

Greenhouse Gas (GHG) Inventory

Executive Summary

This document outlines calculations made to estimate the amount of greenhouse gases (GHG) being released within the geographic boundaries of the Township of Billings (Billings) using the Canadian Supplement of the Partners for Climate Protection (PCP) Protocol. The International Emissions Analysis Protocol (IEAP) provides the guiding principles for the PCP Protocol and has been referenced when PCP guidelines were not applicable. Accordingly, GHG emissions fall into two categories: those coming from municipal corporate assets and operations (Corporate); and those coming from community activities such as emissions generated from heating our homes and work places (Community). Using the best practices outlined in the PCP Protocol, with a baseline year of 2018, we found our emissions to equal **15524** tonnes of carbon dioxide equivalent (**tCO₂e**). A summary of our findings per category measured is outlined in Table 1, as follows:

Table 1: Summary of corporate and community GHG emissions for Billings Township, units expressed as tonnes of carbon dioxide equivalent (tCO₂e).

Municipal Fleet	77.13	Energy Use at Home and Work	8118.84
Waste	22.00	Transportation	4548.36
Municipal Buildings	38.13	Agriculture	1895.73
Low Lift and Water Treatment	3.64		
Streetlights	0.05		
Corporate Total (tCO₂e)	891	Community Total (tCO₂e)	14 633

We also found that the forest cover within the municipality may be absorbing approximately 22 069 tCO₂e per year, more than what is released within our geographic boundaries from human activity. However, this does not relieve us of our obligation to reduce our emissions, as global totals of GHG emissions are still far higher than what could be absorbed globally—and the atmosphere is not politically bounded. Incorporating forest cover in our GHG inventory will enable our community to quantify our natural assets and the carbon sequestration capacity we have available to offset the emissions created from human activity. We have the good fortune to be living in a carbon sink, but our carbon-intensive lifestyles are still contributing to the larger problem.

Through municipal-led actions to both reduce our corporate emissions and to help enable the reduction of community emissions, we can make it easier for community members and visitors alike to reduce the portion of their carbon footprints associated with emissions physically released within our geographic boundaries. Following the review and approval of this GHG inventory, Billings will move to the next stages of a climate change planning process by setting GHG emission reduction targets and developing a Community Emissions and Energy Plan (CEEP) using the guidelines and tools available through the PCP program.

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Introduction

The purpose of a greenhouse gas (GHG) inventory is to define a “starting point” from which emissions can then be reduced. Having a defined starting point allows us to track our progress towards our goals over the years. Without an inventory, taking climate action is a bit like taking a shot in the dark—we wouldn’t know whether what we’re doing is enough.

Calculating corporate and community GHG emissions requires reliable and specific data inputs from multiple sources of emissions in our municipality. To effectively compare emissions from one source to another, it is important to ensure that all sources of emissions use the same method for these calculations. We chose to follow the guidelines developed by the Partners for Climate Protection (PCP) program, outlined in a document known as the PCP Protocol (Canadian Supplement), and also made use of the PCP Tool—an online program available to local governments to standardize the conversion of multiple sources of emissions to a common denominator. Thus, in this report you will see frequent use of the unit “tCO₂e”. This is a unit of measurement used by climate scientists to represent tonnes of different greenhouse gases, equalized in terms of their warming potential, as compared to carbon dioxide (CO₂). Some greenhouse gases last longer in the atmosphere than others, and warm the atmosphere by varying degrees. Since carbon dioxide is the most abundant and well-known greenhouse gas, scientists often report amounts of other greenhouse gases in terms of how much CO₂ their warming effect is equivalent to, over a given time period. For simplicity’s sake, we will only report the total amount of CO₂ equivalent (CO₂e) produced in each category, with amounts of CO₂ and other greenhouse gases having been added together.

The PCP program and the PCP Tool were developed by the Federation of Canadian Municipalities (FCM) and the Canadian chapter of ICLEI Local Governments for Sustainability. These resources are being used by many municipalities across Canada. The PCP Tool will provide municipalities with the ability to track how they have calculated GHG emissions in the community and continuously measure performance for years to come. The implementation of this tool in our municipality will be a cornerstone of developing a sustainable process for tracking GHG emissions and can be used by the municipal staff for years to come.

A note on baseline year: All inventories aim to calculate the amount of greenhouse gases that were produced within a “baseline year”, in other words a year with sufficient data available, against which progress can be tracked as years go by. For our inventory we chose the baseline year of 2018, as it was the most recent complete year when the work on the inventory started, though for some categories data was only available as recently as 2016. It is assumed that emissions in these categories did not change significantly over those two years.

The following sections provide more detail as to where our greenhouse gas emissions are coming from within each category and how these emissions were calculated. The Appendices include still further notes on methodology, calculations, and data collection.

Corporate Emissions

In total the corporate emissions for Billings Township, amounted to **891 tCO₂e** for 2018, with municipal fleet being the biggest category, followed by municipal buildings, then emissions produced from the landfill, low lift station (pump) and water treatment, and lastly streetlights. The corporate emissions profile is visually represented using a bar graph below (Figure 1) in terms of total CO₂e and broken down on a percentage basis in a pie chart (Figure 2) created using the PCP Tool.

