Township of McKellar

Community Milestone 1

submission to:

Federation of Canadian Municipalities
Partners for Climate Protection Program

Version: 1

Date: November 11, 2020

Prepared by:

Organization: Georgian Bay Biosphere
Name: Benjamin John
Position: Climate Change & Energy Specialist
Contact: climate@gbbr.ca

Reviewed by:

Organization: Georgian Bay Biosphere
Name: David Bywater
Position: Conservation Program Manager
Contact: conservation@gbbr.ca

Approved by:

Organization: Township of McKellar

Name: Peter Hopkins
Position: Mayor
Contact: peterhopkins1942@gmail.com

Foreword

In addition to participating in the Federation of Canadian Municipalities' Partners for Climate Protection Program, the Township of McKellar is a proud member of the Integrated Community Energy and Climate Action Plans (ICECAP) Partnership.

ICECAP is a partnership between the Municipalities and First Nations located in the Georgian Bay Biosphere region for the purpose of a collaborative, more cost-effective approach to energy management and the reduction of greenhouse gas emissions for the operations of each corporate stakeholder, for each participating community and for the broader region.

The 4 main objectives of ICECAP are to:

1. Encourage the reduction of greenhouse gas emissions
2. Improve energy efficiency
3. Reduce the use of fossil fuels
4. Adapt to a changing climate by building greater resilience

By completing this community baseline and inventory, the Township of McKellar is also contributing to the achievement of the goals and objectives established by ICECAP. The findings and insights discovered will improve local climate change knowledge by understanding where emissions are coming from in the community. As a result, the information obtained will ultimately inform and provide direction into climate change and energy planning for the Township of McKellar, the ICECAP partnership, and the broader region.

ICECAP's current official members are as follows:

- Township of The Archipelago
- Township of Carling
- Township of Georgian Bay
- Township of McKellar
- Town of Parry Sound
- Township of Seguin
- Georgian Bay Biosphere

Executive Summary

In their Fifth Assessment Report (2014)[1], the Intergovernmental Panel on Climate Change notes that greenhouse gas (GHG) emission growth continues to accelerate, and that ambitious and aggressive mitigation actions are indispensable in mitigating climate change. By actively managing, monitoring, and taking measures to limit the production of GHG emissions, the impacts of climate change will reduce in severity.

As front-line responders to severe weather events and other climate change impacts, municipalities often experience and witness the financial, environmental, and social repercussions of climate change within their own operations and the community they serve. Municipalities therefore have the ability to be leaders in addressing climate change, as their knowledge of community needs and considerations can guide the successful implementation of initiatives designed to tackle climate change. As the Federation of Canadian Municipalities (2009)[2] has noted, municipal governments have the ability to influence or control nearly half of Canada's GHG emissions. Through efforts to reduce GHG emissions, municipalities can therefore lead the way in climate change mitigation, and protect their residents from future climate change impacts.

By taking the appropriate steps to respond to climate change through mitigation and adaptation, municipal governments also have the opportunity to save money in municipal operations, lower energy costs for residents and businesses, and increase investment in the local economy. Establishing a GHG emission baseline is a useful tool to identify areas for improvement, inform the development of a GHG reduction action plan, estimate cost savings from reductions, and serve as a reference point to track improvements. To do this, many municipalities in Canada have joined the Federation of Canadian Municipalities' Partners for Climate Protection program in an effort to reduce the GHG emissions produced by their operations and community.

What is the Federation of Canadian Municipalities?

The Federation of Canadian Municipalities (FCM) is the national voice for municipal governments in Canada. With a congregation of nearly 2,000 municipal members across the country, FCM advocates for municipalities to ensure their citizen's needs are reflected in federal policies and programs. Through this advocacy the FCM is able to provide funding and programming that help municipalities tackle local challenges, such as climate change, asset management, economic development, and more.

[1] https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf

[2] https://fcm.ca/sites/default/files/documents/resources/report/act-locally-municipal-role-fighting-climate-change.pdf

What is the Partners for Climate Protection program?

The Partners for Climate Protection (PCP) program is designed to guide municipalities through the process of reducing greenhouse gas emissions through climate change and energy planning. In partnership with the International Council for Local Environmental Initiatives (ICLEI), the PCP program is administered by the FCM. Since the program's establishment in 1997, nearly 400 municipalities across Canada have joined, with the Township of McKellar becoming a participant in 2019. The PCP program consists of a five-step milestone framework that guides municipalities in their efforts to reduce greenhouse gas emissions. The five milestones are as follows:

The Partners for Climate Protection program looks at these milestones from two different perspectives; corporate and community. **Corporate** refers to the greenhouse gas emissions produced as a result of a local government's operations and services. Its purpose is to identify the GHG emissions within a local government's direct control or influence, and for which the local government is accountable as a corporate entity. **Community** refers to the greenhouse gas emissions generated by the residents and businesses of the community in which the local government serves and represents.

To date, a corporate greenhouse gas emission baseline and inventory has been completed by the Township of McKellar and approved by FCM and ICLEI. Thus, this report focuses on the community's greenhouse gas emission baseline and inventory.

Community Context

Geographically positioned in eastern Georgian Bay and in the heart of cottage country, the Township of McKellar is a major tourist destination. The Township of McKellar thus experiences a massive increase in population during the warmer months, raising the population from 1,111 permanent residents to include thousands of seasonal residents. As a result, the seasonal population has a significant influence over the production of GHG emissions in the Township of McKellar, and it is therefore critical to include the GHG emissions they produce, where possible.

While undergoing data collection for the Township of McKellar's community GHG emission baseline it was discovered that a number of energy consumption data gaps existed. These data gaps largely stemmed around the inability to acquire actual fuel oil and propane consumption data from local providers, and a lack of relevant statistics for common recreational activities, such as boating. As a result, the Georgian Bay Biosphere developed a comprehensive Carbon Calculator tool to collect actual consumption data from the Township of McKellar's community and the broader region. The Carbon Calculator tool has been designed as a survey and is an educational opportunity for the Township of McKellar's community to calculate their own personal GHG emission baseline. Where possible, the information from the Carbon Calculator has been used to validate the values obtained through assumptive energy consumption models or as a direct calculation statistic. In both circumstances, data from the Carbon Calculator has been aggregated at the regional level to produce statistical relevant values. This regional aggregation has been carefully considered, and has been assumed to be representative of the energy consumption behaviours in the Township of McKellar's community based on the similar activities, geography, and economic activities that occur in the broader region. Furthermore, it should be noted that the Carbon Calculator tool is an on-going project delivered by the Georgian Bay Biosphere, and any statistics or numbers used in the development of the Township of McKellar's community GHG emission baseline can be updated as additional entries and better information becomes available. As of November 4th, 2020 the carbon calculator has been completed 191 times in the region, representing the energy consumption behaviours of 478 people. Table A provides an overview of the sources and quality of data used.

Table A: Community Energy & GHG Emission Baseline Data Sources

Emission Sector	Data	Data Source	Data Quality		Notes
			Permanent	Seasonal	
Residential	Electricity Consumption	Hydro One	High	High	Actual electricity consumption in kWh for baseline year.
	Natural Gas Consumption	Enbridge	High	N/A	Actual natural gas consumption in m^3.
	Fuel Oil Consumption	Natural Resources Canada & Government of Ontario & MPAC & Carbon Calculator	Medium	N/A	Actual consumption data and some relevant assumptions.
	Propane Consumption	Natural Resources Canada & Government of Ontario & MPAC & Carbon Calculator	Medium	N/A	Actual consumption data and some relevant assumptions.
	Wood Consumption	Natural Resources Canada & Government of Ontario & Statistics Canada & World Forest Industries & Carbon Calculator	Medium	N/A	Actual consumption data and some relevant assumptions.
Commercial & Institutional	Electricity Consumption	Hydro One	High	N/A	Actual electricity consumption in kWh for baseline year.
	Natural Gas Consumption	Enbridge	High	N/A	Actual natural gas consumption in m^3.

Emission Sector	Data	Data Source	Data Quality		Notes
			Permanent	Seasonal	
	Fuel Oil Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
	Propane Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
Industrial	Electricity Consumption	Hydro One	High	N/A	Actual electricity consumption in kWh for baseline year.
	Natural Gas Consumption	Enbridge	High	N/A	Actual natural gas consumption in m^3.
	Fuel Oil Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
	Propane Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
Transportation	On-Road Transportation	Statistics Canada & Carbon Calculator	Medium	N/A	Local statistics and some relevant assumptions.
	Waterborne Transportation	WPSGN & Statistics Canada & Carbon Calculator & DMM & Online Forums	Low	Low	Calculation based primarily on assumptions.

Emission Sector	Data	Data Source	Data Quality		Notes
			Permanent	Seasonal	
	Off-Road Transportation	WPSGN & Statistics Canada & Carbon Calculator & DMM & Online Forums & Natural Resources Canada	Low	Low	Calculation based primarily on assumptions.
Waste	Tonnes of Waste	Municipality	High	High	Actual amount of solid waste produced in tonnes for baseline year.
	Degradable Organic Content	Carbon Calculator	Medium/ Low	Medium/ Low	Calculation based on Carbon Calculator data.
BAU Forecast	Residential Property Growth Rate	MPAC	High	High	Actual residential property numbers for baseline year and multiple consecutive years prior.

* Legend for Data Quality:
- High: Actual usage data covering the period of the inventory year, from a credible data collector/ provider.
- Medium: Actual usage data provided, with some assumptions from within or around the geographic boundary, inventory year, or otherwise to fill in data gaps.
- Low: Usage data provided, but mainly based on assumptions.
- N/A: Not Applicable

Community Greenhouse Gas Emissions

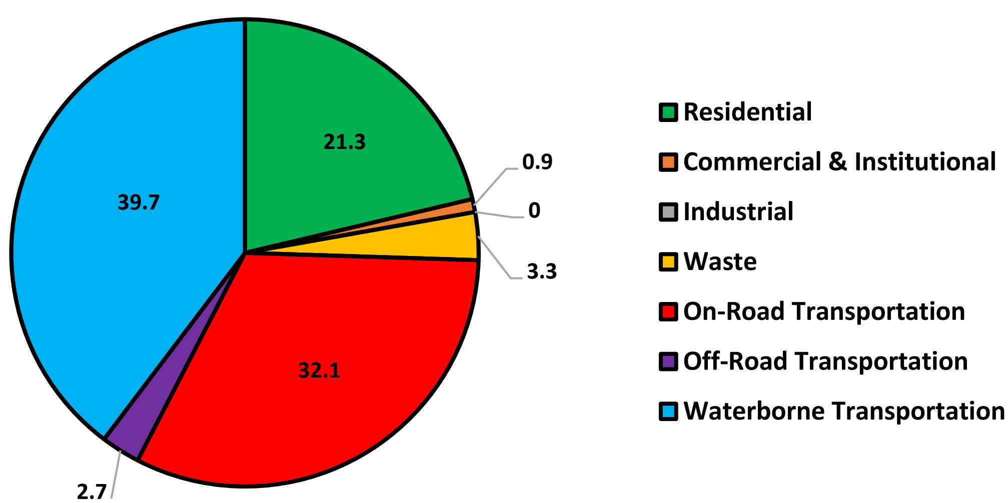
The Township of McKellar's community greenhouse gas (GHG) inventory identifies and quantifies the sources of GHG emissions from community activities and establishes a baseline from which future emissions reductions and progress can be measured. With the production of this inventory, the baseline year of 2016 has been established. Table B lists the Township of McKellar's emission sectors.

