Lake Forest Park Greenhouse Gas Inventory Report – Draft

INVENTORY YEARS 2019, 2022, 2023

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CASCADIA
CONSULTING GROUP

Contents

Executive Summary

The City of Lake Forest Park Greenhouse Gas (GHG) Inventory Report summarizes the findings from two inventories: 1) the 2019, 2022, and 2023 communitywide GHG inventories and 2) the 2023 municipal operations GHG inventory. These inventories were completed by leveraging existing GHG analysis work performed by King County and funding from Washington State Department of Commerce (Commerce). The results from this inventory report will support the development of the Lake Forest Park Climate Element, specifically the GHG Reduction Sub-Element.

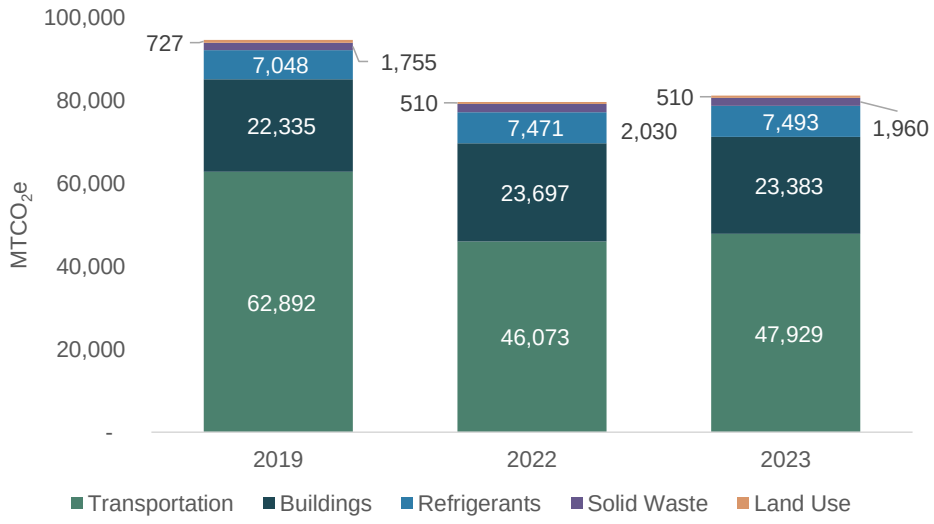
Table 1 below shows the estimated metric tons of carbon dioxide equivalent ($MTCO_2e$) and the average per-capita emissions for each year included in the communitywide GHG inventories.

Table 1. Communitywide $MTCO_2e$ and per-capita emissions, by inventory year.

	2019	2022	2023
$MTCO_2e$	94,757	79,780	81,274
Per-capita emissions	7.2	5.9	5.9

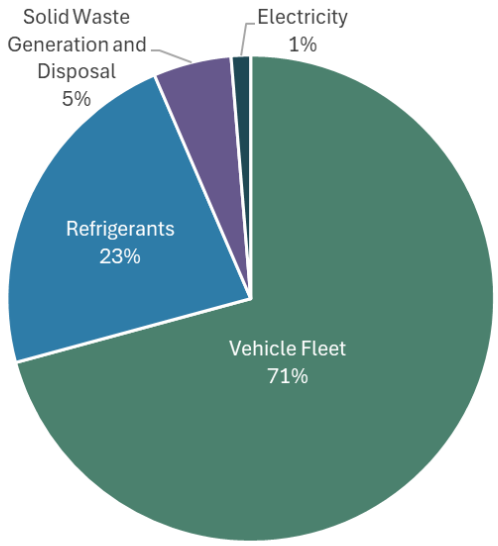
Transportation and **buildings** have consistently been the highest contributors to **communitywide** GHG emissions across inventory years. Emissions have seen a downward trend since 2019, with the largest reductions from the transportation sector. Figure 1 below shows communitywide emissions, by emissions source and inventory year.

Figure 1. 2019, 2022, and 2023 communitywide GHG emissions, by source ($MTCO_2e$).



The City of Lake Forest Park also completed a **municipal operations** GHG inventory for 2023, supported by Commerce through the Climate Commitment Act. Of the emission sources included in the inventory, the municipal **vehicle fleet** was the greatest contributor to GHG emissions from municipal operations. Figure 2 below shows proportions of emissions by source.

Figure 2. 2023 municipal operations GHG emissions, by source (percentage of total municipal operations emissions).



Introduction

Methodology

Lake Forest Park's 2019, 2022, and 2023 communitywide inventories were performed in alignment with both **ICLEI's U.S. Community Protocol for Accounting and Reporting of GHG Emissions (USCP)** and **The Greenhouse Gas Protocol's Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC)**.[1,2] Lake Forest Park's 2023 municipal operations inventory was performed in alignment with the **Local Government Operations Protocol (LGOP)**.[3] These protocols are the industry standard for quantifying emissions from communities and local governments. Following these protocols helps to ensure the inventories are replicable, consistent, and accurate. Additional documentation on the methodologies for both inventories is provided in *Appendix A: Methodology*.

