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Less is More: Where We Build 5.8 Million Homes Matters

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About the PLACE Centre

The PLACE Centre, which stands for Propelling Locally Accelerated Clean Economies, focuses on the complex challenges limiting clean economic growth in Canadian communities. Our core approach is "place-based," meaning the PLACE team works with all levels of government, industry, and civil society organizations to ensure regions across Canada have the solutions needed to overcome the challenges they face in advancing clean economic growth. With this approach, the PLACE team can create practical, place-based recommendations where everyone involved can collaborate and work towards making progress in solving these problems. That way, every region and community across the country can be included in, and benefit from, Canada's growing clean economy.

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About Smart Prosperity Institute

Smart Prosperity Institute is a national research network and policy think tank based at the University of Ottawa. We deliver world-class research and work with public and private partners to advance practical policies and market solutions for a stronger, cleaner economy.

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Task Force for Housing & Climate

This report is part of a package of GHG emissions modelling submitted to the Task Force for Housing & Climate for the purpose of better understanding the three biggest sources of GHG emissions associated building 5.8 million new homes by 2030: building energy performance; embodied emissions from construction materials and supportive infrastructure; and land use planning decisions. For the full package of research, visit:

housingandclimate.ca/ghgs

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Task Force for Housing & Climate

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Key Points From This Report

- Where we build new homes matters from an affordability and climate perspective. To achieve both affordability and net zero objectives, we need to make different choices than we have been making.
- Over the past ten years, the share of new homes that were infill varied considerably by province and by community. British Columbia is far ahead of other provinces. Within provinces, there are also substantial variations in terms of how many new homes were added for each hectare of land lost to settlement expansion — in Regina, Mississauga and Waterloo, for example, more new homes are built per hectare of land lost than in Whitby, Ottawa or Trois-Rivières.
- This report models two scenarios of where 5.8 million homes are built by 2030: an infill scenario and a business-as-usual scenario. The difference between the business-as-usual scenario and a targeted infill scenario in terms of greenhouse gas emissions, is more than **4.5 MT** of CO_2e annually. That's equivalent to the annual emissions from more than **1,100,000** gas-powered cars.
- If we build 5.8 million homes between 2021 and 2030 in the same way and in similar locations as we did from 2011 and 2021, we will likely lose 142,438 hectares of cropland, 6,955 hectares of grassland and 28,143 hectares of forest to settlement expansion. If choose to infill rather than sprawl, we can protect 108,496 hectares of cropland, 5,502 hectares of grassland and 23,057 hectares of forest.
- If we want more housing and less emissions, we need to infill everywhere. That means making the absolute most of the existing land and buildings in every community, prioritizing building close to existing transit service, building on underutilized surface parking lots and brownfield sites and converting vacant commercial buildings to residential uses. Time-limited policies to encourage construction of new housing in these locations as soon as possible should be pursued by all levels of government.

Introduction

There is a broad consensus that Canada is in the midst of a housing affordability crisis. In "Baby Needs a New Home" (2021) and "Ontario's Need for 1.5 Million More Homes" (2022), Mike Moffatt estimates the demand for housing over a ten year period. The Ontario government, and many municipal governments, have established housing targets for 2021 to 2030.[1] The Canadian Mortgage and Housing Corporation (2022) has estimated that 5.8 million homes, nationally, need to be built by 2030 in order to address the housing affordability crisis.

As part of the global effort to mitigate the effects of climate change and keep global warming below 1.5 degrees, Canada has committed to an ambitious emissions reduction plan to reach net zero emissions by 2050 and 40% lower than 2005 levels by 2030 (2022a). More than tripling the rate of new housing construction, which is what is required to reach CMHC's 5.8 million new homes by 2030, will drive significant change and economic activity throughout the country.

But where will these new homes be built and how will where we build affect our national emissions reduction plan? This report explores two scenarios. In the first scenario, **business-as-usual**, the trends over the past 10-year period continue until 2030 but the scale of new home building increases to reach 5.8 million new homes. The high-level geographic distribution of the new homes follows the same pattern as 2011 to 2021. In a second scenario, **targeted infill**, the high-level geographic distribution of new homes stays the same at the municipal level, but where new housing is built *within* those municipalities changes.

Our need for new housing to address the affordability crisis people are facing now and to accommodate projected population growth is acute. Building millions of new homes is going to generate a lot of GHG emissions. But where we build those new homes, as outlined in this report, matters.

The report proceeds in three parts. First, the story over the past 10 year period, 2011 to 2021. Where were new homes constructed? How much land was required to build those new homes? Second, estimates of the GHG emissions related to land use change and transportation mobility for the two scenarios are compared. Finally, the report concludes with recommendations for policymakers at all levels of government.

Our dual goals of more housing and less emissions require us to be creative and to do things differently.

[1] See the Ministry of Municipal Affairs Housing Progress Tracker (2023).

Table 1: Change in dwellings, 2011 to 2021, top 25 municipalities. Home values, rent and household income from the 2021 Census of Population.

		Dwellings built, 2011 to 2021				Average		
Municipality	Pop. Density	Number of Dwellings	As % of Dwellings in 2021	As % of Total Built in Canada	% of Households that Rent	Household Income (2020)	Home Value (2021)	Rent (2021)
Toronto (C)	4428	160,985	13.90%	8.10%	48.1%	$96,000	$1,131,000	$1,562
Calgary (CY)	1592	91,895	18.30%	4.60%	31.2%	$104,900	$519,500	$1,404
Edmonton (CY)	1320	85,740	21.60%	4.30%	36.4%	$92,900	$419,600	$1,302
Montréal (V)	4833	67,310	8.20%	3.40%	63.6%	$69,600	$584,500	$969
Ottawa (CV)	365	59,845	14.70%	3.00%	36.1%	$103,000	$672,000	$1,422
Vancouver (CY)	5750	48,675	15.90%	2.40%	54.5%	$92,500	$1,728,000	$1,660
Surrey (CY)	1798	39,915	21.50%	2.00%	30.5%	$100,100	$1,102,000	$1,434
Brampton (CY)	2469	38,195	20.90%	1.90%	21.9%	$107,100	$967,000	$1,628
Winnipeg (CY)	1623	36,630	12.20%	1.80%	36.9%	$81,200	$364,000	$1,137
Québec (V)	1215	31,755	12.00%	1.60%	48.8%	$72,100	$326,800	$904
Halifax (RGM)	80	25,040	13.10%	1.30%	42.5%	$80,300	$403,600	$1,251
Markham (CY)	1605	22,930	20.70%	1.20%	18.3%	$106,800	$1,208,000	$1,890
Hamilton (C)	509	20,915	9.40%	1.00%	34.3%	$92,100	$752,000	$1,233
Burnaby (CY)	2751	20,745	20.50%	1.00%	39.5%	$88,700	$1,175,000	$1,536
Vaughan (CY)	1186	20,595	19.80%	1.00%	14.1%	$123,000	$1,282,000	$2,048
Saskatoon (CY)	1175	20,330	19.00%	1.00%	35.1%	$87,400	$393,600	$1,210
London (CY)	1004	20,260	11.60%	1.00%	41.9%	$80,800	$583,500	$1,213
Gatineau (V)	851	17,990	14.20%	0.90%	39.8%	$79,800	$360,400	$968
Mississauga (CY)	2453	17,850	7.30%	0.90%	29.6%	$104,300	$999,000	$1,650
Richmond (CY)	1629	17,620	21.70%	0.90%	28.7%	$85,800	$1,178,000	$1,672
Laval (V)	1781	17,405	10.30%	0.90%	33.4%	$84,300	$451,600	$1,003
Regina (CY)	1266	15,520	16.80%	0.80%	33.6%	$88,500	$361,600	$1,214
Milton (T)	365	13,785	34.40%	0.70%	17.4%	$116,300	$1,022,000	$2,042
Kitchener (CY)	1878	13,780	13.80%	0.70%	40.3%	$87,800	$701,000	$1,334
Oakville (T)	1538	13,630	18.50%	0.70%	22.5%	$136,600	$1,388,000	$2,146

The past 10 years: housing growth

If we were to continue building homes from 2021 to 2030 as we did from 2011 to 2021, where would they likely be located?

Targets of 5.8 million homes over nine years or 1.5 million over ten years (Ontario's target) are ambitious, given the number of homes built in Canada over the previous 10 year period. Almost 2 million (1,992,145) dwellings were built between 2011 and 2021.[2] Virtually all of these new homes were built in the 185 census divisions with at least 30,000 population (out of 293 total census divisions), leaving just 59,000 dwellings — less than 3% — constructed in the remaining 108 census divisions. Therefore, the analysis in this report focuses on those 185 census divisions. Table 1 provides an overview of the top 25 municipalities by the total number of dwellings built in the ten year period.

The vast majority of new housing has been built in cities

Most of the growth in new housing is concentrated in municipalities with larger populations in Ontario, Québec, BC and Alberta. More than 939,340 dwellings were built in the top 25 cities from 2011 to 2021, accounting for **almost half (50%) of all dwellings built**. Unsurprisingly, within that

[2]Census of Population, 2021 and National Household Survey, 2011(2023).

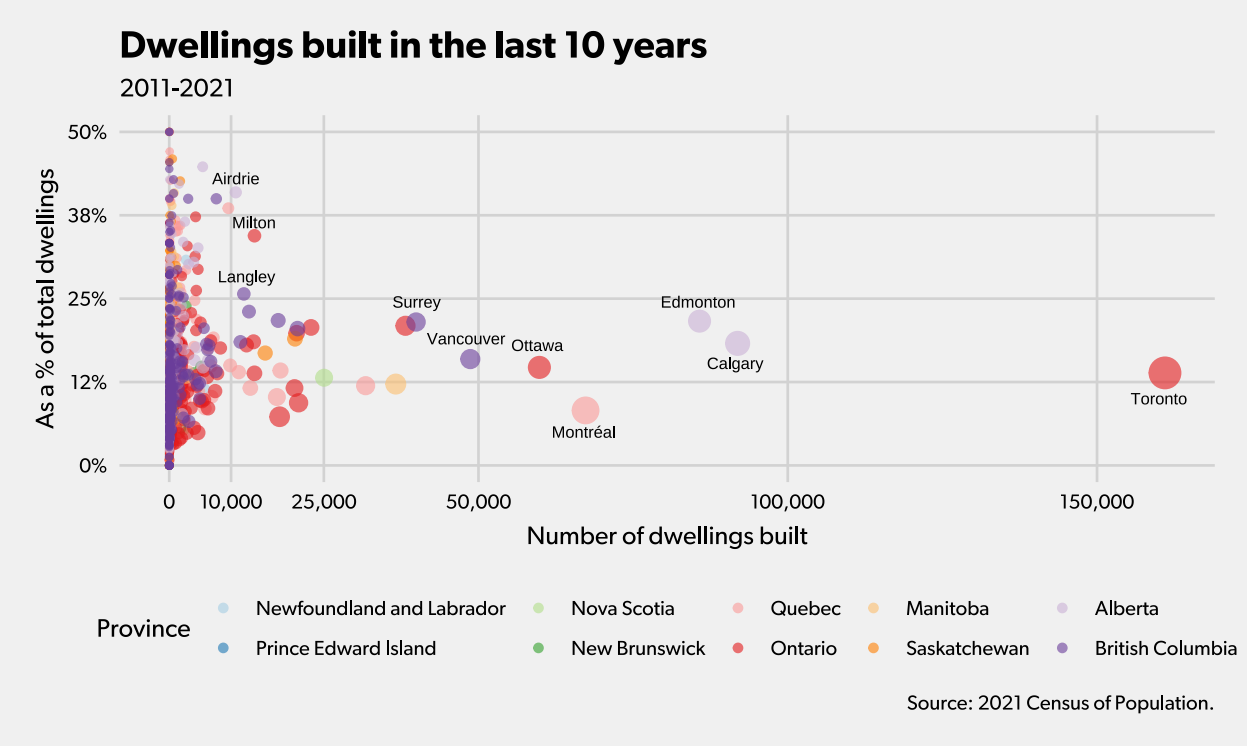


Figure 1: Dwellings built from 2011 to 2021.

top 25, the largest cities account for a significant share of new housing: Toronto (160,985), Calgary (91,895), Edmonton (85,740), Montréal (67,310), Ottawa (59,845), Vancouver (48,675), Surrey (39,915), Brampton (38,195), Winnipeg (36,630), Québec (31,755). Halifax stands out among Atlantic cities.

But what about smaller communities? There are over 3,700 Census Subdivsions (CSDs) within the 185 census divisions.[3] Zero dwellings were added in roughly one quarter of them. Figure 1 shows the distribution of new homes in these 2,206 communities — most of them municipalities — where the number of dwellings in 2021 was higher than it was in 2011. The y-axis shows how significant the number of new dwellings is as a percentage of the total number of dwellings in the community at the end of the period — a measure of the pace of new housing construction. Almost none of the municipalities with a significant number of new dwellings added more than 25% of their housing stock in the past 10 years. This is particularly important in the context of the 5.8 million homes target identified by CMHC, which would be an **increase of 36%** over the number of private dwellings in Canada in 2021.

Looking at municipalities that are adding the most new homes, relative to their existing hous-

[3]Statistics Canada defines Census Subdivisions to include municipalities and areas "treated as municipal equivalents for statistical purposes" such as Indian reserves and unorganized territories (S. Canada 2021). "Census division (CD) is the general term for provincially legislated areas (such as county, municipalité régionale de comté (MRC) and regional district) or their equivalents. In other provinces and the territories where laws do not provide for such areas, Statistics Canada defines equivalent areas for statistical reporting purposes in cooperation with these provinces and territories. Census divisions are intermediate geographic areas between the province/territory level and the municipality (census subdivision)." (S. Canada 2022)

ing stock, and have added at least 2,000 new homes in 10 years, BC, Alberta and Ontario stand out: Cochrane (5,415, +45%), Airdrie (10,765, +41%), Metro Vancouver A (3,070, +40%), Langford (7,615, +40%), Mirabel (9,560, +39%), East Gwillimbury (4,265, +37%), Beaumont (2,540, +37%), Milton (13,785, +34%), Chestermere (2,255, +34%), King (2,950, +33%).

