City of Elk River

Greenhouse Gas Baseline Inventory

June 2016

making change personal paleBLUEdot LLC

Elk River GHG Baseline Inventory

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Elk River GHG Baseline Inventory

Background

In March 2016 the City of Elk River engaged Pale Blue Dot LLC to prepare a Greenhouse Gas (GHG) baseline inventory for City Operations emissions. City Operations baseline data was to be collected and calculated for the first time in this report.

The City of Elk River is committed to improved sustainability. Since 1997, the City has been a designated Energy City by the Minnesota Pollution Control Agency – a designation of the City as a geographical focal point for the demonstration of efficient and renewable energy products, services, and technologies. In October 2011, the City began engagement in the Minnesota Greenstep Cities Program sponsored by the Minnesota Pollution Control Agency. Greenstep Cities is a challenge, assistance, and recognition program supporting cities in achieving sustainability and quality-of-life goals.

This Greenhouse Gas Baseline Inventory report is designed both to meet the requirements for the Greenstep Cities program, but also to provide a framework for on-going dialogue in support of the City's Energy City designation and overall sustainability interest.

The Carbon Cycle and the Role of Greenhouse Gases

The Carbon Cycle is exchanged among the oceans, atmosphere, and ecosystem. This cycle has been a closed, balanced system for hundreds of thousands of years. This cycle is present in the atmosphere primarily as carbon dioxide and methane. These two primary greenhouse gases uniquely allow light to pass while capturing infrared energy. This "Greenhouse Effect" directly impacts Earth's atmospheric energy and temperatures – without the historic levels of greenhouse gases present in the atmosphere, the average surface temperature of the Earth would be 0 degrees Fahrenheit.

Man-Made Greenhouse Contributions

As our current energy systems are fossil fuel based, nearly all products and services are responsible for GHG emissions. This "Carbon Footprint" results from the emissions of fossil fuels burned either directly, or indirectly in delivering that product or service.

Burning fossil fuels release hydrocarbons which have been outside the natural carbon cycle for millions of years. These emissions have increased atmospheric greenhouse gases by 40%, changing the chemistry and raising the total atmospheric energy and contributing to climate change. According to the EPA, man-made carbon emissions are likely to remain in our atmosphere for hundreds of years. Though unintended, our individual actions and business operations are contributing to climate change impacts. (https://www3.epa.gov/climatechange/ghgemissions/gases.html).

Introduction

According to the US EPA:
From "Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste" 1998

Since the preindustrial era, atmospheric concentrations of CO2 have increased by nearly 30 percent and CH4 concentrations have more than doubled. There is a growing international scientific consensus that this increase has been caused, at least in part, by human activity, primarily the burning of fossil fuels (coal, oil, and natural gas) for such activities as generating electricity and driving cars.

In international scientific circles a consensus is growing that the buildup of CO2 and other GHGs in the atmosphere will lead to major environmental changes such as (1) rising sea levels that may flood coastal and river delta communities; (2) shrinking mountain glaciers and reduced snow cover that may diminish fresh water resources; (3) the spread of infectious diseases and increased heat-related mortality; (4) possible loss in biological diversity and other impacts on ecosystems; and (5) agricultural shifts such as impacts on crop yields and productivity.

Many uncertainties remain regarding the precise timing, magnitude, and regional patterns of climate change and the extent to which mankind and nature can adapt to any changes. It is clear, however, that changes will not be easily reversed for many decades or even centuries because of the long atmospheric lifetimes of GHGs and the inertia of the climate system

Minnesota Climate Change Impacts

Minnesota's climate has already begun to change. Average temperatures in Minnesota are 1.5 to 2 degrees warmer than they were in the 1980's and seven of the State's ten warmest years on record have occurred in the last 15 years. Annual frequency of large storms in Minnesota have more than doubled in the last 50 years, with a 70% increase occurring in just the last decade. Minnesota has seen three "1,000 year" flash floods in only 12 years and scientists anticipate occurrence of extreme weather to continue to increase in frequency.

Climate change has already begun to impact the Minnesota economy. In 2013, the State logged some of the highest severe weather-related claims in the country, and since 1997, 32 severe weather natural disasters cost Minnesota over $500,000,000. In addition, University of Minnesota economists have calculated the health and environmental costs of our fossil-fuel based electrical production at over $2,000,000,000 annually.

The State of Minnesota is responding to climate change and is focused on reducing the State's carbon emissions. The State's 2007 Next Generation Energy Act established climate mitigation goals which included a reduction of statewide greenhouse gas emissions to at least 15% below 2005 levels by 2015, 30% below 2005 levels by 2025, and 80% below 2005 levels by 2050. Though the State has missed its first goal, progress has been made and Statewide emissions were reduced between 2007 and 2010 a total of 3%.

Elk River GHG Baseline Inventory

Why Measure?

As the management consultant and author Peter Drucker noted, "What gets measured gets managed". Measurement provides data both to understand where opportunities for improvement exist as well as to understand and reward success. Measurement of GHG emissions is the essential first step to successfully meet reduction goals. Establishing a baseline emissions understanding and updating the data annually is a critical component of meeting the emission reduction goals established by the City of Elk River's adoption of the U.S. Mayors Climate Protection Agreement as well as the Statewide reduction targets. By undertaking this initiative to track emissions, the City of Elk River is yet again illustrating its leadership in sustainability.

> **I have been struck again and again by how important measurement is to improving the human condition.**
>
> **Bill Gates**

Methodology, Sources, and Terminology

This Greenhouse Gas Baseline Inventory is assembled based on the Greenhouse Gas Protocol for businesses and communities established by GHG Protocol (www.ghgprotocol.org/) and is consistent with the protocol established by ICLEI Local Governments for Sustainability.

The community-wide emissions data referred to in this document are all from City of Elk River's reporting engagement in the Regional Indicator's Initiative. The City Operations emissions data are based on raw metrics collected by City of Elk River staff with emissions calculations based on emission factors and Global Warming Potential (GWP) factors established by various sources such as the United States Environmental Protection Agency. All calculations in this document transparently show the emission factors being used as well as source references.

The terminology used in this report is consistent with international Carbon Footprinting protocols. Unless noted otherwise, the Greenhouse Gas (GHG) emissions shown in this report are in CO2e: Carbon Dioxide Equivalent. CO2e is a standard for expressing the impact of all greenhouse gas including those from pollutants such as methane and nitrous oxide in terms of the equivalent amount of CO2 that would have the same impact. GHG emissions are represented in Metric Tonnes (2,204.62 pounds) to be consistent with

Introduction

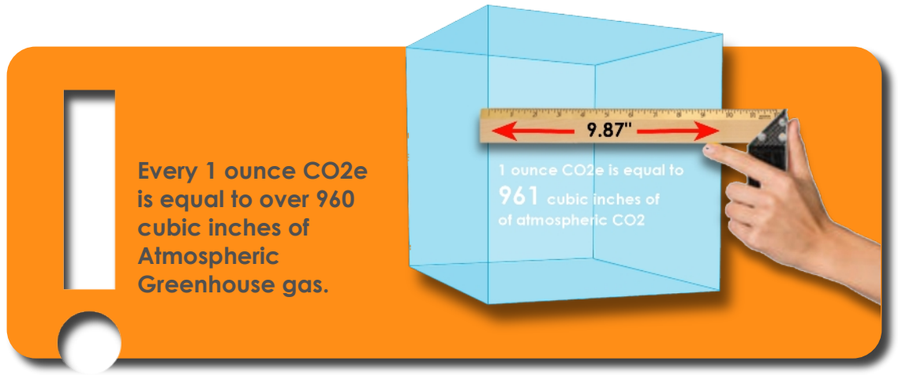
Normalization For Weather

The energy consumption associated with our buildings is very closely related to weather. Colder winters demand more energy consumption to heat our buildings while hotter summers require higher use of air conditioning to maintain temperatures. To facilitate annual comparisons, building energy consumption and GHG emissions should be understood not just in actual levels, but also normalized for weather conditions. This enables a review of year over year GHG performance while filtering out factors which are beyond the City's control.