Table B: Township of McKellar's GHG Emission Sectors in 2016

GHG Emission Sectors	Metric Tonnes of CO_2e
Residential	2934
Commercial & Institutional	121
Industrial	0
Transportation (total)	10,269
On-Road Transportation	*4,427*
Waterborne Transportation	*5,474*
Off-Road Transportation	*368*
Waste	448
Total Emissions	**13,772**

The transportation sector is by far the largest contributor to GHG emissions in the Township of McKellar, accounting for roughly 75% of GHG emissions. This is followed by the residential sector and waste sector, which produce approximately 21% and 3.3% of the community's GHG emissions respectively. Figure A shows the GHG emissions associated with each sector, expressed as a percentage.

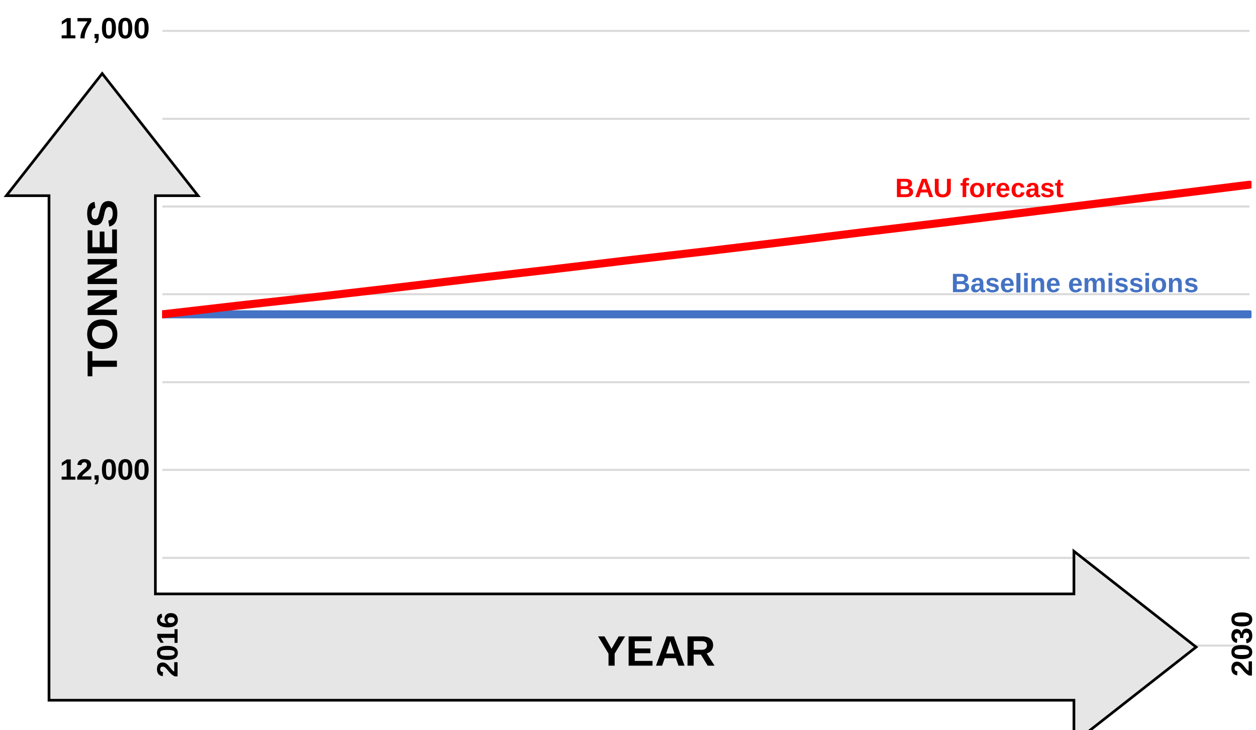
Figure A: GHG Emission Sectors as a Percentage



Business as Usual Forecast

As part of Community Milestone 1, municipalities are also required to forecast GHG emissions to a specified year, based on permanent-resident population growth. However, this is problematic and unrepresentative in producing a business as usual forecast. The Township of McKellar is currently experiencing a decline in its population's permanent residents (2016)[3]. This population decline would therefore demonstrate that GHG emissions would decrease naturally as the permanent-resident population shrinks, a situation which can logically be assumed to be untrue, given the influence seasonal residents have over the production of GHG emissions in the Township of McKellar. As a result, an alternative metric using annual residential property growth rate was developed to capture seasonal resident's influence of community GHG emissions in the Township of McKellar. With an average annual residential property growth rate of 0.73%, community GHG emissions are expected to increase 10.7% by 2030 if no actions are taken to reduce GHG emissions. This will result in community GHG emissions totaling 15,248 tonnes of CO_2e in the year 2030. Figure B shows the TM's expected community GHG emissions growth if business continues as usual.

Figure B: Business as Usual Forecast



	Baseline Emissions (2016)	BAU Forecast (2030)
Total GHG Emissions	**13,772**	**15,248**

[3] https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3549036&Geo2=PR&Code2=35&SearchText=McKellar&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3549036&TABID=1&type=0

Table of Contents

Table of Tables

1. Methodology Background

1.1 Greenhouse Gas Inventory

A greenhouse gas (GHG) inventory brings together data on community and municipal sources of GHG emissions to estimate emissions for a given year. Two separate GHG inventories and forecasts have been created for the Township of McKellar (TM): one for municipal corporate operations and one for community sources. As per the PCP protocol, the inventories consist of the following sources of GHG emissions.

Corporate	***Community***
• Buildings • Streetlights • Water and Sewage Treatment • Municipal Fleet • Solid Waste	• Residential • Commercial and Institutional • Industrial • Transportation • Solid Waste

1.2 Scope

This document will focus solely on ***community*** GHG emissions.

1.2.1 Scope Context & Background

In the TM, residents are often classified as year-round or seasonal for the purposes of property assessments, taxes, energy usage and billing, and many other applications. For the purposes of this report, year-round residents are synonymous with permanent residents. Given that residents of the TM can be classified differently, this baseline has disaggregated data for both resident classifications where necessary and possible. For reporting purposes, these resulting energy consumption quantities and GHG emissions have been aggregated to offer a holistic community perspective. Additionally, the energy consumed and emissions produced by seasonal residents in the TM are those that occur within its jurisdictional boundaries. Energy and emissions relating to the place of primary residence for seasonal residents have been excluded from this baseline. Only in-boundary emissions (those produced within the TM's jurisdiction) are considered.

1.3 Baseline Year

Establishing a baseline is a useful tool to identify areas for improvement, inform the development of a GHG reduction action plan, estimate cost savings from reductions, and serve as a reference point to track improvements. A baseline year of 2016 was selected in order to be consistent with the GHG inventory and forecast submitted by the TM for Corporate Milestone 1. From a methodological perspective, 2016 was selected because it was the year in which the most recent publicly available energy consumption data could be retrieved for some institutions. This also happens to be the year that Statistics Canada released its most recent Census, thereby providing the most current data on population statistics available for this community inventory. Additional data was gathered from other years as well, where relevant, and was referred to throughout the data analysis process. In the event that actual data could not be collected for the baseline year, assumptions were applied from prior, or successive years where relevant.

1.4 Data Collection

To determine the quantity of GHG emissions produced by the TM's community, data on energy consumed and solid waste produced by the community during the baseline year must first be gathered. Once gathered, this data was compiled into an internal database for analysis and calculation.

1.5 Data Sources

Community energy consumption and emissions were calculated for 2016 and reported by sector (residential, commercial and institutional, industrial, transportation, and solid waste) as well as by emissions source (electricity, natural gas, propane, fuel oil, wood, gasoline, diesel, and tonnes of solid waste).

Data quality was assessed primarily on its relevance. While data accuracy is also a critical characteristic when assessing data quality, data accuracy received a secondary role. This is because all data was retrieved from reputable and trustworthy sources, such as federal, provincial, and municipal government agencies, utility providers, individuals, and private organizations and can therefore be considered accurate. As a result, determining data quality was not an exercise in determining the accuracy of the data retrieved. Rather, determining data quality was an exercise in determining whether the data retrieved was relevant to the year in which the baseline and business-as-usual forecast was developed, which would in turn produce an accurate estimate of energy consumption.

While undergoing data collection for the TM's community GHG emission baseline it was discovered that a number of energy consumption data gaps existed. These data gaps largely stemmed around the inability to acquire actual fuel oil and propane consumption data from local providers, and a lack of relevant statistics for common recreational activities, such as boating. As a result, the Georgian Bay Biosphere developed a comprehensive Carbon Calculator tool to collect actual consumption data from the TM's community and the broader region. The Carbon Calculator tool has been designed as a survey and is an educational opportunity for the TM's community to calculate their own personal GHG emission baseline. Where possible, information from the Carbon Calculator has been used to validate the values obtained through assumptive energy consumption models or as a direct calculation statistic. In both circumstances, data from the Carbon Calculator has been aggregated at the regional level to produce statistical relevant values. This regional aggregation has been carefully considered, and has been assumed to be representative of the energy consumption behaviours in the TM's community based on the similar activities, geography, and economic activities that occur in the broader region. Furthermore, it should be noted that the Carbon Calculator tool is an on-going project delivered by the Georgian Bay Biosphere, and any statistics or numbers used in the development of the TM's community GHG emission baseline can be updated as additional entries and better information becomes available. As of November 4th, 2020 the carbon calculator has been completed 191 times in the region, representing the energy consumption behaviours of 478 people.

For a detailed summary of community data sources and quality, please refer to Table 1.

Table 1: Community Energy & GHG Emission Baseline Data Sources

Emission Sector	Data	Data Source	Data Quality: Permanent	Data Quality: Seasonal	Notes
Residential	Electricity Consumption	Hydro One	High	High	Actual electricity consumption in kWh for baseline year.
	Natural Gas Consumption	Enbridge	High	N/A	Actual natural gas consumption in m^3.
	Fuel Oil Consumption	Natural Resources Canada & Government of Ontario & MPAC & Carbon Calculator	Medium	N/A	Actual consumption data and some relevant assumptions.
	Propane Consumption	Natural Resources Canada & Government of Ontario & MPAC & Carbon Calculator	Medium	N/A	Actual consumption data and some relevant assumptions.
	Wood Consumption	Natural Resources Canada & Government of Ontario & Statistics Canada & World Forest Industries & Carbon Calculator	Medium	N/A	Actual consumption data and some relevant assumptions.
Commercial & Institutional	Electricity Consumption	Hydro One	High	N/A	Actual electricity consumption in kWh for baseline year.
	Natural Gas Consumption	Enbridge	High	N/A	Actual natural gas consumption in m^3.