Emissions Sources

The GHG emissions sources analyzed in the GHG inventories are detailed below in Table 2.

Table 2. Emissions sources analyzed in Lake Forest Park's 2019, 2022, and 2023 GHG inventories.

Sector	Emissions Source
Communitywide GHG Inventories (2019, 2022, and 2023)	
Buildings	Electricity Natural gas Propane Fuel oil
Transportation	On-road Off-road Air travel
Solid Waste	Landfilled waste generation and disposal Compost generation and disposal
Refrigerants	Refrigerants
Land Use	Tree loss
Municipal Operations GHG Inventory (2023)	
Buildings	Electricity
Transportation	Vehicle fleet
Solid Waste	Landfilled waste generation and disposal Compost generation and disposal
Refrigerants	Stationary and mobile refrigerants

[1] US Community Protocol | ICLEI USA
[2] Global Protocol for Community-Scale GHG Inventories (GPC) | GHG Protocol
[3] Local Government Operations (LGO) Protocol | ICLEI USA

Communitywide GHG Emissions Results

Lake Forest Park's community emitted an estimated 94,757, 79,780, and 81,274 $MTCO_2e$ in 2019, 2022, and 2023, respectively. **Transportation** was the highest emitter across all three inventory years, with emissions from **buildings** being the second largest emitter across all three years. Emissions have seen a downward trend since 2019 with the largest reductions occurring from air travel and on-road vehicles. Lake Forest Park's communitywide GHG emissions for 2019, 2022, and 2023 are detailed below in Table 3, by emissions source.

Table 3. 2019, 2022, and 2023 communitywide GHG emissions and percent change, by emissions source.

Emissions Source	2019	2022	2023	% Change (2019-2023)
Buildings	**22,335**	**23,697**	**23,383**	**5%**
Electricity	497	403	464	-7%
Natural Gas	19,007	21,352	21,021	11%
Other Fuels	2,831	1,942	1,898	-33%
Transportation	**62,892**	**46,073**	**47,929**	**-24%**
On-road	24,929	23,600	23,511	-6%
Air travel	31,916	16,161	18,041	-43%
Off-road	6,047	6,313	6,377	5%
Solid Waste	**1,755**	**2,030**	**1,960**	**12%**
Landfill	1,318	1,568	1,512	15%
Compost	437	462	448	2%
Refrigerants	**7,048**	**7,471**	**7,493**	**6%**
Land Use (Tree Loss)	**727**	**510**	**510**	**-30%**
Total Emissions	**94,757**	**79,780**	**81,274**	**-14%**

Buildings

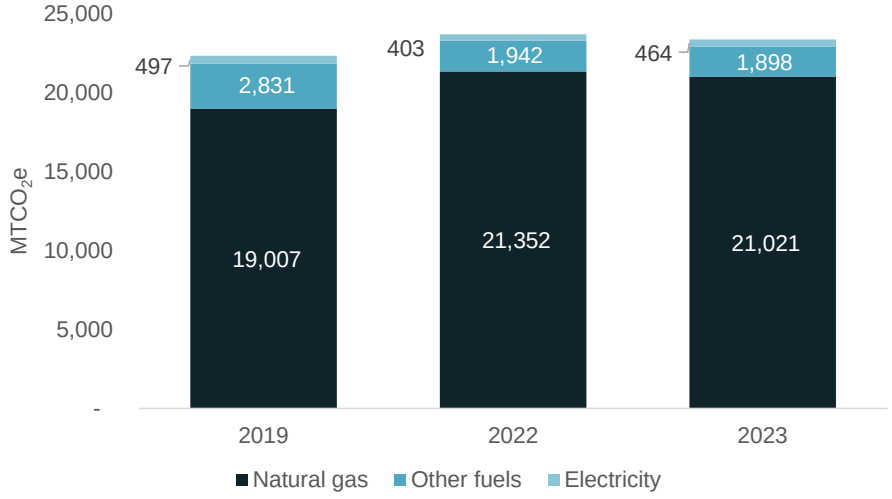
The **buildings** sector emitted an estimated 22,335, 23,697, and 23,383 $MTCO_2e$ in 2019, 2022, and 2023, respectively, representing **29%** of total 2023 emissions. Emissions from buildings stem from electricity, natural gas, and other fuels (propane and fuel oil) used to heat, cool, and power homes and buildings in the community.