The many smaller, rural communities, when added together, added 169,785 new homes, slightly more than the City of Toronto.[4]

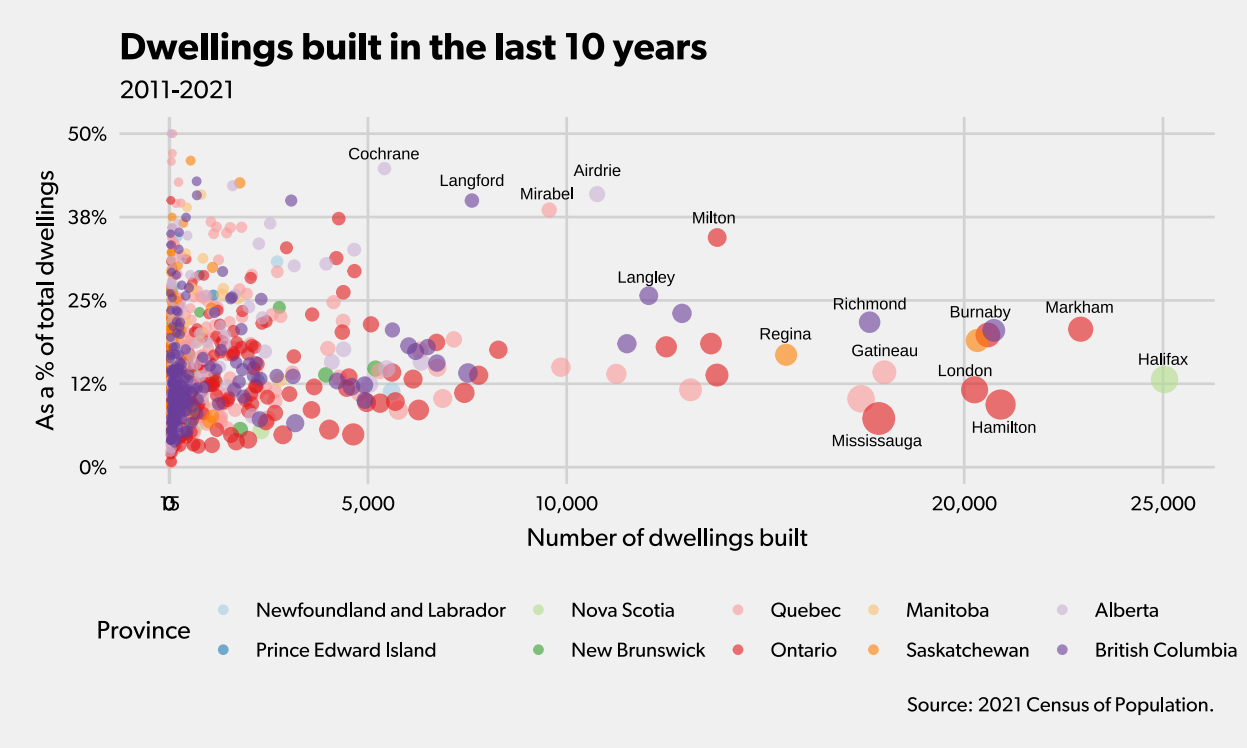


Figure 2: Dwellings built from 2011 to 2021 in communities that added between 25 and 25,000 dwellings.

Figure 2 shows the number of dwellings and the rate of new housing construction for communities that added 25,000 or fewer new homes over the past 10 years. Focusing in on these mostly small and mid-size communities, there are only a handful of municipalities that have added a substantial number of new homes (at least 5,000 over 10 years) very rapidly (+30% or more of their housing stock).

Understanding where homes have been built, and the pace at which different communities are building new housing is important. But what kind of homes are being built? Although many of the housing targets are expressed in terms of total units over time, a single-detached home with a two-car garage is very different — especially in terms of affordability — than a townhouse, semi-detached or an apartment.

Figure 3 shows the breakdown of housing starts from January 2011 to January 2021, by type of dwelling, in communities with at least 10,000 people. Summarized at the provincial level, the

[4]Only communities with a population density lower than 50 people per square kilometer are included in this total.

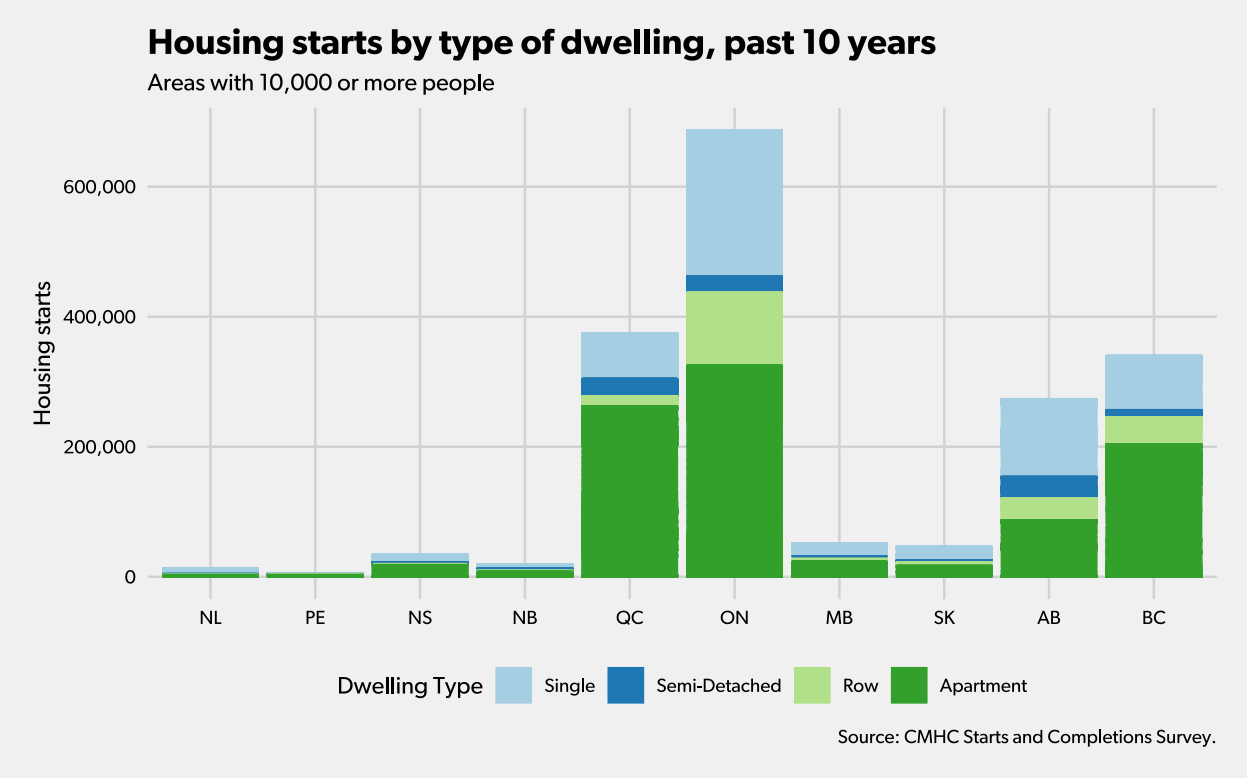


Figure 3: Housing starts by type of dwelling, past 10 years.

more affordable types of homes — row, semi-detached and apartments — account for the largest share of new homes. Still, single-detached homes are the second-most common type of new home constructed, after apartments.

At the municipal level, the mix of dwelling types built varies considerably. Figure 4 shows housing starts by dwelling type for nine municipalities that have either added a lot of new homes (in total numbers) or added a lot of new homes (as a share of overall housing stock). Montréal and Toronto are adding almost entirely apartments. Vancouver is adding apartments, but single-detached homes account for a small but relatively larger share of starts in Vancouver than in Montréal or Toronto.[5] In Ottawa, Edmonton and Calgary on the other hand, single detached homes have been a significant component of overall housing starts throughout the 10-year period. Finally, in smaller but fast-growing municipalities like Airdrie and Milton, single detached homes account for more than half of all housing starts in some years.

The past 10 years: land use change and settlement expansion

Different kinds of housing require more or less space than others. For example, a median single detached home in Toronto CMA is more than four times larger, in terms of living area, than a me-

[5]These single detached starts in Vancouver are very likely newer homes built on lots of pre-existing homes that were demolished.

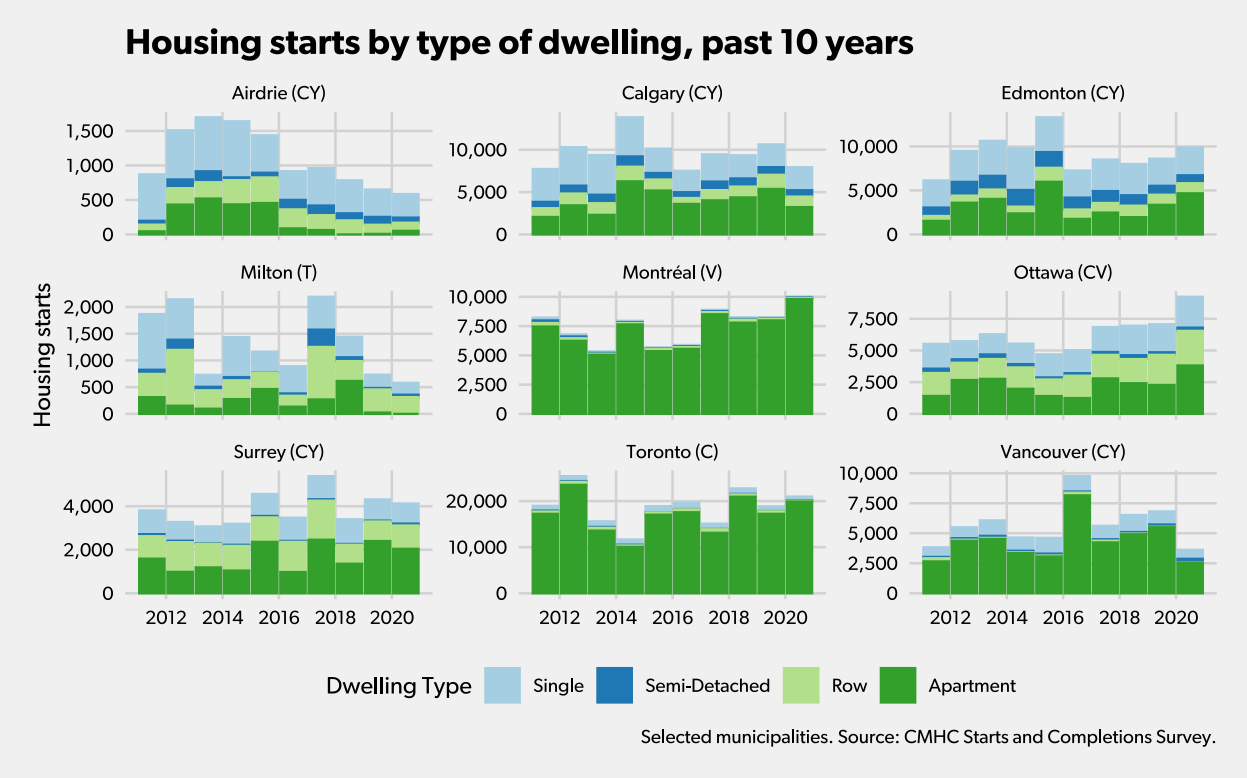


Figure 4: Housing starts in selected municipalities by type of dwelling, past 10 years.

dian condominium apartment built in the same time period.[6] Even for the same type of dwelling, there can be substantial differences between the same type of dwelling, built in the same time period in different metropolitan areas. For example, the median square footage of recently-built single detached home in Toronto CMA is approximately 8% larger than a median single detached home built in Vancouver CMA.[7] Beyond floor space differences, housing units that are stacked on top of each other require less land per unit.

To understand how different municipalities have grown over time, and what kind of land new housing is being built on, this report analyzes land use change at the municipal level between 2010 and 2020. The data informing the analysis come from a remote sensing dataset published by Agriculture and Agri-Food Canada, which divides the land area of Canada, south of the 60th parallel, into 30 metre by 30 metre blocks. Each block is coded into one of 28 specific land use categories within the International Panel on Climate Change's seven broad land use categories of settlement, forest, cropland, grassland, wetland, water and other. Newly-detected settlement (detected within the past 10 years) is reported for 2020 and 2010. Through a process of assigning the 30m by 30m blocks into Census Subdivisions and assessing the change in land use over time in those communities, this paper calculates how much land of different classes (forest, cropland, grasslands and wetlands) has been lost to settlement expansion in each of the 2,206 municipalities, how much housing was built in those places, and a **ratio of new homes built per hectare of cropland, grass-**

[6] See Senagama, (2019). Ratio is 2,890 square feet to 650 square feet). https://assets.cmhc-schl.gc.ca/sf/project/cmhc/pubsandreports/housing-market-insight/2019/housing-market-insight-canada-68469-2019-m05-en.pdf

[7] Ibid.

land, forest and wetlands lost.[8] Table 2 shows the 50 municipalities where the most housing was built, the ratio of new homes to land lost to settlement expansion, and the hectares of land lost for cropland, forest, grassland and wetland. Figure 10 plots dwellings built and dwellings built per hectare of land lost, separated by province, for the 2,206 municipalities.

British Columbia leads the way

Eight of the top ten municipalities with the highest ratios of new housing built per hectare of land lost are in BC: New Westminster, Vancouver, Burnaby, Coquitlam, Surrey, Nanaimo, Langford and Richmond.[9] Langford, in particular, added 7,615 new homes, which is 40% of its housing stock, while losing just 13 hectares of land. Overall, the province has one of the highest average ratios, at 50.1 new homes per hectare of land lost.

Alberta

Edmonton (122 homes/ha) and Calgary (89 homes/ha) lead the way in Alberta, both in terms of the total number of homes built and efficiency of land use. Although hundreds of hectares of land, most of it cropland, has been lost to settlement expansion, their ratios are relatively high, at six and four-and-a-half times the provincial average ratio of 19.7 homes/ha of land lost. Lethbridge is not far behind and Airdrie, which is growing very rapidly, is also well above the provincial average.

Big differences between big cities in Saskachewan and Manitoba

Regina and Saskatoon are both adding more than 100 new homes per hectare of land lost, which is 13-21 times the provincial average ratio of 8 new homes per hectare of land lost. Winnipeg, in contrast, although it has a higher population density than either city, has a ratio of just 44 new homes per hectare of land lost, which is roughly two-and-a-half times the Manitoba average of 16.7.

A wide range in Ontario and Quebec

Toronto is in a category of its own in terms of the number of dwellings built and minimizing land lost to settlement expansion. However, Markham (264 new homes/ha), Mississauga (209 new homes/ha) and Waterloo (141 new homes/ha) are adding new homes in a much more land-efficient way than Ottawa or Vaughan (both 49 new homes/ha), London (38 new homes/ha), Milton (32 new homes/ha) or Hamilton and Whitby (both 28 new homes/ha). The provincial average is 24.4 new homes/ha. Many cities in Queebec rank highly, including Saint-Jérôme (358 new homes/ha) and Longueuil (124 new homes/ha), well above the provincial average of 17.6.

[8] See Appendix for more on details on assessing land use change over time, what changes in land use classes are included in this report's calculations and Table 5 for adjusted totals.

[9] Amongst the top 100 municipalities by total number of dwellings built.

