

Climate Change Mitigation Strategy

for the Lake Simcoe Watershed



Lake Simcoe Region
conservation authority

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Recommended Citation:

LSRCA [Lake Simcoe Region Conservation Authority]. 2020. *Climate Change Mitigation Strategy for the Lake Simcoe Watershed*. 55 pp.

The data contained in the maps in this report have been compiled from various sources. While every effort has been made to accurately depict the information, data mapping errors may exist.

Acknowledgements

The Lake Simcoe Watershed Climate Change Mitigation Strategy was completed with the assistance of many participants. The report was prepared by LSRCA's Integrated Watershed Management (IWM) staff, with input from other LSRCA staff, as well as an external steering committee. The names of those who contributed are listed below and we would like to express our appreciation to all those involved for their time and expertise.

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Executive Summary

Overview and Purpose

Climate change is a major environmental threat currently facing society and will require local collective action in order to mitigate its potential detrimental impacts. In the Lake Simcoe watershed, increased air temperature and changing precipitation patterns are projected to have significant impacts on the ecology of the lake and watershed (LSRCA 2019). The extent of these impacts will depend on actions society takes to reduce greenhouse gases both locally and globally. Based on current efforts to reduce greenhouse gas emissions; for example, using public transit and carpooling as an alternative way of commuting, a changing climate could mean an increase in average annual temperature of 5.5°C. However, if we are able to reduce greenhouse gas emissions and increase carbon sequestration, the increase in average annual temperatures may only reach 3°C. Although this difference may seem small; it will greatly improve and sustain the health of the Lake Simcoe watershed.

The Lake Simcoe watershed supports a variety of different land use types, the most significant of which for the purposes of the Climate Change Mitigation Strategy include urban areas (including residential, industrial, commercial, and institutional), agricultural areas (including both intensive and non-intensive agriculture), and natural heritage features. With respect to mitigating the effects of climate change, this rich and varied landscape provides opportunities to reduce emissions (e.g. urban areas) and increase sequestration (e.g. increase natural features). As growth and development proceed within the Lake Simcoe watershed, urban areas are expected to expand into the agricultural areas, further increasing the challenge of mitigating greenhouse gas emissions.

In order to engage the public and our municipal partners in taking further action to reduce emissions, as well as alter our own programs and services to better consider climate change mitigation, we recognized that a more widespread and strategic approach was required.

The approach taken in developing the Climate Change Mitigation Strategy was first to develop an inventory of the greenhouse gas emissions and carbon sequestration in the Lake Simcoe watershed and then to develop scenarios of possible future emissions and sequestration, depending on levels of effort invested. Quantifying current and future watershed wide greenhouse gas emissions was used as the basis for the development of 18 recommendations for action. The next phase of the strategy will require implementing these recommendations and monitoring the results.

This Climate Change Mitigation Strategy is unique and the first of its kind as it views climate change across a watershed boundary, whereas typically, these types of strategies are specific to political boundaries. However, while watershed-wide, this strategy focuses on actions that LSRCA can undertake and recognizes that action from all sectors across all political boundaries is required.

The goal of creating this strategy is to determine what actions should be taken to be most effective considering the LSRCA mandate, and to determine how we can work together with our municipal partners and the public to decrease our carbon footprint and reduce the impacts of the anticipated changes.

Emissions Inventory and Forecast

The watershed-wide greenhouse gas emissions inventory and forecast provided us with a better idea of which sectors and areas within the Lake Simcoe watershed were “hotspots” for emissions and allowed us to begin thinking about how we can better direct what is delivered in our programs and services.

Using 2016 as the baseline year, the results indicate that businesses and residents in the Lake Simcoe watershed produced a total of approximately 3,809,500 tonnes of carbon dioxide equivalent, or 7.44 tonnes of carbon dioxide equivalent per capita. The transportation, residential, and industrial, commercial, institutional sectors produced the highest greenhouse gas emissions within the watershed and together were responsible for over 80% of the total emissions. The emissions for all sectors are generally greater in the more urbanized southern end of the watershed, and lower in the more rural northern end of the watershed.

However, if we are to continue with our “Business as Usual” way of life, the anticipated growth within the watershed will undoubtedly affect greenhouse gas emissions in the watershed. An emissions forecast to 2031 was developed and predicted that with this future growth and development, total emissions within the Lake Simcoe watershed could increase 45 percent from the 2016 baseline.

Carbon Sequestration

Determining the Lake Simcoe watershed’s greenhouse gas emissions inventory and forecast helped us to understand the current and future distribution of emissions across the watershed. However, it is also important to consider the critical role that natural features such as forests and wetlands play in offsetting carbon emissions, through carbon sequestration.

Research conducted in partnership with Lakehead University and the University of Toronto estimates that wetlands and forests in the Lake Simcoe watershed sequester an estimated 632,212 tonnes and 126,827 tonnes, respectively, of carbon from the atmosphere annually.

In order to develop a projection of potential future sequestration rates, two land-use scenarios were developed: a “full build out” scenario that assumes that any forest or wetland which is not protected by provincial or municipal policy would be lost to development, and a “restoration” scenario that assumes that the targets established in LSRCA’s Natural Heritage System Restoration Strategy (2018) are achieved.

Carbon Budget

These estimates of carbon emissions and sequestration were compiled into a watershed-scale carbon budget, to examine which parts of the watershed are experiencing net emissions, and which are experiencing net sequestration. Projections of both emissions and sequestration

were combined into two projected future carbon budgets: the “business as usual” and the “targets met”.

The “Business as Usual” scenario where population growth proceeds as projected, and no specific action is taken on emissions reduction, predicted an increase of 57% in net emissions from the 2016 baseline. The “Targets Met” scenario, where population growth is balanced by LSRCA and watershed municipalities achieving their emission reduction and sequestration targets, predicts a 20% reduction in net emissions.

While sequestration is an important consideration in climate change mitigation, projected increases in greenhouse gas emissions are much greater than projected increases in sequestration. This clearly indicates that LSRCA cannot take climate action alone, and that a collaborative approach between municipalities, other government agencies and the private sector will be necessary to achieve success. What LSRCA can do, however, is optimize the carbon sequestration benefits of the work we do including increasing our focus on wetland creation, and working with municipalities to enhance urban tree canopies, particularly in new developments.

Recommendations

This Climate Change Mitigation Strategy has developed a set of 18 recommendations for action under five over-arching goals. These recommendations will build upon the LSRCA’s programs and services and help us collaborate with our municipal partners and the public to further reduce the carbon footprint of the Lake Simcoe watershed. These recommendations focus on creating new and enhancing existing LSRCA programs, services and operations, as well as working with watershed municipalities to enhance urban tree canopies.

Goal 1: Leadership

Provide leadership in the field of climate change and carbon sequestration by continuing to support and provide resources to our municipal partners.

1. Continue to play a leadership role in municipal climate change working groups to help coordinate municipal climate mitigation activities and build expertise in carbon capture and sequestration in watershed municipalities.
2. Work with emerging municipalities who are net emitters to develop their capacity for climate change mitigation and carbon sequestration efforts.
3. Using LSRCA's Corporate Carbon Reduction Strategy as a guiding template, advise municipalities/organizations in the development and implementation of their own Corporate Carbon Reduction Strategies.
4. Work with municipalities to help them develop or update their trail strategies/trail master plans in order to help connect trail systems and create a stronger active transportation network within the watershed.
5. Work with the Lake Simcoe Conservation Foundation to create a fundraising program which enables donors to support projects that will offset their carbon footprint

Goal 2: Education & Communications

Effectively communicate the necessary information to educate and empower people within the Lake Simcoe watershed to take action to combat climate change within their communities.

6. Develop a Climate Change Engagement Strategy that will serve to educate LSRCA staff on our current climate change strategies, educate the public on local climate change impacts and mitigation actions, as well as engage a more diverse audience in order to leverage additional perspectives and support for programs.
7. Through the Annual LSRCA Conservation Awards, keep up to date with what community members/organizations are doing and recognize those who have gone above and beyond to help combat climate change within their community.
8. Expand current climate change educational programming to include public workshops as well as resources and tools so watershed residents can engage in climate change mitigation/carbon sequestration efforts within their homes and communities.
9. Develop and provide climate change and carbon sequestration focused materials for teachers and students.

Goal 3: Tools & Resources

Provide the tools and resources that will allow LSRCA and our municipal partners to apply best practices to their carbon reduction or sequestration efforts.

10. Periodically update the emissions inventory, projections, and landcover mapping, while also considering emerging technologies and methodologies in order to provide an accurate accounting tool for the watershed.
11. Use LSRCA's Natural Heritage System Restoration Strategy, and data from sequestration studies, to identify areas within the watershed that are not reaching their full carbon sequestration potential, as well as additional areas that could sequester substantial carbon if restored to natural habitat.

Goal 4: Build Knowledge

Use the tools and resources to expand and build upon our collective knowledge and understanding of climate change mitigation and carbon sequestration.

12. Building off York Region's expertise in carbon capture of urban forests, expand the implementation of Urban Forest studies to other watershed municipalities. Use the results of these studies to further our understanding of the current and potential carbon sequestration in urban canopies.
13. Explore the carbon sequestration potential of grassland habitats within the Lake Simcoe watershed.
14. Research and estimate the co-benefits and value of low impact development/green infrastructure from a carbon reduction/sequestration perspective.

Goal 5: Sustainable Communities

Support municipalities in incorporating carbon sequestration into community design and energy plans.

15. Conduct a review of municipal planning policies to identify best-in-class approaches to 'complete community' design at a local level and convene a workshop with municipal planners and climate change staff to develop template policies as necessary.
16. Promote the uptake of energy efficiency design charettes with industry partners such as developers and builders.
17. Work with others to refine the accounting of carbon sequestration by individual trees, with a long-term goal of developing a community scale carbon budget calculator that would help municipal planners and developers progress towards 'net zero' communities.
18. Support municipalities in developing or updating Green Development Standards that include carbon budgets as a consideration.

Chapter 1

1.0 Introduction

1.1 Lake Simcoe Watershed Background

The Lake Simcoe watershed is over 3,400 km² in size and includes the major population centers of Barrie, Orillia, Newmarket, Aurora, Bradford-West Gwillimbury, and Keswick, as well as the lands of the Chippewas of Georgina Island First Nation (Figure 1). The Lake Simcoe watershed has one of the most rapidly expanding populations in Canada and the Provincial growth plan projects an additional 150,000 people in the watershed by 2031 (MMAH, 2019), an increase of approximately 25%. The municipalities that make up the Lake Simcoe watershed range from slow-growing rural areas to more rapidly growing urban areas.



Figure 1 - Map of the Lake Simcoe watershed

The Lake Simcoe watershed supports a variety of different land use types, the most significant of which for the purposes of the Climate Change Mitigation Strategy include urban areas (including residential, industrial, commercial, and institutional), agricultural areas (including both intensive and non-intensive agriculture), and natural heritage features (Figure 2). As

growth and development proceed within the Lake Simcoe watershed, urban areas are expected to expand into the agricultural areas.



Figure 2 - Land use within the Lake Simcoe watershed

1.2 Climate Change in the Lake Simcoe Watershed

As illustrated by LSRCA’s Climate Change Adaptation Strategy (LSRCA 2020), the Lake Simcoe watershed is expected to experience changes in precipitation patterns, air temperature, water quality, and aquatic and terrestrial ecosystem structure and function as a result of climate change. The Adaptation Strategy presented climate projections under two different greenhouse gas emissions scenarios: Representative Concentration Pathway (RCP) 8.5, which represents a high carbon, or a ‘Business as Usual’ scenario; and RCP 4.5, which represents a mid-carbon scenario where greater mitigation efforts are adopted (LSRCA, 2019). For example, the RCP 8.5 scenario projects an increase in annual average temperatures of 5.5°C by the end of the century, whereas the RCP 4.5 scenario projects an increase of 3°C (Figure 3).

The pervasive and significant impacts climate change is projected to have on Lake Simcoe and its watershed highlights the importance of taking action to reduce or mitigate greenhouse gas levels. This is especially critical if we are to help achieve a change from the current business as usual scenario to one of lower impact such as the mid-carbon scenario (RCP 4.5). Although the Lake Simcoe watershed is a small player in the global fight against climate change, collective action through both mitigation and adaptation will help to lessen the potential negative impacts on our watershed and ultimately, the planet as a whole.

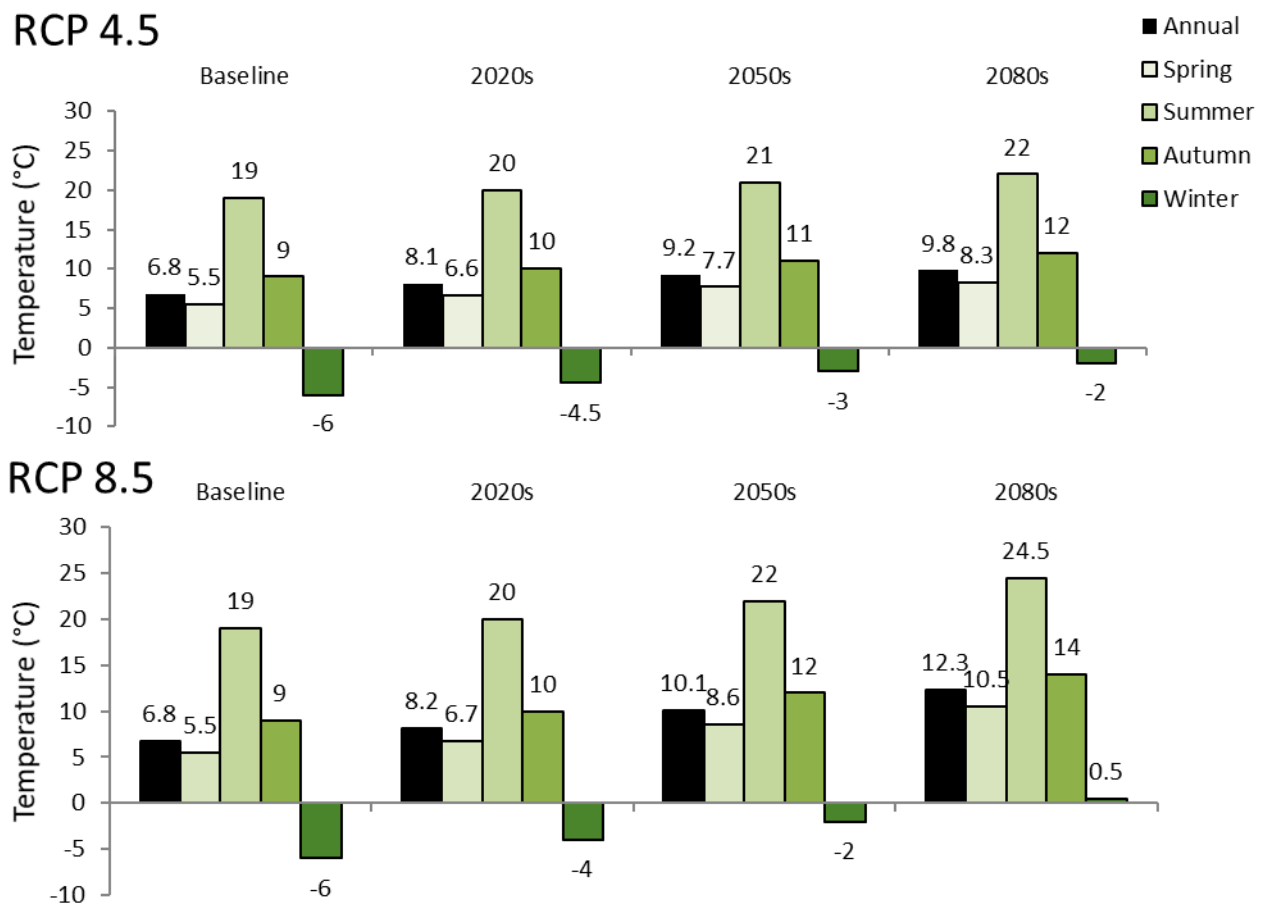


Figure 3 - Mean annual and seasonal air temperatures projections in the RCP4.5 and RCP8.5 scenarios compared to the 1981 to 2010 baseline. Data source: Environment Canada (baseline) and Climate Change Hazards Information Portal (projections).

1.3 Watershed-wide Climate Change Mitigation Strategy

Corporately, LSRCA has already taken strides towards mitigating its carbon emissions through the preparation and implementation of a Corporate Carbon Reduction Strategy (LSRCA, 2019). This strategy identified numerous opportunities for the Authority to reduce emissions associated with business operations and facilities, including using lower emission fleet vehicles, installing solar panels and encouraging carpooling and virtual meetings among staff. However, in order to engage the public and our municipal partners in taking further actions to reduce emissions, as well as alter our own programs and services to better consider climate change mitigation, we recognized that a more widespread and strategic approach was required.

As a result, LSRCA's 2016-2020 Strategic Plan identified the development of a watershed-wide Climate Change Mitigation Strategy as the third element of LSRCA's response to climate change. The approach taken in developing this strategy was first to quantify GHG emissions and sequestration in the Lake Simcoe watershed and then to develop scenarios of possible future trends through the development of a carbon budget. The carbon budget was prepared for both present day (2016) and projected forward to 2031 based on a "Business as Usual" scenario. The budget includes specific details on sources of emissions and sequestration that allowed us to better contextualize the climate change problem on a local scale and thus, better inform the development of recommendations for action. It is important to note that there is a level of uncertainty in the data due to various assumptions that were made throughout the process. However, despite these limitations, the analysis provides a high-level understanding of emissions and sequestration in the Lake Simcoe watershed.