Weather Normalization is achieved by calculating a normalization factor comparing a given year's total Heating Degree Days (HDD) and Cooling Degree Days (CDD) against a 30 year average. These normalization factors are then applied to the portion of electrical energy typically attributed to cooling and the portion of gas energy typically used for building heat. It is assumed that 25% of all electricity consumption is for air conditioning and for electrical normalization calculations is adjusted by the CDD factor. The remaining 75% of electrical use is unaffected. Similarly, 80% of gas usage in Minnesota is assumed to be for building heating and is adjusted by the HDD factor while the remaining 20% is unaffected in Normalized calculations.

Graphic Representations

Much of the emissions data reported in this Baseline Inventory report are also graphically represented in terms of volume of atmosphere. These representations are a unique hallmark of the Pale Blue Dot's work and they are included in order to help facilitate an increased awareness of the order of magnitude our collective emissions represent. Volumetric calculations used in these graphics are based on the average atmospheric volume occupied by carbon dioxide as calculated by the International Carbon Bank and Exchange.



Elk River GHG Baseline Inventory

Summary of Inventory Results

This report summarizes the Greenhouse Gas emissions inventory for both the City of Elk River municipal operations as well as the Elk River Municipal Utilities (ERMU) operations. Those emissions are primarily reported separately, however, as a traditional function of municipal public works, the emissions associated with street lighting have been reported under the City of Elk River operations rather than ERMU.

The City and ERMU operate a total of 16 facilities, numerous city vehicles, lift/pump stations, street lights, and street signals. Each of these components of the City's operational infrastructure consume grid-based electricity, natural gas, gasoline, or diesel fuel. For the baseline 2015 year, the City of Elk River municipal operations totaled 5,922.33 Metric Tonnes (13,056,487 pounds) CO2e while the ERMU operations totaled 1,532.77 Metric Tonnes (3,379,175 pounds) CO2e. Together, these emissions represent over 146 million cubic feet of man-made greenhouse atmosphere annually.

The sections which follow detail the breakdown of these total operational emissions for the City as well as ERMU within the categories of Buildings and Grounds, Streetlights and Signals, Vehicles, Transportation and Travel, Water and Wastewater, and Solid Waste. The calculations and emissions factors used to arrive at these emission totals can be found in the appendix of this report.

Community Comparisons

The results of community GHG inventories vary somewhat due to the information collected, as well as the range of services provided by city entities directly, services contracted out on behalf of the subject city, or services which are provided by entirely separate governmental agencies or privatized. Consequently, a direct city-to-city comparison should not be viewed as a comprehensive comparison of Greenhouse Gas emission efficiencies. We believe, however, that as an emerging practice, municipalities should look towards building and sharing data in order to develop a stronger understanding of where each municipality can advance efficiencies and meet Greenhouse Gas reduction goals. The following is a brief comparison of City Operations Emissions between a few Twin City Metro communities:

City Operations	Metric Tonnes		
Elk River:	**5,922** Total	**49** /FTE	**43**/Facility SF
Maplewood:	**5,267** Total	**32** /FTE	**48**/Facility sf
Edina:	**24,939** Total	**50** /FTE	
Bloomington:	**17,974** Total	**58** /FTE	
Falcon Heights:	**397** Total	**24** /FTE	

Opportunities for Reduction

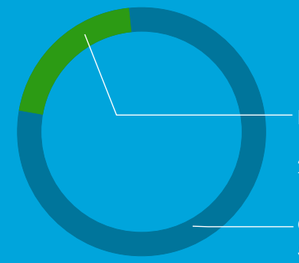
The sections in this report summarizing each GHG inventory category include identification of potential opportunities for reduction. Though not comprehensive, these strategies represent municipal best practices which the City may benefit from continuing, expanding, or implementing. We have selected a few we believe the City may benefit from the most and have included them in Potential Next Steps for The City of Elk River

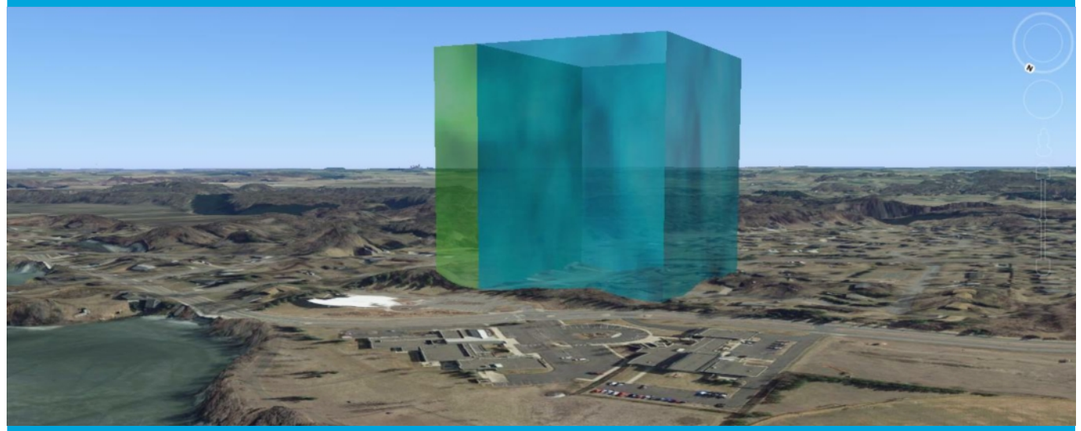
Executive Summary

Total City Emissions

7,455.10
Metric Tonnes

146,277,466
Cubic Feet of Man-Made Atmosphere





Volume Visualization

The graphic above represents the volume of man-made GHG atmosphere produced annually by the City of Elk River operations (blue) and ERMU operations (green) emissions totals. The volume of atmosphere is equal to a cube 527 feet on each face, with a total volume of 146,277,466 cubic feet, roughly **3x** the volume of Orono

Potential Next Steps for the City of Elk River

We recommend City leadership implement the following:

1) Engage a consultant to work with City Leadership to develop a GHG Reduction goal and action plan.

2) Maintain and update City and ERMU Operations GHG inventory annually to track progress against energy and greenhouse gas reduction goals.

3) Engage a consultant for a detailed Facility Assessment, Energy Audit, and energy efficiency action plan for the Public Safety, Ice Arena, and Waste Water facilities.

4) Explore the feasibility of installation of renewable energy generation on one or more City facility

5) Conduct a detailed waste sort study to span a minimum of one full week of collection

6) Develop a long-range vehicle replacement plan to migrate to electric and hybrid vehicles.

7) Explore Efficiency Programs focused on diesel engine retrofits, installation of auxiliary power units

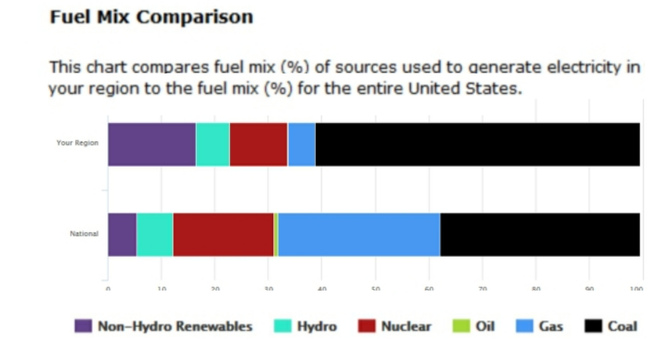
8) Implement Public Transit Commuter Campaign building awareness among City staff by communicating public transit routes, establish carpool groups, and communicate reimbursement potentials available under December 2015 US Consolidated Appropriations Act (HR 2029)

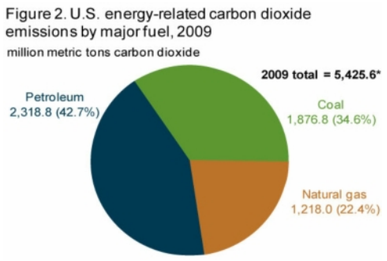
Elk River GHG Baseline Inventory

How do City Operated Buildings and Grounds contribute to Greenhouse Gas Emissions?

According to the US Department of Energy, use for buildings accounts for 41% of the total US energy consumption nationally. Building heating and cooling, lighting, and electronic equipment use makes up nearly 70% of all commercial building energy use. In the two decades between 1980 and 2009, the total energy consumed by our buildings increased 49%.

