Corporate Benchmarking Report

2023 Energy and Greenhouse Gas Emissions Summary

Date of Completion: October 31, 2024

Prepared for: Municipality of Thames Centre
Authored by: eMission Software Inc.

October 31, 2024

To Whom it May Concern,

eMission Software Inc. is pleased to present the Municipality of Thames Centre's Corporate Benchmarking Report for the 2023 calendar year. This report is part of Thames Centre's ongoing commitment to environmental sustainability and transparency in operations.

The report outlines the municipality's corporate inventory, encompassing energy consumption and greenhouse gas emissions, as defined by the *Canadian Partners for Climate Protection Protocol*. It provides recommendations for reducing energy use and costs as well as greenhouse gas emissions. Additionally, the baseline key performance indicators established for 2023 will serve as benchmarks for future years to track and analyze Thames Centre's progress in minimizing the impact of their corporate operations.

We believe that transparency in environmental impact is crucial for building trust with stakeholders and communities. We welcome any feedback or inquiries regarding the data and methodologies used in this report.

For more information, please contact us by phone or email.

Sincerely,
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Contents

1.0 Executive Summary

In response to the growing imperative for sustainable practices and the increasing global focus on energy conservation, this Corporate Benchmarking Report presents an overview and analysis of energy consumption and greenhouse gas (GHG) emissions from the Municipality of Thames Centre's (Thames Centre's) corporate operations in 2023. The project encompasses a thorough evaluation of existing energy consumption patterns, identifying potential areas for improvement and formulating targeted strategies to enhance overall energy efficiency and reduce costs and GHG emissions.

Name of Municipality	Municipality of Thames Centre
Province	Ontario
Country	Canada
Land Area	433.99 km^2
Population[1]	13,980

Included in the 2023 corporate inventory, broken down by sector, are:

- 11 Buildings & Facilities
- 67 Fleet Vehicles
- 3 Streetlight & Traffic Signal groups
- 6 Water & Wastewater facilities
- 1 Solid Waste disposal site

The report unfolds by delving into the state of energy usage and GHG emissions during the 2023 calendar year, providing a baseline for recommendations and subsequent evaluations. Through a multidimensional lens, the aim is to empower decision-makers with actionable insights that align with the dual objectives of environmental responsibility and economic viability.

Key Findings

Overall Consumption and Emissions: In 2023, Thames Centre's corporate operations used 31,290 GJ of energy and emitted 6,491 tonnes of greenhouse gases.

Benchmarking Results: Each sector within the Thames Centre inventory has distinct key performance indicators (KPIs). These are provided in Section 2.2, with the results from 2023 intended as a baseline for subsequent evaluations.

Areas for Improvement: The Buildings & Facilities sector consumed the most energy and incurred the highest energy costs, with the Flight Exec Centre being the largest contributor to both. The Solid Waste sector had the highest GHG emissions as it encompasses all solid waste for the municipality disposed of at the landfill.

[1] **Canadian national census population 2021 (Statistics Canada, 2023)**

Discluding solid waste disposal, Fleet Vehicles was the most GHG emission intensive sector, and Streetlights was the most cost intensive for energy use. In particular, the diesel-fuelled vehicles in the Transportation Services deparment created the most emissions per unit of energy used, and the Harrietsville Ball Diamond had the highest energy cost per unit of energy consumed.

Strategic Recommendations

Invest in Energy Efficiency Improvements: Prioritize energy efficiency procedures, retrofits and upgrades in the identified underperforming areas to reduce energy consumption and emissions.

Implement Engagement Programs: Develop programs to engage Thames Centre staff, residents and other stakeholders in energy conservation efforts, fostering a culture of sustainability across the community.

Planning and Feasibility Studies: Explore opportunities to conduct feasibility studies and plan major improvements/retrofits/repairs to increase energy efficiency and reduce GHG emissions and costs for corporate operations.

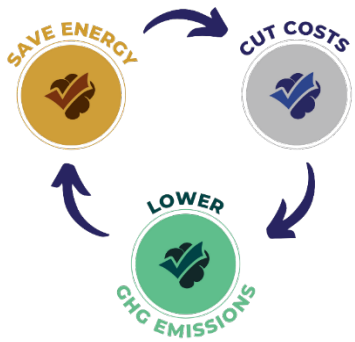
Use Renewable Energy: Explore opportunities for incorporating renewable energy sources to reduce emissions and energy costs, and future-proof against grid energy flucuations.

eMission strongly recommends solar at strategic locations across the inventory, particularly the Flight Exec Centre (which was the largest electricity consumer) and the Thorndale Lions Community Centre (which paid the highest rate for electricity).

Monitoring: Continue tracking energy use, costs and GHG emissions for corporate operations year-over-year to monitor the effectiveness of improvements and identify priority areas.

Conclusion

The findings of this report highlight specific opportunities for future improvement. By investing in energy conservation measures, engaging stakeholders, and leveraging data-driven insights, Thames Centre can achieve their sustainability objectives, reduce operational costs, and enhance the overall value of their corporate assets.



2.0 Findings

2.1 Data Collection and Methodology

The Partners for Climate Protection (PCP) Protocol guidelines were selected for this corporate energy analysis and GHG inventory, as it is Canadian-specific, meets international GHG emission reporting standards, and may be used as a starting point for municipalities that wish to join the PCP program and take action against climate change.

The particular methodology used for this report follows the *PCP Protocol: Canadian Supplement to the International Emissions Analysis Protocol*.[2] Data from each corporate sector in 2023 was collected using the best available method; either:

- Actuals – readings from input points or by using receipts and purchase records
- Estimates – where actuals aren't available; methods vary

Details on the specific data collection and GHG calculation methods used will be provided for each sector.

GHG Emissions

Global Warming Potential

The concept of global warming potential (GWP) was developed to compare how different GHGs (e.g. carbon dioxide, methane, nitrous oxide, etc.) trap heat in the atmosphere (radiative forcing) and to assess their emissions on a common basis. GWP measures the time-integrated change in radiative forcing from the release of a specific amount of a GHG, relative to the radiative forcing from the same amount of carbon dioxide (CO_2). This enables all GHG emissions to be expressed equivalently in units of carbon dioxide equivalent (CO_2e).

Since GHGs have varying atmospheric lifetimes, the GWP of each gas depends on the time frame over which it is calculated. The Intergovernmental Panel on Climate Change (IPCC) develops and updates GWP values for international reporting, ensuring they align with the latest science. The 100-year GWP values from the IPCC's *Fifth Assessment Report* was used for this 2023 inventory (IPCC, 2013):

Table 1. 100-Year Global Warming Potential Values

GHG	GWP
CO_2	1
CH_4	28
N_2O	265

[2] **"The purpose of the PCP Protocol is to provide municipalities with a set of clear accounting and reporting guidelines for developing corporate and community-level GHG inventories within the context of the PCP program" (Partners for Climate Protection, 2021)**

Emission Factors

GHG emissions in this inventory are estimated by multiplying measured activity data (e.g. energy consumption) by emission factors. Emission factors represent the mass of GHGs emitted per unit of a specific activity. The emission factors used in this GHG inventory are sourced from the *National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada* (NIR 2022).

Table 2. Emission Factors

Source		GHG Emission Factor[3]				NIR 2022
		CO_2	CH_4	N_2O	CO_2e	
Electricity					36 g/kWh	Table A13-7 (2021 value[4])
Natural Gas		1921 g/m^3	0.037 g/m^3	0.035 g/m^3		Tables A6.1-1 & A6.1-3
Gasoline	Motor (*uncategorized*)	2307.0 g/L	0.1 g/L	0.02 g/L		Table A6.1-6
Gasoline	LDGT	2307.3 g/L	0.111 g/L	0.007 g/L		Table A6.1-15
Gasoline	HDGV	2307.3 g/L	0.068 g/L	0.2 g/L		Table A6.1-15
Gasoline	Off-road 4-stroke	2307.3 g/L	5.0825 g/L	0.0642 g/L		Table A6.1-15
Diesel	Refineries/Others (*uncategorized*)	2681.0 g/L	0.078 g/L	0.022 g/L		Table A6.1-6
Diesel	Truck-freight	2680.5 g/L	0.11 g/L	0.151 g/L		Table A6.1-15
Diesel	Off-road <19kW	2680.5 g/L	0.07259 g/L	0.02222 g/L		Table A6.1-15
Diesel	Off-road ≥19kW	2680.5 g/L	0.07259 g/L	0.22666 g/L		Table A6.1-15
Propane	Off-road	1515.0 g/L	0.6425 g/L	0.08691 g/L		Table A6.1-15

Units of Measurement

Energy consumption data was converted to a common unit of measurement, gigajoules (GJ) or terajoules (TJ) [1 TJ = 1000 GJ], and all GHG emissions were converted to tonnes of carbon dioxide equivalent (tCO_2e) to allow for meaningful comparison between different sectors, energy sources and greenhouse gases.[5]

[3] The most region and source-specific emission factors available in NIR 2022 were used for each source category. Only the vehicle sub-categories were presumed to be the highest standard - i.e. Tier 3, three-way catalyst, non-catalytic controlled, advanced control. (Environment and Climate Change Canada, 2024)

[4] 2022 values were still in the "preliminary" stage, so 2021 values were used

[5] Conversions were based on common conversions and unit tables and verified with the Energy Conversion Calculator (Canada Energy Regulator, 2021)

2.2 Corporate Energy and GHG Analysis

2.2.1 Corporate Overview

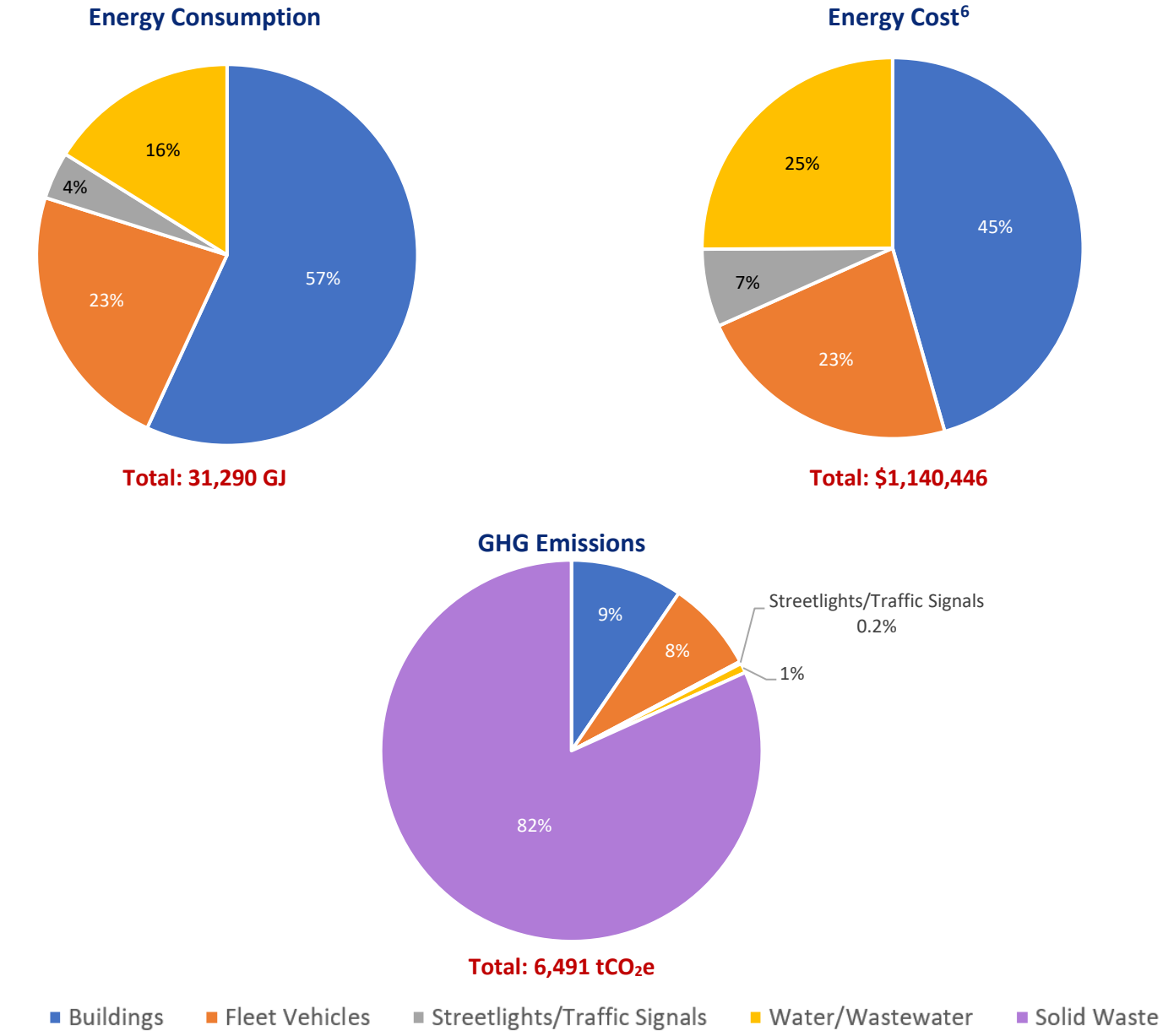


Figure 1. Corporate energy use, energy costs & GHG emissions by sector 2023[7]

In 2023, the Buildings & Facilities sector consumed the most energy (17,799 GJ) and incurred the highest energy costs ($519,903). Solid Waste, which includes the entire community's 2023 waste disposal at the corporate-owned landfill had the most GHG emissions (5,306 tCO_2e).

[6] Total cost for the Buildings and Streetlights/Traffic Signals sectors are gross dollars spent, including rebates; Water/Wastewater sector is gross dollars spent including taxes; Fleet Vehicles is net dollars spent

[7] Energy consumption and cost associated with Corporate Solid Waste are not part of this analysis.

