The Town of Hamilton, NY
2015 Community Greenhouse Gas Inventory

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Executive Summary

The following report is a community greenhouse gas (GHG) inventory of the Town of Hamilton, NY. The report was prepared by six students from the Fall 2017 section of ENST 390: Community-based Study of Environmental Issues with help from Assistant Professor of Environmental Studies Andrew Pattison and several community partners (see Acknowledgements section). The document begins with introductory information about GHG inventories in general and the boundaries of this inventory (Sections 2 and 3). Section 4 gives a step-by-step analysis of each sector that contributes to the community's GHG emissions, outlining the sector, data sources, methodologies, and results. Sectors include Stationary Energy in the Built Environment, Product Use, Transportation, Solid Waste Management, Wastewater, and Livestock.

Combining emissions from all sectors gives a rough estimate of 33,804 metric tons of carbon dioxide equivalents (MTCO2e), the unit of measure used for GHG inventories. Transportation makes up the largest percentage of emissions from the Town of Hamilton. The report concludes with a series of recommendations for various sectors where the authors see plausible room for improvement.

Introductions

Climate Smart Communities Program Overview

The Climate Smart Communities (CSC) Program is a New York State program launched in 2009 (New York State Department of Environmental Conservation, 2014, p.I-6). The goal of the program is to assist communities in New York State (NYS) at reducing their GHG emissions and preparing for the effects of climate change. To become a CSC, a community must adopt a 10-element pledge outlined by the program (New York State Department of Environmental Conservation, 2014; p. I-10). The pledge elements are as follows:

1. Pledge to be a Climate Smart Community
2. Set goals, inventory emissions, plan for climate action
3. Decrease community energy use
4. Increase community use of renewable energy
5. Realize benefits of recycling and other climate-smart solid waste management practices
6. Reduce greenhouse gas emissions through use of climate-smart land-use tools
7. Enhance community resilience and prepare for the effects of climate change
8. Support development of a green innovation economy
9. Inform and inspire the public
10. Commit to an evolving process of climate action

The Town of Hamilton is participating in the CSC program which can offer financial benefits and encourage sustainable practices within the community. For example, the CSC grant program, which has been available through the 2016 and 2017 New York State Consolidated Funding Application (CFA) and is expected to be available in future years, provides 50/50 matching grants to counties, cities, towns and villages of the State of New York for eligible climate adaptation and mitigation projects. Designed around the pledge elements above, the CSC Certification Program also recognizes communities for their accomplishments through a rating system leading to three levels of award: Bronze, Silver, and Gold. The creation of this community inventory falls under pledge element #2, in tandem with the Town of Hamilton's municipal GHG inventory, which was completed in Spring 2017. In addition to participating in the CSC program, thus far, the Town of Hamilton has received Clean Energy Community designation from NYSERDA. Due to overlap between the CSC and Clean Energy Communities (CEC) program, Hamilton has been able to score points for both programs. Through CEC, the Town of Hamilton has reserved a $50,000 grant for an additional clean energy project.

The purpose of this inventory is twofold: 1) to produce a baseline set of data and results from which to set actionable emissions reduction goals, and comparatively measure the progress of these efforts in the future, and 2) to serve the Town of Hamilton in its objective to satisfy the New York State guidelines for designation as a Climate Smart Community. This report is meant to provide comprehensive and rigorous data and viable recommendations. These recommendations are vital in Hamilton's next step to create a climate action plan which will ultimately assist the Town's effort to achieve certification for New York State climate programs and grants, as stated above.

Greenhouse Gas Inventory Framework

A greenhouse gas (GHG) inventory is an analysis of the types and quantities of GHG emissions sources released within an established boundary. Completing an inventory allows for the development of baseline emissions for a specific year, which will be used to set emissions reduction goals that will provide the greatest return on investment in terms of economic, social and environmental priorities. The baseline year for this inventory is 2015. However, in reality, much of the data is based on the 2010 census for the Town of Hamilton. Updated numbers may be available with the 2020 census.

Inventories can be specific to either municipal or community activities. Municipal GHG inventories encompass the emissions associated with the activities of local government operations, while community GHG inventories include emissions from residential and commercial activities within the Town of Hamilton's boundaries that are not specifically related to municipal operations. This is a community greenhouse gas inventory report that will analyze the emissions using the Town of Hamilton as a boundary.

To compile a community GHG inventory, emission sources must be identified, quantified and in some cases converted into CO_2 equivalents based on their potency. Conversion can be done using accepted emissions factors found in the Climate Smart Communities Community and Regional GHG Inventory Guide and other reliable sources. To complete this inventory we have followed the guidance of the CSC Guide from 2015 (NYSERDA Communities Team, 2015). This guide was chosen specifically because of Hamilton's pledge to be a CSC.

Geographic Boundaries and Spatial Components

This community greenhouse gas inventory is being conducted for the Town of Hamilton. Though nested within the Town of Hamilton, the Villages of Hamilton and Earlville are politically and jurisdictionally separate from the town. Given the availability of data at the county level and the desire to not require duplication of work, this inventory includes the population of the entire Town of Hamilton, which is to say it includes the activities (e.g. driving habits and home and commercial energy use) within the Villages and hamlets including Colgate University.[1] The Town of Hamilton covers 41.4 square miles and is home to 6,690 residents, as of the 2010 census.

Inventory Guidance and Decisions Made

This guide follows closely the protocol outlined by the Climate Smart Communities New York Community and Regional GHG Inventory Guidance document, which is frequently referred to in this inventory as the CSC Guide (NYSERDA Communities Team, 2015). This guide pulls many of its methods from the ICLEI protocol from 2012.

[1] According to the CSC Certification requirements, "A municipality may not earn Climate Smart Communities (CSC) certification points for an inventory that covers only the county or region within which the municipality is located; the municipality must submit an inventory that corresponds with its municipal boundaries."

Due to limited time and resource constraints, information from the 2013 Madison County Greenhouse Gas Inventory was used and scaled down to the Town of Hamilton where more specific data for the Town was not available. The Madison County GHG Inventory includes both municipal and community emissions but since this inventory is only for the community, county-level municipal emissions were ignored.

According to the 2010 census, the population of Madison County was 73,442 (Data Access and Dissemination System, 2010). In the same year, the Town of Hamilton's population was 6,690. Hamilton's population represents 9.11% of the population of Madison County. As a result, where no specific data for Hamilton exists, this inventory scaled the emissions from Madison County down by that percentage. Emissions calculations for which this method was used are clearly noted in the document. The phrase "Hamilton Scaling Percentage" refers to using 9.11% as a faction to scale down county-wide emissions.

Classifying Emissions

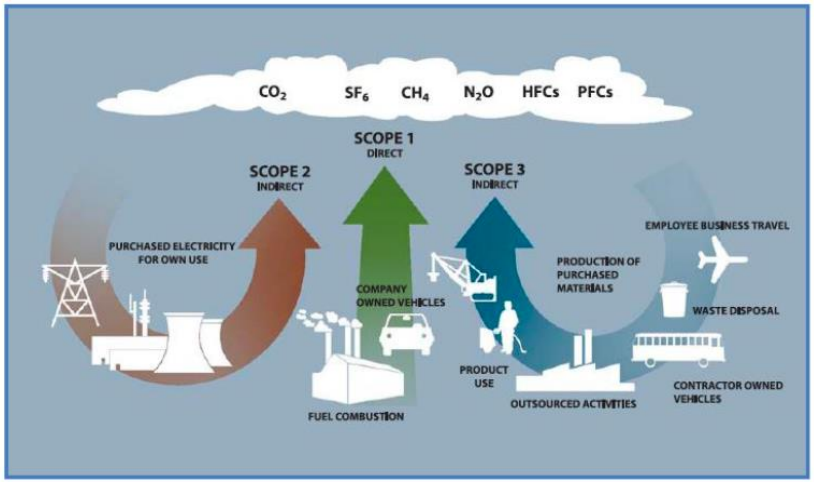
Mitigating greenhouse gas emissions and adapting to climate changes are complementary strategies for reducing and managing the risks of climate change over time. This greenhouse gas inventory establishes an identification of emission sources and greenhouse gases that should be measured and reported to a standard of relevance, completeness, consistency, transparency, and accuracy for the community. The community inventory includes emissions generated by all residences and businesses that are within the Town of Hamilton's boundary.

