



City of Whitehorse

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# Corporate Greenhouse Gas Emissions Inventory – 2020 Update

City of Whitehorse

Updated June 28<sup>th</sup>, 2021

## Abstract:

This document provides a quantitative assessment of the City of Whitehorse's corporate greenhouse gas emissions. The assessment focuses on emissions from burning fossil fuels, while also providing estimates of methane emissions from anaerobic decomposition at the Whitehorse landfill and sewage lagoons.





## Executive Summary

Taking an inventory of the City's corporate greenhouse gas (GHG) emissions is a critical step to fighting climate change effectively. The emissions inventory provides the quantitative information necessary to help decision-makers and staff focus on actionable, impactful actions to reduce the City's greenhouse gas emissions. A corporate emissions inventory is also an important milestone in the Federation of Canadian Municipalities' (FCM's) Corporate Emissions Mitigation Maturity Scale.

This inventory analyzed three related but distinct indicators:

- Annual GHG emissions
- Annual energy consumption
- Annual energy costs

This report builds on the 2019 Emissions Inventory, updating it with 2020 data and continuing to analyze trends and key drivers.

A few significant events occurred in 2020 that impacted the City's energy consumption. Firstly, COVID-19 resulted in partial shutdowns and reduced occupancy in many City buildings, most notably at the Canada Games Centre (CGC). This resulted in reduced energy consumption and greenhouse gas emissions for these facilities. It should be noted that this inventory does not consider any increases in household energy consumption associated with staff working from home.

Whitehorse also experienced a record snowfall year, and fleet vehicle fuel consumption increased along with the City's snow clearing efforts.

The City also commissioned our new Operations Building, adding to our total energy consumption. Staff were moving from the old Municipal Services Building into the Operations Building in the 3<sup>rd</sup> and 4<sup>th</sup> quarters of 2020, so both buildings had to be heated during that time. The Municipal Services Building won't be heated through the summer/fall of 2021, so energy and emissions reductions from this move should be observed in the 2021 inventory.

Finally, Whitehorse experienced colder weather in 2020<sup>1</sup>, resulting in increased use of energy for spacing heating.

The net result was that the City's total energy consumption was relatively unchanged for 2020 compared to 2019. An increase in propane consumption was largely offset by minor decreases in electricity and oil consumption.

Looking ahead, a number of energy and GHG reduction projects are in progress, and the City hopes to see some notable reductions in GHG emissions in coming years as a result. Ongoing work includes:

- Waste Heat Recovery Upgrade at the CGC (Completion Summer 2021)

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<sup>1</sup> Measured in Annual Heating Degree Days.



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- 139 Tlingit Street (Old Transit Garage) energy retrofit and biomass heating (Completion in 2022)
- City Hall renovation and energy upgrade (Completion in 2023)

Additional projects will be required to get the City back on track with its emissions reduction targets.

### Updated Electrical GHG Emissions Methodology

A notable change was made to how electrical emissions are calculated for 2020. In the past, electricity emissions have been computed on a monthly basis using data supplied by Yukon Energy to determine the percentages of electricity generated by LNG, diesel, and renewable sources. The result is that the City's emissions inventory can change significantly as a result of electrical load growth across the territory, mine openings/closures, and construction of new electrical generating infrastructure. These external factors were the primary driver of the observed electrical emissions increase from 2015 to 2019, and are not representative of changes to the City's operations. In 2020, higher than usual snowfall and rainfall supplying the hydro reservoirs would have reduced the City's electrical GHG emissions substantially.

The release of Yukon Government's Our Clean Future in 2020 and its commitment to a long term average of 93% renewable electricity creates an alternative reference for the City to base our electrical emissions calculations on.

For 2020, this inventory calculates electrical emissions based on an average of 93% renewable electricity. The intention is to continue using this standard in future years, so that the inventory better reflects changes in the City's corporate operations and assets, rather than macro trends largely outside of the City's control.

The calculation method for previous years is left unchanged.

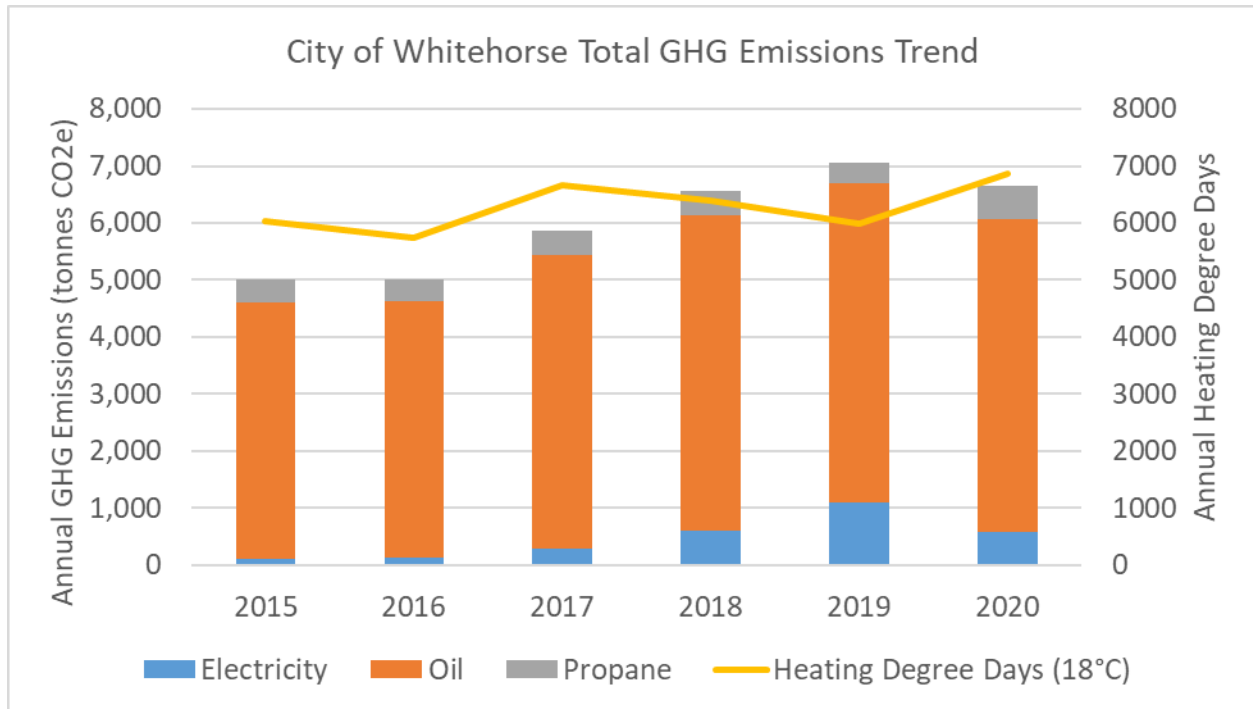
This inventory shows a decrease in electrical GHG emissions of approximately 523 tonnes CO<sub>2</sub>e from 2019 to 2020. The bulk of this decrease (approximately 507 tonnes) should be interpreted as the long-term impact of Government of Yukon's commitment to 93% renewable electricity, rather than the result of the City's energy conservation efforts.