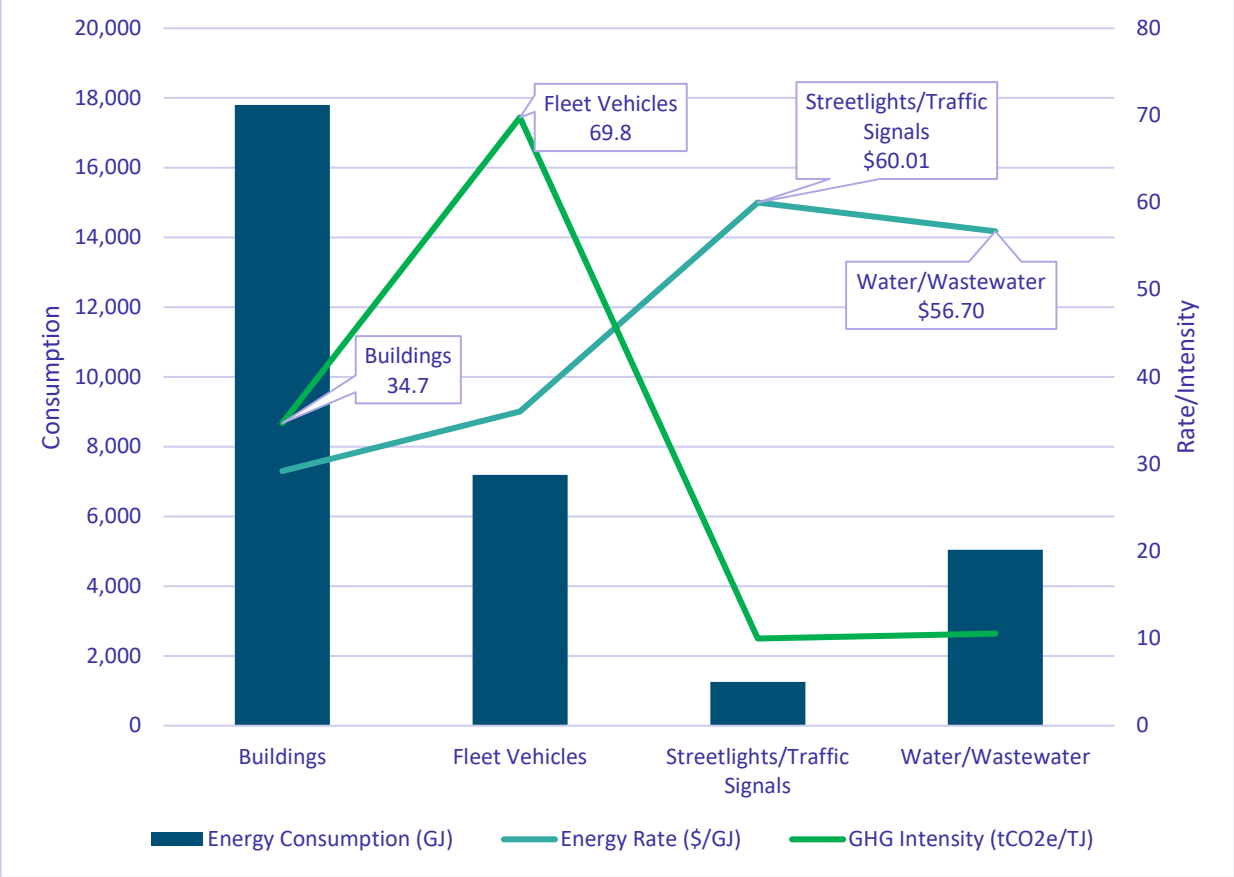


Figure 2. Corporate energy consumption, energy rate and greenhouse gas intensity by sector 2023

Figure 2 compares the overall energy consumed by each sector to the cost- and emission-intensity per unit of energy consumed. The sectors with the highest energy rates are those that primarily use electricity as an energy source (Streetlights & Traffic Signals and Water & Wastewater); correspondingly, they also have the lowest GHG intensity due to Ontario's low emission electricity grid.

ENERGY RATE[6]
is the dollars spent per unit of energy consumed

Conversely, the Buildings and Fleet Vehicles sectors use cheaper but more emission-intensive fuels (natural gas, motor gasoline, propane and diesel) and therefore have lower energy rates but higher GHG intensities.

GHG INTENSITY
is the total GHG emissions created per unit of energy consumed

Across the 2023 inventory, Fleet Vehicles emitted the most GHGs and Streetlights & Traffic Signals cost the most per unit of energy consumed.

Corporate GHG Emissions

Table 3. 2023 GHG Emissions by Sector

	GHG Emissions (tCO_2e)
Buildings & Facilities	617.8
Fleet Vehicles	501.6
Streetlights & Traffic Signals	12.6
Water & Wastewater	53.3
Solid Waste	5,305.8

Figure 3 below shows a breakdown of the three scopes of GHG emissions specified in the *Greenhouse Gas Protocol*. Scope 1 emissions make up the largest portion, encompassing fuels consumed directly, including natural gas in the buildings and facilities (stationary fuel), fuel used for the fleet vehicles/equipment (mobile fuel), and the municipal landfill's solid waste collection. Scope 2, which makes up 2%, includes all indirect emissions from grid energy use – which in Thames Centre's case is all grid electricity used for the buildings and other facilities as well as streetlights/other outdoor lighting. Scope 3 emissions (other indirect emissions) aren't currently being tracked by the municipality.

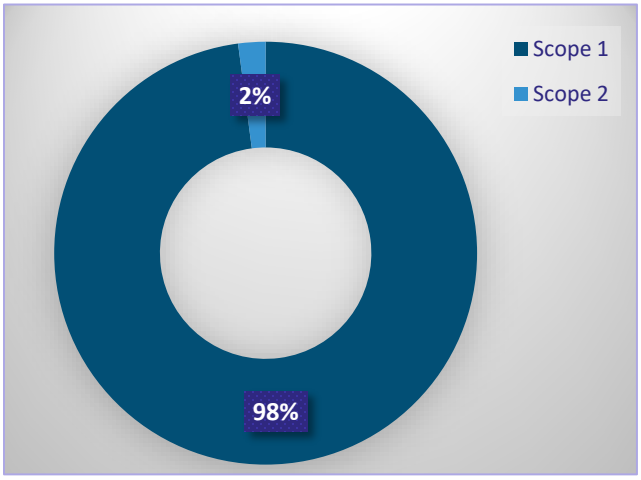


Figure 3. Corporate GHG emissions by scope 2023

Scope 1: Direct GHG Emissions
- Stationary fuel: 543 tCO_2e
- Mobile fuel: 507 tCO_2e
- Corporate-owned landfill: 5,306 tCO_2e

Scope 2: Indirect GHG Emissions from Energy Purchases
- Electricity: 135 tCO_2e
- Steam: n/a
- District energy: n/a

Scope 3: Other Indirect GHG Emissions
- Staff Commute/Business Travel: *not tracked*

NOTE: Additional information on each asset included in the corporate inventory and the raw data can be found in Appendices 5.1 and 5.2.

2.2.2 Buildings and Facilities

Corporate buildings and facilities included in the inventory:

- Dorchester Fire Hall
- Flight Exec Centre
- Community Pool
- Municipal Office
- Dorchester Library
- Thorndale Library
- Landfill Scale House & Shed
- 32 Mill Road
- Operations Centre
- Thorndale Fire Hall
- Thorndale Lions Community Centre

Data Collection Method: Bills/invoices from fuel and electricity providers

Buildings Overview

Table 4. Corporate Buildings & Facilities Energy and GHG Emission Benchmarks

	2023 (baseline)	2024	2025	2026
Scope 1 - natural gas & other fuel				
GHG Emissions (tCO_2e)	545			
Energy Consumption (GJ)	10,491			
Gross Cost ($)	$130,537			
Scope 2 - electricity				
GHG Emissions (tCO_2e)	73			
Energy Consumption (GJ)	7,308			
Gross Cost ($)	$389,366			
Total Annual				
GHG Emissions (tCO_2e)	618			
Energy Consumption (GJ)	17,799			
Gross Cost ($)	$519,903			
Benchmarking				
Metric - m^2	17,132			
KPI 1 – tCO_2e/TJ	34.71			
KPI 2 – GJ/m^2	1.04			
KPI 3 - $/GJ	$29.21			

In 2023, the Buildings & Facilities sector derived 59% of its energy consumption and 88% of its GHG emissions from primarily natural gas use. However, electricity accounted for the majority of the cost, comprising 75% of the total.

Buildings Energy Use

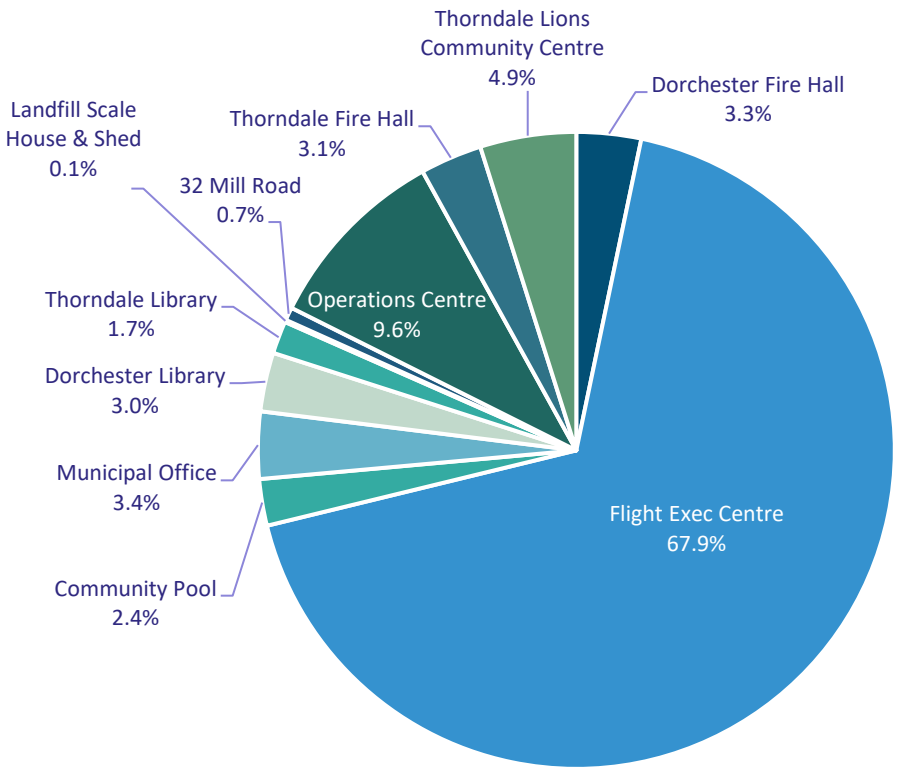


Figure 4. Buildings & facilities energy consumption 2023

In 2023, the Flight Exec Centre had the highest energy consumption (12,089 GJ). However, when normalized for size, it is the Community Pool that has the highest energy use intensity (EUI) at 2.32 GJ/m^2. This is illustrated in Figure 5 on the following page.

Energy Use Intensity (EUI)
is the total energy consumed per unit of floor area

When comparing the EUI of the buildings in this inventory to the average Canadian building of similar function, size and vintage, most of Thames Centre's buildings performed at or better than average. The only exception was the Community Pool, which is an outdoor pool and is considerably more energy intensive than the other Thames buildings as well as other recreation centres across Canada.

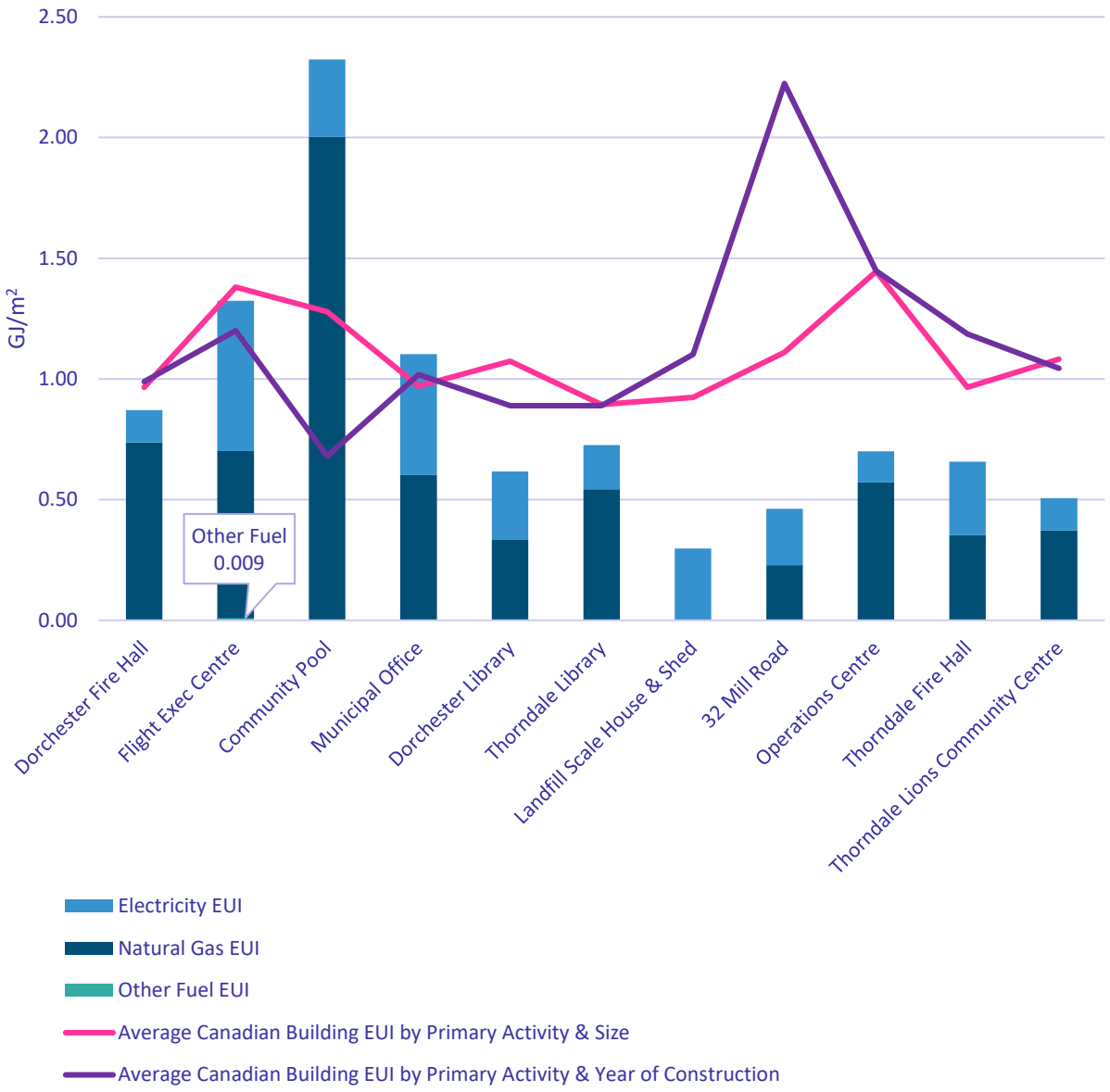


Figure 5. Buildings & facilities EUI and average Canadian EUI for similar buildings[8] 2023