- **Electricity** contributed 497, 403, and 464 $MTCO_2e$ to building emissions in 2019, 2022, and 2023, respectively. Electricity accounted for **less than 1%** of total 2023 emissions.
- **Natural gas** contributed the most to 2019, 2022, and 2023 building emissions, emitting 19,007, 21,352, and 21,021 $MTCO_2e$, respectively. Natural gas accounted for **26%** of total 2023 emissions.
- **Other fuels**, including propane and fuel oil, contributed 2,831, 1,942, and 1,898 $MTCO_2e$ to building emissions in 2019, 2022, and 2023, respectively. Other fuels accounted for **2%** of total 2023 emissions.

Commented [AF1]: Note: This section, along with summary graphics and tables, will likely need to be updated once we hear back from Seattle City Light on missing inventory data. We are currently waiting on Seattle City Light to provide 2019 electricity consumption data.

Emissions from buildings have seen an upward trend since 2019, mostly driven by increases in natural gas consumption. Figure 3 below shows the breakdown of building emissions, by energy source, in each inventory year.

Figure 3. Building emissions, by source, in 2019, 2022, and 2023 ($MTCO_2e$).



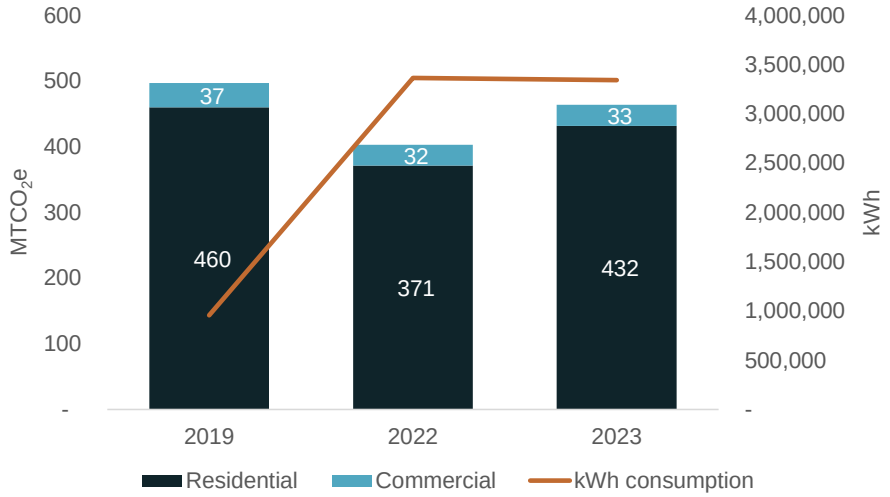
ELECTRICITY

Electricity contributed <1% to communitywide emissions in each inventory year. Electricity data was provided by Puget Sound Energy and Seattle City Light for these studies. Since 2019, emissions from electricity have seen a downward trend, as shown in Figure 4, primarily driven by an increase in customer participation in Puget Sound Energy's green power programs. In 2023, Puget Sound Energy and Seattle City Light powered the grid with about 50% and 95% renewables, respectively; both are committed to 100% clean electricity by 2030.

Commented [AF2]: Note: We will update this section once we receive data from Seattle City Light. We'll report on trends in consumption and emission factors, as relevant.

- The residential sector is the largest contributor to electricity emissions, as shown in Figure 4.
- Consumption of electricity has seen about a X% increase or decrease since 2019, as shown in Figure 4. This increase in consumption is likely due to an increase in population.

Figure 4. Communitywide electricity emissions, by sector, along with trends in consumption in 2019, 2022, and 2023 ($MTCO_2e$ and kWh).