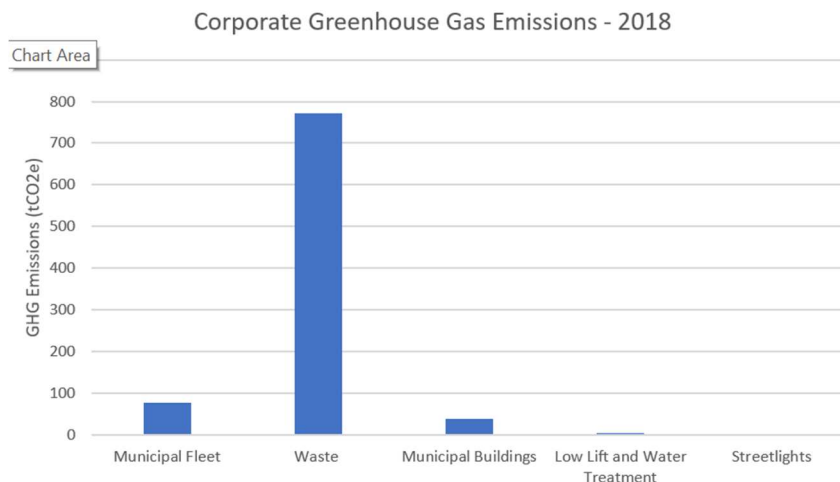


Figure 1: Corporate GHG emissions profile for Township of Billings. Details on the methodology for data collection and calculations can be found below and in Appendix A

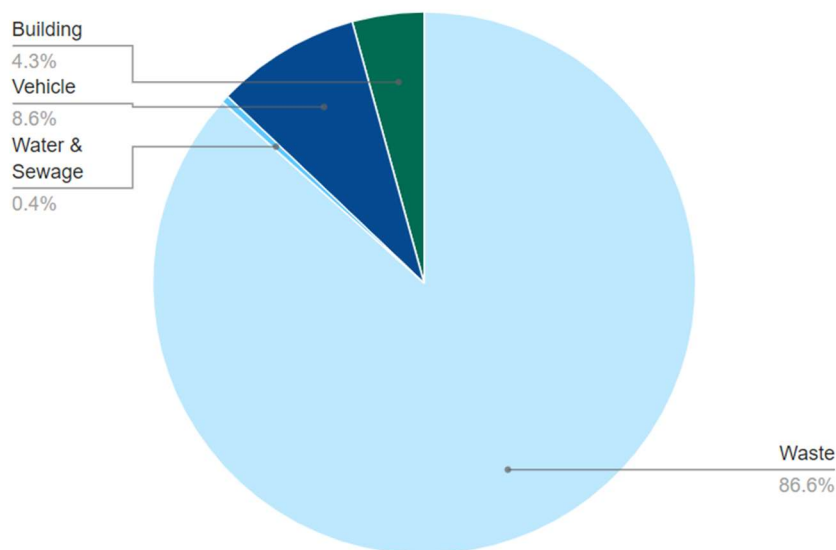


Figure 2: Corporate GHG emission (tCO₂e) profile for the Billings represented on a percentage basis.

Municipal Fleet

The transportation fuel burned by our own municipal fleet vehicles resulted in **60.67 tCO₂e** in 2018. Since some municipalities provide trucking of waste as part of their fleet services, we included emissions from this activity as well, even though in our case that service is outsourced to GFL Environmental. The municipality has hired GFL Environmental to pick up recycling from the landfill that is owned and operated by Billings. Once a week two large front-end trucks pick up cardboard and comingled recycling types (plastic, aluminum cans) and transport this recycling to Blind River. These two trucks also pick up recycling from at least half a dozen other communities on the Island as part of the same trip, therefore we have calculated Billings' share of the emissions to be 1/6 of the total, emitting **16.46 tCO₂e** in a year. The emissions from the recycling processes are currently excluded from the PCP protocol because it is assumed that the emissions associated with the recycling of our materials will be accounted for in the building emissions profile of that facility, in the municipal boundary it is located. In this case, it is assumed that the recycling facility in Blind River is responsible for reporting the emissions from our recycling in their facility.

When combined with the tCO₂e values for our own fleet, the emissions for this category add up to 77.13 tCO₂e.

Waste

Billings owns and operates an open pit landfill that has been in operation under the supervision of the Ministry of Environment, Conservation and Parks (MECP) since 1980. Residents are responsible for dropping off waste and recycling at the facility. Billings has had a recycling program in place since at least 2013 to divert cardboard, plastic, and aluminum cans from being included in the waste area of the landfill. Emissions from the recycling haulage from the landfill to Blind River is outlined in the Municipal Fleet section of this report. Like many small rural landfills in Ontario, this landfill does not have a landfill gas or leachate collection system to capture the GHG emissions from the decomposition of waste. Billings does not own or operate any closed landfills.

The GHG emissions from waste are evaluated differently than other corporate emission categories because the emissions from waste are released over the course of many years as the waste decomposes. Each

Waste is slightly different from all the other categories because the emissions from waste deposited in a landfill are released over the course of many years as the waste decomposes. There are two ways to calculate emissions from waste for a given year:

- Methane commitment model: Calculates the amount of emissions that the waste deposited within that year will produce over the course of its decomposition, assigning all future emissions to the current year, or;
- Waste-in-place/First Order Decay: Calculates the amount of emissions being released in the current year by all waste that has already accumulated in the landfill.

The methane commitment model is simpler and more frequently used by municipal owned and operated sites that have minimal staff and are required to report the approximate volume deposited in the landfill.

In this case, the first method, the methane commitment model is the most relevant as it provides a GHG emission value that is proportional to the waste that was produced in the 2018 baseline year of this report. This assumption is also reasonable because most of our actions will involve reducing the amount of total waste being produced going forward.

Each year, Billings is required to report the total amount of waste deposited into the landfill to comply with the Certificate of Approval 'CoA' issued by MECP to operate a landfill location. In 2018, the volume of waste deposited was 1576 cubic yards. This total volume is reported by inventorying the number of compacted garbage truck loads that are deposited into the landfill. The garbage truck used for compaction at the landfill does not provide curbside pick-up and operates within the boundary of the landfill site, the emissions from this truck have been included within the municipal fleet category.