[8]**Canadian building averages (Statistics Canada, 2019)**

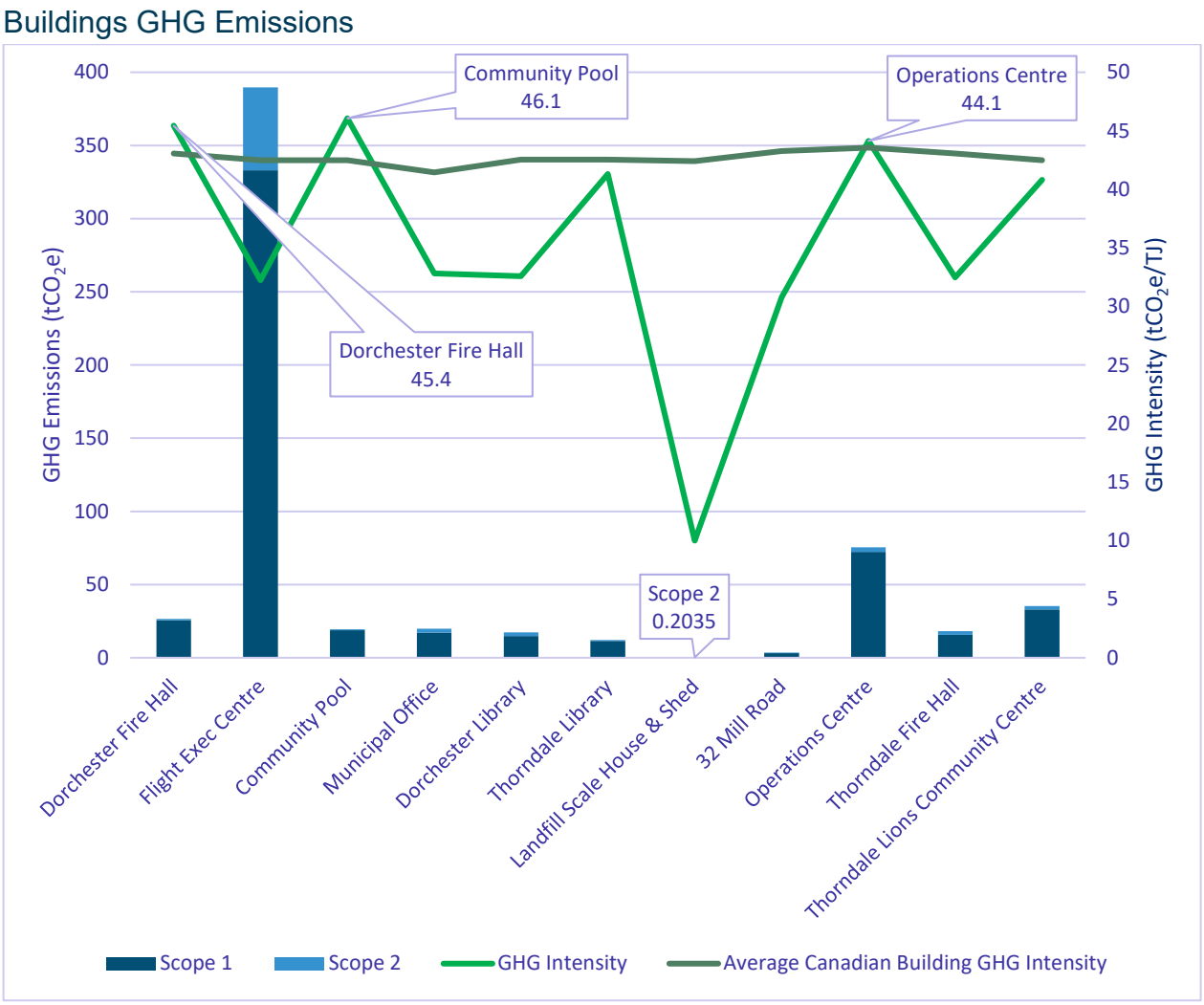


Figure 6. Buildings & facilities GHG emissions & intensity and GHG intensity of the average Canadian building of similar function[9] 2023

The Flight Exec Centre had by far the most GHG emissions in 2023 (390 tCO_2e), but it is also the largest building in the inventory at nearly 3.75x larger than the next biggest building. When the buildings are normalized for GHG emissions by unit of energy consumed, it is the Dorchester Fire Hall, the Community Pool and the Operations Centre which stand out as the most GHG-intensive within the Buildings sector.

Most of the buildings in Thames Centre's corporate inventory had a lower GHG intensity than the average Canadian building of similar activity. While this comparison is useful to see where Thames Centre sits within a national context, it should be noted that they are being compared to a national inventory which includes buildings over an extreme provincial variation in grid intensities.[10]

[9]Canadian commercial/institutional sector building GHG intensity (Office of Energy Efficiency, Natural Resources Canada and Statistics Canada, 2019)

[10] National rather than provincial averages are included, because Canada's emissions data is available including electricity, while the provincial emissions data is only available excluding electricity. (Office of Energy Efficiency, Natural Resources Canada and Statistics Canada, 2019)

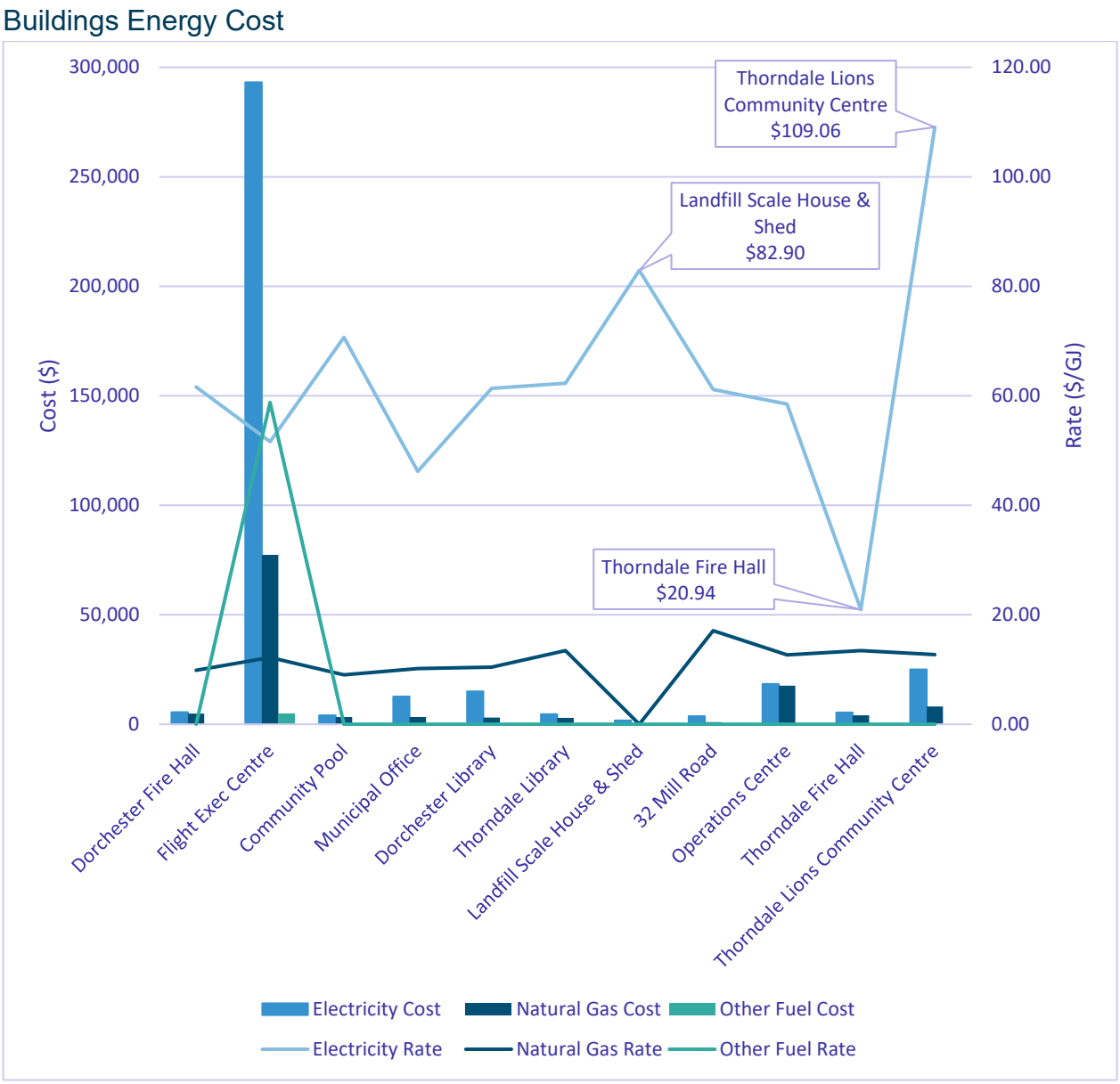


Figure 7. Buildings & facilities energy cost and rate by energy type 2023

The Flight Exec Centre incurred the highest total energy costs ($375,428). The Operations Centre and Thorndale Lions Community Centre are the next most costly at $36,096 and $33,114, respectively.

Electricity was the majority of the energy expense in this sector, costing Thames Centre almost $389,366 across all buildings versus $125,626 for natural gas in 2023.

The natural gas rate between buildings is fairly consistent, but the electricity rates are higher and vary considerably. In particular, the electricity rates paid at the Thorndale Lions Community Centre and the Landfill Scale House & Shed are much higher than for the other buildings in this inventory. Whereas, the Thorndale Fire Hall pays a much lower electricity rate compared to the other buildings.

2.2.3 Fleet Vehicles

Included in the Fleet Vehicles inventory:

- 16 Community Services vehicles
- 6 Environmental Services vehicles
- 11 Protective Services vehicles
- 24 Transportation Services vehicles
- Rental vehicles/equipment (uncategorized)
- Fuel cans for miscellaneous equipment (grouped by municipal department)

Data Collection Method: Invoices and receipts from fuel purchased in 2023; estimated portions were used for select vehicles filled from municipal site fuel tanks

Fleet Vehicles Overview

Table 5. Corporate Fleet Vehicles Energy and GHG Emission Benchmarks

	2023 (baseline)		2024	2025	2026
Scope 1 – gasoline & diesel					
GHG Emissions (tCO_2e)		502			
Energy Consumption (GJ)		7,190			
Net Cost ($)		$259,109			
Benchmarking					
Metric 1 – km | hours	429,616	7,276			
KPI 1 – tCO_2e/TJ		69.8			
KPI 2 – GJ/100km | GJ/hour	0.95	0.42			
KPI 3 - $/GJ		$36.04			

The Fleet Vehicles sector has the highest GHG intensity in the inventory, at an overall value of 69.8 tCO_2e/TJ.

Thirty-six vehicles in the inventory have their mileage (km) tracked, and 21 vehicles/equipment are tracked by hourly usage. The rentals and smaller equipment fueled from storage cans used throughout the municipality do not have their usage tracked, so they are not included in Metric 1 / KPI 2.

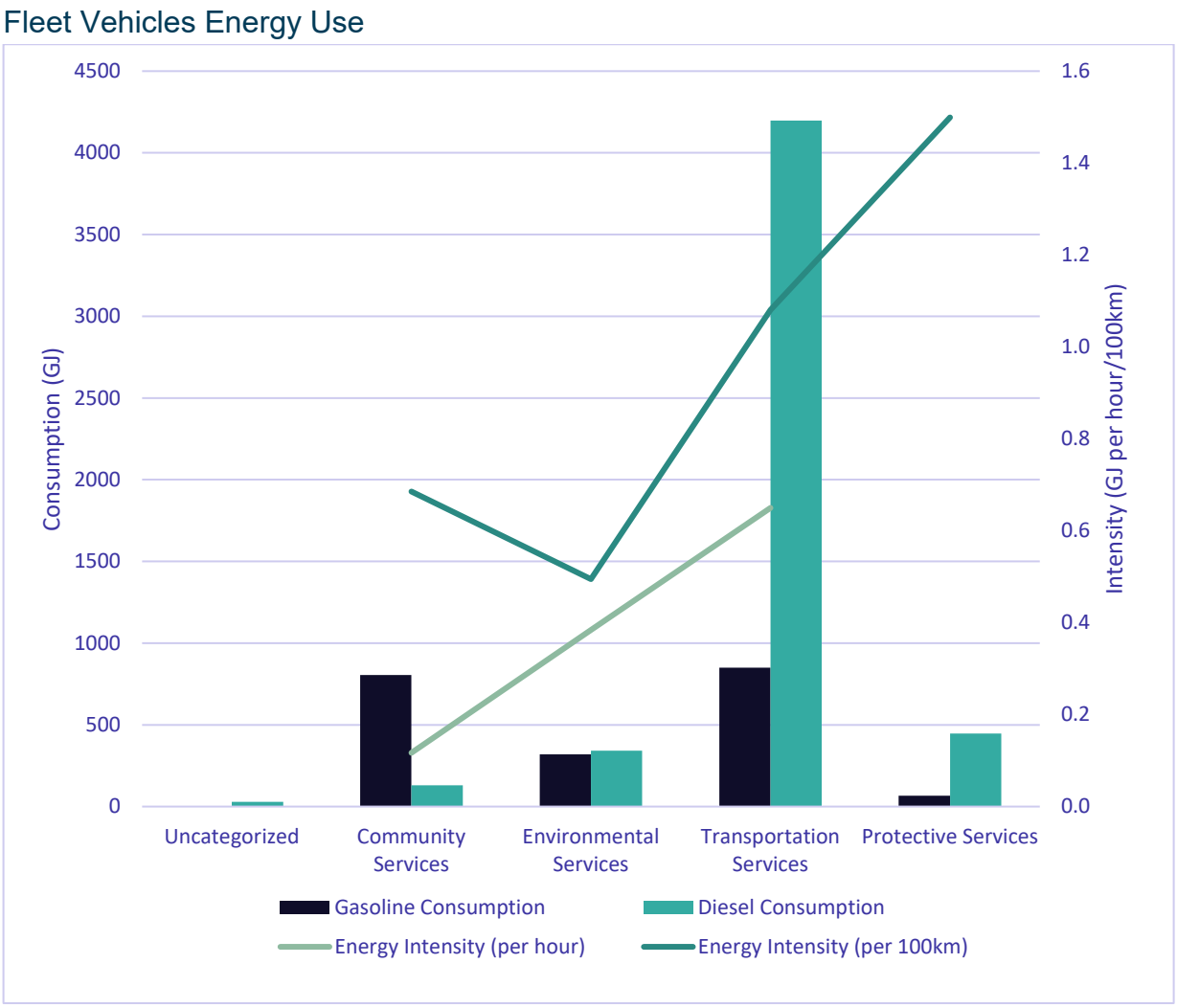


Figure 8. Fleet vehicles energy consumption and intensity 2023

The majority of the fuel consumption in the Fleet Vehicles sector comes from the Transportation Services department (70%), and most of that is from diesel-fueled vehicles and equipment (4,198 GJ). The Transportation department also has the most energy-intensive equipment for those tracked on a hourly usage basis (0.65 GJ/hour). For vehicles that have their mileage tracked, the Protective Services department is the most energy intensive at 1.5 GJ/100km.