We hope that by providing this watershed-wide Climate Change Mitigation Strategy and associated implementation plan, we can work together with our staff, municipal partners and the public to decrease the carbon footprint of the Lake Simcoe watershed.

Chapter 2

2.0 Emissions Inventory

2.1 Methodology and Assumptions

2.1.1 Overview

The first phase in developing the Climate Change Mitigation Strategy was creating a baseline greenhouse gas emissions inventory for the Lake Simcoe watershed. The methodology used in this study followed the Intergovernmental Panel on Climate Change Protocol's (IPCC) Tier 1 Greenhouse Gas Emissions Inventory, which is the most basic inventory in terms of complexity and data requirements (IPCC, 2019). This involved identifying applicable sectors and determining the scale and availability of data needed for each sector. Environment Canada's 2016 National Inventory Report (Environment and Climate Change Canada, 2018) includes an inventory of greenhouse gas estimates in five main sectors: energy; industrial processes and product use; agriculture; waste; and land use, land-use change and forestry. Each of these sectors is broken down further into categories and subcategories. For example, the Energy sector is broken down as follows:

1. Energy
 - a. Stationary Combustion Sources
 - i. Public Electricity and Heat Production
 - ii. Petroleum Refining Industries
 - iii. Mining and Upstream Oil and Gas Production
 - iv. Manufacturing Industries
 - v. Construction
 - vi. Commercial and Institutional
 - vii. Residential
 - viii. Agriculture and Forestry

Once the applicable sectors, categories, and subcategories to the Lake Simcoe watershed were selected, the baseline estimate of greenhouse gas emissions was completed by downscaling the estimates provided in the 2016 National Inventory to the watershed level.

2.1.2 Downscaling National Data

The Environment Canada 2016 National Inventory Report provides annual emission estimates from all major sources within each Province. The inventory includes a breakdown of major greenhouse gas types (e.g. carbon dioxide, nitrous oxide, and methane) as well as total emissions presented in kilotonnes of carbon dioxide equivalents (Tables A11-12)). The overall greenhouse gas emissions are provided in carbon dioxide equivalents in order to determine the “number of metric tonnes of carbon dioxide emissions with the same global warming potential as one metric ton of another greenhouse gas” (EPA, 2019). Emissions from each subcategory were then downscaled to the Lake Simcoe watershed by using 2016 census data or the LSRCA landcover layer, depending on the sector. Table 1 provides an example of this downscaling approach using data from the 2016 Canadian Census to estimate emissions produced by the residential sector in East Gwillimbury.

Table 1 – An example of the methodology for estimating emissions produced by the residential sector in East Gwillimbury. Data source: 2016 Canadian Census, National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada

Region	Census Tract	Population (2016)	Proportion of Ontario Population in Geographic Area (%)	GHG Emissions in Geographic Area (tCO ₂ eq)	CO ₂ Emissions in Geographic Area (tCO ₂)
Ontario	n/a	13,448,494	100	18,100,000	17,100,000
East Gwillimbury	5350455.00	8,254	0.06	11,108	10,495
East Gwillimbury	5350456.01	4,480	0.03	6,029	5,696
East Gwillimbury	5350456.02	7,199	0.05	9,688	9,153
East Gwillimbury	5350456.03	4,058	0.03	5,461	5,159

In order to be more precise with the emissions inventory and include only the areas located within the boundaries of the Lake Simcoe watershed, each municipality in the watershed was broken down into individual census tracts or dissemination areas (Figure 4). Census tracts are defined by Statistics Canada as “small, relatively stable geographic areas that usually have a population between 2,500 and 8,000 persons”, whereas dissemination areas are defined as “a small area composed of one or more neighboring dissemination blocks, with a population of 400 to 700 persons” (2016). Census tracts have not been defined by Statistics Canada for the more rural parts of the watershed with less dense populations; in those cases, dissemination areas were used instead. For the purposes of this study, if a census tract or dissemination area was situated 50% or more within the boundaries of the watershed, it was considered as fully in the watershed, and any that were situated less than 50% within the boundaries of the watershed were not considered as part of the watershed.

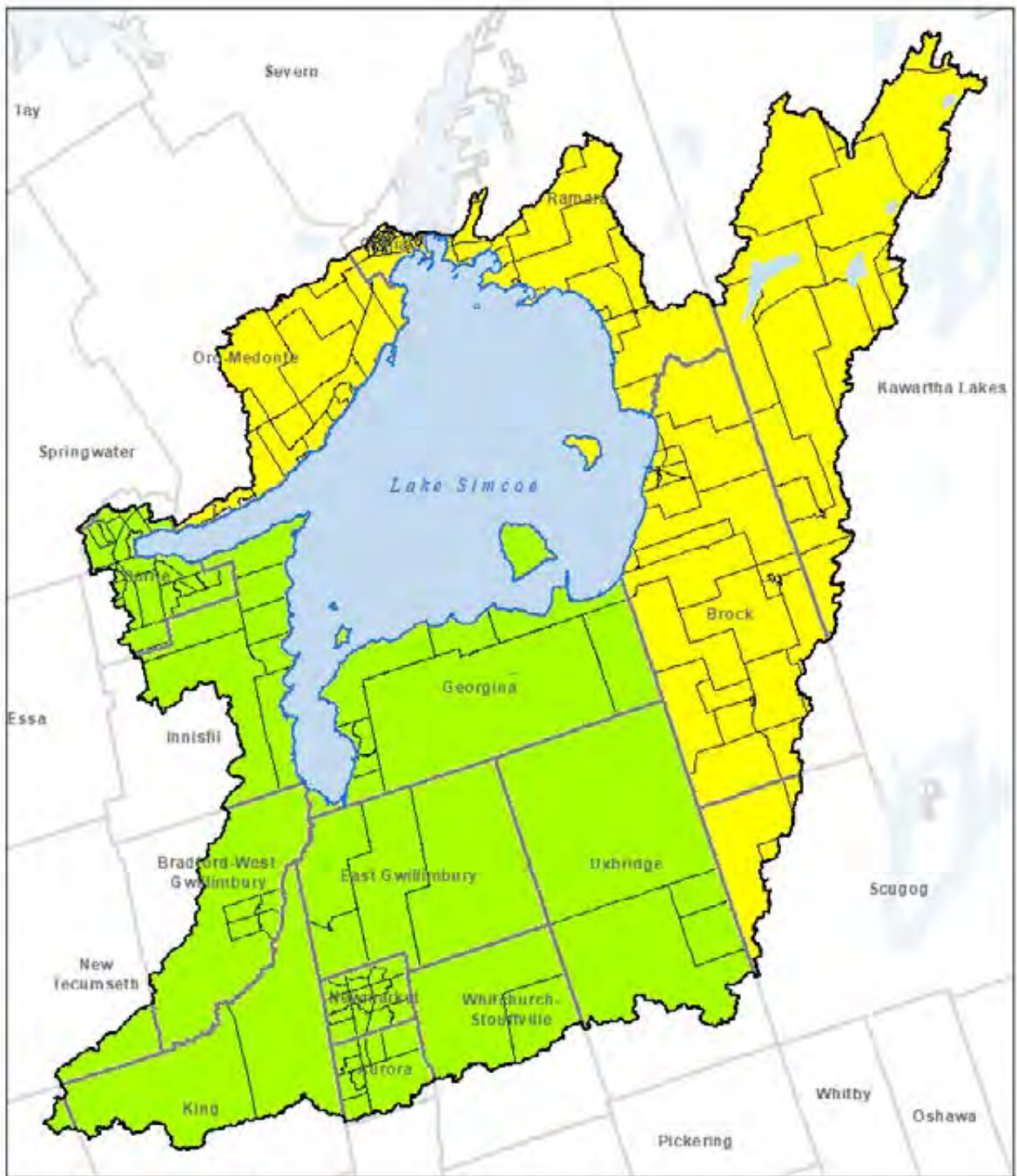


Figure 4 - The census tracts and dissemination areas of the Lake Simcoe watershed.

Legend		Geographic unit	
Lake Simcoe	Lower Tier Municipality	Census tract	Dissemination Area
Lake Simcoe Watershed			

0 2.5 5 10 15 20 Kilometres

The content was prepared by the Lake Simcoe Region Conservation Authority with some content prepared by the local government of Lake Simcoe. This content is provided for informational purposes only. It is not intended to be used for any other purpose.

Figure 4 - The census tracts and dissemination areas of the Lake Simcoe watershed

2.1.3 Calculating Sector Emissions

When completing an emissions inventory of any scale, there are three main scopes to consider (Table 2). As the emissions associated with Scope 3 are outside of LSRCA’s jurisdiction, only Scope 1 and Scope 2 were included in the emissions inventory (Figure 5; C40, ICLEI and World Resources Institute, 2014).

Table 2 - Scopes 1, 2 and 3 as defined by the Greenhouse Gas Protocol (C40, ICLEI and World Resources Institute, 2014). Only scope 1 and 2 were considered as part of this emissions inventory.

Scope	Definition
Scope 1	GHG emissions from sources located within the city (or watershed) boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city (or watershed) boundary
Scope 3	All other GHG emissions that occur outside the city (or watershed) boundary as a result of activities taking place within the city (or watershed) boundary

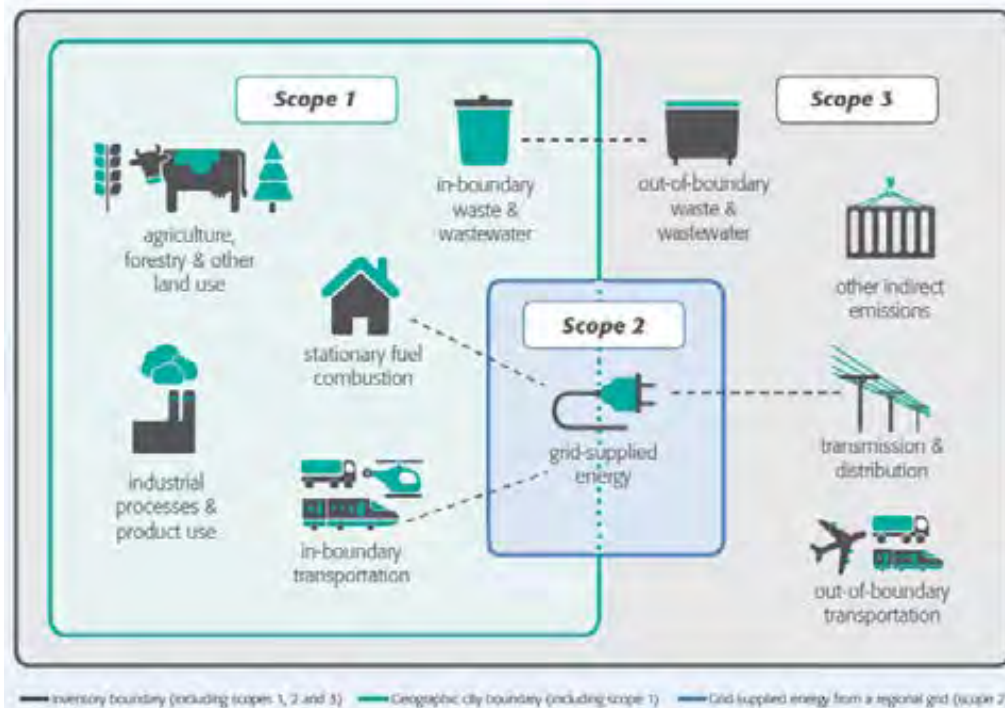


Figure 5 - A visual representation of scopes 1, 2 and 3 (C40, ICLEI and World Resources Institute, 2014)

Bearing this in mind, of the five main sectors included in the 2016 National Inventory Report, only the energy (stationary combustion sources and transport), agriculture, and waste sectors were used to calculate the emissions inventory for the Lake Simcoe watershed. As heavy industrial processes do not occur in the Lake Simcoe watershed, these were not included in the emissions inventory.

For most subcategories, population data obtained from the 2016 Canadian Census was used to downscale national inventory data to the watershed level. However, even though the methods remain the same for most subcategories, there were slight differences in how this was undertaken for some, which is explained in the section following Table 3.

Table 3 - A summary of the methodology used in the emissions inventory.

Sector	Subcategory	Data used/obtained from	National Inventory data downscaled based on
Energy – Stationary Combustion	Public Electricity and Heat Production	Population in each census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area
Energy – Stationary Combustion	Residential	Population in each census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area
Energy – Stationary Combustion	Industrial, Commercial, Institutional	Area of industrial, commercial, and institutional buildings obtained from the LSRCA landcover layer (ca. 2013)	The energy use intensity for each census tract and dissemination area, derived from the Newmarket Community Energy Plan
Energy – Stationary Combustion	Construction Practices	Population change from 2011 to 2016 in each census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area
Energy – Stationary Combustion	Agriculture and Forestry	Total number of farms within each municipality obtained from the 2016 Canadian Census of Agriculture	Proportion of the total number of farms in Ontario in each geographic area
Energy – Transport	On-Road Transportation	Population of census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area
Energy – Transport	Off-Road Transportation	Population in each census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area
Energy – Transport	Railway	Length of railway (kilometres) obtained from the LSRCA landcover layer (ca. 2013)	Proportion of Ontario's railway in each census tract or dissemination area
Agriculture	Enteric Fermentation	Total ruminant livestock species obtained from the 2016 Canadian Census of Agriculture	Proportion of Ontario's total ruminant livestock species in each geographic area
Agriculture	Manure Management	Total livestock species obtained from the 2016 Canadian Census of Agriculture	Proportion of Ontario's total livestock species in each geographic area
Agriculture	Agriculture Soils	Area of crop land obtained from the LSRCA landcover layer (ca. 2013)	Proportion of Ontario's crop land in each geographic area
Waste	Solid Waste Disposal	Population in each census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area
Waste	Wastewater Treatment and Discharge	Population in each census tract or dissemination area obtained from 2016 Canadian Census	Proportion of the Ontario population living in each census tract or dissemination area

2.1.3.1 Energy

Stationary Combustion Sources

Public Electricity and Heat Production, and Residential

The emissions generated from public electricity and heat production as well as residential fuel consumption (including personal residences such as homes, apartments, hotels, condominiums and farmhouses; Environment and Climate Change Canada, 2016) was assumed to be proportional to population due to supply and demand of energy.

Industrial, Commercial, and Institutional

The emissions for this subcategory were not downscaled from the National Inventory Report data, as there were no provincial-level data available that allowed us to downscale the federal report. Instead, the emissions were calculated based on an energy use intensity value of 3.64 GJ/m² which was derived from the Newmarket Community Energy Plan (Town of Newmarket, 2016). This report was selected as it was recent and within our watershed. This value was multiplied by the total area of industrial, commercial, and institutional buildings obtained from the LSRCA landcover layer to give the energy use intensity for each census tract and dissemination area in the watershed. It should be noted that the “industrial” buildings category in the LSRCA Landcover layer was the closest available dataset to the manufacturing consumption subcategory in the National Inventory Report, and therefore, this was used instead and merged into one subcategory.

Construction Practices

The emissions generated from the construction practices subcategory were estimated by using the population change between 2011 and 2016 in each census tract or municipality within the Lake Simcoe watershed as a measure of construction activity. The emissions were downscaled to the watershed level by using the total population change in Ontario between 2011 and 2016. This population data was obtained from the 2016 Canadian Census (Statistics Canada, 2016). This specific approach was taken because land-use data that quantifies the amount of construction occurring in the Lake Simcoe watershed was not available. Additionally, as there was no available population data for dissemination areas in 2011, the total population of the municipality was used instead. In census tracts or dissemination areas where the population is shrinking, it can be assumed that construction practices are non-existent (or at least minimal) and therefore, emissions from construction practices in these geographic areas were zero.

Agriculture and Forestry

The emissions generated from the agriculture and forestry subcategory includes the total number of agricultural, hunting, and trapping farms, as well as forestry and logging service farms. The data pertaining to number of farms was compiled based on census divisions and census consolidated subdivisions (Figure 6), rather than census tracts and dissemination areas. Census divisions are defined by Statistics Canada as a “group of neighbouring municipalities joined together for the purposes of regional planning and managing common services”, and a census consolidated subdivision is defined as “a group of adjacent census subdivisions within the same census division” (Statistics Canada, 2016).