Appendix A provides further detail on the calculations required to determine the amount of GHG emission potential that results from 1576 cubic yards of waste using the methane commitment model. It is noted that this GHG emission value is likely an underestimate of emissions from this volume of waste as other factors, including the open burning of garden, yard and wood waste and emissions from waste deposited at the landfill from 1980 to 2018 have not been included in the GHG inventory at this time. Recommendations for future data collection and monitoring are also available in Appendix A for consideration in future GHG inventory.

The waste landfilled in 2018 will result in 772 tCO₂e over the course of its decomposition. This value accounts for more than 80% of the corporate emissions, even though the waste deposited into the landfill is generated from the entire community. It has been included in the corporate emissions profile because the PCP protocol categorizes waste facilities that are owned and operated by a municipality as a corporate asset. Thus, to reduce emissions from our waste it must be a collaborative effort from the entire community.

Municipal Buildings

For this category we decided to include all buildings/structures with significant energy usage over which Billings administration has both ownership and some degree of operational influence. This amounted to twelve buildings, including three that are being leased out, with the leased portion of the Old Mill building being counted as a building of its own. It should be noted that the Old Church's energy use shows up as being minimal, as it has yet to return to full use. Figure 3, below, provides a visual representation of each building and the emissions associated with operating these buildings in 2018. **The electricity and propane use in these buildings resulted in 38.13 tCO₂e in 2018.** The total amount of energy used was 1026 GJ, which cost \$38,655.58 including the leased-out properties.

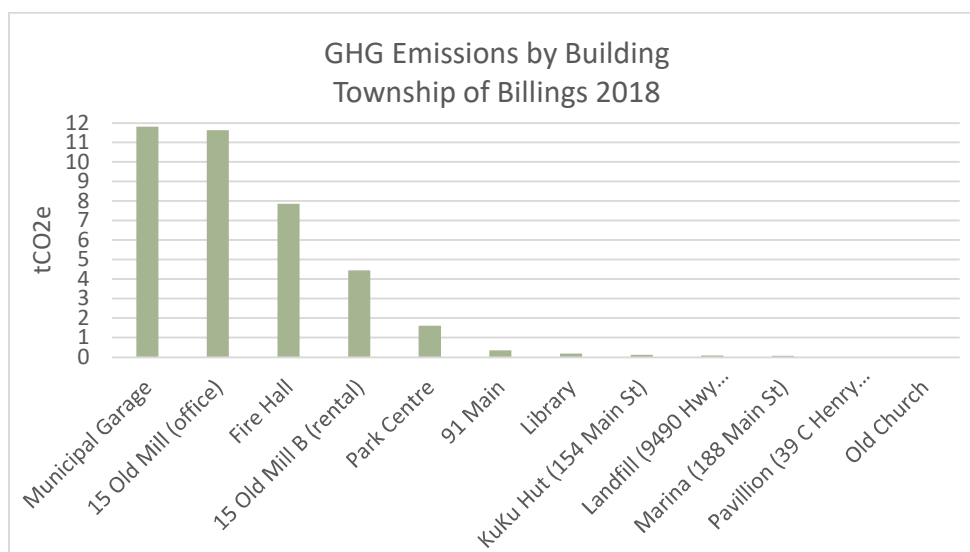


Figure 3: Breakdown of emissions generated from each municipal building in the Township of Billings

Figure 4 and 5 provide a further detailed visual representation of the propane and energy use in each building operated by the municipality.

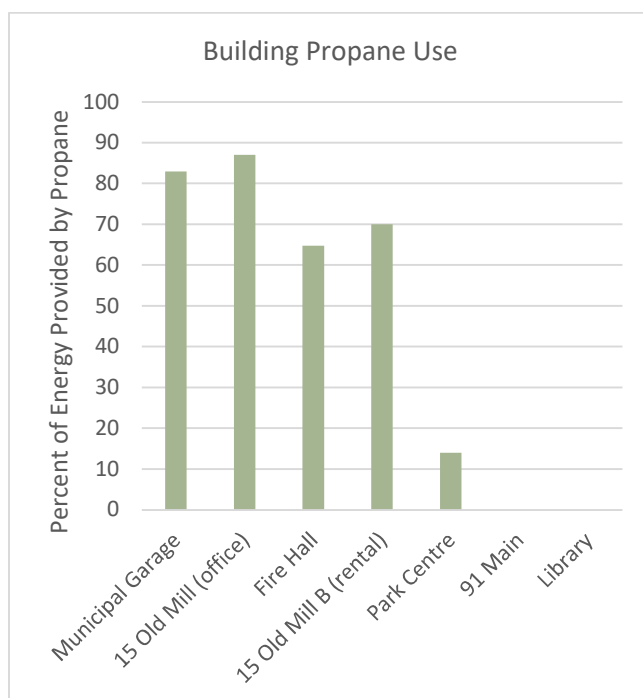


Figure 4: Reliance on propane - the amount of propane usage of each municipal building represented in percentage use

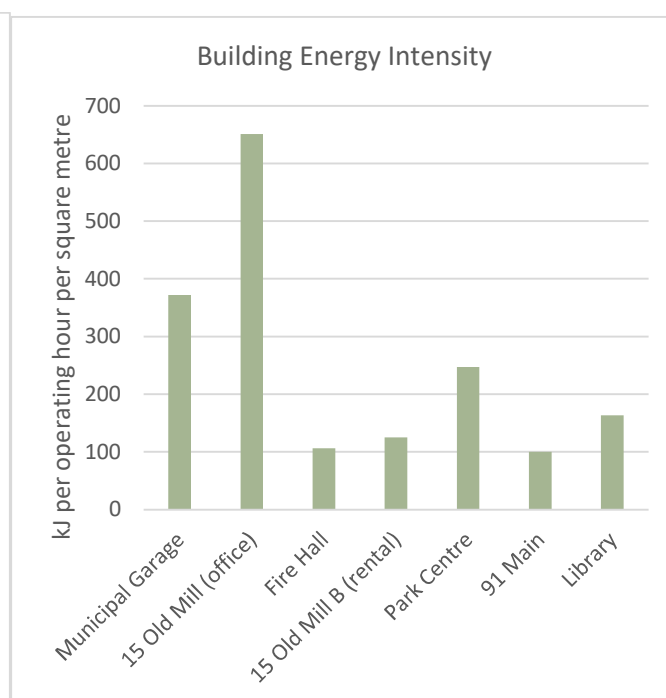


Figure 5: Energy efficiency matrix – representation of energy use per square foot for each municipal building

