City of Mission 2022 Community & Municipal Greenhouse Gas Emissions Inventory Report

LOTUS
Engineering & Sustainability

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Executive Summary

In response to the regional Climate Action Plan by MARC and Climate Action KC, the City of Mission formed a Climate Action Task Force in early 2022. The Climate Action Task Force was charged with developing 1-, 3-, and 5-year climate action strategies for the City. The Task Force also recommended the following City-specific emission-reduction goals: net-zero emissions for local government operations by 2025, net-zero emissions for energy generation by 2035, and net-zero emissions for homes and buildings by 2035. To reach these goals, the city is updating its greenhouse gas (GHG) inventory, the last inventory having been completed with 2005 as the baseline. Contained in this report are data for the most recent greenhouse gas inventory for 2022 community and municipal operations. Mission will be able to use this data to inform GHG reduction strategies and track reductions.

Community Emissions

Mission's 2022 community GHG emissions totaled 173,390 metric tons of carbon dioxide equivalent (mt CO_2e) and included all GHG emissions generated in Mission from building energy use, transportation, and waste. Broken down by sector, the three-largest contributors of emissions were commercial buildings (39% of total emissions), transportation (32%), and residential buildings (21%). These sectors were followed by waste and wastewater emissions at 8% and refrigerant emissions at 0.2%. See Figure ES 1 below for the breakdown of sector emissions.

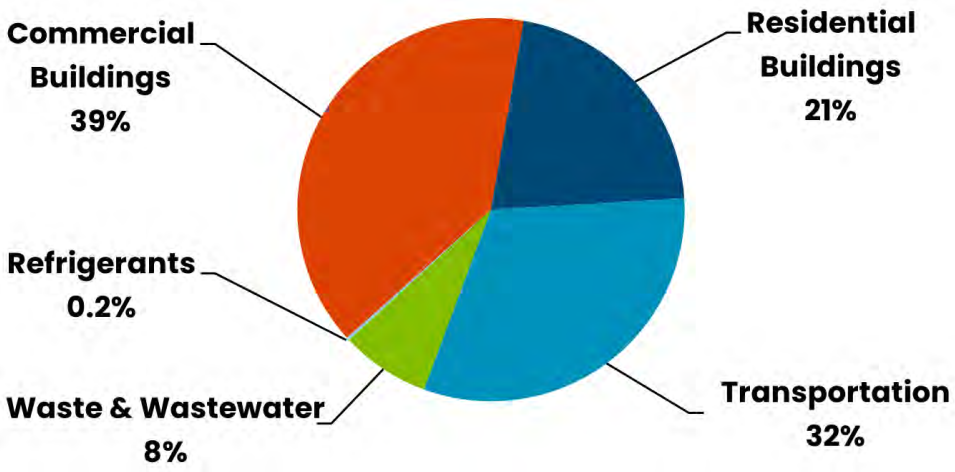

Figure ES 1. Total 2022 community-wide GHG emissions by sector.

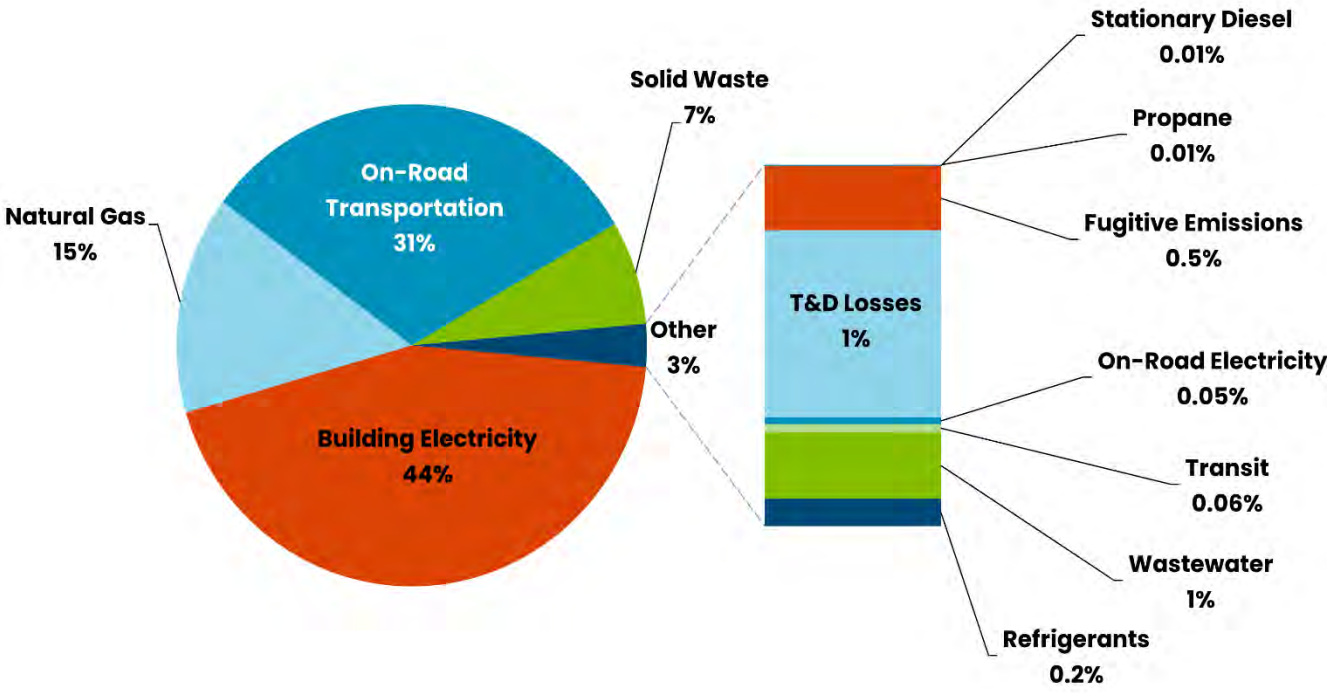

Figure ES 2. Total 2022 community-wide GHG emissions by source.

Each emissions sector is comprised of several emissions sources. For Mission in 2022, the three-largest sources of community emissions were building electricity (44% of total emissions), on-road transportation (31%), and natural gas (15%). Solid waste came next (7%), followed by the remaining sources that, combined, make up 3% of total emissions. A breakdown of emissions sources can be seen above in Figure ES 2.

