional officials and planners can attempt to direct growth, there are also external trends that drive intensification. These include economic factors that drive housing demand overall; demographic structure of the population (e.g., age or family size) that dictates choices such as unit type; housing supply, and subsequently, housing cost and affordability; and changing lifestyle preferences showing a demand for well-serviced urban areas with a concentration of amenities (Lorius and Associates 2020). GGH intensification patterns in recent years are shown in Table 3. Intensification is captured by the percentage of new development in the built boundary. Aside from Toronto, which builds exclusively infill, the jurisdictions that have succeeded in intensifying include the Cities of Kawartha Lakes and Barrie, and the Regions of Waterloo and Durham. Counties in the outer ring have intensified the least.

We reviewed the land use goals of the top four jurisdictions, excluding Toronto, with the highest levels of intensification.[11] These areas exceeded their minimum percentage of new development in the built boundary by 25–60 percent. We compared their intensification and densification measures along with their housing targets. Additionally, we reviewed their plans for reducing GHG emissions and any additional incentives for growth within the built boundary.

Each of the four land use plans encourages intensification through various policies that promote development in urban areas. They set targets for the amount of new residential development occurring annually within the built boundary and minimum density targets or boundaries for urban growth centres and transit corridors. This latter measure is not required for all areas within the Growth Plan boundaries. The density targets for urban growth centres in the Regions of Waterloo and Durham and the City of Barrie range from 150–200 residents and jobs per hectare (1,500–2,000 per km^2). While the City of Kawartha Lakes has growth centre boundaries, it does not have minimum density targets.

11. Official Plans reviewed included the Region of Durham (2017, 2020), and the Region of Waterloo (2015), the City of Barrie (2010, 2023) and the City of Kawartha Lakes (2012). Archived plans were included to match timelines in this report.

Table 3. Change in housing units 2006–2021 by percentage built within built-up areas

Macro	Municipality	Growth 2006–2021	In built boundary (%)	In urban growth centre (%)	In transit buffer (%)
Inner Ring (GTHA)	City of Toronto	212,641	100.0	55.2	64.6
	Region of Durham	48,404	66.0	1.8	3.2
	City of Hamilton	28,602	55.9	4.0	6.9
	Region of Peel	94,515	53.5	10.3	7.2
	Region of York	119,091	43.7	2.0	9.4
	Region of Halton	51,976	43.5	2.9	6.4
Outer Ring	City of Kawartha Lakes	961	90.0	0.0	0.0
	Region of Waterloo	46,165	69.4	4.3	22.7
	City of Barrie	9,080	67.0	9.1	5.8
	City of Guelph	11,777	62.5	5.2	5.9
	City of Peterborough	4,964	61.8	1.0	0.0
	City of Orillia	2,415	55.6	0.0	0.0
	Region of Niagara	28,023	53.7	2.2	0.8
	City of Brantford	6,306	53.2	5.1	0.0
	County of Dufferin	4,634	43.0	0.0	0.0
	County of Northumberland	5,569	39.3	0.0	0.0
	County of Simcoe	33,535	31.6	0.0	0.1
	County of Haldimand	2,324	29.8	0.0	0.0
	County of Wellington	5,646	25.1	0.0	0.0
	County of Brant	2,261	23.1	0.0	0.0
	County of Peterborough	995	17.3	0.0	0.0

Note: Data in the built boundary is based on areal interpolation of DA-level census data on dwelling units built between 2006 and 2021 within the built boundary, a GIS analysis of the reaggregation of data from one set of polygons (the source polygons) to another (the target polygons). The transit buffer is calculated as a one km buffer from any subway, regional GO train, or light rail transit station, circa 2021.

Waterloo, Durham, and Barrie have various types of development incentive programs that help encourage growth in defined areas. Waterloo waives fees for all development occurring in core areas of the Cities of Cambridge and Kitchener. Additionally, it has a regional development charge exemption and other financial assistance for remedying projects in brownfield areas (Region of Waterloo 2022). Durham's Regional Revitalization Program provides financial support for redevelopment and intensification projects within municipal community improvement plan areas and encourages both residential and

employment growth in key urban locations (Durham Region 2023). Barrie also has community improvement plans that facilitate grants to help fund certain developments (City of Barrie 2019). Its Redevelopment Grant Program provides incentives to promote the redevelopment of underutilized sites within the urban growth centre and strategic growth areas.

The GGH plans we reviewed do not directly relate land use strategies to reducing GHG emissions. However, in more recent iterations of official plans, some discuss climate change or GHG emissions. For example, Durham supports renewable energy, and promotes tree planting and energy efficient buildings, and Barrie outlines potential policies for development design and promotes renewable energy.

Bill 23 amends various acts, including Ontario's *Planning Act*. A scheduled amendment that has yet to be proclaimed will influence the ability of GGH Regions to exercise planning authority, putting the responsibility for land use decision-making on the individual 89 lower-tier municipalities. These changes have yet to take full effect but will greatly impact the long-term implementation of land use strategies, including density and intensification measures, as lower-tier municipalities begin to take full responsibility for directing growth.