Table 2: Change in dwellings and land lost to settlement expansion

Municipality	Pop. Density	Dwellings built, 2011 to 2021			Land lost to settlement expansion (ha)			
		Number of Dwellings	As % of Dwellings in 2021	Dwellings per ha of land lost	Cropland	Grassland	Forest	Wetland
New Westminster (CY)	5052	6,500	18.00%	Inf	0	0	0	0
Vancouver (CY)	5750	48,675	15.90%	60,093	0	0	1	0
Burnaby (CY)	2751	20,745	20.50%	38,417	0	0	0	0
Toronto (C)	4428	160,985	13.90%	6,674	24	0	0	0
Coquitlam (CY)	1217	12,900	23.10%	689	0	0	18	0
Surrey (CY)	1798	39,915	21.50%	569	49	0	21	0
Nanaimo (CY)	1104	6,735	15.60%	563	5	1	6	0
Langford (CY)	1124	7,615	40.00%	557	0	0	13	0
Richmond (CY)	1629	17,620	21.70%	502	34	0	1	0
Montréal (V)	4833	67,310	8.20%	435	141	13	1	0
Saint-Jérôme (V)	889	7,160	19.20%	358	9	1	10	0
Québec (V)	1215	31,755	12.00%	292	66	5	37	0
Markham (CY)	1605	22,930	20.70%	264	83	0	3	0
Mississauga (CY)	2453	17,850	7.30%	209	84	1	1	0
Regina (CY)	1266	15,520	16.80%	174	89	0	0	0
Waterloo (CY)	1896	8,280	17.60%	141	58	0	0	0
Longueuil (V)	2198	13,115	11.60%	124	94	2	10	0
Edmonton (CY)	1320	85,740	21.60%	122	695	1	6	0
Saskatoon (CY)	1175	20,330	19.00%	111	156	15	10	1
Langley (DM)	432	12,065	25.70%	111	81	2	26	0
Kelowna (CY)	682	11,515	18.50%	109	64	4	37	0
Halifax (RGM)	80	25,040	13.10%	97	3	2	252	0
Calgary (CY)	1592	91,895	18.30%	89	920	90	18	10
Burlington (CY)	1004	6,275	8.60%	86	72	0	0	0
Gatineau (V)	851	17,990	14.20%	82	173	24	22	0
Lethbridge (CY)	812	6,340	15.80%	71	82	7	0	0
Kitchener (CY)	1878	13,780	13.80%	69	192	1	6	0
Oshawa (CY)	1204	7,425	11.10%	67	105	1	5	0
Brampton (CY)	2469	38,195	20.90%	66	576	0	5	0
Brossard (V)	2025	6,305	17.60%	66	88	6	1	0
Richmond Hill (T)	2004	12,505	18.00%	64	180	1	14	0
Guelph (CY)	1644	7,785	13.80%	64	113	0	8	0
Chilliwack (CY)	357	6,200	17.30%	63	75	4	21	0
Airdrie (CY)	878	10,765	40.90%	57	188	0	0	2
Oakville (T)	1538	13,630	18.50%	55	247	0	3	0
Sherbrooke (V)	489	11,250	14.00%	50	190	12	21	0
Ottawa (CV)	365	59,845	14.70%	49	899	15	311	0
Vaughan (CY)	1186	20,595	19.80%	49	410	2	11	0
Winnipeg (CY)	1623	36,630	12.20%	44	801	1	31	0
Abbotsford (CY)	409	7,515	14.10%	38	166	5	26	0
London (CY)	1004	20,260	11.60%	38	508	1	24	0
Laval (V)	1781	17,405	10.30%	38	438	6	16	0
Milton (T)	365	13,785	34.40%	32	414	2	12	0
Hamilton (C)	509	20,915	9.40%	28	724	3	22	0
Whitby (T)	944	6,135	13.20%	28	217	0	5	0
Lévis (V)	334	9,855	15.00%	27	322	30	19	0
Trois-Rivières (V)	482	6,880	10.30%	24	203	14	64	0
Terrebonne (V)	780	6,745	14.90%	24	232	18	36	0
Clarington (MU)	166	6,725	18.70%	22	257	3	46	1
Mirabel (V)	126	9,560	38.60%	15	552	6	67	0

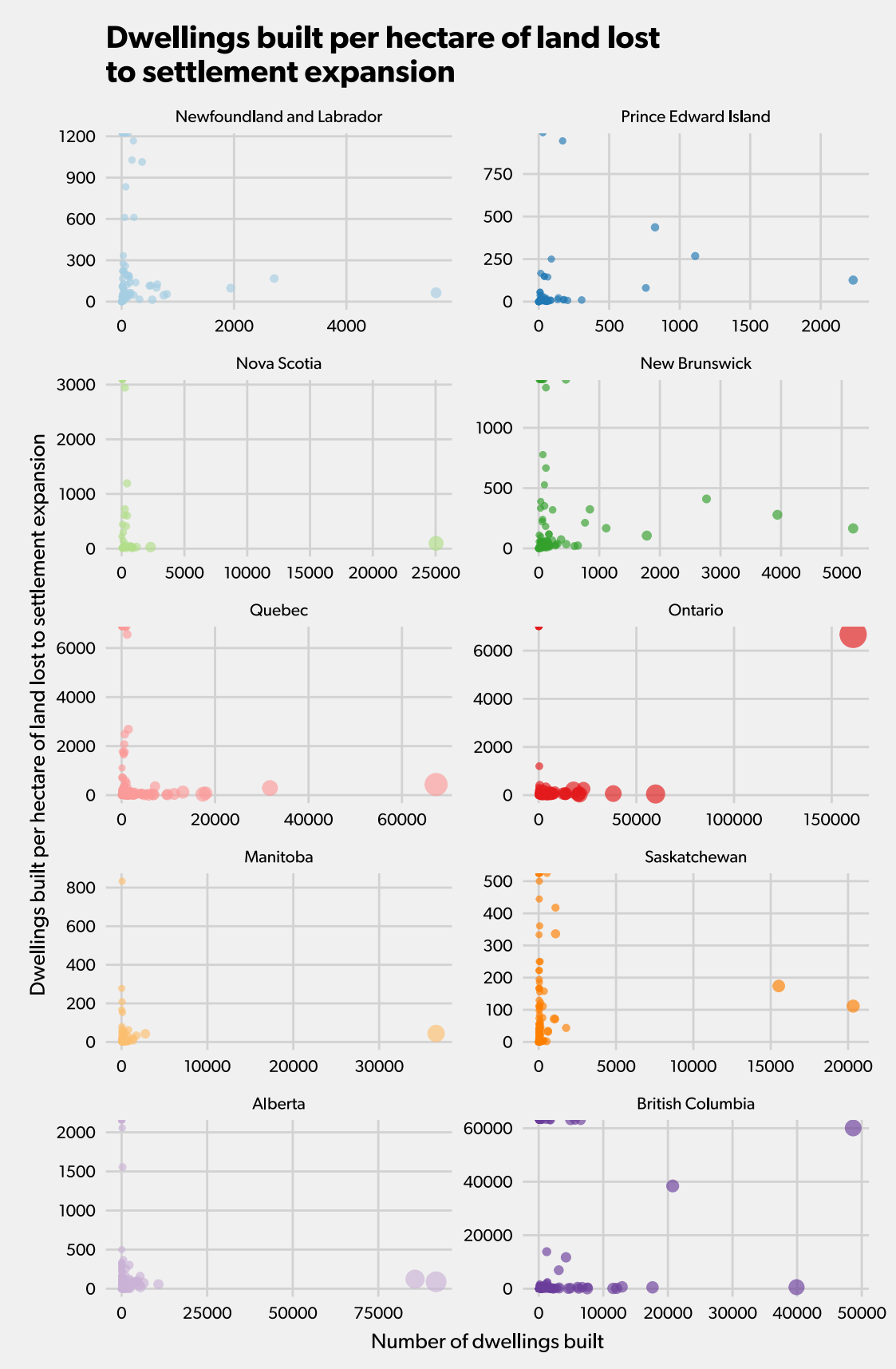


Figure 5: Dwellings per hectare of land lost to settlement expansion

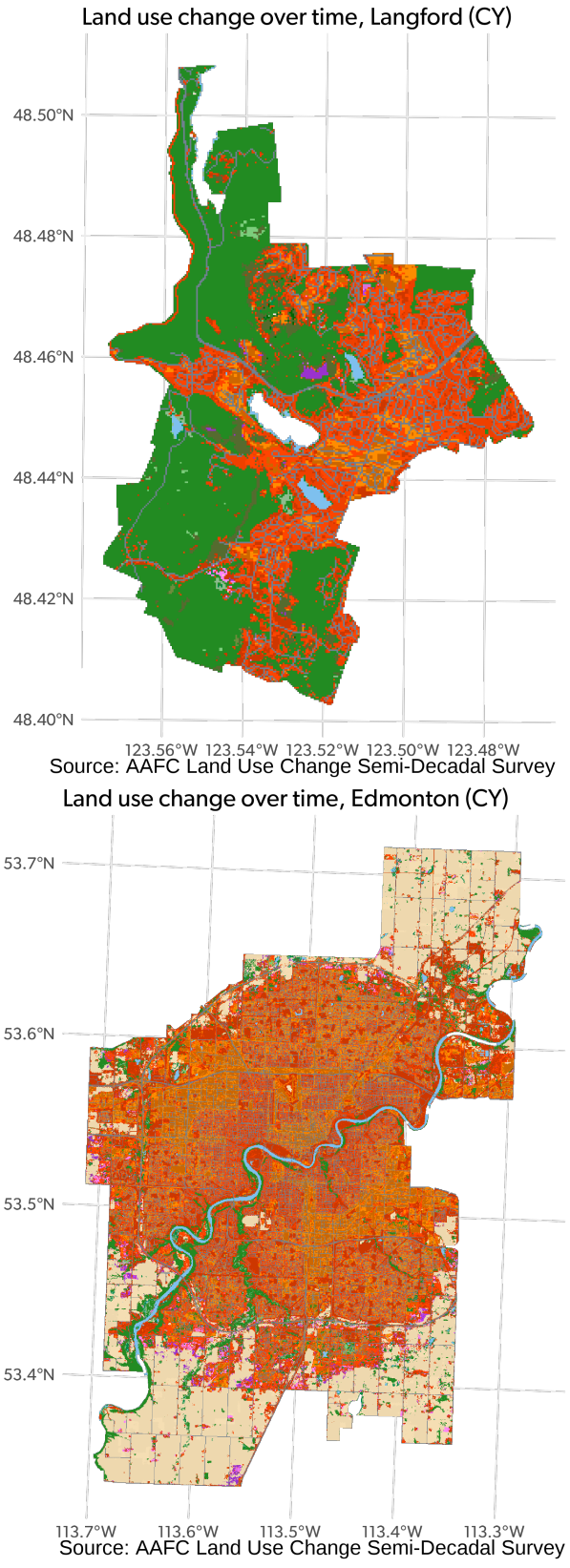
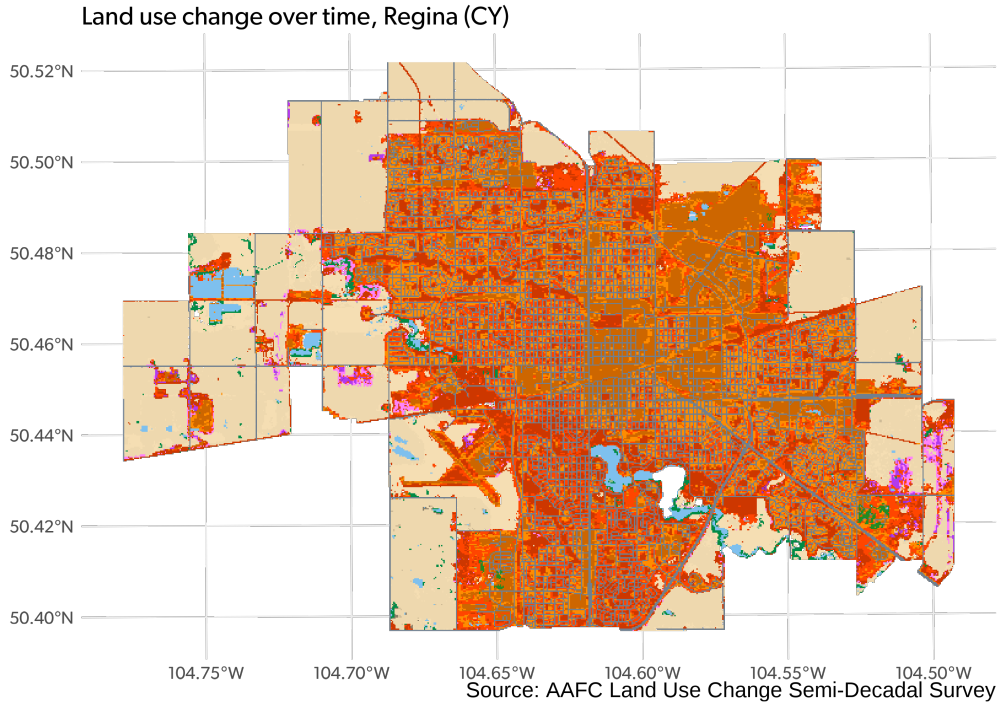


Figure 6: Land use in Langford, BC and Edmonton, AB, 2020. Purple indicates land lost to settlement expansion in the past 10 years.



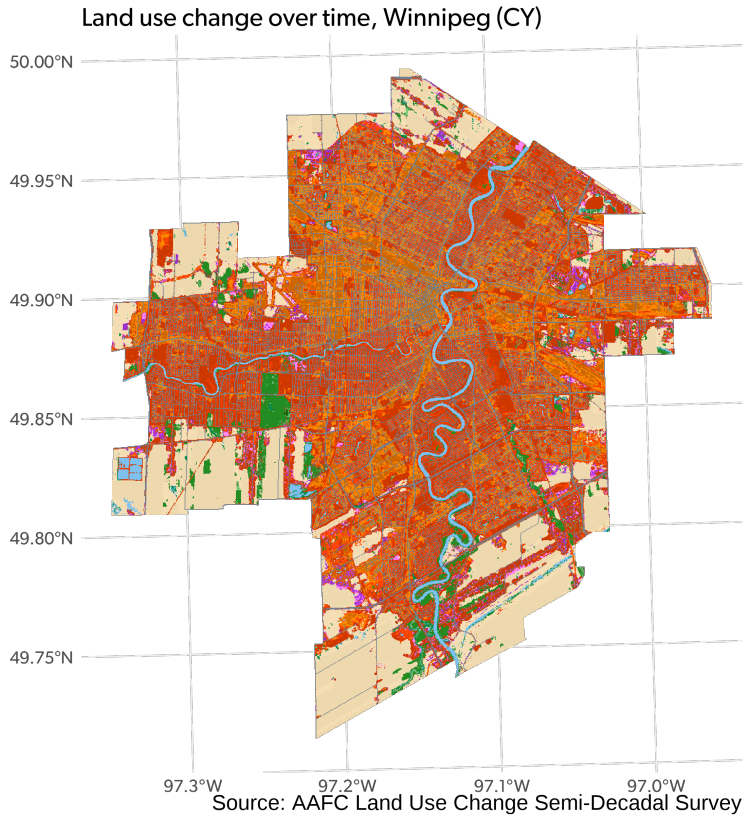


Figure 7: Land use in Regina and Winnipeg, 2020. Purple indicates land lost to settlement expansion in the past 10 years.