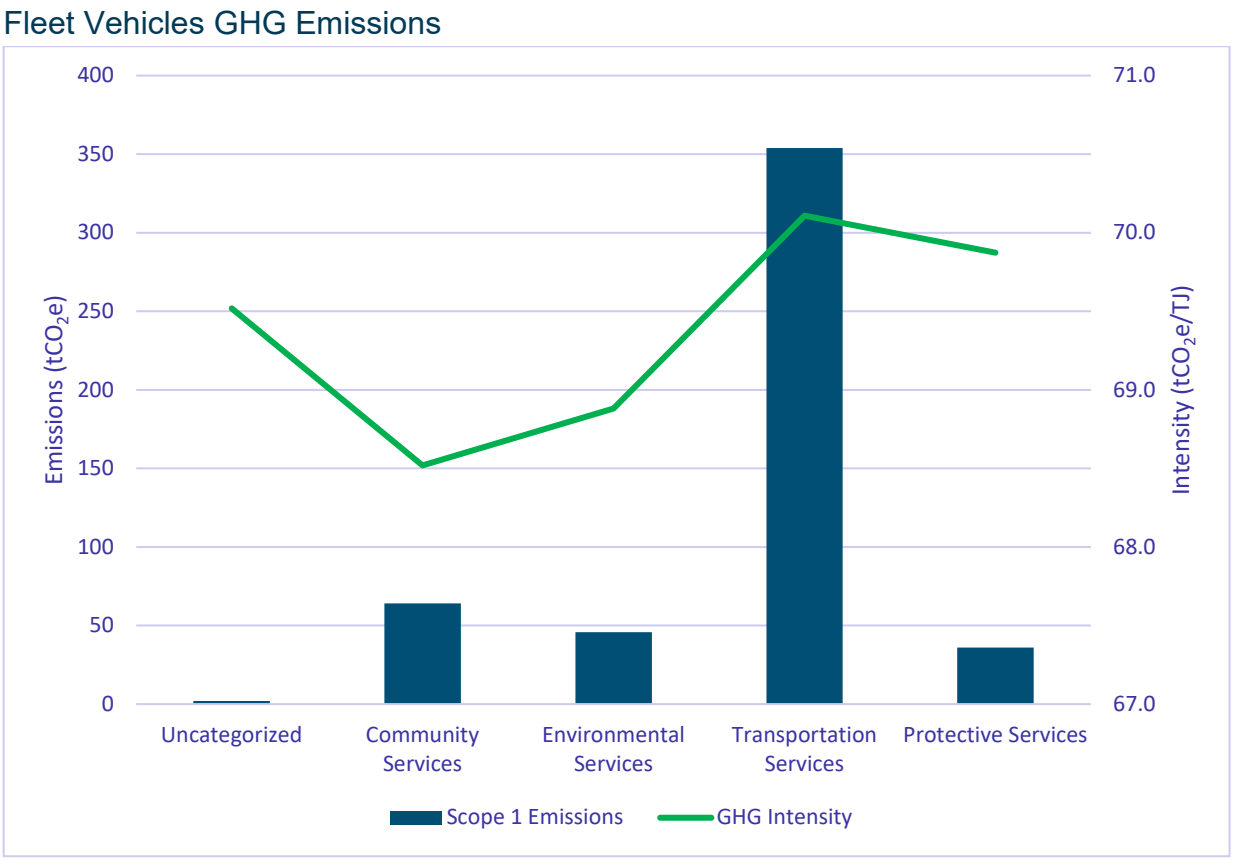


Figure 9. Fleet vehicles GHG emissions and intensity by department 2023

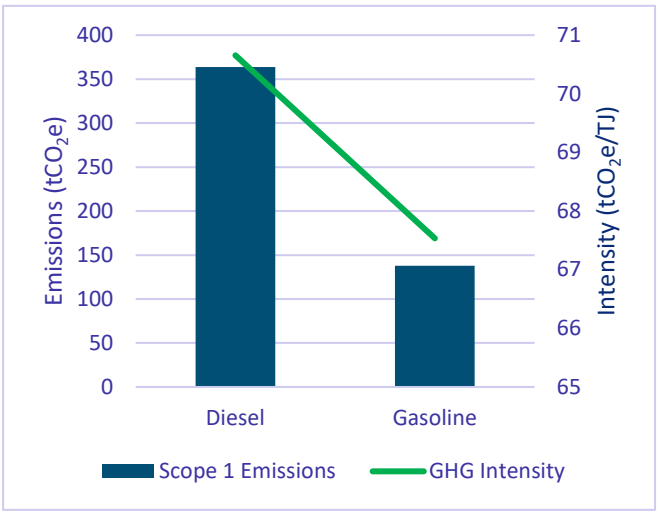


Figure 10. Fleet vehicles GHG emissions and intensity by fuel type 2023

The Transportation Services department accounted for 71% of all Fleet Vehicles GHG emissions in 2023. This department was also the most GHG-intensive at 70.1 tCO_2e/TJ.

When emissions are broken down by fuel-type, 72% came from diesel consumption. Diesel also has a higher GHG-intensity (70.7 tCO_2e/TJ) than gasoline (67.5 tCO_2e/TJ).

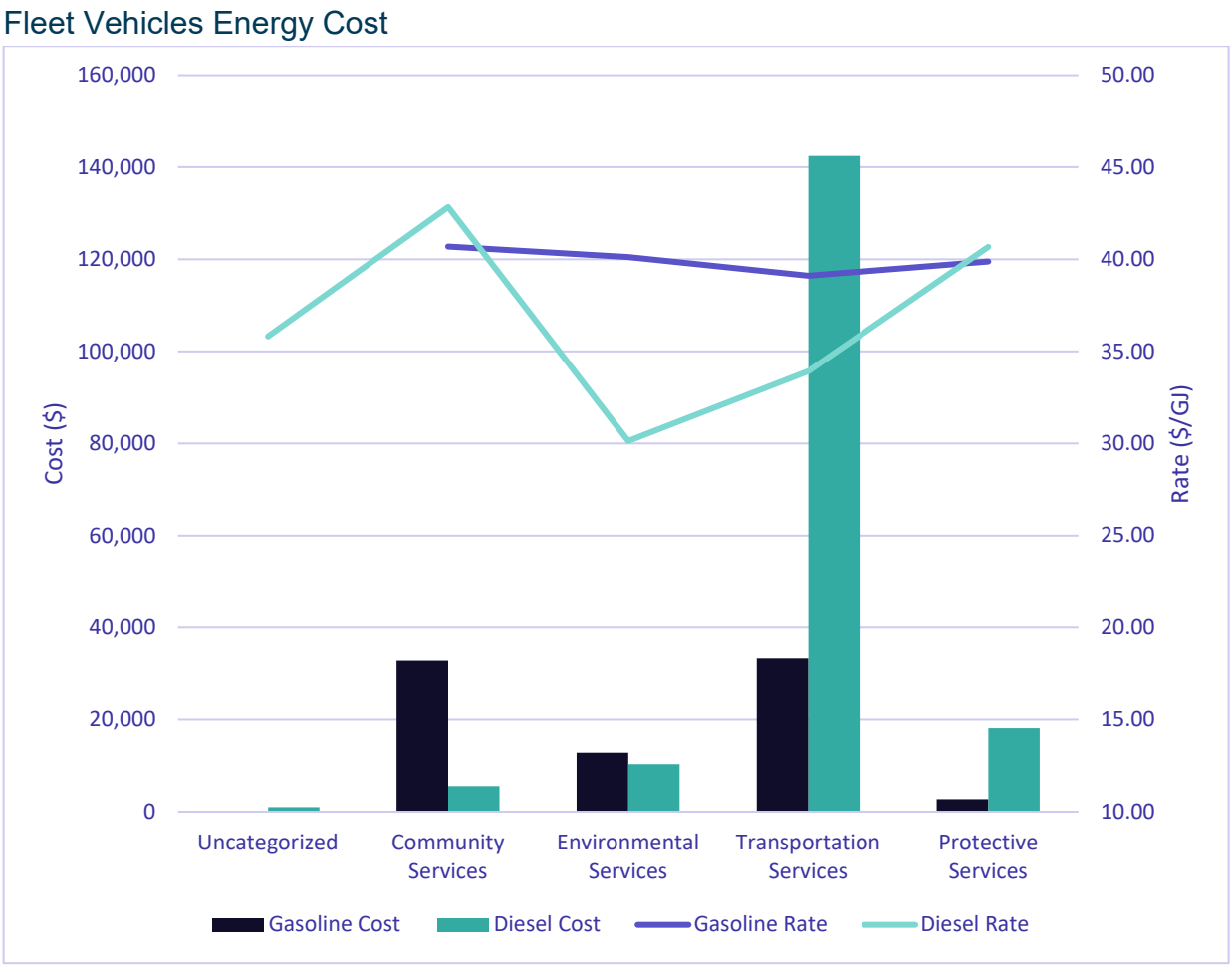


Figure 11. Fleet vehicles energy costs and rates 2023

The Transportation department spent the most on both gasoline and diesel in 2023 - $33,258 for gasoline, $142,419 for diesel = $175,677 total.

The gasoline rates per unit of energy consumed were fairly consistent between departments, while the diesel rates varied. The Protective Services and Community Services departments paid the most for diesel at $40.68/GJ and $42.84/GJ, respectively.

2.2.4 Streetlights and Traffic Signals

Lighting groups included in the inventory:

- Streetlights
- Harrietsville Ball Diamond
- Outdoor Recreation Centre (ORC) Soccer Fields and Baseball Fields

Data Collection Method: Invoices from grid electricity provider

Lights Overview

Table 6. Corporate Streetlights Energy and GHG Emission Benchmarks

	2023 (baseline)	2024	2025	2026
Scope 2 - electricity				
GHG Emissions (tCO_2e)	12.6			
Energy Consumption (GJ)	1,256			
Gross Cost ($)	$75,387			
Benchmarking				
Metric - # of lights	1,090			
KPI 1 – tCO_2e/TJ	10.0			
KPI 2 – GJ/light	1.15			
KPI 3 - $/GJ	$60.01			

Lights Energy Use

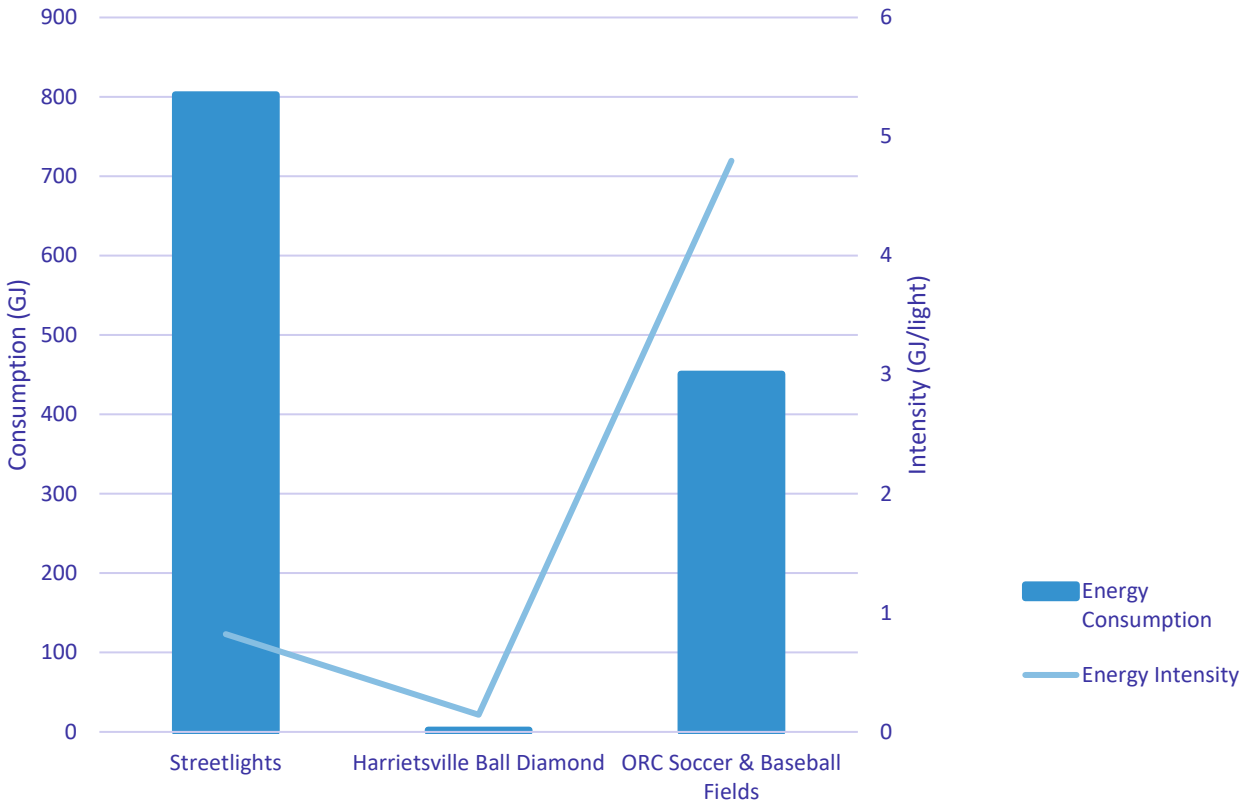


Figure 12. Lights energy consumption and energy intensity per light 2023

Thames Centre streetlights used the most energy in 2023, accounting for 64% of the total for the Streetlights & Traffic Signals sector. However, when normalized for per light usage, the ORC Soccer & Baseball Fields had the highest energy-intensity at 4.8 GJ/light.