MAP 2B

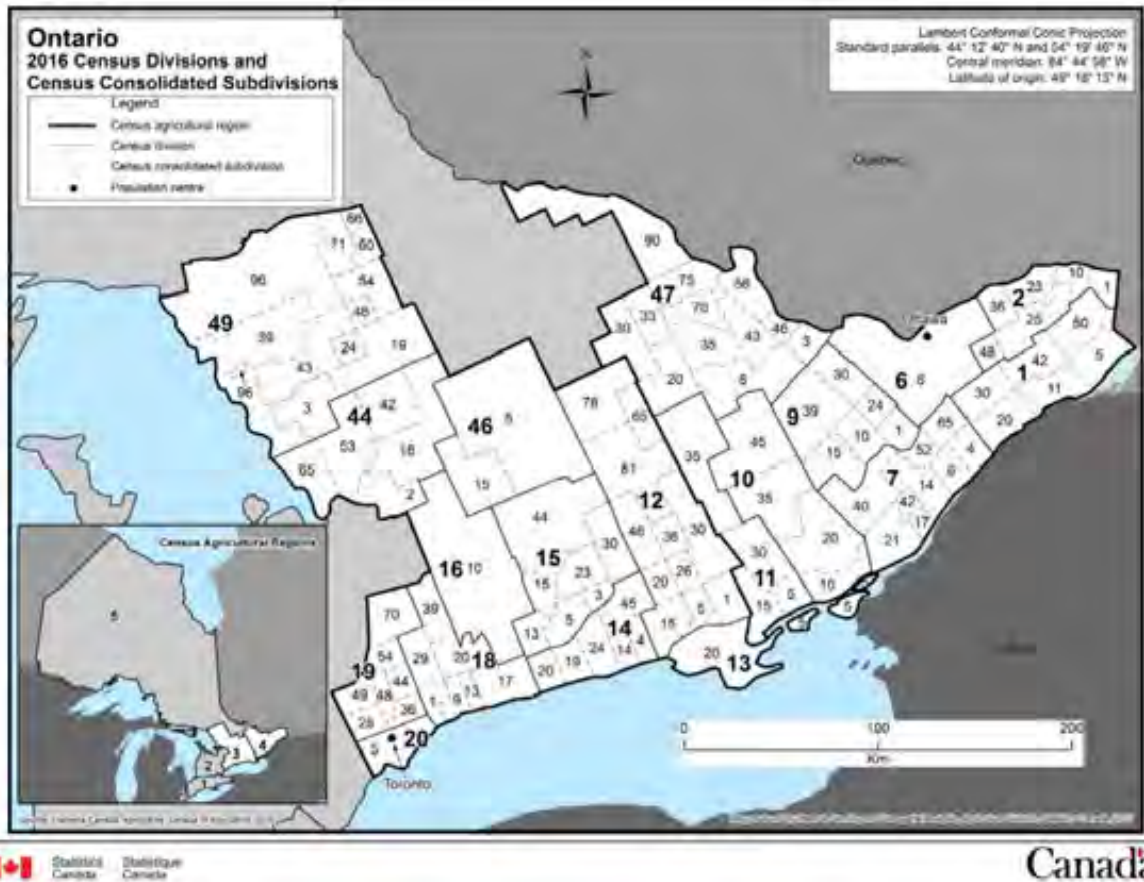


Figure 6 - The 2016 Census Divisions and Census Consolidated Subdivisions used to compile the agriculture and forestry emissions inventory. Data source: 2016 Canadian Census of Agriculture.

Transport

On-Road Transportation and Off-Road Transportation

The emissions generated from on-road and off-road transportation was assumed to be proportional to their population, rather than basing the estimate on detailed information on travel patterns or traffic density. The off-road transportation subcategory includes vehicles that are not licensed to operate on roads, such as heavy machinery and equipment used for agriculture, forestry, and construction. The advantage of this approach is that it accounts for the emissions associated with commuting in the neighbourhood where the commuter lives, not along the route they travel. For example, emissions associated with traffic on Highway 400 is not associated with the census tracts that the highway happens to pass through; rather they are associated with the census tract where commuters live, to assist in targeting action related to behaviour change or land use change. It should be noted however that this approach is a simplification and does not consider the possibility that residents of the Lake Simcoe watershed have longer commutes than the average Ontarian.

Railway

The emissions generated from the railway subcategory were based on total number of kilometres of railway within the Lake Simcoe watershed. The drawback of this approach is that it does not account for ridership.

2.1.3.2 Agriculture

a. Enteric Fermentation

The emissions generated from enteric fermentation was based on the number of ruminant livestock species in each geographic area including such species as cattle, sheep, and goats. The emissions associated with enteric fermentation are primarily methane resulting from digestion by ruminants; carbon dioxide itself is minimal and was treated as being non-existent. The methane emissions are reported as carbon dioxide equivalent, to allow comparison with other sectors.

b. Manure Management

The emissions generated from manure management were compiled in a similar way as enteric fermentation, however, it is based on all livestock populations, not just the population of ruminant livestock. Similar to enteric fermentation, the emissions associated with manure management are primarily methane and nitrous oxide resulting from the storage of feces, urine and bedding materials and from the cleaning of barns and pens; carbon dioxide itself is minimal, and was treated as being non-existent. The methane and nitrous oxide emissions are reported as carbon dioxide equivalent, to allow comparison with other sectors.

c. Agriculture Soils

The emissions generated from agriculture soils (land that contains crops) was based on both direct and indirect sources. Direct sources refer to the nitrous oxide emissions resulting from synthetic fertilizer; manure on cropland; pasture range and paddock; crop residue; tillage; summer fallow; irrigation; and cultivation of organic soils. Indirect sources include nitrous oxide emissions from volatilization and leaching of animal manure nitrogen; synthetic fertilizer nitrogen; and crop residue nitrogen.

2.1.3.3 Waste

a. Solid Waste Disposal

The emissions generated from solid waste disposal (i.e. landfills) was calculated based on population, assuming that the number of people in a municipality is directly related to the amount of waste produced.

b. Wastewater Treatment and Discharge

Similar to enteric fermentation and manure management, the emissions associated with wastewater treatment and discharge are primarily methane; carbon dioxide itself is minimal and was treated as being non-existent. The methane emissions are reported as carbon dioxide

equivalent, to allow comparison with other sectors. While both solid waste disposal and wastewater treatment and discharge facilities aren't present in abundance within the Lake Simcoe watershed, it is important to include them within the emissions inventory as it is a way to identify problems and pave the way for solutions for municipalities.

2.2 Results

The assessment of all Scope 1 and 2 emissions within the Lake Simcoe watershed identified the release of approximately 3,809,500 tonnes of carbon dioxide equivalent, or 7.44 tonnes of carbon dioxide equivalent per capita in 2016.

The transportation, residential, and industrial, commercial, and institutional sectors produced the highest emissions within the watershed and were responsible for over 80% of the total emissions within the Lake Simcoe watershed (Figure 7). The transportation sector alone (including both on and off-road transportation) accounts for approximately 50% of the total emissions, while residential and industrial, commercial, and institutional accounts for approximately 30%. A summary of emissions from each sector in each municipality within the Lake Simcoe watershed is provided in Appendix A.

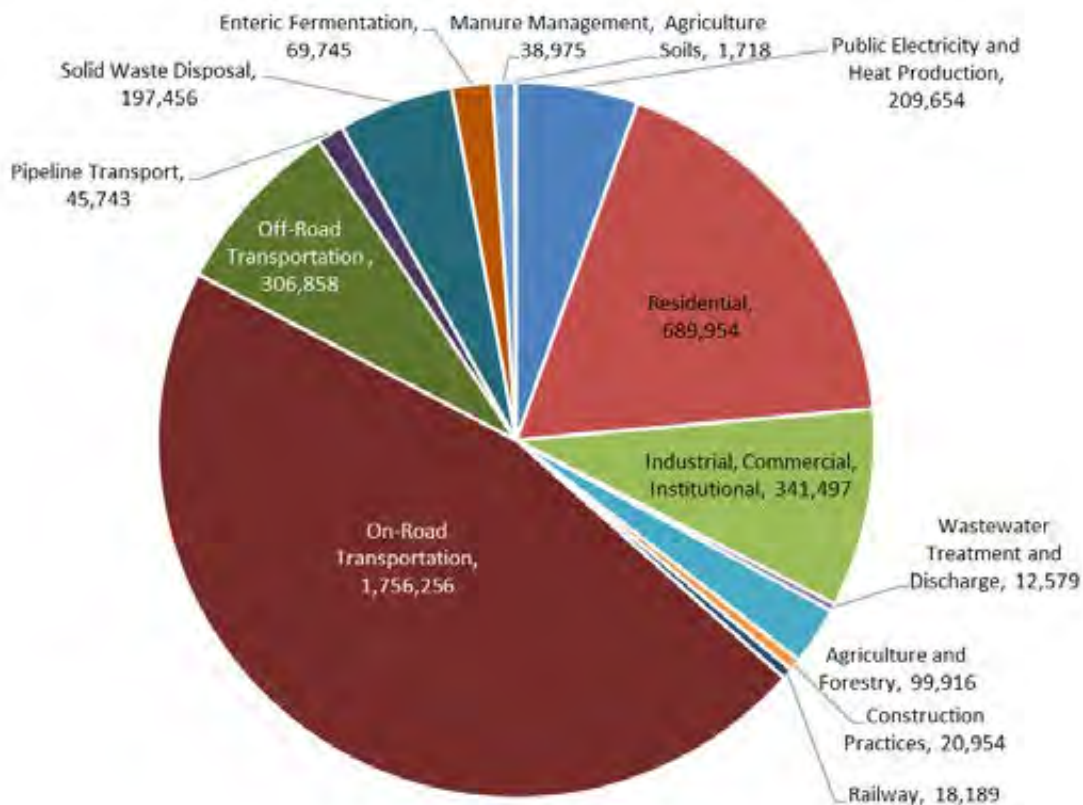


Figure 7 - Total annual greenhouse gas emissions from each sector in 2016 (units are in tonnes of carbon dioxide equivalent per year). Data source: Environment and Climate Change Canada (2018)

The distribution of total emissions across the Lake Simcoe watershed (Figure 8) shows that there is a trend to higher emissions in the more urbanized southern end of the watershed, and lower in the more rural northern end of the watershed. Within urban areas, emissions tend to be greatest in residential neighbourhoods. The higher emissions in the northern arm of the watershed in the City of Kawartha Lakes are attributed to the high density of agricultural areas in this region.

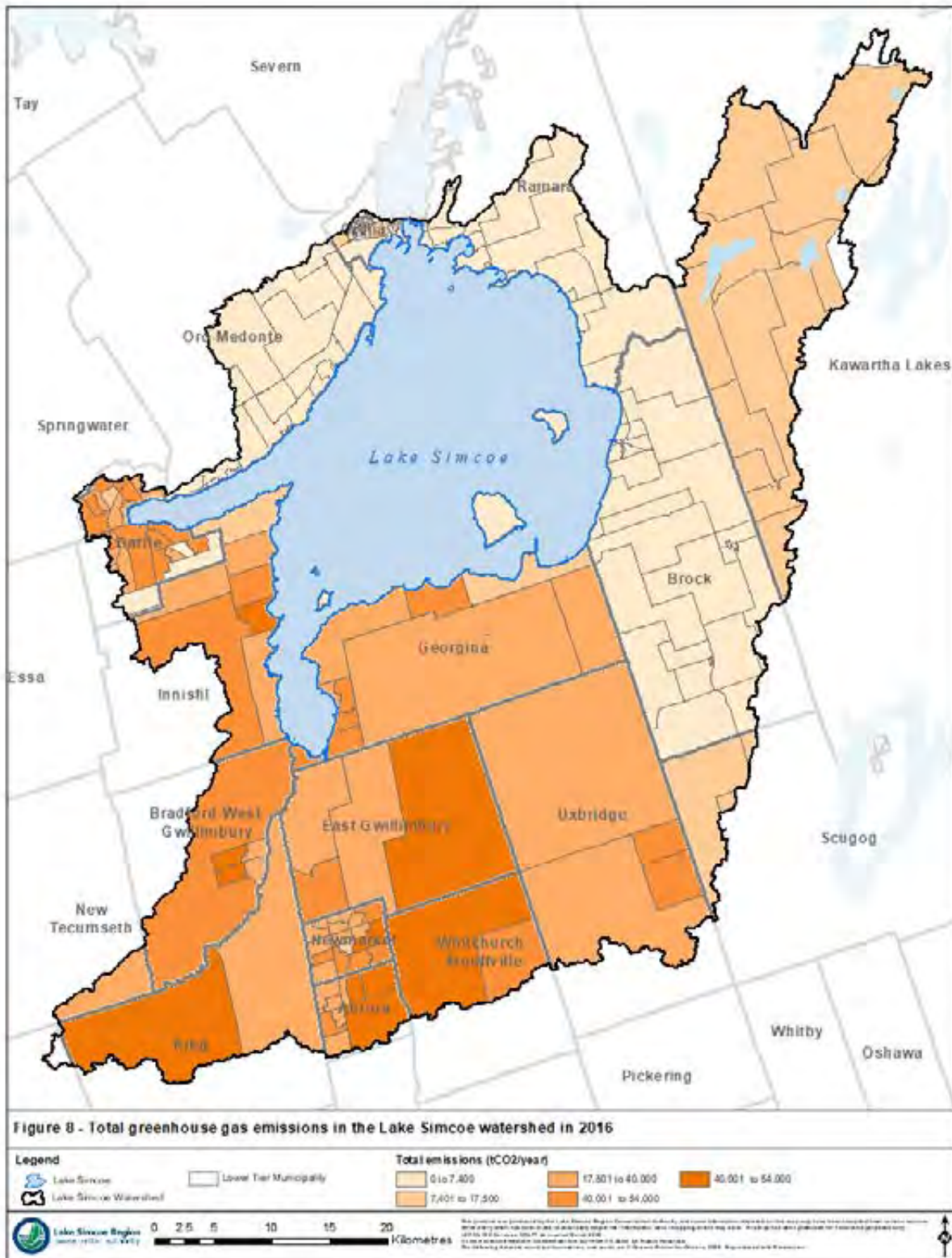


Figure 8 - Total greenhouse gas emissions in the Lake Simcoe watershed in 2016

2.2.1 Transportation

Transportation (both on- and off-road) produced approximately 2,063,100 tonnes of carbon dioxide equivalent, which constitutes 54% to the total emissions in the watershed in 2016. The highest emissions occur in the more densely populated southern end of the watershed, in comparison to the more rural areas in the northern and eastern ends of the watershed (Figure 9).

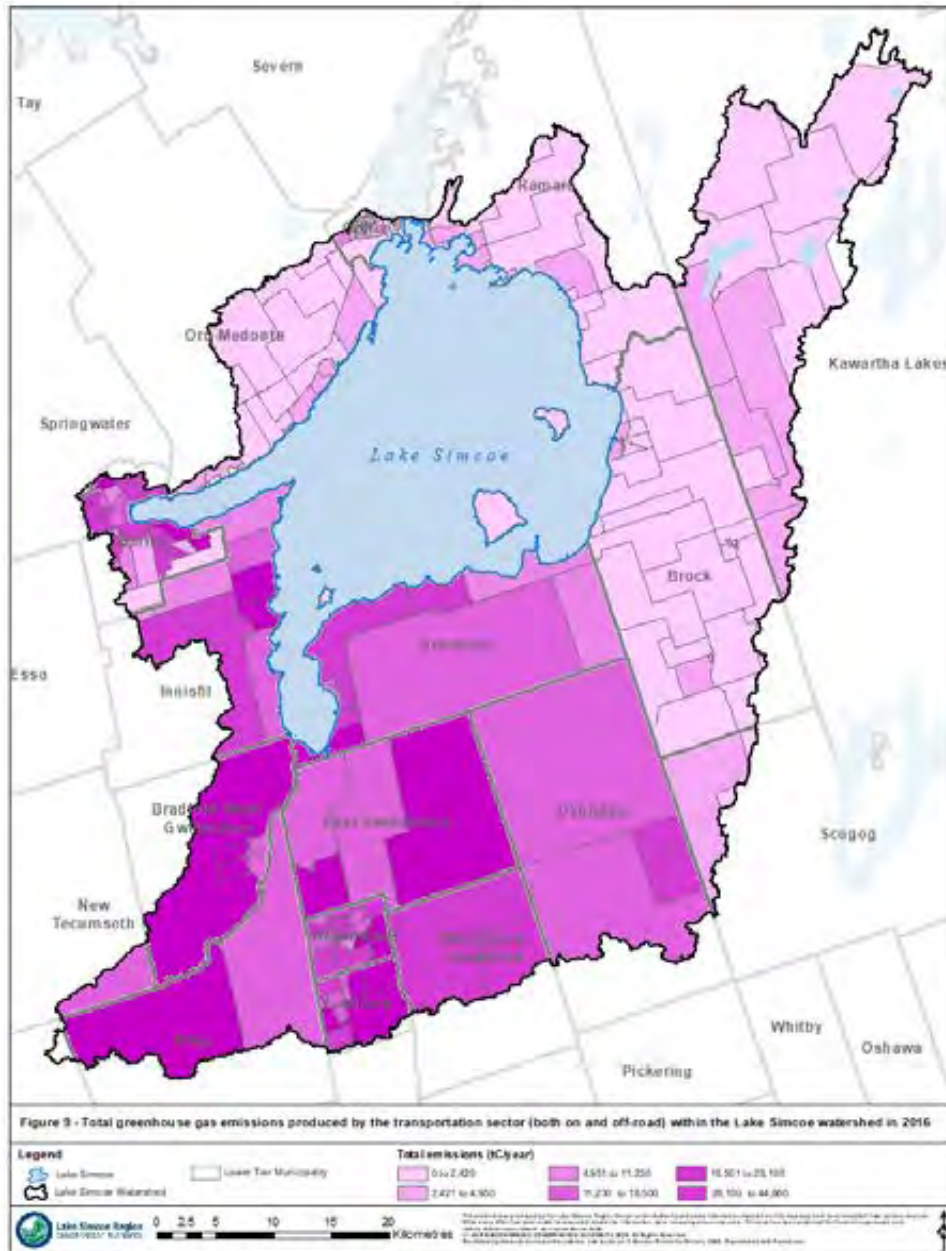


Figure 9 - Total greenhouse gas emissions produced by the transportation sector (both on- and off-road) within the Lake Simcoe watershed in 2016

2.2.2 Residential

The residential sector produced approximately 690,000 tonnes of carbon dioxide equivalent, which constitutes 18% of the total emissions within the watershed in 2016. Much like the transportation sector, higher emissions occur in the more densely populated urban areas of the southern end of the watershed compared to the more rural northern and eastern ends (Figure 10).