Scopes of Emissions: Direct and Indirect Emissions

Direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity. Indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity.

Scopes separate greenhouse gas emissions into direct and indirect emissions. Refer to Figure 1 below for a visual overview of scopes and emissions sources.

Figure 1. Overview of scopes and emission sources. Source: WRI/ WBCSD GHG Protocol Corporate Standard Chapter 4 (2004)



To help delineate direct and indirect emission sources, improve transparency, and provide utility for different types of organizations and different types of climate policies and business goals, three scopes (Scope 1, Scope 2, and Scope 3) are defined for GHG accounting and reporting purposes.

Scope 1 emissions come from sources that are directly controlled by the reporting entity (such as burning fuel oil or gasoline) and occur within the boundary of the municipality. In the community GHG inventory, Scope 1 emissions are all direct GHG emissions that result from the combustion of transportation fuels (e.g., diesel or gasoline) in vehicles and heating fuels (e.g., fuel oil, propane, natural gas, or biomass) used in residences, commercial, or industrial facilities.

Scope 2 emissions are indirect emissions that occur due to actions taken within a municipality and associated with the consumption of purchased or acquired electricity, steam, heating, or cooling by the community. Examples would include emissions from electricity produced at a power plant outside of the municipality but used in the municipality.

Scope 3 emissions are all other indirect emissions not covered in Scope 2. As an example, emissions resulting from the generation and management of solid waste from the community is included in Scope 3 emissions in this inventory because the municipality disposes of the waste in a landfill located outside of the municipality. Additional examples of scope 3 emissions are outsourced activities.

In addition to categorizing GHG emissions by scope, this inventory examines emissions by sector and source. The community-wide approach is for entities that want to understand the GHG emissions of their community as a whole, which does not include local government operations in the case of the Town of Hamilton Community GHG inventory. This community inventory allows elected members within the community to implement projects to engage the overall community or adopt a policy to affect change within the community itself (Hart, J., 2013).

Data Collection of GHG Emissions by Sector

Stationary Energy in the Built Environment

This section accounts for Scope 1 emissions from heating sources such as fuel oil, propane, natural gas, and wood, as well as Scope 2 emissions from electricity consumption. Residential energy consumption, as well as commercial/institutional energy consumption, are also distinguished in this section. The CSC Community Inventory Guide and the ICLEI U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (2012a) provide a protocol for how to measure energy consumption from residential and commercial sectors (NYSERDA Communities Team, 2015, pp.15-26).

Data and Methods

Obtaining direct consumption data is the most accurate method for determining residential and commercial/institutional data and corresponding emissions. Fortunately, this data was available in some cases. For example, electricity consumption in the Village of Hamilton (including Colgate University) as well as heat energy used in Colgate University's central heating plant. However, it is most often the case that direct consumption data is not available at the community level. This is especially true for fuels such as fuel oil or propane that are delivered to hundreds if not thousands of residential or commercial tanks by various providers. An accepted and common alternative method to obtain this kind of data is to downscale existing state or county data for both residential and commercial/institutional consumption. While direct consumption data were used where available, this inventory also had to downscale state and county data when necessary.

Scope 1: Heat Energy (biomass, natural gas, fuel oil, and propane)

Biomass (wood, wood chips, or pellets) Emissions

Burning wood – in the form of logs, wood chips, or pellets – for energy releases stored carbon into the atmosphere. However, according to the international protocol specified in the GHG Protocol guidelines, this carbon does not add to the Town's greenhouse gas footprint or contribute to anthropogenic climate change. Carbon released from combusting wood chips is on the natural and short carbon cycle and would eventually cycle back into the atmosphere through death and decomposition. The current protocol suggests that we track emissions associated with the Town's combustion of wood for energy, but report these emissions separately from the rest of the Town's emissions (Table 1).

Table 1. Town of Hamilton residential and commercial biomass emissions (2015)

	Residential		Commercial		Total GHG Emissions
	Town of Hamilton	Village of Hamilton	Town of Hamilton	Colgate University	MTCO2e
Units	MMBtu	MMBtu	MMBtu	Tons	
Consumption	24,114	Incl in Town	8,562	21,287	
Emissions Factor	0.009110021	0.009110021	0.009110021	1.78351514	
Total Emissions (MTCO2e)	221	Incl in Town	78	37,966	38,264

Residential Emissions

Direct heat energy consumption was not available for the residents within the Town of Hamilton (including the Village). Therefore, we followed the ICLEI protocol outlined in Appendix E to calculate emissions for residential fuel usage (2012b). Information was obtained from the U.S. Energy Information Administration. Emissions for coal, geothermal, and solar were excluded from this inventory because they are not used or because of lack of adequate data. Additionally, electricity

emissions associated with home heating were excluded from this set of emissions because it was impossible to disaggregate this data and they are accounted for in Scope 2 emissions (below).

EIA State Energy Data System and American Community Survey (ACS) data from 2010 was used to calculate household emissions from residential fuel oil, LPG, and wood. New York State data from EIA was compared to home heating fuel for the state as provided in the ACS to calculate fuel oil, LPG, and wood use per household. The per-household figures were then multiplied by the number of households within the Town using each fuel according to the ACS. According to ACS, the number of households in the Town of Hamilton was 1,753 for the years 2012-2016. Total fuel use within the Town of Hamilton was then converted to MTCO2e by multiplying the emissions factor for each fuel. Fuel oil use was calculated to be 41,297 MMBtu (3,074 MTCO2e) and LPG use was calculated to be 16,544 MMBtu (1,052 MTCO2e) for a total of 4,126 tons of emissions (Table 2).

Table 2. FY 2015 Town of Hamilton residential heat energy consumption and emissions

Fuel Type	Fuel Oil #2	Propane (LPG)
Units	MMBtu	MMBtu
Consumption	41,297	16,544
Emissions Factor	0.074429072	0.063527020
Total Emissions (MTCO2e)	3,074	1,052

Commercial/Institutional Emissions

Direct heat energy consumption for activities within the Town was available for Colgate University only. In order to estimate consumption and emissions from other commercial activities in the Town, we used the EIA State Energy Data System and American Community Survey (ACS) data from 2010 to calculate commercial emissions from residential fuel oil, LPG, and wood. New York State data from EIA showed an average of 5.4 square feet of commercial floor space per worker in 2010. Multiplying this figure by the number of non-agricultural workers in the Town of Hamilton (2,691) provided by the ACS results in 14,531 square feet of commercial floor space in the Town of Hamilton. It was then assumed that the percentage of commercial floor space in the Town that uses each heating fuel is the same as the percentage of residential homes using each heating fuel. These percentages were multiplied by the total commercial floor space in the Town to yield the total square footage of floor space in the Town of Hamilton using each heating fuel. These figures were compared to EIA data for New York State to calculate the square footage of commercial floor space heated by each fuel as a percentage of the New York State total. These percentages were then multiplied by the total New York State commercial consumption data for each fuel to calculate the amount (MMBtu) of each fuel used within the Town of Hamilton. Total fuel use within the Town of Hamilton was then converted to MTCO2e by multiplying by the emissions factor for each fuel. Fuel oil use was calculated to be 23,996 MMBtu (1,786 MTCO2e) and LPG use was calculated to be 5,903 MMBtu (375 MTCO2e) for a total of 2,161 tons of emissions (Table 3).