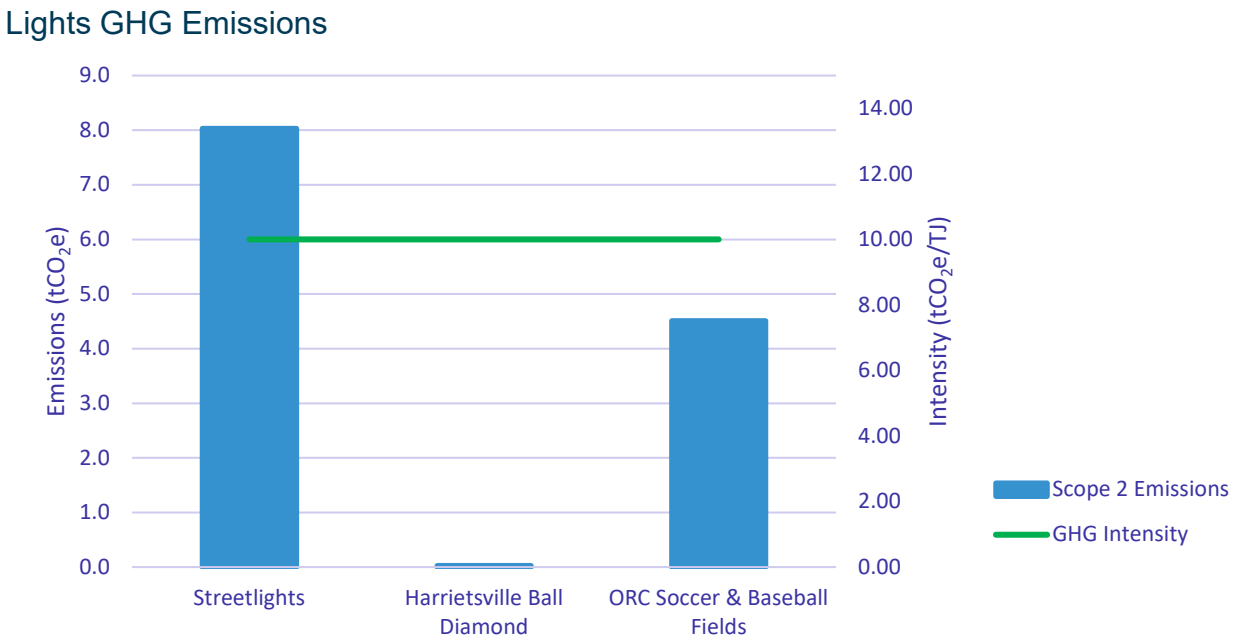


Figure 13. Lights GHG emissions and intensity 2023

The streetlights category created the most GHG emissions in 2023 – 8.03 tCO_2e or 64% – but also accounted for 90% of the total lights in this sector.

The GHG-intensity for each category is consistent at 10 tCO_2e/TJ. This figure is based on the GHG emission factor for Ontario's electricity grid, which is the only source of energy for Thames' lighting sector.

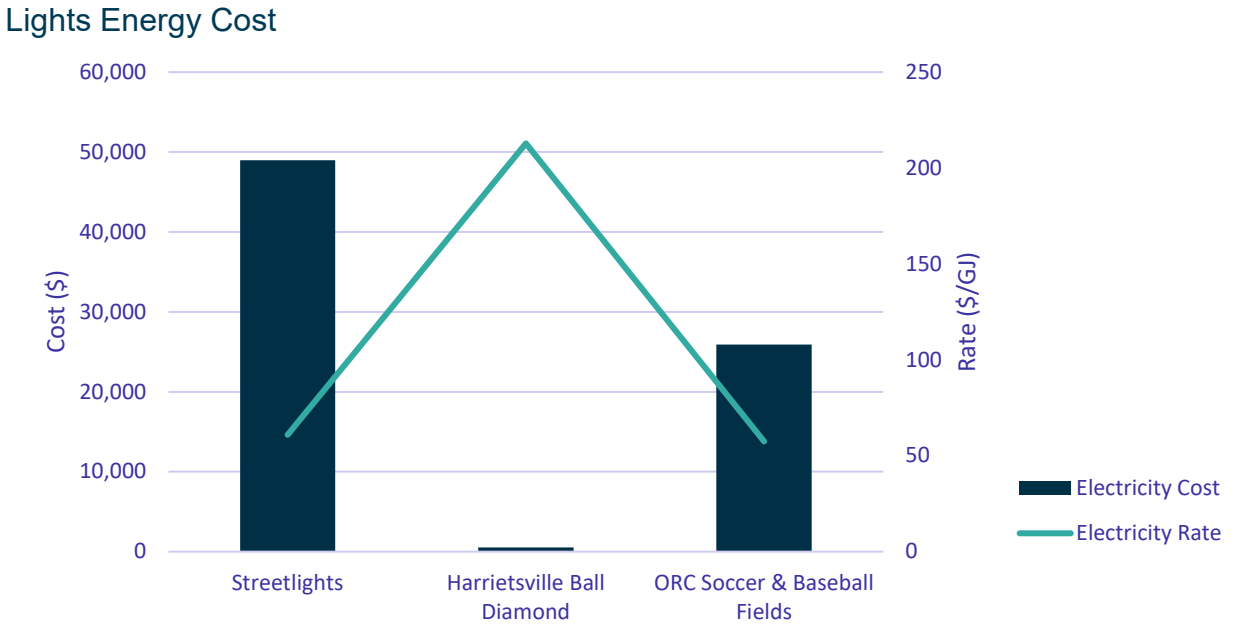


Figure 14. Lights energy cost and rate 2023

The streetlights category cost the municipality the most in 2023 at $48,967, but it was the Harrietsville Ball Diamond that was the most cost-intensive at $213/GJ.

2.2.5 Water and Wastewater

Water and wastewater facilities included in the inventory:

- Dorchester Water Treatment Plant (WTP)
- Thorndale Water Treatment Plant (WTP)
- Dorchester Wastewater Treatment Plant (WWTP)
- Thorndale Wastewater Treatment Plant (WWTP)
- Pumping Station #1
- Pumping Station #3

Data Collection Method: Invoices from energy/utility providers

Water Overview

Table 7. Water & Wastewater Energy and GHG Emission Benchmarks

	2023 (baseline)	2024	2025	2026
Scope 1 - natural gas				
GHG Emissions (tCO_2e)	3.6			
Energy Consumption (GJ)	69			
Gross Cost ($)	$1,144			
Scope 2 – electricity				
GHG Emissions (tCO_2e)	49.8			
Energy Consumption (GJ)	4,975			
Gross Cost ($)	$284,903			
Total Annual				
GHG Emissions (tCO_2e)	53.3			
Energy Consumption (GJ)	5,045			
Gross Cost ($)	$286,047			
Benchmarking				
Metric – m^3	1,031,606			
KPI 1 – tCO_2e/TJ	10.6			
KPI 2 - GJ/1000m^3	4.9			
KPI 3 - $/GJ	$56.70			

The facilities included in the Water & Wastewater sector are all powered exclusively from grid electricity with the exception of the Dorchester WWTP which uses both natural gas and electricity. These facilities in 2023 processed a total volume of 1,031,606 m^3 and emitted 53.3 tCO_2e.

Water Energy Use

As can be seen in the figure below, the Dorchester WTP consumed the most energy at 1,911 GJ. However, when standardized by the volume processed in 2023, Pumping Station #3 was the most energy intensive followed by the Thorndale WWTP and the Dorchester WWTP.

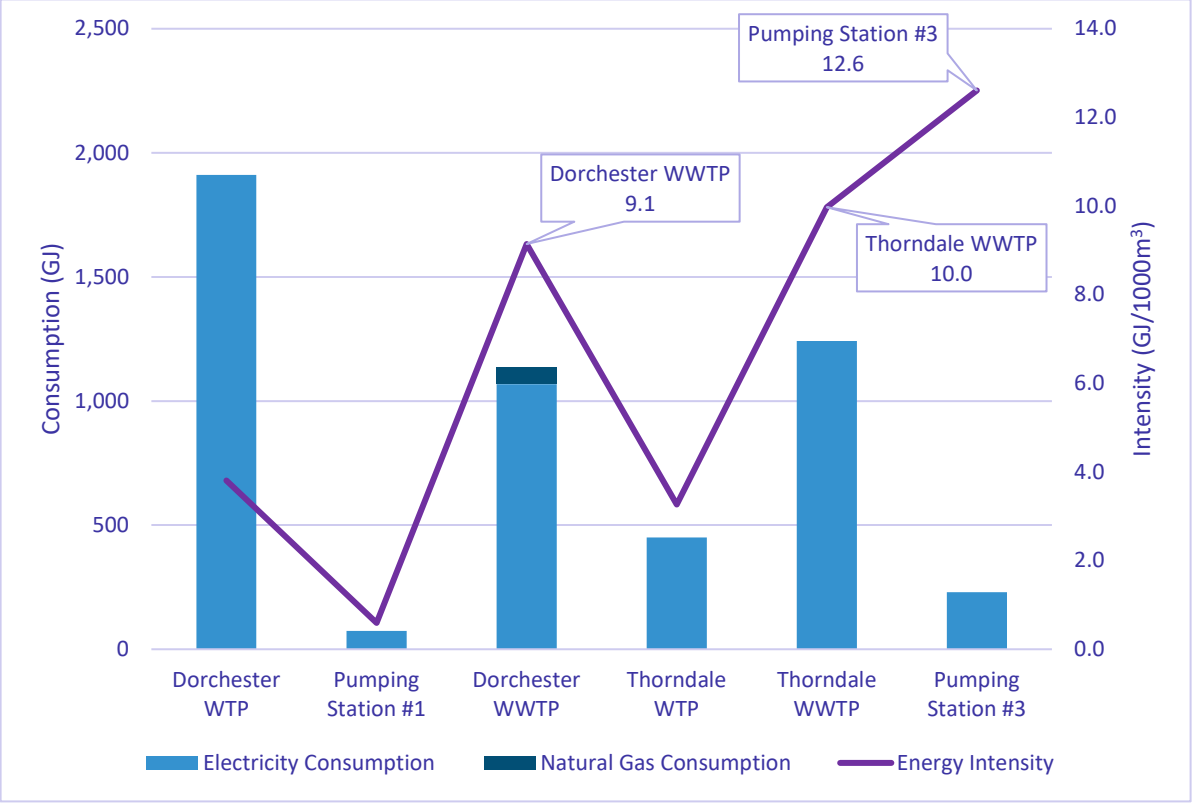


Figure 15. Water & wastewater energy consumption and intensity 2023

Water GHG Emissions

As the highest energy consumer, the Dorchester WTP also created the most GHG emissions (19.1 tCO_2e or 36% of the total for this sector). The GHG intensity was consistent for all facilities that exclusively used grid electricity as an energy source (10.0 tCO_2e/TJ). The Dorchester WWTP had a higher GHG intensity (12.5 tCO_2e/TJ) due to its use of natural gas, which is a more emission intensive energy source than electricity in Ontario.

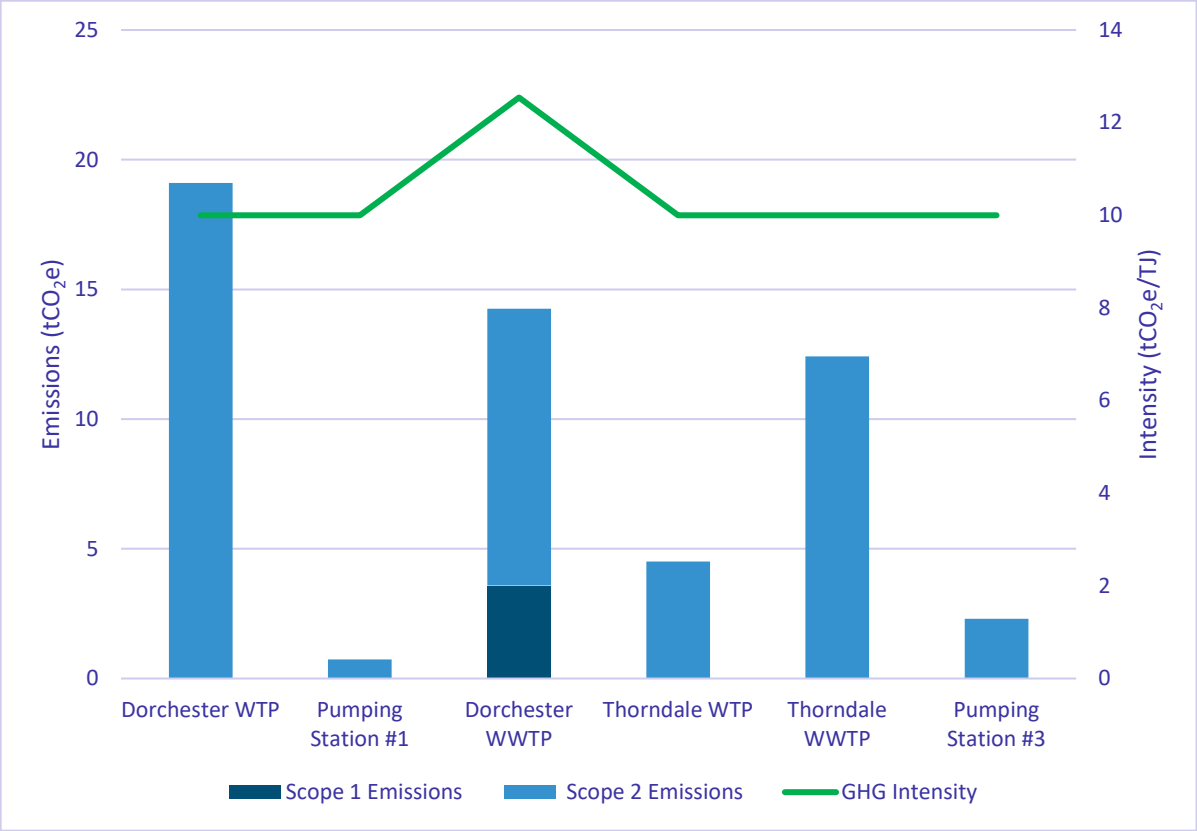


Figure 16. Water & wastewater GHG emissions and GHG intensity by energy consumed 2023

Water Energy Cost

In 2023, the Dorchester WTP had the highest total energy cost at $124,512 and the second highest energy rate at $65.16/GJ. Interestingly, the pumping stations represent the two extremes in energy rate with Pumping Station #1 having the highest rate and #3 having the lowest rate.