Greenhouse gas emissions associated with that building energy use comes from direct emissions of fossil fuels burned on site (natural gas, fuel oil, etc), as well as indirectly from fossil fuels burned to create electricity off-site. The greenhouse gas emissions factor associated with on-site fuel use is directly related to the carbon content of the fuels burned (see Community Wide Energy Use for fuel factors). The emissions factor associated with electricity use varies based on the raw fuel sources used by the electrical utilities suppling the local electrical grid – utility providers who source more of their power through renewable energy sources, have commensurately lower GHG emission factors.





Summary of Findings*

For the City Operations Baseline year of 2015, the eleven City of Elk River buildings reporting to B3 Benchmarking consumed a total of 3,215,907 kwh of electricity and 135,447 therms of natural gas. This relates to an average Energy Use Intensity (EUI) of 106.77 kBTU's per square foot of building space. According to the State's B3 Benchmarking system, on a building by building basis this EUI performance ranges from 27th percentile performance (Public Safety) to 100th percentile performance (Public Works). When compared against the EPA's Energy Star EUI reference index, the City of Elk River's total facility EUI is 135% of the median EUI of 78.8.

The GHG emission associated with City of Elk River buildings and grounds energy use for the Baseline year of 2015 totaled 3,226.55 Metric Tonnes (7,113,317 pounds) CO2e. Total GHG emissions equal 23.19 pounds CO2e per facility square foot per year. Emissions associated with electricity use were 77.7% while natural gas use emissions equaled 22.3% of the total GHG emissions.

When Normalized for Weather, total annual energy consumption for City of Elk River buildings and grounds is adjusted downward 0.98% for electricity and upward 10% for natural gas. The resulting Weather Normalized annual Building and Grounds GHG increases 0.8% to a total of 3,252.68 Metric Tonnes.

* Sources: energy consumption as reported on B3 Benchmarking, emission factors based on US EPA and Excel Energy,

City Operations Buildings and Grounds

Annual Greenhouse Gas equal to:

3,252.68 Metric Tonnes

63,821,145 Cubic Feet of Man-Made Atmosphere

54.92% City Operations Total

Volume Visualization

the light gray mass represents the Police, City Hall, and Library facilities relative height compared with the annual emissions associated with building operations for City owned facilities. These emissions represent an average volume of man-made atmosphere equal to a mass over **206'** high for each of the 11 buildings included.

Opportunities for Reduction

The City of Elk River has already engaged in a number of efforts aimed at reducing the energy consumption of existing City owned facilities. A number of the City's facilities, including Public Works and the Library perform well when compared against both B3 peer groups as well as EPA Energy Star averages.

A few of the City's facilities have weaker energy performance when compared B3 and EnergyStar. These include the Public Safety, Ice Arena, and the Waste Water Treatment Plant. Making energy efficiency improvements to these three facilities to align them with the EnergyStar median EUI performance (88 for Public Safety, 42 for Ice Arena, and 2.89KBTU per gallon per day for Waste Water) would reduce a total of 10,557,000 KBTU and may represent a savings of $100,000 or more annually.

Recommendations:

- Engage a consultant team to conduct a detailed Facility Assessment and Energy Audit and develop an energy efficiency action plan for the Public Safety, Ice Arena, and Waste Water facilities.
- Explore the feasibility of installation of renewable energy generation on one or more City facility.

Elk River GHG Baseline Inventory

How do City Streetlights and Signals contribute to Greenhouse Gas Emissions?

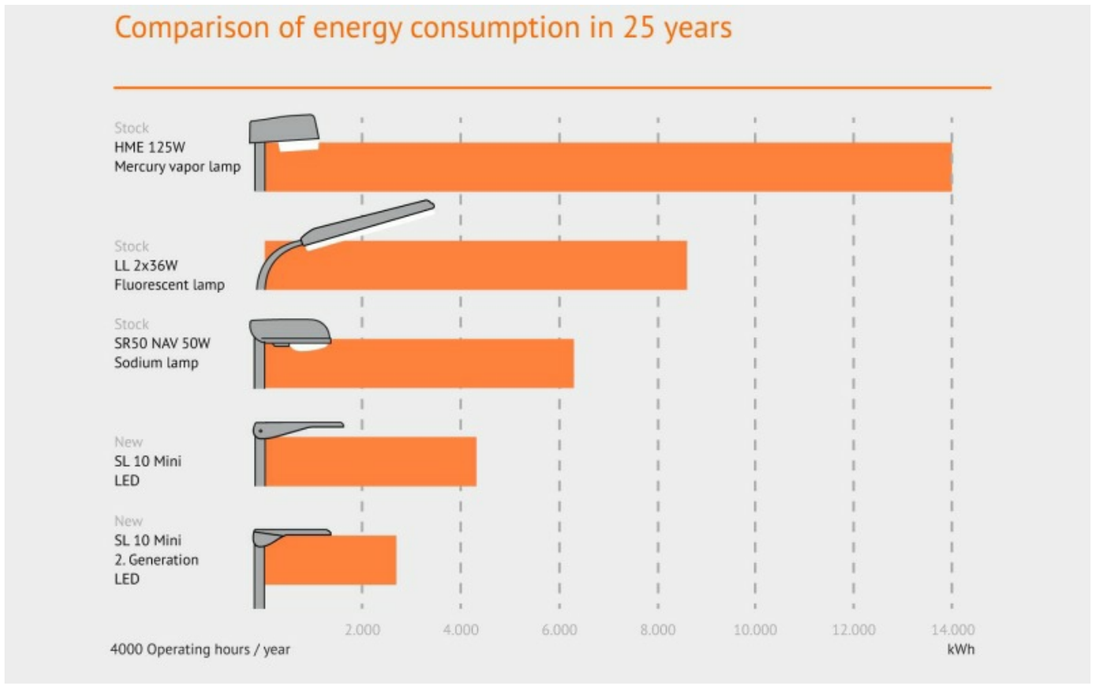
As with Buildings and Grounds, the electricity used to supply our street lighting is a source of Greenhouse Gas. The emissions factor associated with electricity use varies based on the raw fuel sources used by the electrical utilities suppling the local electrical grid – utility providers who source more of their power through renewable energy sources, have commensurately lower GHG emission factors.

According to a 2011 study by the Lighting Research Center, on average, municipal lighting uses 4 kwh per mile of street light coverage. Assuming an average of 4,300 hours of operation annually, that represents 17,520 kwh of energy use and a GHG emission of 12.37 Metric Tonnes (12,271 pounds) of CO2e annually per mile of street lighting.

Summary of Findings*

For the City Operations Baseline year of 2015, Elk River Municipal Utilities reports a total electrical use of 377,143 kwh for City owned streetlights and signals. The GHG emission associated with City of Elk River Streetlight energy use for the Baseline year of 2015 totaled 266.18 Metric Tonnes (586,826 pounds) CO2e.

* Sources: City of Elk River and Elk River Municipal Utilities data, emission factors based on US EPA and Excel Energy,



City Operations Streetlights and Signals

Annual Greenhouse Gas equal to:

266.18 Metric Tonnes

5,222,830 Cubic Feet of Man-Made Atmosphere

4.49% City Operations Total

Operations of City of Elk River streetlights and signals produces a volume of greenhouse gas equal to:

880 Cubic Feet of man-made Atmosphere annually For every family in Elk River (Figure to scale)

Opportunities for Reduction

Approximately 20% of the Elk River streetlight infrastructure are LED light fixtures, with the remaining 80% being High Pressure Sodium. According to a 2012 Minnesota Department of Commerce study, switching from HPS to LED luminaires typically produces 40% to 60% savings in electricity consumption if the system is properly designed. In addition, wireless control and monitoring systems can allow the city to implement dimming strategies that may reduce street lighting energy consumption by another 10-20%.

By continuing to convert from HPS to LED street lighting fixtures, energy consumption associated with street lighting should be reduced by 120,000 to 180,000 kwh annually. This reduction in energy consumption would mean a reduction of 80 to 130 Metric Tonnes of CO2e annually.

Elk River GHG Baseline Inventory

How do City Vehicles contribute to Greenhouse Gas Emissions?

Fossil Fuels used in transportation produce GHG when burned, primarily CO2. In fact, the weight of CO2 produced actually exceeds the weight of the fuel burned. The amount of GHG produced by common vehicle fuels ranges from 19.4 pounds per gallon for gasoline to 22.5 pounds for diesel.