Municipal Emissions

Mission's 2022 municipal operations GHG emissions totaled 19,156 metric tons (11% of Mission's community emissions) of carbon dioxide equivalent (mt CO_2e) and included all GHG emissions generated by Mission's municipal operations, including building energy use, transportation, waste, and consumption. A detailed breakdown of municipal emissions can be found later in this report.

The 2022 GHG inventories reflect the City's advancement toward its climate goals. However, continual action is needed to meet the City's goals and limit environmental impact. These inventories provide a way for Mission to recognize opportunities for emissions reductions and encourage and prioritize sustainable action in future planning and policy.

Overview

To help achieve Mission's goals to reduce greenhouse gas (GHG) emissions and combat the realities and consequences of the changing climate, the City has completed an updated community-wide GHG inventory to measure and identify the sources of GHG emissions. An additional inventory was completed to identify GHG emission sources from municipal operations. GHG emissions are heat-trapping gases that contribute to climate change through atmospheric warming and are often produced as a result of fossil-fuel combustion and other human activities. This report focuses on the calendar year of 2022. Conducting inventories regularly is important because it allows for frequent checking of emissions totals and helps track emissions reduction goals. The City is evaluating the frequency with which to update inventories going forward.

Lotus Engineering and Sustainability, LLC (Lotus) was hired to complete the 2022 community and municipal GHG emissions inventories alongside City staff. The community inventory was developed using the methodology outlined in the Global Protocol for Community-Scale GHG Inventories (GPC) for a BASIC inventory. BASIC inventories include emissions generated from building energy, transportation, waste and industrial processes and product use. The municipal operations GHG inventory was developed using the Local Government Operations Protocol (LGOP). Additional emissions sources (BASIC+ sources) were calculated for Mission. These included emissions from refrigerant leakage (Scope 1 BASIC+) and transmission and distribution losses (Scope 3 BASIC+). A full description of scopes is available later in this report.

The following report reviews 2022 GHG emissions sectors and sources, and progress toward Mission's sustainability goals.

Figure 1. Mission cityscape along Johnson Drive.

2022 Community GHG Emissions

Emissions Overview

In 2022, community GHG emissions in Mission totaled 173,390 metric tons of carbon dioxide equivalent (mt CO_2e). Commercial electricity was the largest source of GHG emissions for Mission in 2022, producing 56,250 mt CO_2e or 33 percent of all emissions. Figure 2 (below) shows the percentage of emissions produced by each sector and source, while Table 1 shows the quantity of emissions. Emissions from each sector are described in more detail in the following sections.

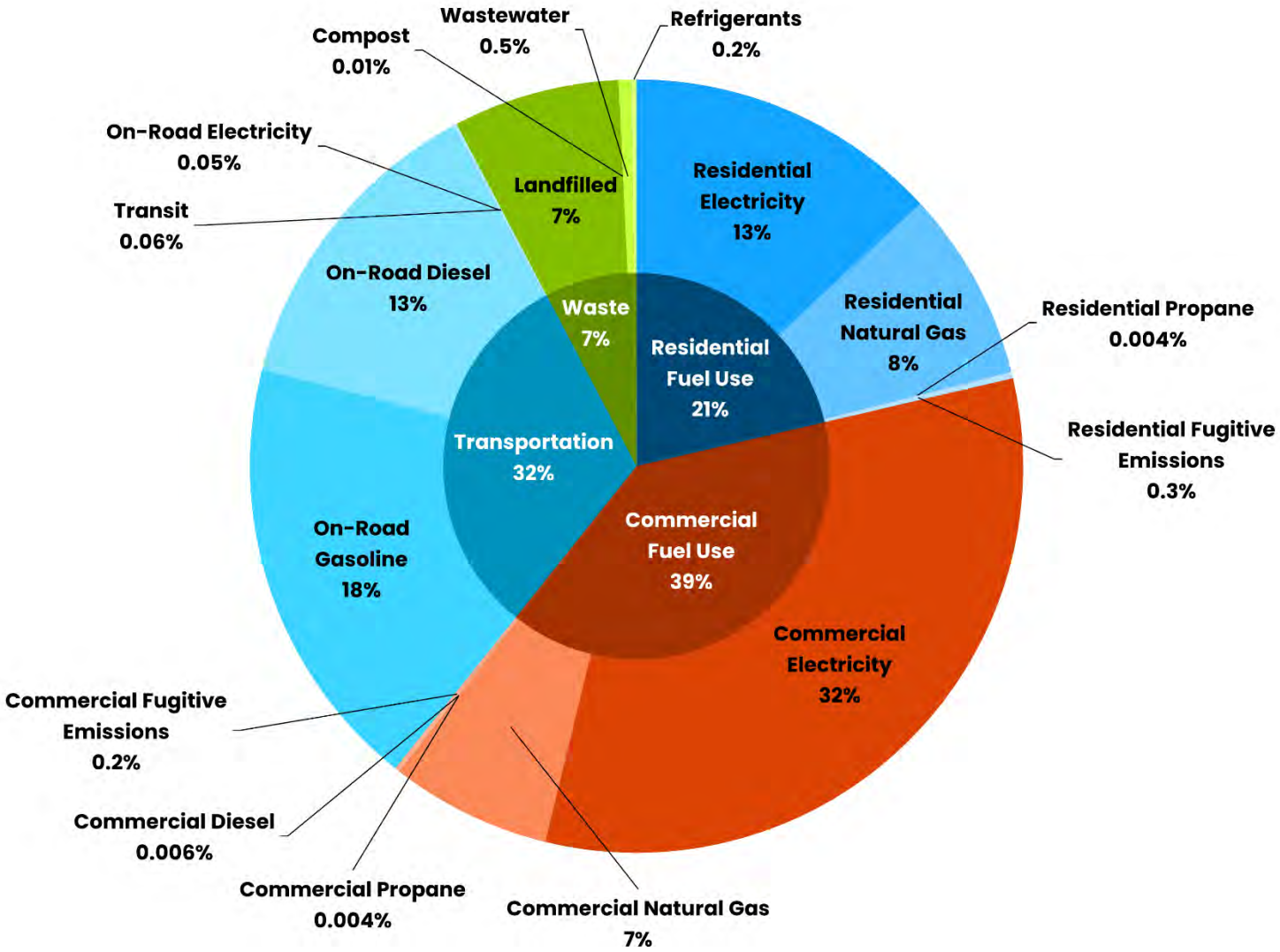

Figure 2. Mission's 2022 community emissions by sector and source.