Emission Sector	Data	Data Source	Data Quality		Notes
			Permanent	Seasonal	
	Fuel Oil Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
	Propane Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
Industrial	Electricity Consumption	Hydro One	High	N/A	Actual electricity consumption in kWh for baseline year.
	Natural Gas Consumption	Enbridge	High	N/A	Actual natural gas consumption in m^3.
	Fuel Oil Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
	Propane Consumption	Natural Resources Canada & MPAC	Medium	N/A	Provincial consumption levels and some relevant assumptions.
Transportation	On-Road Transportation	Statistics Canada & Carbon Calculator	Medium	N/A	Local statistics and some relevant assumptions.
	Waterborne Transportation	WPSGN & Statistics Canada & Carbon Calculator & DMM & Online Forums	Low	Low	Calculation based primarily on assumptions.

Emission Sector	Data	Data Source	Data Quality		Notes
			Permanent	Seasonal	
	Off-Road Transportation	WPSGN & Statistics Canada & Carbon Calculator & DMM & Online Forums & Natural Resources Canada	Low	Low	Calculation based primarily on assumptions.
Waste	Tonnes of Waste	Municipality	High	High	Actual amount of solid waste produced in tonnes for baseline year.
	Degradable Organic Content	Carbon Calculator	Medium/ Low	Medium/ Low	Calculation based on Carbon Calculator data.
BAU Forecast	Residential Property Growth Rate	MPAC	High	High	Actual residential property numbers for baseline year and multiple consecutive years prior.

* Legend for Data Quality:
- High: Actual usage data covering the period of the inventory year, from a credible data collector/ provider.
- Medium: Actual usage data provided, with some assumptions from within or around the geographic boundary, inventory year, or otherwise to fill in data gaps.
- Low: Usage data provided, but mainly based on assumptions.
- N/A: Not Applicable

1.5.1 Residential

Actual energy consumption data for electricity was provided by Hydro One. Data on the quantity of natural gas consumed in the TM was provided by Enbridge, however, it should be noted that no residential natural gas consumption takes place in the TM due to a lack of associated infrastructure. Unfortunately, actual consumption data for private sales of fuel oil, heating oil, and propane were unavailable at this time. The quantities of these fuel sources consumed was therefore estimated using statistics and data from Natural Resources Canada, the Government of Ontario, the Municipal Property Assessment Corporation (MPAC), and the Carbon Calculator. Similarly, actual consumption data on wood could not be obtained at this time. The quantity of wood consumption in the TM was thus estimated using data from Natural Resources Canada, the Government of Ontario, the Municipal Property Assessment Corporation, World Forest Industries, and the Carbon Calculator.

While the quality of data varies across fuel sources, it can be said with confidence that overall, the GHG emissions and fuel consumption quantities reported under the residential sector for the TM are accurate.

1.5.2 Commercial & Institutional

Actual energy consumption data for electricity was provided by Hydro One. Data on the quantity of natural gas consumed in the TM was provided by Enbridge, however, it should be noted that no commercial and institutional natural gas consumption takes place in the TM due to a lack of associated infrastructure. Unfortunately, actual consumption data for the private sales of fuel oil, heating oil, and propane were unavailable at this time. The quantities of these fuel sources consumed was therefore estimated using statistics and data from Natural Resources Canada and the Municipal Property Assessment Corporation.

While the quality of data varies across fuel sources, it can be said with confidence that overall, the GHG emissions and fuel consumption quantities reported under the commercial and institutional sector for the TM are accurate.

1.5.3 Industrial

Actual energy consumption data for electricity was provided by Hydro One. Data on the quantity of natural gas consumed in the TM was provided by Enbridge, however, it should be noted that no industrial natural gas consumption takes place in the TM due to a lack of associated infrastructure. Unfortunately, actual consumption data for the private sales of fuel oil, heating oil, and propane were unavailable at this time. The quantities of these fuel sources consumed was therefore estimated using statistics and data from Natural Resources Canada and the Municipal Property Assessment Corporation.

Overall, it can be said with confidence that the GHG emissions and fuel consumption quantities reported under the industrial sector for the TM are accurate.

1.5.4 Transportation

Unfortunately, for all aspects of transportation in the TM (on-road, waterborne, and off-road) actual fuel consumption data was unavailable. The quantities of gasoline and diesel consumed by all types of vehicles in the TM was therefore estimated using statistics and data from Natural Resources Canada, Municipal Property Assessment Corporation, West Parry Sound Geography Network, the Government of Ontario, Statistics Canada, the District Municipality of Muskoka, the Carbon Calculator, and select online forums.

While the quality of data varies for these sources, it can be said with confidence that overall, the GHG emissions and fuel consumption quantities reported under the transportation sector for the TM are accurate.

1.5.5 Solid Waste

GHG emissions from solid waste are a unique emission source to be quantified by local governments. These emissions reflect the impact of methane released through the decomposition of organic matter in landfills and can be calculated based on total waste deposited in a landfill.

Located in rural Northern Ontario, a solid waste curbside collection program does not exist for the TM. Instead, community members bring their waste to a municipally operated transfer station, where the TM outsources waste removal once the receptacles at the transfer station have reached capacity. The cost associated with outsourcing waste removal is measured in terms of weight being hauled. As a result of providing this service and paying the removal fee, the TM is the owner of community waste tonnage data, eliminating the data barrier of trying to receive waste data from a private business. Therefore, given that the TM maintains ongoing records of the tonnage of community-generated solid waste being removed, it can be said with a high degree of confidence that the reported waste tonnage quantity is highly accurate and relevant given the access to actual solid waste production data.

Despite having a record of the total weight of waste being removed, the TM does not have records of the types of household waste being removed. In order to obtain this data, the TM would need to undergo a comprehensive waste audit. As a result, regional data collected by the Carbon Calculator was used to determine the types of waste entering into the household waste stream.

While the quality of data for the waste sector varies, it can be said with confidence that overall, the GHG emissions and values reported under the waste sector for the TM are accurate.

1.5.6 Business as Usual Forecast

Data on the number of residential properties in the TM for the baseline year and multiple consecutive years prior was obtained from the Municipal Property Assessment Corporation. As a result, it can be said with a high degree of confidence that the reported residential property growth rate is highly accurate given the access to data on the actual number of residential properties in the TM.

1.6 Emission Factors & Global Warming Potentials

Emission factors (EF) and global warming potentials (GWP) are a fundamental component of every formula used to determine GHG emissions. An emissions factor is a representative value that attempts to relate the quantity of a pollutant released into the atmosphere with an activity associated with the release of that pollutant. For example, grams (g) of carbon dioxide (CO_2) emitted per kilogram (kg) of biomass consumed. There are many factors that influence the values of emission factors, such as the technology used to consume the fuel source and the end user of that fuel. Therefore, as technologies improve and research on greenhouse gasses develop, the values of EF and GWP change over the years, resulting in both EF and GWP to be variable when compared across years. For an example of how EF and GWP can be variable across years please refer to Table 2.

Table 2: Emission Factor and Global Warming Potential Variability Example

		2011		2016	
Consumption Method	**GHG**	**EF (g/kg fuel)**[4]	**GWP**[5]	**EF (g/kg fuel)**[6]	**GWP**[7]
Residential Biomass Consumption with Conventional Woodstove	Carbon Dioxide	1696	1	1539	1
	Methane	15	21	12.9	25
	Nitrous Oxide	0.16	310	0.12	298
Industrial Biomass Consumption	Carbon Dioxide	840	1	840	1
	Methane	0.09	21	0.09	25
	Nitrous Oxide	0.06	310	0.06	298

For reporting purposes, the PCP tool has automatically programmed the emission factors and global warming potentials into the equation, should fuel consumption quantities be reported. However, in the event that emissions had to be directly reported into the PCP tool, the emission factors and global warming potentials for the baseline year were used. The emission factors and global warming potential values were obtained from the baseline year's edition of Environment Canada's (2016)[8] *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada*.

[4] Environment Canada's National Inventory Report 1990-2011: Greenhouse Gas Sources and Sinks in Canada, Part 2, Annex 8, pp. 205.
[5] Environment Canada's National Inventory Report 1990-2011: Greenhouse Gas Sources and Sinks in Canada, Part 1, Chapter 1, pp. 33.
[6] Environment Canada's National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada, Part 2, Annex 6, pp. 225.
[7] Environment Canada's National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada, Part 1, Chapter 1, pp. 17.
[8] http://www.publications.gc.ca/site/eng/9.506002/publication.html

1.7 System of Measurement

For the purposes of this report and baseline, GHG emission quantities are expressed in terms of ***carbon dioxide equivalent (CO_2e).***

The concept of global warming potentials mentioned above is used to compare the ability of each GHG to trap heat in the atmosphere relative to CO_2. Essentially, GHGs have different capabilities in terms of their ability to impact or influence the atmosphere based on their unique atmospheric lifetime and heat-trapping potential. By factoring these global warming potentials into account, it also allows for a comparison of GHG emissions in terms of how much CO_2 would be required to produce a similar warming effect over a given time period. For example, in 2016, methane had a global warming potential of 25, meaning that over a 100-year period, it would require 25 times the amount carbon dioxide to assert the same atmospheric influence as methane on a unit to unit basis (i.e. gram to gram). In doing so, this normalization into a single unit of measurement enables the quantification of “total community emissions”, expressed as CO_2e.

2. Calculation Process and Assumptions

2.1 Residential

To calculate the GHG emissions produced by residential buildings in the TM, the PCP recommended approach of obtaining actual energy consumption data was pursued, where possible. Where actual energy consumption data was unavailable, the alternative method of estimating energy consumption data was utilized.

2.1.1 Formula for Calculating Residential Building Emissions

There is only one formula for calculating the GHG emissions produced by residential buildings in the TM. For reference, the formula as determined by the PCP protocol is as follows:

$$CO_2e_a = (x_a * CO_2EF_a) + (x_a * CH_4EF_a * GWP_{CH4}) + (x_a * N_2OEF_a * GWP_{N2O})$$

Where:

- x_a = Amount of energy source ‘a’ consumed in one year
- CO_2EF_a = The Carbon Dioxide (CO_2) emission factor for energy source ‘a’
- CH_4EF_a = The Methane (CH_4) emission factor for energy source ‘a’
- N_2OEF_a = The Nitrous Oxide (N_2O) emission factor for energy source ‘a’
- a = Energy source (electricity, natural gas, propane, fuel oil)
- GWP_{CH4} = Global warming potential of Methane (CH_4)
- GWP_{N2O} = Global warming potential of Nitrous Oxide (N_2O)
- CO_2e_a = The Carbon Dioxide (CO_2) equivalents of energy source ‘a’

2.1.2 Assumptions

No assumptions were made in calculating the GHG emissions produced by electricity consumption in the TM due to Hydro One's provision of actual electricity consumption for the baseline year. Furthermore, no assumptions were needed for natural gas, district energy, and diesel consumption since residential buildings in the TM do not consume these fuel sources due to a lack of infrastructure.