Nationally, Americans drive over 3 trillion miles annually, producing 1.2 billion Metric Tonnes of vehicle related GHG emissions.*

*For more information: http://www.bluedotregister.org/carbon-copy/2014/12/11/a-mountain-of-an-impact-the-carbon-footprint-of-american-roads

How can GHG emissions weigh more than the fuel we burn

?

According to the US EPA:

The amount of carbon dioxide (CO2) that is produced from burning a fuel weighs more than the amount of the fuel itself, because during complete combustion, each carbon atom in the fuel combines with two oxygen atoms in the air to make CO2. The addition of two oxygen atoms to each carbon atom forms CO2, which has an atomic weight of 44—roughly 3.6667 times the atomic weight of the carbon, which is 12.

Summary of Findings*

The City of Elk River owns and operates vehicles as a critical support to functions in Police, Fire, Public Works, Streets, Parks, Waste Water, and City Administration functions. During the 2015 Baseline year, the City's vehicle fleet used 53,691 gallons of gasoline and 79,872 gallons of diesel fuel. The emissions volume associated with the fleet's fuel consumption totaled 744.08 Metric Tonnes (1,640,414 pounds) CO2e, approximately 0.60% of community wide vehicle emissions.**

* Sources: City of Elk River data, emission factors based on US EPA and EIA.
**Based on Regional Indicators Initiative data.

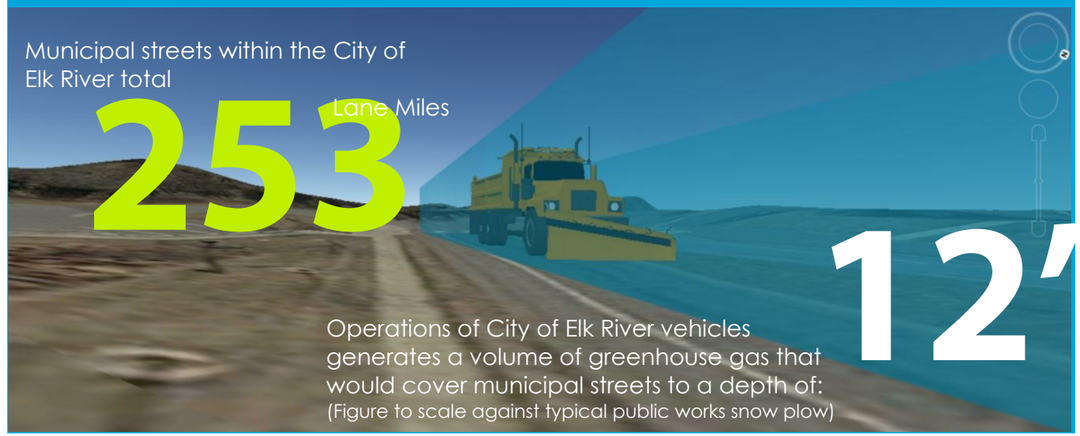
City Operations
City Vehicles

Annual Greenhouse Gas equal to:

744.08 Metric Tonnes

14,499,678 Cubic Feet of Man-Made Atmosphere

12.56% City Operations Total



Opportunities for Reduction

Recommendations from Greenstep Cities offer a range of best practice concepts which can greatly reduce municipal fleet fuel consumption when implemented and reviewed regularly for continued advancement. Best practices which the City of Elk River may be able to leverage for continued fuel efficiency include:

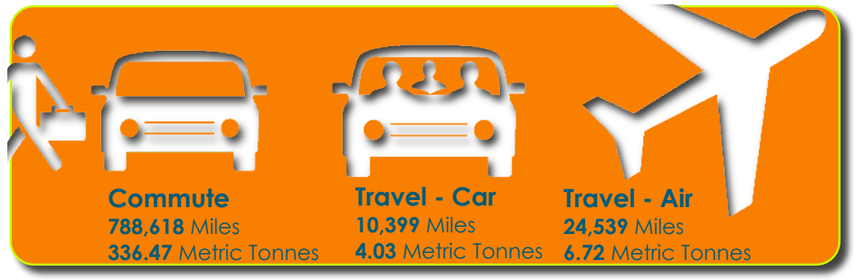
- **Efficiently use existing fleet** of city vehicles by encouraging trip bundling, video conferencing, carpooling, vehicle sharing and incentives/technology.
- **No-Idling practices and policies**
- **Vehicle replacement plan** to migrate to electric and hybrid vehicles.
- **Optimize street maintenance and snow plowing routes** for highest fuel economy.
- **Explore Efficiency Programs** focused on diesel engine retrofits, installation of auxiliary power units
- **Conduct a Sidewalk and Trails** study to identify opportunities to encourage and increase biking and walking as transit options both for city employees as well as the public.

Elk River GHG Baseline Inventory

How does City Employee Transportation contribute to Greenhouse Gas Emissions?

The City's operational travel and transport emissions come from three primary sources: employee commute to and from work, auto-oriented business travel within region, and business air travel regionally/nationally.

As with the City Vehicle sector of City Operations GHG emissions, employee travel to and from work and required business travel regionally and out of state require fossil fuel use. The amount of GHG produced by common transportation fuels ranges from 19.4 pounds per gallon for gasoline to 21.5 pounds for jet fuel and 22.5 pounds for diesel.



Summary of Findings*

According to the City's 2015 employee commuter survey, the average round-trip employee commute distance is 26.07 compared with the US Census estimated community-wide average of 38 miles. City employee work commutes surveyed are entirely in single occupant vehicle. Total annual vehicle miles traveled for City employee commute is calculated at 788,618 miles. Total City employee commuter emissions for the 2015 Baseline year equal 336.47 Metric Tonnes (741,788 pounds) CO2e.

Business travel through the Baseline 2015 year totaled 10,399 miles for road transportation and 24,530 miles for air transportation. Annual emissions associated with this business travel equal 4.03 Metric Tonnes for auto, and 6.72 Metric Tonnes for air for a total of 10.75 Metric Tonnes (23,670 pounds) CO2e.

The 347.11 Metric Tonnes associated with these three City Operations travel and transportation equal 0.28% of Community Wide travel and transportation emissions.**

* Sources: City of Elk River data, emission factors based on US EPA and EIA. Calculations for car business travel were calculated based on current reimbursement rates. Calculations for air business travel were calculated based on national average cost-per-mile data http://airlines.org/data/annual-round-trip-fares-and-fees-domestic/

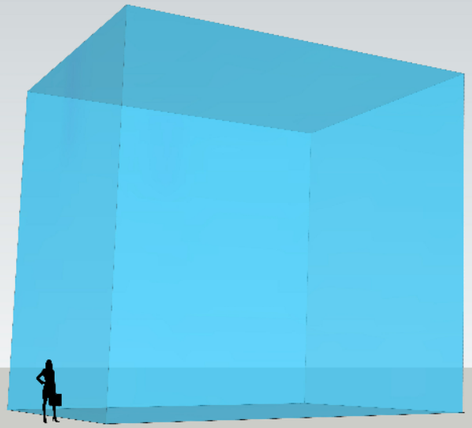
** Community-wide total travel and transportation GHG emissions total 124,096 Metric Tonnes. Source Regional Indicators Initiative.

City Operations
Employee Transportation

Annual Greenhouse Gas equal to:

347.21 Metric Tonnes

6,812,715 Cubic Feet of Man-Made Atmosphere



Emissions associated with employee commute
And business travel total

56,303

Cubic Feet of man-made atmosphere per City employee (Figure to scale)

Opportunities for Reduction

Business Travel Optimization by encouraging trip bundling, video conferencing, carpooling, vehicle sharing and incentives/technology.

Explore Partnership with Nice Ride Minnesota for installation of bike sharing locations convenient to city staff as well as community members as strategy to increase commute via public transit and bike.

Implement Public Transit Commuter Campaign by building awareness through communicating public transit routes, establish carpool groups, and communicate reimbursement potentials available under December 2015 US Consolidated Appropriations Act (HR 2029)
http://www.nctr.usf.edu/programs/clearinghouse/commutebenefits/

Elk River GHG Baseline Inventory

How do the provision of Water and Wastewater Utilities contribute to Greenhouse Gas Emissions?