Table 1. Mission 2022 community GHG emissions by sector and source.

Emissions Sources	Scope	Emissions ($mtCO_2e$)		Percent
Residential Fuel Use	**1, 2**	**37,018**		**21%**
Residential Electricity	2		22,733	13%
Residential Natural Gas	1		13,799	8%
Residential Propane	1		9	0.004%
Residential Fugitive Emissions	1		479	0.3%
Commercial Fuel Use	**1, 2**	**68,275**		**39%**
Commercial Electricity	2		56,250	32%
Commercial Natural Gas	1		11,606	7%
Commercial Propane	1		6	0.004%
Commercial Stationary Diesel	1		11	0.01%
Commercial Fugitive Emissions	1		403	0.2%
Transportation	**1, 2**	**54,737**		**32%**
On-Road Gasoline	1		31,713	18%
On-Road Diesel	1		22,822	13%
On-Road Electricity	2		91	0.05%
Transit	1		112	0.06%
Waste	**3**	**12,981**		**7%**
Landfilled	3		12,056	7%
Compost	3		11	0.01%
Wastewater	3		914	0.5%
Industrial Processes and Product Use	**1**	**379**		**0.2%**
Refrigerant Leaks	1		379	0.2%
Total		**173,390**		**100%**

Emissions By Scope

Emission sources fall into one of three scope categories, detailed below. Mission worked with Lotus to determine which emission sources occurred within Mission's city boundary and chose to measure the Scope 3 sources that Mission had some level of control over the reduction of GHG emissions over time.

- **Scope 1** includes GHG emissions from sources within the City boundary, such as building fuel use (other than electricity; see Scope 2 notes below) or vehicle activity within the City. Refrigerant leakage emissions are also included as a Scope 1 BASIC+ source.
- **Scope 2** includes emissions from the use of grid-supplied electricity, heat, steam, and cooling within the City boundary. The only Scope 2 emission source for Mission is grid-supplied electricity.
- **Scope 3** emissions include all other GHG emissions occurring outside the City as a result of activities within the City boundary. For example, waste is a Scope 3 emission for Mission, as waste is taken to a landfill outside of City limits for disposal. Transmission and distribution (T&D) losses are also included as a Scope 3 BASIC+ source.

Scope 1 emissions accounted for 47 percent of Mission's total emissions (82,250 mt CO_2e). On-road transportation and natural gas usage were the largest contributors to Scope 1 emissions. Scope 2 emissions from grid-supplied electricity made up 44 percent of total

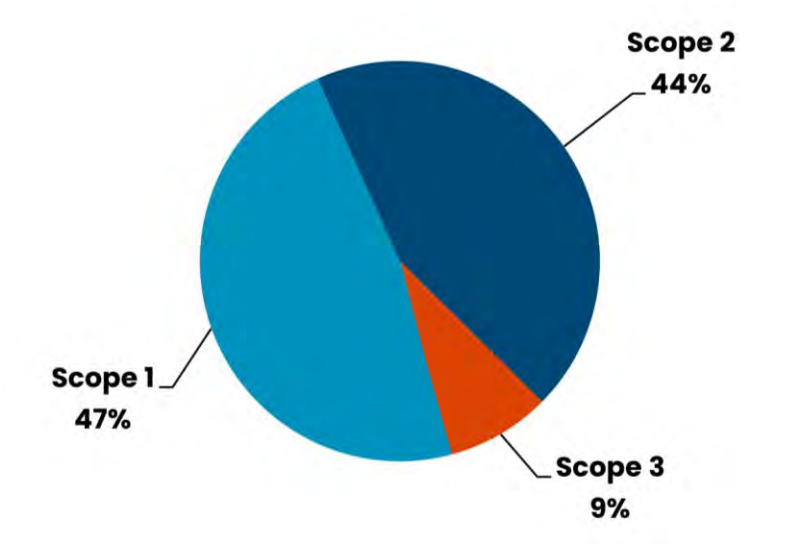

Figure 3. Community emissions by scope.

emissions from the City (76,500 mt CO_2e). Scope 3 emissions made up 9 percent of Mission's emissions (14,640 mt CO_2e). Figure 3 shows the percentage of emissions from each scope.[1]

Emissions By Sector

Emissions sectors are the broad categories of activities that result in GHG emissions. Mission's inventory is split into the following emissions sectors:

- Building Energy (including residential fuel use and commercial fuel use)
- Transportation (including on-road vehicles and transit)
- Waste and Wastewater Treatment (including landfilled waste, compost, and wastewater treatment)
- Industrial Processes and Product Use (including refrigerant leakage)

Each emissions sector contains individual sources, which represent the specific activities resulting in the emissions. Emissions sectors and the sources within them are further discussed in the following subsections.

With a population of 9,864 in 2022, emissions per resident were approximately 18 mt CO_2e. Regional, national, and international emissions are shown in Table 2. In 2019, national per capita emissions totaled 15 mt CO_2 and international per capita emissions totaled 4 mt CO_2e.

Table 2. Annual emission intensities.

Metric	Annual Emissions (mt CO_2e)
Mission per capita (2022)	18
National per capita (2019)[2]	15
Kansas City Regional per capita (2015)[3]	14
Johnson County, KS per capita (2020)[4]	13
International per capita (2019)[4]	4

[1] As noted above, additional Scope 1 and Scope 3 emission sources (sometimes referred to as BASIC+ sources) from refrigerant leaks and transmission and distribution (T&D) losses were calculated for the 2022 inventory.

[2] National and international annual per capita GHG emission data are from The World Bank: CO_2 emissions (metric tons per capita). Data are from 2019 and are assumed to be more comparable to 2022 data due to the pandemic affecting data in 2020-2021. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC.

[3] Calculated from: https://kcmetroclimateplan.org/wp-content/uploads/2021/05/Climate-Action-Plan.pdf.

[4] Calculated from: https://www.jocogov.org/sites/default/files/files/2023-03/2020%20Greenhouse%20Gas%20Inventory%20Update.pdf

STATIONARY ENERGY

The stationary energy sector includes emissions from buildings, primarily from electricity and natural gas usage. Other sources of stationary energy emissions include propane and stationary diesel combustion. Fugitive emissions, or emissions from the sourcing and transport of natural gas, are also included.