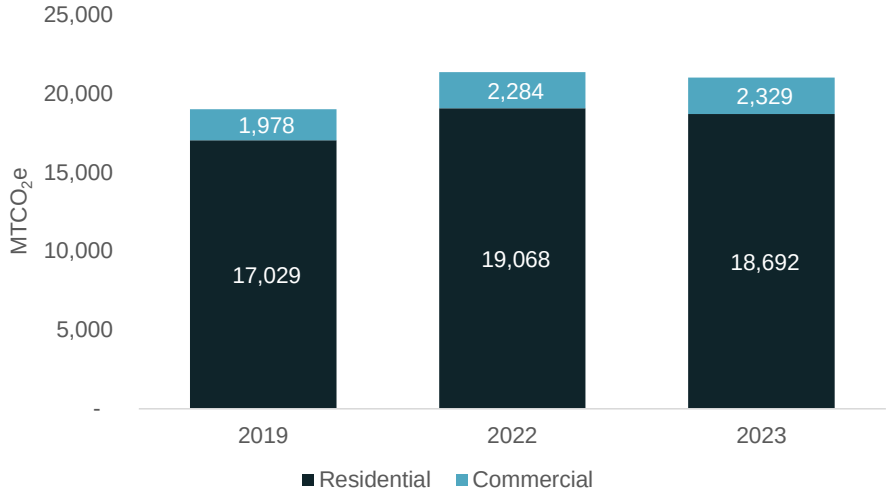


NATURAL GAS

Natural gas accounted for 20%, 27%, and 26% of Lake Forest Park's communitywide emissions in 2019, 2022, and 2023, respectively. Natural gas data was provided by Puget Sound Energy for these studies. Since 2019, emissions from natural gas have seen an upward trend, as shown in Figure 5, primarily driven by changes to natural gas consumption, increased fugitive emissions occurring as natural gas is transported through the pipeline to consumers, and a dirtier carbon intensity of the natural gas provided by Puget Sound Energy.

- The residential sector has contributed the most to 2019, 2022, and 2023 natural gas emissions, contributing 17,029, 19,068, and 18,692 $MTCO_2e$, respectively, as shown in Figure 5.
- Consumption of natural gas has decreased by about 2% despite an increase in emissions, as shown in Figure 5. Despite this decrease, the increase in emissions from 2019 to 2023 can be attributed to multiple factors including changing carbon intensity of natural gas and increased fugitive emissions as stated above.

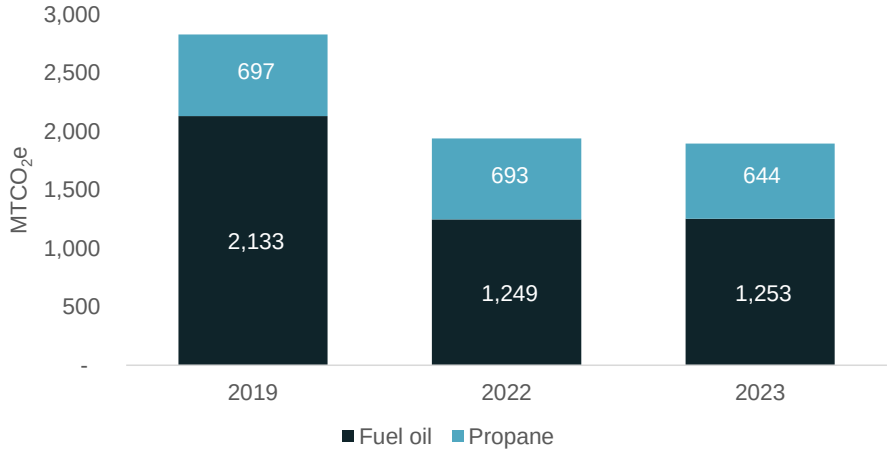
Figure 5. Communitywide natural gas emissions, by sector, in 2019, 2022, and 2023 ($MTCO_2e$).



OTHER FUELS

Other fuels, including **propane** and **fuel oil**, accounted for 3%, 2%, and 2% of communitywide emissions in 2019, 2022, and 2023, respectively. The residential sector was the largest contributor to emissions from propane and fuel oil. Since 2019, emissions from propane and fuel oil have seen a downward trend, as shown in Figure 6, primarily driven by a decrease in consumption. Propane and fuel oil data was estimated from annual U.S. Energy Information Administration (EIA) reports for these studies.

Figure 6. Communitywide other fuels emissions, by fuel type, in 2019, 2022, and 2023 ($MTCO_2e$).



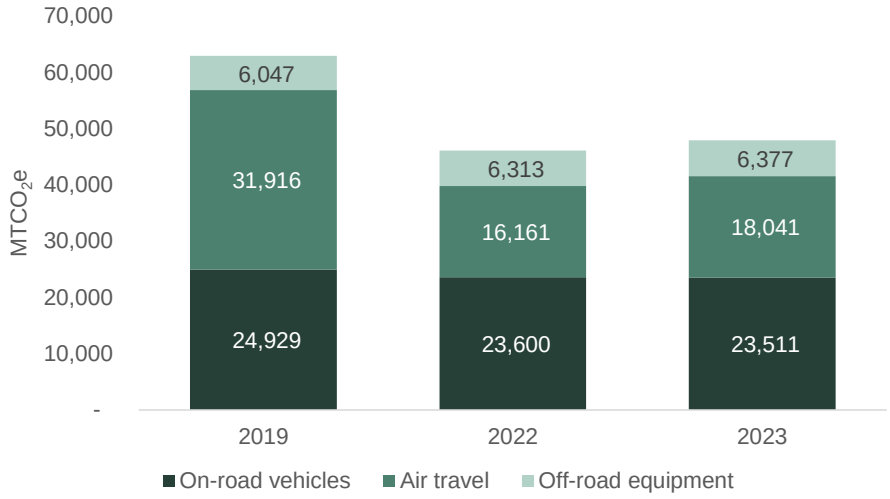
Transportation

The **transportation** sector emitted an estimated 62,892, 46,073, and 47,929 $MTCO_2e$ in 2019, 2022, and 2023, respectively, representing **59%** of total 2023 emissions. Emissions from transportation stem from on-road and off-road vehicles and equipment use within the community and air travel attributed to Lake Forest Park's residents.