Provincial and municipal governments need to develop effective channels for working together on innovative land use policies that reduce emissions and facilitate development. The California regions which have successfully incentivised land use planning for GHG reductions benefit from the state establishing a stable institutional framework for long-range regional plans that incorporates local government participation via metropolitan planning organizations (Barbour, Deakin, and Smith 2024). Similarly, Ontario will need to provide a structure for regional governance in order to integrate land use and transportation effectively.

Effective land use strategies in Ontario: Region of Waterloo

A study for the Region of Waterloo has documented not only the need for more diverse housing options for residents, but also a notable market shift toward denser building typologies (Eby et al., 2022). With a rapidly aging population, the region will need much more housing conducive to senior living, particularly in townships outside of larger municipalities. The study recommends intensification of centres within rural townships, rather than continued urban expansion. And in fact, the last decade has seen more construction of apartments and fewer single- and semi-detached units than forecasted.

Waterloo attributes this trend in part to having invested in a rapid transit system, zoning for higher densities along transit corridors, and planning for complete communities that contribute to a shift toward multi-unit new construction within urban boundaries. The Region also has a high rate of secondary suite adoption: in 2022, 14 percent of Waterloo's total new housing supply for the entire region was secondary suites, laneway houses, or tiny homes added to existing properties by homeowners (Eby et al., 2022).

Effective land use strategies outside the GGH: Kelowna, British Columbia

In the City of Kelowna's *Official Community Plan* (OCP), the land use and climate policies are intended to stop urban sprawl into rural lands and focus residential density in urban centres and along transit corridors (City of Kelowna 2018). The City set a permanent growth boundary, which means urban uses in rural lands are not supported and subdivisions are discouraged. It also set a 2040 goal of 73% for residential unit distribution in urban centre and core areas (In 2017, 40 percent of new residential units were built in the urban core [City of Kelowna 2018b].) The OCP connects land use planning to climate resiliency while providing GHG emissions reduction targets. The City plans to build climate resiliency through land use design by focusing growth in connected, walkable, urban centres and core areas, providing diverse transportation options to shift away from a car-centric culture, and reducing energy consumption by constructing energy efficient buildings and neighbourhoods (City of Kelowna 2018).

In addition, Kelowna's *Community Climate Action Plan* aims to reduce GHGs from five main categories (transit, buildings, waste, planning, renewable energy), with transit emission reduction targets accounting for 72 percent. The action plan discusses land use planning as a means of reducing energy and emissions, primarily by focusing growth in urban areas. When residents and workers are located closer to transit and services, the amount of people who drive can be reduced by 20–40 percent and GHG emissions can be reduced by 18–36 percent. Land use planning accounts for ten percent of the City's total reduction targets, an estimated reduction of 5,400 tonnes (City of Kelowna 2018b).

7. The Potential of Land Use Strategies to Mitigate Climate Change: Discussion and Recommendations

Evidence from other regions, academic literature, and policy research makes it clear that land use strategies are a necessary element in reducing and eliminating GHG emissions. Technology-forcing strategies alone are not sufficient. Demand-side policies that incentivise and facilitate structural changes to reduce GHG emissions from buildings and transportation are a crucial component. Recent work by the Clean Economy Fund shows that strong demand-side policies can provide one-third of the GHG reductions necessary to enable Canada to meet its targets (Task Force for Housing and Climate 2023). Land use policies that encourage dense development, particularly near transit nodes, are a key part of these strategies. These policies have significant potential to reduce the emissions generated by buildings, preserve open space that provides critical carbon sequestration, and reduce VKT (vehicle kilometres travelled).

Pursuing dense development rather than sprawl through land use policies is also an approach that can be started immediately and by local and regional governments.

Technology-forcing policies and carbon trading, as well as other elements in the fight against climate change, require agreements at provincial, national, and international scales, which necessarily require longer timelines for deliberation, approval, and implementation. Land use strategies can be developed and implemented by local and regional leaders and agencies, with far-reaching effects for national carbon budgets.

Finally, land use strategies that do not prioritise intensification at all, like those of the current Ontario government, exacerbate the climate crisis. Not only are GHG emissions markedly higher in greenfield development, but the urban development patterns created through sprawl encourage compounding negative effects: increased costs and decreased feasibility of public or active transportation infrastructure and increased travel distances and VKT. While producing additional housing units is one of the key strategies for addressing the affordability crisis in the GGH, addressing this immediate need cannot contribute further to GHG emissions. Climate change is not only a long-term threat but an immediate one.

7.1 Recommendations

To help meet Canada's climate goals, land use planning by provincial, regional, and municipal orders of government should aggressively constrain sprawling development and encourage intensification. Supporting both residential growth and climate goals will require coordination among all orders of government, and with the oft-siloed agencies that oversee housing and infrastructure development.