Emissions from stationary energy accounted for 61 percent of Mission's GHG emissions (105,293 mt CO_2e). Figure 4 (below) breaks down the specific sources of stationary energy emissions. Overall, electricity use, including T&D losses, accounted for 75 percent (91,205 mt CO_2e) of stationary energy emissions, and natural gas, including fugitive emissions, made up 25 percent (26,286 mt CO_2e). Propane and stationary diesel together accounted for less than one percent of stationary energy emissions (24 mt CO_2e).

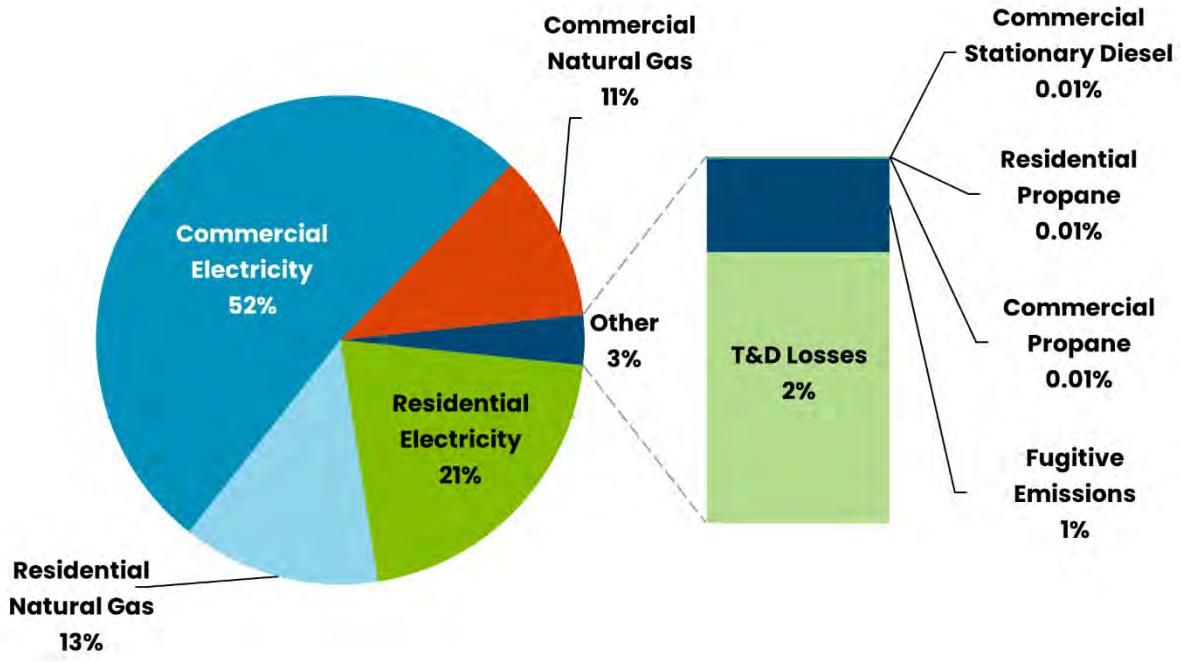

Figure 4. Mission's 2022 community stationary energy use sector emissions.

Splitting energy use by building type provides a more detailed understanding of the sources contributing to stationary energy emissions. In 2022, commercial buildings (e.g., shops, offices, hotels, warehouses, and other places of business) accounted for 65 percent of Mission's stationary energy emissions (69,275 mt CO_2e), while homes made up 35 percent of stationary energy emissions (37,018 mt CO_2e). Commercial electricity use was the largest individual source of stationary energy emissions (54,419 mt CO_2e). Commercial natural gas emissions, including fugitive emissions (12,008 mt CO_2e), were lower than residential natural

gas emissions (14,278 mt CO_2e). Commercial and residential propane usage, as well as commercial stationary diesel usage, were minimal, making up less than one percent of emissions.

TRANSPORTATION

The transportation sector accounted for 32 percent of Mission's total GHG emissions (54,737 mt CO_2e). Figure 5 (below) provides a breakdown of the contributing sources to emissions from the transportation sector. This sector includes emissions from various types of vehicles, including motorcycles, passenger vehicles, gas hybrid electric vehicles, battery electric vehicles, plug-in hybrid electric vehicles, buses, and trucks. The GPC requires that on-road emissions are calculated from the following three types of vehicle miles traveled:

- Trips that originate and end in-boundary.
- Trips that originate in the city and terminate outside the city.
- Trips that originate outside the city and terminate in the city.

On-road gasoline vehicles contributed the most to transportation emissions, making up 58% (31,713 mt CO_2e). On-road diesel vehicles were the second-largest source of transportation emissions, making up 42% (22,822 mt CO_2e). Transit, electric vehicles, and T&D losses from electric vehicles together made up under 1% of total transportation emissions. As of 2022, there were 43 electric vehicles registered in Mission, including 40 battery electric vehicles and 3 plug-in hybrid electric vehicles[5].

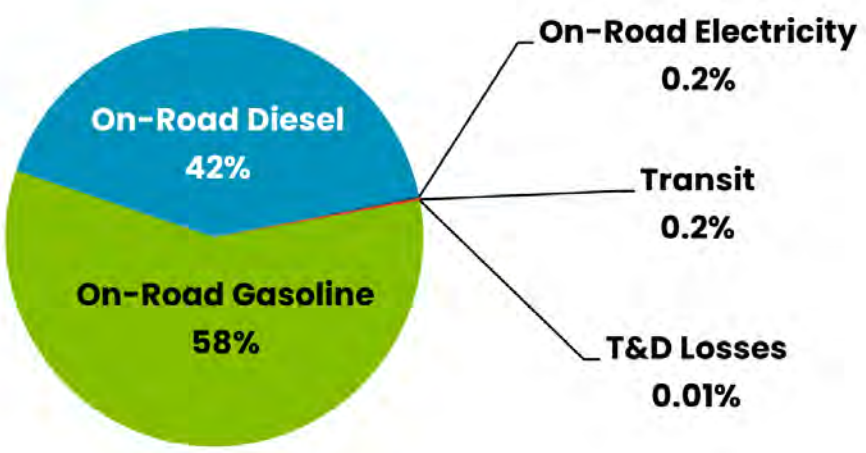

Figure 5. Mission's 2022 community transportation sector emissions.

[5] Data provided by Mid-America Regional Council. Source data included number of EVs by county. Lotus scaled the data down by population.

Waste & Wastewater

Waste and wastewater emissions made up 7 percent of Mission's total 2022 emissions (12,981 mt CO_2e).