Water and energy use are inextricably linked in modern cities. Energy is required to extract, treat, and distribute water to residences and businesses. Nationally, the United States consumes over 355 billion gallons of water daily, requiring an estimated 500 billion kwh annually to distribute to users. Globally, water treatment and distribution is estimated to contribute 2-3% of total greenhouse gas emissions annually.

As with water processing and distribution, Wastewater collection and treatment requires energy inputs. With our current energy grid, those energy inputs are significantly fossil fuel based.

In addition to emissions associated with fossil fuel use, wastewater treatment produces significant "Biogenic" emissions associated with the microbial processing of the waste solids. The primary gas emitted during biological nitrogen removal is Nitrous Oxide (N2O), a greenhouse gas with a potency roughly 300 times that of CO2. With such potency and an observed increase of atmospheric N2O of over 17%, ongoing studies by the US EPA and Intergovernmental Panel on Climate Change (IPCC) continue to refine understanding of the origins, impacts, and reduction strategies for wastewater N2O emissions.

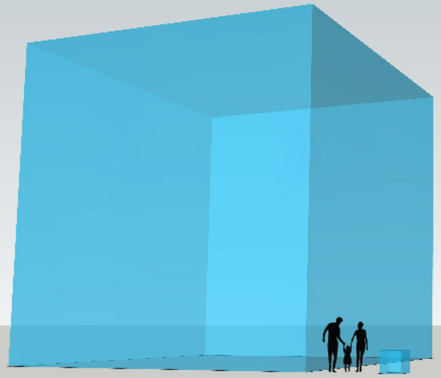
For the purposes of GHG calculations for community carbon footprint reporting, these "Biogenic" emissions are considered to be a part of the biological carbon cycle and are not currently included in the GHG totals. Protocols may change in the future to include wastewater Biogenic N2O emissions.

City Operations
Water and Wastewater

Annual Greenhouse Gas equal to:

1,303.58 Metric Tonnes

25,577,632 Cubic Feet of Man-Made Atmosphere



Daily emissions associated with Elk River Waste Water treatment represent:

63,455
Cubic Feet of man-made atmosphere
(Figure to scale)

13
Cubic Feet per household per day Figure to scale)

Summary of Findings*

The City of Elk River operates the Elk River Waste Water Treatment plant (WWT). For the Baseline 2015 year, the WWT plant processed 463,000,000 gallons of waste water, serving 4900 customers averaging 259 gallons per customer connection per day. The Elk River WWT plant used 1,138,145 kwh of electricity and 43,486 therms of natural gas through the Baseline 2015 year, while sanitary sewer line lift stations operated by the City required 382,154 kwh of electricity. Greenhouse Gas emissions associated with WWT operations total 1,303.58 Metric Tonnes (2,873,872 pounds) CO2e, equating to 0.09 ounces per gallon of waste water treated.

Water service in the City of Elk River is provided by Elk River Municipal Utilities (ERMU). Energy use and total emissions associated with the water utility are reported in the ERMU sections in this report.

* Sources: energy consumption as reported by City of Elk River, emission factors based on US EPA and Excel Energy,

Opportunities for Reduction

Recommendations:

- Engage a consultant team to conduct a detailed Facility Assessment and Energy Audit and develop an energy efficiency action plan for the City of Elk River Wastewater facilities.
- Explore the feasibility of installation of renewable energy generation to support City of Elk River wastewater functions.

Elk River GHG Baseline Inventory

How does City Operations Solid Waste contribute to Greenhouse Gas Emissions?

According to US EPA studies, traditional waste management contributes 1-5% of our collective GHG emissions in the United States. The processing and treatment of waste can produce emissions of several of the greenhouse gases. Even recycling of waste produces some greenhouse gas emissions, however, these are usually offset by the reduction in fossil fuel use that would be required to create a similar amount of product from raw resources.

The most prevalent greenhouse gas produced through municipal solid waste is the methane released during the breakdown of organic matter in landfills. Pound for pound, the cumulative climate change effect of methane is 25 times more potent than that of carbon dioxide. Additionally, municipal solid waste is frequently combusted, which produces CO2 as well as nitrous oxide (N2O) which is 298 times more potent than CO2 as a greenhouse gas.

Nationally, emissions from solid waste landfills total 301,203,000,000 pounds annually, creating a volume of man-made atmosphere equal to 2.7 Trillion cubic feet.

Summary of Findings*

The volume of the City facilities' solid waste handled are not currently measured by the City's waste handlers. Community wide total solid waste handled, total recycled waste, and totaled solid waste sent to landfill are recorded. Using this data to establish community-wide averages for waste volume for Elk River per capita, the total municipal solid waste (MSW) from City facilities can be estimated.

MSW handled from City of Elk River facilities for Baseline year 2015 is estimated to total 28.67 tons, or 474 pounds of waste annually per City employee (FTE). Using the community wide blended GHG factor for MSW handled, the GHG emissions associated with City of Elk River facility waste handled totals 8.6 Metric Tonnes (18,960 pounds) CO2e.

* Sources: Total waste handled data, and community waste characteristics based on Regional Indicators Initiative and MPCA. Blended emission factor per ton MSW handled based on Regional Indicators Initiative.

City Operations Solid Waste

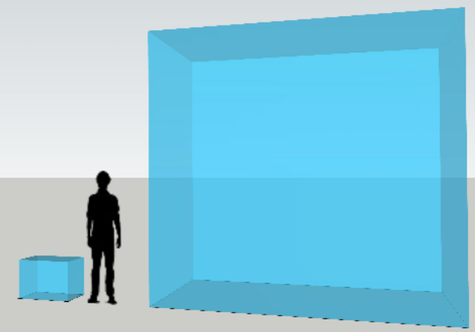
Annual Greenhouse Gas equal to:

8.60 Metric Tonnes

168,805 Cubic Feet of Man-Made Atmosphere

Annual emissions associated with solid waste generated at Elk River facilities totals:

1,395 Cubic Feet of man-made Atmosphere per employee (Figure to scale)



5.5 Cubic Feet per pound of solid waste (Figure to scale)

Opportunities for Reduction

We recommend that the City of Elk River conduct a detailed waste sort study to span a minimum of one full week of collection. The waste sort study should focus on total MSW collected, recycling materials collected, and waste characteristics. Data from this study combined with community wide data should reveal opportunities for increased efficiency and decreased total landfill waste stream.

Elk River GHG Baseline Inventory

City Operations Greenhouse Gas Emissions

GHG emissions for the 2015 City Operations Baseline year total 5,922.33 Metric Tonnes (13,056,487 pounds) CO2e, an emission rate of 31.92 Metric Tonnes per employee (FTE), or 42.57 pounds CO2e per City facility per year. The City Operations total GHG emissions represent 1.36% of Elk River community-wide GHG emissions*. City Operation emissions are as follows:

City Buildings and Grounds	3,252.68 Metric Tonnes	(54.92%)
Streetlights and Signals	266.18 Metric Tonnes	(4.49%)
City Vehicles	744.48 Metric Tonnes	(12.56%)
Employee Travel and Transportation	347.21 Metric Tonnes	(5.86%)
Water and Wastewater	1,303.58 Metric Tonnes	(22.01%)
Solid Waste	8.06 Metric Tonnes	(0.15%)
Total:	5,922.36 Metric Tonnes	(100%)

* Community Wide total as reported by Regional Indicators Initiative

Indirect GHG Emissions Not Included

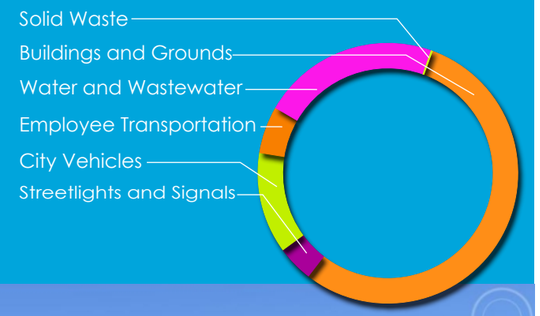
The total GHG emissions captured by this assessment do not do not include indirect emissions associated with city food and product purchases, or with services provided to the City of Elk River such as professional consulting. On average, indirect full supply chain emissions associated with products and services purchased equal 1 pound of CO2e per dollar spent.