Low Lift Station and Water Treatment Plant

The energy required by the water treatment plant and low lift station cost the municipality \$29,537.24 in 2018 and resulted in **3.64 tCO₂e**; which is a fairly low value because the treatment plant was updated in

Streetlights

The electricity use of all streetlights was found to be 3062 kWh in 2018. **This resulted in 0.05 tCO₂e**, and cost the municipality \$7,612.10.

Community Emissions

Typically much more substantial than corporate emissions, community emissions can be subdivided into categories of building energy use (or “energy use at home and work”), transportation, land/agriculture. The only component here which includes emissions happening outside our geographic boundaries is emissions from production of electricity elsewhere if that electricity is being used here. The electricity production emissions are included so that electricity use-related emissions can be compared with the direct emissions from other home heating sources i.e. the burning of fuel oil, propane, and wood, which occurs on-site (though for these sources, production-related emissions are not included by the PCP Tool). In total, our community emissions were **14 632.93 tCO₂e** for 2018.

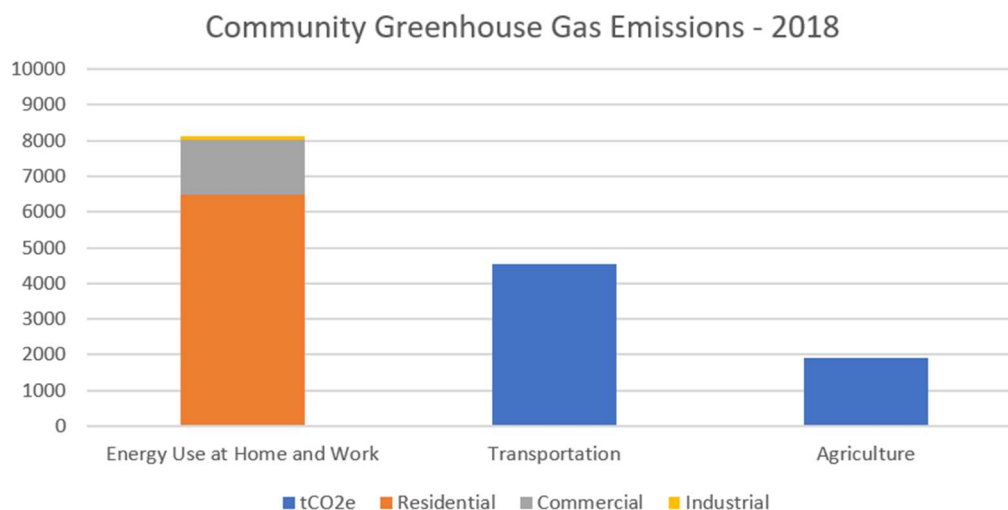


Figure 6: Summary of Community GHG emissions for Billings.

Energy Use at Home and Work

In the PCP Tool, this category is termed “Stationary Energy,” meaning energy that is used in buildings of every kind, as well as off-road farm equipment—energy that is being used in one place. In many

Ontario homes, people source their energy from electricity and/or natural gas, but with no natural gas available on the Island, our sources also include propane and fuel oil, as well as firewood—this category includes both energy for heating as well as for powering lights, appliances, etc.

Through calculations based on provincial average home energy requirements, local building age¹, estimates on how many people use which types of fuel, and District-level Hydro data, we found that in Billings approximately **81.45 tCO₂e are being annually emitted from electricity, 1014.26 tCO₂e from propane, 864.70 tCO₂e from fuel oil, and 4509.39 tCO₂e from wood, for a total of 6469.80 tCO₂e from residential energy use, attempting to include seasonal residents.**

Using the District-wide ratio of electricity use in residential vs. commercial vs. industrial vs. other sectors as a starting point, we came up with estimates resulting in **final values of 1538.39 tCO₂e for commercial, 110.49 tCO₂e for industrial, and 0.16 tCO₂e for “other”**, including estimated fuel oil and propane use in commercial and industrial sectors.

We do not have sufficient data at this time to calculate emissions from off-road farm vehicles and equipment, which would normally be included in this category. However, the National Farmers’ Union² lists fuel combustion as being among the top three sources of emissions from farms, so this should still be considered in our action plan.

Transportation

The ideal way to calculate transportation emissions is to estimate the number of kilometres travelled within the municipal boundaries by all vehicles in a given year (this is called the Vehicle Kilometres Travelled (VKT)), then to multiply this number by the amount of CO₂e that the average vehicle of average fuel type emits per kilometre. To estimate VKT, we multiplied traffic counts done for provincial highway segments³ by the length of those segments that fall within our municipal boundaries, then added to this an estimate for commuter travel on municipal roads based on commute durations as found in the Census⁴. This resulted in a total of 11 524 500 km travelled within municipal boundaries in one year. **When entered into the PCP Tool, this yields emissions of 4548.36 tCO₂e.** This number does not however account for recreational travel on municipal roads, so is very likely to be an underestimate.