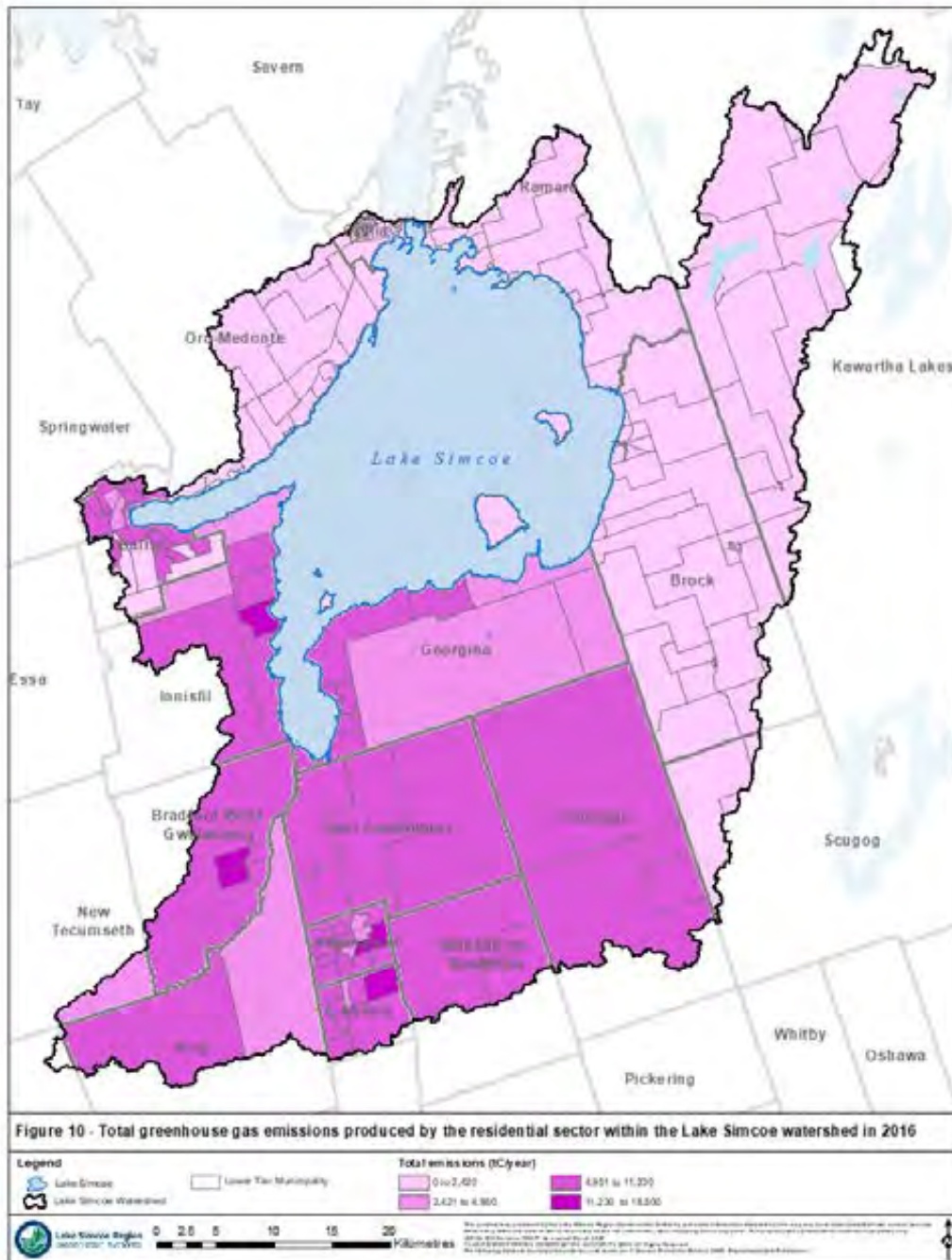


Figure 10 - Total greenhouse gas emissions produced by the residential sector within the Lake Simcoe watershed in 2016

2.2.3 Industrial, Commercial, Institutional

The industrial, commercial, and institutional sectors produced approximately 341,500 tonnes of carbon dioxide equivalent, which constitutes 9% of the total emissions within the watershed in 2016. As depicted in Figure 11, the highest emissions for the industrial, commercial, and institutional sector occurs in particular neighbourhoods in the more urban municipalities such as Barrie, Aurora, and Newmarket, where zoning by-laws permit the land use.

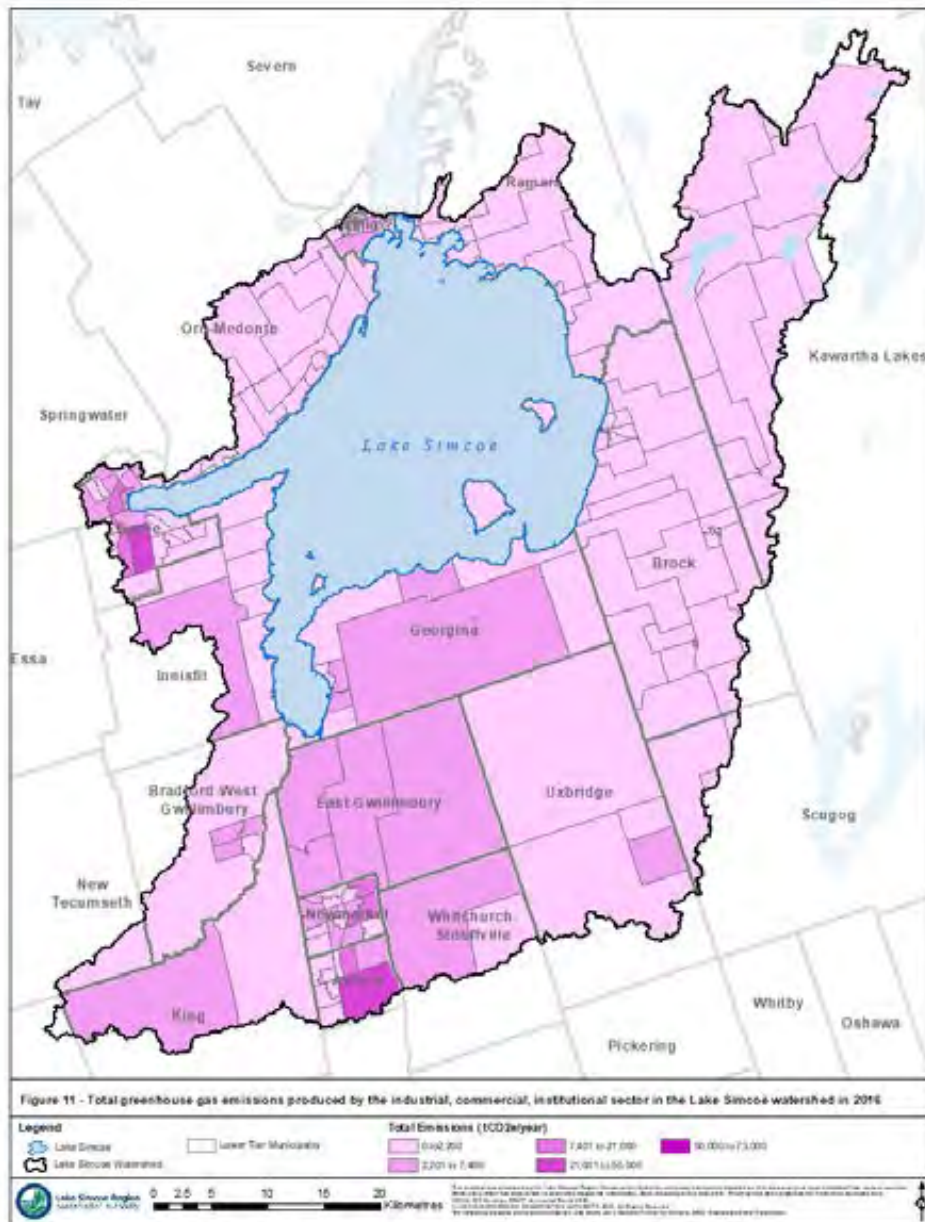


Figure 11 - Total greenhouse gas emissions produced by the industrial, commercial, institutional sector in the Lake Simcoe watershed in 2016

2.3 Benchmarking

The emissions estimate was calculated by downscaling national estimates to local data, as it provided an efficient, inexpensive and logical way of estimating relative sources of greenhouse gases in the Lake Simcoe watershed. The risk in doing this, however, was that the Lake Simcoe watershed may not be “typical” of the province or country as a whole. Therefore, a benchmarking exercise was completed in order to gauge how the Lake Simcoe watershed emissions inventory compares to these other municipalities and regions. Overall, the local estimates were similar to the overall Lake Simcoe watershed level estimates, especially when considering the number of assumptions that were made as part of this methodology.

The Lake Simcoe watershed’s estimate of 7.44 tonnes of carbon dioxide equivalent per capita per year is very similar to Brock and Uxbridge Townships estimate of 7.64 tonnes of carbon dioxide equivalent per capita per year (Durham Sustain Ability 2010). As Brock Township and the population centre in Uxbridge are almost entirely in the Lake Simcoe watershed, this allowed a direct comparison between their more detailed methodology and the down-scaled estimate reported here.

The per capita emissions estimates of Ontario and Canada from the National Inventory Reports were considerably higher than the local estimates (Figure 12). This difference can be attributed to the fact that the National Inventory Reports included emissions generated from heavy industrial and manufacturing processes such as iron and steel, and pulp and paper, as well as from domestic aviation, none of which occur in the Lake Simcoe watershed, and thus fall under the Scope 3 category and were out of scope for this watershed-wide inventory and municipal inventories.

While these other studies categorized sectors slightly differently than the National Inventory Report, the sector-based emission estimates in this study were generally similar to those reported by Newmarket, Uxbridge, and Brock Township.

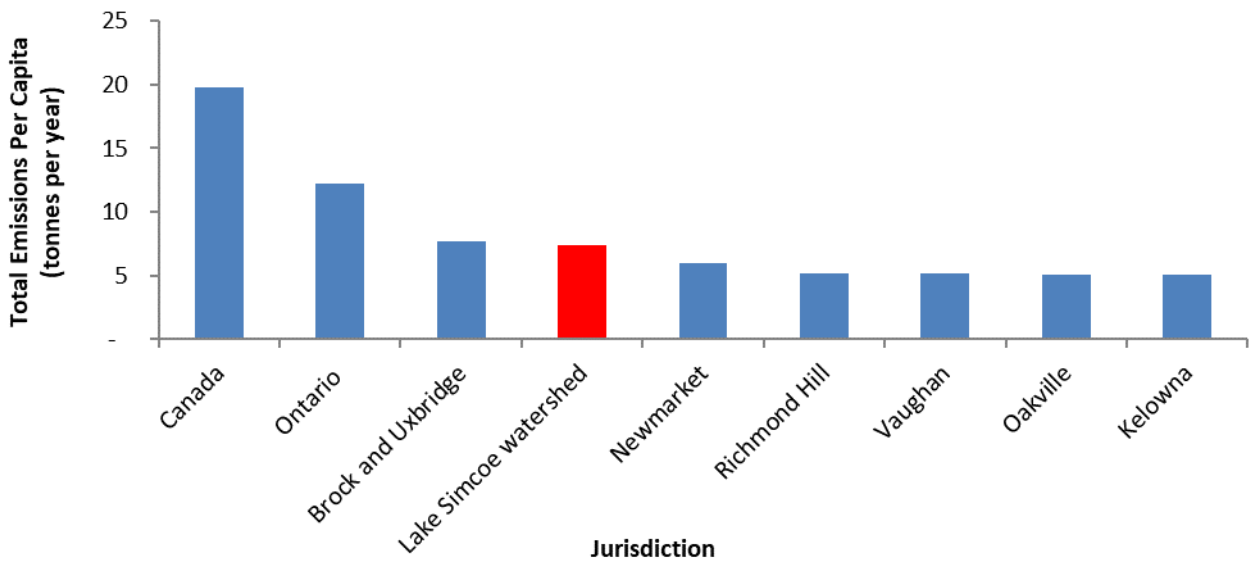


Figure 12 - Reported emissions per capita in jurisdictions of varying scales within Canada. Data source: Environment and Climate Change Canada (2018), Durham Sustain Ability (2010), Town of Newmarket (2016), Town of Richmond Hill (2004), City of Vaughan (2014), Town of Oakville (2004), and City of Kelowna (2018).

Chapter 3

3.0 Emissions Forecast

The intent of the emissions forecast is to predict how growth and development in the Lake Simcoe watershed will affect greenhouse gas emissions. It should be noted that the forecasts are developed using a “Business as Usual” scenario and do not consider any future emission reductions such as those resulting from societal change, local, provincial or federal government action or advancements in technology.

In an effort to be consistent with the recommended global targets and to head toward a more sustainable future, some municipalities within the Lake Simcoe watershed have set corporate and/or community carbon reduction targets. For example, The Township of King has set a target of 45% reduction in their corporate energy emissions by 2030 (Township of King, 2019) and the Town of Newmarket has a per capita reduction of 40% below the 2013 baseline by 2031 (Town of Newmarket, 2016). With some municipalities setting aggressive reduction targets, this level of municipal effort means the Business as Usual scenario may result in an overestimate. For the purposes of scoping recommendations for action however, the Business as Usual scenario is the most appropriate one for targeting actions.

3.1 Methodology and Assumptions

The greenhouse gas emissions forecast was developed using population forecasts and land use mapping from municipal official plans (where data existed) and applied to the calculations described in Chapter 2.

3.1.1 Forecasting Population

Population forecasts for watershed municipalities were provided by the Provincial Growth Plan (MMAH, 2019). As 2031 was the only year with provincial population forecasts for all the municipalities within the Lake Simcoe watershed, it was selected as the year to which emissions were forecasted. The greenhouse gas emissions estimate for 2031 was developed by multiplying the proportional increase in population from 2016 to 2031 to the emissions inventory estimate for each census tract and dissemination area. Table 4 provides an example of this forecasting approach, applied to the residential sector in East Gwillimbury.

Table 4 - An example of the methodology for forecasting future emissions in the residential sector in East Gwillimbury. This 'Business as Usual' scenario assumes that no action is taken to reduce per capita emissions. Data source: 2016 Canadian Census, MMAH (2019).

Region	Census Tract	Population (2016)	Population (2031)	Population Change (%)	GHG Emissions (t CO2 equivalent)	CO2 Emissions (t)
East Gwillimbury	5350455.00	8,254	15,740	191	21,184	20,014
East Gwillimbury	5350456.01	4,480	30,120	672	40,538	38,298
East Gwillimbury	5350456.02	7,199	18,620	259	25,060	23,676
East Gwillimbury	5350456.03	4,058	11,310	279	15,222	14,382

If residential land use projections from municipal Official Plans were available in geospatial format, population forecasts for each census tract or subdivision were developed by allocating total population forecasts to individual census tracts and dissemination areas within the Lake Simcoe watershed. For the sectors that used population to calculate the emissions inventory (see Chapter 2), the forecast was calculated using this estimated population for 2031.

However, if residential land use projections were not available in geospatial format or were currently under revision (as was the case with Kawartha Lakes, King, New Tecumseth, Ramara, Scugog, and Whitchurch-Stouffville), locally specific approaches were taken to estimate population growth.

For Kawartha Lakes, Scugog, and New Tecumseth, where projected growth is anticipated to occur beyond the Lake Simcoe watershed, and where geospatial data representing land use designations were not available, population growth in census tracts in the watershed was assumed to be zero. However, for King and Whitchurch-Stouffville, which will experience some growth in our watershed, land use designations in the York Region Official Plan were used to allocate total population forecasts to individual census tracts and dissemination areas within the Lake Simcoe watershed. Finally, for Orillia and Ramara, which will also experience some growth within our watershed and did not have Official Plan mapping available in geospatial format, growth was allocated equally across all census tracts or subdivisions. See the population and employment forecast spreadsheet and map in Appendix B for more information.

3.1.2 Forecasting Land Use

3.1.2.1 Industrial, Commercial, Institutional

Areas identified in Official Plans as employment/business areas, community centres, commercial areas, general commercial and industrial areas, and schools/institutions, which were not currently used for industrial, commercial, or institutional land uses, were projected to become so by 2031. However, any areas mapped as natural heritage features in the LSRCA Landcover layer were assumed to be protected, and thus removed from the projected industrial, commercial, and institutional land base. The 2031 emissions projection for this sector

was calculated by multiplying the proportional increase of land use from 2016 to 2031 to the 2016 baseline emissions for the industrial, commercial and institutional sector within each census tract and dissemination area. This calculation used the assumption that an increase in land use would lead to a proportional increase in emissions.

3.1.2.2 Agriculture Soils

In some cases, the land designated to support growth in residential, industrial, commercial, and institutional uses is currently agricultural. In order to account for the change in agricultural emissions as land conversion occurs, any area currently mapped as agriculture, but designated as one of these other land use types, was removed from the total agricultural area in each census tract. The resulting agriculture land base was then multiplied by the greenhouse gas emission generated from this sector, as described in Chapter 2.

3.1.2.3 Railway, Agriculture and Forestry, Enteric Fermentation, and Manure Management

Emissions generated from the railway, agriculture and forestry, enteric fermentation, and manure management sectors were left unchanged due to limited data availability. However, for the case of enteric fermentation and manure management, it was assumed that the number of livestock in the watershed would remain unchanged in 2031 but might intensify on a shrinking land base.

Growth data pertaining to railways (i.e. increase in number of trips) as well as agriculture and forestry (i.e. change in the number of farms for hunting/trapping and logging) was unavailable; however, as it remains a small contribution to the total carbon emissions within the watershed, it is not expected to have a large impact on future carbon emissions.

3.2 Results

Under the ‘Business as Usual’ scenario, the total emissions within the Lake Simcoe watershed are estimated to increase from 3,809,494 tonnes of carbon dioxide equivalent in 2016 to 5,519,757 tonnes of carbon dioxide equivalent in 2031; an increase of 45 percent. Nearly all sectors will experience an increase (Figure 13), however the top three emitting sectors are projected to remain transportation, residential, and industrial, commercial, and institutional. Figure 14 compares the 2016 baseline total emissions to the 2031 projected emissions and identifies which census tracts and dissemination areas are anticipated to experience the greatest increases.