All landfilled waste and compost generated in Mission is disposed of outside the city boundary (Table 3). Solid or landfilled waste made up the majority of waste emissions at 93% (12,056 mt CO_2e, Figure 6). Compost emissions were negligible, making up 0.1% of waste emissions (11 mt CO_2e). Wastewater treatment made up 7% of waste emissions (914 mt CO_2e). All wastewater produced in Mission is treated at the Nelson wastewater treatment plant in Mission. The Nelson plant is currently undergoing facility upgrades and improvements which, once completed, could reduce emissions from wastewater treatment processes.

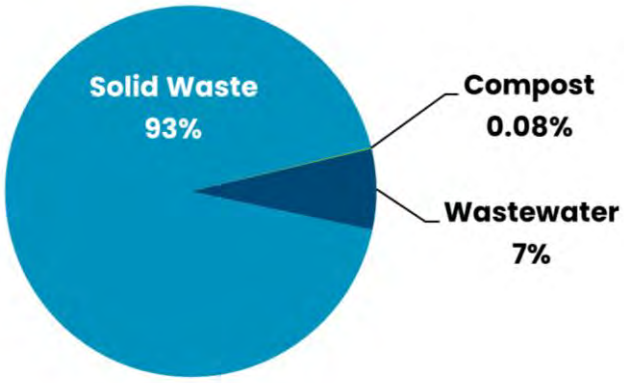

Figure 6. Mission's 2022 waste emissions breakdown.

Table 3. Waste, recycling, and compost tonnages in Mission in 2022.

Waste Type	Tons
Landfill	10,789
Recycling	260
Compost	142
2022 Waste Diversion Rate: 3.6%	
2018 US National Diversion Rate: 32.1[6]	

Industrial Processes and Product Use

The only source of emissions within this sector is refrigerant leaks. This data point accounts for any emissions that occur from commercial air conditioning leakage. For Mission in 2022, this refrigerant leakage produced 379 mt CO_2e, comprising only 0.2% of Mission's total emissions.

BASIC+ Emissions

As noted earlier, BASIC+ emissions from refrigerant leakage and electricity transmission and distribution (T&D) losses were calculated for the 2022 inventory. **Together these sources accounted for 2,953 mt CO_2e, approximately 2% of overall emissions.**

[6] National Overview: Facts and Figures on Materials, Wastes and Recycling Accessed June 1, 2023.

T&D losses represent electricity that is generated but does not reach intended customers due to inefficiencies in the transmission and distribution systems. These losses can vary year-to-year and can be reduced through the utility making updates to the grid. In 2022, it was estimated that 3.36% of electricity did not make it to the intended customer resulting in approximately 5 million kWh being lost on the way to Mission. Total emissions from these losses are 2,570 mt CO_2e. See Industrial Processes and Product Use section for information on refrigerant leakage.

Year-over-year Comparison

The previous inventory for Mission was completed in 2008 with data for the years 2005, 2006, and 2007. Mission's baseline year against which the City set GHG reduction targets is 2005, when emissions totaled 421,844 mt CO_2e. Not all emissions sources included in 2022 were included in the 2005 GHG inventory. The comparable emissions sources are: electricity use, natural gas use, on-road transportation, and landfilled waste. Looking at comparable emissions, the city has reduced emissions 61% since 2005 (163,030 mt CO_2e in 2022). When comparing all emissions sources between inventories, emissions reduced 59% (Table 4).

Table 4. Emissions and activity data comparisons between inventories.

Emissions by Sector								
Emission Source	**2005 Emissions (mt CO2e)**	**2005 Activity (MMBtu)**	**2007 Emissions (mt CO2e)**	**2007 Activity (MMBtu)**	**2022 Emissions (mt CO2e)**	**2022 Activity (MMBtu)**	**% Change (2005-2022)**	**% Change (2007-2022)**
Commercial and Industrial Buildings	114,773	664,899	111,514	638,103	68,275	582,952	-41%	-39%
Residential Buildings	59,081	445,691	58,583	433,107	37,018	406,814	-37%	-37%
Transportation	249,999	2,914,080	242,680	2,831,554	54,737	756,186	-78%	-77%
Transportation (Estimated using GPC Protocol)	69,421	815,942	67,950	792,835	54,737	756,186	-21%	-19%
Waste & Wastewater	(2,009)	N/A	(2,009)	N/A	12,981	N/A	746%	746%
IPPU	N/A	N/A	N/A	N/A	379	N/A	N/A	N/A
Total	**421,844**		**410,768**		**173,390**		**-59%**	**-58%**
Total (GPC Protocol)	**243,275[7]**		**238,047[6]**		**173,390**		**-28.7%**	**-27.2%**

It should be noted that in the previous inventory transboundary trips on I-35 were included in the total vehicle miles traveled and in emissions calculations. These trips are not included in the 2022 inventory as subsequent GHG inventory protocols explicitly state that pass through trips should not be included. Additionally, there are differences in calculations

[7] Does not include negative emissions from Waste & Wastewater. See Appendix A for more detail.

between the original inventory and this most recent update due to the implementation of protocols to help cities standardize emissions calculations across jurisdictions and to help emissions calculations be repeatable over time. See Appendix A for more detail. In order to reach net-zero emissions by 2050, Mission will need to reduce its emissions 8% per year, or approximately 8,100 mt CO_2e per year.

2022 Municipal GHG Emissions

Emissions by Sector

The City's internal emissions in 2022 totaled 19,156 mt CO_2e. This is approximately 11% of total community emissions. Mission's municipal emissions were broken down into five sectors: stationary energy, transportation, waste, refrigerants, and consumption-based sources. The consumption-based sector created the most emissions, making up 81 percent of all municipal emissions (15,480 mt CO_2e). Consumption-based sources include emissions from asphalt and cement use, food purchases, computer and hardware purchases, paper purchases, and well-to-wheel emissions (emissions from the transport of gasoline and diesel from the well to the gas station). The stationary energy sector came next, comprising 9% of emissions (1,690 mt CO_2e). The transportation sector made up 7% of municipal emissions (1,422 mt CO_2e), which includes emissions from City fleet vehicles and equipment, employee commuting, and business travel. Refrigerant emissions comprised 2% of total emissions (334 mt CO_2e) and waste emissions comprised 1% of municipal emissions (230 mt CO_2e).