Table 3. FY 2015 Town of Hamilton commercial heat energy consumption and emissions

Fuel Type	Fuel Oil #2	Propane (LPG)
Units	MMBtu	MMBtu
Consumption	23,996	5,903
Emissions Factor	0.074429072	0.063527020
Total Emissions (MTCO2e)	1,786	375

In 2015, in addition to wood chips (above), Colgate University also consumed natural gas, fuel oil #2, kerosene, and propane to heat its campus buildings (Table 4).

Table 4. FY 2015 Colgate University heat energy consumption and emissions

Fuel Type	Natural Gas	Fuel Oil #2	Kerosene	Propane
Units	MMBtu	Gallons	Gallons	Gallons
Consumption	61,329	245,859	3,439	34,141
Emissions Factor	0.053166722	0.010313450	0.010313450	0.005257712
Total Emissions (MTCO2e)	3,261	2,536	35	180

Scope 2: Electricity

Residential Emissions

Direct electricity consumption was available for the residents within the Town of Hamilton (including the Village). However, the supply of electricity is different for the Town than it is for the Village. The Town's electricity is supplied by NYSEG and the Village operates its own municipal electric utility. Therefore, emissions associated with consumption of electricity in the Town is different from the emissions within the Village.

The emissions factor for the Town of Hamilton's electric grid comes from the eGrid NYUP CO2e Emission Factor (note that 2014 v2 is the most up to date) and is 367.6 lb/MWh." (Klebanoff, Enberg, Schick, & Moroney, 2017). The emissions factor was divided by 2.2 to convert from pounds to kilograms and then multiplied by the total MWh of electricity for residential usage, separately. These totals came from the Updated Hamilton Community Energy Consumption Trend Report for 2016 (Climate Action Associates LLC., 2017). Once the emissions totals for residential usage were calculated, the numbers were each divided by 1,000 to convert kg CO2 to MTCO2e. In 2015, residents in the Town of Hamilton (excluding the Village) consumed 6,408 MWh of electricity that resulted in 1,071 tons of emissions.

FY 2015 Town of Hamilton Residential Electricity Calculations (NYSEG)
kg CO2e = emissions factor x lbs to kg conversion x megawatt hours of electricity used in the Town of Hamilton

kg CO2e = 367.6 lb/MWh x (1kg/2.2lb) x 6,408 MWh
kg CO2e = 1,070,735.25 kg

1,070,735.25 kg/1000 kg = 1,070.74 MTCO2e

The emissions factor for the Village of Hamilton's electric grid needs to be calculated by knowing the sources of electric generation that feed the Village's grid. In 2015, the vast majority (84 percent) of the Village's electricity was produced directly from large-scale hydroelectric power mainly from Niagara Falls. The remaining electricity (16 percent) was produced from the Upstate New York grid and comes from a mix of sources, including nuclear, wind, coal, and other fossil fuels. The Village's emissions factor in 2015 was 0.0000596931 MTCO2e/kWh. This low emissions factor is based on the large amount of hydroelectric, nuclear, and wind power that makes up the Village's electricity mix. The result is comparatively low emissions per kWh consumed when compared to residents who live in the Town who purchase their electricity from NYSEG. In 2015, residents in the Village of Hamilton (excluding Colgate University) consumed 40,631 MWh[2] of electricity that resulted in 2,425 tons of emissions.

FY 2015 Village of Hamilton Residential Electricity Calculations (Village Municipal Electric)
Electricity consumption (kWh) x emissions factor (MTCO2e/kWh) = MTCO2e
40,630,836 kWh x 0.0000596931 MTCO2e/kWh = 2,425 MTCO2e

Commercial Emissions

Direct commercial electricity consumption was available for the Town of Hamilton (excluding the Village and Colgate University) from the Updated Hamilton Community Energy Consumption Trend Report for 2016 (Climate Action Associates LLC., 2017). In 2015, commercial electricity consumption in the Town of Hamilton was 525.1 MWh that resulted in 87.74 tons of emissions (Table 5).

FY 2015 Town of Hamilton Commercial Electricity Calculations (NYSEG)
(367.6lb) x (1kg/2.2lb) = 167.09 kg
(167.09 kg/MWh) x (525.1 MWh)/1,000 = 87.74 MTCO2e

Direct commercial electricity consumption was also available for Colgate University. In 2015, Colgate University consumed 30,200 MWh of electricity that resulted in 1,803 tons of emissions.

Colgate University Commercial Electricity Calculations (Village Municipal Electric)
Electricity consumption (kWh) x emissions factor (MTCO2e/kWh) = MTCO2e
30,199,884 kWh x 0.0000596931 MTCO2e/kWh = 1,803 MTCO2e

[2] This figure includes both residential and commercial consumption for the Village excluding Colgate University.

Table 5. FY 2015 Town of Hamilton electricity consumption and emissions

	Residential		Commercial	
	Town of Hamilton	Village of Hamilton	Town of Hamilton	Colgate University
Consumption (kWh)	6,408,000	40,631,000	525,000	30,199,884
Emissions Factor	0.000167135	0.0000596931	0.000167619	0.0000596931
Total Emissions (MTCO2e)	1,071	2,425	88	1,803

Results

The Town of Hamilton's total stationary energy emissions for Fiscal Year 2015 was 17,985 MTCO2e (Table 6). This includes emissions associated with residential home heating (4,347 MTCO2e), commercial heating (8,251 MTCO2e), residential electricity consumption (3,496 MTCO2e), and commercial electricity consumption (1,891 MTCO2e). Based on available data, it was impossible to disaggregate emissions from the Town and the Village (except for residential electricity). As a result, community-wide residential and commercial heat energy and electricity emissions for the Town (including the Village) totaled 10,170 MTCO2e. Heat energy and electricity emissions from Colgate University totaled 7,815 MTCO2e for FY 2015.

Table 6. FY 2015 Town of Hamilton stationary energy GHG emissions

Source of Emissions	Town of Hamilton	Village of Hamilton	Colgate University	Total Emissions (MTCO2e)
Residential Heat Energy	4,347	Incl in the Town	-	4,347
Commercial Heat Energy	2,239	Incl in the Town	6,012	8,251
Residential Electricity	1,071	2,425	-	3,496
Commercial Electricity	88	Incl in the Town	1,803	1,891
Total Emissions (MTCO2e)	7,745	2,425	7,815	17,985

Product Use

Industrial processes not related to energy production create chemical by-product emissions through manufacturing. Any facility that produces more than 25,000 MTCO2e must report emissions to the EPA as part of the Mandatory Reporting Rule (NYSERDA Communities Team, 2015, p.27). The only facility related to the Town of Hamilton that falls into this category is the Madison County Landfill, but the landfill itself is not located within the Town's boundaries. The trash sent to the landfill from the Town of Hamilton is accounted for in the Solid Waste sector in this report.

Hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) are ozone depleting substitutes (ODS) that helped to replace ozone-depleting chlorofluorocarbons after the Montreal Protocol. However,

HFCs and SF6 are potent greenhouse gases used as refrigerants and coolants. They are emitted by refrigerators, air conditioners, fire extinguishers, as well as insulation for electrical wires. While there are no industrial processes within the Town of Hamilton, the Town does produce emissions from ODS.

Data and Methods

Industrial processes in Hamilton are confirmed to be zero from both the Central New York GHG Inventory (2012) and data from the tax assessor shows that nothing within the Town has been zoned as industrial. Estimates for ODS emissions were obtained following the guidelines set forth by the CSC: New York Community and Regional GHG Inventory Guide (NYSERDA Communities Team, 2015). ODS emissions are population-based. The model uses town, state, and national averages of population, households, and electricity consumption to determine an estimate on GHG emissions. HFCs were calculated by using the national average for ODS pollution (given by the CSC guide) and factoring in the Town of Hamilton's population (Tables 7 and 8). Direct fugitive ODS emissions were also available from Colgate University (Table 9). The town's SF_6 emissions were obtained by taking the rate of SF6 per MMBTU found in the CSC Guide Table 12 and multiplying this number by the total MMBTUs of electricity in 2015 from the 2016 Energy Consumption Trend Report along with electricity data from the Village of Hamilton and Colgate University (Tables 10 and 11).

Table 7. ODS (HFC) GHG emissions per capita based on 2010 census data, Source: NYSERDA Communities Team, 2015, Table 11

	Units	GHG Emissions
U.S. ODS Emissions	MTCO2e	114,600,000
U.S. Population		308,745,538
ODS per Capita	MTCO2e/Capita	0.371

Table 8. Town of Hamilton's ODS (HFC) emissions

	Units	GHG Emissions (MTCO2e)
ODS per Capita	MTCO2e/Capita	0.37
Hamilton Population		6,690
Hamilton ODS Emissions	MTCO2e	2,482

Table 9. Colgate University ODS (HFC and HCFC) greenhouse gas emissions

Refrigerant	Refrigerant Loss (lbs)	Emissions Factor	GHG Emissions (MTCO2e)
HFC-134a	20	0.648637089	13
HCFC-22	120	0.82100219	99
Total Emissions (MTCO2e)			112

Table 10. SF6 emissions rate based off 2010 US Census data. Source: NYSERDA Communities Team, 2015, Table 12

	Units	Consumption
U.S. SF6 Emissions	MTCO2e	11,800,000
U.S. Electricity Consumption	MMBTU	12,810,300,000
SF6/MMBTU consumed	MTCO2e/MMBTU	0.0009211

Table 11. Calculation of SF6 emissions for the Town of Hamilton

	Residential		Commercial		
	Town of Hamilton	Village of Hamilton	Town of Hamilton	Colgate University	Total
Consumption (MWh)	6,408	40,631	525	30,200	77,764
MMBTU/1 MWh	3	3	3	3	
Total MMBTU	21,851	138,552	1,790	102,982	265,175
MTCO2e/MMBTU	0.0009211	0.0009211	0.0009211	0.0009211	
SF6 Emissions (MTCO2e)	20	128	2	95	244

Results

The total product use emissions for the Town of Hamilton are estimated at 2,839 MTCO2e (Table 12). Refrigerants (HFCs and HCFCs) make up a majority of these emissions with 2,594 MTCO2e with SF_6 making up about 244 MTCO2e.

Table 12. FY 2015 Town of Hamilton product use emissions

Source of Emissions	Town of Hamilton	Village of Hamilton	Colgate University	Sum Total Emissions (MTCO2e)
HFC	2,482	Incl in the Town	-	2,482
HFC-134a	-	Incl in the Town	13	13
HCFC-22	-	Incl in the Town	99	99
SF6	22	128	95	245
Total Emissions (MTCO2e)	2,504	128	207	2,839

Transportation

On-road Mobile

Data and Methods

To calculate on-road transportation emissions, vehicle miles traveled within the Town of Hamilton were first calculated using Annual Average Daily Traffic (AADT) counts where available and multiplying by the length of road segment within the Town. The New York State Department of Transportation (NYSDOT) Traffic Data Viewer and information collected by the Syracuse Metropolitan Transportation Council (SMTC) provided data on the Annual Average Daily Traffic (AADT) going through the Town of Hamilton. GIS data was utilized to generate road lengths within the Town boundary, and these lengths were multiplied with the traffic counts to derive estimates for daily vehicle miles traveled (DVMT). DVMT was then multiplied by 365 days per year to derive annual vehicle miles traveled (AVMT). These estimates were then converted to emissions by multiplying by the emissions factors for gasoline, ethanol, and diesel.

The NYSDOT relies on actual and estimated traffic counts for their model, which may result in slight over or underestimations in the average daily traffic data. Additionally, the counts do not distinguish between origin and destination; therefore, these counts represent all vehicle trips that begin, end, and travel through the Town of Hamilton, therefore resulting in slight overestimations of Town VMT. Also, the NYSDOT tracks traffic counts for main arteries only; therefore, additional calculations for AADT were needed to estimate AVMT for local/collector roads, as well as some main arteries that do not have AADTs available. The total length of roads in Hamilton with traffic counts is 37.714 miles in 2010, while 69.051 miles of roads do not have AADT counts available.

According to the *Minimum Maintenance Standards Regulation 239/02*, a set of guidelines produced by the Association of Municipalities of Ontario to help local communities estimate traffic volume, while conducting an AADT count, it is possible to estimate the traffic volume for dead-ends and cul-de-sacs to avoid resource-intensive counts. This is done by multiplying the number of houses on the roadway by a factor of 6 for rural areas and 10 for urban areas.

This method was applied to the Town of Hamilton for the roads without AADT counts. It was determined that there were 1,891 occupied households in the Town of Hamilton in 2010, according to the 2010 US Census. It was assumed that all 1,891 homes are on roadways that do not have a count, since most houses are on local/collector roads and almost all local/collector roads in Hamilton did not have an AADT count. By multiplying 1,891 homes by 6, a combined AADT count of 11,346 was calculated for all 69.051 miles of roads without AADT counts available. In order to calculate VMTs, an average AADT value was needed, and derived by dividing by 11,346 by the 69.051 miles of uncounted roadway. This gave an average AADT value of 164, which was applied to all roadways that did not have a count.

There is some error involved in using this method. For instance, the method is meant to be applied to dead-end streets and cul-de-sacs, but this study applied it to all roads in Hamilton without AADT counts available. In addition, there may have been some double counting if homes in Hamilton are located on roads that have AADT counts available. However, counting the number of houses on each road that did not have an AADT count would have been time-consuming, and this VMT calculation is supposed to serve as a general reference for the Town, not as an exact figure. Although this method involves some error, it is the best estimation of traffic volume given the availability of data.

Annual VMT in the Town of Hamilton was calculated to be 17,768,854.419. VMT was then converted to emissions by entering into ICLEI's ClearPath tool using the VMT & MPG calculation method, using averages provided by ICLEI for percentage of passenger vehicles, light trucks, and heavy trucks, and multiplying by the emissions factors for ethanol (assumed as a 10% adder to gasoline), gasoline, and diesel.

Results

On-road transportation emissions for the Town of Hamilton were calculated to equal a total of 8,478 MTCO2e, with 6,320 MTCO2e from gasoline, 35 MTCO2e from ethanol, and 2,123 MTCO2e from diesel.

Off-road Mobile

Data and Methods

The 2015 CSC Guide provides a table detailing GHG Emissions by off-road vehicles and pleasure craft broken down by NYS counties. The totals of these emissions were taken for Madison County and then multiplied by the Hamilton Scaling Percentage (Tables 13 and 14).