In determining the quantity of GHG emissions produced by residential buildings in the TM, assumptions surrounding the consumption of propane, fuel/ furnace oil, and wood needed to be made because actual consumption data for these fuel sources could not be obtained at this time.

2.1.2.1 Fuel Oil and Propane Assumptions & Consumption Estimate Methodology

Due to a lack of natural gas infrastructure, residential natural gas consumption does not occur in the TM. As a result, residential dwellings typically consume fuel/ furnace oil, propane, wood, or any combination of these fuel sources for space heating, water heating, cooking, and other purposes. Therefore, estimating the quantity of GHG emissions produced through the consumption of these fuel sources is critical to accurately depict the emissions produced by residential dwellings in the TM.

The theory of logic behind estimating the residential consumption of propane and fuel/ furnace oil stems from the simplified process of allocating the average residential consumption of these fuel sources to the number of residential dwellings in the TM that use these fuel sources.

The first assumption derived from determining how many residential dwellings consumed propane or fuel/furnace oil in the baseline year. In determining this amount, residential dwellings that are used seasonally were not considered. Seasonal dwellings were omitted from consideration because according to Natural Resources Canada (2020)[9], roughly 62% of residential energy consumption is used for space heating purposes, with an additional 19% of residential energy consumption used for water heating purposes. The heating properties derived from the combustion of propane and fuel/furnace oil thus make it logical to assume that these fuels are used primarily for space heating purposes. With this is mind, the vast majority of seasonal residences are only occupied during the warmer months when space heating is not required, and therefore eliminates the primary purpose of these fuels. Additionally, since these fuel sources are not needed for their primary purpose, it is not uncommon for seasonal dwellings to have electric water heaters to fill the void of their remaining heating purposes. As a result, only residential buildings that are occupied year-round in the TM were factored into calculating residential propane and fuel/furnace oil consumption.

[9] https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/energy-and-greenhouse-gas-emissions-ghgs/20063

To determine this amount, data from Statistics Canada's 2016 Census (2016)[10] on private dwellings occupied by usual residents was chosen over total private dwellings. In looking at Statistics Canada's following definition of total private dwellings, it is evident that a single building can have multiple dwellings within it, such as an apartment building. Under the definition of 'total private dwellings':

> "private dwelling refers to a separate set of living quarters with a private entrance either from outside the building or from a common hall, lobby, vestibule or stairway inside the building. The entrance to the dwelling must be one that can be used without passing through the living quarters of some other person or group of persons."

However, when compared to Statistics Canada's following definition of private dwelling occupied by usual residents, it is evident that there is an important feature missing from the definition of 'total private dwellings'.

> "'Private dwelling occupied by usual residents' refers to a private dwelling in which a person or a group of persons is permanently residing. Also included are private dwellings whose usual residents are temporarily absent."

Comparing the two definitions, it is apparent that 'total private dwellings' does not factor whether people are consistently present in the dwelling or not, where private dwellings occupied by usual residents does. As a result, it was assumed that only dwellings occupied by usual residents would consume fuel oil and propane, since usual residents were assumed to be year-round residents. The rationale behind this is that if a dwelling is typically unoccupied there is no need for thermal control or comfort, and consuming these fuels in an unoccupied dwelling would be financially irresponsible for the owner, a sunk cost that would likely be avoided if possible.

Now that the total number of dwellings using propane or fuel/ furnace oil had been determined, the next step was to determine the precise number of dwellings consuming either of the fuel sources. For this step it was assumed that a dwelling consumed either propane or fuel/furnace oil and never both. This assumption was made based on the rationale that the appliances using these fuels are typically designed to consume one fuel source or the other, and not both.

Using data on the percentage of residential dwellings consuming propane or fuel/ furnace oil in Ontario, a subsequent percentage could be drawn and applied to the number of private dwellings occupied by usual residents in the TM. For example, it was found that in Ontario, 1.1% of households use propane as their primary fuel source and 6.8% use fuel/ furnace oil. Since it was assumed that households in the TM use either propane or fuel/furnace oil, 100% of households could be accounted for in the cumulative 7.9% of households in the province using these fuel sources. Considering

[10] https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3549028&Geo2=PR&Code2=35&SearchText=McKellar&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3549028&TABID=1&type=0

this cumulative percentage as a holistic total (since it represents 100% of households), the subsequent percentage can then define the ratio of households on propane to fuel/furnace oil. In calculating this ratio, 1.1% equates to 13.92% of 7.9% and 6.8% equates to the remaining 86.08%. These percentages (13.92% and 86.08%) were then applied to the number of private dwellings occupied by usual residents in the TM to determine how many were consuming propane and how many were consuming fuel/furnace oil.

The next step was to determine how much of each fuel source that each dwelling using that fuel source was consuming. In determining this amount, the average residential consumption quantities for each fuel source in Ontario was used. Although these quantities were reported in terms of gigajoules (GJ) of energy produced, energy conversion ratios allowed for this number to be translated into an amount in litres. It should be noted, however, that the most recent data on the average GJ of energy consumed of each fuel source that could be retrieved was for the year 2011. As a result, the residential consumption growth rate of each fuel source was applied to determine average consumption in the baseline year. In applying this growth rate, it was assumed that the growth rate for the provincial residential consumption of propane and fuel/furnace oil would be similar to the growth rate in the TM and could be applied to produce a localized quantity of energy consumption for the baseline year. Unfortunately, data from Natural Resources Canada and the Government of Ontario only covers up to the year 2015 and therefore could not be obtained to the baseline year. As a result, the propane and fuel/furnace oil consumption for the year 2015 was reported as the consumption quantities for the 2016 baseline.

While it is best to have consumption data for the precise baseline year, the consumption quantities reported represent the best available data that could be obtained at this point in time. As government data continues to be updated and made publicly available, the calculation process pursued allows for this baseline to be updated quickly to reflect the most up to date information.

For a numeric explanation of the calculation process please see Table 3.

Table 3: Residential Propane and Fuel/Furnace Oil Consumption Calculation Process

CELL	1	2	3	4	5
A	DATA	VALUE	UNIT	CALCULATION STEP	SOURCE
B	% of Ontario Households on Propane	1.1	%		1
C	% of Ontario Households on Oil	6.8	%		1
D	Ontario Households on Oil or Propane	7.9	%	B2 + C2	
E					
F	% of TM Households on Propane	13.92	%	B2 / D2	
G	% of TM Households on Oil	86.08	%	C2 / D2	
H					
I	# Occupied private dwellings in TM	525			3
J	# Occupied private dwellings on Propane	73		F2 * I2	
K	# Occupied private dwellings on Oil	452		G2 * I2	
L					
M	Average propane use per household in Ontario, 2011	26	GJ		2
N	GJ to MJ energy conversion	1 MJ = 0.001 GJ			2
O	MJ per litre of propane	25.3	MJ		2
P	Average propane use per household in Ontario, 2011	1027.668	Litres	(M2 * 1000) / O2	
Q	Residential propane consumption growth, 2011-2015	8.33	%		1 & 4
R	Average propane use per household in Ontario, 2015	1113.273	Litres	(1 + Q2) * P2	
S	Residential Propane use, 2015	81,269	Litres	R2 * J2	
T					
U	Average oil use per household in Ontario, 2011	70	GJ		2
V	GJ to MJ energy conversion	1 MJ = 0.001 GJ			2
W	MJ per litre of oil	38.2			2
X	Average oil use per household in Ontario, 2011	1832.461	Litres	(U2 * 1000) / W2	
Y	Residential oil consumption growth, 2011-2015	-7.7	%		1 & 4
Z	Average oil use per household in Ontario, 2015	1691.361	Litres	(1 + Y2) * X2	
AA	Residential oil use, 2015	764,495	Litres	Z2 * K2	
AB	SOURCES	COLUMN 5 VALUE	RESOURCES		
AC	Natural Resources Canada	1	Comprehensive Energy Use Database		
AD	Natural Resources Canada	2	Households and the Environment: Energy Use		
AE	Statistics Canada	3	2016 Census		
AF	Government of Ontario	4	Fuels Technical Report		

2.1.2.2 Wood

The process of calculating methane and nitrous oxide emissions produced by residential wood consumption in the TM took a very similar approach as calculating propane and fuel/furnace oil consumption. To begin, it first had to be determined how many private dwellings occupied by usual residents consumed wood as a fuel source. Natural Resources Canada's *Comprehensive Energy Use Database* (n.d.)[11] reported that in the baseline year, 2.3% of households in Ontario were using wood as a fuel source for heating.

Returning back to the assumptions made for calculating propane and fuel/furnace oil consumption, where 100% of households in the TM are considered in the cumulative 7.9% of Ontario households using these fuel sources, it was assumed that the 2.3% of Ontario households using wood was a supplement to these 7.9% using oil and propane. The rationale behind this assumption is based on Natural Resources Canada (2012)[12] statement that "wood is often used for supplementary heating." This observation is consistent of energy consumption behaviour in the TM, as it is quite common for households in the TM to have a wood stove or fireplace in addition to their oil or propane tanks and furnaces. Using this assumption revealed that nearly 40% of households in the TM used wood as a fuel source.

The next step involved determining how much wood each of household consumed in the baseline year. Unfortunately, actual consumption data for each household was unavailable, so it was assumed that each household consumed the average amount of wood per household in Ontario, as determined by Natural Resources Canada in their *2011 Households and the Environment Survey* (2013)[13].

Even more difficult was determining the density of the wood each household was consuming, since softwood and hardwood species produce vastly different quantities of energy. Therefore, given that the TM is located on eastern Georgian Bay, a region with a variety of hard and soft wood tree species, it was assumed that there would be even mix of hardwood and softwood consumption. Using this assumption, the energy production per cord of hardwood and softwood was averaged in order to determine the number of cords of wood consumed on average by households in the TM.