- **On-road vehicles** contributed 24,929, 23,600, and 23,511 $MTCO_2e$ to transportation emissions in 2019, 2022, and 2023, respectively, and accounted for **29%** of total 2023 emissions.
- **Air travel** contributed 31,916, 16,161, and 18,041 $MTCO_2e$ to transportation emissions in 2019, 2022, and 2023, respectively, and accounted for **22%** of total 2023 emissions.
- **Off-road equipment** contributed 6,047, 6,313, and 6,377 $MTCO_2e$ to transportation emissions in 2019, 2022, and 2023, respectively, and accounted for **8%** of total 2023 emissions.

Emissions from transportation have seen a downward trend since 2019, mostly driven by a reduction in air travel and on-road vehicle activity. Figure 7 below shows the breakdown of transportation emissions, by source, in each inventory year.

Figure 7. Transportation emissions, by source, in 2019, 2022, and 2023 ($MTCO_2e$).

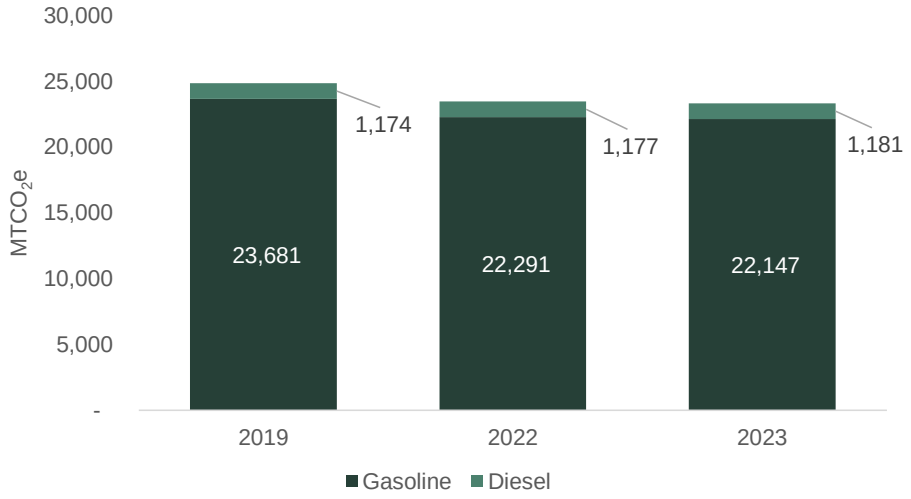


ON-ROAD VEHICLES

On-road vehicle miles traveled (VMT) accounted for 26%, 30%, and 29% of Lake Forest Park's communitywide emissions in 2019, 2022, and 2023, respectively. On-road VMT activity data was estimated from the Puget Sound Regional Council (PSRC) travel demand model for all three years, and a post-pandemic adjustment factor was applied to the 2022 and 2023 VMT

activity data based on StreetLight Big Data estimates for Lake Forest Park. Since 2019, emissions from on-road vehicles have seen a downward trend, as shown in Figure 8, primarily driven by a 4% decrease in VMT from 2019 to 2023 and an increased uptake of electric vehicles. While VMT has decreased since 2019, StreetLight Data indicates that this reduction is largely due to shorter vehicle trip lengths, not a reduction in vehicle trips.

Figure 8. Communitywide on-road vehicle emissions, by fuel type, in 2019, 2022, and 2023 ($MTCO_2e$).



AIR TRAVEL

Air travel accounted for 34%, 20%, and 22% of Lake Forest Park's communitywide emissions in 2019, 2022, and 2023, respectively. Air travel emissions were estimated using a combination of SeaTac fuel consumption data, passenger survey data, and U.S. Census median household income data. Emissions from SeaTac's origin passengers who report living in King County are allocated to cities based on median household income from the U.S. Census under the assumption that communities with a higher median household income are more likely to travel by plane.

The 43% decrease in emissions from air travel can be attributed to a reduction in SeaTac fuel use from 2019 to 2023 along with a reduction in origin passengers who reported coming from King County in SeaTac's passenger survey. In 2019, 82% of origin passengers reported coming from King County, while in 2022, only 52% of origin passengers reported coming from King County.

