

GHG Emissions of City of Ithaca Vehicles and Equipment: Estimates and Recommendations

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Introduction

There is now general agreement that climate change and the end of cheap fossil fuels will constitute significant threats to our future well-being, threats to which the City of Ithaca will not be immune. Effective risk management will depend on accurate, timely, and appropriate data collection, including life-cycle accounting for the City's fleet of vehicles and equipment. This report summarizes the data gathered in an initial attempt to evaluate City fleet fuel usage and greenhouse gas emissions and provides recommendations for improvements in data collection and fleet practices.

Data

The data used for calculating greenhouse gas (GHG) emissions due to City of Ithaca fleet vehicles and equipment was provided in the form of a spreadsheet workbook and a Microsoft Access database by the Supply Manager, City of Ithaca Streets and Facilities. The spreadsheet workbook was divided into two sheets, one containing the City of Ithaca current vehicle and equipment inventory (fiscal year 2006 only) and one containing the fuel transactions for vehicles and equipment (fiscal years 2002–2006). "Vehicles" includes over-the-road vehicles (cars, light trucks, heavy trucks, etc.), while "equipment" refers to all fossil-fuel-burning devices that are not road vehicles (trimmers, shredders, generators, etc.). The term "fleet" will be used in the following to refer to both vehicles and equipment.

The City's vehicle data does not allow for a readily extractable evaluation of the GHG emissions of the fleet by vehicle, because the equipment/vehicle number on the inventory spreadsheet is entered in a form different from the vehicle identification number (VIN) used in the transaction sheet. To reconcile the differences in these formats would require significant additional programming beyond the capabilities of this author.

Accurate accounting is further complicated by errors in the fuel transaction data, especially in the odometer readings. The errors were made either at the time the odometer reading was recorded, or at the time of data entry, or both. These difficulties conspire against an accurate vehicle-by-vehicle accounting of the fuel used. Consequently, at this time we cannot be certain of the efficiency or GHG emissions of our over-the-road fleet.

Before going into any of the data, it is important to note when comparing the City's fleet with the general vehicular traffic for all types of vehicles passing through and around the perimeter of the City that the City's fleet is not of a number, nor probably of a daily consistent usage, to constitute a significant percentage of the transportation sector GHG emissions in Ithaca. The general daily traffic, combined with the City's commitment to continued growth, will likely overwhelm any efforts made by the City to mitigate GHG emissions if those mitigation efforts remain confined to the City fleet and facilities (see Appendix C). As the Local Action Plan currently confines itself to City operations, however, the following data and recommendations do not attempt to account for the much greater amount of GHG emissions due to private vehicular traffic.

Inventory

According to the numbers provided, the City owns 55 light-duty over-the-road vehicles (22 automobiles, 13 vans, 17 pickups, and 3 SUVs), all fueled with unleaded gasoline; 61 heavy-duty over-the-road-vehicles (33 dump trucks and 28 utility trucks), mostly fueled with diesel; and 27 tractor/loader type vehicles that are not classed as over-the-road vehicles. This is a total of 143 fossil-fuel-burning vehicles. The city also owns a significant amount of fossil-fuel-burning small engine equipment (mowers, blowers, chain saws, etc.).

Twenty-two of the 55 light-duty vehicles and 29 of the 61 heavy-duty vehicles were built before the year 2000. This is an important consideration for fuel economy and GHG emissions, because the engines of these vehicles become less efficient as they age.

Emissions estimates

Calculation estimates for GHG (here limited to carbon dioxide) per gallon of unleaded gasoline and diesel were taken from the Environmental Protection Agency (EPA) web site at www.epa.gov/otag/climate/420f0500a.pdf (Appendix A). Owing to the data deficiencies noted above, there is no possible correlation to vehicle type, engine size, miles traveled, fuel efficiency, or hours of operation. At this time, the EPA carbon content estimates by fuel type appear to provide the only basis for an estimate of City fleet GHG emissions; the EPA estimates are 19.4 pounds of CO₂ per gallon for unleaded gasoline and 22.2 pounds of CO₂ per gallon for diesel fuel.

For EPA estimates for all U.S. car and light truck emissions, see www.epa.gov/otag/consumer/f00013.htm (Appendix B).