We do not have sufficient data at this time to calculate emissions from off-road transportation such as snowmobiles, ATVs, and landscaping/construction equipment, though in our area this could make up a sizeable amount of emissions—typical snowmobiles are known as being extremely heavy polluters.

Agriculture

Agricultural emissions are one of the more complicated categories to calculate, and directions for doing so are not yet included in the PCP Protocol. However, since agriculture is a large part of life in Billings, we have managed to include it by following the PCP Tool’s suggestion of referencing Chapter

10 of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). This chapter divides agricultural greenhouse gas emissions into three categories: those from livestock, those from land use and land use change, and those from “aggregate sources and non-CO₂ emissions sources on land”, in other words substances that are added to the soil, as well as other actions such as harvesting of wood.

Livestock

For emissions from livestock, we focused only on cattle, getting approximate numbers for our municipality by dividing the total number of cattle in the District⁵ by our percentage of land area. These numbers for each cattle type were then multiplied by corresponding emissions factors found in Canada’s National Inventory Report (NIR). It should be noted that these emissions factors are based on average practices for each cattle type across Ontario, and due to practices likely being more sustainable on Manitoulin, the resulting numbers of **1805.53 tCO₂e** from enteric fermentation (burps) and **90.20 tCO₂e** from methane emissions from manure management may be overestimates. We were not able to get an estimate for nitrous oxide (N₂O) emissions from manure management, however, so in this sense our **total of 1895.73 tCO₂e** could be an underestimate.

For Land Use and Land Use Change

Carbon release from soils in Billings’s croplands is assumed to be zero, based on the likelihood that this soil would have lost most carbon it could lose in its early years of being tilled. No more is likely being lost on a yearly basis; however, carbon could be restored to the soil through a change in practices. The effects of grasslands, wetlands, settlements, and other land use types have not been included here.

For aggregate sources and non-CO₂ emissions sources on land

It was assumed that there is no field burning or rice production within the municipality. Only two farms in the District reported lime use in the 2016 Census, and the acreage is not reported, so we have excluded this from our inventory. We were not able to estimate the amount of nitrous oxide (N₂O) being emitted as a result of fertilizer application either. Seeing as very little land within the District has fertilizer applied to it, it is tempting to say that omitting this category is just as well. However, every bit counts when it comes to greenhouse gases, and N₂O has an extremely high Global Warming Potential—265 times that of CO₂². So, reducing fertilizer use should still be considered as a valuable action.

Harvested wood products is also included in this section of the GPC, but as we have included the burning of harvested firewood under “Energy Use at Home and Work”/Stationary Energy, we have not included it in this section. Harvesting wood to be otherwise used for construction or furniture-making etc., can act as a carbon sink, since the carbon may be stored in that format for a long time. However, we do not have data for this activity currently.

Local Carbon Sequestration

In addition to quantifying the greenhouse gas emissions occurring within our municipal boundaries, the Land Use section of the GPC also addresses carbon sequestration—the capacity of our trees, for instance, to remove some carbon from the atmosphere. We used an estimate of 50% of land in Billings being forested, combined with an estimate of carbon storage per hectare of forest taken from a study⁶ on the northern Bruce Peninsula (which has a similar tree species composition to here), to calculate an estimate of **approximately 22 069.4 tCO₂ being absorbed by the forests of Billings Township each year, although in reality, the amount that a forest absorbs changes as it ages.**

Typically, younger forests absorb carbon more quickly, since more rapid growth is occurring, while older forests have more carbon stored up on the whole. Therefore, it's possible that an absorption rate of 22 069.4 tCO₂ per year may be an overestimate when looking forward. The impact of changing climate conditions on the forest's ability to hold onto CO₂ should be considered as well. Please see Appendix C for more details on the above estimation.

Conclusion

It is important to note that some activities occurring here—or engaged in by community members when they are elsewhere—result in further emissions being produced in other parts of the world. Actions such as travelling outside of the municipality, buying goods and food that were produced outside the municipality, and even investing money indirectly in industries outside the municipality, all have a climate impact we can control. Similarly, some of the emissions occurring within the municipality are connected to consumption habits of folks who do not live here. By improving measuring, monitoring and ultimately improving the sustainability of all local activities, we can make it possible for those who source our products or visit our locations to reduce their footprints, and make it possible for local residents to reduce the portion of their footprints tied to local emissions.

Even though it turns out that within our geographic boundaries, more carbon is likely being absorbed by trees than is being emitted by human activities, that does not exempt Billings from taking climate action. Climate change is a global issue, and globally we are nowhere near being carbon neutral, let alone carbon negative, like Billings. While Billings residents are fortunate to be living in the midst of one of the world's carbon sinks, that does not make our own contribution to the global levels of greenhouse gases any less important—Canadians have some of the highest carbon footprints in the world. For example, based on a study⁸ using Canada's total GHG emissions and population it was estimated that every Canadian on average has an annual carbon footprint of 16.08 tCO₂e. Canada is regularly in the top 10 of countries in the world for average emissions per capita. In Billings, based on this GHG emissions data and population estimates in 2018 the average emissions per capita, per year is **25.33 tCO₂e**. This is of course based on permanent resident population data and if population increases by four times in the summer, the average does go down to about 10 tCO₂e but this value does not incorporate the amount of emissions seasonal residents are expending when they travel to the island, indicating that the per capita average based on permanent residents is likely a more

reasonable figure to use to evaluate our community average in comparison to the rest of Canada and the world.

Given the global context, this inventory shows that Billings has the capacity to aid the fight against climate change by both enhancing our substantial carbon sequestration capacity and by reducing our substantial carbon footprints to be closer to the Canadian average and strive for greater reductions through community lead initiatives.