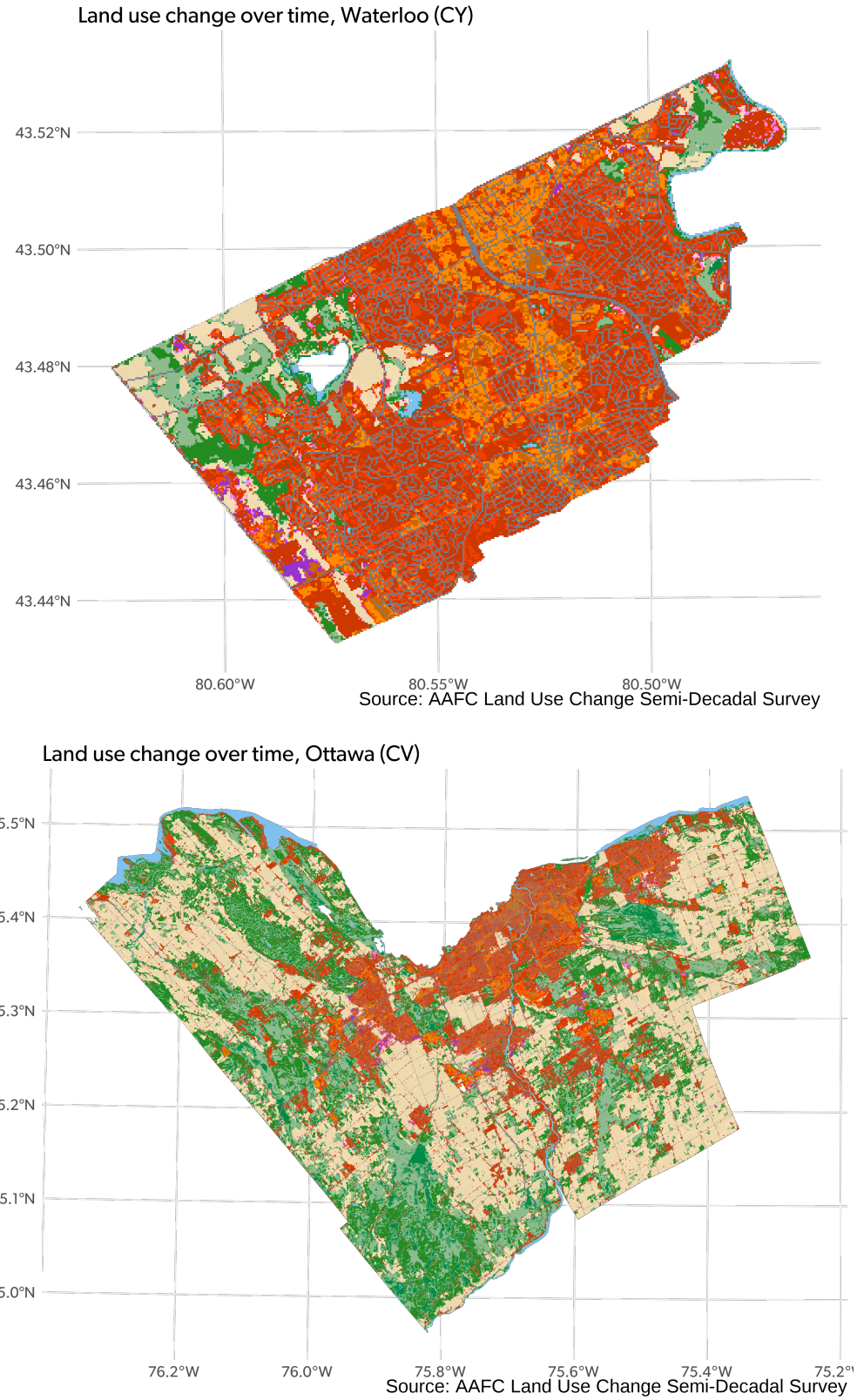


Figure 8: Land use in Waterloo and Ottawa, 2020. Purple indicates land lost to settlement expansion in the past 10 years.

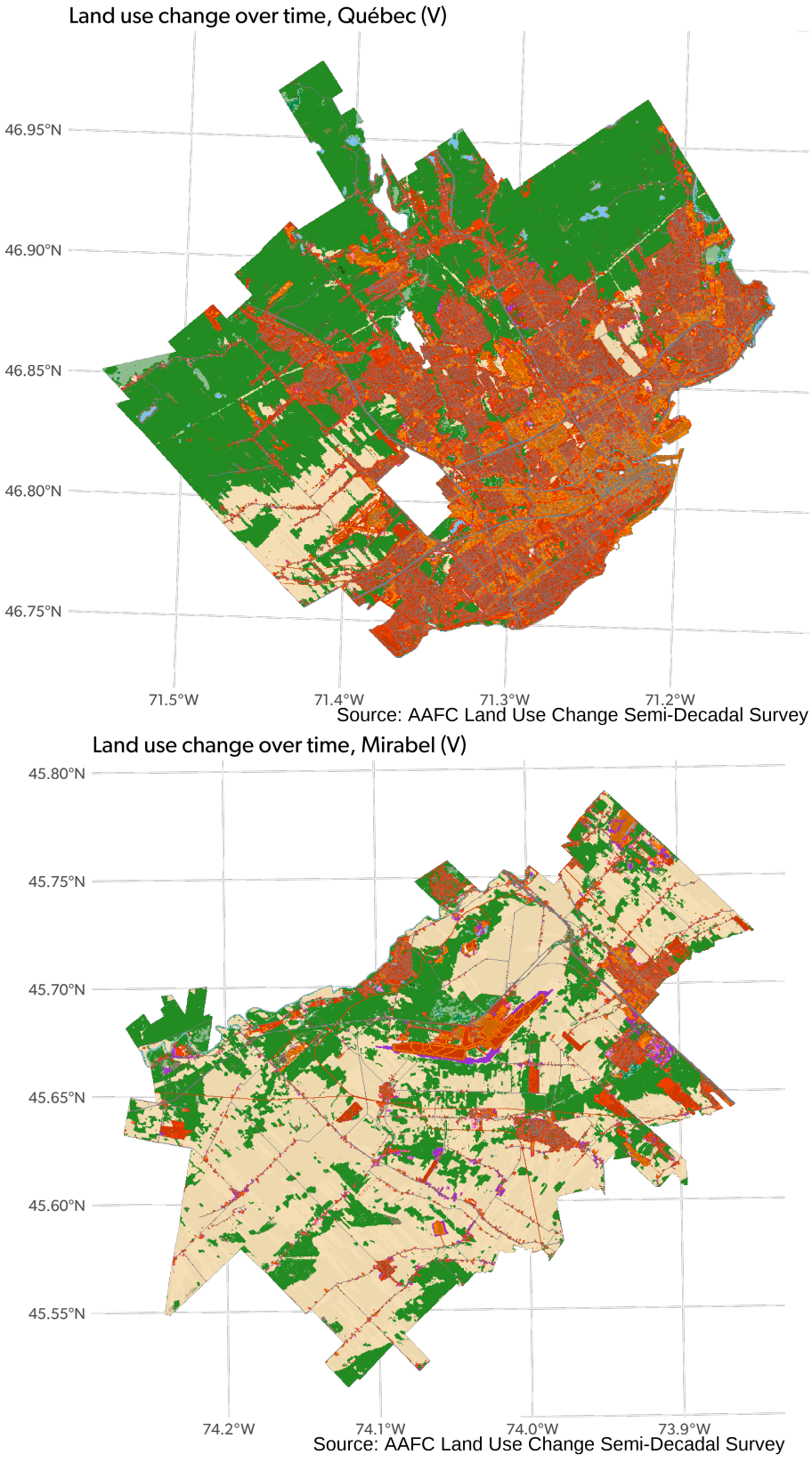


Figure 9: Land use in Québec City and Mirabel, 2020. Purple indicates land lost to settlement expansion in the past 10 years.

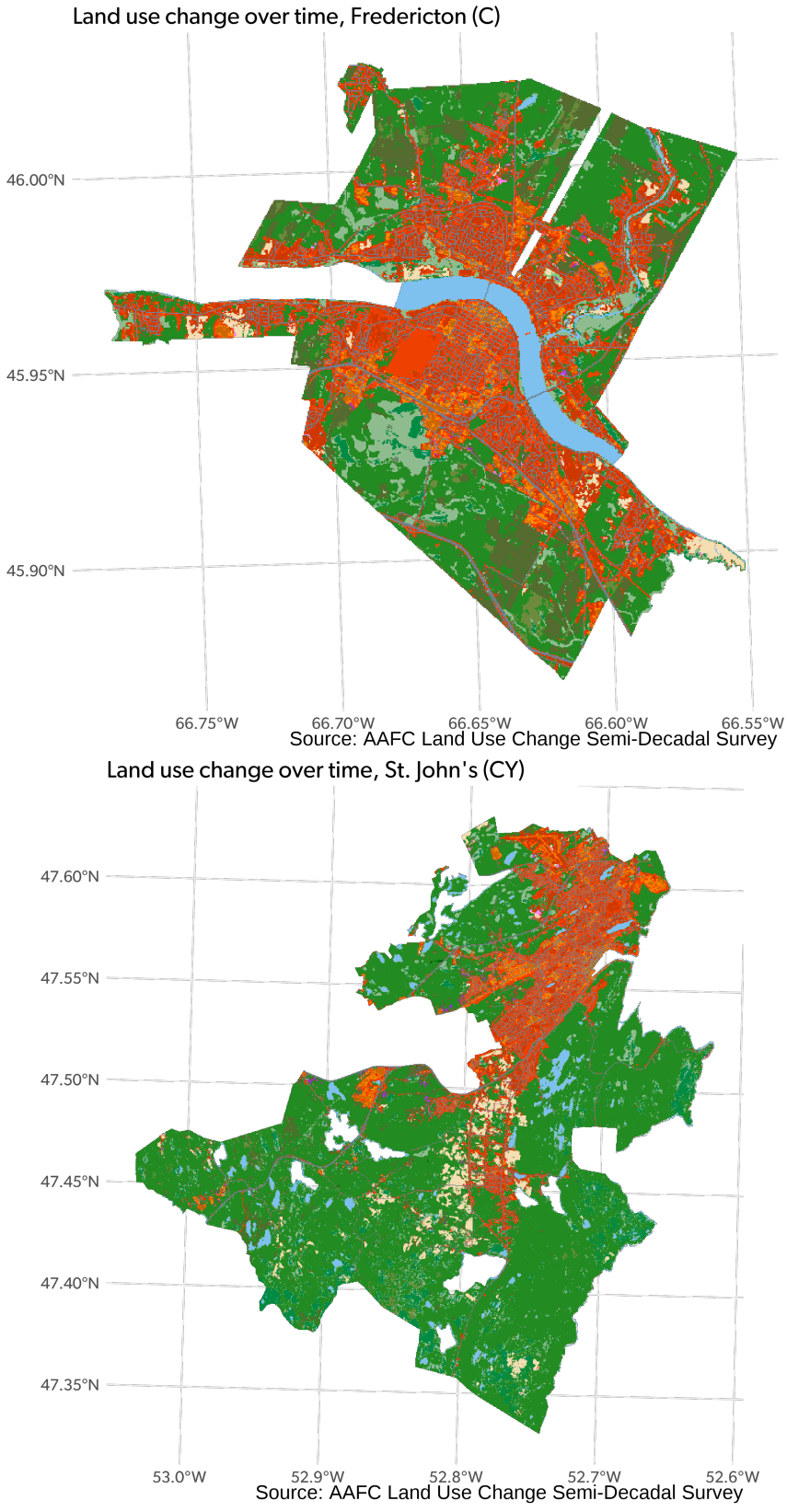


Figure 10: Land use in Fredericton and St. John's, 2020. Purple indicates land lost to settlement expansion in the past 10 years.

Inward and upward or outward

Analyzing the growth in housing units at the dissemination area level, which is the lowest level at which counts are reported, this report categorizes those areas into one of four categories: **infill**, where at least 70% of the land area in 2010 was already settlement and *no new land was lost to settlement expansion*; **infill loss**, where at least 70% of the land was settlement in 2010 but there was some additional land conversion to settlement; **sprawl**, where the land area in 2010 was *less* than 70% and there was additional land conversion; and, finally, *no new homes*, where no new homes were built. Figure 11 shows infill rates by province (includes both infill and infill loss).[10]

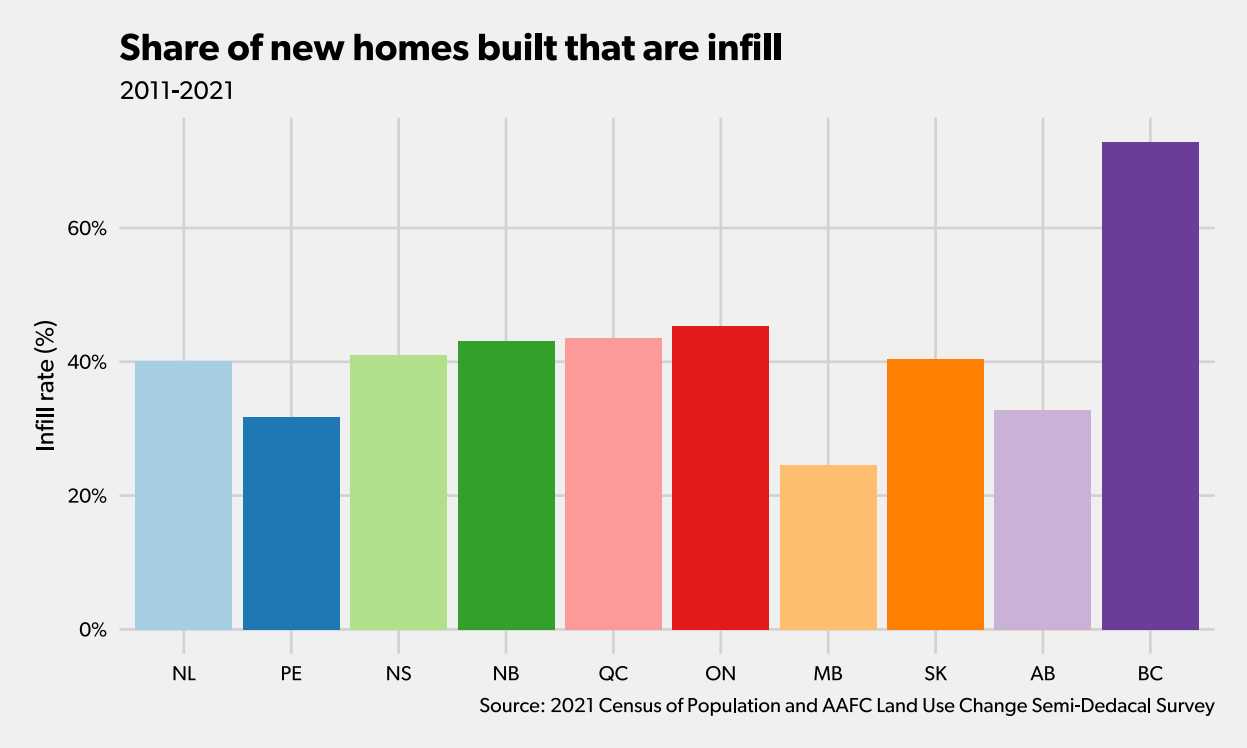


Figure 11: Share of homes built that are infill

Provincial level rates mask important differences at the municipal level. Figure 12 shows select municipalities within each province.