OFF-ROAD EQUIPMENT

Off-road equipment accounted for 6%, 8%, and 8% of Lake Forest Park's communitywide emissions in 2019, 2022, and 2023, respectively. Off-road emissions were estimated by running

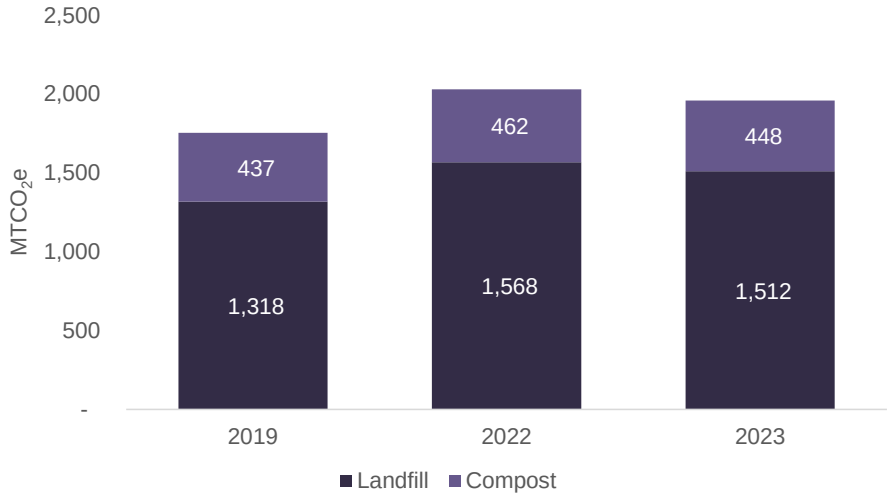
the EPA MOVES model at a county level and scaling by city population.[4] Off-road emissions include the following equipment types: recreational, construction, industrial, lawn/garden, agriculture, commercial, logging, airport support, oil field, pleasure craft, and railroad. Across all three inventory years, **construction, industrial,** and **lawn/garden equipment** produced the most emissions.

Solid Waste

The **solid waste** sector emitted an estimated 1,755, 2,030, and 1,960 $MTCO_2e$ in 2019, 2022, and 2023, respectively, representing **2%** of total 2023 emissions. Emissions from solid waste are generated by the transportation and disposal of landfilled and composted waste produced by Lake Forest Park's residents, employees, and visitors. **Landfilled waste** accounted for 77% of 2023 solid waste emissions, while **composted waste** accounted for 23%.

Emissions from solid waste have seen an upward trend since 2019, primarily driven by increases in both landfilled and composted waste generated. Figure 9 below shows the breakdown of solid waste emissions, by source, in each inventory year.

Figure 9. Solid waste emissions, by source, in 2019, 2022, and 2023 ($MTCO_2e$).



[4] MOVES and Mobile Source Emissions Research | U.S. EPA

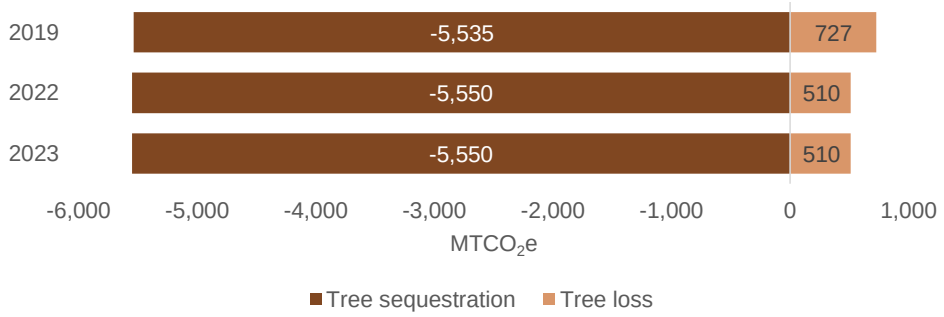
Refrigerants

Refrigerants emitted 7,048, 7,471, and 7,493 $MTCO_2e$ in 2019, 2022, and 2023, respectively, representing **9%** of total 2023 emissions. Refrigerants are used for cooling equipment such as air conditioners and refrigerators. Emissions from refrigerants stem from refrigeration equipment leakage and occur most often from hydrofluorocarbons (HFCs) which have a high global warming potential (amount of global warming units that results from one unit of gas). Emissions from refrigerants have seen an upward trend since 2019. Refrigerant consumption is not tracked locally, so refrigerant emissions were estimated using a national EPA dataset for refrigerants and scaled to Lake Forest Park based on population.[5]

Land Use

Land use emitted an estimated 727, 510, and 510 $MTCO_2e$ in 2019, 2022, and 2023, respectively, representing **less than 1%** of total 2023 emissions. These emissions occur from tree loss and occur when tree canopy is lost or when forests are converted to alternate land use. Land use also has the additional benefit of carbon sequestration from tree canopy gain and undisturbed tree canopy. Lake Forest Park's tree canopy sequestered an estimated 5,535, 5,550, and 5,550 $MTCO_2e$ in 2019, 2022, and 2023, respectively. To ensure proper accounting of emissions, tree canopy sequestration benefits are reported separately from emissions. Land use emissions were calculated using the ICLEI's Land Emissions and Removals Navigator (LEARN) tool using a GIS shapefile of Lake Forest Park's geographic boundaries.[6] The tool provides multi-year estimates (in this case, 2016-2019 for 2019 and 2019-2021 for 2022 and 2023) that are then averaged for a per-year estimate. Figure 10 below illustrates emissions from tree loss along with the annual sequestration values for 2019, 2022, and 2023.