It should be noted, however, that this consumption value corresponds to 2011, five years prior to the baseline in question. Therefore, an effort was made to estimate wood consumption for the baseline year. While 2011 was the latest year on which average household wood consumption data could be obtained, the Government of Ontario kept record of the amount of wood being consumed by the residential sector as a whole up until 2015. This data thus allowed a growth rate to be developed and applied to number of cords consumed per household in the TM in 2011. Using this growth rate, it was

[11] https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=on&rn=14&page=0

[12] https://www150.statcan.gc.ca/n1/pub/11-526-s/2010001/part-partie1-eng.htm

[13] https://www150.statcan.gc.ca/n1/en/daily-quotidien/130318/dq130318b-eng.pdf?st=IHFTE373

assumed that the arriving value for 2015 would be the same as 2016. This assumption was made because the behavioural use of wood is incredibly variable in the TM. Since it is primarily used as a supplement to oil and propane, wood consumption fluctuates as temperatures fluctuate and according to the thermal comfort levels of each individual. Without available data, these factors make it incredibly difficult to estimate for the year 2016. Therefore, the residential wood consumption for 2015 was used for the 2016 baseline because it is the closest year to the baseline for which existing consumption data could be used to make an evidence-based assumption.

Following this step, the quantity of GHG emissions produced during the combustion of wood in the TM needed to be determined. This required the quantity of wood consumed to be known, which first required the quantity or volume of wood being consumed to be converted into weight. However, depending on the species of tree the wood was harvested from, the weight of a cord of wood can vary due to naturally occurring differences in density.

Using Natural Resources Canada's *Guide to Residential Wood Heating* (2002)[14], common tree species for residential wood heating were cross referenced against the Government of Ontario's *Tree Atlas* to determine which species are found in the eastern Georgian Bay region. It was assumed that only regional tree species would be used for residential wood heating in the TM because of economic and logistic factors. The seasoned cord weight of tree species found in the region were then averaged.

The final assumption involved determining the technology through which the wood would actually be consumed and the corresponding emission factors. As per Environment and Climate Change Canada's *National Greenhouse Gas Inventory 1990-2016: Greenhouse Gas Sources and Sinks in Canada* (2017)[15], wood consuming technologies have varying emission factors. However, given that wood is primarily used as a supplementary fuel source in the TM, the majority of households consuming wood do so with a conventional wood stove or fireplace. For calculation purposes, and given that these two consumption technologies have the same emission factors, it was thus assumed that all residential wood was consumed through these two technologies.

The resulting emissions produced from wood consumption were reported as direct emissions under the non-specified sources category because a dedicated location to record residential wood consumption does not exist in the PCP tool.

For a numeric explanation of the calculation process please see Table 4 & 5.

[14] file:///C:/Users/clima/Downloads/GuidetoResidentialWoodHeating%20(5).pdf

[15] http://publications.gc.ca/collections/collection_2018/eccc/En81-4-2016-2-eng.pdf

Table 4: Residential Wood Consumption Calculation Process

CELL	1	2	3	4	5
A	DATA	VALUE	UNIT	CALCULATION STEP	SOURCE
B	% of Ontario Households using Wood	2.3	%		4
C	% of Ontario Households on Oil or Propane	7.9	%		4
D	% Ontario Households supplementing with wood	37.97	%	B2 / C2	
E	# Occupied private dwellings in the TM	525			2
H	# Occupied private dwellings supplementing w/ wood	200		D2 * E2	
I					
J	Average wood use per household in Ontario, 2011	77	GJ		1
K	GJ to MJ energy conversion	1 MJ = 0.001 GJ			1
L	MJ per cord of softwood	18,700	MJ		1
M	MJ per cord of hardwood	30,600	MJ		1
N	Average MJ per cord of wood	24,650	MJ	(L2 + M2) / 2	
O	Average wood use per household in Ontario, 2011	3.12	cords	(J2 * 1000) / N2	
P	Ontario residential wood consumption growth, 2011-2015	-8.9	%		3 & 4
Q	Average wood use per household in Ontario, 2015	2.85	cords	(1 + P2) * O2	
R	Residential wood consumption, 2015	570	cords	H2 * Q2	
S	Average weight per cord of wood	1459.14	KG		TABLE 5
T	Residential wood consumption, 2015	831,710	KG	R2 * S2	
U					
V	CH_4 emission factor for wood burning stoves, 2016	12.9	g/KG		5
W	N20 emission factor for wood burning stoves, 2016	0.12	g/KG		5
X	Tonnes of CH_4 emitted from residential wood	10.73	T	(T2 * V2) / 1,000,000	
Y	Tonnes of N20 emitted from residential wood	0.1	T	(T2 * Y2) / 1,000,000	
Z	Tonnes of CO_2e from wood consumption	298.05	T	(X2 * 25) + (Y2 * 298)	
AA	SOURCES	COLUMN 5 VALUE	RESOURCES		
AB	Natural Resources Canada	1	Households and the Environment: Energy Use		
AC	Statistics Canada	2	2016 Census		
AD	Government of Ontario	3	Fuels Technical Report		
AE	Natural Resources Canada	4	Comprehensive Energy Use Database		
AF	Environment and Climate Change Canada	5	National GHG Inventory Report 1990-2016		

Table 5: Average Weight Per Cord of Wood

CELL	1	2	3	4	5
A	SPECIES	REGIONAL	SEASONED CORD WEIGHT	UNIT	SOURCE
B	Ironwood	Yes	1765	KG	1 & 2 & 3
C	Rock Elm	No		KG	1 & 2 & 3
D	Hickory	No		KG	1 & 2 & 3
E	Oak	Yes	1704	KG	1 & 2 & 3
H	Sugar Maple	Yes	1704	KG	1 & 2 & 3
I	Beech	Yes	1704	KG	1 & 2 & 3
J	Yellow Birch	Yes	1429	KG	1 & 2 & 3
K	Ash	Yes	1673	KG	1 & 2 & 3
L	Red Elm	No		KG	1 & 2 & 3
M	Red Maple	Yes	1769	KG	1 & 2 & 3
N	Tamarack	Yes	1473	KG	1 & 2 & 3
O	Douglas Fir	No		KG	1 & 2 & 3
P	White Birch	Yes	1448	KG	1 & 2 & 3
Q	Manitoba Maple	No		KG	1 & 2 & 3
R	Red Alder	No		KG	1 & 2 & 3
S	Hemlock	No		KG	1 & 2 & 3
T	Poplar	Yes	1649	KG	1 & 2 & 3
U	Pine	Yes	1014	KG	1 & 2 & 3
V	Basswood	Yes	956	KG	1 & 2 & 3
W	Spruce	Yes	1126	KG	1 & 2 & 3
X	Balsam Fir	Yes	1014	KG	1 & 2 & 3
Y	AVERAGE WEIGHT ALL SPECIES		1459.142857	KG	SUM (B2:X2) / 14
Z					
AA	SOURCES		COLUMN 5 VALUE	RESOURCES	
AB	Natural Resources Canada		1	A Guide to Residential Wood Heating	
AC	Government of Ontario		2	Tree Atlas	
AD	World Forest Industries		3	Firewood BTU Ratings	

2.1.3 Outcome

For a summary of the quantities of each fuel source consumed by the residential buildings in the TM, please see Table 6.

The TM residential buildings produced **2,934.1 tonnes of CO_2e** in 2016.

Table 6: Residential Consumption Quantities per Fuel Source

Year	Electricity (kWh)	Natural Gas (m^3)	Fuel Oil (L)	Propane (L)	Wood (kg)
2016	11,046,773	0	764,495	81,269	831,710

2.2 Commercial & Institutional

To calculate the GHG emissions produced by commercial and institutional buildings in the TM, the PCP recommended approach of obtaining actual energy consumption data was pursued, where possible. Where actual energy consumption data was unavailable, the alternative method of estimating energy consumption data was utilized.

2.2.1 Formula for Calculating Commercial & Institutional Building Emissions

There is only one formula for calculating the GHG emissions produced by commercial and institutional buildings in the TM. For reference, the formula as determined by the PCP protocol is as follows:

$$CO_2e_a = (x_a * CO_2EF_a) + (x_a * CH_4EF_a * GWP_{CH4}) + (x_a * N_2OEF_a * GWP_{N2O})$$

Where:

- x_a = Amount of energy source ‘a’ consumed in one year
- CO_2EF_a = The Carbon Dioxide (CO_2) emission factor for energy source ‘a’
- CH_4EF_a = The Methane (CH_4) emission factor for energy source ‘a’
- N_2OEF_a = The Nitrous Oxide (N_2O) emission factor for energy source ‘a’
- a = Energy source (electricity, natural gas, propane, fuel oil)
- GWP_{CH4} = Global warming potential of Methane (CH_4)
- GWP_{N2O} = Global warming potential of Nitrous Oxide (N_2O)
- CO_2e_a = The Carbon Dioxide (CO_2) equivalents of energy source ‘a’

2.2.2 Assumptions

No assumptions were made in calculating the GHG emissions produced by electricity consumption in the TM due to Hydro One’s provision of actual electricity consumption for the baseline year. However, since data provided by Hydro One was an aggregate of all commercial and institutional electricity consumed in the baseline year, the electricity consumed by the TM for corporate operations was subtracted from the aggregate as the TM’s consumption can be considered commercial in nature. This was done to avoid double counting as this electricity consumption has already been reported in corporate milestone 1. Furthermore, no assumptions were needed for natural gas, district energy, and diesel consumption since commercial and institutional buildings in the TM do not consume these fuel sources due to a lack of infrastructure.

In determining the quantity of GHG emissions produced by commercial and institutional buildings in the TM, assumptions surrounding the consumption of propane, fuel/ furnace oil, and wood needed to be made because actual consumption data for these fuel sources could not be obtained at this time.

2.2.2.1 Fuel Oil and Propane Assumptions & Consumption Estimate Methodology

Due to a lack of natural gas infrastructure, commercial and institutional natural gas consumption does not occur in the TM. As a result, commercial and institutional buildings typically consume fuel/ furnace oil or propane for space heating, water heating, and auxiliary equipment. Therefore, estimating the quantity of GHG emissions produced through the consumption of these fuel sources is critical to accurately depict the emissions produced by commercial and institutional buildings in the TM.

Similar to the process of calculating residential fuel/ furnace oil and propane consumption, the process with commercial and institutional buildings began by determining how many buildings were on fuel/ furnace oil and how many were on propane. To make this calculation it was assumed that commercial and institutional buildings only consumed one fuel source to achieve efficiencies in their operations.

Using data on the percentage of energy consumption by fuel source for commercial and institutional buildings in Ontario, a subsequent percentage could be drawn and applied to the number of commercial and institutional buildings in the TM as per MPAC. For example, it was found that in Ontario, 1% of energy consumption in the commercial and institutional sector came from fuel/ furnace oil, while 4% was from propane. Since it was assumed that either propane or fuel/ furnace oil was used, 100% of commercial and institutional building fuel/ furnace oil and propane consumption in the TM could be accounted for in the cumulative 5% of energy consumption in the province. Considering this cumulative percentage as a holistic total (since it represents 100% of commercial and institutional buildings), the subsequent percentage can then define the ratio of commercial and institutional buildings on propane to fuel/furnace oil. In calculating this ratio, 1% equates to 20% of 5% and 4% equates to the remaining 80%. These percentages (20% and 80%) were then applied to the number of commercial and institutional buildings that had a heating system that could accommodate fuel/ furnace oil or propane (as per MPAC data) to determine how many were buildings were consuming these fuel sources.