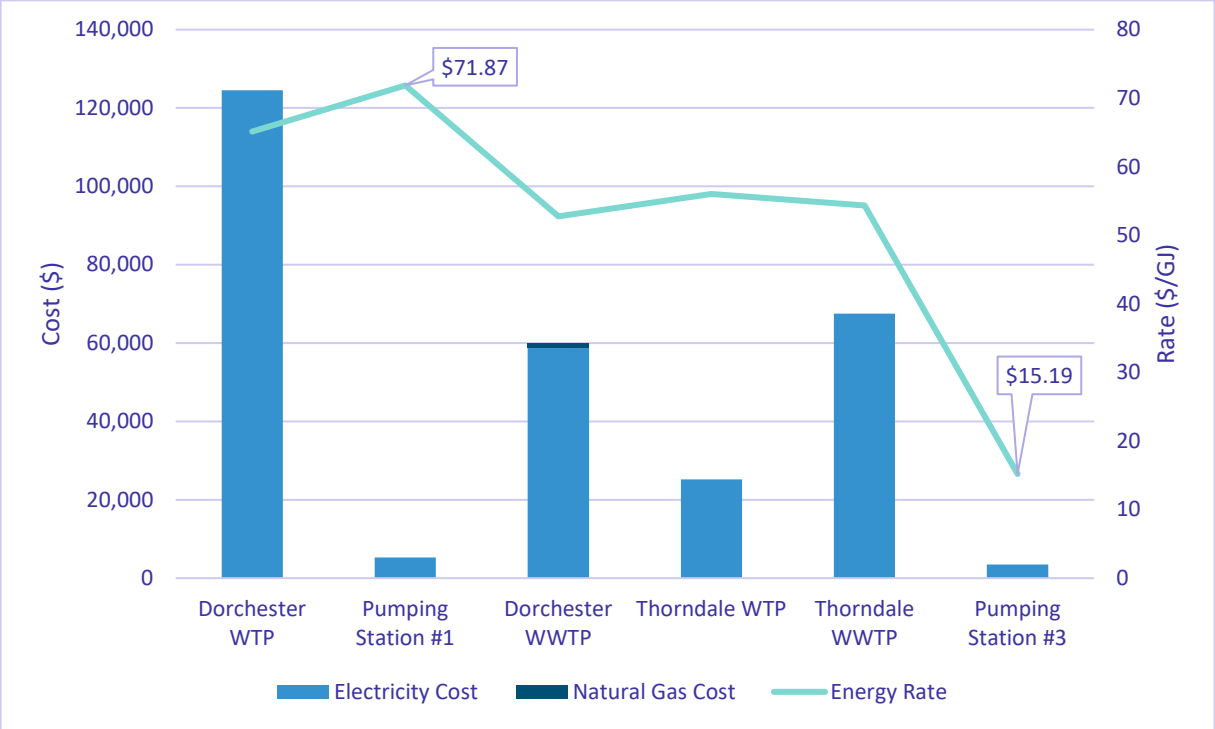


Figure 17. Water & wastewater energy costs and rates 2023

2.2.7 Solid Waste

Solid Waste Management: Solid waste in the municipality is disposed of at the Thames Centre Landfill, which is within the municipal boundaries. The landfill currently has no gas collection system in place.

Data Collection Method: Disposal weight from landfill scale tickets

Solid Waste Overview

Table 8. Corporate Solid Waste Disposal & GHG Emission Benchmarks

	2023 (baseline)	2024	2025	2026
Scope 1 – solid waste				
Disposal (tonnes)	2,921			
GHG Emissions (tCO_2e)[11]	5,306			
Benchmarking				
Metric - population[1]	13,980			
KPI 1 – tCO_2e/tonne disposed	1.8			
KPI 2 – tCO_2e/capita	0.38			

Solid Waste GHG Emissions

Corporate solid waste disposal results in methane (CH_4) emissions that enter the air directly as waste decomposes at landfills. The methane commitment model used to calculate Thames Centre's corporate solid waste GHG emissions estimates the total downstream CH_4 emissions generated over the course of the waste's decomposition. This model is the most practical for municipalities that don't have extensive data on historical waste disposal, and it is the most comparable approach.[12] A disadvantage of this model is that it does not represent GHG emissions during *just* the inventory year. It rolls together current and future emissions and treats them as equal, as opposed to other emissions in this inventory which only consider current (2023) emissions.

The Thames Centre Landfill collected 2,921 tonnes of solid waste in 2023. Assuming waste management procedures remain consistent, this will amount to 5,306 tCO_2e over the waste's decomposition lifetime, or 1.8 tonnes of CO_2e per tonne of waste disposed. On a per capita basis, this is 0.38 tCO_2e per resident of Thames Centre.

[11] GHG emissions calculated for corporate solid waste using PCP Protocol Approach 1, Method C, Methane Commitment Model – using the general municipal solid waste composition values for Canada, MCF=1.0 (anaerobic managed), DOC_F=0.6 (default), F=0.5 (default), f_{rec}=0 (no LFG system), OX=0.1 (managed, covered with CH_4 oxidizing material) (Partners for Climate Protection, 2021)
[12] As per the PCP Protocol guidelines (Partners for Climate Protection, 2021)

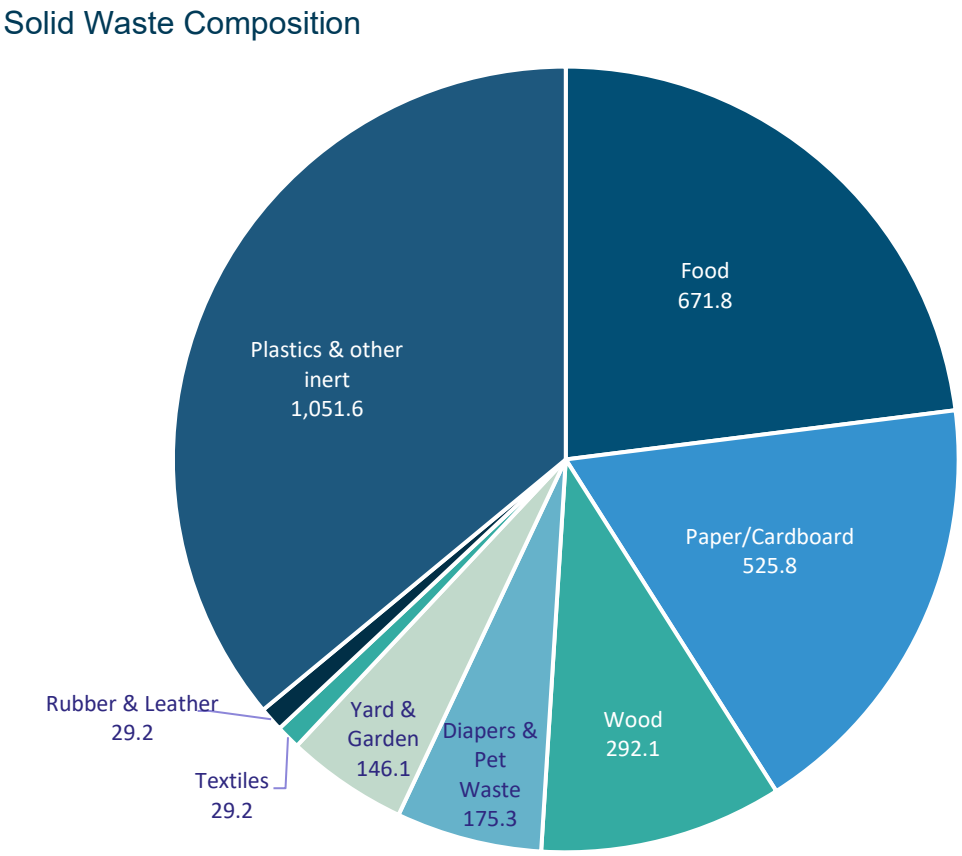


Figure 18. Approximate solid waste composition in tonnes 2023

Thames Centre does not currently track the composition of the landfill's waste. But the figure above illustrates the approximate breakdown of Thames' waste based on general Canadian solid waste composition values (Partners for Climate Protection, 2021).

3.0 GHG Emissions Forecast

It is estimated that the population of Thames Centre will increase by 4.78% over the next 10 years between 2023 and 2033. This is based on the compound annual growth rate of 0.39% documented between 2006 and 2021, according to population data from the last four censuses (Statistics Canada, 2023).

If the current average annual population growth trend continues and everything else remains business-as-usual (BAU) for the municipality, it is expected that solid waste disposal and water/wastewater demands will increase proportionally with population. However, due to the relatively small growth, it is not anticipated that there will be a need to expand assets such as streetlights, fleet vehicles, or buildings/facilities. As a result, there is unlikely to be any significant increase in energy consumption or emissions in these sectors over the next 10 years, particularly given Thames Centre's close proximity to larger urban centres.

Table 9. Ten Year GHG Emissions Business-As-Usual Forecast by Sector

Sector	BAU Forecast	GHG Emissions Change 2023-2033
Buildings & Facilities	Negligible change	0%
Fleet Vehicles	Negligible change	0%
Streetlights/Traffic Signals	Negligible change	0%
Water & Wastewater	Change proportional to population growth	4.78%
Solid Waste	Change proportional to population growth	4.78%

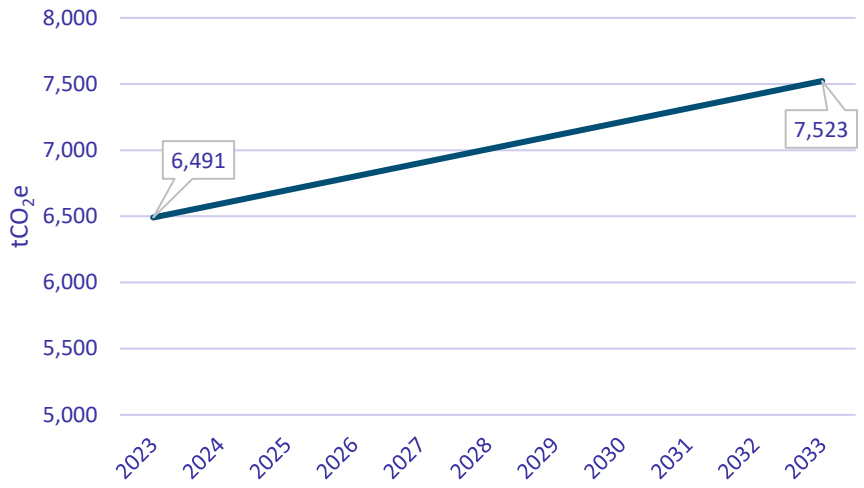


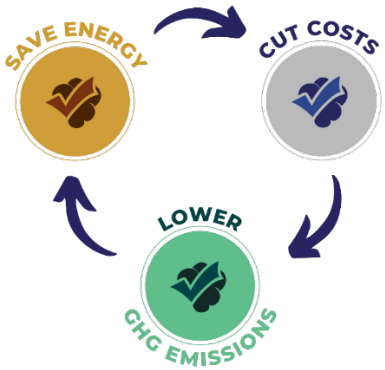
Figure 19. GHG Emissions BAU Forecast 2023-2033

4.0 Recommendations

4.1 General

To enhance energy efficiency and reduce GHG emissions, several strategic recommendations are proposed. The recommendations in this section (4.1) can be applied to multiple sectors within Thames Centre's corporate inventory, and the following sections (4.2 – 4.6) contain sector-specific advice.

By adopting the recommendations provided, Thames Centre can achieve substantial energy and cost savings, reduce their carbon footprint, and contribute to a more sustainable future.



Set Clear Targets & Monitor Progress: Establish specific, measurable targets for energy and GHG reductions and regularly track progress to ensure goals are met using eMission Software Inc.'s Municipal Dashboard. Consider expanding monitoring to include the community inventory (residential, institutional, commercial and industrial buildings/facilities, and transportation), which will provide a more complete picture of Thames Centre's impact on the environment.

Energy Efficiency Procedures: Develop and implement formal energy efficiency procedures for all assets and train staff on the procedures. By implementing these procedures and fostering a culture of energy conservation, staff can play a significant role in reducing energy consumption/GHG emissions and promoting sustainability.

- ***Training and Education:*** Provide training sessions and educational materials to raise awareness about energy conservation practices and the importance of energy efficiency. Staff should be knowledgeable about energy-saving strategies, equipment operation, and maintenance best practices.
- ***Regular Equipment Maintenance:*** Establish a maintenance schedule for systems and equipment. Regular maintenance helps ensure that equipment operates efficiently and can identify and address issues promptly.
- ***Equipment Shutdown:*** Implement procedures for shutting down non-essential equipment and appliances when not in operation.

- ***Behavioral Changes:*** Foster a culture of energy conservation among users by encouraging responsible energy use and recognizing staff efforts to save energy. Consider implementing incentives or recognition programs to reward these behaviors.

Procurement Process: Formalize corporate requirements to include energy efficiency and environmental impact considerations when purchasing and replacing assets across all sectors.

District Renewable Energy – e.g. geothermal, wind power, solar power. A district renewable energy installation can help power multiple assets, cut costs over the long-term, reduce reliance on grid energy, and lower GHG emissions.

4.2 Buildings and Facilities

Buildings and facilities constitute the most energy- and cost-intensive components of Thames Centre's corporate inventory. Therefore, it is recommended energy efficiency initiatives and projects in this sector be prioritized.

Energy Efficiency Procedures:

- ***Building Temperature Control:*** For areas where automation is not feasible, encourage staff to set thermostats to energy-efficient temperatures during occupied and unoccupied hours.
- ***Lighting Management:*** For areas where automation is not feasible, encourage staff to turn off lights when not in use and utilize natural daylight whenever possible.
- ***Equipment Shutdown:*** Turning off computers, printers, copiers, appliances, and other plug loads that consume energy when not in use.

Smart Controls: Install smart thermostats, smart light controls, timer/sensor lighting and smart power strips for equipment to automatically adjust energy use based on need/occupancy levels.