Figure 10. Tree canopy GHG emissions and sequestration ($MTCO_2e$).

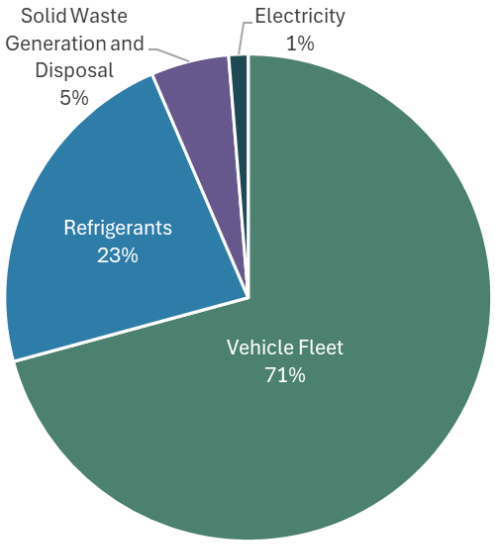


[5] Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2022 | U.S. EPA
[6] Land Emissions and Removals Navigator (LEARN) | ICLEI USA

Municipal Operations GHG Emissions Results

Lake Forest Park's municipal operations produced 247 $MTCO_2e$ in 2023. **Transportation** was the highest emitting sector, with the City's **vehicle fleet** responsible for **71%** of total municipal operations emissions. Lake Forest Park's municipal operations GHG emissions for 2023 are shown below in Figure 11, by emissions source.

Figure 11. 2023 municipal operations GHG emissions, by source (percentage of total municipal operations emissions).



Buildings

The **buildings** sector emitted an estimated 3 $MTCO_2e$ in 2023, accounting for **1%** of total municipal operations emissions. Emissions from buildings stem from **electricity** used to power, heat, and cool City-owned facilities. The City does not use natural gas in its facilities.

Transportation

The **transportation** sector emitted an estimated 175 $MTCO_2e$ in 2023, accounting for **71%** of total municipal operations emissions. Emissions from transportation stem from **on-road**

vehicles and **off-road vehicles and equipment** (on-road vehicles comprised over 99% of municipal fleet emissions).

Note: the City did not have data available to estimate emissions from employee commuting or employee business travel. If the City is interested in a more comprehensive municipal operations inventory in the future, City staff can administer employee commute surveys and collect data on employee business travel to estimate emissions associated with these activities.

Solid Waste

The **solid waste** sector emitted an estimated 13 $MTCO_2e$ in 2023, accounting for **5%** of total municipal operations emissions. Emissions from solid waste stem from the transportation and disposal of landfilled and composted waste generated at City-owned or -operated facilities. **Landfilled waste** contributed the most to 2023 municipal solid waste emissions, emitting close to 12 $MTCO_2e$. **Composted waste** contributed 1 $MTCO_2e$ to solid waste emissions in 2023.

Refrigerants

Municipal **refrigerant use** emitted 56 $MTCO_2e$ in 2023, accounting for **23%** of total municipal operations emissions. Refrigerants are used for cooling equipment such as air conditioners and refrigerators in both stationary and mobile equipment. Of the 56 $MTCO_2e$ produced by refrigeration equipment used by the City, 98% was produced by stationary equipment such as HVAC systems, while 2% was produced by air conditioning units in the City's fleet vehicles. Emissions from refrigerants stem from refrigeration equipment leakage and occur most often from hydrofluorocarbons (HFCs) which have a high global warming potential (amount of global warming units that results from one unit of gas).

Policy Recommendations

The 2019, 2022, and 2023 communitywide GHG emissions inventory results were used to inform GHG emissions reduction policy for Lake Forest Park's Climate Element. To adhere with Washington's HB 1181, which was passed in 2023, Lake Forest Park must incorporate policy in its Comprehensive Plan aimed at reducing GHG emissions. These policies at minimum must result in overall GHG emissions reductions and reductions in VMT per-capita and prioritize reductions that benefit overburdened communities.[7] Based on the Commerce guidance and the results of this GHG analysis, it is recommended that Lake Forest Park pursue the development of Climate Element policies that:

- **Reduce VMT per-capita**, such as through measures that promote multi-modal transportation, improve public transit infrastructure and access, or manage parking
- **Expand electric vehicle infrastructure**
- **Increase building efficiency** in new and existing buildings
- **Promote building electrification** in new and existing buildings
- **Reduce landfilled waste**

[7] Climate Element Planning Guidance | WA State Department of Commerce

Appendix A: Methodology

This appendix provides a detailed description of the calculation methodology used to complete Lake Forest Park's communitywide and municipal operations GHG inventories.