After determining the number of commercial and institutional buildings consuming fuel/ furnace oil or propane the total floor area of the buildings on each respective fuel source was determined. Due to the inability to determine precisely which buildings consumed fuel/ furnace oil versus propane, this was achieved by applying the percentage of buildings on each fuel source (20% and 80%) to the total floor area of buildings that were consuming either fuel source.

Now that floor area had been determined the average energy intensity per square metre of floor for Ontario's commercial sector could be applied. However, it is important to note that this average energy intensity by floor area considers all the energy consumed by commercial and institutional buildings in Ontario, and for the purposes of this calculation only fuel/ furnace oil and propane are in consideration. Therefore, to eliminate double counting of other energy sources, such as electricity, the percentage of energy coming from the use of fuel/ furnace oil and propane needed to be determined. Fortunately, Canada's Comprehensive Energy Use Database provides a percentage breakdown of energy end-use. With streetlighting already captured in the TM's corporate baseline, it was assumed that lighting, space cooling, and water heating were electrically powered. This left the possibility of space heating and auxiliary equipment and motors to be achieved through the consumption of fuel/ furnace oil or propane. However, in reviewing MPAC data for the TM, most of the commercial and institutional buildings were used for accommodative purposes or lacked the need for auxiliary equipment and motors. As a result, it was assumed that fuel/ furnace oil and propane were only used for space heating, and this percentage was applied to the energy intensity by floor area.

With a refined energy intensity by floor area, the next step was calculating the quantity of each fuel source consumed. After each calculation was made to determine total energy consumed by each fuel source, the appropriate energy conversion to volume value was applied to determine the quantity of fuel/ furnace oil consumed in terms of litres.

For a numeric explanation of the calculation process please see Table 7.

Table 7: Commercial & Institutional Propane and Fuel/ Furnace Oil Calculation Process

CELL	1	2	3	4	5
A	DATA	VALUE	UNIT	CALCULATION STEP	SOURCE
B	fuel oil % of Ontario commercial energy use	1	%		1
C	propane % of Ontario commercial energy use	4	%		1
D	% Ontario commercial energy use from propane or oil	5	%	B2 + C2	
E					
H	% commercial properties on oil	20	%	B2 / D2	
I	% commercial properties on propane	80	%	C2 / D2	
J					
K	# of buildings on commercial properties in the TM	49			2
L	# buildings using heating system with propane or oil	14			2
M	total floor area of buildings w. propane or oil heating	1185.72	m^2		2
N	total floor area of buildings w. propane heating	948.58	m^2	M2 * I2	
O	total floor area of buildings w. oil heating	237.14	m^2	M2 * H2	
P					
Q	commercial energy intensity by floor area	1.39	GJ/ m^2		1
R	% energy for heating or auxiliary purposes	57.4	%		1
S	GJ to MJ energy conversion	1 MJ = 0.001 GJ			3
T	MJ per litre of propane	25.3			3
U	MJ per litre of oil	38.2			3
V					
W	commercial propane energy consumption	756,834	MJ	N2 * (Q2 * R2) * S2	
X	commercial propane consumption	29,914	Litres	W2 / T2	
Y					
Z	commercial oil energy consumption	189,205	MJ	O2 * (Q2 * R2) * S2	
AA	commercial oil consumption	4,953	Litres	Z2 / U2	
AB					
AC	SOURCES	COLUMN 5 VALUE	RESOURCES		
AD	Natural Resources Canada	1	Comprehensive Energy Use Database		
AE	West Parry Sound Geography Network	2	MPAC		
AF	Natural Resources Canada	3	Households and the Environment: Energy Use		

2.2.2.2 Wood

It was assumed that the commercial and institutional sector in the TM did not consume any wood. This assumption was based on the observation that Natural Resources Canada's *Comprehensive Energy Use Database* did not report wood consumption for Ontario's commercial sector for the baseline year. As a result, it was assumed that wood consumption was not reported for the commercial sector because wood was not consumed as an energy source by this sector.

2.2.3 Outcome

For a summary of the quantities of each fuel source consumed by the commercial and institutional buildings in the TM, please see Table 8.

The TM's commercial and institutional buildings produced **121.45 tonnes of CO_2e** in 2016.

Table 8: Commercial & Institutional Consumption Quantities per Fuel Source

Year	Electricity (kWh)	Natural Gas (m^3)	Fuel Oil (L)	Propane (L)
2016	1,682,828	0	4,953	29,914

2.3 Industrial

To calculate the GHG emissions produced by industrial buildings in the TM, the PCP recommended approach of obtaining actual energy consumption data was pursued, where possible. Where actual energy consumption data was unavailable, the alternative method of estimating energy consumption data was utilized.

2.3.1 Formula for Calculating Industrial Building Emissions

There is only one formula for calculating the GHG emissions produced by industrial buildings in the TM. For reference, the formula as determined by the PCP protocol is as follows:

$$CO_2e_a = (x_a * CO_2EF_a) + (x_a * CH_4EF_a * GWP_{CH4}) + (x_a * N_2OEF_a * GWP_{N2O})$$

Where:

- x_a = Amount of energy source 'a' consumed in one year
- CO_2EF_a = The Carbon Dioxide (CO_2) emission factor for energy source 'a'
- CH_4EF_a = The Methane (CH_4) emission factor for energy source 'a'
- N_2OEF_a = The Nitrous Oxide (N_2O) emission factor for energy source 'a'
- a = Energy source (electricity, natural gas, propane, fuel oil)
- GWP_{CH4} = Global warming potential of Methane (CH_4)
- GWP_{N2O} = Global warming potential of Nitrous Oxide (N_2O)
- CO_2e_a = The Carbon Dioxide (CO_2) equivalents of energy source 'a'

2.3.2 Assumptions

No assumptions were made in calculating the GHG emissions produced by electricity consumption in the TM due to Hydro One's provision of actual electricity consumption for the baseline year. Furthermore, no assumptions were needed for natural gas, district energy, and diesel consumption since industrial buildings in the TM do not consume these fuel sources due to a lack of infrastructure.

It should be noted that the TM has a small industrial sector. In fact, as per MPAC, there are only 2 buildings in the TM on industrial properties. Additionally, it can be assumed that neither of the buildings consume propane or fuel/ furnace oil based on the heating systems in place. Therefore, industrial electricity consumption has been aggregated with commercial and institutional electricity consumption, based on the size of the industrial sector and for privacy reasons. Taking this approach will result in more efficient strategies during the planning and implementation phase.

2.3.3 Outcome

For a summary of the quantities of each fuel source consumed by the industrial buildings in the TM, please see Table 9.

Table 9: Industrial Consumption Quantities per Fuel Source

Year	Electricity (kWh)	Natural Gas (m^3)	Fuel Oil (L)	Propane (L)
2016	IE*	0	N/A	N/A

*Included Elsewhere

2.4 Transportation

The transportation section has been split into three categories; on-road transportation, waterborne transportation, and off-road transportation.

2.4.1 On-Road Transportation

To calculate the GHG emissions produced by transportation in the TM, the vehicle kilometres travelled (VKT) approach was used. The VKT approach was chosen because of its ability to include assumptions into the calculation process. The VKT approach allows for known data to be integrated with evidence-based assumptions to develop a representative transportation model for the TM.

2.4.1.1 Formula for Calculating On-Road Transportation Emissions

In calculating the VKT for the TM, the alternative approach and formula as per the PCP protocol was pursued where possible. For reference, the formula as determined by the PCP protocol is as follows:

$$\boldsymbol{VKT = H * V * D}$$

Where:

- VKT = Vehicle Kilometres Traveled
- H = Number of households in the community
- V = Number of light-duty vehicles per household
- D = Average annual distance traveled by light-duty vehicles

2.4.1.2 Assumptions

Determining the amount of fuel consumed by community on-road transportation and the subsequent emissions is arguably the most difficult task in producing a community GHG emission baseline. This is because the task requires the quantification of fuel consumed and the emissions produced within a fixed boundary for a trans-boundary activity. As a result of this difficulty, the Government of British Columbia[16] has noted that there are two theoretical approaches that can be taken when measuring community on-road transportation emissions: Gross Domestic Emissions (GDE) and Gross Resident Emissions (GRE). GDE considers all emissions generated by on-road vehicles in the community, irrespective of whether those vehicles are resident in the community, and GRE considers all emissions generated by vehicles resident to the community, irrespective of whether those emissions are produced within or outside the community's boundaries. In addition to the data available at this time, the GRE method was used for the following reasons.

When thinking of calculating community VKT under the GDE method, the associated PCP protocol approach requires knowledge of road segment lengths and average annual daily traffic on those road segments. In general, roadways in Ontario can be considered municipally-managed and provincially-managed, thereby making a GDE calculation a product of both municipal and provincial roadways in the TM. The problem with doing so, however, is that the TM has little to no influence over those roadways which are provincially managed. Therefore, it is safe and reasonable to assume that implemented initiatives will have little impact on VKT on provincial roadways as a result of limited management control.

Conversely, by taking the GRE approach the TM has greater management control over the emissions produced by on-road transportation, since they are produced solely by its residents. With greater management control also comes the possibility of greater results, since metrics are meaningful and relevant. For example, any strategies implemented to reduce on-road transportation emissions can target, and be developed for TM residents. The performance of these programs can thus be measured through the Carbon Calculator, community feedback, and other metrics.

[16] https://www2.gov.bc.ca/assets/gov/environment/climate-change/z-orphaned/ceei/ceei-comparison-study.pdf

In taking the GRE approach the calculation process was completed with data from the Carbon Calculator and Statistics Canada. Should additional data become available through the Carbon Calculator the GHG emissions reported in this baseline inventory will be updated.

For a numeric explanation of the calculation process please see Table 10.

Table 10: On-Road Transportation VKT Calculation Process

CELL	1	2	3	4	5
A	DATA	VALUE	UNIT	CALCULATION STEP	SOURCE
B	Private dwellings occupied by usual residents	525			1
C	Vehicles per household	1.55			2
D	Average annual VKT	16,072	KM		2
E	VKT	13,078,590	KM	B2 * C2 * D2	
F					
G	SOURCES	COLUMN 5 VALUE	RESOURCES		
H	Statistics Canada	1	2016 Census		
I	Georgian Bay Biosphere	2	Carbon Calculator		

2.4.1.2 Outcome

On-road Transportation in the TM produced **4,426.89 tonnes of CO_2e** in 2016.

2.4.2 Waterborne Transportation

Including waterborne transportation is critical to producing an accurate and representative emissions baseline for the TM. This is because the TM has access to many in-land lakes, making boating a common recreational activity.