Appendix A: Corporate Emissions - Data Collection and Calculations

Municipal Fleet:

The total number of litres of gasoline and diesel used by all fleet vehicles in 2018 was obtained from a previously compiled report from Green Economy North (a program of ReThink Green), for which numbers were supplied by the Deputy Clerk, who also provided the associated expenditure numbers. 5360.0 L of gasoline were used, which cost the municipality \$3740.94, and 17 583.6 L of diesel were used, which cost \$14 350.87.

To calculate fuel use required by our 1/6 share of the two large front-end trucks taking recycling to Blind River, an estimate for how much diesel fuel would be burned by each truck each trip was obtained by referencing numbers given for the large garbage pick-up truck that services Central Manitoulin, as this truck is the same size. Given that the large garbage pick-up truck for Central's commercial waste requires 190 L of diesel for each round-trip from Espanola, and Espanola is 109 km from Central Manitoulin (according to Google Maps), that means that truck used for hauling recycling from Billings is burning approximately 0.87 litres of diesel per kilometre. The recycling plant, however, is in Blind River, which is 200 km from Manitoulin Island (using the centralized location point on Google Maps, used since this service is shared with other communities), so for a round-trip it can be assumed that the large recycling trucks each burn 348 L of diesel. Multiplied by two trucks and 52 weeks and divided by six to get our share, that means that for Billings' recycling pick-up from the dump, approximately 6032 L of diesel are burned in a year.

Waste:

Per discussion above the methane commitment model was selected to calculate the emissions resulting from 1576 cubic yards of waste deposited in 2018. The application of this method usually requires a waste audit to be completed to convert the volume of waste into units of weight. Since Billings has not performed a waste audit, the following average values from the PCP Protocol were used to complete the estimated emissions resulting from the volume of waste deposited, mainly:

Conversion of cubic yards to cubic meters:

$$1576 \text{ y}^3 \times 0.764555 = 1205 \text{ m}^3$$

PCP Protocol assumptions:

Average density of household waste: 481kg/m³

1 tonne = 1000kg

Mass (weight) = (Density x Volume)/1000 to convert to tonnes = (1205 m³ x 481kg/m³)/1000 = 576t

Degradable Organic Compound:

Waste Composition		% Comp	DOC	DOC for Billings waste
Food		0.4	0.15	0.06
Garden		0	0.2	0
Paper		0.2	0.4	0.08
Wood Products		0.06	0.43	0.0258
Textiles		0.04	0.24	0.0096
Plastics, other inert		0.3	0.15	0.045
			DOC Total	0.2204

DOC values used are from page 26 of PCP Protocol but Food was changed from 35% to 40% and paper, plastics and other inert waste was reduced slightly because Billings has a recycling program. We can assume, however, that some paper and plastics are still in the waste stream despite a recycling program being in place.

Methane Generation Potential, using DOC for Billings waste (Page 26 – PCP Protocol):

Therefore, the following calculation can be applied to calculate emissions:

$$CO_2e = 21 \cdot M \cdot L_0 (1 - f_{rec})(1 - OX)$$

M = Mass = 576t

$L_0 = 0.0705$

$F_{rec} = 0$ (Fraction of emissions recovered at landfill is zero because Billings does not have a LFG collection system)

OX = Oxidation Factor = is generally 0.1 for well-managed landfills

$$tCO_2e = 21 \times 576t \times 0.0705(1-0)(1-0.1) = 772$$

Municipal Buildings:

The electricity and propane use for the seven major buildings was obtained from an in-house excel spreadsheet showing energy use bill amounts back to 2011. Since 2018 is our inventory year, only the numbers from that year were totaled up; where a given billing period spanned across different calendar years, the bill was allotted to year according to its end date. Energy use for the remaining five buildings/structures was obtained directly from the bills. Operating hours and floor area were obtained from the BPS Reporting chart (2017) for the seven major buildings; these numbers however have not been updated in many years, over which hours of use may have changed.

Water and Sewage Treatment:

The amount of electricity and propane used by the water pump and treatment plant was also obtained from the excel spreadsheet of energy bill amounts, and was inputted into the PCP Tool. The

amount of water processed (118 478 100 L) was also entered into the tool for reference, having been obtained from the year-end report.

Streetlights:

The electricity use of all streetlights was added up from our hydro bills.

Appendix B: Community Emissions - Data Collection and Calculations

Energy Use at Home and Work:

Propane and fuel oil usage numbers are not readily available from suppliers, and Hydro One is not able to provide data delineated by municipal boundaries. Instead, we made use of a tool developed by ReThink Green (a non-profit based in Sudbury) that allows communities to carefully estimate residential usage of electricity, propane, fuel oil, and wood using provincial per home energy requirements, filtered through the age of buildings in this area, and multiplied of course by our number of dwellings (a video explaining this tool should be available at <http://www.smartgreencommunities.ca/resources/>), with data having been sourced from Natural Resources Canada and the National Inventory Report. Using this tool also requires a breakdown of how many houses use which heating source, for which we are temporarily using an estimate of 25% each between electricity, propane, fuel oil, and wood.

Residential:

To find out the age and number of dwellings built in this area, we referenced the 2016 Census¹, as recommended by ReThink Green. Running this and the aforementioned information through the ReThink Green excel tool resulted in finding out that Billings residents use a total of 224 152 L of fuel oil, 1 783 698 kWh electricity, 405 547 L of propane, and 856 151 kg of wood to heat their houses. They also use approximately 1 579 790 kWh electricity for non-heating needs such as running appliances, etc. The ReThink Green tool assumes a breakdown of 95% of non-heating energy use being supplied by electricity and 5% by natural gas, but since we have no natural gas, we have assumed that this 5% is instead supplied by propane. This would then amount to 1596 GJ of propane, or approximately 62 499 L of propane, since the ReThink Green tool lists 39.16 L of propane as being required to generate one GJ worth of energy. The PCP Tool asks for residential energy use all inputted in one category for each energy source however, so we inputted 224 152 L fuel oil, 3 363 488 kWh electricity, and 468 046 L propane. The PCP Tool does not have an emissions factor for wood, so we used the ReThink Green tool's calculation for emissions from this source instead.