Calculating Lake Forest Park's GHG inventories involved identifying and applying emissions factors to activity data, summarized in Table 4 below.

- **Activity data** quantifies the amount of activity that ultimately generates emissions. Examples of activity data include kilowatt hour of electricity consumed, vehicle miles traveled (VMT), and tons of waste generated.
- **Emissions factors** are values that are used to determine the amount of a specific GHG emitted based on one unit of activity data. Examples of emission factors include metric tons of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), or CO_2 equivalence emitted per kilowatt hour of electricity consumed, per ton of waste generated, or per VMT.

Table 4. Calculation methodology, including activity data and emissions factor sources.

Sector	Activity Data	Emissions Factors (EFs)
Buildings		
Natural gas	City-specific consumption provided by utilities	Utility-provided emission factors provided by Puget Sound Energy
Electricity	City- and municipal-specific consumption provided by utilities	1) Utility-specific emission factors (from Department of Ecology Clean Fuel Standard program utility-specific electricity calculations) 2) Emissions & Generation Resource Integrated Database (eGRID) EFs (for informational purposes only)
Fuel oil	WA fuel oil consumption by sector from U.S. Energy Information Administration (EIA)	U.S. Environmental Protection Agency (EPA) Emission Factors (EF) Hub[8] average EFs
Propane	WA propane consumption by sector from U.S. EIA	U.S. EPA EF Hub average EFs
Transportation		
On-road vehicles *(communitywide)*	Vehicle miles traveled data and estimated emissions from Puget Sound Regional Council (PSRC) travel demand model outputs. StreetLight Data was used to create a VMT adjustment factor that accounts for pandemic-related travel changes from 2019 conditions.	U.S. EPA EF Hub vehicle EFs (by vehicle & fuel type)

[8] GHG Emission Factors Hub | U.S. EPA

Sector	Activity Data	Emissions Factors (EFs)
	This adjustment factor was applied to the PSRC VMT data for 2022 and 2023	
On-road vehicles *(municipal operations)*	City-provided vehicle type, fuel type, fuel use, and miles traveled for municipal fleet vehicles	U.S. EPA EF Hub vehicle EFs (by vehicle & fuel type)
Off-road equipment *(communitywide)*	EPA Motor Vehicle Emission Simulator (MOVES)[9] model outputs, by county then scaled by city population	N/A - reported in terms of emissions
Off-road equipment *(municipal operations)*	City-provided vehicle/equipment type, fuel type, fuel use, and miles traveled for municipal fleet off-road vehicles/equipment	U.S. EPA EF Hub vehicle EFs (by vehicle & fuel type)
Aviation	Two approaches, depending on data availability: 1) Volume of fuel (jet-A and aviation gasoline) loaded onto all planes departing from airports within county; volume of all fuel used in helicopters, light aircraft operating within county boundaries (e.g., police, sightseeing, training) 2) Number of landing and takeoff cycles that could be used to estimate fuel based on similar airports Emissions from Seattle-Tacoma International Airport (SEA) were attributed to individual cities using Approach 1 (described above), in combination with passenger survey data, population, and household income data from the U.S. Census.	U.S. EPA EF Hub average EFs, by fuel type
Solid Waste		
Landfill	City- and municipal-specific tonnage and King County waste characterization data	EPA Waste Reduction Model (WARM)[10] EFs, customized for landfill attributes
Compost	City- and municipal-specific tonnage and King County waste characterization data	EPA WARM EFs
Refrigerants		
Refrigerants *(communitywide)*	EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks	N/A - reported in terms of emissions

[9] MOVES and Mobile Source Emissions Research | U.S. EPA
[10] Waste Reduction Model | U.S. EPA

Sector	Activity Data	Emissions Factors (EFs)
Refrigerants *(municipal operations)*	City-reported refrigerant use in municipal facilities and fleet vehicles	Global warming potential (GWP) values from California Air Resources Board (AR5 values)[11]
Land Use		
Tree loss	ICLEI's LEARN tool[12] with a city-specific GIS shapefile of geographic boundaries	ICLEI's LEARN tool

[11] High-GWP Refrigerants | CA Air Resources Board
[12] Land Emissions and Removals Navigator (LEARN) | ICLEI USA