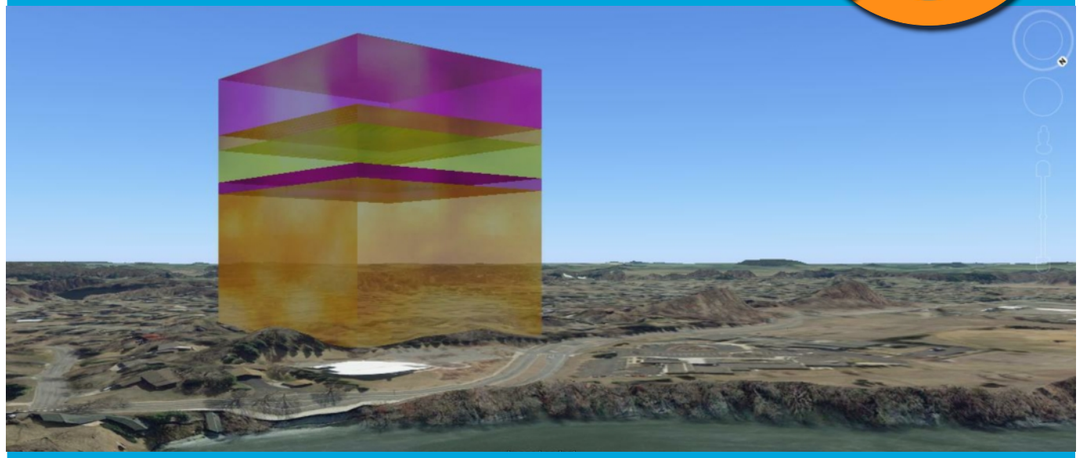
City Operations Total

Annual Greenhouse Gas equal to:

5,922.33 Metric Tonnes

116,202,806 Cubic Feet of Man-Made Atmosphere





Volume Visualization

The graphic above represents the volume of man-made GHG atmosphere produced annually by the City of Elk River operations, broken down by category, shown in scale with Elk River City Hall and Orono Lake in foreground.

Elk River Municipal Utilities
GHG Baseline Inventory

How do ERMU Operated Buildings and Grounds contribute to Greenhouse Gas Emissions?

According to the US Department of Energy, use for buildings accounts for 41% of the total US energy consumption nationally. Building heating and cooling, lighting, and electronic equipment use makes up nearly 70% of all commercial building energy use. In the two decades between 1980 and 2009, the total energy consumed by our buildings increased 49%.

Greenhouse gas emissions associated with that building energy use comes from direct emissions of fossil fuels burned on site (natural gas, fuel oil, etc), as well as indirectly from fossil fuels burned to create electricity off-site. The greenhouse gas emissions factor associated with on-site fuel use is directly related to the carbon content of the fuels burned (see Community Wide Energy Use for fuel factors). The emissions factor associated with electricity use varies based on the raw fuel sources used by the electrical utilities suppling the local electrical grid – utility providers who source more of their power through renewable energy sources, have

The US EPA identified energy intensity for Massachusetts water utilities at 1,500 kwh/MG. In a 2008 study in the state of New York, the energy consumption at drinking water facilities ranged from 600-1,080 kWh/MG. Beyond the United States, Global Water Research Coalition compiled energy data from their members and established energy use in water facilities globally to range from 378-3,823 kWh/MG, with typical values of 1,800 kWh/MG reported (GWRC 2008). Finally, the State of Wisconsin Energy Office which tracks energy use for water utilities within the State shows a median energy use of 1,810 kwh/MG for water utilities with 4,000 or more customers (largest category) and a median energy use for all water utilities regardless of size of 2,100 kwh/MG.

Summary of Findings*

For the ERMU Operations Baseline year of 2015, the ERMU facilities consumed a total of 2,156,469 kwh of electricity and 16,138 therms of natural gas. The GHG emission associated with ERMU buildings and grounds energy use for the Baseline year of 2015 totaled 1,767.61 Metric Tonnes (3,896,908 pounds) CO2e. Emissions associated with electricity use were 95.2% while natural gas use emissions equaled 4.8% of the total GHG emissions.

When Normalized for Weather, total annual energy consumption for ERMU buildings and grounds is adjusted downward 1.9% for electricity and upward 10% for natural gas. The resulting Weather Normalized annual Building and Grounds GHG increases 1.3% to a total of 1,744.96 Metric Tonnes.

* Sources: energy consumption as reported on B3 Benchmarking, emission factors based on US EPA and Excel Energy,

Opportunities for Reduction

For the Baseline year of 2015, ERMU facility energy use averaged 2,696kwh/MG of water produced. Based on the studies outlined above, this represents an energy use at 150% of both the GWRC global average as well as the Wisconsin State median for ERMU capacity class. If ERMU facility energy consumption could be optimized beyond its current levels to meet these averages of 1,800 kwh/MG, ERMU total greenhouse gas emissions could be reduced over 550 Metric Tonnes and a potential corresponding energy cost reduction of up to $55,000 annually (based on ERMU cost per kwh purchased).

Recommendations:

- Engage a consultant team to conduct a detailed Facility Assessment and Energy Audit and develop an energy efficiency action plan for the ERMU facilities.
- Explore the feasibility of installation of renewable energy generation on one or more ERMU facility.

Emissions associated with ERMU buildings and grounds equal:

51 Cubic Inches of man-made atmosphere for every gallon of water pumped.
(Figure to scale)

ERMU Operations Buildings and Grounds

Annual Greenhouse Gas equal to:

1,208.62 Metric Tonnes

23,714,540 Cubic Feet of Man-Made Atmosphere

78.85% ERMU Operations Total

Elk River Municipal Utilities

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Elk River Municipal Utilities
GHG Baseline Inventory

How do ERMU Vehicles contribute to Greenhouse Gas Emissions?

Fossil Fuels used in transportation produce GHG when burned, primarily CO2. In fact, the weight of CO2 produced actually exceeds the weight of the fuel burned. The amount of GHG produced by common vehicle fuels ranges from 19.4 pounds per gallon for gasoline to 22.5 pounds for diesel.

Nationally, Americans drive over 3 trillion miles annually, producing 1.2 billion Metric Tonnes of vehicle related GHG emissions.*

*For more information: http://www.bluedotregister.org/carbon-copy/2014/12/11/a-mountain-of-an-impact-the-carbon-footprint-of-american-roads

How can GHG emissions weigh more than the fuel we burn

?

According to the US EPA:

The amount of carbon dioxide (CO2) that is produced from burning a fuel weighs more than the amount of the fuel itself, because during complete combustion, each carbon atom in the fuel combines with two oxygen atoms in the air to make CO2. The addition of two oxygen atoms to each carbon atom forms CO2, which has an atomic weight of 44—roughly 3.6667 times the atomic weight of the carbon, which is 12.

Summary of Findings*

ERMU owns and operates vehicles as a critical support to all functions related to providing electrical and water utilities to its customers. During the 2015 Baseline year, ERMU's vehicle fleet used 14,310 gallons of gasoline and 6,930 gallons of diesel fuel. The emissions volume associated with the fleet's fuel consumption totaled 197.83 Metric Tonnes (436,139 pounds) CO2e, approximately 0.16% of community wide vehicle emissions**.

* Sources: City of Elk River data, emission factors based on US EPA and EIA.
**Based on Regional Indicators Initiative data.

Opportunities for Reduction

Recommendations from Greenstep Cities offer a range of best practice concepts which can greatly reduce municipal fleet fuel consumption when implemented and reviewed regularly for continued advancement. Best practices which Elk River Municipal Utilities may be able to leverage for continued fuel efficiency include:

Efficiently use existing fleet of ERMU vehicles by encouraging trip bundling, video conferencing, carpooling, vehicle sharing and incentives/technology.