The PCP Tool says that this resulted in 58.18 tCO₂e from electricity, 724.47 tCO₂e from propane, and 617.64 tCO₂e from fuel oil. We used ReThink Green's calculation for wood, which was 1820.70 tCO₂e —this could then be added directly to the PCP Tool through option 2 “set total emissions”. Our total residential energy use emissions from this stage of calculations are therefore 3220.99 tCO₂e.

However, these emissions only reflect the energy use of year-round residents, as the housing data came from Census Canada, which only reports on year-round dwellings. Actual hydro usage data from Hydro One for all postal codes in Manitoulin District, when divided by the percentage of the District's

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Amendments: K. Neale July 14, 2020

year-round population that resides within Billings, yielded a higher number than ReThink Green's—this may be due to the fact that this actual-use data would include energy use by seasonal residents. In order to attempt to incorporate seasonal residents into our estimates, we have multiplied all of the residential energy emissions calculated above by the ratio by which the Hydro One data departs from the electricity use number estimated in the tool from ReThink Green. With Hydro One reporting District-wide residential electricity use as being 103 185 830 kWh in 2018, and Billings' population being 4.55% of the entire District's (according to the Census), this results in a Hydro-based estimate of 4 694 955.26 kWh residential electricity use. This is approximately 1.40 times the ReThink Green estimate of 3 363 488 kWh electricity, so we will multiply all emissions results by 1.40, including those coming from fuel oil, propane, and wood. What this estimate doesn't account for is a potential difference in the energy use mix between summer and winter—if some energy is being used for cooling dwellings during the summer as opposed to heating, then it is likely that summer energy use is more electricity-based. Therefore the emissions could be slightly lower than what is estimated.

Commercial, Industrial, and Other:

In order to get estimates for commercial and industrial energy use, we turned again to the electricity use data provided by Hydro One by postal code. Unfortunately we do not have any fuel oil, propane, or wood data for these commercial or industrial categories, but will assume that fuel oil and propane are used in the same proportion as they are in the residential sector. Hydro One was able to give us the electricity used by residential, commercial, industrial, and "other" categories for each postal code within Manitoulin District, for the year of 2018. The total electricity use was 103 185 830 kWh for residential, 59 533 652 kWh for commercial, 618 314 kWh for industrial, and 207 147 kWh for "other". Assuming that all communities across the District have the same residential electricity use per person, this would amount to about 4 694 955.26 kWh residential electricity being used in Billings, as shown above. We will use the ratio between this and the commercial, industrial, and "other" categories for the District to estimate Billings-specific numbers for those categories. For the District, commercial electricity use is 57.5% that of residential, industrial electricity use is 0.6% that of residential, and "other" is 0.2% that of residential. When applied to Billings's residential use—assuming that commercial, industrial, and other uses are distributed across the District in proportion to population—this would result in 2 699 599.28 kWh of commercial electricity use, 28 169.73 kWh industrial electricity use, and 9389.91 kWh "other" electricity use. We are going to assume that these sectors have the same breakdown of electricity compared to other fuel sources as the residential sector does, with the exception of wood—that will be dealt with later. For the residential sector, the ratio from our entries to the ReThink Green tool was 1 kWh electricity: 0.14L propane: 0.07L fuel oil: 0.26kg wood. So commercial use would be 2 699 599.28 kWh electricity, 377 943.90 L of propane, 188 971.95 L of fuel oil, and 701 895.81 kg wood. For industrial, those numbers are: 28 169.73 kWh electricity use, 3943.76 L propane, 1971.88 L fuel oil, and 7324.13 kg wood. Since the "other" category comprises Hydro-specific power uses we will only enter a value for electricity: 9389.91 kWh. As done in the previous section, we used the PCP Tool to calculate resulting emissions for all fuel types except for wood. This resulted in 1153.79 tCO₂e from commercial, 82.87 tCO₂e from industrial, and 0.16 tCO₂e from "other". We do not have an easy way of inputting the wood values into the ReThink Green tool, as that was designed for residential emissions, and as we are not confident wood

is readily used by commercial and industrial sectors to the same extent it is in the residential sector, we have multiplied the emissions from these sectors by 4/3 to approximate the electricity, fuel oil, and propane taking the place of wood.

Transportation:

As it was not feasible to do our own traffic counts for all road segments within the municipality, we instead used traffic counts that had been done in 2016 by the Ontario Ministry of Transportation³ on provincial highways, and isolated the information pertaining to the segments of provincial highway within our boundaries. These traffic counts were then multiplied by road lengths of the associated highway segments, or rather the portion of them falling within our municipal boundaries, taken as rough measurements on our GIS files provided by the Manitoulin Planning Board. These numbers were then added together and multiplied by 365 since the traffic counts represent the average two-way traffic passing through that stretch of road on one average day. In Billings, this worked out to 11 014 970 km being travelled on provincial highways within our boundaries in a year.

Since no traffic counts were available for our municipally managed roads, and roads classifications were not precise enough, we decided to base the estimate for VKT on municipal roads on commuting habits as documented by Statistics Canada. In the 2016 Census⁴, the number of Billings residents who commute to a regular work location is recorded, along with the time durations and transit modes of their commutes. Since thirty people are documented as travelling less than fifteen minutes, and thirty people are also said to travel by bike, foot, or as a passenger, we assumed those were the same thirty people, and thus did not count them in terms of emissions.