2.4.2.1 Formula for Calculating Waterborne Transportation Emissions

Unfortunately, the PCP protocol does not provide direction on how to calculate the fuel and GHG emissions consumed by recreational watercraft. As a result, the formula for calculating the GHG emissions produced from gasoline and diesel consumption in the on-road transportation sector was used as these fuel sources are also consumed by waterborne vehicles. It should also be noted that the appropriate emission factors have been obtained from Canada's *National Inventory Report: Greenhouse Gas Emissions and Sinks* (2017)[17]. GHG emissions from waterborne transportation have been directly reported in the PCP tool. For reference, the general formula is as follows:

$$CO_2e_a = (x_a * CO_2EF_a) + (x_a * CH_4EF_a * GWP_{CH4}) + (x_a * N_2OEF_a * GWP_{N2O})$$

Where:

- x_a = Amount of energy source 'a' consumed in one year
- CO_2EF_a = The Carbon Dioxide (CO_2) emission factor for energy source 'a'
- CH_4EF_a = The Methane (CH_4) emission factor for energy source 'a'
- N_2OEF_a = The Nitrous Oxide (N_2O) emission factor for energy source 'a'
- a = Energy source (electricity, natural gas, propane, fuel oil)
- GWP_{CH4} = Global warming potential of Methane (CH_4)
- GWP_{N2O} = Global warming potential of Nitrous Oxide (N_2O)
- CO_2e_a = The Carbon Dioxide (CO_2) equivalents of energy source 'a'

2.4.2.2 Assumptions

To determine the quantity of gasoline or diesel consumed by waterborne vehicles a considerable number of assumptions needed to be made. These assumptions were made while determining the quantity of fuel consumed by waterborne vehicles. For example, based on data gathered through the Carbon Calculator, it was assumed that for the purposes of this baseline, only gasoline was consumed by waterborne vehicles.

It should be noted that as better information becomes available this portion of the baseline and its assumptions will be reviewed and any applicable changes made.

[17] http://publications.gc.ca/collections/collection_2018/eccc/En81-4-2016-2-eng.pdf

2.4.2.2.1 Gasoline Assumptions & Consumption Estimate Methodology

To calculate the quantity of gasoline consumed by waterborne vehicles, it first needed to be determined how many waterborne vehicles were in the TM. This was achieved by conjoining data on the number of permanent and seasonal residences and the average number of average waterborne vehicles for each respective residence type.

Next, the average fuel efficiency of waterborne vehicles needed to be calculated. This process was discovered in boating forums and magazines providing guidance on how to estimate the amount of fuel a boat will consume given the size of its motor. In assessing the applicability of this method, further boating forums were researched that validated our recommended approach. As a result, it was assumed that this is a consist method for estimating the fuel consumed by waterborne vehicles and would be relevant in the production of this baseline.

After the average fuel efficiency of waterborne vehicles was calculated, it was multiplied by the average annual operating hours each vehicle was in operation and the number of waterborne vehicles in the TM. The average annual operating hours was used because in comparison to on-road vehicles, waterborne vehicles measure fuel consumption as a function of time, rather than distance. This value was obtained through entries in the Georgian Bay Biosphere's Carbon Calculator, and was assumed to be representative at this time since no other data could be found to suggest otherwise. Should more data become available, this value can be updated to improve the accuracy of the gasoline consumption and subsequent GHG emissions reported.

It should be noted that this calculation is limited in its ability to only consider the fuel consumed by waterborne vehicles that are associated with a residence in the TM. In reality, many individuals residing outside of the TM will launch their waterborne vehicles at public boat launches or marinas. As a result, the fuel consumption and subsequent GHG emissions reported in this baseline is considered to be a conservative estimate.

For a numeric explanation of the calculation process please see Table 11.

2.4.2.3 Outcome

Waterborne transportation in the TM produced **5,474.04 tonnes of CO_2e** in 2016.

Table 11: Waterborne Transportation Gasoline Consumption Calculation Process

CELL	1	2	3	4	5
A	DATA	VALUE	UNIT	CALCULATION STEP	SOURCE
B	# of permanent residences	525			1 & 2
C	# of seasonal residences	960			1
D	average # of watercraft per permanent residence	0.31			3
E	average # of watercraft per seasonal residence	1.8			4
F	# of watercraft in the TM	1891		(B2 * D2) + (C2 * E2)	
G					
H	average gasoline engine horsepower	109			3
I	average annual watercraft operating time	36.67			3
J	gasoline consumption rate	0.5	lbs/ HP		5
K	gasoline weight by volume	6.1	lbs/ gallon		5
L					
M	average watercraft gasoline consumption efficiency	8.934	GPH	(J2 * H2) / K2	5
N	average watercraft gasoline consumption	328	Gallons	I2 * M2	
O	total watercraft gasoline consumption	620,248	Gallons	F2 * N2	
P	gallon to litre conversion	3.78541	Litres per Gallon		
Q	watercraft gasoline consumption	2,347,893	Litre	O2 * P2	
R					
S	CO2 emission factor for watercraft gasoline	2307	g/L		6
T	CH4 emission factor for watercraft gasoline	0.22	g/L		6
U	CH4 emission factor for watercraft gasoline	0.063	g/L		6
V	Tonnes of CO2 emitted from watercraft	5,416.59	T	(Q2 * S2) / 1,000,000	
W	Tonnes of CH4 emitted from watercraft	0.51	T	(Q2 * T2) / 1,000,000	
X	Tonnes of N20 emitted from watercraft	0.15	T	(Q2 * U2) / 1,000,000	
Y	Tonnes of CO2e emitted from watercraft	5,474.04	T	V2 + (W2 * 25) + (X2 * 298)	
Z					
AA	SOURCES	COLUMN 5 VALUE	RESOURCES		
AB	West Parry Sound Geography Network	1	MPAC		
AC	Statistics Canada	2	2016 Census		
AD	Georgian Bay Biosphere	3	Carbon Calculator		
AE	District Municipality of Muskoka	4	Muskoka Second Home Study		

AF	Boating Magazine	5	Calculating Boat Fuel Consumption
AG	Natural Resources Canada	6	National Inventory Report: GHG Sources and Sinks

2.4.3 Off-Road Transportation

In addition to being located in eastern Georgian Bay, the TM is a rural municipality. Due to its ruralness, off-road vehicles are often used for recreation and transportation via extensive trail networks, as well as on in-land lakes when they freeze over in the winter months. As a result, including off-road transportation is critical to producing an accurate and representative GHG emissions baseline for the TM.

2.4.3.1 Formula for Calculating Off-Road Transportation Emissions

Unfortunately, the PCP protocol does not provide direction on how to calculate the GHG emissions produced by off-road vehicles. As a result, the formula for calculating the GHG emissions produced from gasoline and diesel consumption in the on-road transportation sector was used as these fuel sources are also consumed by off-road vehicles. It should also be noted that the appropriate emission factors have been obtained from Canada's *National Inventory Report: Greenhouse Gas Emissions and Sinks* (2017)[18]. GHG emissions from off-road vehicles have been directly reported in the PCP tool. For reference, the general formula is as follows:

$$CO_2e_a = (x_a * CO_2EF_a) + (x_a * CH_4EF_a * GWP_{CH4}) + (x_a * N_2OEF_a * GWP_{N2O})$$

Where:

- x_a = Amount of energy source 'a' consumed in one year
- CO_2EF_a = The Carbon Dioxide (CO_2) emission factor for energy source 'a'
- CH_4EF_a = The Methane (CH_4) emission factor for energy source 'a'
- N_2OEF_a = The Nitrous Oxide (N_2O) emission factor for energy source 'a'
- a = Energy source (electricity, natural gas, propane, fuel oil)
- GWP_{CH4} = Global warming potential of Methane (CH_4)
- GWP_{N2O} = Global warming potential of Nitrous Oxide (N_2O)
- CO_2e_a = The Carbon Dioxide (CO_2) equivalents of energy source 'a'

2.4.3.2 Assumptions

To determine the GHG emissions produced by off-road transportation in the TM, assumptions surrounding the quantity of gasoline or diesel consumed by off-road vehicles needed to be made. For example, based on data gathered through the Carbon Calculator, it was assumed that for the purposes of this baseline, only gasoline was consumed by off-road vehicles.

It should be noted that as better information becomes available this portion of the baseline and its assumptions will be reviewed and any applicable changes made.

[18] http://publications.gc.ca/collections/collection_2018/eccc/En81-4-2016-2-eng.pdf

2.4.3.2.1 Gasoline Assumptions & Consumption Estimate Methodology

The first step in calculating the GHG emissions produced by off-road vehicles was to determine the number of off-road vehicles operated by residents in the TM. To do this, data on the number of permanent and seasonal residences and the average number of off-road vehicles for each respective residence type was considered. However, it is important to note that while off-road vehicles are similar in classification, they differ in their engine classification as being either 2-stroke or 4-stroke. It is important to differentiate these engine types as they have different emission factors associated with them when calculating GHG emissions. As a result, data from the Carbon Calculator on the percentage of off-road vehicles as 2-stroke versus 4-stroke was applied to determine the number of 2-stroke and 4-stroke off-road vehicles.

The next step was to determine the average amount of fuel each off-road vehicle consumed. It was assumed that off-road vehicles only consumed gasoline, as this is the most common fuel source consumed by these vehicles, and no information could be found on off-road diesel consumption at this time. Since off-road vehicles measure their use in terms of operating hours, the average amount of fuel consumed could be calculated by multiplying the average operating hours of all off-road vehicles by the average fuel efficiency.

Some assumptions were required in order to determine off-road fuel efficiency. At first, little information could be found on the process of measuring fuel efficiency for off-road vehicles. As a result, the process for measuring fuel efficiency for boats was applied to this situation. It was assumed that this allocation would be relevant because the process only considers fuel and engine aspects and doesn’t include environmental considerations that would make this process irrelevant to off-road vehicles. Moving into the details of the process, off-road vehicle engines are often described in terms of cubic centimetres (CCs) rather than horsepower. Therefore, a conversion ratio was needed to measure CCs in terms of horsepower. Through extensive research it was discovered that the general rule of thumb is that 1 horsepower is equal to a range between 15 and 17 CCs. Due to the differences in power and torque between 2-stroke and 4-stroke engines it was assumed that the 2-stroke and 4-stroke conversions would respectively be 15 and 17 CCs to 1 horsepower.

After the average fuel efficiency was calculated, it was multiplied by the average annual operating hours of each off-road vehicle and the number of 2-stroke and 4-stroke off-road vehicles to get total gasoline consumption. GHG emissions were then calculated based on this fuel consumption. It should be noted that the average annual operating hours was obtained from the Georgian Bay Biosphere’s Carbon Calculator, and was assumed to be representative at this time since no other data could be found. Should more data become available, this value can be updated to improve the accuracy of the gasoline consumption and subsequent GHG emissions reported.

For a numeric explanation of the calculation process please see Table 12.