Facility Plug & Process Loads: Plug and process loads (PPLs) include all plug-in and hardwired loads in a facility and account for ~47% of commercial building energy consumption.[13] The following guide and associated workbook from the US National Renewable Energy Laboratory is a free resource that can be used to conduct an assessment of a facility's PPL and make reductions in energy use - *Assessing and Reducing Plug and Process Loads*.

LED Lighting: Retrofit and replace all lights with LED lighting. LED lightbulbs use up to 90% less energy, on average, and last approximately 15 times longer than traditional incandescent light bulbs.[14] And LED lights are 18%-44% more efficient than T8 fluorescent lamps.[15]

[13] **Assessing and Reducing Plug and Process Loads in Office Buildings (US Dept. of Energy, Office of Energy Efficiency and Renewable Energy, 2020)**
[14] **For Energy Star-certified LED light bulbs (Natural Resources Canada, 2022)**
[15] **According to a study by Liu L, Keoleian G, Lewis G. at the University of Michigan (Atherton, 2023)**

Major Upgrades, Retrofits and Operational Practices:

- ***Efficient building HVAC systems*** - general information on HVAC systems and energy efficiency can be found here - The Ultimate Guide to Commercial HVAC Systems | LG Home Comfort (LG Home Comfort, 2023)
  - Heat pumps are an example of a highly efficient heating and cooling system that transfers heat rather than generating it directly making them much more energy-efficient than traditional furnaces or air conditioners. They also reduce greenhouse gas emissions and can be powered by renewable energy sources.
- ***High-performance building envelope*** – Space heating accounts for nearly 80% of commercial building GHG emissions in Ontario.[16] Evaluating options to improve building envelopes to reduce heat loss will cut GHG emissions. Particular attention should be paid to the buildings with the highest energy- and GHG-intensities.
- ***Energy recovery systems*** – e.g. heat waste recovery - Reclaim waste heat from rink - Arena Guide (arena-guide.com) (Signify Canada Ltd., n.d.)
- ***On-site renewable energy*** – e.g. geothermal, wind power, solar power
  - A solar thermal water heater system at the Community Pool, for example, would significantly lower the GHG intensity of that facility.
  - A solar (PV) installation at the Thorndale Lions Community Centre would save the municipality on energy costs for this facility, as it pays the highest electricity rate in the buildings sector ($109/GJ).
- ***SCADA systems/smart sensors and controls*** for efficient facility operations and maintenance

Flight Exec Centre (Arena): This report has identified the municipality's arena as the largest energy consumer and emissions creator within the Buildings sector. Additionally, it has the second highest EUI and the highest energy costs. Focusing on improvements to this building will yield a high return for the community.

- ***Rooftop solar (PV) installation*** – the arena used 1,578,590 kWh of electricity in 2023 which cost the municipality $293,209. Additionally, "Ontario's Independent Electricity System Operator (IESO) now forecasts that electricity demand alone will increase by 75 per cent by 2050" (Government of Ontario, 2024). A solar installation could significantly reduce those costs, and future-proof the arena as grid electricity demand increases.
- ***Building efficiency*** – the arena's natural gas consumption accounted for over 50% of the GHG emissions in the Buildings sector. The following fact sheet provides more specific information for indoor ice rinks that expand on the general recommendations made in this report for improving building efficiency and reducing emissions - Building-level solution: High-efficiency indoor ice rinks (fcm.ca) (Green Municipal Fund, 2024).

4.3 Fleet Vehicles

Energy Efficiency Procedures:

- ***Equipment Shutdown:*** Implement an anti-idling policy for fleet vehicles.

[16] **Average GHG emissions by end use for provinces, like Ontario, with low-carbon grids (Federation of Canadian Municipalities, 2020)**

Procurement Process: Perform a cost/benefit analysis when replacing or purchasing new vehicles, taking into consideration electrical and hybrid options. Particular attention should be paid to replacing diesel vehicles and equipment in the Transportation Services department with less GHG-intensive options.

4.4 Streetlights and Traffic Signals

LED Lighting: Retrofit and/or replace all outdoor lighting with LED lights to reduce energy consumption, cost and GHG emissions.

On-site or district renewable energy: e.g. geothermal, wind power, solar power

- The Harrietsville Ball Diamond energy rate was the highest across the entire inventory at nearly $213/GJ of electricity used. A renewable energy source, such as solar panels, would offset that cost.

4.5 Water and Wastewater

On-site or district renewable energy: e.g. geothermal, wind power, solar power

SCADA systems/smart sensors and controls for efficient facility operations and maintenance

4.6 Solid Waste

Composting Program: Expand the yard waste composting program to include all types of compostable material and regular pickups to reduce the amount of waste landfilled and the resultant GHG emissions. This could help divert approximately 672 tonnes of food waste (~23% of the total solid waste in 2023).

Landfill Gas Collection System: Implement a gas collection system at the landfill to start capturing emissions and converting them into fuel types with lower emission intensities.

5.0 Appendices

5.1 Corporate Inventory

ID	Building/Facility	Year of Construction	Size (ft^2)	Primary Activity	Lighting	HVAC	Notes
B-007	Dorchester Fire Hall	1991	7,218	Public safety – police and fire station	Fluorescent/CFL	Central A/C, Furnace	On-call hours
B-013	Flight Exec Centre (Arena)	1976	98,300	Ice rink	LED	Central A/C, Furnace	Monday- Sunday 6:30am-12:00am; Sensors, Smart Hub Compressor System, Computer Controlled HVAC; Renos/additions in 2012; Food Bank & Storage Shed on property are on the same utility meter; Two propane-powered ice resurfacers included (vehicle ID 65 & 85)
B-016	Community Pool	1971	1,950	Recreation centre	LED		Outdoor pool; Seasonal hours; Reconstruction in 2020; Includes pavilion, splash pad, wading pool and walkway lighting
B-033	Thames Centre Municipal Office	1959	5,907	Office space – excluding medical	LED	Central A/C, Furnace	Monday- Friday 8:30-4:30pm; Condition assessment notes improvement ideas for automation; EV charging station installation planned
B-036	Dorchester Library	2001	9,285	Library or archives	LED	Central A/C, Furnace	Monday- Sunday hours vary
B-037	Thorndale Library	2006	4,366	Library or archives	Fluorescent/CFL	Central A/C, Furnace	Hours vary
B-041 B-040	Thames Centre Landfill Scale House & Shed	2001 2002	90 645	Other	*Unknown*	Electric baseboard	Limited hours; Two buildings at landfill site on one utility meter
B-046	32 Mill Road	1968	2,755	Food or beverage store	Incandescent	Central A/C, Furnace	Privately operated store – only open during Summer months; Building owned by municipality

ID	Building/Facility	Year of Construction	Size (ft^2)	Primary Activity	Lighting	HVAC	Notes
B-048	Operations Centre	2013	26,270	Vehicle dealership, repair, or storage	LED	Central A/C, Furnace	Monday - Friday 6:00 - 5:00pm, hours vary for on-call snowplowing; Motion sensors
B-049	Thorndale Fire Hall	2018	9,166	Public safety – police and fire station	LED	Central A/C, Furnace	On-call hours; On-site storage shed included
B-050	Thorndale Lions Community Centre	2021	18,460	Recreation centre	LED	Central A/C, Furnace	Includes the concession stand, pavilion, washrooms, ball diamonds, storage building and fieldhouse; Monday-Sunday 7:30-11:30pm; Motion sensors

ID	Vehicle Make	Vehicle Model	Year	Department	Vehicle Type	Fuel Type	Notes
2	Chevrolet	Silverado	2016	Community Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
3	John Deere	1025R	2016	Community Services	Off-road <19kW	Diesel	Tractor/Mower
7	Toro	2000 Series	2017	Community Services	Off-road 4-stroke	Gasoline	Side discharge mower
8	Kubota	1724XKW	2022	Community Services	Off-road 4-stroke	Gasoline	Zero turn
9	John Deere	Z930R	2021	Community Services	Off-road 4-stroke	Gasoline	Zero turn
10	Western	Star	2014	Transportation Services	Truck - freight	Diesel	Tandem plow truck
11	CAT	440-07	2023	Transportation Services	Off-road ≥19kW	Diesel	Backhoe loader
23	International	1	2016	Transportation Services	Truck - freight	Diesel	Tandem plow truck
24	Freightliner	114SD	2018	Transportation Services	Truck - freight	Diesel	Tandem plow truck
31	Kubota	X900W	2019	Community Services	Off-road <19kW	Diesel	RTV
32	Kioti	Merchron 2200	2014	Community Services	Off-road <19kW	Diesel	RTV
36	Kioti	CK25	2005	Community Services	Off-road <19kW	Diesel	Tractor
37	Dodge	Ram 1500	2019	Transportation Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
40	Dodge	Ram 1500	2018	Transportation Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
41	Dodge	Ram 1500	2019	Transportation Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
42	CAT	938M	2017	Transportation Services	Off-road ≥19kW	Diesel	Loader
45	CAT	816F	1996	Environmental Services	Off-road ≥19kW	Diesel	Compactor
49	Dodge	Ram 1500	2019	Transportation Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	

ID	Vehicle Make	Vehicle Model	Year	Department	Vehicle Type	Fuel Type	Notes
54	International		2010	Transportation Services	Truck - freight	Diesel	Single axle plow truck
55	Dodge	Ram 3500	2017	Transportation Services	Heavy-Duty Vehicle (>3856kg)	Gasoline	
58	Dodge	Ram 1500	2019	Transportation Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
60	Vermeer	Chipper	2010	Transportation Services	Off-road ≥19kW	Diesel	Brush chipper
61	Dodge	Ram 1500	2019	Community Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
66	CAT	Grader 140M3	2018	Transportation Services	Off-road ≥19kW	Diesel	
69	International		2013	Community Services	Off-road ≥19kW	Diesel	Landscape dump body
70	John Deere	4520	2012	Community Services	Off-road ≥19kW	Diesel	Compact Tractor
71	John	Deere Backhoe	2013	Environmental Services	Off-road ≥19kW	Diesel	This is used in multiple locations.
74	Ford	F150	2013	Transportation Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
75	John	Deere Grader	2013	Transportation Services	Off-road ≥19kW	Diesel	
77	Chevrolet	Silverado	2015	Community Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
80	Case	590 Backhoe	1997	Transportation Services	Off-road ≥19kW	Diesel	
81	International	HV507	2023	Transportation Services	Truck - freight	Diesel	Single axle plow truck
82	Chevrolet	Silverado	2020	Environmental Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
83	Chevrolet	Silverado	2020	Protective Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
86	Trackless	Sidewalk Plow	2018	Transportation Services	Off-road ≥19kW	Diesel	
87	Freightliner	114SD	2020	Transportation Services	Truck - freight	Diesel	Tandem plow truck
88	Freightliner	114SD	2021	Transportation Services	Truck - freight	Diesel	Tandem plow truck
89	Chevrolet	Silverado	2021	Environmental Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
90	Chevrolet	Silverado	2021	Environmental Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
91	Case IH Farmall	40C Series II	2021	Community Services	Off-road ≥19kW	Diesel	Tractor
92	John Deere		2021	Community Services	Off-road 4-stroke	Gasoline	Zero Turn Mower
93	Chevrolet	Silverado 2500	2021	Transportation Services	Heavy-Duty Vehicle (>3856kg)	Gasoline	
94	Chevrolet	Silverado 2500	2021	Community Services	Heavy-Duty Vehicle (>3856kg)	Gasoline	
95	Chevrolet	Silverado	2022	Community Services	Light-Duty Truck (<3856kg, truck/SUV/van)	Gasoline	
96	CAT	953C	2003	Environmental Services	Off-road ≥19kW	Diesel	Crawler Loader
97	International	HV507	2023	Transportation Services	Truck - freight	Diesel	Tandem plow truck

ID	Vehicle Make	Vehicle Model	Year	Department	Vehicle Type	Fuel Type	Notes
98	Fendt	FT822	2023	Transportation Services	Off-road ≥19kW	Diesel	
100	Spartan	Metro Star	2017	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	Pumper/Tanker Truck
101	Rosenbauer	Pumper Truck	2007	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	
103	Sparten	Metrostar	2021	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	
104	E	One	1991	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	
105	Ford	F550	2017	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	
108	International		2012	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	Water/Vacuum Truck
200	Freightliner	1025R	2003	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	Rescue Truck
204	International	Work Star	2014	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	
205	Pierce	Tanker	2010	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	
206	E	One	2012	Protective Services	Heavy-Duty Vehicle (>3856kg)	Diesel	Typoon pumper truck
500	RENTALS	n/a	n/a	*uncategorized*	*uncategorized*	Diesel	miscellaneous rentals
991	Misc Diesel	Rec. Dept	n/a	Community Services	n/a	Diesel	Storage cans for equipment such as lawnmowers, weed whippers, portable generators, etc. used throughout the municipality
992	Misc Coloured	Rec. Dept	n/a	Community Services	n/a	Diesel	
993	Misc Gasoline	Rec. Dept	n/a	Community Services	n/a	Gasoline	
994	Misc Coloured	ES Dept.	n/a	Environmental Services	n/a	Diesel	
995	Misc Gasoline	ES Dept.	n/a	Environmental Services	n/a	Gasoline	
996	Misc Gasoline	Fire Dept.	n/a	Protective Services	n/a	Gasoline	
997	Misc Coloured	Fire Dept.	n/a	Protective Services	n/a	Diesel	
998	Misc Gasoline	Trans Dept.	n/a	Transportation Services	n/a	Gasoline	
999	Misc Coloured	Trans Dept.	n/a	Transportation Services	n/a	Diesel	

Lighting Group	Type	Light Source	# of Lights	Notes
Streetlights	Streetlights	LED	979	photocell sensors, timers
Harrietsville Ball Diamond	Sports lights	*Unknown*	17	
Outdoor Recreation Complex (ORC) – Soccer & Baseball Fields	Sports lights	*Unknown*	94	

ID	Water Facility	Year of Construction	Type	Notes
ES-009	Dorchester WTP	2004	Water Treatment Plant	
ES-013	Pumping Station #1	2000	Pump Station	
ES-015	Dorchester WWTP	2000	Sewage/Wastewater Treatment Plant	Natural gas heating
ES-017	Thorndale WTP	1975	Water Treatment Plant	Upgrades/additions 2004
ES-018	Thorndale WWTP	2012	Sewage/Wastewater Treatment Plant	
ES-019	Pumping Station #3	2018	Pump Station	