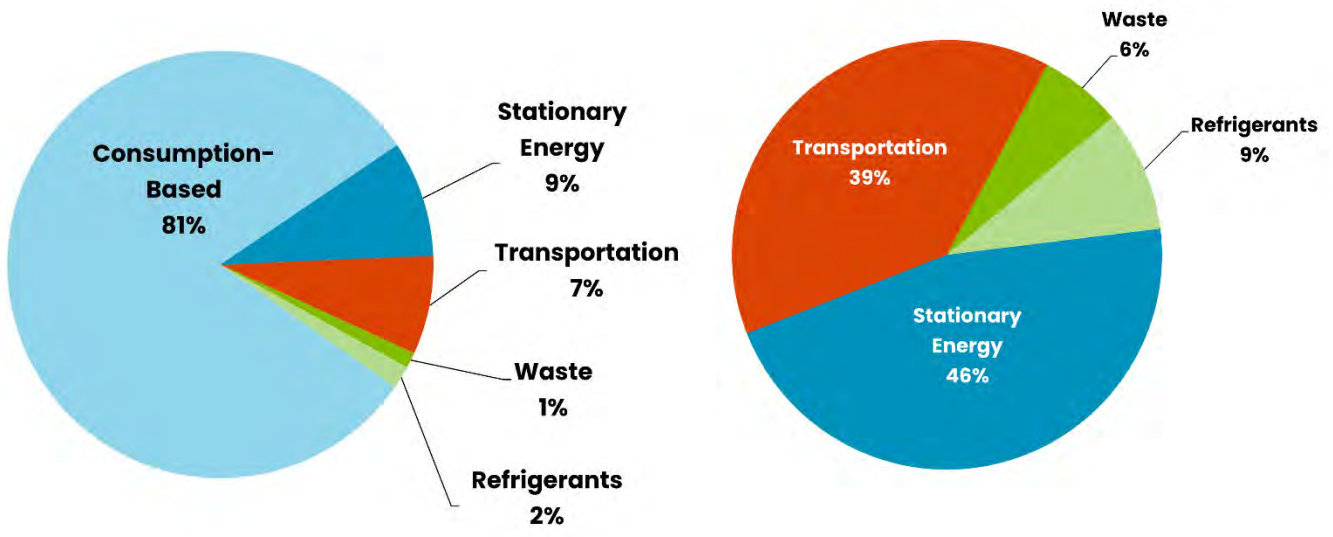

Figure 7. Mission's 2022 municipal emissions by sector including consumption-based emissions (left) and excluding consumption-based emissions (right).

Excluding consumption-based emissions provides a clearer understanding of the other sectors' impacts. Without including these emissions, the stationary energy sector makes up 46% of municipal emissions. This is followed by the transportation sector at 39%, refrigerant emissions at 9%, and waste emissions at 6%. See Figure 7 above.

Emissions by Source

Mission's largest source of municipal emissions in 2022 was cement. Emissions from cement production made up 79% of municipal emissions (15,037 mt CO_2e). The second-largest source of emissions was electricity use at 7% (1,231 mt CO_2e). This was followed by employee commuting emissions at 6% (1,159 mt CO_2e). See Figure 8 below and Table 5.

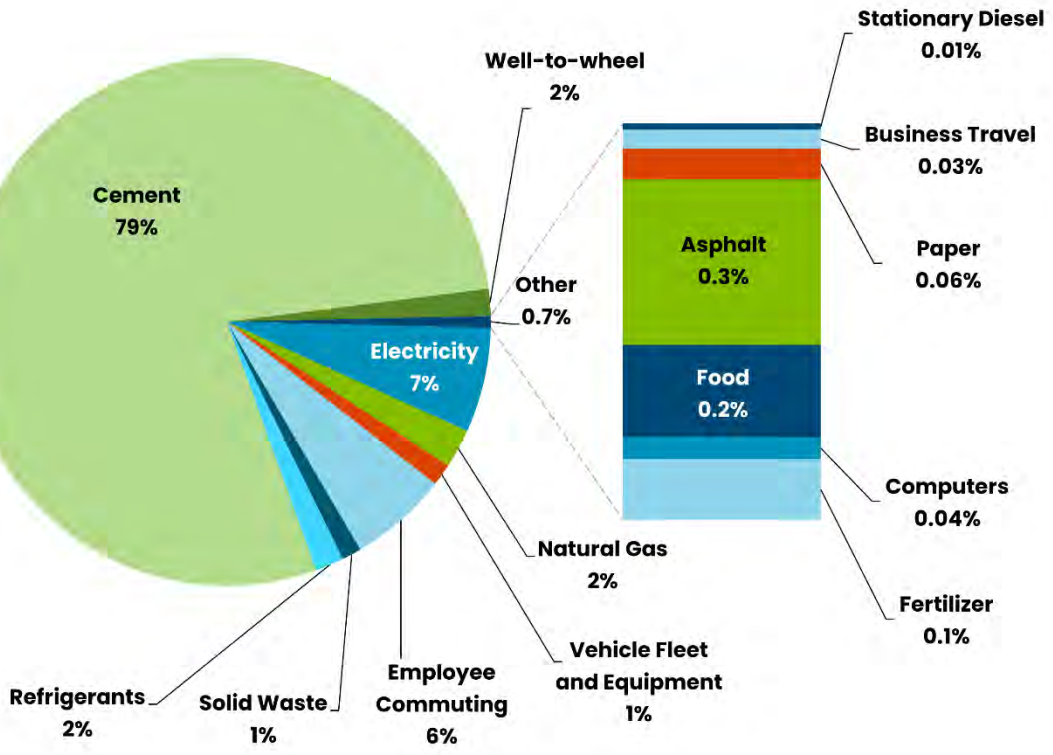

Figure 8. Mission's 2022 municipal emissions by source (including consumption-based).

Table 5. 2022 municipal operations GHG emissions by source.

Emission Source	Emissions (mt CO2e)	% of Total
Cement	15,037	78%
Electricity	1,231	7%
Employee Commuting	1,159	6%
Natural Gas	457	2%

Refrigerants	334	2%
Well-to-Wheel	314	2%
Vehicle Fleet and Equipment	256	1%
Solid Waste	230	1%
Asphalt	58	0.3%
Food	32	0.2%
Fertilizer	21	0.1%
Paper	11	0.1%
Computers and Hardware	8	0.04%
Business Travel	7	0.04%
Stationary Diesel	2	0.01%
Total	**19,156**	**100%**

Excluding consumption-based sources, the three-largest sources of municipal emissions are electricity use (37%), employee commuting (35%), and natural gas use (14%). This is followed by vehicle fleet and equipment (7%), solid waste (7%), business travel (0.2%), and stationary diesel use (0.06%). See Figure 9.