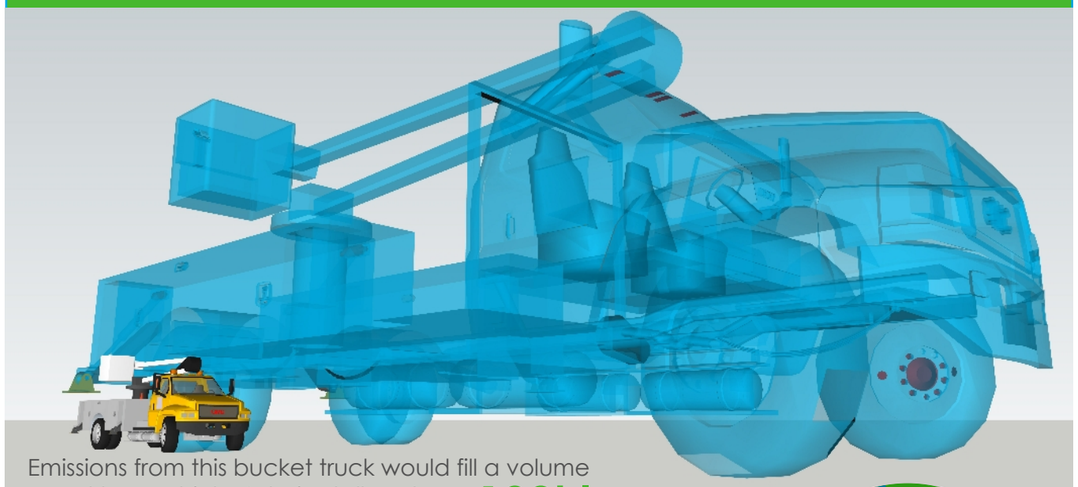
No-Idling practices and policies

Vehicle replacement plan to migrate to electric and hybrid vehicles.

Explore Efficiency Programs focused on diesel engine retrofits, installation of auxiliary power units

Volume Visualization

On average, the emissions from each ERMU vehicle produce a quantity of man-made atmosphere filling a volume **163 times** the size of the vehicle.



Emissions from this bucket truck would fill a volume equal to a vehicle 4 stories tall and over **130' long**

ERMU Operations
ERMU Vehicles

Annual Greenhouse Gas equal to:

197.83 Metric Tonnes

3,881,696 Cubic Feet of Man-Made Atmosphere

12.91% ERMU Operations Total

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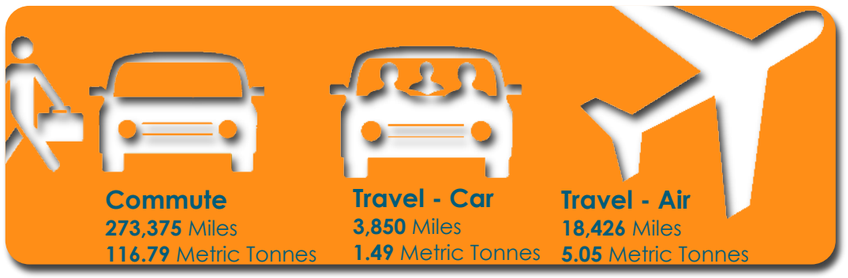
Elk River Municipal Utilities
GHG Baseline Inventory

How does Employee Transportation contribute to Greenhouse Gas Emissions?

ERMU's operational travel and transport emissions come from three primary sources: employee commute to and from work, auto-oriented business travel within region, and business air travel regionally/nationally.

Employee travel to and from work and required business travel regionally and out of state require fossil fuel use. The amount of GHG produced by common transportation fuels ranges from 19.4 pounds per gallon for gasoline to 21.5 pounds for jet fuel and 22.5 pounds for diesel.



Summary of Findings*

Using the City of Elk River's city employee commuter survey as a basis for ERMU employee commute, the average round-trip employee commute distance is 26.07 compared with the US Census estimated community-wide average of 38 miles. Employee work commutes surveyed by the City are entirely in single occupant vehicle. Based on these statistics, the total annual vehicle miles traveled for ERMU employee commute is estimated at 273,375 miles annually. Total ERMU employee commuter emissions for the 2015 Baseline year are estimated at 116.79 Metric Tonnes (257,478 pounds) CO2e.

Business travel for ERMU employees through the Baseline 2015 year totaled 3,850 miles for road transportation and 18,426 miles for air transportation. Annual emissions associated with this business travel equal 1.49 Metric Tonnes for auto, and 5.05 Metric Tonnes for air for a total of 6.45 Metric Tonnes (14,220 pounds) CO2e.

The 123.33 Metric Tonnes associated with these three ERMU Operations travel and transportation equal 0.1% of Community Wide travel and transportation emissions.**

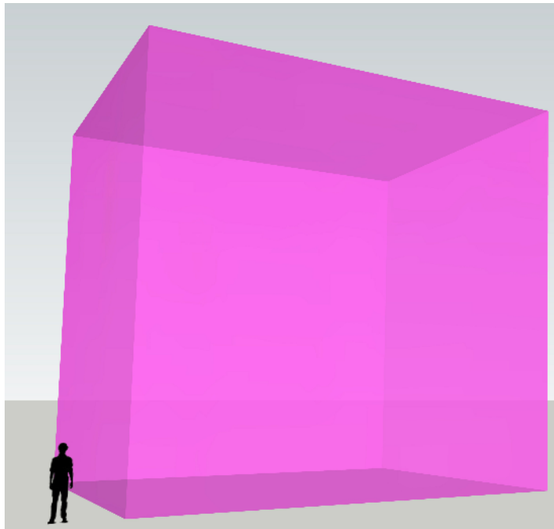
* Sources: City of Elk River data, emission factors based on US EPA and EIA. Calculations for car business travel were calculated based on current reimbursement rates. Calculations for air business travel were calculated based on national average cost-per-mile data http://airlines.org/data/annual-round-trip-fares-and-fees-domestic/
** Community-wide total travel and transportation GHG emissions total 124,096 Metric Tonnes. Source Regional Indicators Initiative.

Opportunities for Reduction

Business Travel Optimization by encouraging trip bundling, video conferencing, carpooling, vehicle sharing and incentives/technology.

Explore Partnership with Nice Ride Minnesota for installation of bike sharing locations convenient to city staff as well as community members as strategy to increase commute via public transit and bike.

Implement Public Transit Commuter Campaign by building awareness through communicating public transit routes, establish carpool groups, and communicate reimbursement potentials available under December 2015 US Consolidated Appropriations Act (HR 2029)
http://www.nctr.usf.edu/programs/clearinghouse/commutebenefits/



Emissions associated with employee commute
And business travel total

57,615

Cubic Feet of man-made atmosphere per ERMU employee (Figure to scale)

ERMU Operations Employee Transportation

Annual Greenhouse Gas equal to:

123.33 Metric Tonnes

2,419,832 Cubic Feet of Man-Made Atmosphere

8.05% ERMU Operations Total

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Elk River Municipal Utilities
GHG Baseline Inventory

How does ERMU Operations Solid Waste contribute to Greenhouse Gas Emissions?

According to US EPA studies, traditional waste management contributes 1-5% of our collective GHG emissions in the United States. The processing and treatment of waste can produce emissions of several of the greenhouse gases. Even recycling of waste produces some greenhouse gas emissions, however, these are usually offset by the reduction in fossil fuel use that would be required to create a similar amount of product from raw resources.

The most prevalent greenhouse gas produced through municipal solid waste is the methane released during the breakdown of organic matter in landfills. Pound for pound, the cumulative climate change effect of methane is 25 times more potent than that of carbon dioxide. Additionally, municipal solid waste is frequently combusted, which produces CO2 as well as nitrous oxide (N2O) which is 298 times more potent than CO2 as a greenhouse gas.

Nationally, emissions from solid waste landfills total 301,203,000,000 pounds annually, creating a volume of man-made atmosphere equal to 2.7 Trillion cubic feet.

Summary of Findings*

The volume of the ERMU facilities' solid waste handled are not currently measured by the Utility's waste handlers. Community wide total solid waste handled, total recycled waste, and totaled solid waste sent to landfill are recorded. Using this data to establish community-wide averages for waste volume for Elk River per capita, the total municipal solid waste (MSW) from ERMU facilities can be estimated.

MSW handled from ERMU facilities for Baseline year 2015 is estimated to total 9.95 tons, or 474 pounds of waste annually per ERMU employee (FTE). Using the community wide blended GHG factor for MSW handled, the GHG emissions associated with ERMU facility waste handled totals 2.99 Metric Tonnes (6,592 pounds) CO2e.