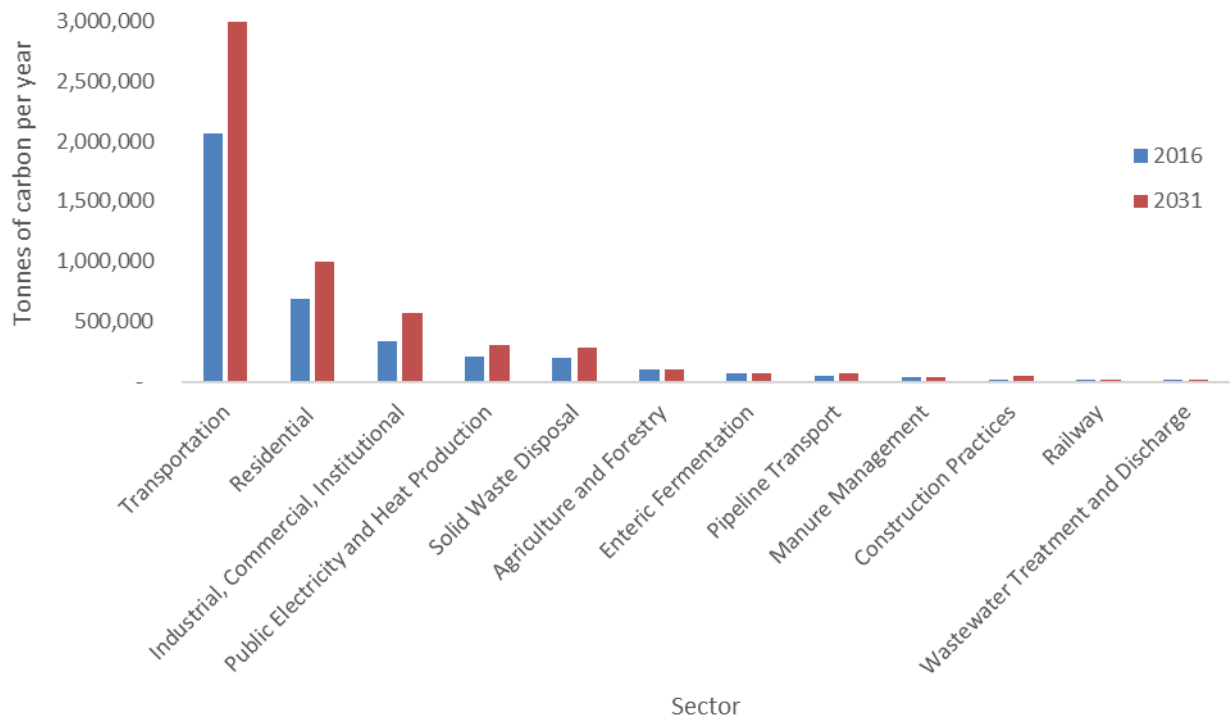


Figure 13 - A sector-based comparison of total carbon emissions in 2016 vs. 2031. This projection built under the ‘Business as Usual’ scenario, which assumes no actions are taken to reduce per capita emissions. Data source: National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada, 2016 Canadian Census, Places to Grow: 2017 Growth Plan for the Golden Horseshoe

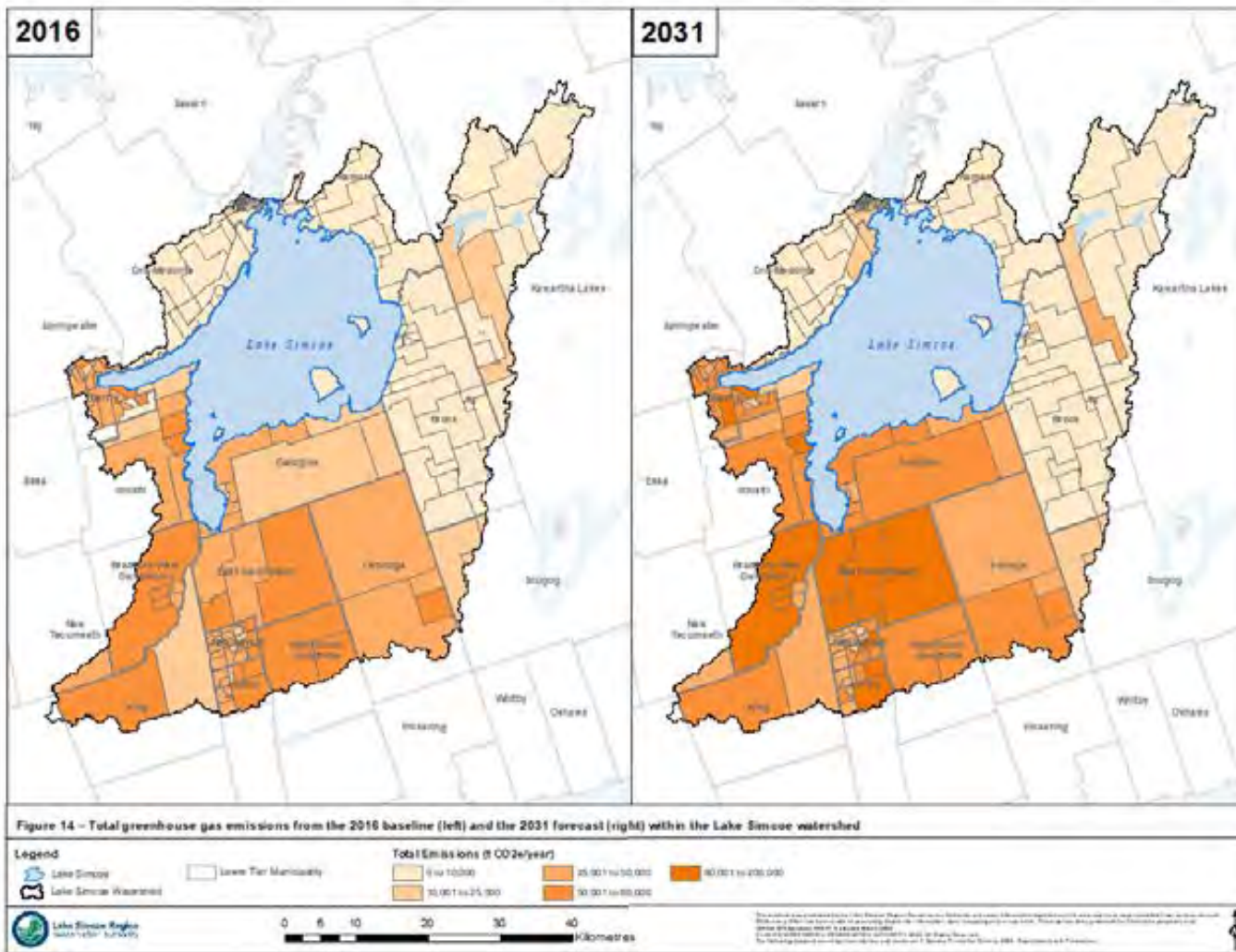


Figure 14 - Total greenhouse gas emissions from the 2016 baseline (left) and the 2031 forecast (right) within the Lake Simcoe watershed

3.2.1 Transportation

Transportation (both on- and off-road) is projected to produce 2,995,328 tonnes of carbon dioxide equivalent in 2031, which is an increase of 45 percent from the 2016 baseline. The highest emissions in this sector still occur in the southern end of the watershed; however, they intensify most notably in the south end of Barrie, Bradford-West Gwillimbury, East Gwillimbury, and Georgina (Figure 15), which are major commuter corridors for those working further south in the GTA.

As previously noted, this forecast represents a “Business as Usual” scenario and does not consider evolving emission reductions opportunities such as improved transportation planning or advancements in technology. However, according to the Environmental Protection Agency’s ‘Automotive Trends Report’, the carbon dioxide emissions from new vehicles are at a record low and fuel economy is at a record high. The report indicates that, within the last five years, eleven of the fourteen largest vehicle manufacturers in the United States market improved both carbon dioxide emissions and fuel economy of their new vehicles (EPA, 2019). Additionally, according to a report completed by the International Energy Agency, the number of electric vehicles in Canada has doubled from 2017 to 2018 (IEA, 2019). Therefore, if newer vehicles are becoming more efficient with the adoption of more advanced technologies, and more people are purchasing electric vehicles, it can be expected that carbon emissions produced from the transportation sector may not grow as rapidly as predicted.

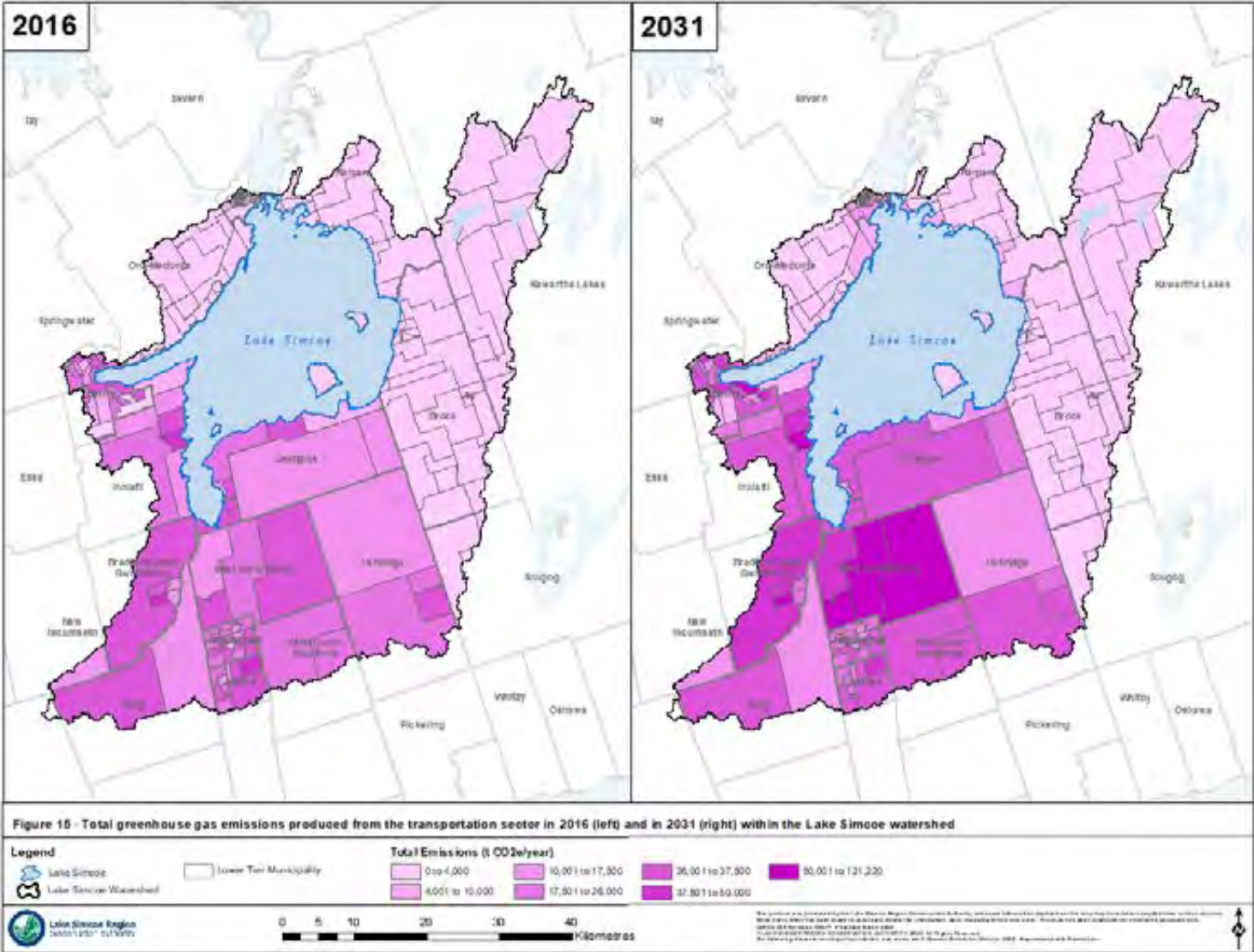


Figure 15 - Total greenhouse gas emissions produced by the transportation sector in 2016 (left) and 2031 (right) within the Lake Simcoe watershed

3.2.2 Residential

The residential sector is projected to produce 1,001,708 tonnes of carbon dioxide equivalent in 2031, which is an increase of 45 percent from the 2016 baseline. The highest emissions still occur in the southern end of the watershed; however, they are projected to intensify most notably in Barrie, Innisfil, Bradford-West Gwillimbury, East Gwillimbury, and Georgina by 2031 (Figure 16).

As previously noted, this forecast represents a “Business as Usual” scenario and does not take into consideration any future additional actions, efficiencies or technological advancements that will change current emission trajectory in the residential sector. There are positive signs, however, that this “Business as Usual” will decrease; for example, the recent movement towards increasing standards in the Building Code requires new buildings to be built with a higher R-value. This means better insulation and therefore, less emissions generated from heating and cooling. Additionally, in support of this increasing trend toward more energy efficient homes, beginning in 2022, all new home appliances must be Energy Star certified (Office of the Prime Minister, 2019).

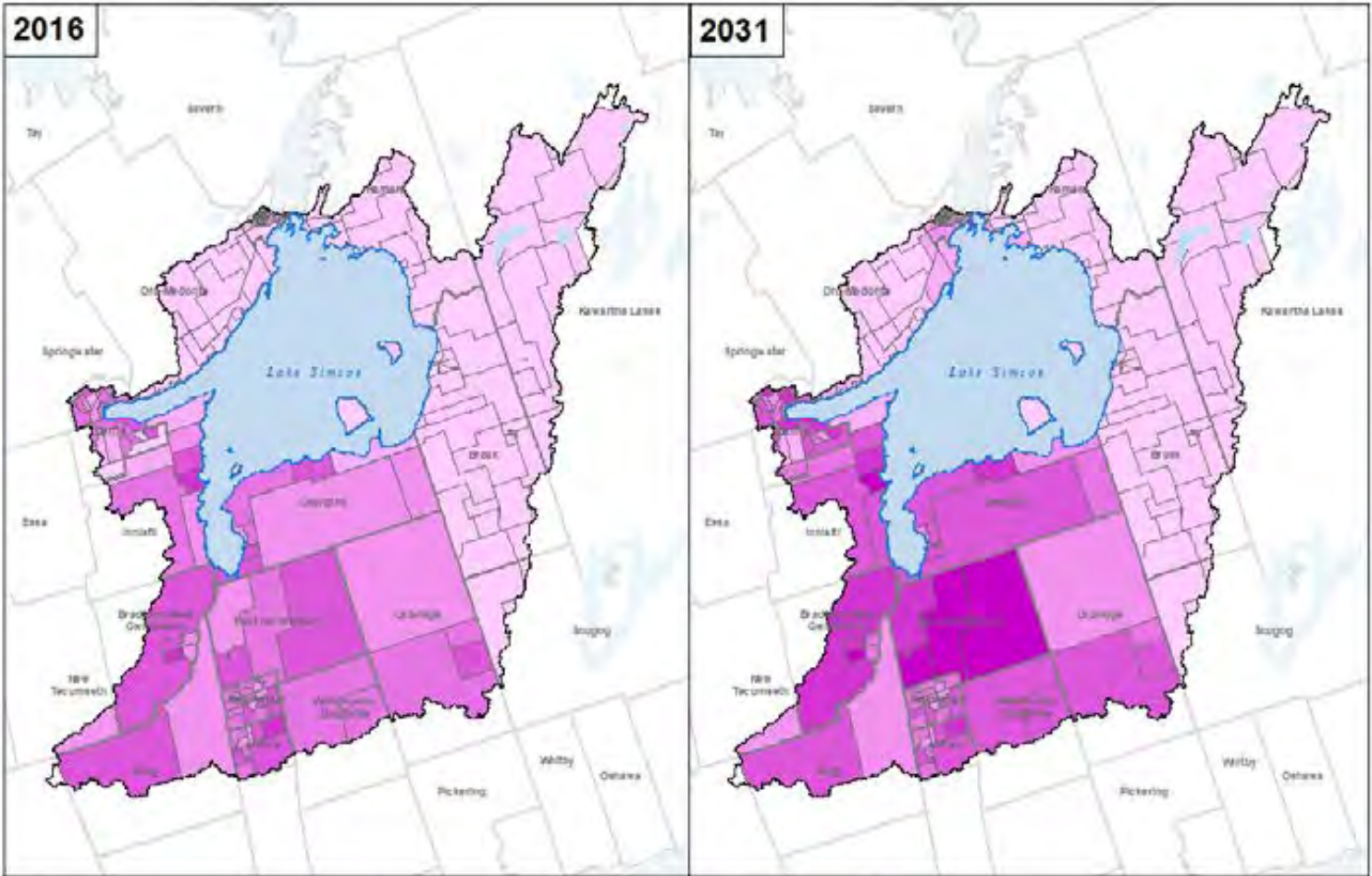


Figure 16 - Total greenhouse gas emissions produced from the residential sector in 2016 (left) and in 2031 (right) within the Lake Simcoe watershed

Legend

- Lake Simcoe
- Lake Simcoe Watershed
- Lower Tier Municipality

Total Emissions (t CO₂e/year)

0 to 1,500	3,501 to 6,000	8,001 to 12,500	17,001 to 40,540
1,501 to 3,500	6,001 to 8,000	12,501 to 17,000	

Lake Simcoe Region
2020-10-21 11:44:57

0 5 10 20 30 40
Kilometres

This document is prepared for the Lake Simcoe Region. It is not intended to be used for any other purpose. The information contained herein is for informational purposes only. It is not intended to be used for any other purpose. It is not intended to be used for any other purpose. It is not intended to be used for any other purpose.