Table 12: Off-Road Transportation Gasoline Consumption Calculation Process

CELL	1	2	3	4	5
A	DATA	VALUE	UNIT	CALCULATION STEP	SOURCE
B	# of permanent residences	525			1 & 2
C	# of seasonal residences	960			1
D	average # of off-road vehicles per permanent residence	0.377			3
E	average # of off-road vehicles per seasonal residence	0.267			3
F	# of off-road vehicles	454		(B2 * D2) + (C2 * E2)	
G					
H	% of off-road vehicles as 2-stroke	35.9	%		3
I	% of off-road vehicles as 4-stroke	64.1	%		3
J	# of 2-stroke off-road vehicles	163		H2 * F2	
K	# of 4-stroke off-road vehicles	291		I2 * F2	
L					
M	average 2-stroke engine CCs	490	CC		3
N	average 4-stroke engine CCs	566	CC		3
O	2-stroke CC to horsepower ratio	15	CC per HP		4
P	4-stroke CC to horsepower ratio	17	CC per HP		4
Q	average 2-stroke engine HP	32.67	HP	M2 / O2	
R	average 4-stroke engine HP	33.29	HP	N2 / P2	
S	average annual off-road operating time	31.597	Hours		3
T	gasoline consumption rate	0.5	lbs/ HP		5
U	gasoline weight by volume	6.1	lbs/ gallon		5
V					
W	average 2-stroke fuel efficiency	2.678	GPH	(Q2 * T2) / U2	5
X	average 4-stroke fuel efficiency	2.729	GPH	(R2 * T2) / U2	5
Y	average 2-stroke fuel consumption	84.617	Gallons	W2 * S2	
Z	average 4-stroke fuel consumption	86.228	Gallons	X2 * S2	
AA	total 2-stroke gasoline consumption	13,793	Gallons	Y2 * J2	
AB	total 4-stroke gasoline consumption	25,092	Gallons	Z2 * K2	
AC	gallon to litre conversion	3.78541	Litres per Gallon		
AD	off-road 2-stroke vehicle gasoline consumption	52,212	Litres	AA2 * AC2	
AE	off-road 4-stroke vehicle gasoline consumption	94,984	Litres	AB2 * AC2	

AF					
AG	CO2 emission factor for off-road (2 & 4-stroke) gasoline	2307	g/L		6
AH	CH4 emission factor for 2-stroke gasoline	10.61	g/L		6
AI	CH4 emission factor for 4-stroke gasoline	5.08	g/L		6
AJ	N2O emission factor for 2-stroke gasoline	0.013	g/L		6
AK	N2O emission factor for 4-stroke gasoline	0.064	g/L		6
AL	Tonnes of CO2 emitted from off-road vehicles	339.58	T	((AD2 * AG2) + (AE2 * AG2)) / 1,000,000	
AM	Tonnes of CH4 emitted from off-road vehicles	1.04	T	((AD2 * AH2) + (AE2 * AI2)) / 1,000,000	
AN	Tonnes of N20 emitted from off-road vehicles	0.007	T	((AD2 * AJ2) + (AE2 * AK2)) / 1,000,000	
AO	Tonnes of CO2e emitted from off-road vehicles	367.66	T	AL2 + (AM2 * 25) + (AN2 * 298)	
AP					

	SOURCES	COLUMN 5 VALUE	RESOURCES
AR	West Parry Sound Geography Network	1	MPAC
AS	Statistics Canada	2	2016 Census
AT	Georgian Bay Biosphere	3	Carbon Calculator
AU	Off-Road Vehicle Online Forum	4	How to Convert CC to HP
AV	Boating Magazine	5	Calculating Boat Fuel Consumption
AW	Natural Resources Canada	6	National Inventory Report: GHG Sources and Sinks

2.4.3.3 Outcome

Off-road transportation in the TM produced **367.66 tonnes of CO_2e** in 2016.

2.5 Solid Waste

To calculate the GHG emissions produced by the TM's community, the methane commitment model was used. This decision was made since the landfill the TM sends its community's waste to does not have an LFG system in place. For reference, a simplified version of this formula, as per the PCP Protocol, is as follows:

2.5.1 Formula for Calculating Solid Waste Emissions

$$CO_2e = 25 * M * \left(\left(\frac{16}{12}\right) * MCF * DOC * DOC_F * F\right) * (1 - f_{rec}) * (1 - OX)$$

Where:

- M = Quantity of solid waste in tonnes sent to landfill in inventory year
- 16/12 = Stoichiometric ratio between methane and carbon
- MCF = Methane correction factor
- DOC = Degradable organic carbon
- DOC_F = Fraction of DOC dissimilated
- F = Fraction of methane in landfill gas
- f_{rec} = fraction of methane emissions recovered at the landfill
- OX = Oxidation factor

2.5.2 Assumptions

Data on the actual tonnage of solid waste generated by the TM's community was provided by municipal staff. However, the actual tonnage of solid waste generated is a cumulative total that includes the waste produced during corporate operations. As a result, the reported corporate solid waste generation was subtracted from the total to determine the quantity produced by the community. Gaining an understanding of solid waste practices and policies can help to determine some of the factors and coefficients of the formula that are determinant on landfill management and operations.

Municipal staff explained that when solid waste is generated by the community, it is sent to the various transfer stations. Once the transfer stations have reached capacity, solid waste is then diverted to the McDougall landfill. Staff from the McDougall landfill informed the Georgian Bay Biosphere that no emission capture technology has been installed. This is because a feasibility study was undertaken, which determined that it was economically unfeasible to purchase the technology and embark on installation. While this technology does not exist, the landfill is still being actively managed. Garbage is compacted daily to reduce volume and then buried to allow for additional landfill space, and to deter wildlife. The landfill is also classified as engineered. The landfill is lined to capture leachate, which is then removed and sent to an offsite treatment facility for processing. These factors helped to determine assumptions on several of the values required by the formula.

The next step was to determine the degradable organic content of the community generated waste. While the PCP protocol provides these values, they were determined to be unrepresentative of the TM because of the differences in lifestyle and consumption behaviours that exist between the TM and other communities. As a result, data from the Carbon Calculator was used to determine the waste composition values. It was assumed that data from the Carbon Calculator would be more representative because it considers the waste composition for the TM's region in particular, thereby considering those lifestyle and consumption behaviours. It should be noted that as more data from the Carbon Calculator becomes available, the reported solid waste composition values in this baseline can be updated.

2.5.3 Outcome

Solid waste in the TM produced **448.21 tonnes of CO_2e** in 2016.

2.6 Business as Usual

In calculating the business-as-usual (BAU) forecast, the year 2030 was chosen as the forecast year.

2.6.1 Assumptions

In their 2016 Population Census[19], Statistics Canada reported that the TM experienced a 2.9% decline in population between the years 2011 and 2016. However, given that the BAU forecast is determined by annual population growth, it was determined that the reported decline in population would be unrepresentative of community GHG emissions and the projected BAU for the following reasons.

Geographically positioned in eastern Georgian Bay and in the heart of cottage country, the TM is a major tourist destination. As a result of this tourism, a massive increase in population occurs during the warmer months, raising the population from 1,111 permanent residents to include thousands of seasonal residents. Yet Statistics Canada only accounts for the 1,111 permanent residents in their 2016 Population Census. As a result, Statistics Canada's population decline is derived from permanent residents, failing to account for the major seasonal population influx. This is problematic and unrepresentative in producing a BAU forecast because the seasonal population has a significant influence over the production of GHG emissions in the TM. It is also fair and reasonable to assume that given the influence seasonal resident's have on GHG production in the TM, as the seasonal population grows, so too will community GHG emissions. Thus, by using Statistics Canada's population decline it would demonstrate that there would be a natural decrease in GHG emissions as population shrinks. As a

[19] https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3549036&Geo2=PR&Code2=35&SearchText=McKellar&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3549036&TABID=1&type=0

result, the following methodology and assumptions were considered in producing a growth statistic that would factor seasonal population in producing a BAU forecast.

Data was first retrieved from the MPAC. This data was referenced because it classifies each property in Ontario according to its functional purposes. For example, data entries categorized as a 300 series property are classified as a residential property, including both permanent residences and seasonal residences.

It can be difficult to assume the number of people that are staying at a seasonal residence at any given time. For example, it is common for numerous different families to rent a single seasonal residence throughout the summer. This produces a high degree of variability in the population of any single seasonal residence, as one week could have 3 residents occupying the premises and the following week could have 8. From a calculation perspective, the most appropriate response would be to use a provincial statistic, such as the average number of residents per household. However, using a statistical average such as the average number of residents per household results in a static number, and shifts the aspect of variability to the object it represents, which in this case is the household. Therefore, accounting for seasonal population in an annual population growth rate would require calculating the growth rate of the number of residential properties as determined by MPAC.

Based on the static nature of the number of residents per household, it was assumed that the growth rate of the number of residential properties would be the same as population. As a result, the annual growth rate of residential properties was used to determine the BAU forecast.

Given that the BAU forecast was determined by annual residential property growth, multiple years of data was used to eliminate the possibility of an outlier skewing the calculation result. With this consideration, the residential property growth rate was calculated for each year from 2010 to 2016, and then averaged. This resulted in an average annual residential property growth rate of 0.73%. Following the PCP protocol, this 0.73% growth rate was used to determine the forecasted emissions for the year 2030.

2.6.2 Outcome

Given a 0.73% annual residential property growth rate forecasted to the year 2030, community emissions in the TM are expected to be 15,248 tonnes of CO_2e in 2030, representing a 10.7% increase from baseline levels, if business is to continue as usual.

Appendix

List of Acronyms

BAU = Business as Usual (in context of emissions forecasts)

EF = Emission Factor

FCM = Federation of Canadian Municipalities

GDE = Gross Domestic Emissions

GHG = Greenhouse Gas

GWP = Global Warming Potential

ICECAP = Integrated Community Energy and Climate Action Plans

ICLEI = International Council for Local Environmental Initiatives

MPAC = Municipal Property Assessment Corporation

PCP = Partners for Climate Protection

TM = Township of McKellar

VKT = Vehicle Kilometres Travelled

List of Key Definitions

Business as Usual	A scenario for predicting future emissions and energy use activity which assumes there will be no major changes in technology, policy, economics, and human activity/attitudes.
Baseline	The reference conditions against which change is measured.
Climate	Long-term averages of temperature, rainfall, and humidity. Long-term may be the span of seasons, years, or decades.
Climate Change	The long-term shift in global or regional climate patterns, usually in the context of rising global temperatures due to human-caused changes in atmospheric composition or in land use.
Emissions	In the context of climate change, refers to greenhouse gases that are released from human activities such as burning fossil fuels, deforestation, and food production.
Greenhouse Gas	Gases that trap heat in the Earth's atmosphere, creating a warmer-than-usual condition similar to the effect of a greenhouse. Examples include carbon dioxide and methane.
Mitigation	The act of limiting or reducing the harmful effects of something.