Table 13. Off-road emissions for Madison County. Source: NYSERDA Communities Team (2015), Table A-4

GHG Emissions (MTCO2e)						
Off-road Vehicles and Equipment (Land-Based)				**Pleasure Craft (Boats)**		Total
Gasoline (E-10)	Diesel	LPG	CNG	Gasoline (E-10)	Diesel	
12,228	21,544	26,78	193	1,669	300	38,612

Table 14. Off-road GHG emissions for the Town of Hamilton

Madison County Total Off-road emissions (MTCO2e)	Percentage of Madison County population in Hamilton	Hamilton Total Off-road emissions (MTCO2e)
38,612	9.11%	3,517

Results

Total off-road GHG emissions for the Town of Hamilton equals 3,517 MTCO2e (Table 14).

Rail and Air Emissions

Data and Methods

Rail emissions are any emissions that come directly or indirectly from the movement of people or freight via rail lines. Railroads are classified as Class I/II/III (long distance, local, or regional freight), Line Haul Commuter, or Line Haul Amtrak. The only railroad that passes through Hamilton is the New York Susquehanna and Western (NYSW) Railway, a regional railroad headquartered in Cooperstown, NY. There are two Class I railroads which pass through Madison County – the NYSW, which has 11.40 miles of track within the county (Melanie Boyer, personal communication, 2017), and CSX Transportation, which runs approximately 13.50 miles of track through the county. We used the CSC guide's appendix for each county's Railroad Emissions and calculated the proportion of miles of Madison County's Class I railroad tracks located in Hamilton in order to calculate these emissions (Table 15). A map showing the location of rail located within Hamilton's boundaries can be found in Appendix A. The distance shown on the map is slightly different from the number provided to us through personal communication.

It was impossible, given our resources, to find figures specific to the Town of Hamilton with respect to emissions caused by air travel. As a result, we have excluded emissions from air travel from this inventory. This follows the protocol of the Madison County GHG Inventory as well.

Table 15. Rail emissions for the Town of Hamilton. Source: Melanie Boyer, personal communication, 2017; CSC Guide 2015 Tables A-3

Miles of Rail in Madison County	Miles of Rail in Hamilton	Percentage of Madison County rail miles in Hamilton	Class I RR diesel consumption (gal), Madison County	Rail diesel consumption (gal), Hamilton	Diesel emissions factor	Hamilton rail GHG emissions (MTCO2e)
24.9	7.65	30.72%	919,016	282,348	0.01021	2,883

Results

Using the CSC guide's appendix for each county's Class I Railroad Emissions, and calculating the proportion of miles of Madison County's Class I railroad tracks located in Hamilton, we have found that over the course of a year, trains which pass through Hamilton are responsible for 2,883 MTCO2e as they pass through the town's boundaries (Table 15). This is 7.62% of total transportation emissions for the Town of Hamilton. Although this may seem somewhat high for a relatively small length of track, it is important to note that these locomotives run on diesel, which has a large emissions factor relative to most other forms of fuel.

Solid Waste Management

Within the category of solid waste management, GHG emissions can be divided into Scope 1 and Scope 3 emissions. Scope 1 emissions related to solid waste management are the GHG emissions being released by a landfill itself. A community will only have Scope 1 solid waste emissions if a landfill is located within its boundaries. Scope 3 emissions for solid waste management are those emissions resulting from the solid waste generated in the community conducting the GHG inventory but that is disposed of elsewhere. The Town of Hamilton Community Greenhouse Gas Inventory includes only Scope 3 solid waste emissions because the Madison County Landfill, which is where the solid waste from the Town goes, lies outside its boundaries.

Data and Methods

The Madison County Department of Solid Waste and Sanitation provided monthly tonnage data of waste collected from the Town of Hamilton by Commercial Haulers and at the Poolville Transfer Station for the year 2015 (See appendix 2 for raw data) (C. Shoener, personal communication, November 7, 2017). Data regarding tonnage of municipal solid waste (MSW) and construction and demolition (C&D) waste delivered from the Town of Hamilton for each month was collected. Likewise, solid waste data was collected for the Village and Colgate University for the year 2015 from the Madison County Department of Solid Waste and Sanitation (Table 16). However, specific waste characterization for Hamilton was not obtained.

As landfill waste decomposes it emits methane, a powerful greenhouse gas with 25 times the radiative forcing of carbon dioxide. How this methane is handled is important for reducing

greenhouse gas emissions. In FY 2010, the Madison County Landfill installed methane capture technologies to avoid the release of methane into the atmosphere. Then, in FY 2012, they added an electric generation system that feeds electricity into the grid. As a result, there are negative emissions associated with the decomposition of Madison County's landfill waste. Specifically, the emissions factor for Madison County's methane recovery and electricity generation system is -0.03 MTeCO2/short ton.

Table 16. FY 2015 Town of Hamilton solid waste generation and emissions

	Town of Hamilton	Village of Hamilton	Colgate University	Totals (MTCO2e)
Solid Waste (tons)	2,671	1,984	749	5,215
Emissions Factor	- 0.03	- 0.03	- 0.03	
Total Emissions (MTCO2e)	- 80	- 60	- 22	- 162

Additionally, emissions from collection and transportation of waste in the Town of Hamilton have not been included separately in this inventory, as these emissions should already be included in the Transportation section or would fall outside of Town boundaries. A map of the distance between the Town of Hamilton and the Madison County Landfill can be found in Appendix 2.

Results

The total emissions from the solid waste sector are -162 MTCO2e which includes totals from the Town of Hamilton (-80 MTCO2e), the Village of Hamilton (-60 MTCO2e), and Colgate University (-22 MTCO2e). See Table 16.

Wastewater Management

Data and Methods

Wastewater treatment plants emit methane and nitrous oxide as a part of the treatment process, and septic tanks emit methane. The Village, but not the Town of Hamilton, is serviced by a municipal wastewater treatment plant. Therefore, we assume that every building in the Town of Hamilton (excluding those in the Village) with plumbing has an attached septic tank. Each individual septic tank will dissipate gas into the atmosphere and soil via its soil dispersion system (Diaz-Valbuena et al, 2011, p.2743).

The 2013 Madison County GHG Inventory provides data on how many emissions within the county come from wastewater treatment plant (WWTP) operations and how many come from septic tanks. The inventory also provides data on how many county residents use either a WWTP or a septic tank. For this inventory, we assumed that every house in the Village of Hamilton (including all facilities at Colgate University) is serviced by the Village's WWTP and every house located in the Town of Hamilton, but not within the Village of Hamilton, is serviced by a septic tank. According

to the 2010 census, the population of the Town of Hamilton as a whole is 6,690 and of that 4,239 live in the Village of Hamilton (DADS, 2010).

Table 17. Wastewater calculations. Source: 2013 Madison County Greenhouse Gas Inventory; DADS, 2010

	Emissions (MTCO2e)		Madison County Population Using WWTP	Per Capita Emissions	Village of Hamilton Population using WWTP	Hamilton Emissions (MTCO2e)
	WWTP	Septic Tank				
Process N2O	33.6	--	33,907	0.0009909	4,239	4.20
Fugitive N2O	81.4	--		0.0024007		10.18
CH4	--	3,602.5	39,535	0.0911218	4,239	400.63
Total	115	3,602.5	73,442	0.09451	6,690	415.01

Results

Under the assumption that all residents of the Town of Hamilton not located in the Village of Hamilton utilize septic tanks for their homes and businesses and all residents of the Village of Hamilton utilize a WWTP the total wastewater emissions equal 415.01 MTCO2e released per year (Table 17). The emissions due to septic tanks, which make up the bulk of the emissions, are somewhat necessary to buildings with indoor plumbing in the absence of a sewer system, which would be economically and environmentally unfriendly to build in such a rural environment. As such, there are very few ways to reduce the Town of Hamilton's wastewater-related emissions.