Figure 16 - Total greenhouse gas emissions produced from the residential sector in 2013 (left) and in 2031 (right) within the Lake Simcoe watershed

3.2.3 Industrial, Commercial, Institutional

The industrial, commercial, institutional sector is projected to produce 567,343 tonnes of carbon dioxide equivalent in 2031, which is an increase of 66 percent from the 2016 baseline. The highest emissions are still projected to occur in the southern end of the watershed; however, they are projected to intensify the most in the industrial corridor along highway 400 in Bradford-West Gwillimbury, Innisfil, and Barrie, as well as in the growth areas in East Gwillimbury (Figure 17).

As previously noted, this forecast represents a “Business as Usual” scenario and does not account for future additional actions, efficiencies or technological advancements that will change the current emission trajectory in the industrial, commercial, institutional sector. However, recent federal mandates require advances in the electrification of Canadian industries through new, zero-carbon clean electricity generation and transmissions systems and grid modernization (Office of the Prime Minister, 2019), which will help to support the trend in energy efficiency within this sector.

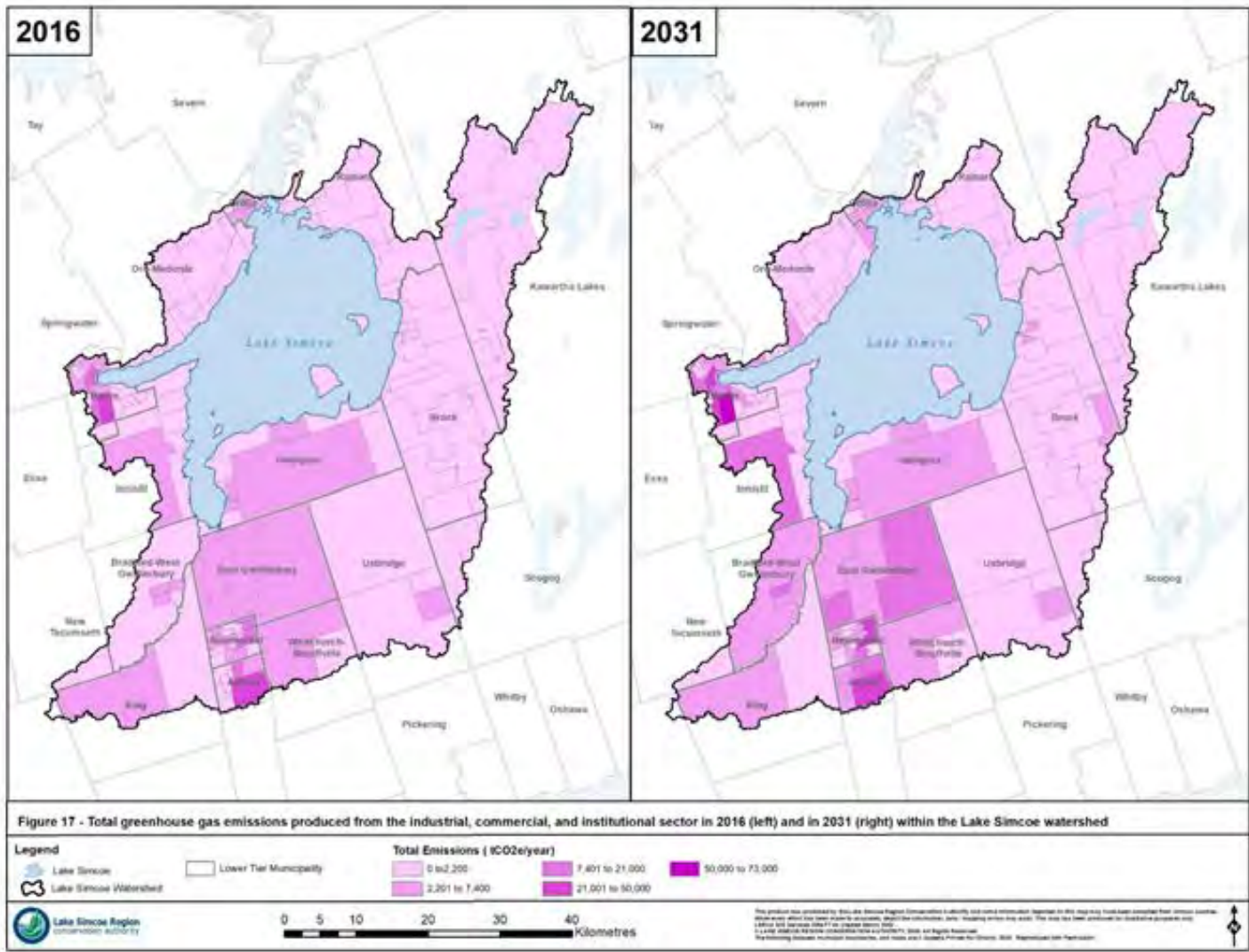


Figure 17 - Total greenhouse gas emissions produced from the industrial, commercial, institutional sector in 2016 (left) and in 2031 (right) within the Lake Simcoe watershed

Chapter 4

4.0 Carbon Sequestration Inventory and Forecast

While determining the Lake Simcoe watershed's greenhouse gas emissions inventory and forecast are fundamental parts of understanding the current and future distribution of emissions across the watershed, an equally important aspect of this strategy is to highlight the critical role that natural features play in offsetting carbon emissions.

Forests (including treed wetlands) cover approximately 34.9% of the Lake Simcoe watershed (LSRCA, 2018), making them the predominant natural vegetation feature of the watershed. They play an important role in carbon sequestration as they can store large amounts of carbon in vegetation and in soils through the processes of photosynthesis, respiration, and decomposition. Wetlands, on the other hand, cover 18% of the Lake Simcoe watershed (LSRCA, 2018), and although they are not as widespread as forests, they also play an important role in the carbon cycle by sequestering carbon in their biomass and soils.

LSRCA partnered with University of Toronto and Lakehead University to help determine the annual rates of carbon sequestration of forests and wetlands within the Lake Simcoe watershed. The following sections describe the methodology and results of these studies, as well as an assessment into what the future of sequestration may look like in the watershed.

It should be noted that there are other aspects of the Lake Simcoe watershed including waterbodies (e.g. Lake Simcoe), farmland, grasslands, and urban street trees that may have the ability to sequester carbon but are not included in this strategy as additional research is required. These are discussed in Section 4.2.4.

4.1 Methodology

4.1.1 Wetland Sequestration

Historical and current rates of carbon sequestration in the Lake Simcoe watershed were assessed at 11 sites of varying wetland functional classes including deciduous swamp, coniferous swamp, floating-leaved shallow aquatic, meadow marsh, mixed shallow aquatic, mixed swamp, shallow marsh, submerged shallow aquatic, thicket swamp, shrub fen, and shrub bog (Pendea, 2020). Two approaches were taken to assess sequestration rates, these being:

1. The annual carbon accumulation rates based on above-ground and below-ground biomass.
2. Historical rates of carbon accumulation for the last 100 years based on isotope analysis of soil cores

In order to compare the results between the wetland sequestration study and the forest sequestration study, the annual carbon accumulation rates were scaled up to the Lake Simcoe watershed by applying the ecosystem-specific rates to LSRCA's 2013 Landcover map. However, the annual rates do not account for carbon losses over the longer-term that are incorporated into the historical rates, and therefore only illustrate the shorter-term carbon sequestration.

4.1.2 Forest Sequestration

The research team at University of Toronto used over 700 Vegetation Sampling Protocol (VSP) monitoring plots sampled between 2011 and 2017, as well as information derived from remote sensing images and other auxiliary data to model and estimate carbon sequestration across the entire Lake Simcoe watershed. The VSP plots were classified into one of the three successional and three persistence forest classes, based on species composition per VSP plot. From this data, average annual carbon sequestration values were estimated for mature and early successional forest classes (Puric-Mladenovic and Araya, 2019).

Similar to the wetland sequestration estimate, these estimates were scaled up to the watershed using LSRCA's 2013 land cover map. To avoid duplication of estimates within treed wetlands, the forest sequestration estimate was limited to upland forests.

4.1.3 Sequestration Forecast

Using the total average annual carbon sequestration value (from wetlands and forests) as a baseline, two scenarios were developed to predict how sequestration might change in the future: a "Full Build out" scenario, and a "Restoration" scenario. For the "Full Build out" scenario, it was assumed that any forest or wetland which is not protected by provincial or municipal policy would be lost to development. The "Restoration" scenario represents the amount of carbon that could be sequestered if the targets set out in LSRCA's Natural Heritage System Restoration Strategy (LSRCA, 2018) are met (with the exception of grasslands, for which we don't yet have sequestration estimates).

4.2 Results

4.2.1 Wetland Sequestration

The wetland carbon accumulation study determined that the wetlands in the Lake Simcoe watershed sequester approximately 632,212 tonnes of carbon dioxide annually. The annual accumulation rates for most wetland types were within a similar range of between 200-400 grams per square metre, whereas the shallow marsh rates were significantly higher at an average net annual carbon sequestration potential of 855 grams per square metre.

The interannual variation in accumulation rates differed greatly between wetland types (Figure 18). Swamps and bogs, for example, displayed very little variability whereas marshes, fen, and swamp thickets displayed large variations between years. It will be important to understand this variability moving forward because as the climate changes, the sequestration efficiency of these features may change as well in order to adapt to different conditions.

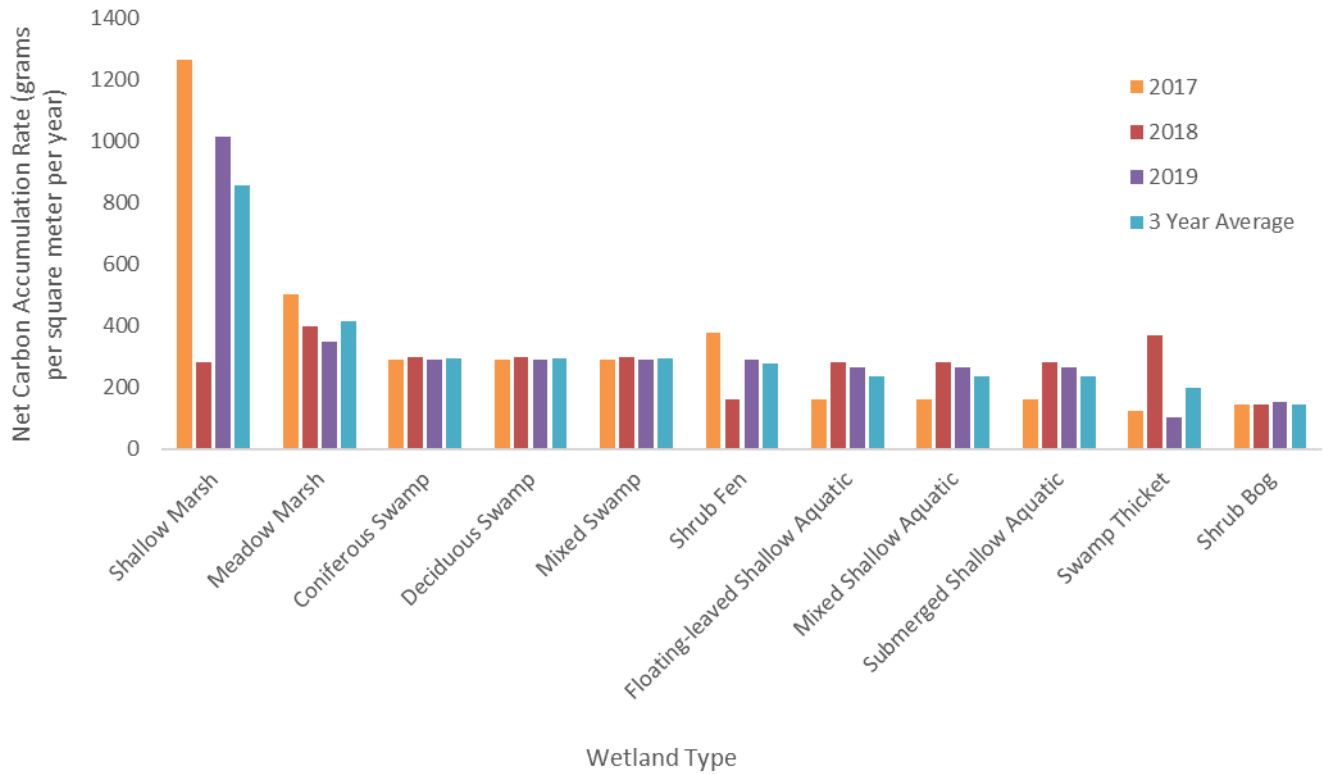


Figure 18 - Net organic carbon accumulation rates of the 11 studied wetland types (as defined by the Ecological Land Classification [Lee et al. 1998]) over the 3-year study period, as well as the 3-year average. Data source: Lakehead University

If left undisturbed, carbon stored in wetlands will become a long-term carbon sink, meaning these features will store and continue to sequester carbon deep within their biomass for many years (Pendea, 2020). The exceptions to this general trend are the swamp thicket and shrub bog, which exhibit higher long-term rates (Figure 19). This may be because historically, the productivity and hence biomass of these wetland types was significantly higher. Therefore, even considering the degradation and loss of carbon overtime, these historical rates are still higher than present rates. This result may also be due to the relatively low sample size of the study, and an incomplete characterization of the range of variability within these classes.

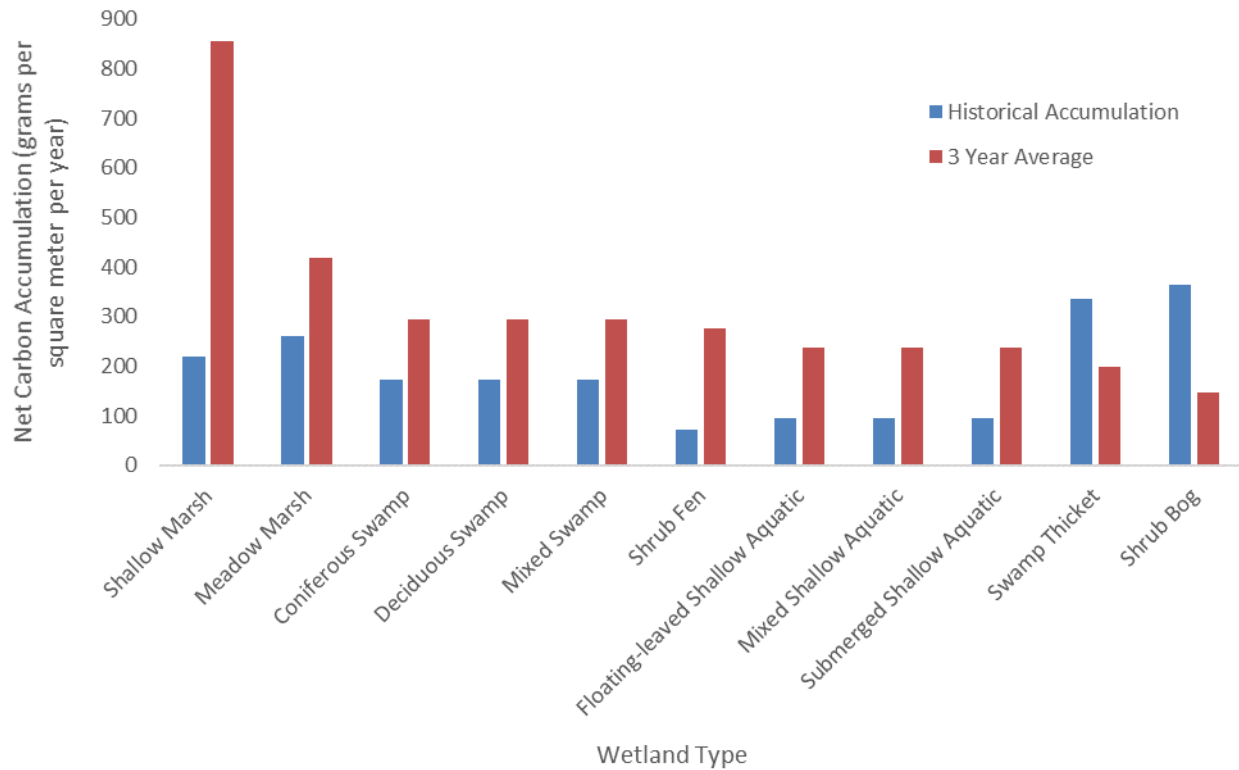


Figure 19 - A comparison of the historical carbon accumulation (represented in blue) and the 3-year average of carbon accumulation (represented in red) in the 11 studied wetland types (as defined by the Ecological Land Classification) in the Lake Simcoe watershed.

Forests, however, differ from wetlands in terms of their carbon sequestration abilities. As illustrated above, unlike wetlands which store carbon over the long-term, the carbon stored in forests is shallower and is released back into the atmosphere as carbon dioxide or methane when the landscape is disturbed. The strategy has been developed using annual accumulation rates in order to be consistent with emissions estimates and estimates of sequestration in forests. However, it is important to remember that over the longer term, the rates of carbon sequestration in forests are less due to continued decay and release of carbon to the atmosphere.