Managing residential growth is a primary goal of the GGH Growth Plan, with planning for intensification through strategic growth areas. We recommend that there be continued and focused planning for growth in urban growth centres and transit corridors to direct and promote intensification, with additional local strategic growth areas such as regional centres, local centres, corridors, transit areas, and in some cases, waterfronts. Cities are also encouraged to make use of secondary plans in core areas, where they are not already doing so. Urban growth centres are recognized by various regions as focal points for both new development and redevelopment across geographies (City of Barrie 2023; Durham Region 2020; Regional Municipality of Halton 2022; Region of Waterloo 2015). Growth centres are often planned with transit in mind and are connected through supportive corridors with active transportation. They should continue to be a focus for development and growth incentives with coordinated planning to ensure they can thrive and contribute to more sustainable communities.

Specific policies, programs, and incentives by regional and municipal governments will encourage intensification. First, municipalities need to modify zoning to allow density to occur. Aligning density strategies with city-building objectives will produce the most social and economic sustainability while reducing GHG emissions. Bill 23's provisions (allowing up to three units on a lot) are a start, but in urban growth centres and transit station areas, municipalities need to spur much higher densities. This will mean the use of zoning tools such as density bonuses, purchase or transfer of development rights, mixed use zoning, high minimum density zoning, and reduction or elimination of parking requirements (Delaware Valley Regional Planning Commission 2004; Housing Solutions Lab, 2023; Siemiatycki and Fagan 2021).

Second, municipalities need to provide regulatory relief by streamlining permitting, approval, and environmental review processes (Delaware Valley Regional Planning Commission 2004; Housing Solutions Lab, 2023; Siemiatycki and Fagan 2021).

Third, jurisdictions need to provide a flexible menu of financial incentives, including development charge waivers, land assembly assistance, low interest loans, infrastructure development, and tax abatements (Delaware Valley Regional Planning Commission 2004).

Finally, larger development projects will require building multi-sectoral partnerships, engaging diverse stakeholders, and cobbling together multiple sources of funding (Siemiatycki and Fagan 2021; Urban Land Institute 2012).

As a complement to these infill development incentives, Ontario's municipalities and regions should combine public investment and private incentives that encourage revitalization and development projects (Hare 2001). Many GGH cities and regions already offer incentives in various forms. The Region of Waterloo provides development incentive options in the form of grants and development charge exemptions, particularly for core areas such as Kitchener, Cambridge, and Northdale (Region of Waterloo 2022). The Region of Durham has multiple incentives, including development charge credits and exemptions, servicing upgrades, and funding for redevelopment projects (Durham Region 2023). The City of Hamilton recommends educational programs about the benefits of densification and makes efforts to attract new residents to high-density living (City of Hamilton 2021; Lorius and Associates 2020).

In addition, the Province of Ontario should revisit Bill 23, preserving elements that spur the production of housing, but reinstating and reforming the regional planning powers that enable GHG emissions reduction. It should also reverse its plans to repeal the Growth Plan and reinstitute the more progressive intensification and greenfield density targets it weakened in its 2020 amendments to the plan. Only through some form of inter- and intra-regional planning will Ontario be able to coordinate its transportation and land use systems to meet both climate and housing goals expeditiously (Chapple 2014; Iveson and Eidelman 2023). Regional bodies can then provide an array of carrots and sticks that incentivise municipalities to constrain sprawl and help counter any local political opposition.

Finally, researchers should continue to model these effects, including taking into account other contributing factors (such as embodied carbon) and on-going technological, behavioural, and demographic shifts, as well as examining the GHG impacts of commercial and industrial growth outside the urban core. These combined models, along with stakeholder input, can help promote growth that also helps mitigate climate change through efficient intensification and resource use.

Appendix A: Greater Golden Horseshoe Housing Quotas, Bill 23

Macro	Municipality	Housing quota
GTHA	City of Hamilton	47,000
	City of Toronto	285,000
	Region of Durham	84,000
	Region of Halton	83,000
	Region of Peel	246,000
	Region of York	125,000
GTHA Subtotal		**870,000**
Outer Ring	City of Barrie	23,000
	City of Brantford	10,000
	City of Guelph	18,000
	City of Kawartha Lakes*	8,000
	City of Orillia*	7,000
	City of Peterborough*	5,110
	County of Brant*	3,050
	County of Dufferin*	3,860
	County of Haldimand*	2,720
	County of Northumberland*	3,910
	County of Peterborough*	9,640
	County of Simcoe*	28,240
	County of Wellington*	8,020
	Region of Niagara	19,000
	Region of Waterloo	70,000
Outer Ring Subtotal		**219,550**
GGH Total		**1,089,550**

Note: Blue text with an asterisk indicates pledges or estimated targets based on housing projections, and do not have official targets under the Bill 23 mandate.

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