* Sources: Total waste handled data, and community waste characteristics based on Regional Indicators Initiative and MPCA. Blended emission factor per ton MSW handled based on Regional Indicators Initiative.

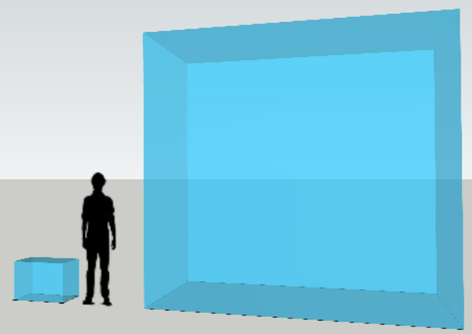
Opportunities for Reduction

We recommend that Elk River Municipal Utilities conduct a detailed waste sort study to span a minimum of one full week of collection. The waste sort study should focus on total MSW collected, recycling materials collected, and waste characteristics. Data from this study combined with community wide data should reveal opportunities for increased efficiency and decreased total landfill waste stream.

Annual emissions associated with solid waste generated at ERMU facilities totals:

1,395
Cubic Feet of man-made Atmosphere per employee (Figure to scale)

5.5
Cubic Feet per pound of solid waste (Figure to scale)

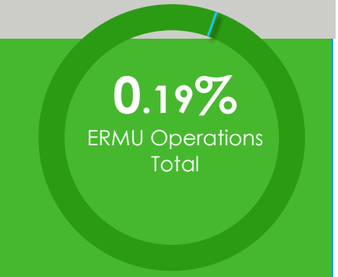


ERMU Operations Solid Waste

Annual Greenhouse Gas equal to:

2.99 Metric Tonnes

58,594 Cubic Feet of Man-Made Atmosphere



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Elk River Municipal Utilities
GHG Baseline Inventory

ERMU Operations Greenhouse Gas Emissions

For the Baseline year 2015, Elk River Municipal Utilities (ERMU) pumped a total of 799,974,000 gallons of water serving 4,762 customers and sold a total of 282,265,268 kwh to 10,499 customers. Electricity sold by ERMU is produced by third party entities and the operational emissions associated with their electricity production are not included in this report.

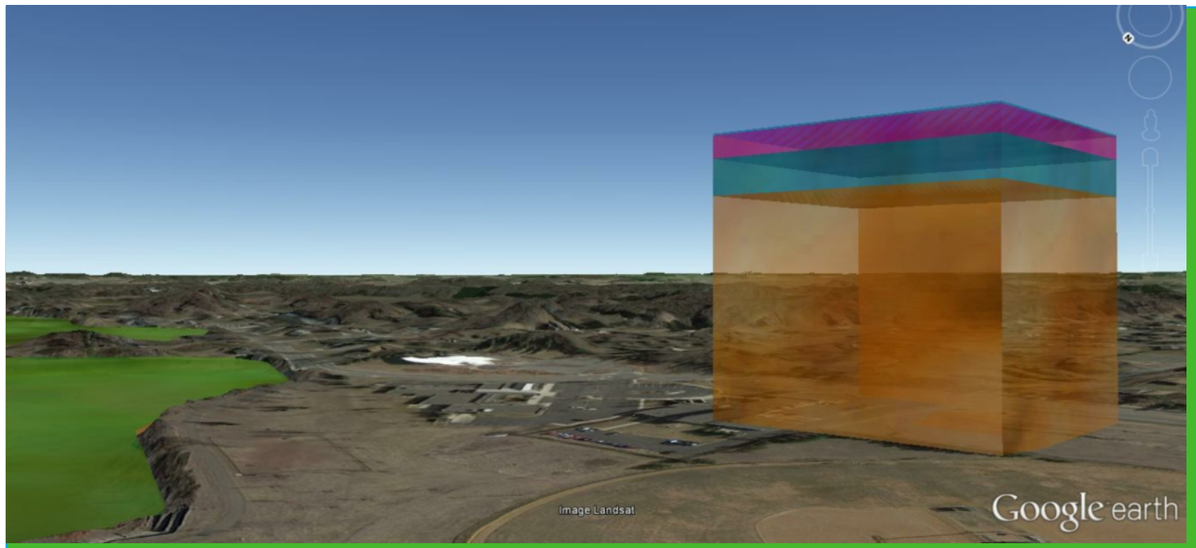
GHG emissions for the 2015 ERMU Operations Baseline year total 1,532.77 Metric Tonnes (3,379,175 pounds) CO2e, an emission rate of 36.49 Metric Tonnes per employee (FTE), or 3.38 pounds CO2e/MG water pumped. The City Operations total GHG emissions represent 0.35% of Elk River community-wide GHG emissions*. ERMU Operation emissions are as follows:

ERMU Buildings and Grounds	1,208.62 Metric Tonnes	(78.85%)
ERMU Vehicles	197.83 Metric Tonnes	(12.91%)
Employee Travel and Transportation	123.33 Metric Tonnes	(8.05%)
Solid Waste	2.99 Metric Tonnes	(0.19%)
Total:	1,533.62 Metric Tonnes	(100%)

Indirect GHG Emissions Not Included

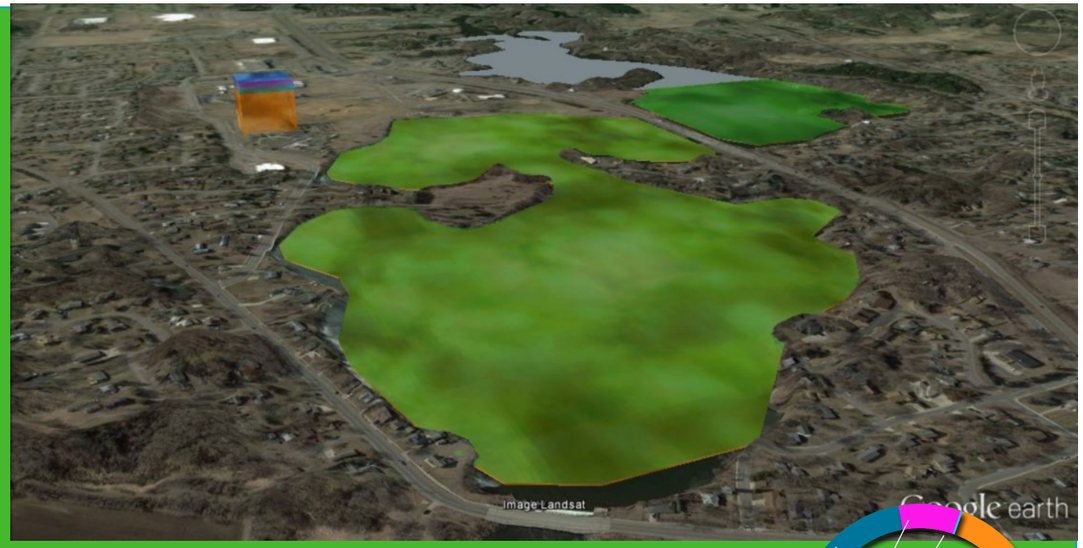
The total GHG emissions captured by this assessment do not do not include indirect emissions associated with ERMU food and product purchases, or with services provided to Elk River Municipal Utilities such as professional consulting. On average, indirect full supply chain emissions associated with products and services purchased equal 1 pound of CO2e per dollar spent.

* Community Wide total as reported by Regional Indicators Initiative



Volume Visualization

The graphic above represents the volume of man-made GHG atmosphere produced annually by the Elk River Municipal Utilities operations, broken down by category. The volume of atmosphere is equal to a cube 311 feet on each face, with a total volume approximately **60%** the volume of Orono Lake, illustrated to the right.

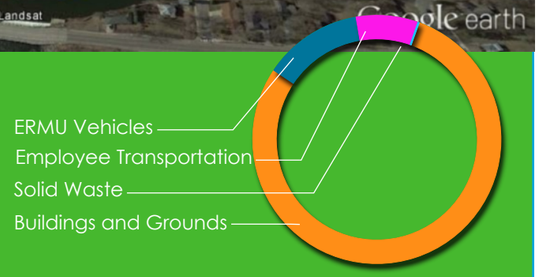


ERMU Operations Total

Annual Greenhouse Gas equal to:

1,532.77 Metric Tonnes

30,074,661 Cubic Feet of Man-Made Atmosphere



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