[10]To protect confidentiality, Statistics Canada uses random rounding of raw counts to 5 or 10, so aggregating up from lower levels of geography may lead to different totals than the counts reported at the higher levels. For example, if 12 new homes were built in a dissemination area, it could be rounded down to 10 or up to 15. See https://www12.statcan.gc.ca/census-recensement/2021/ref/98-304/2021001/chap10-eng.cfm

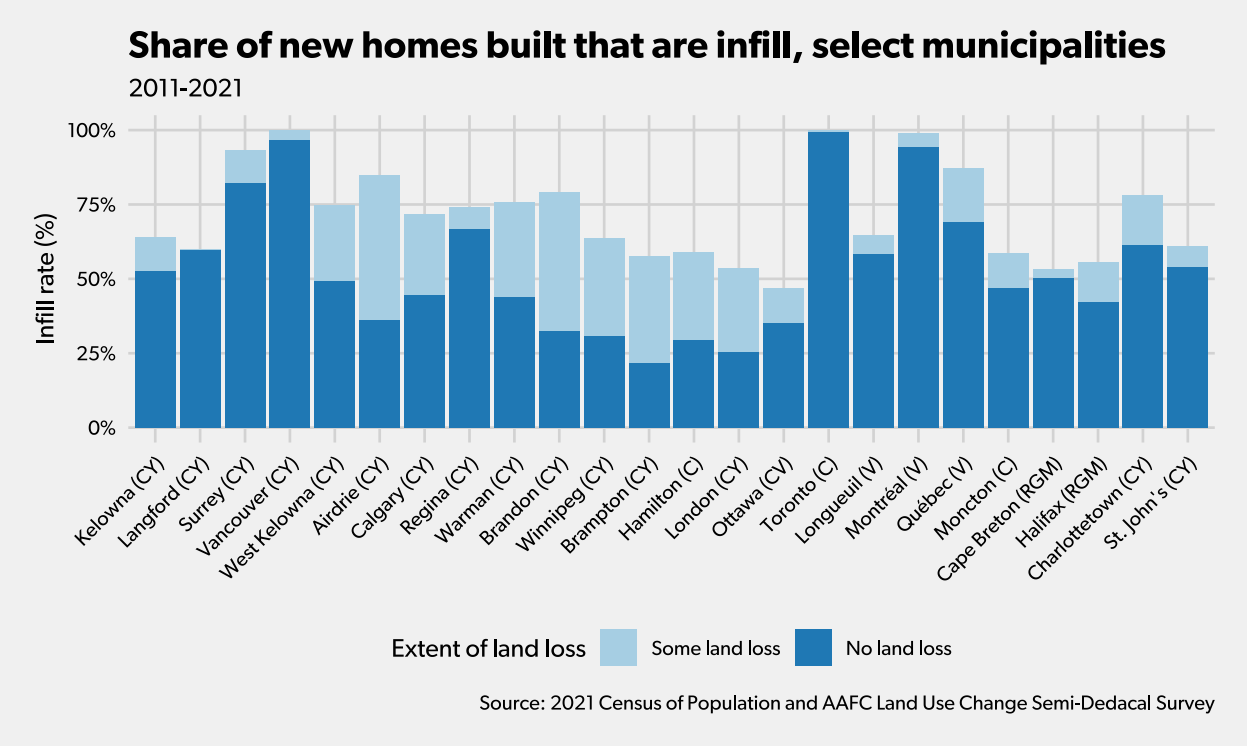


Figure 12: Share of homes built that are infill, selected municipalities.

Greenhouse gas emissions of losing cropland, grassland and forest

To understand the greenhouse gas emissions related to losing cropland, grassland and forest to settlement expansion, this report takes two different approaches. For agricultural land losses, which includes both cropland and grassland, Agriculture and Agri-Food Canada's estimates for each soil region in Canada are assigned to each dissemination area in the 2,206 municipalities. Only dissemination areas where cropland or grassland loss to settlement expansion has been detected over the past 10 years are assigned a value, which is estimated by areal-weighted interpolation from the soil regions to the dissemination areas. As shown in Figure 13, the GHG emissions for different soil regions vary considerably, with negative or very low values in much of the prairies and considerably higher values in other parts of Canada, depending on the nature of the agricultural activity and soil management practices.[11]. To calculate municipal level estimates, the values at the dissemination area level are aggregated up to the CSD level.

Figure 14 shows the annual GHG emissions from agriculture *avoided* through conversion of cropland and grassland to settlement. In isolation, this reduction in GHG emissions could be seen as a positive change, but there would be offsetting increases in GHG emissions — from the construction of new homes, new roads and other infrastructure, and transportation mobility. Moreover, the loss of cropland in one part of a region is often offset by the addition of cropland elsewhere in the region, typically at the expense of forest land.

[11] See AAFC (2021b) for the data

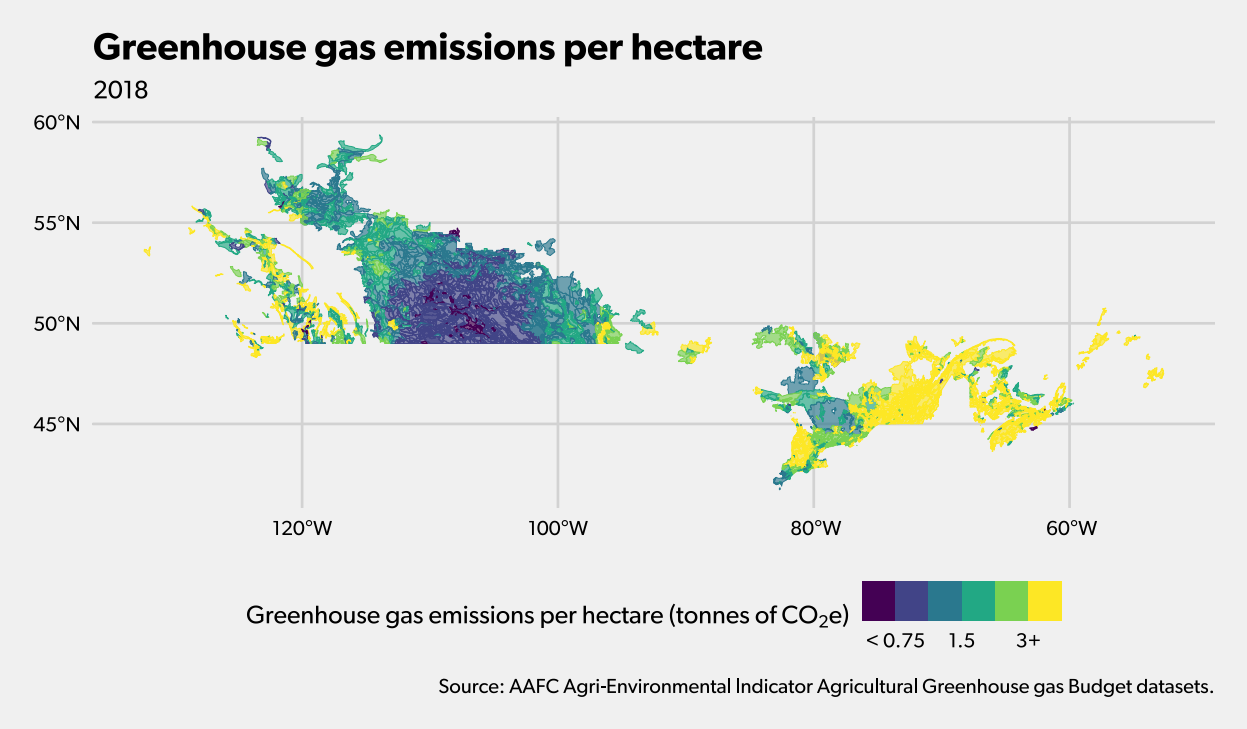


Figure 13: Soil region map of Canada showing estimated GHG emissions per hectare

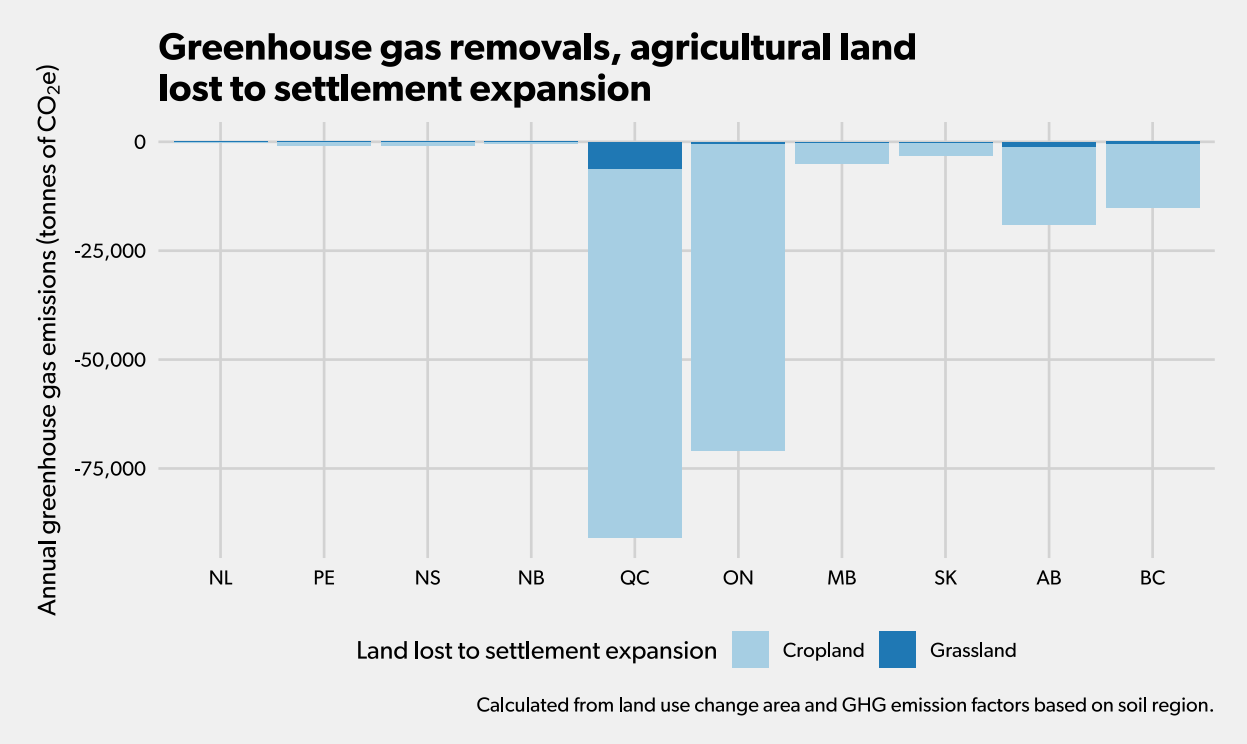


Figure 14: GHG emissions avoided from loss of agricultural land to settlement expansion.

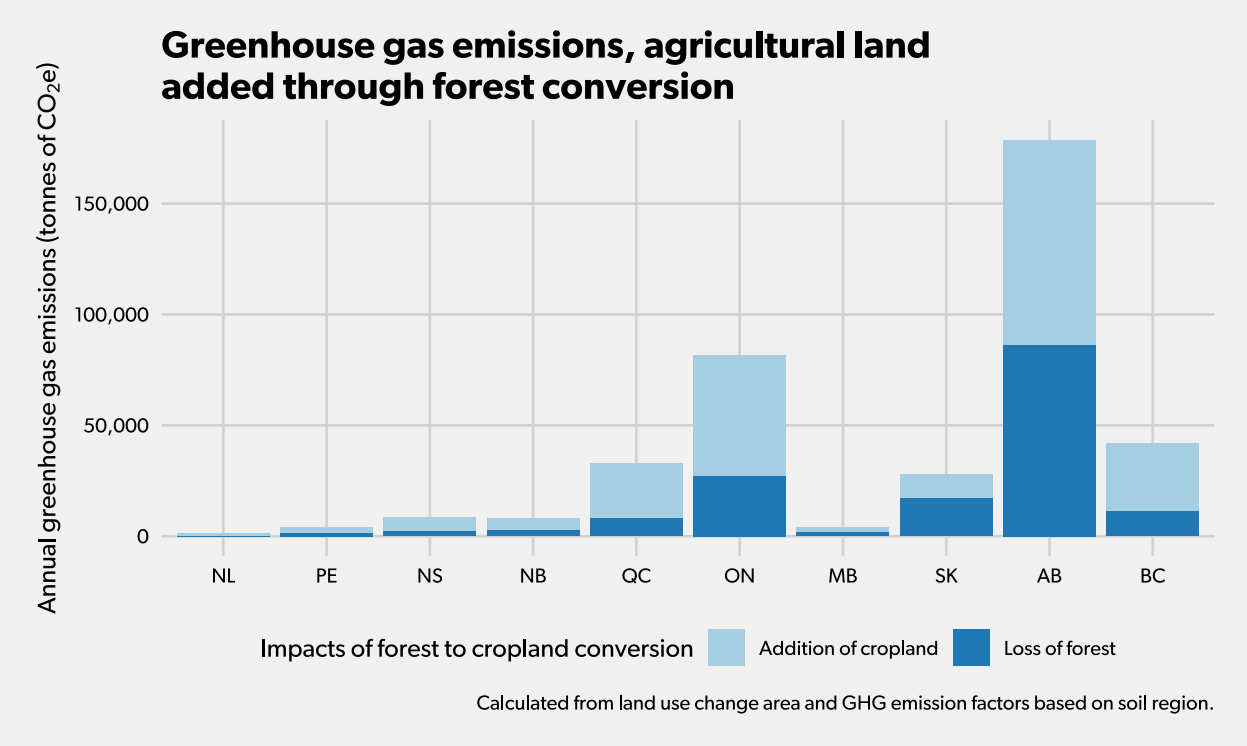


Figure 15: GHG emissions for forest lost to settlement expansion.

Figure 15 shows the annual GHG emissions from agriculture *added* through conversion of forest to cropland to grassland. As in the calculations of the GHG emissions for cropland and grassland lost to settlement, GHG emissions estimates are made for each dissemination area based on its soil region. As these lands are newly-converted to agriculture uses, the GHG estimates based on the overall soil region may be less accurate than they are for land lost to settlement expansion. Estimating carbon emissions and removals from forest is a complex endeavour. This report uses a gross sequestration rate of 2.12 tonnes of CO_2 per hectare per year and a net sequestration factor of 1.57.[12] Only the annual GHG emissions that could be sequestered by the forest if it were not converted to cropland are included in the total. The emissions generated by the process of deforestation itself, which could include use of trees as building materials, burning or slow decomposition, is not included. This is therefore a conservative estimate of the GHG emissions related to converting forest to cropland.