This left 145 residents regularly commuting to work by driving a vehicle, with their commutes taking more than fifteen minutes. To figure out what portion of each of their commutes took place on municipal roads as opposed to provincial highways—which already would be counted in the traffic count-based estimates—we estimated how long it takes to travel to the highway from the median residential distance away from the highway. By referencing our GIS map, we found that the residential point furthest away from the provincial highway was 14 km away (Maple Point), so we then divided that by two to get a median distance-from-highway of 7 km. We then assumed that for these 145 commuters, they each have to travel 7 km on municipal roads to get from their house to the highway each morning. (Since our roads are fairly highspeed, and you can travel 20 km in fifteen minutes at 80 km/hr, that 7 km would easily fit within their commute; we assume the rest of their commute is on the highway). There were 251 workdays in 2016, so with 145 people travelling 7 km both to and from work on municipal roads each of those days, this amounts to 509 530 km of commuter travel on municipal roads. It's possible the commuter travel is slightly overestimated since the 7 km is a median, not an average, but seeing as this estimate does not include traffic from residents of other areas travelling into Billings for work, or for any recreational travel at all, it probably is an underestimate overall. When this is combined with our previous number for provincial highways, we end up with a total of 11 524 500 km travelled within municipal boundaries in one year.

Agriculture:

Livestock:

Livestock numbers for Manitoulin District were obtained from Statistics Canada for 2016⁵. The percentage of land in the District that falls within Billings' boundaries was calculated from land areas as listed on Wikipedia: 209.64 sq km / 3107.13 sq km = approximately 0.0675, so Billings comprises 6.75% of land within the District. The resulting estimates for cattle numbers within Billings can be found in an internal spreadsheet.

For methane emissions from enteric fermentation, the estimated number of cattle in each category was multiplied by the corresponding emissions factors for 2016 provided on page 233 of Part 2 of the NIR, and divided by 1000 as per the equation in the GPC. To convert the amount of methane emitted to CO₂e, we multiplied by 25, as this is the Global Warming Potential for methane most recently used by the PCP program. The same process was repeated for methane emissions from manure management, using a separate set of corresponding emissions factors for each cattle type for this category, found on page 92 of Part 2 of the NIR.

The NIR is not able to provide country-specific emissions factors for nitrous oxide (N₂O) from manure management, let alone provincial ones, and to use international emissions factors seemed too inaccurate. We excluded this category from our inventory.

Land Use and Land Use Change:

The GPC refers readers to their national inventory reporting bodies, among other sources, as a source for numbers on this, and Part 2 of Canada's NIR refers us on pg 241 to Annex 3.5.4, which assumes that if cropland is remaining cropland, and has not seen any change in soil management practices, then its carbon stock change has probably already reached equilibrium.

Aggregates:

Our best bet at estimating the amount of nitrous oxide (N₂O) being emitted as a result of fertilizer application would be to estimate how much fertilizer is applied based on the number of square kilometres to which fertilizer, etc., is applied, according to data from OMAFRA. However, the number of square kilometres to which fertilizer is applied in Manitoulin District is so small that this calculation could be a privacy issue, and furthermore emissions factors and input data are not readily available for this category.

Appendix C: Carbon Sequestration - Data Collection and Calculations

For forest land, Annex 3.5.2 of Part 2 of the NIR describes how Canada's carbon stock change was calculated using a model developed by Kurz et al. 2009, called Version 3 of CBM-CFS3. This model could potentially be used to estimate the current and future carbon storage potential of the forests within the municipality. However, this requires information on the growth pattern of forest stands which we do not currently have available.

Instead, we have made an estimate based on a study done on the forests of the northern Bruce Peninsula. As Manitoulin Island has a similar tree species composition to forests in the northern

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Bruce, this estimate should hold fairly true. The study used three different models for estimating the amount of carbon stored in the northern Bruce's trees (more precisely, in Eco-district 6E14). The average result for the amount of carbon stored in the region's forests was 11 492 047 tCO₂, which is equal to 231.6 tCO₂ per hectare of forest⁶. To find out how many hectares of forest there are within Billings, we looked at Google Maps satellite, and decided on a rough, conservative estimate of 50% of land being forested. Since Billings Township covers 209.64 square kilometres (Wikipedia), which equals 20 964 hectares, this would amount to 2 427 631.2 tCO₂ being stored in Billings forests. In order to approximate how much carbon is added to that store every year, we need to know how old the forests are. For the Bruce Peninsula, another source⁷ states that most of the forest stands date from either the early 1900s or the 1920s, as regrowth following fires, logging, and farm abandonment. Assuming that the forests of Manitoulin Island have a similar recent history, we used an average age of 110 years, dividing the total amount of carbon accumulated over time (as estimated above) by that number.

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1: Statistics Canada. (2017). Billings, TP [Census subdivision], Ontario and Manitoulin, DIS [Census division], Ontario (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Retrieved from <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3551021&Geo2=CD&Code2=3551&SearchText=Billings&SearchType=Contains&SearchPR=01&B1=Housing&TABID=1&type=0>

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- 5: Statistics Canada. Table 32-10-0424-01 Cattle and calves on census day. Retrieved from <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210042401&pickMembers%5B0%5D=1.1337>

- 6: Puric-Mladenovic, D., Gleeson, J., and Nielsen, G. (2016). Estimating carbon storage in Southern Ontario forests at regional and stand levels. *Ministry of Natural Resources and Forestry: Climate Change Research Note Number 12*.

- 7: Forests. (n.d.). Community conservation and stewardship plan: Chapter 3: Biodiversity features. Retrieved from <http://www.bpba.ca/bpcsp/uploads/CH3Forests140518.pdf>

- 8: GHG Emissions per capita <https://knoema.com/atlas/Canada/CO2-emissions-per-capita#:~:text=In%202018%2C%20CO2%20emissions%20per,16.08%20metric%20tons%20in%202018>

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