Livestock

Agriculture emissions are direct Scope 1 emissions, which the ICLEI Protocol classifies into three major categories; enteric fermentation, manure management, and agricultural soils. Enteric fermentation concerns emissions associated with the digestive processes of livestock, while manure management refers to emissions from livestock wastes; both release methane, while the latter may admit nitrous oxide if the waste management system uses anaerobic digesters. Although livestock is generally defined as ruminant animals, including beef cattle, dairy cattle, horses, swine, sheep, and goats, the 2013 Madison County GHG Inventory only calculates emissions from cattle. As such, our calculations will refer specifically to emissions from beef cattle and dairy cattle.

Data and Methods

The ICLEI U.S. Community Protocol outlines methods to estimate emissions from cattle. These calculations require information regarding the population of each animal type and manure management systems. However, due to the high degree of uncertainty of this information for the Town of Hamilton, this inventory utilizes numbers calculated in the 2013 Madison County GHG

Inventory. The total livestock emissions from Madison County were simply scaled down to the Town of Hamilton.

Using these numbers assumes a uniform distribution of cattle across Madison County which of course is not the case. Unfortunately, time and resource constraints prevented more exact calculations.

Town of Hamilton Emissions = Madison County Emissions x Hamilton scaling percentage
Town of Hamilton Emissions = 82,787 MTCO2e x 9.11%
Town of Hamilton Emissions = 7,542 MTCO2e

Results

The estimated emissions for agricultural activity in Hamilton came to a total of 7,542 MTCO2e.

Overall Emissions

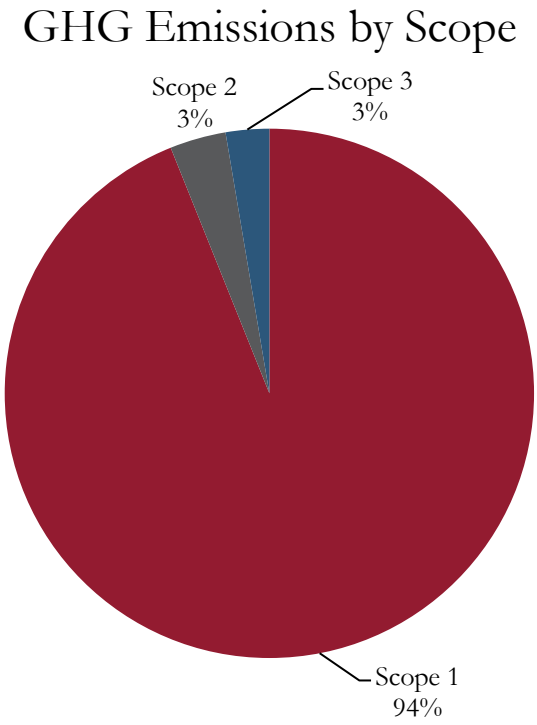
Emissions were calculated for each sector by fuel source and scope. Above are the emissions separated by sector. Here we will compare the sectors and scopes to one another so it becomes clear which areas are the greatest contributors to the community's GHG footprint. Because data sources varied by sector in detail and accuracy, breakdown by fuel source and scope will not be comparable between all sectors.

Overall results show that the majority of emissions come from Scope 1 (see Table 18) followed by Scope 3. Scope 3 is made up only of solid waste emissions. Scope 1 has emissions contributions from the greatest number of sectors: Stationary Energy in the Built Environment, Product Use, Transportation, Wastewater, and Livestock.

Table 18. Town of Hamilton community GHG emissions by scope (2015)

Sector/Source	GHG Emissions (MTCO2e)			Information Source
Residential Energy Consumption	Scope 1	Scope 2	Scope 3	
Electricity		3,496		Hamilton Community Energy Consumption Trend Report; 2017 Town of Hamilton Municipal GHG Inventory
Natural Gas	0			Hamilton Community Energy Consumption Trend Report
Propane/LPG	1,052			EIA RECS Data; EIA SEDS Data; American Community Survey
Distillate Fuel Oil (#2, Kerosene)	3,074			EIA RECS Data; EIA SEDS Data; American Community Survey
Commercial Energy Consumption	Scope 1	Scope 2	Scope 3	
Electricity		1,891		Hamilton Community Energy Consumption Trend Report; 2017 Town of Hamilton Municipal GHG Inventory; Colgate University 2015 GHG Inventory Report
Natural Gas	3,261			Colgate University 2015 GHG Inventory Report
Propane/LPG	555			EIA RECS Data; EIA CBECS Data; American Community Survey; Colgate University 2015 GHG Inventory Report
Distillate Fuel Oil (#2, Kerosene)	4,357			EIA RECS Data; EIA CBECS Data; American Community Survey; Colgate University 2015 GHG Inventory Report
Product Use	Scope 1	Scope 2	Scope 3	
HFC's (R-22; R-134a)	2,594			Hamilton Community Energy Consumption Trend Report; CSC Guide; Colgate University 2015 GHG Inventory Report
Sf6	245			Hamilton Community Energy Consumption Trend Report; CSC Guide
Transportation	Scope 1	Scope 2	Scope 3	
On-road	8,478			NYS DOT, SMTC, GIS data
Off-road	3,517			CSC Guide
Rail	2,883			CSC Guide; Melanie Boyer
Waste Management	Scope 1	Scope 2	Scope 3	
Solid Waste Management			-162	Madison County Solid Waste and Sanitation; 2013 Madison County GHG Inventory; Colgate University 2015 GHG Inventory Report
Wastewater	415			2013 Madison County Greenhouse Gas Inventory; DADS, 2010
Livestock	Scope 1	Scope 2	Scope 3	
Cattle Emissions	7,542			2013 Madison County Greenhouse Gas Inventory
Total GHG Emissions	37,973	5,387	-162	43,198

Figure 2. GHG emissions by scope



When separated by sector, it is clear that transportation makes up a majority of GHG emissions from the community (See Figure 2). Stationary Energy in the Built Environment is second with 22.9% of GHG emissions attributed to the town. Emissions from Livestock follow closely behind with 22.3%. The dominance of these three sectors makes sense in a rural community in central New York. Because everything is very spread out, public transportation is minimal and commuting takes place over long distances. Due to the cold and long winters in Hamilton, NY, energy spent heating homes makes up a large portion of overall energy expenditures by the community. Agriculture is an important part of the area.