The following table shows City vehicle fuel use, costs, and estimated GHG emissions for the years 2002 through 2006.

	2002	2003	2004	2005	2006
Diesel fuel used (gallons)	63654.00	59681.00	63276.00	63432.00	57415.00
Diesel cost per gallon	0.794	1.310	1.249	1.843	2.170
Total cost of diesel fuel used	\$50,559.55	\$61,560.35	\$79,036.74	\$116,879.76	\$124,601.21
DIESEL GHG EMISSIONS (TONS)	707	662	702	704	637
Gasoline used (gallons)	129343.00	128978.00	135348.00	87642.00	90633.00
Gasoline cost per gallon	0.810	1.026	1.329	1.627	1.980
Total cost of gasoline used	\$104,761.60	\$132,279.42	\$179,881.34	\$142,596.21	\$179,636.32
GASOLINE GHG EMISSIONS (TONS)	1255	1251	1313	850	879
TOTAL GHG EMISSIONS (TONS)	1962	1913	2015	1554	1516

Recommendations

Data acquisition

Following are the minimum recommended changes for data acquisition:

- ◆ The same vehicle/equipment identification number should be used for both the inventory data and the fuel purchasing data.
- ◆ The entry of a new vehicle or piece of equipment should be accompanied by a data item giving the EPA emissions estimate for that vehicle or piece of equipment.
- ◆ The data format should be modified to distinguish between over-the-road vehicles and other equipment.

These changes would allow the City to easily compute the miles per gallon or gallons per hour for each unit and to calculate a far more accurate estimate of the fleet's emissions. In addition, an annual report of efficiency and emissions estimates should be provided to Common Council and key City officials and published on the City's web site. Supervisory steps should be taken to educate City employees in the need for accurate data collection, and regular auditing of data accuracy should be a part of the process.

Fleet efficiency

In 2006, the City used over 148,000 gallons of gasoline and diesel fuel with a cost of more than \$300,000. Any significant reduction in fuel use would represent a significant reduction in both GHG emissions and cost to the City's taxpayers. Operation of fleet vehicles and equipment should always have as a paramount objective the reduction of fleet GHG emissions through a reduction in the burning of fossil fuels. Following are some steps that could be taken to accomplish such a reduction.

- ◆ Incentives should be introduced to stimulate efficient operation of the fleet, for instance, less idle time.
- ◆ The City should discontinue employee use of City vehicles for private purposes. Less use of the fleet equals less fuel burned and consequently, fewer GHG emissions.
- ◆ All future vehicle purchases should be "green" purchases: hybrid, diesel, or electric vehicles for over-the-road units.
- ◆ All future vehicle purchases should be aimed toward maximum fuel efficiency: no SUVs, smaller light-duty trucks where possible, etc.
- ◆ As the fleet ages, a program to maintain emission control systems and engine efficiency should be rigorously followed.

Appendix A

Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel (EPA)

The U.S. Environmental Protection Agency (EPA) developed this series of four fact sheets to facilitate consistency of assumptions and practices in the calculation of emissions of greenhouse gases from transportation and mobile sources. They are intended as a reference for anyone estimating emissions benefits of mobile sources air pollution control programs.

Carbon content in motor vehicle fuels

One of the primary determinants of carbon dioxide (CO₂) emissions from mobile sources is the amount of carbon in the fuel. Carbon content varies, but typically we use average carbon content values to estimate CO₂ emissions.

The Code of Federal Regulations (40 CFR 600.113) provides values for carbon content per gallon of gasoline and diesel fuel which EPA uses in calculating the fuel economy of vehicles:

Gasoline carbon content per gallon:	2,421 grams
Diesel carbon content per gallon:	2,778 grams

Note that for the “Inventory of U.S. Greenhouse Gas Emissions and Sinks,” EPA estimates CO₂ emissions from fuel from the heat content of the fuel and carbon content coefficients in terms of carbon content per quadrillion BTU (QBTU), using data from the Energy Information Administration (EIA). EIA’s numbers are derived from carbon content by mass, and equate to roughly the same carbon content per gallon of fuel as the values provided in 40 CFR 600.113. EPA uses heat content data from Energy Information Administration’s (EIA “Annual Energy Outlook 2003” and carbon content from EIA’s “Emissions of Greenhouse Gases in the United States, 2000.”