Figure 16 adds the contribution of loss of forest to settlement expansion to Figure 15. Only in Québec, where the amount of cropland converted to settlement is higher than forest converted to cropland, do these changes in land use result in net reductions in GHG emissions. Manitoba and Saskatchewan stand out, both in terms of the gross impacts, which are relatively low, given the amount of cropland in those provinces, and for the net impact. There is a relatively high contribution from forest to cropland in both BC and Ontario and a very large impact in Alberta.

[12] These are the rates used in Pasher et al (2014). For more on calculating emissions and removals from forests, see the National Inventory Report (2022b)

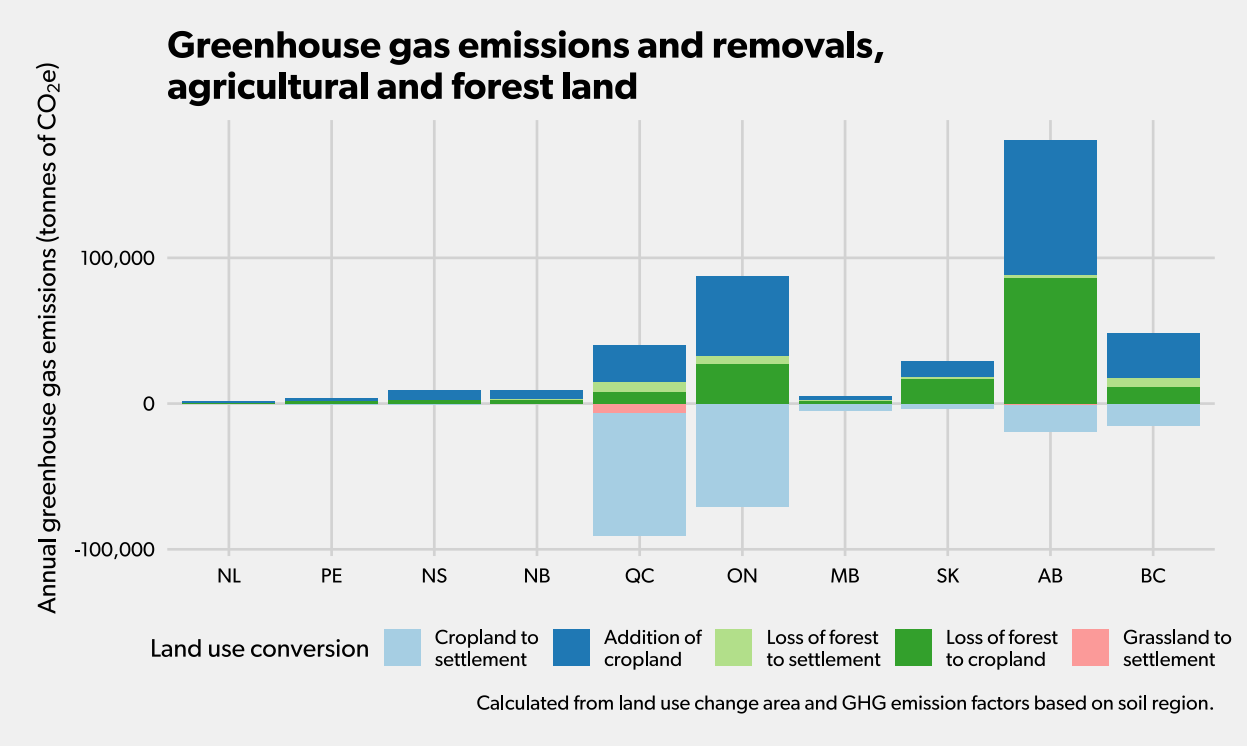


Figure 16: Greenhouse gas emissions and removals, agriculture and forest land conversions.

The past 10 years: where we live and how we move

The people who live in the millions of homes that are targeted for construction by 2030 will need to move around to go to work, school and live their lives. If most of those homes are built in places that are auto-dependent, most of those people will need cars to get around. This is important for GHG emissions for two reasons: first, emissions embodied in the manufacturing of different kinds of vehicles; and second, emissions involved in operating different kinds of vehicles, which is largely a function of how many vehicle kilometers are driven.

At the national level, the number of vehicles has increased over time, reaching 26,302,526 in 2022. Figure 17 shows how vehicle registrations have increased in all provinces except Newfoundland and Labrador over the five-year period. There is also an noticeable shift in the mix of vehicles, with multi-purpose vehicles (SUVs) accounting for an increasing share of total vehicles registered in all provinces. The overall mix of vehicles, however, differs by province — pickup trucks are a lot more common in Saskatchewan than they are in Québec, for example. Table 3 shows the number of vehicles in the largest categories — essentially light duty vehicles — per dwelling.

The most recent distribution of vehicle types and fuel types at the provincial level informs the business-as-usual scenario. Recent models for the most common vehicle and fuel type combinations, along with the provincial energy grid's consumption intensity, are used to develop a BAU estimate of GHG emissions per km.[13] A typical internal combustion sedan, driven ~18,500 kilo-

[13]Popular and recent vehicles in each class were used for the estimates of grams of CO_2 per km for each vehicle class, drawing on data from (N. R. Canada 2023).

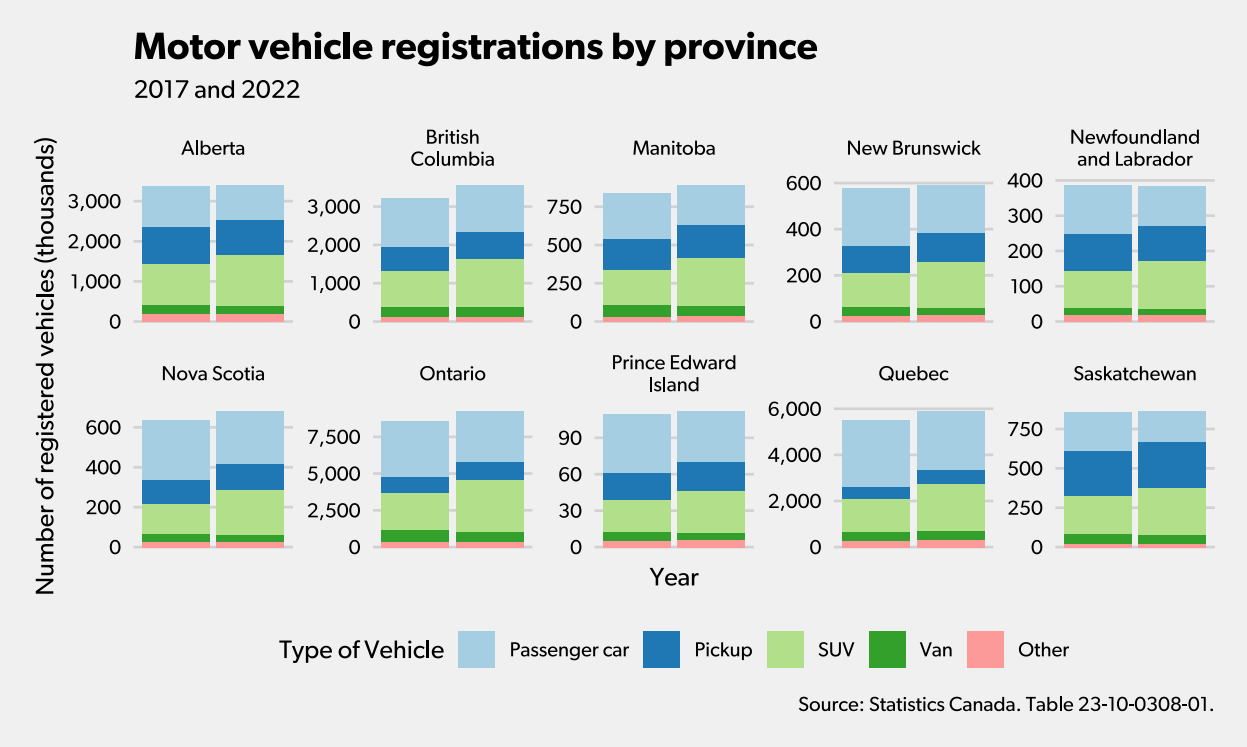


Figure 17: Vehicle registrations by province and fuel type

Table 3: Vehicle Registrations per Dwelling, 2021

	Vehicles per Dwelling				
	Total	Vehicles < 4,535 kg			
Province		All	Car	Truck	SUV
Alberta	2.01	1.74	0.50	0.44	0.28
Saskatchewan	1.81	1.60	0.41	0.52	0.26
New Brunswick	1.65	1.51	0.59	0.33	0.25
Manitoba	1.61	1.46	0.46	0.36	0.22
Prince Edward Island	1.60	1.44	0.60	0.31	0.22
Ontario	1.59	1.50	0.60	0.21	0.24
British Columbia	1.59	1.45	0.54	0.27	0.23
Quebec	1.48	1.37	0.66	0.15	0.23
Newfoundland and Labrador	1.43	1.32	0.42	0.37	0.25
Nova Scotia	1.42	1.32	0.57	0.26	0.21

meters per year, generates roughly 3.5 metric tonnes of CO_2e per year. This is above and beyond the emissions that are embodied in the manufacturing of a new vehicle. Although electric vehicles have lower operating emissions per km, varying according to the consumption intensity of the provincial energy supply, the lifetime CO_2 for manufacturing the batteries and vehicles is significant. As the focus of this report is on the emissions impacts of *where* new homes are built, alternative pathways to electrifying personal vehicles are not developed.[14] While the pace of electrification has increased, in 2022, 90.5% of all registered vehicles burned gasoline. As shown in Figure 18, quarterly registrations of zero-emission vehicles vary substantially between metro areas.

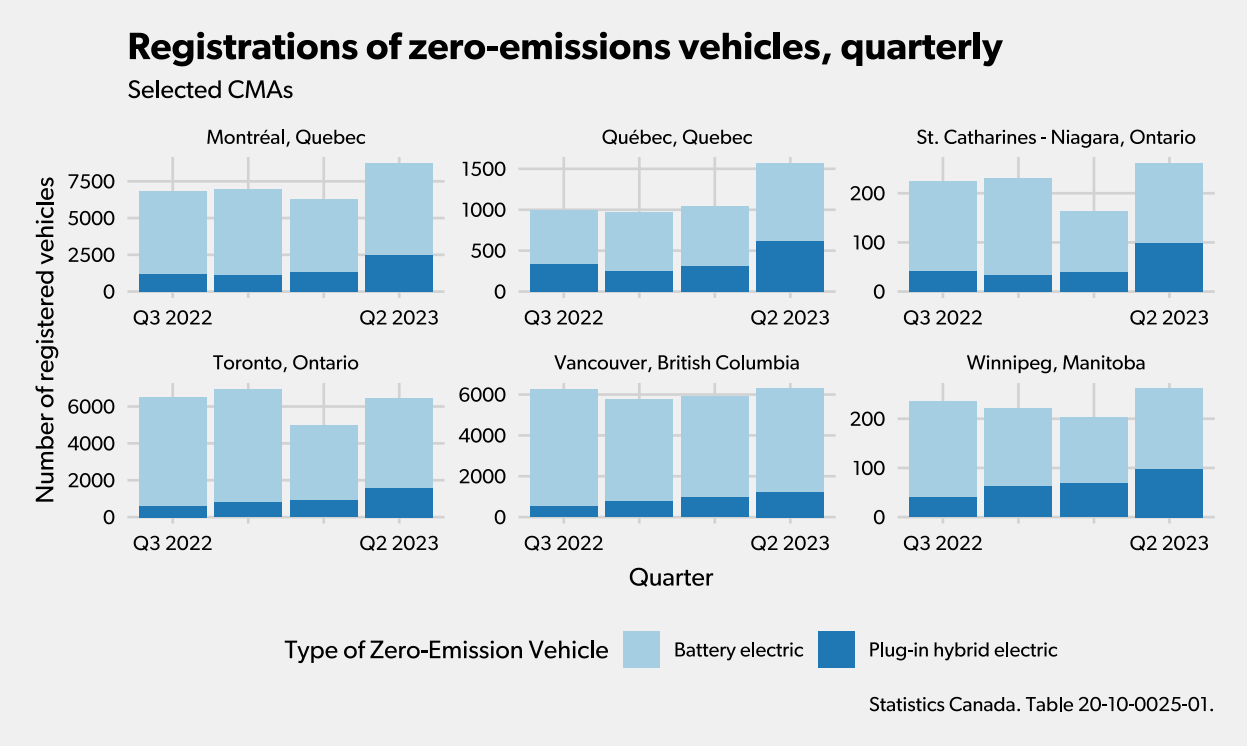


Figure 18: Registrations of zero-emissions vehicles, quarterly.

Two paths forward

Looking to 2030, this report presents two potential scenarios for building 5.8 million homes. The **business-as-usual** scenario continues the trends observed over the past 10 year period. The **targeted infill** scenario limits sprawl and re-allocates the new homes that would be built as sprawl to be within the existing settlement area of each community.

[14] See Lemphers (2022) for an analysis of a shift to electromobility in Calgary, Toronto and Montréal.

Land use and emissions

If we follow the businesss-as-usual path, the rate of land lost to settlement expansion stays the same in each community, the distribution of new housing stays the same, but the number of new homes built more than triples to 5.8 million homes. If we build 5.8 million homes between 2021 and 2030 in the same way and in similar locations as we did from 2011 and 2021, we will likely lose 142,438 hectares of cropland, 6,955 hectares of grassland and 28,143 hectares of forest to settlement expansion.

If we follow the lead of the builders and municipalities that are already choosing to prioritize infill, shifting away from what would have been land-intensive sprawl development, we would save tens of thousands of hectares of cropland, grassland and forests. This **targeted infill scenario** envisions that every community that had a mix of sprawl and infill development over the past 10 year period shifts to building only infill or infill with minimal loss of land. However, in communities that only experienced very low density development over the past 10 years (no infill), the business-as-usual pattern of growth is expected to continue.[15]

Although the worst-case scenario of losing a lot of agricultural land in Ontario, Alberta and Québec results in GHG removals from the conversion of those lands away from agriculture, it is likely that farmers would expand their agricultural land, largely at the expense of trees and forests. Modelling that response is beyond the scope of this report, but based on the detected levels of forest to cropland conversion over the past 10 years, as reported in Figure 15, that additional loss of forest land could be very significant.

The GHG estimates in Figure 19 illustrate the very large differences in GHG emissions per hectare depending on the nature and location of agricultural activities, as shown in Figure 13. Under an infill scenario, the net impact of land use conversions is reduced substantially, especially in Québec and Ontario.

Emissions from vehicles

One way of estimating the number of vehicles that will be need for the people who will live in the 5.8 million homes would be to simply scale the number of homes forecast to be built by the provincial rates per dwelling. But this would mask variation at the municipal level. Although comprehensive data are not available at the municipal level, this report draws on four datasets that include data at the municipal level in Ontario, Québec, British Columbia and Alberta to impute values for municipalities in the rest of Canada.[16] Combined, the four datasets cover more than 24 million registered vehicles in 1,051 communities.[17] The number of vehicles in each commu-

[15] See the Appendix for more details on how this was done.