ID	Solid Waste Facility Name	Ownership	Disposal (Landfill or Incineration)	Classification	Type	Gas Collection System
B-040	Thames Centre Landfill	Corporate owned/operated	Landfill	Landfill - Anaerobic managed solid waste disposal	Landfill - Managed - covered with CH4 oxidizing material	None

5.2 Data

Building ID	Date Range (yyyy-mm-dd)	Electricity Consumption (kWh)	Electricity Gross Cost ($)	Natural Gas Consumption (m^3)	Natural Gas Gross Cost ($)	Other Fuel Consumption (L)	Other Fuel Net Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
B-007	2023-01-01 to 2023-12-31	24,866.0000	5,516.62	13,267.00000	4,876.07	N/A	N/A	Utility invoices	26.5179
B-013	2023-01-01 to 2023-12-31	1,578,590.0000	293,209.14	169,746.00000	77,307.41	3,273.0000	4,911.00	Utility/fuel invoices	389.7544
B-016	2023-01-01 to 2023-12-31	16,162.3100	4,111.22	9,742.00000	3,283.58	N/A	N/A	Utility invoices	19.3967
B-033	2023-01-01 to 2023-12-31	76,496.9000	12,720.17	8,862.00000	3,354.46	N/A	N/A	Utility invoices	19.8692
B-036	2023-01-01 to 2023-12-31	68,103.0000	15,047.72	7,712.00000	2,997.15	N/A	N/A	Utility invoices	17.3460
B-037	2023-01-01 to 2023-12-31	20,565.1200	4,611.26	5,913.00000	2,959.30	N/A	N/A	Utility invoices	12.1602
B-041 B-040	2023-01-01 to 2023-12-31	5,652.1100	1,686.84	N/A	N/A	N/A	N/A	Utility invoices	0.2035
B-046	2023-01-01 to 2023-12-31	16,509.6100	3,633.51	1,575.00000	1,002.88	N/A	N/A	Utility invoices	3.6362
B-048	2023-01-01 to 2023-12-31	87,509.0500	18,425.07	37,404.00000	17,671.17	N/A	N/A	Utility invoices	75.3891
B-049	2023-01-01 to 2023-12-31	71,947.2200	5,422.49	8,068.00000	4,042.74	N/A	N/A	Utility invoices	18.1719
B-050	2023-01-01 to 2023-12-31	63,627.9100	24,982.35	17,146.00000	8,131.18	N/A	N/A	Utility invoices	35.4049

Vehicle ID	Date Range (yyyy-mm-dd)	Kilometres Travelled	Hours Used	Fuel Consumption (L)	Fuel Net Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
2	2023-01-01 to 2023-12-31	14,034	N/A	2,816.0000	4,004.96	Fuel invoices/receipts	6.5113
3	2023-01-01 to 2023-12-31	N/A	88	372.0000	559.00	Fuel invoices/receipts	1.0001
7	2023-01-01 to 2023-12-31	N/A	353	1,697.0000	2,546.00	Fuel invoices/receipts	4.1859
8	2023-01-01 to 2023-12-31	N/A	504	1,697.0000	2,546.00	Fuel invoices/receipts	4.1859
9	2023-01-01 to 2023-12-31	N/A	346	1,697.0000	2,546.00	Fuel invoices/receipts	4.1859
10	2023-01-01 to 2023-12-31	35,285	N/A	7,622.0000	11,704.42	Fuel invoices/receipts	20.7592
11	2023-01-01 to 2023-12-31	N/A	443	3,690.0000	4,575.70	Fuel invoices/receipts	10.1202
23	2023-01-01 to 2023-12-31	4,774	N/A	2,731.0000	3,176.99	Fuel invoices/receipts	7.4381
24	2023-01-01 to 2023-12-31	15,691	N/A	8,141.0000	12,748.70	Fuel invoices/receipts	22.1728
31	2023-01-01 to 2023-12-31	N/A	333	372.0000	559.00	Fuel invoices/receipts	1.0001
32	2023-01-01 to 2023-12-31	N/A	161	372.0000	559.00	Fuel invoices/receipts	1.0001
36	2023-01-01 to 2023-12-31	N/A	97	372.0000	559.00	Fuel invoices/receipts	1.0001
37	2023-01-01 to 2023-12-31	6,526	N/A	879.0000	1,289.91	Fuel invoices/receipts	2.0325
40	2023-01-01 to 2023-12-31	55,353	N/A	7,950.0000	10,016.09	Fuel invoices/receipts	18.3825

Vehicle ID	Date Range (yyyy-mm-dd)	Kilometres Travelled	Hours Used	Fuel Consumption (L)	Fuel Net Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
41	2023-01-01 to 2023-12-31	17,862	N/A	2,825.0000	4,170.23	Fuel invoices/receipts	6.5321
42	2023-01-01 to 2023-12-31	N/A	323	3,067.0000	4,627.95	Fuel invoices/receipts	8.4115
45	2023-01-01 to 2023-12-31	N/A	101	3,145.6000	3,479.12	Fuel invoices/receipts*	8.6271
49	2023-01-01 to 2023-12-31	9,573	N/A	1,211.0000	1,644.95	Fuel invoices/receipts	2.8002
54	2023-01-01 to 2023-12-31	4,073	N/A	2,657.0000	2,915.26	Fuel invoices/receipts	7.2366
55	2023-01-01 to 2023-12-31	14,488	N/A	4,178.0000	5,608.82	Fuel invoices/receipts	9.8693
58	2023-01-01 to 2023-12-31	10,849	N/A	1,439.0000	2,161.59	Fuel invoices/receipts	3.3273
60	2023-01-01 to 2023-12-31	N/A	96	383.0000	440.71	Fuel invoices/receipts	1.0504
61	2023-01-01 to 2023-12-31	18,751	N/A	2,748.0000	3,773.58	Fuel invoices/receipts	6.3541
66	2023-01-01 to 2023-12-31	N/A	1,071	24,010.0000	31,962.02	Fuel invoices/receipts	65.8498
69	2023-01-01 to 2023-12-31	3,336	N/A	1,130.0000	2,217.45	Fuel invoices/receipts	3.0991
70	2023-01-01 to 2023-12-31	N/A	449	372.0000	559.00	Fuel invoices/receipts	1.0202
71	2023-01-01 to 2023-12-31	N/A	562	2,573.0000	3,373.37	Fuel invoices/receipts	7.0567
74	2023-01-01 to 2023-12-31	6,341	N/A	1,044.0000	1,531.30	Fuel invoices/receipts	2.4140
75	2023-01-01 to 2023-12-31	N/A	900	18,365.0000	24,671.43	Fuel invoices/receipts	50.3678
77	2023-01-01 to 2023-12-31	23,852	N/A	3,676.0000	4,825.20	Fuel invoices/receipts	8.4999
80	2023-01-01 to 2023-12-31	N/A	0	0.0000	0.00	Fuel invoices/receipts	0.0000
81	2023-01-01 to 2023-12-31	14,296	N/A	8,804.0000	10,260.04	Fuel invoices/receipts	23.9785
82	2023-01-01 to 2023-12-31	19,871	N/A	3,080.0000	4,366.96	Fuel invoices/receipts	7.1218
83	2023-01-01 to 2023-12-31	12,632	N/A	1,894.0000	2,609.61	Fuel invoices/receipts	4.3794
86	2023-01-01 to 2023-12-31	N/A	134	1,160.0000	1,600.75	Fuel invoices/receipts	3.1814
87	2023-01-01 to 2023-12-31	14,261	N/A	8,194.0000	9,873.54	Fuel invoices/receipts	22.3171
88	2023-01-01 to 2023-12-31	5,674	N/A	3,453.0000	3,955.83	Fuel invoices/receipts	9.4046
89	2023-01-01 to 2023-12-31	20,307	N/A	2,870.0000	3,985.51	Fuel invoices/receipts	6.6362
90	2023-01-01 to 2023-12-31	24,424	N/A	3,273.0000	4,471.79	Fuel invoices/receipts	7.5680
91	2023-01-01 to 2023-12-31	N/A	188	372.0000	559.00	Fuel invoices/receipts	1.0202
92	2023-01-01 to 2023-12-31	N/A	231	1,697.0000	2,546.00	Fuel invoices/receipts	4.1859
93	2023-01-01 to 2023-12-31	22,694	N/A	4,919.0000	6,711.25	Fuel invoices/receipts	11.6197
94	2023-01-01 to 2023-12-31	14,326	N/A	3,506.0000	4,957.69	Fuel invoices/receipts	8.2819
95	2023-01-01 to 2023-12-31	11,125	N/A	2,893.0000	3,826.12	Fuel invoices/receipts	6.6894

Vehicle ID	Date Range (yyyy-mm-dd)	Kilometres Travelled	Hours Used	Fuel Consumption (L)	Fuel Net Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
96	2023-01-01 to 2023-12-31	N/A	230	3,145.6000	3,479.12	Fuel invoices/receipts*	8.6271
97	2023-01-01 to 2023-12-31	9,847	N/A	5,657.0000	6,788.33	Fuel invoices/receipts	15.4074
98	2023-01-01 to 2023-12-31	N/A	666	10,358.0000	12,841.85	Fuel invoices/receipts	28.4078
100	2023-01-01 to 2023-12-31	3,209.00	N/A	2,126.0000	3,635.12	Fuel invoices/receipts	5.7904
101	2023-01-01 to 2023-12-31	3,814	N/A	1,792.0000	3,237.05	Fuel invoices/receipts	4.8807
103	2023-01-01 to 2023-12-31	2,696	N/A	1,535.0000	2,677.28	Fuel invoices/receipts	4.1807
104	2023-01-01 to 2023-12-31	1,432	N/A	657.0000	1,080.49	Fuel invoices/receipts	1.7894
105	2023-01-01 to 2023-12-31	1,128	N/A	576.0000	816.88	Fuel invoices/receipts	1.5688
108	2023-01-01 to 2023-12-31	1,028	N/A	1,036.0000	1,937.41	Fuel invoices/receipts	2.8216
200	2023-01-01 to 2023-12-31	1,394	N/A	477.0000	620.90	Fuel invoices/receipts	1.2992
204	2023-01-01 to 2023-12-31	1,302	N/A	896.0000	991.93	Fuel invoices/receipts	2.4403
205	2023-01-01 to 2023-12-31	1,562	N/A	810.0000	801.11	Fuel invoices/receipts	2.2061
206	2023-01-01 to 2023-12-31	1,806	N/A	803.0000	1,343.34	Fuel invoices/receipts	2.1870
500	2023-01-01 to 2023-12-31	N/A	N/A	734.0000	1,016.72	Fuel invoices/receipts	1.9737
991	2023-01-01 to 2023-12-31	N/A	N/A	0.0000	0.00	Fuel invoices/receipts	0.0000
992	2023-01-01 to 2023-12-31	N/A	N/A	0.0000	0.00	Fuel invoices/receipts	0.0000
993	2023-01-01 to 2023-12-31	N/A	N/A	812.0000	1,208.14	Fuel invoices/receipts	1.8799
994	2023-01-01 to 2023-12-31	N/A	N/A	0.0000	0.00	Fuel invoices/receipts	0.0000
995	2023-01-01 to 2023-12-31	N/A	N/A	17.0000	26.13	Fuel invoices/receipts	0.0394
996	2023-01-01 to 2023-12-31	N/A	N/A	50.0000	77.65	Fuel invoices/receipts	0.1158
997	2023-01-01 to 2023-12-31	N/A	N/A	854.0000	1,053.54	Fuel invoices/receipts	2.2964
998	2023-01-01 to 2023-12-31	N/A	N/A	90.0000	123.52	Fuel invoices/receipts	0.2084
999	2023-01-01 to 2023-12-31	N/A	N/A	237.0000	275.50	Fuel invoices/receipts	0.6373

Lighting Group	Date Range (yyyy-mm-dd)	Electricity Consumption (kWh)	Electricity Gross Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
Streetlights	2023-01-01 to 2023-12-31	223,042.9000	48,966.84	Utility invoices	8.0295
Harrietsville Ball Diamond	2023-01-01 to 2023-12-31	680.0000	521.06	Utility invoices	0.0245
ORC Soccer and Baseball Fields	2023-01-01 to 2023-12-31	125,237.3100	25,898.91	Utility invoices	4.5085

Water/ Wastewater ID	Date Range (yyyy-mm-dd)	Water Processed (m^3)	Electricity Consumption (kWh)	Electricity Gross Cost ($)	Natural Gas Consumption (m^3)	Natural Gas Gross Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
ES-009	2023-01-01 to 2023-12-31	502,209.0000	530,822.0000	$124,511.77	N/A	N/A	Utility invoices	19.1096
ES-013	2023-01-01 to 2023-12-31	124,333.0000	20,522.0000	$5,309.38	N/A	N/A	Utility invoices	0.7388
ES-015	2023-01-01 to 2023-12-31	124,333.0000	296,595.8300	$58,831.09	1,854.0000	$1,143.81	Utility invoices	14.2581
ES-017	2023-01-01 to 2023-12-31	137,942.0000	125,181.8000	$25,249.26	N/A	N/A	Utility invoices	4.5065
ES-018	2023-01-01 to 2023-12-31	124,514.0000	344,960.4100	$67,502.87	N/A	N/A	Utility invoices	12.4186
ES-019	2023-01-01 to 2023-12-31	18,275.0000	64,000.0000	$3,498.90	N/A	N/A	Utility invoices	2.3040

Solid Waste Site ID	Date Range (yyyy-mm-dd)	Solid Waste Disposal (tonnes)	Annual Cost ($)	Data Source	Calculated GHG Emissions (tCO_2e)
B-040	2023-01-01 to 2023-12-31	2,921.00	*Unknown*	Scale tickets	5,305.7511

**Estimate – vehicles 45 and 96 each allotted 50% of Landfill diesel fuel tank purchases in 2023*

5.3 Abbreviations and Acronyms

Abbreviation /Acronym	Term/Name
CH_4	Methane
N_2O	Nitrous oxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
GHG	Greenhouse gas
GJ	Gigajoule
GWP	Global warming potential
HDGV	Heavy-duty gasoline vehicle (>3856kg)
IPCC	Intergovernmental Panel on Climate Change
KPI	Key performance indicator
kWh	Kilowatt-hour
LDGT	Light-duty gasoline truck (<3856kg, truck/SUV/van)
m^3	Cubic metre
NIR	National Inventory Report
PCP	Partners for Climate Protection
t	Metric tonne
tCO_2e	Tonnes of carbon dioxide equivalent
TJ	Terajoule

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