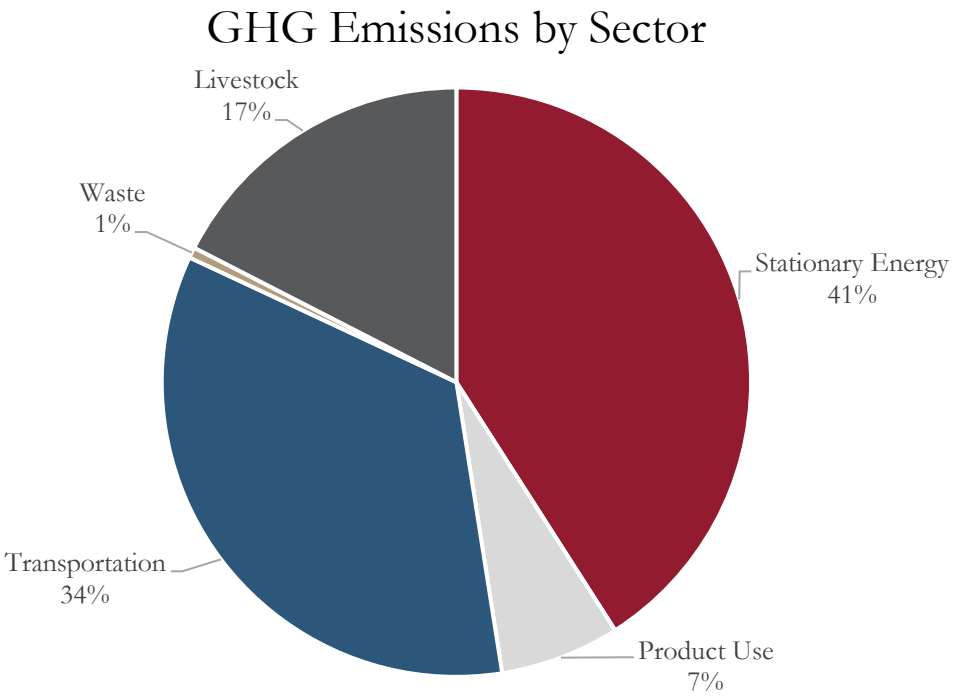
Table 19. FY 2015 Town of Hamilton GHG emissions totals by source

Sector/Source	GHG Emissions (MTCO2e)			Total GHG Emissions
Residential Energy Consumption	**Town of Hamilton**	**Village of Hamilton**	**Colgate University**	**MTCO2e**
Electricity	1,071	2,425	-	3,496
Natural Gas	0	Incl in Town	-	0
Propane/LPG	1,052	Incl in Town	-	1,052
Distillate Fuel Oil (#2, Kerosene)	3,074	Incl in Town	-	3,074
Commercial Energy Consumption	**Town of Hamilton**	**Village of Hamilton**	**Colgate University**	**MTCO2e**
Electricity	88	Incl in Town	1,803	1,891
Natural Gas	0	Incl in Town	3,261	3,261
Propane/LPG	375	Incl in Town	180	555
Distillate Fuel Oil (#2, Kerosene)	1,786	Incl in Town	2,571	4,357
Product Use	**Town of Hamilton**	**Village of Hamilton**	**Colgate University**	**MTCO2e**
Hfc's (R-22; R-134a)	2,482	Incl in Town	112	2,594
Sf6	22	128	95	245
Transportation	**Town of Hamilton**	**Village of Hamilton**	**Colgate University**	**MTCO2e**
On-road	8,478	Incl in Town	Incl in Town	8,478
Off-road	3,517	Incl in Town	Incl in Town	3,517
Rail	2,883	Incl in Town	Incl in Town	2,883
Waste Management	**Town of Hamilton**	**Village of Hamilton**	**Colgate University**	**MTCO2e**
Solid Waste Management	-80	-60	-22	-162
Wastewater	401	14	Incl in Village	415
Livestock	**Town of Hamilton**	**Village of Hamilton**	**Colgate University**	**MTCO2e**
Cattle Emissions	7,542	Incl in Town	-	7,542
Total GHG Emissions	32,691	2,507	8,000	43,198

Table 20. FY 2015 Town of Hamilton emissions totals by sector

Sector	MTCO2e
Stationary Energy	17,686
Product Use	2,839
Transportation	14,878
Waste	253
Livestock	7,542
Total	43,198

Figure 3. GHG emissions by sector



Next Steps and Recommendations

Grant Funding

As a registered Climate Smart Community (CSC), it is essential for The Town of Hamilton to keep information updated and continue moving forward with the certification process. Each year, the CSC grant program updates its priorities for planning and implementation projects and actions. For instance, 2017 focused on actions that reduce flood risk, increase preparedness for future extreme weather events, reduce transportation of and amount of food waste. CSC Certification grants of $10,000 to $100,000 are available through the 2018 round of the NYS Consolidated Funding Application (CFA) to assist municipalities in becoming certified CSCs, and grants of $10,000 to $2,000,000 are available through the 2018 round of the NYS CFA for CSC implementation projects. It is expected that there will be future rounds of CSC grant funding as well which the Town could pursue. CSC grant applications are due each year towards the end of July (see http://www.dec.ny.gov/index.html for exact date).

Other grants through the NYS CFA will also be available which could assist with infrastructure resiliency, most likely for stormwater control and new culverts.

Having a regularly updated Community GHG Inventory and Climate Action Plan will help the Town of Hamilton be more competitive for state and federal funding.

Stationary Energy in the Built Environment

A large portion of residential energy consumption and emissions comes from fuel oil heating. Collectively, Town of Hamilton residents could reduce a large portion of their emissions by switching from fuel oil to a less polluting fuel source such as propane, natural gas, geothermal, or air-source heat pumps. Renewable energies are a good alternative for community members to consider.

Solid Waste

Even though solid waste does not contribute to the Town's emissions footprint, waste mitigation strategies help to engage residents to support pro-environmental behaviors. The Town of Hamilton might consider focusing on communication and education initiatives in order to inform residents on how to reduce waste and how to dispose of specific products (cf. Zotos et. al, 2009). For example, an improvement to the Town website could be to attach or link to a recycling guide and to list where items such as electronic waste, textiles, and hazardous waste can be disposed of. If collection centers for these items do not yet exist, the creation of those programs is another area for improvement. Obtaining specific waste characterization data would allow the town to target efforts to reduce waste.

Agriculture

In making agriculture recommendations, it should be noted that all of our agricultural emissions data is modeled and therefore may not be fully representative of the nuances in local livestock farming practices. Modifying manure management systems used for beef cattle from dry lot to liquid slurry would change the N_20 emissions factor from .02 to .005 kg N2O-N/kg Kjdl N, providing a reduction in overall manure management emissions. Additionally, Niggli et al. (2009) provide a few recommendations drawn from organic farming practices including composting manure to improve soil carbon sequestration and utilizing methane from liquid/slurry systems to produce biogas. However, it is up to individual farmers to make decisions about implementing best practices on their farms, so an educational campaign or technical assistance from local agricultural organizations, such as Cornell Cooperative Extension of Madison County Soil and Water Conservation District, may be worthwhile.

Conclusions

As a Climate Smart Community, the Town of Hamilton has partnered with state and local agencies to combat climate change and pledge to reduce greenhouse gas emissions. The first milestone for meeting climate mitigation goals, according to ICLEI-Local Governments for Sustainability, is to conduct a baseline emissions inventory and forecast. This study was the first attempt to comprehensively quantify these emissions for the Town of Hamilton. It will provide a benchmark for planning purposes with the goal of setting an emissions reduction target and developing a Climate Action Plan.

Emissions for the Town of Hamilton calculated in this report total 43,198 MTCO2e. Though we had hoped to use 2015 as our baseline year, lack of available data prevented us from doing this in many areas. Instead 2015 electricity, natural gas, and waste tonnage was used while 2010 census data was used for other heating fuels, product use, on- and off-road transportation, waste emissions factors, wastewater information, and livestock, and 2002 data for rail. The overwhelming majority of community emissions are categorized as Scope 1 sources, which are easiest to influence through local policies and planning initiatives such as switching community energy to less damaging fuel sources. There is potential for reduction in transportation through carpooling and electric vehicle initiatives. Overall, the local community government can provide information and assistance to community members to encourage them to take environmentally conscious action. This report serves as an important step in that process.