[16] The first dataset, for Québec, includes vehicle class and municipality (Government of Québec 2023). The second dataset, for Ontario, does not include vehicle class but it does include fuel type, also at the municipal level (Partnership 2023). The third dataset, from the Insurance Bureau of British Columbia, provides counts by class of vehicle at the municipal level (Insurance Corporation of British Columbia 2023). Finally, in Alberta counts by municipality of the total number of vehicles are provided (Government of Alberta 2022).

[17] A multivariate regression model using census socio-economic and structural type of dwelling variables at the municipal level was fit to the combined datasets. This model was used to generate predicted numbers of vehicles per

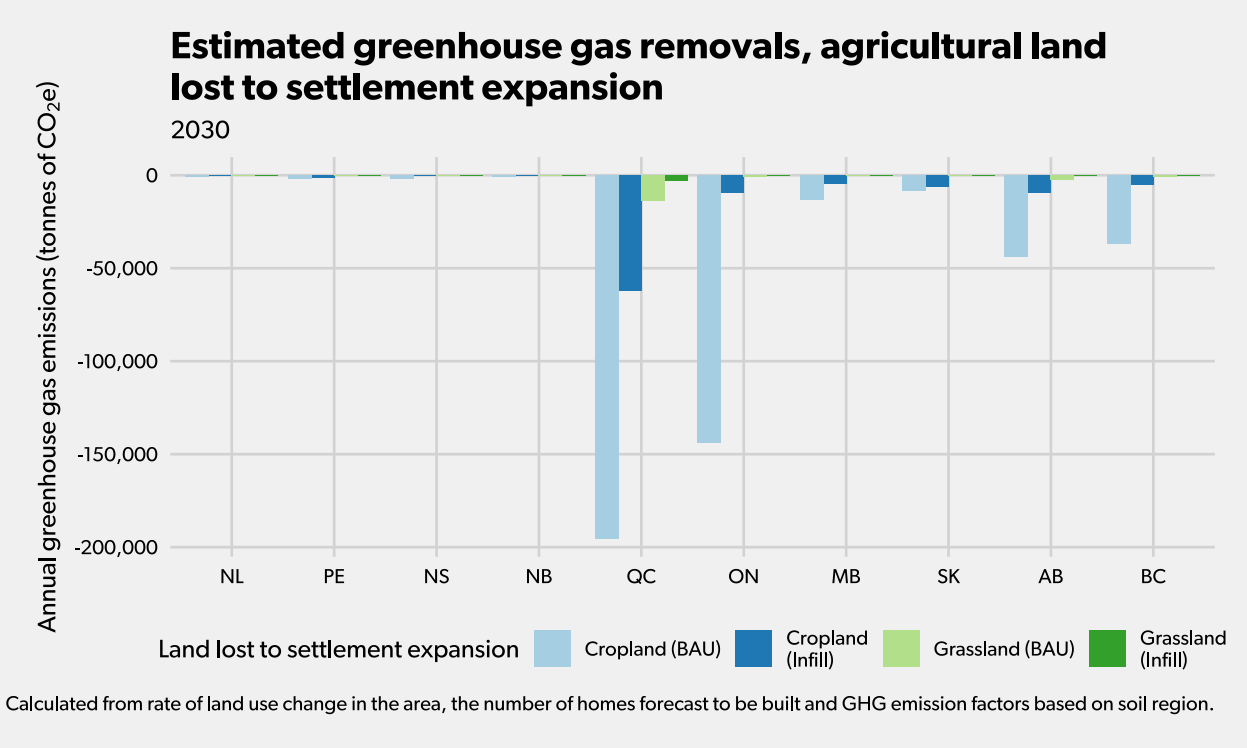


Figure 19: GHG emissions avoided from loss of agricultural land to settlement expansion.

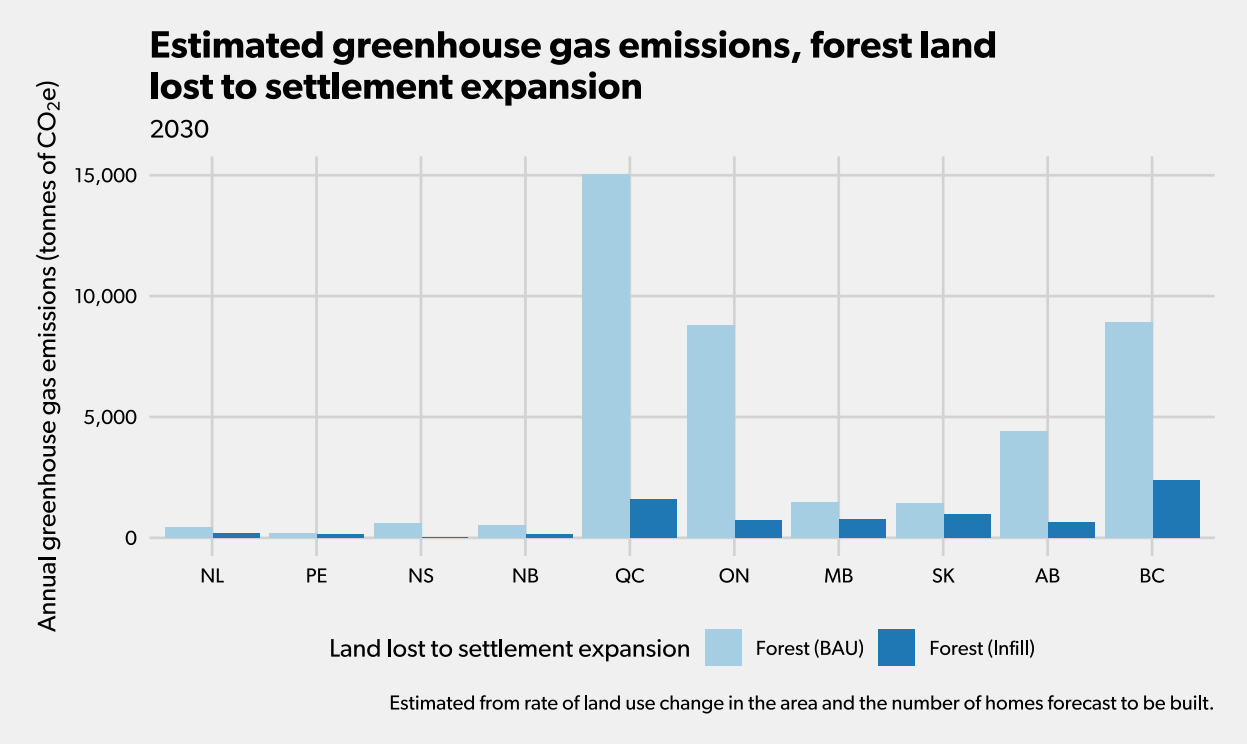


Figure 20: GHG emissions from loss of forest land to settlement expansion.

nity were estimated using a linear regression model, adjusted to account for differential rates of vehicles per dwelling.

From this baseline estimate of the number of vehicles in each community, the provincial level shares of vehicles by vehicle type and fuel type, this report estimates the number and distribution of vehicles likely to be required if we build 5.8 million homes as we built them in the past 10 years. For this business-as-usual scenario, an estimate of the number of vehicles per dwelling in each dissemination area is developed and each new home is expected to have the average number of vehicles per dwelling in the area and mobility mode shares consistent with the commuting population in the area.[18]

Knowing how many vehicles and where, generally, they are likely to be located is part of the story. But how far will they be driven? Kasraian et al (2022)'s modelling of vehicle-km travelled (vkt) and passenger-km travelled (pkt) per trip in travel zones in the Greater Toronto and Hamilton Area identified several significant factors that drive vkt per trip, the effect of which varies by the level of urbanity of the zone. For example, seniors in rural areas drive much more than seniors in very urban areas — the effect of age varies depending on spatial context. Their research shows that location matters, both where people *live* and where they *work*, in terms of vkt per trip. However, modelling vkt and pkt travelled at the geographic level of traffic analysis zones relies on data from the Transportation for Tomorrow Survey (TTS); similar data are not available for the 2,206 municipalities that are the focus of this study.

Recognizing that detailed zone-level modelling would be ideal, this report, which is national in scope and focused on emissions rather than detailed transportation infrastructure planning, estimates the number of vehicles per dwelling at the dissemination area level in each community and applies a range of reasonable mean vehicle-km trip lengths based on the level of urbanity of the dissemination area.[19]

In total, under a business-as-usual scenario, 35,077,191 tonnes of CO_2 per year are estimated to be added by 2030, representing a more than 40% increase in total GHG emissions from passenger vehicles in 2021.[20] Despite its magnitude, given the scale of building 5.8 million homes (more than a third of all existing dwellings in Canada), the overall magnitude is on the same trajectory. Figure

dwelling for the remaining municipalities without actual counts by municipality (roughly 2 million of the 26 million vehicles registered nationally.

[18] Although it is quite likely that some of the people who form these new households already own vehicles — roommates who move out to form their own households — it is also likely that others forming new households are switching away from sharing a car, for example, think of kids living with their parents or cases of divorce.

[19] In line with CHMC (2000) and Pucher (2005), this paper assumes that rural and suburban households have longer trips by car, on average, than urban commuters. To reflect the urbanity of an area, the dissemination areas in the 2,206 municipalities are categorized into six categories and this report sets vkt per trip as follows depending on the level of urbanity of the area: Very Rural (16km), Rural (15km), Mostly Rural (14km), Mostly Urban (12 km), Urban (11km) and Very Urban (9km). These parameters are slightly lower than the mean vehicle-km per worker in Urban and Non-Urban Growth Centres in the GTHA reported in Xi et al (2020) and generally consistent with the median commute distances in major Canadian CMAs reported in Savage (2019) for 2016. Urbanity is measured by population density. Estimates of vehicle-km per trip at the dissemination area geographic level are scaled by a constant number of 1,500 trips per year. Because of the wide variation in geography, built form and regional commuting patterns amongst the 2,206 municipalities considered in this report, categorization by population density is reasonable. For more on approaches to modelling vehicle-km travelled, see, for example, Hawkins (2020).

[20] See the emissions reporting from Environment and Climate Change Canada (2023).

21 shows the total estimated GHG emissions in 2030 attributable to the growth in the vehicle stock and the location of the vehicles under the two scenarios.

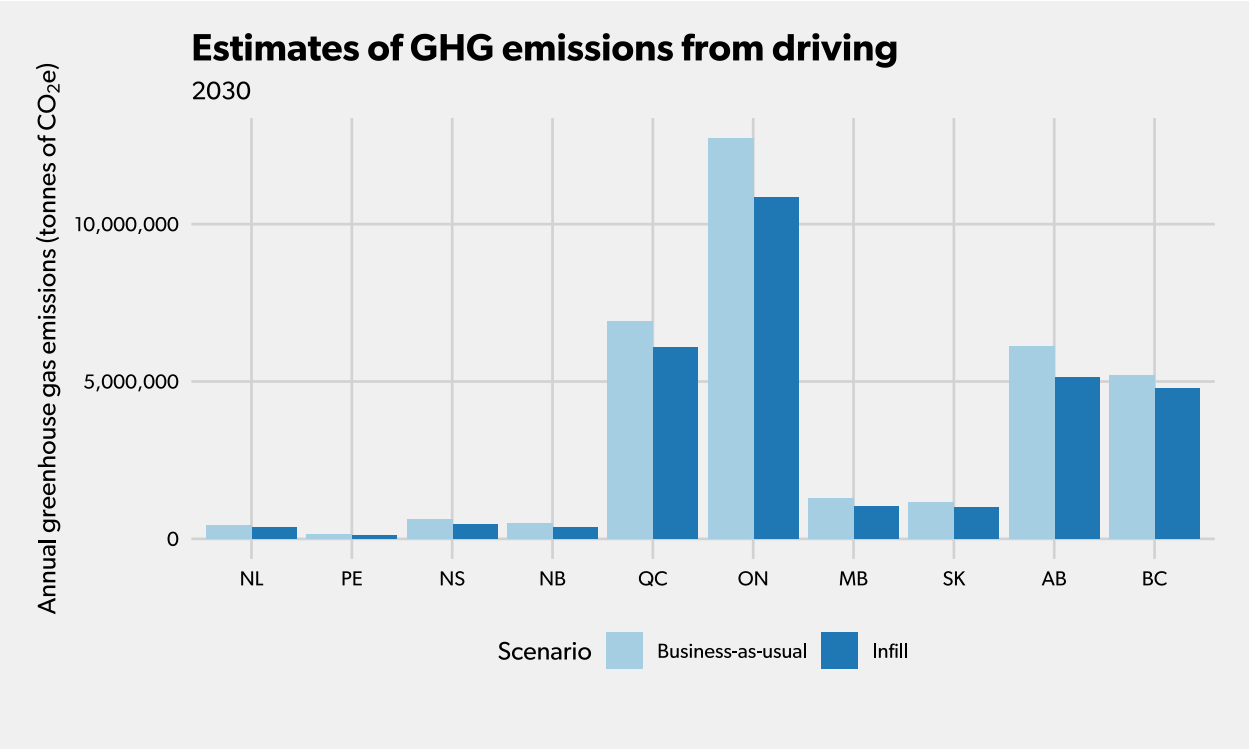


Figure 21: Estimates of GHG emissions from vehicle-km travelled for new homes under business-as-usual and targeted infill scenarios.

Transit and active modes

The focus of this report is on personal vehicles. Making reasonable estimates of marginal transit service hours needed to meet increased demand for transit requires detailed assessment of each transit system. Without analysing each transit system, the marginal GHG emissions per passenger-km are likely to be 75 grams CO_2e for bus transit, which is almost one-third of a typical vehicle-km driven in a gas-powered car.[21] However, we can estimate the likely demand for transit. Figure 22 shows estimates under the two scenarios.

How we can get there

This report considers two paths that we could take as we scale up the construction of new homes to address the housing affordability crisis. Doing things as we have done over the past 10 year period will lead to substantial increases in emissions from both land use change and auto mobility.

[21] See Bigazzi (2020).