4.2.2 Forest Sequestration

The 57,670 hectares of upland forest in the Lake Simcoe watershed sequester approximately 126,827 tonnes of carbon dioxide equivalent annually. This value was based on an average sequestration rate of 2.6 tonnes per hectare per year for mature forests and 1.14 tonnes per hectare per year for early successional forests. It was found that mid-successional forests, which cover the largest area in the Lake Simcoe watershed, store the most carbon dioxide (52%), followed by mature forests (37%), plantations (9%) and early successional forests (2%; Puric-Mladeovic and Araya, 2019).

4.2.3 Total Sequestration

On an annual basis, the wetlands and forests within the Lake Simcoe watershed sequester an estimated 759,039 tonnes of carbon dioxide. Of this total, wetlands sequester approximately 80%, and forests sequester approximately 20% (Figure 20). The sequestration features are distributed relatively evenly throughout the watershed, though some of the higher sequestration areas may be concentrated in large wetland areas including the Holland Marsh, the Beaver River wetland, the Zephyr-Egypt wetland complex in Georgina and Uxbridge, the extensive swamps along the shoreline in Ramara, as well as large forested areas in the City of Kawartha Lakes, and on Georgina Island (Figure 21).

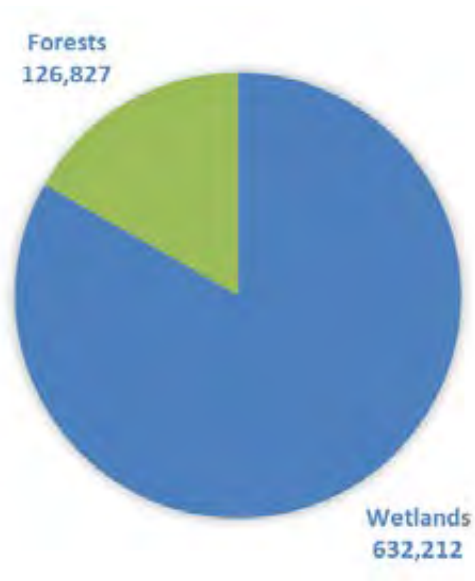


Figure 20 - The total annual sequestration (in tonnes of carbon dioxide equivalent) of forests and wetlands in the Lake Simcoe watershed.

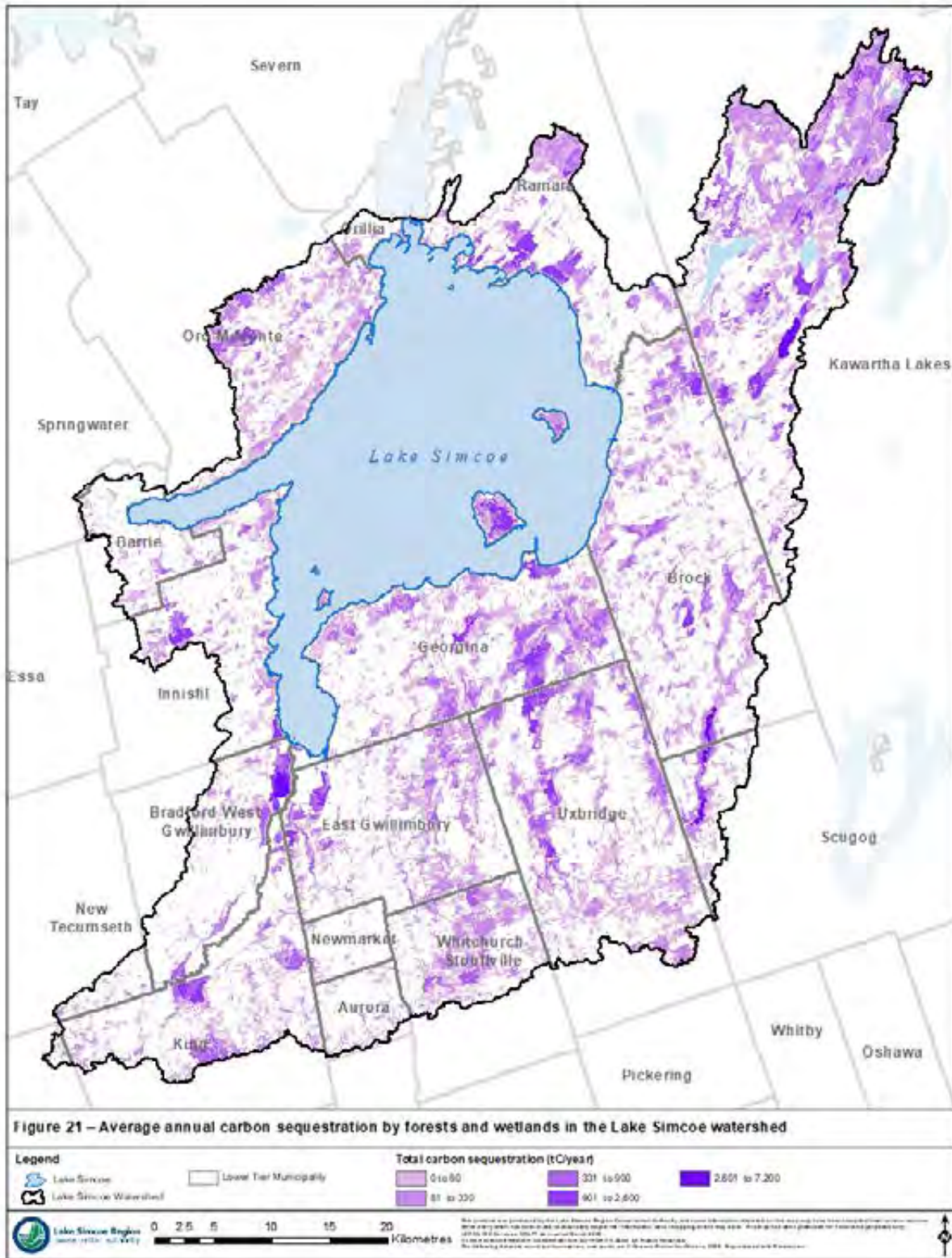


Figure 21 - Average annual carbon sequestration by forests and wetlands in the Lake Simcoe watershed

4.2.5 Sequestration Forecast

The “Full Build-out” scenario predicts a 5% decrease in sequestration (Figure 22), largely because early successional forests do not tend to be protected by provincial or municipal policies, and because LSRCA Ecological Offsetting policy was not included in this scenario. The “Restoration” scenario predicts a 13% increase in sequestration (Figure 22), which demonstrates the value of LSRCA’s restoration program, particularly when compared to the projected increases in emissions.

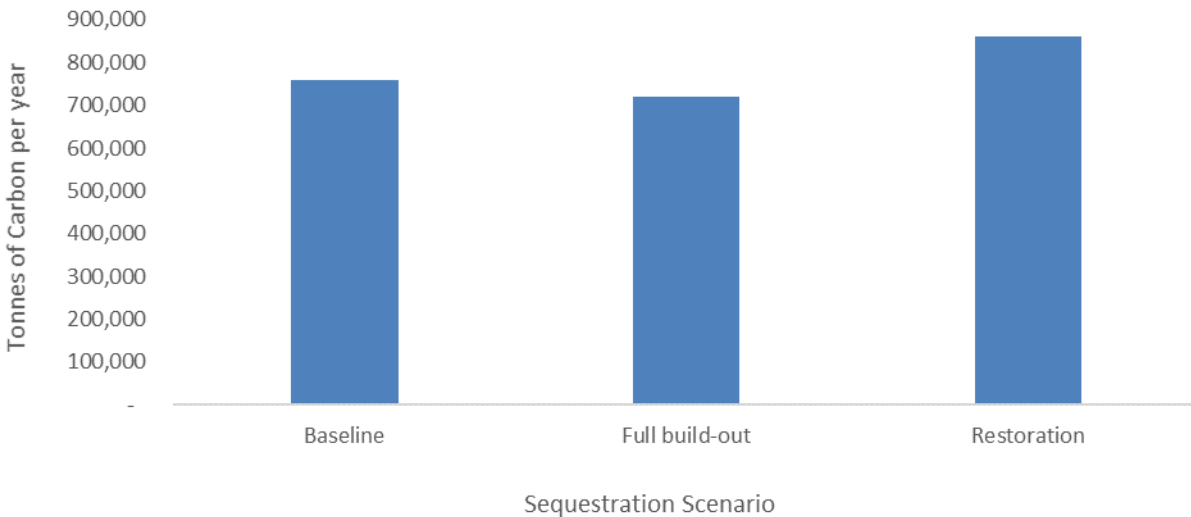


Figure 22 - Total carbon sequestration represented in three different scenarios: "Baseline", "Full-build out", and "Restoration".

4.2.4 Unaccounted for Sequestration

The Lake Simcoe watershed is home to other features such as water bodies, street trees, farmland, and grasslands, all of which play important roles in carbon sequestration. These features were not included in the carbon sequestration estimate or forecast as they require further research to quantify their annual sequestration rates. While LSRCA has not conventionally played a role in protecting or expanding features of these types, they will be important in further increasing carbon sequestration in the Lake Simcoe watershed and as such, offsetting the emissions identified in Chapter 2.

4.2.4.1 Lake Sequestration

There is an obvious carbon sequestration feature in the Lake Simcoe watershed, which is Lake Simcoe itself. Inland waters are responsible for a significant component of the global carbon cycle (Tranvik et al., 2009) through the uptake of carbon dioxide during plant and algae growth and the release of carbon dioxide back into the atmosphere during decomposition. Whether the lake is absorbing or emitting carbon dioxide depends on various factors including trophic status, depth, time of year, geology, and the surrounding watershed. However, due to lack of available and current data, it is uncertain if this 722 km² lake is a net source or a sink of carbon dioxide.

A study completed in Cook’s Bay, which is an elongated basin located at the most southern part of Lake Simcoe, determined that Cook's Bay is likely a carbon sink during the plant growing season, but would become a source in the colder months with plant decomposition and methane release. The study also determined that the rates of carbon sequestration decreased into the deeper waters of the main basin (Blodau et al., 2017).

It is likely, however, that as the climate warms, Lake Simcoe will become a bigger net source of carbon dioxide as open water in the winter months would allow emissions into the atmosphere. However, without specific research conducted on Lake Simcoe, it is difficult to provide a reliable and accurate estimate that would represent the entire lake as the values for carbon exchange seem to be specific to each individual lake, and each individual bay in Lake Simcoe.

4.2.4.2 Sequestration by the urban canopy

The forest sequestration estimate reported in the previous section does not include street or backyard trees (i.e. the urban canopy). Separate studies completed by Toronto and Region Conservation Authority (TRCA, 2016) and LSRCA (LSRCA, 2016) for Aurora and Newmarket respectively, found that the amount of carbon sequestered by street trees in these two municipalities actually surpassed that sequestered by remnant woodlots (Table 5). As such, within dense urban areas, the urban canopy also plays a significant role in the carbon cycle.

Table 5 - Estimated carbon sequestration rates (tonnes per year) in the urban forests of Aurora and Newmarket, based on more detailed analysis completed by TRCA (2016) and LSRCA (2016).

	Aurora	Newmarket
Forests	1,906	772
Street trees	2,193	805

4.2.4.3 Farmland and Grassland Sequestration

Farmland and grasslands are also important features to consider in terms of carbon sequestration due to their abundance in the Lake Simcoe watershed. Further research to quantify actual and potential carbon sequestration rates from these features in the watershed will be helpful in moving LSRCA's Restoration programs forward, as well as in helping municipalities achieve "net zero" emissions.

Grasslands can store carbon in their soil, much like forests and wetlands (LSRCA, 2018). No work on carbon sequestration in grasslands has been done in the Lake Simcoe watershed, however grasslands used for grazing in the Canadian prairies sequester an average of 19 grams of carbon per square meter per year. Cropland restored to native grassland exhibited net sequestration rates four times that (Wang et al. 2014). While much lower than the amount sequestered by wetlands (Figure 18), grasslands cover nearly 30,000 hectares of the Lake Simcoe watershed, which indicates that they may also play an important role in the watershed's carbon budget.

Cropland can also sequester carbon which, like the other ecosystem types, happens through the process of converting plant material to soil organic matter. Provincial data however documents a decrease in soil organic matter in Ontario farms since 2000 (Christine Brown, OMAFRA, pers. comm.), suggesting that cropland in Ontario may be underperforming from a carbon sequestration standpoint.

Chapter 5

5.0 Carbon Budget

A watershed-scale carbon budget was developed to determine how much carbon is emitted and sequestered across the Lake Simcoe watershed, and to estimate how that balance might be affected by ongoing growth and development. It should be noted that while the emissions inventory and forecast were based on all greenhouse gases, the carbon budget was based on pure carbon dioxide emissions to account for the fact that not all greenhouse gas emissions can be sequestered.

5.1 Carbon Budget Baseline

A baseline carbon budget was developed based on the emissions inventory estimates in Chapter 2 and the carbon sequestration estimates in Chapter 4. This carbon budget in Figure 23 illustrates that the wetlands and forests within the Lake Simcoe watershed sequester approximately 20% of the 2016 baseline emissions. It also highlights the importance of protecting and expanding these features in the watershed in order to to promote further carbon sequestration.

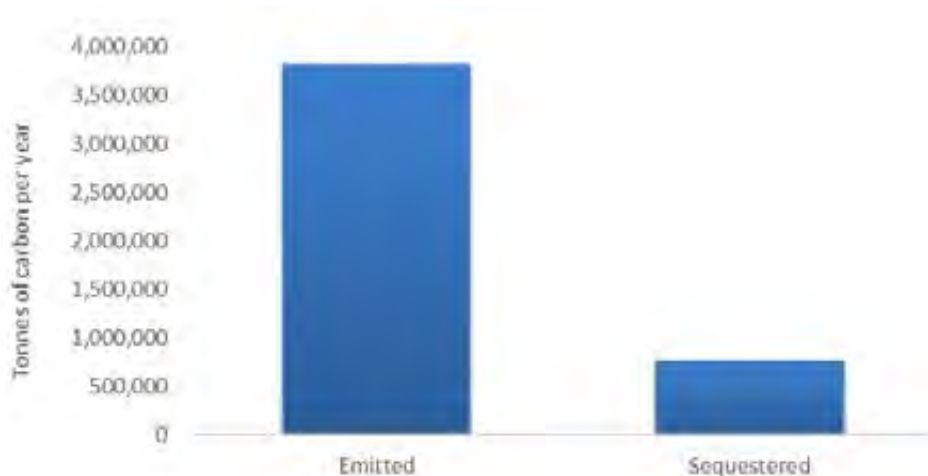


Figure 23 - The carbon emissions produced in the Lake Simcoe watershed ("Emitted") vs the carbon sequestered by wetlands and forests ("Sequestered") within the Lake Simcoe watershed.

When applied to the entire Lake Simcoe watershed (Figure 24), the carbon budget highlights areas that are emitting more than they sequester (represented in red and orange), and areas

that are sequestering more than they are emitting (represented in green). This provides a rationale for prioritizing efforts to reduce emissions in the red/orange areas of the maps.

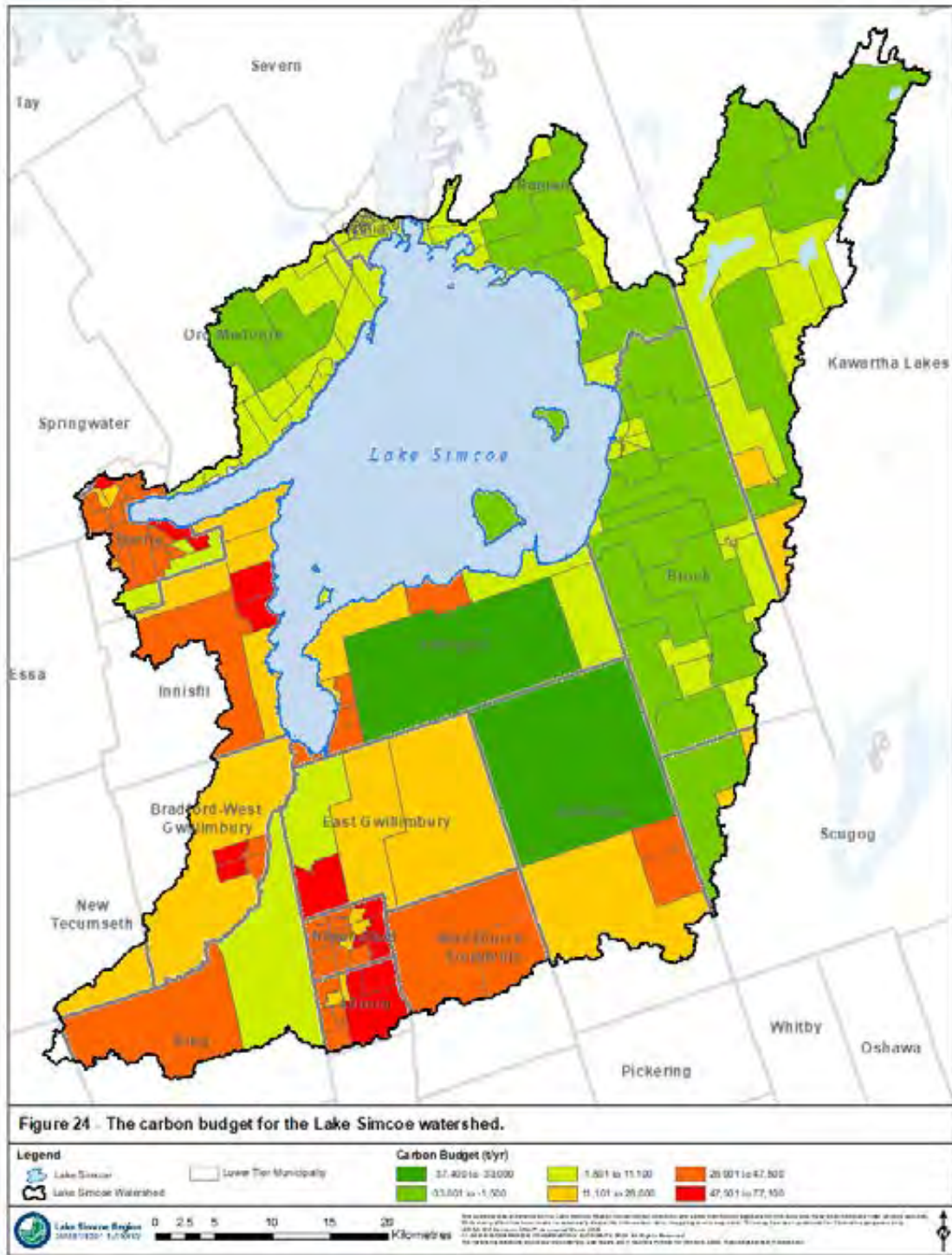


Figure 24 - The carbon budget for the Lake Simcoe watershed.