Note also that these estimates are based only on an average carbon content of conventional gasoline and diesel, and do not specifically address the impact of fuel additives such as ethanol or methyl tertiarybutyl ether (MTBE) that may depend on the feedstock.

Calculation CO₂ Emissions

The Intergovernmental Panel on Climate Change (IPCC) guidelines for calculating emissions inventories require that an oxidation factor be applied to the carbon content to account for a small portion of the fuel that is not oxidized in CO₂. For all oil and oil products, the oxidation factor used is 0.99 (99 percent of the carbon in the fuel is eventually oxidized, while 1 percent remains un-oxidized.)¹

Finally, to calculate the CO₂ emissions from a gallon of fuel, the carbon emission are multiplied by the ratio of the molecular weight of CO₂ (m.w. 44) to the molecular weight of carbon (m.w. 12): 44/12.

CO₂ emissions from a gallon of gasoline = 2,421 grams x 0.99 x (44/12) = 8,788 grams = 8.8 kg/gallon = 19.4 pounds/gallon

CO₂ emissions from a gallon of diesel = 2,778 grams x 0.99 x (44/12) = 10,084 grams = 10.0 kg/gallon = 22.2 pounds/gallon

Note: These calculations and the supporting data have associated variation and uncertainty. EPA may use other values in certain circumstances, and in some cases it may be appropriate to use a range of values.

¹ Based on emissions data, EPA’s Office of transportation and Air Quality (OTAQ) is currently examining whether this fraction is higher (closer to 100 percent) for gasoline.

Appendix B

Average Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks (EPA)

The figures presented in this document are averages only. Individual vehicles may differ in miles traveled and pollution emitted per mile than indicated here. Emission rates and fuel consumption totals may differ slightly from original sources due to rounding.

Background

The emission rates for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) shown in the following tables are from U.S. Environmental Protection Agency (EPA) highway vehicle emission factor models. They assume an average, properly maintained vehicle on the road in July 2000, operating on typical gasoline on a warm summer day (72-96 degrees F). Emissions may be higher in very hot (especially HC) or very cold (especially CO) weather.

The calculations for Total Annual Pollution Emitted and Fuel Consumed are based on an average annual passenger car mileage of 12,500 miles and an average annual light truck mileage of 14,000 miles. Fuel consumption is based on fleetwide average in-use fuel economy of 21.5 miles per gallon (mpg) for passenger cars and 17.2 mpg for light trucks, as reported in the 19th edition of the "Transportation Energy Data Book," prepared for the U.S. Department of Energy.

Passenger Car

Component	Emission Rate and Fuel Consumption per mile (mi) ¹	Calculation	Total Annual Pollution Emitted and Fuel Consumed
Hydrocarbons	2.80 grams (g)	$(2.80 \text{ g/mi}) \times (12,500 \text{ mi}) \times (1 \text{ lb}/454 \text{ g})$	77.1 pounds of hydrocarbons
Carbon Monoxide	20.9 grams	$(20.9 \text{ g/mi}) \times (12,500 \text{ mi}) \times (1 \text{ lb}/454 \text{ g})$	575 pounds of carbon monoxide
Oxides of Nitrogen	1.39 grams	$(1.39 \text{ g/mi}) \times (12,500 \text{ mi}) \times (1 \text{ lb}/454 \text{ g})$	38.2 pounds of oxides of nitrogen
Carbon Dioxide ²	0.916 pound (lb)	$(0.916 \text{ lb/mi}) \times (12,500)$	11,450 pounds of carbon dioxide
Gasoline	0.0465 gallon	$(0.0465 \text{ gallon/mi}) \times (12,500 \text{ mi})$	581 gallons of gasoline