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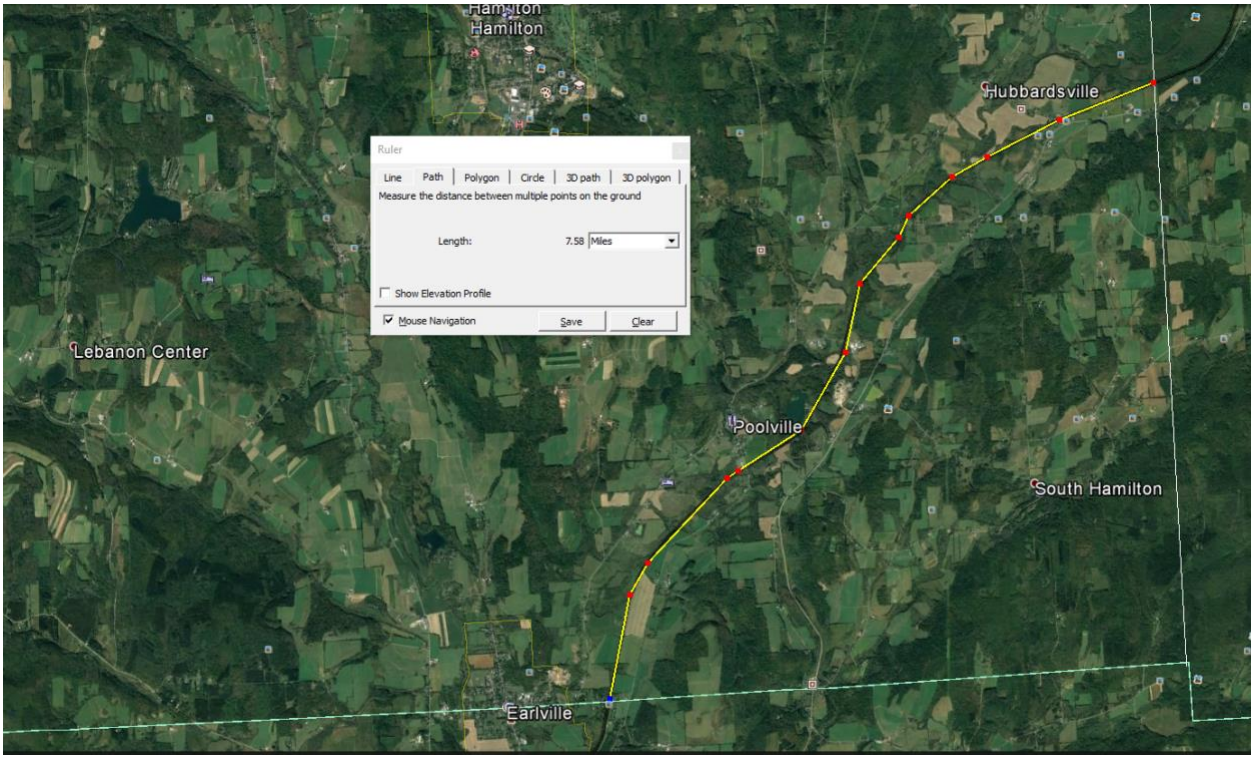
Appendix

Transportation

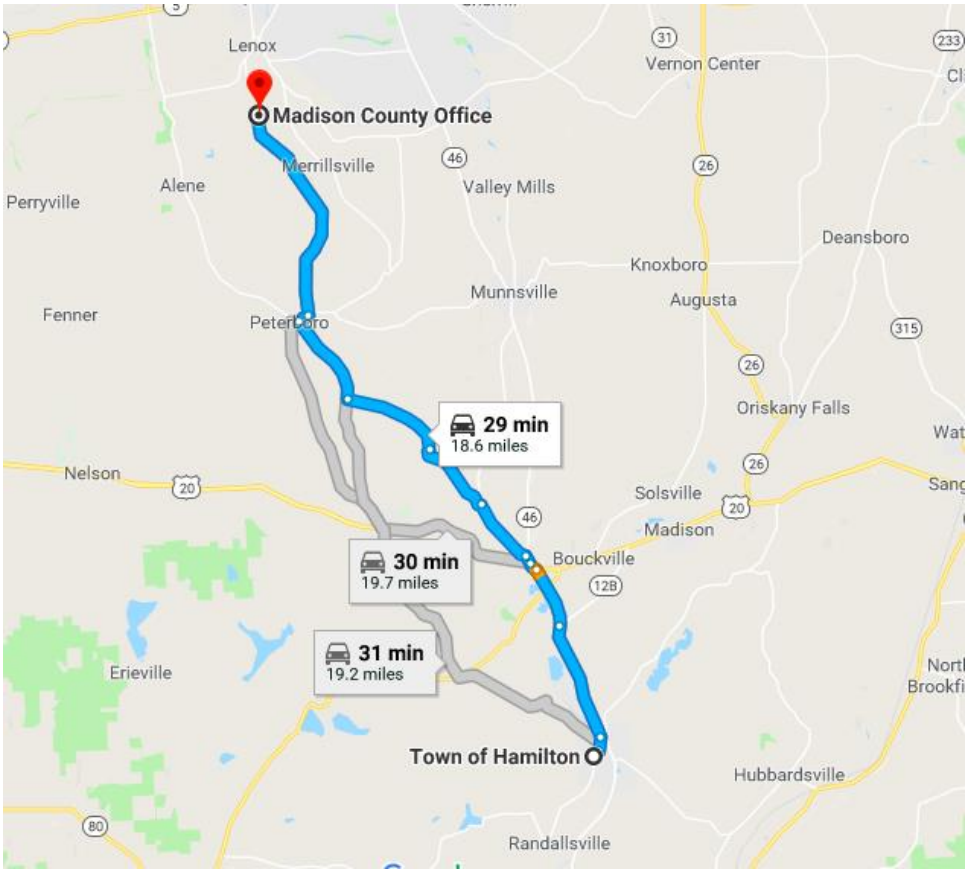
Rail located in the Town of Hamilton



Waste Management

Waste Generated in the Town of Hamilton - 2015			
Excluding the Village of Hamilton and Colgate College			
Commercial Hauler Waste			
Month	MSW Tonnage	C&D	
January	63.54	16.32	
February	47.23	7.34	
March	74.17	16.12	
April	97.78	24.87	
May	133.00	104.11	
June	89.47	132.18	
July	173.00	139.06	
August	137.31	278.26	
September	148.95	54.39	
October	85.81	83.99	
November	90.36	46.34	
December	126.59	33.04	
Transfer Station			
Month	MSWTonnage	C&D	
January	43.20	3.29	
February	24.92	2.23	
March	38.99	6.34	
April	41.95	10.72	
May	56.84	11.18	
June	46.44	17.02	
July	40.96	17.57	
August	42.21	14.32	
September	45.06	16.20	
October	50.88	10.81	
November	42.66	12.04	
December	56.45	15.34	
Total	1797.77	1073.08	2870.85
	MSW	C&D	

Distance between the Town of Hamilton Center to Madison County Landfill


Lenox
Vernon Center
Madison County Office
Merrillsville
Valley Mills
Alene
Perryville
Deansboro
Knoxboro
Munnsville
Augusta
Fenner
Peterboro
Oriskany Falls
29 min
18.6 miles
Nelson
Solsville
Madison
30 min
19.7 miles
Bouckville
31 min
19.2 miles
Erieville
Town of Hamilton
Hubbardsville
Randallsville