5.2 Carbon Budget Forecast

Two scenarios were developed in order to predict how the carbon budget of the Lake Simcoe watershed could change as development proceeds, and as climate action is (or is not) taken. The “Business as Usual” scenario, incorporates the total emissions forecast outlined in Chapter 3 and the “Business as Usual” scenario for carbon sequestration in Chapter 4. This scenario predicts that the Lake Simcoe watershed could see an increase of 45 percent in total emissions and a decrease of 5 percent in total carbon sequestration from the 2016 baseline (Figure 25).

The “Targets Met” scenario reflects a best-case scenario where total emissions are reduced, and carbon sequestration is increased through collective municipal and conservation authority action. This scenario was developed using the Town of Newmarket’s 40% per capita reduction target (Town of Newmarket, 2016) as an example, and the restoration targets in the LSRCA Natural Heritage System Restoration Strategy for sequestration (Figure 22). This scenario predicts a decrease in total emissions and an increase in sequestration. However, due to projected population increases, this “Targets Met” scenario only projects a 20% reduction in overall net emissions (Figure 25).

Many municipalities are similarly developing emission reductions targets, although the targets established (and under consideration) vary. In order to offset projected population increases in the Lake Simcoe watershed, and Canada’s relative inaction on emissions reduction to-date, per capita reduction targets of 50% would be necessary to achieve the Federal government’s target of a 30% reduction (below 2005 levels) by 2030. The target of net-zero by 2050 would require even more aggressive climate action.

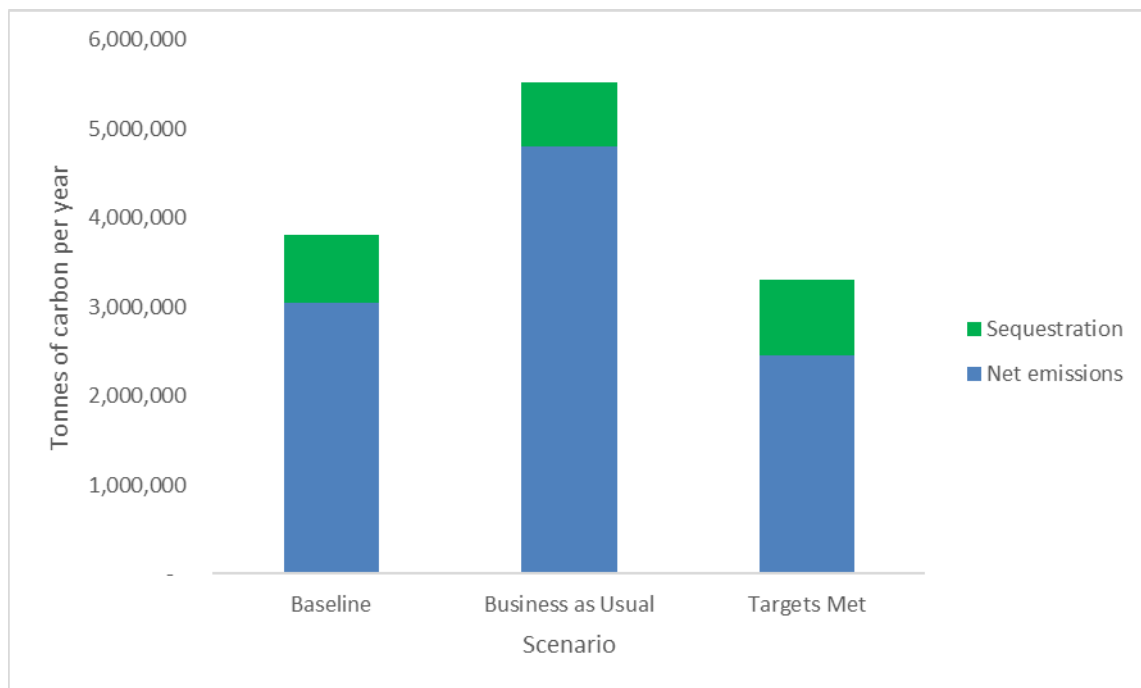


Figure 25 - The total carbon emitted and sequestered (in tonnes) in the Lake Simcoe watershed in the "Business as Usual" and "Targets Met" scenarios

Chapter 6

6.0 Conclusions

Carbon sequestration within the Lake Simcoe watershed removes approximately 20% of emissions through wetlands and forests. However, in relation to the current and projected emissions, the additional sequestration resulting from the restoration of natural features as outlined in the Natural Heritage Systems Restoration Strategy would not lead to a significant overall improvement in the carbon budget. In order to achieve a more balanced carbon budget, emissions need to be reduced significantly. As the highest emissions are produced from sectors that are not within LSRCA's mandate, it is important that LSRCA works together with our municipal partners, residents, and industry leaders to reduce emissions originating from these sectors.

There are certain aspects of the Lake Simcoe watershed that were not accounted for in this strategy as they require further research in order to determine their specific carbon sequestration rates. These include waterbodies (e.g. Lake Simcoe), urban forestry (e.g. street trees), agriculture, and low impact developments

The carbon accounting methodology used in this strategy employs various assumptions to provide a basic, high level estimate of emissions and sequestration. Although affordable, scalable and practical, a more precise accounting tool will be necessary to track changes in emissions or sequestration as climate action is taken.

The recommendations for actions outlined in the following section represent LSRCA's assessment of the role we can best play in reducing greenhouse gas emissions in the Lake Simcoe watershed, and maintaining (or improving) the watershed's carbon budget.

Chapter 7

7.0 Recommendations

The results from the previous sections revealed the sector ‘hotspots’ for carbon emissions, which led to the development of recommendations for action. All aspects of LSRCA’s programs and services including communication, education, planning and restoration, can play an active role in supporting climate change mitigation efforts.

However, as can be seen from Figure 25, reducing the emissions within the Lake Simcoe watershed will not be achieved alone; it will require a collaborative multi-agency and multi-sectoral approach. This strategy has identified 18 recommendations for action which will build upon the strength of LSRCA’s programs and services and provide ways for us to work with our municipal partners and the public to further reduce the carbon footprint of the Lake Simcoe watershed.

7.1 Process

The process to develop recommendations for action was an iterative one, including both a review of actions taken by other agencies, and an internal review of existing and potential areas for action within LSRCA’s program areas.

Firstly, a gap analysis was conducted to identify key research needs, barriers for climate action, and opportunities for collaboration with climate change adaptation and mitigation initiatives in the Lake Simcoe watershed. A jurisdiction scan was also completed to gain an understanding of the climate change mitigation initiatives already being undertaken by municipalities within the watershed as well as other Conservation Authorities and to avoid duplication or redundancies. Once completed, a set of draft recommendations was developed by the lead project team.

Secondly, an internal workshop was conducted to give LSRCA staff an opportunity to review the first draft of recommendations and provide feedback as well as provide input on programs and services that could be potentially integrated into their existing work plans. Following this workshop, an external partner workshop was conducted to share the refined draft recommendations with our municipal and health unit partners.

Lastly, the final set of recommendations was developed by reviewing the feedback from the workshops and refining and grouping the recommendations into five overarching goals: leadership, education & communications, tools & resources, build knowledge, and sustainable communities.

7.2 Goals & Recommendations

Goal 1: Leadership

Provide leadership in the field of climate change and carbon sequestration by continuing to support and provide resources to our municipal partners.

Mitigating the impacts of climate change, whether through reducing emissions or increasing sequestration, is a large challenge, and one that no organization can take on alone. As with other program areas though, LSRCA can play a role in convening partners, sharing knowledge, and building bridges across jurisdictions. Much work is currently underway in the Lake Simcoe watershed to facilitate information sharing, and LSRCA can continue to play a role in these working groups, sharing our experience and providing our natural heritage expertise, and particularly in supporting those smaller municipalities who have limited capacity to plan for climate change action.

1. Continue to play a leadership role in municipal climate change working groups to help coordinate municipal climate mitigation activities and build expertise in carbon capture and sequestration in watershed municipalities.
2. Work with emerging municipalities who are net emitters to develop their capacity for climate change mitigation and carbon sequestration efforts.
3. Using LSRCA's Corporate Carbon Reduction Strategy as a guiding template, advise municipalities/organizations in the development and implementation of their own Corporate Carbon Reduction Strategies.
4. Work with municipalities to help them develop or update their trail strategies/trail master plans in order to help connect trail systems and create a stronger active transportation network within the watershed.
5. Work with the Lake Simcoe Conservation Foundation to create a fundraising program which enables donors to support projects that will offset their carbon footprint

Goal 2: Education & Communications

Effectively communicate the necessary information to educate and empower people within the Lake Simcoe watershed to take action to combat climate change within their communities.

There is an overwhelming amount of data and information available pertaining to climate change at a global scale. However, it is important to ensure that the residents of the Lake Simcoe watershed are equipped with the most up to date, accurate information about how climate change relates to them at a local scale. This will enable them to understand the impacts and how they can change their behaviours to be a part of the solution. LSRCA's Education department has already been involved in environmental public education and is shifting its focus to climate change as it continues to be an issue within the Lake Simcoe watershed. We can also help to engage a new generation of young environmentalists by providing students and

teachers of the Lake Simcoe watershed specific educational materials relating to climate change.

6. Develop a Climate Change Engagement Strategy that will serve to educate LSRCA staff on our current climate change strategies, educate the public on local climate change impacts and mitigation actions, as well as engage a more diverse audience in order to leverage additional perspectives and support for programs.
7. Through the Annual LSRCA Conservation Awards, keep up to date with what community members/organizations are doing and recognize those who have gone above and beyond to help combat climate change within their community.
8. Expand current climate change educational programming to include public workshops as well as resources and tools so watershed residents can engage in climate change mitigation/carbon sequestration efforts within their homes and communities.
9. Develop and provide climate change and carbon sequestration focused materials for teachers and students.

Goal 3: Tools & Resources

Provide the tools and resources that will allow LSRCA and our municipal partners to apply best practices to their carbon reduction or sequestration efforts.

As the landscape of the Lake Simcoe watershed changes in response to anticipated growth and development, it will be crucial to understand how these changes impact greenhouse gas emissions and carbon sequestration. We will continue to track and monitor these parameters in house and refine the accounting tool to ensure accuracy. This will be crucial information to understand for LSRCA's Watershed Restoration program and our municipal partners looking to undertake restoration projects.

10. Periodically update the emissions inventory, projections, and landcover mapping, while also considering emerging technologies and methodologies in order to provide an accurate accounting tool for the watershed.
11. Use LSRCA's Natural Heritage System Restoration Strategy, and data from sequestration studies, to identify areas within the watershed that are not reaching their full carbon sequestration potential, as well as additional areas that could sequester substantial carbon if restored to natural habitat.

Goal 4: Build Knowledge

Use the tools and resources to expand and build upon our collective knowledge and understanding of climate change mitigation and carbon sequestration.

The Lake Simcoe watershed will be relying heavily on offsetting its future increases in emissions through carbon sequestration. While we already know how much carbon wetlands and forests are capable of sequestering, there are other features still left to explore. Quantifying the annual carbon sequestration rates of these features will be accomplished largely through existing work

undertaken by the Integrated Watershed Management, Forestry, and Watershed Restoration departments.

12. Building off York Region's expertise in carbon capture of urban forests, expand the implementation of Urban Forest studies to other watershed municipalities. Use the results of these studies to further our understanding of the current and potential carbon sequestration in urban canopies.
13. Explore the carbon sequestration potential of grassland habitats within the Lake Simcoe watershed.
14. Research and estimate the co-benefits and value of low impact development/green infrastructure from a carbon reduction/sequestration perspective.

Goal 5: Sustainable Communities

Support municipalities in incorporating carbon sequestration into community design and energy plans.

As new developments are built within the Lake Simcoe watershed, it will be important to consider ways to achieve 'complete communities' and ensure carbon sequestration features are not lost. This can be accomplished through policy and establishment of best practices and refining the carbon accounting tool to consider the carbon sequestration potential of individual street trees. LSRCA's Planning and Development department can play a supportive role through sharing information and providing suggestions on how to incorporate carbon sequestration into municipal plans.

15. Conduct a review of municipal planning policies to identify best-in-class approaches to 'complete community' design at a local level and convene a workshop with municipal planners and climate change staff to develop template policies as necessary.
16. Promote the uptake of energy efficiency design charrettes with industry partners such as developers and builders.
17. Work with others to refine the accounting of carbon sequestration by individual trees, with a long-term goal of developing a community scale carbon budget calculator that would help municipal planners and developers progress towards 'net zero' communities.
18. Support municipalities in developing or updating Green Development Standards that include carbon budgets as a consideration.

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Appendices

Appendix A – Emissions Inventory

Municipality / First Nation	Emissions (kt CO ₂ e)								
	Public Electricity & Heat Production	Residential	ICI	Transportation	Agriculture	Water & Wastewater	Construction	Landfills	Total
Aurora	22.68	74.62	46.36	228.99	0.01	1.36	1.86	21.36	397.23
Barrie	50.78	167.10	110.29	513.37	0.01	3.05	3.90	47.82	896.32
Bradford	14.45	47.54	17.37	146.52	12.04	0.87	4.25	13.61	256.64
Brock	4.76	15.67	5.34	48.90	21.29	0.29	0.17	4.48	100.91
Chippewas of Georgina Island First Nation	0.11	0.35	0.18	1.07	0.00	0.01	0.00	0.10	1.82
East Gwillimbury	9.81	32.29	17.20	100.54	4.04	0.59	1.02	9.24	174.73
Georgina	18.57	61.13	17.61	188.30	4.00	1.11	1.23	17.49	309.45
Innisfil	14.95	49.21	12.13	152.35	14.39	0.90	2.23	14.08	260.24
Kawartha Lakes	2.69	8.87	0.92	27.10	62.32	0.16	1.26	2.54	105.85
King	4.75	15.64	4.28	47.80	0.87	0.29	0.24	4.48	78.34
New Tecumseth	1.32	4.36	0.36	13.65	5.25	0.08	0.29	1.25	26.56
Newmarket	34.44	113.36	66.60	347.02	0.65	2.07	2.97	32.44	599.55
Orillia	8.52	28.04	20.01	85.70	0.00	0.51	0.33	8.02	151.15
Oro-Medonte	4.00	13.17	4.59	40.24	9.67	0.24	0.55	3.77	76.23
Ramara	2.97	9.78	3.56	32.47	5.14	0.18	0.12	2.80	57.02
Scugog	0.94	3.09	0.05	9.44	43.03	0.06	0.03	0.88	57.52
Uxbridge	8.66	28.50	10.14	89.24	9.21	0.52	0.36	8.16	154.78
Whitchurch- Stouffville	5.24	17.24	4.50	54.34	18.43	0.31	0.16	4.93	105.16

Appendix B – Population Forecast (MMAH 2019)

Municipality / First Nation	Year							Population change 2016-2031
	2011	2016	2021	2026	2031	2036	2041	
Aurora	57,300	63,700	68,100	69,600	70,200	77,200	79,000	6,500
Barrie	136,063	141,434	N/A	N/A	210,000	231,000	253,000	68,566
Bradford West Gwillimbury	28,077	35,325	N/A	N/A	50,500	N/A	N/A	15,175
Brock	12,385	12,650	12,810	13,325	14,015	N/A	N/A	1,365
Chippewas of Georgina Island First Nation	275	261	N/A	N/A	N/A	N/A	N/A	N/A
East Gwillimbury	22,473	34,700	48,100	66,300	86,500	104,700	118,700	51,800
Georgina	43,517	52,800	57,900	63,900	70,300	67,900	71,300	17,500
Innisfil	32,727	36,566	N/A	N/A	56,000	N/A	N/A	19,434
Kawartha Lakes	73,219	75,423	N/A	N/A	100,000	101,000	107,000	24,577
King	19,899	27,000	29,900	32,500	34,900	37,400	37,900	7,900
New Tecumseth	30,234	34,242	N/A	N/A	56,000	N/A	N/A	21,758
Newmarket	79,978	88,700	91,900	94,500	97,100	105,100	108,200	8,400
Orillia	30,586	31,166	N/A	N/A	41,000	44,000	46,000	9,834
Oro-Medonte	20,078	21,036	N/A	N/A	27,000	N/A	N/A	5,964
Ramara	9,275	9,488	13,890	14,840	13,000	N/A	N/A	3,512
Scugog	22,585	23,250	23,415	24,355	25,390	N/A	N/A	2,140
Uxbridge	20,940	22,545	23,740	25,570	26,965	N/A	N/A	4,420
Whitchurch-Stouffville	37,628	49,400	55,800	59,100	60,600	63,400	64,500	11,200



Figure 26 – Projected population growth between 2016 and 2031 in the Lake Simcoe watershed