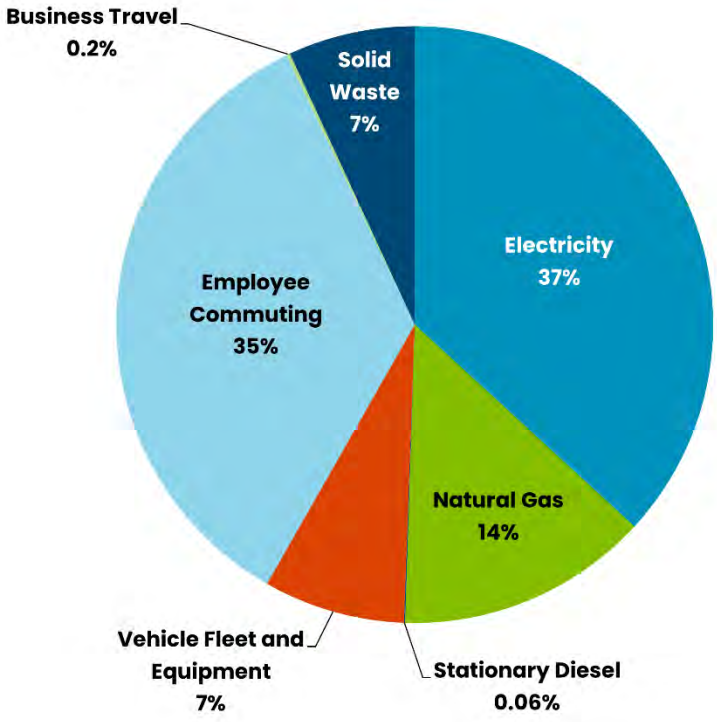

Figure 9. Mission's 2022 municipal emissions by source (excluding consumption-based).

Some of the emissions sources in the municipal operations GHG inventory overlap with the emissions in the community-wide GHG inventory. These sources are: building electricity and

natural gas use, vehicle fleet and equipment, solid waste disposal and refrigerant use (totaling 2,508 mt CO_2e). When looking at comparable emissions sources, municipal operations emissions comprise 1.4% of community-wide GHG emissions. Mission's city building electric and natural gas use makes up 2.6% of the community's commercial building electric and natural gas use. It is important for Mission to lead by example and continue to implement projects and programs like the ones from the Facility Conservation Improvement Program completed in 2021-2022 to help the greater community reduce emissions.

Year-over-year Comparison

As referenced above, the previous inventory for Mission was completed in 2008 with data for the years 2005, 2006, and 2007. Mission's baseline emissions for municipal operations in 2005 were 5,363 mt CO_2e. When comparing all emissions, Mission's municipal operations emissions increased 257%. Not all emissions sources are comparable between iterations, however. Comparable sources include electricity use, natural gas use, fuel used by the vehicle fleet and equipment, employee commuting, business travel, and solid waste. **Analyzing comparable sources shows that emissions have reduced by 36% from the 2005 baseline (3,340 mt CO_2e).** Mission has an ambitious goal of net zero emissions from municipal operations by 2025. Using comparable emissions sources, Mission will need to reduce its emissions 1,113 mt CO_2e per year for the next 3 years. For comparison, the Facility Conservation Improvement Program was estimated to have reduced emission by 929 mt CO_2e.

Summary

The City of Mission is making significant progress community-wide and internally to reduce emissions, and therefore carbon footprints. In light of the climatic changes expected to manifest due to warming temperatures, it is important to keep tracking emissions and actively work to reduce them. In order to reach net-zero emissions by 2050, Mission will need to reduce its emissions 8% per year, or approximately 8,100 mt CO_2e per year. There are many ways for Mission residents to reduce their own emissions, and the City is working hard to reduce community and municipal emissions.

Opportunities to Reduce Emissions in the Community

Stationary Energy

With recent federal legislation, the electrical power generating sector is projected to decrease grid carbon emissions 68%-78% below 2005 levels by 2030[8]. Evergy's electric emissions factor has already decreased by 43% since 2005 and Evergy has a goal of achieving net zero carbon emissions by 2045[9]. The addition of wind and solar energy resources to the electrical grid presents multiple opportunities for low to no carbon electrification of heating homes and businesses. Heat pump technology allows for efficient heating and cooling, while receiving power from the electrical grid, getting cleaner each year of operation.

Transportation Energy

Encouraging alternative forms of transportation within the community can lessen the number of vehicle miles traveled. Additionally, expanding infrastructure and/or incentivizing electric vehicles (EVs) and EV charging within the community can help to both reduce emissions and improve air quality locally. Expanding multimodal transportation options within the community, such as adding more bike lanes and paths or expanding transit service, offers residents the option to use modes other than their personal vehicle to get to their destination.

Waste & Wastewater

Waste that is generated from the community is disposed of outside of the community and through the decomposition of organic waste contributes to methane and CO_2 emissions. Reducing overall waste generation and increasing the diversion of recyclables and organic waste will reduce the emissions associated with those waste streams.

Opportunities to Reduce Emissions in Government Operations

Consumption

The production of cement causes GHG emissions both from the combustion of fuels as well as the decomposition of limestone. Blended cement and substitutes for limestone-based substances like fly ash can decrease the number of carbon emissions per ton of cement purchased. Additionally, some applications of cement in horizontal projects can be replaced with aggregate or porous pavers that have additional stormwater benefits. Other new technologies for green cement continue to show promise in some applications but are still a

[8] https://www.energy.gov/eere/articles/nrel-study-identifies-opportunities-and-challenges-achieving-us-transformational-goal
[9] https://investors.evergy.com/TCFD

way off from large-scale applications. It should be noted that for a city of its size (just under 10,000 residents), Mission has a well-developed, dedicated street maintenance program that extends the life of the existing infrastructure and should serve as a model for other cities. Local governments can also pursue green procurement practices to ensure sustainable products are prioritized.

Stationary Energy

Like the community-wide opportunities above, the increase in wind and solar resources on the electrical grid presents multiple opportunities for low to no carbon electrification of heating government buildings. Heat pump technology allows for efficient heating and cooling while receiving power from the electrical grid, which gets cleaner over time. Energy efficiency opportunities can conserve energy as well as decrease expenses. Mission's retrofitting of streetlights and traffic signals, one project of the City's wider Facility Conservation Improvement Program (FCIP), is a perfect example of how efficiency can lower emissions and financial costs. Continuing to implement the projects outlined in the FCIP will help reduce energy use and consequently GHG emissions.