Light Truck

Component	Emission Rate and Fuel Consumption per mile (mi) ¹	Calculation	Total Annual Pollution Emitted and Fuel Consumed ³
Hydrocarbons	3.51 grams (g)	$(3.51 \text{ g/mi}) \times (14,000 \text{ mi}) \times (1 \text{ lb}/454 \text{ g})$	108 pounds of hydrocarbons
Carbon Monoxide	27.7 grams	$(27.7 \text{ g/mi}) \times (14,000 \text{ mi}) \times (1 \text{ lb}/454 \text{ g})$	854 pounds of carbon monoxide
Oxides of Nitrogen	1.81 grams	$(1.81 \text{ g/mi}) \times (14,000 \text{ mi}) \times (1 \text{ lb}/454 \text{ g})$	55.8 pounds of oxides of nitrogen
Carbon Dioxide ²	1.15 pounds (lb)	$(1.15 \text{ lb/mi}) \times (14,000 \text{ mi})$	16,035 pounds of carbon dioxide
Gasoline	0.0581 gallon	$(.0581 \text{ gallon/mi}) \times (14,000 \text{ mi})$	813 gallons of gasoline

Notes:

1. These emission factors and fuel consumption rates are averages for the entire in-use fleet. Newer cars and trucks will emit less pollution and use less gasoline; older cars and trucks may emit more pollution and use more gasoline.
2. Carbon dioxide, while not regulated as an emission, is the transportation sector's primary contribution to climate change. Carbon dioxide emissions are directly proportional to fuel economy--each 1% increase (decrease) in fuel consumption results in a corresponding 1% increase (decrease) in carbon dioxide emissions.
3. The total annual emissions and fuel consumption are greater for light trucks than was presented in the April 1998 version of this fact sheet. This reflects the increasing trend toward the largest, heaviest light trucks, which currently and in the past have had less stringent emission standards and lower fuel economy than do the lighter light trucks and cars. The new "Tier 2" emission standards taking effect starting with the 2004 model year will bring all light trucks into compliance with the same emission standards as cars (for HC, CO, and NOx).

Appendix C

City Fleet Operations in Context

Efforts to reduce City GHG emissions through attention to City fleet operations should take place within a context of reasonable expectations. The fact is that City fleet operations make a negligible contribution to vehicle emissions in Ithaca.

City of Ithaca Transportation Engineering Technician Kent Johnson has estimated that around 50,000 vehicles per day operate within or pass through Ithaca. Let us estimate for purposes of discussion that half of these vehicles are automobiles and half are light trucks (including SUVs). Let us further very conservatively estimate that each of these vehicles travels from the City limits to the center and back, a total distance of about 3.7 miles; call it 3. Then total annual driving miles in the City for each category would be $25,000 \text{ vehicles} \times 3 \text{ miles} \times 365 \text{ days} = 27,375,000 \text{ miles}$. Using the EPA estimates provided in Appendix B, this translates into $27,375,000 \times .916 = 25,675,500 \text{ lbs}$ (12,838 tons) of carbon dioxide emissions per year for passenger cars and $27,375,000 \times 1.15 = 31,481,250 \text{ lbs}$ (15,741 tons) of carbon dioxide emissions per year for light trucks, giving a total of 28,579 tons annually for both vehicle types combined.

Other types of vehicles contribute to local GHG emissions as well. Statistics for the many heavy trucks passing through the City each day are unavailable, but we do know that TCAT buses use 375,000 gallons of diesel fuel every year; if we estimate that half of this is used within City limits, then (using the EPA estimates by fuel type in Appendix A) TCAT buses contribute another 4,162,000 lbs (2,081 tons) of CO₂ in addition to the amount due to light vehicle operation, giving a total of about 61,320,000 lbs (30,660 tons) annually for all vehicles except heavy trucks in the City.

By comparison, the CO₂ produced by City fleet operations over the last five years averages 3,584,000 lbs (1,792 tons) annually. In other words, non-fleet vehicles in the City emit more than 17 times as much CO₂ as vehicles in the City fleet. A more accurate accounting of non-fleet vehicle use in the City would almost certainly place this multiple even higher.

It is apparent from the above that reducing GHG emissions due to City fleet use will have a trivial net effect on the City's carbon footprint, and one wonders if this point wouldn't apply to the Local Action Plan as a whole. Clearly, to have more than a merely token effect, it will be necessary to address the contributions to GHG emissions within the City from sources other than the City fleet or facilities. Indeed, this would likely mean taking harder measures than is mandated for the LAPC and would probably lead to legislated changes to City of Ithaca resident behavior. It is to be hoped that local politics will not inspire the City to resort to mere public relations measures regarding the very serious level of GHG emissions within the City of Ithaca.