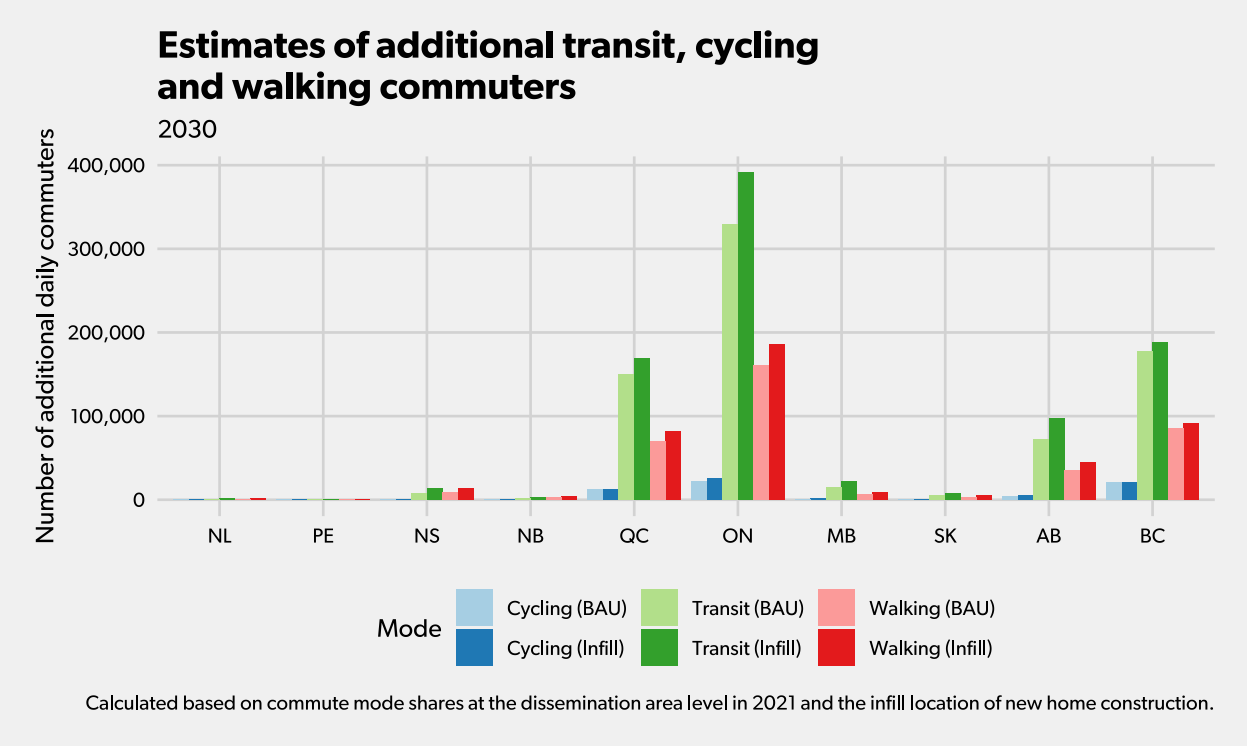


Figure 22: Estimates of additional commuters by transit and active modes.

Although electrification of vehicles is likely to mitigate some of these increases, it is not enough to change the overall trajectory. If we choose, however, to focus our collective efforts on building new housing in ways that require us to do less — to consume less land and to travel fewer kilometers to get to work, run errands, pick up kids from school — we can make a big difference in terms of GHG emissions. Beyond the benefits to our environment, this focus on infill and intensification will also save money by avoiding costs that would otherwise be incurred.

It will not be easy, but it is possible. There are many places in Canada that are showing the way and they are not all huge cities. Communities large and small, and the private sector builders who drive housing construction in those communities, are adding new homes in ways that are good for our environment and our pocketbooks. Building new homes, any new home, means change. But what kind of change do we need?

Recommendations

More homes, less underutilized urban land. This means building climate- and family-friendly homes on parcels of land that are currently vacant or underutilized. The drive-till-you-qualify phenomenon and out-migration of young families with kids from places like Toronto and Hamilton, as detailed in "Who Will Swing the Hammer?"(2023), means that cities, in particular, need to prioritize building family-sized units on underutilized land. Governments that own lands like these, including municipalities that use them for municipal parking lots, can leverage their current ownership to drive re-development forward. Less surface parking for cars, but more housing

for families. Grant programs and other incentives should be changed to focus them, at least for the next eight years, on re-development of these parcels. Municipalities can also stop the too common practice of extending temporary-use zoning to allow surface parking.

More homes, better use of commericial space. It's not just how we zone for housing, but also how we zone for commercial uses. Infilling new homes on existing commercial properties has many benefits, allowing people to live closer to where they work or shop. For example, building residential on existing surface parking lots at large mall properties. Zoning should be more supportive of mixed residential and commercial uses and less supportive of building new single-storey commercial buildings, which are a very inefficient use of land that gets us no closer to 5.8 million homes. Parking minimums for commercial buildings should be eliminated in favour of maximums.

More homes, less vacant office space. Although converting office buildings can be challenging, vacant buildings are opportunities for infill. A "carrot and stick" approach that pairs tax measures that *increase* the cost of vacant commercial buildings with funding programs to *lower* the costs of renovating them into housing could spur action. Again, such programs could be time-limited to encourage action in the short-term.

More transit, cycling and walking, less congestion. Even under the targted infill scenario, millions of more cars throughout the country will worsen existing traffic congestion. Transit service improvements and capital projects that encourage a shift from auto travel to transit and active modes like cycling and walking are even more critical now.

More options for seniors, fewer empty nests. In 2022, more than 800 Canadians per day retired from the workforce. Seniors who have recently retired or will retire soon are looking for options to downsize, but they need more and better options to age-in-place, in or near the neighbourhoods they live in now. For middle-income and lower-income seniors, governments at all levels should be aligning affordable and community housing projects. The federal government's recent move to remove the HST from new purpose-built rental should help on this front, as many seniors are moving from owning to renting for the first time in decades.

More space for students, less vacancy in hotels. In college and university cities, especially those that have experienced significant increases in university and college student enrollment, the pressure on the rental market is intense. All levels of government should do what they can to accelerate the creation of new places for students to live. In particular, provinces can allocate capital funding for the construction of new residence spaces and municipalities can initiate zoning amendments to allow greater height and density on or near campuses. Beyond new construction, which takes a lot of time to plan, finance and construct, opportunities to convert existing hotel operations in downtown cores, which are well-suited as residences, should be explored.

More infill capital projects, less land-intensive capital projects. The main driver of development charges and other ways of financing growth infrastructure is the nature of the growth projects themselves. Right now, we need to focus existing capital budgets on projects that will accelerate infill. For example, already planned and approved rapid transit, improvements in transit service, upsizing and replacement of old sewer systems, construction of active transportation infrastructure, and so on. Although many of these decisions are made at the municipal level, other levels of government can support nimble decision-making on capital projects by allowing for flexibility in existing infrastructure programs.

Appendix

Measuring land use change over time

The AAFC Land Use Change datasets are described in detail in the ISO data specification.[22] For the time periods analyzed in this report, there are 28 specific land use classes. Key land use classes, as well as their definitions, are listed in Table 4. Each of the settlement classes has a "Newly-detected" equivalent for pixels that were detected as that class of settlement in the previous 10 year period.

Between 2010 and 2020, there were 199 different combinations of land use classes, including land use classifications that stayed the same. Each 30m by 30m area is represented by a single pixel. Counting pixels that show change over time is how this report measures land use change over time. However, as noted in the AAFC data specification, "pixels of change will always be a combination of real change and uncertainty in the data."[23] This is an important limitation in the data, especially when analysing land use change in 2,200+ Census Subdivisions. In comparing some areas with significant land use change over time to contemporary satellite imagery from Google Earth, there were some areas, for example, that were cropland in 2010 and are coded as Newly-detected Vegetated Settlement in 2020, but appear to still be cropland. To be conservative in estimating the land lost to settlement expansion and the ratio of dwellings per hectare of land lost, this report only includes lands that are coded as Newly-Detected Settlement (81), High Reflectance Settlement (82) or Very High Reflectance Settlement (89) as lands lost to settlement expansion. Table 5 shows the difference in the dwellings per hectare lost and the total number of hectares. "Base" includes only classes 81, 82 and 89. "Adjusted" includes all Newly-Detected Settlement Classes (81, 82, 84, 88, 89). These values should be interpreted as upper (adjusted) and lower (base) bounds on the estimates of land lost to settlement expansion.

Choosing infill over sprawl

As an alternative to the business-as-usual scenario, a targeted infill scenario was developed. Under this targeted infill scenario, the number of new homes that would be built as sprawl under the business-as-usual-scenario is added up and re-allocated from dissemination areas that would be sprawl to dissemination areas *within the same community* that meet a test based on land use in 2020: at least 25% of the land use in the area must be urban core, which includes settlement, high and very high reflectance settlement and roads. This excludes settlement categories of vegetated settlement and settlement forest, which helps to avoid, for example, re-allocating new housing into large green spaces like parks. This also means that areas that are built out, but may not be zoned for residential, are included. In communities *with* transit mode share, the re-allocation is to areas that rank at or above 50th percentile in the community in terms of transit mode share. In communities *without* transit, the re-allocation is evenly to all dissemination areas, so there is no concentration of new housing in particular areas.

[22] AAFC (2021a)
[23] Ibid, p. 19

Table 4: Agriculture and Agri-Food Canada Land Use Change Classes

Land Use Class (Value)	Description
Settlement (21)	Urban and rural residential, commercial, industrial, transportation or other built infrastructure use
Settlement Forest (24)	Settlement areas mostly or entirely covered by tree canopy
Vegetated Settlement (28)	Settlement areas with observable vegetation such as lawns, golf courses, and settlement areas with 30-50% tree canopy
High Reflectance Settlement (22)	Settlement areas with high spectral reflectance such as pavement, buildings, or other surfaces with little to no observable vegetation
Very High Reflectance Settlement (29)	Settlement areas with very high spectral reflectance such as pavement, buildings, or other surfaces with no observable vegetation
Roads (25)	Primary, secondary and tertiary roads
Forest (41)	Land covered by trees with a canopy cover >10% and a minimum height of 5m, or capable of growing to those measurements within 50 years
Forest Wetland (42)	Wetland with forest cover (canopy cover over 10% and minimum height 5m, or capable of growing to those measurements within 50 years)
Cropland (51)	Annual and perennial cropland
Annual Cropland (52)	Annual cropland (identified beginning in 2015)
Land Converted to Cropland (55)	Cropland that did not appear to be cropland 10 years prior (this class is identified beginning in 2010)
Land Converted to Annual Cropland (56)	Annual cropland that did not appear to be cropland 10 years prior (this class is identified beginning in 2015)
Grassland Managed (61)	Natural grass and shrubs used for cattle grazing
Wetland (71)	Wetland with vegetation at or above the surface of the water

In communities where the last ten year's growth pattern was sprawl in every dissemination area — no infill at all within the community — that pattern is not changed. Similarly, in cities where there the growth pattern did not include any sprawl — it was all infill or infill with minimal loss of land — the same trend is projected to continue and the location of new homes within the community is not changed.

Table 5: Change in dwellings and land lost to settlement expansion

Municipality	Pop. Density	Dwellings built, 2011 to 2021		Dwelling per ha of land lost		Land lost to settlement expansion, adjusted (ha)			
		Number of Dwellings	As % of Dwellings in 2021	Base	Adjusted	Cropland	Grassland	Forest	Wetland
New Westminster (CY)	5052	6,500	18.00%	Inf	Inf	0	0	0	0
Vancouver (CY)	5750	48,675	15.90%	60,093	60,093	0	0	1	0
Burnaby (CY)	2751	20,745	20.50%	38,417	7,435	1	0	1	0
Toronto (C)	4428	160,985	13.90%	6,674	2,085	67	0	10	0
Coquitlam (CY)	1217	12,900	23.10%	689	406	6	0	26	0
Langford (CY)	1124	7,615	40.00%	557	345	4	0	18	0
Montréal (V)	4833	67,310	8.20%	435	286	210	20	5	0
Nanaimo (CY)	1104	6,735	15.60%	563	191	15	2	19	0
Saint-Jérôme (V)	889	7,160	19.20%	358	142	23	2	26	0
Richmond (CY)	1629	17,620	21.70%	502	120	142	0	4	0
Surrey (CY)	1798	39,915	21.50%	569	101	305	0	89	0
Markham (CY)	1605	22,930	20.70%	264	97	208	0	28	0
Québec (V)	1215	31,755	12.00%	292	87	179	6	181	0
Longueuil (V)	2198	13,115	11.60%	124	82	130	3	28	0
Mississauga (CY)	2453	17,850	7.30%	209	72	228	1	20	0
Waterloo (CY)	1896	8,280	17.60%	141	70	110	0	8	0
Regina (CY)	1266	15,520	16.80%	174	59	235	29	1	0
Calgary (CY)	1592	91,895	18.30%	89	58	1,112	413	40	10
Brossard (V)	2025	6,305	17.60%	66	55	104	7	3	0
Edmonton (CY)	1320	85,740	21.60%	122	53	1,604	1	17	1
Kitchener (CY)	1878	13,780	13.80%	69	46	272	1	26	0
Saskatoon (CY)	1175	20,330	19.00%	111	44	283	152	29	1
Richmond Hill (T)	2004	12,505	18.00%	64	43	252	1	35	0
Gatineau (V)	851	17,990	14.20%	82	42	333	28	68	0
Airdrie (CY)	878	10,765	40.90%	57	34	316	0	2	2
Brampton (CY)	2469	38,195	20.90%	66	33	1,097	0	55	1
Lethbridge (CY)	812	6,340	15.80%	71	33	101	91	1	0
Halifax (RGM)	80	25,040	13.10%	97	31	46	3	752	1
Oakville (T)	1538	13,630	18.50%	55	30	431	0	17	0
Guelph (CY)	1644	7,785	13.80%	64	27	265	0	27	0
Laval (V)	1781	17,405	10.30%	38	26	621	8	35	0
Vaughan (CY)	1186	20,595	19.80%	49	26	739	2	65	1
Winnipeg (CY)	1623	36,630	12.20%	44	25	1,401	1	45	0
Oshawa (CY)	1204	7,425	11.10%	67	25	277	1	23	0
London (CY)	1004	20,260	11.60%	38	24	780	1	62	0
Sherbrooke (V)	489	11,250	14.00%	50	21	432	16	83	0
Kelowna (CY)	682	11,515	18.50%	109	17	403	93	163	0
Ottawa (CV)	365	59,845	14.70%	49	17	2,581	16	903	1
Terrebonne (V)	780	6,745	14.90%	24	14	353	19	94	0
Burlington (CY)	1004	6,275	8.60%	86	14	424	0	27	0
Lévis (V)	334	9,855	15.00%	27	13	621	34	88	0
Whitby (T)	944	6,135	13.20%	28	12	469	0	39	0
Trois-Rivières (V)	482	6,880	10.30%	24	12	427	17	132	0
Langley (DM)	432	12,065	25.70%	111	12	875	9	133	0
Chilliwack (CY)	357	6,200	17.30%	63	11	437	16	119	0
Mirabel (V)	126	9,560	38.60%	15	9	884	9	150	0
Milton (T)	365	13,785	34.40%	32	9	1,529	2	70	0
Abbotsford (CY)	409	7,515	14.10%	38	7	977	16	75	0
Hamilton (C)	509	20,915	9.40%	28	7	2,842	3	236	3
Clarington (MU)	166	6,725	18.70%	22	5	1,103	3	187	2

Table 6: Net estimated impact of emissions from vehicles and transit (tonnes of CO 2 e), BAU and Targeted Infill scenarios

Infill		Business-as-usual		Difference
Driving	Transit	Driving	Transit	
30,209,337	607,073.1	35,077,191	514,849.6	-4,775,631

Table 7: Net Impact of emissions and removals from loss of land to settlement expansion

Infill			Business and Usual			Difference	
Cropland	Grassland	Forest	Cropland	Grassland	Forest	Cropland and Grassland	Forest
-98,919.82	-3,982.335	7,547.336	-446,801.8	-18,742.01	41,764.31	362,641.7	-34,216.98

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