Transportation Energy

Incentivizing alternative commuting options for employees, including telecommuting and public transit, helps limit the amount of vehicle miles traveled. Expanding infrastructure to support electric vehicles helps to limit the amount of carbon emitted per vehicle mile traveled; it also contributes to better air quality. In some cases, local governments have supported these opportunities with other options such as reimbursing emergency rides home or allowing goods and services to be delivered to employee workplaces.

Solid Waste

Like the Community opportunities, increasing the diversion of recyclables and organic waste will contribute to emissions reductions. Additionally, public buildings also present an opportunity to educate the public about waste diversion options in public spaces and at home.

Industrial Processes & Product Use

Mission can look at continuing to phase out refrigerants with high global warming potentials, as was done in the FCIP, and as lower global warming potential refrigerants are developed over time. More efficient technology, and in some cases technology shifts like heat pump systems, can also offer improved cooling with less energy. Finally, Mission can explore the

option of writing language in servicing contracts to ensure that little to no leakage of refrigerants occurs during the servicing of the City's vehicles and HVAC systems.

Appendix A – Protocol Comparison

Emissions by Sector								
Emission Source	**2005 Emissions (mt CO2e)**	**2005 Activity (MMBtu)**	**2007 Emissions (mt CO2e)**	**2007 Activity (MMBtu)**	**2022 Emissions (mt CO2e)**	**2022 Activity (MMBtu)**	**% Change (2005-2022)**	**% Change (2007-2022)**
Commercial and Industrial Buildings	114,773	664,899	111,514	638,103	68,275	582,952	-41%	-39%
Residential Buildings	59,081	445,691	58,583	433,107	37,018	406,814	-37%	-37%
Transportation	249,999	2,914,080	242,680	2,831,554	54,737	756,186	-78%	-77%
Transportation (Estimated using GPC Protocol)	69,421	815,942	67,950	792,835	54,737	756,186	-21%	-19%
Waste & Wastewater	(2,009)	N/A	(2,009)	N/A	12,981	N/A	746%	746%
IPPU	N/A	N/A	N/A	N/A	379	N/A	N/A	N/A
Total	**421,844**		**410,768**		**173,390**		**-59%**	**-58%**
Total (GPC Protocol)	**243,275[10]**		**238,047[6]**		**173,390**		**-28.7%**	**-27.2%**

Commercial & Industrial Buildings

Electricity and natural gas use declined slightly, even as the population saw a slight uptick. This is most likely attributed to the adoption of energy efficient components in the commercial and industrial building sectors. Additionally, the emissions factor for electricity saw a steep decline on par with the US. Total consumption of electricity and natural gas fell only 2%, while the emissions factor decline was 43%. Methodologies across all years of inventories are relatively consistent, and there is a high degree of confidence in both the activity and emissions factor data.

Residential Buildings

Like commercial buildings, residential properties also saw a decrease in overall consumption (roughly 8%), but the majority of the total emissions decline is due to emissions factor decreases of 41%. Methodologies across all years of inventories are relatively consistent and there is a high degree of confidence in both the activity and emissions factor data.

[10] Does not include negative emissions from Waste & Wastewater. See Appendix A for more detail.

Transportation

Activity data for 2005 & 2007 was based on AADT and VMT data provided by the Kansas Department of Transportation. The original GHG Inventory report mentions "KDOT provided yearly **limited access highway** (emphasis added) AADT values for the years 2001-2007, raw traffic counts for few selective local roads dated April 2001 and raw traffic counts for arterial roads for the year 2007." Based on this information, it is presumed that VMT calculations included "passthrough" trips along Interstate 35 – a limited access highway. Those VMT numbers were input in the CACP "Transportation Assistant" to determine emissions values. At the time of the 2005 and 2007 inventory work there was ongoing deliberation about an origin-destination vs in-boundary emissions from on-road vehicles. This uncertainty of which approach to take was resolved in the 2013 version of the US Community Protocol:

> *The recommended method (TR.1.A) presented in this guidance recognizes that local governments possess the authority to influence GHG emissions from passenger vehicle trips both inside and outside of a community's geographic boundaries. This method also recognizes that local governments cannot influence all passenger vehicle GHG emissions within their boundaries. As such, the recommended origin-destination method (using a demand-based model) better captures a local government's ability to affect passenger vehicle emissions than the alternate method (TR.1.B) to calculate in-boundary emissions, which ICLEI USA has included in past guidance, including Clean Air and Climate Protection (CACP) Software.*

This approach was also confirmed in the first edition of the Global Protocol for Community-wide Greenhouse Gas Inventories. These updates assigned 50% of inbound VMT (trips ending in the community) and 50% of outbound VMT (trips that begin in the community) and 100% of intra-boundary VMT (trips that begin and end in the community) to that community. The updated protocols explicitly does not include passthrough trips that have no link to the community other than the road happens to be within the community. This is most likely the cause of the large emissions reductions.

Waste Emissions

Activity data for the 2005 and 2007 inventories is likely accurate as it relates to the total tonnage of waste generated within the city and disposed of outside the city. However, these previous versions of the inventory incorrectly applied a sequestration value AND

overestimated the methane capture of the landfill itself. Note that this latter issue was recognized in the 2013 US Community Protocol update:

> *There are significant controversies about using 75% capture efficiency for landfill gas collection systems applied both as an instantaneous rate for inventory year emissions from an in-jurisdiction landfill (see Method SW.1) and as a life-time rate for all future emissions of waste generation in an inventory year (see Method SW.4). While these rates cannot be equal in reality, no other widely accepted rates are available at this time and actual emission rates will differ widely between individual landfills. The prevailing practice for many greenhouse gas inventories has been to use this single 75% capture efficiency rate in both methods.*

The issue of sequestration is more accurately described as removing carbon from the atmosphere. For example, the natural carbon cycle includes the removal of carbon via photosynthesis. In the case of waste, there is no “removal of carbon” when it is placed in a landfill. The resulting methane produced is impacted by several variables including landfill moisture, temperature, waste characteristics, oxidation rate, etc. To estimate those emissions more accurately, most landfills provide a calculation of methane generation as well as capture/destruction to estimate emissions. This approach was applied to the 2022 Inventory.