By staying with the 93% renewable standard moving forward, future emissions inventory work will provide a more consistent comparison of the City's corporate GHG reduction efforts, while maintaining the recognition that there are GHG emissions associated with electricity consumption in Yukon.

Total GHG emissions were reduced by 4% from 7050 tonnes<sup>2</sup> in 2019 to 6643 tonnes in 2020 due largely to the impacts of Yukon Government's commitment to 93% renewable electricity. GHG emissions from Oil were reduced by 84 tonnes, while total propane emissions increased by 201 tonnes, largely due to the completion of the new Operations Building (+154 tonnes CO<sub>2</sub>e).

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<sup>2</sup> The 2019 inventory stated that total GHGs in 2019 were 7023 tonnes CO<sub>2</sub>e. Minor improvements in the data collection process resulted in the slight increase to 7050 tonnes for 2019 quoted in this report.



### Summary of Landfill and Wastewater Emissions

Landfill and wastewater emissions are considered separately due to the high degree of uncertainty associated with the calculations, and the fact that landfill emissions (methane) are released slowly over many years as the waste decomposes. The City’s composting program currently reduces future landfill emissions by approximately 12% and the ongoing expansion into multi-residential and commercial organics will achieve further emissions reductions. **It must be noted that the City’s landfill emissions are estimated to be significantly greater than all of the City’s corporate fossil fuel emissions combined.**

In response to the potentially high levels of GHG emissions at the landfill, the City is incorporating a Landfill Gas Management plan into our 2023-2033 Solid Waste Management Plan. This work will provide us with a revised GHG emissions estimate, as well as an assessment of various options to mitigate the release of landfill gas (methane) at the site.

**The wastewater emissions estimates indicate that methane and nitrous oxide emissions from the sewage lagoons are also more GHG intensive than the City’s corporate fossil fuel emissions.** Wastewater emissions are expected to rise proportionately with the City’s population growth.



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## Table of Contents

Executive Summary.....	i
Updated Electrical GHG Emissions Methodology.....	ii
Summary of Landfill and Wastewater Emissions.....	iii
1.0 Introduction .....	1
2.0 Community and Corporate Emissions.....	1
3.0 What is a Greenhouse Gas Emissions Inventory.....	1
4.0 Unknown Emissions .....	2
5.0 Data Sources .....	2
6.0 Greenhouse Gas Emissions Reduction Commitments.....	3
7.0 Updated Electrical GHG Calculation Methodology.....	4
8.0 City of Whitehorse Annual Corporate Greenhouse Gas Emissions .....	5
9.0 Energy Usage Trend .....	7
10.0 2020 Energy Costs Breakdown.....	9
11.0 Energy Consumption By End Use.....	11
12.0 GHG Emissions by End Use .....	12
13.0 Oil Consumption by End Use.....	13
14.0 Electricity Consumption by End Use .....	14
15.0 Propane Consumption by End Use .....	16
16.0 Looking Ahead to 2021 .....	16
17.0 Electric Vehicles .....	17
18.0 Landfill Emissions .....	17
19.0 Wastewater Emissions.....	19
20.0 Conclusion.....	20
Appendix A: Emissions Factors .....	A
Appendix B: Landfill Emissions Calculations .....	B
Appendix C: Wastewater Emissions Calculations .....	C





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## Table of Figures

Figure 1: City of Whitehorse Corporate Emissions and Targets .....	4
Figure 2: City of Whitehorse Corporate GHG Emissions Trend .....	6
Figure 3: City of Whitehorse GHG emissions by energy source .....	7
Figure 4: City of Whitehorse Total Energy Usage Trend .....	8
Figure 5: Weather Normalized Fuel Consumption .....	8
Figure 6: City of Whitehorse Energy Usage Trend by Energy Source .....	9
Figure 7: City of Whitehorse 2020 Energy Costs By Energy Source .....	10
Figure 8: City of Whitehorse Total Energy Costs Trend .....	10
Figure 9: City of Whitehorse Total Energy Consumption by End Use.....	12
Figure 10: City of Whitehorse GHG Emissions Sources by Year.....	13
Figure 11: City of Whitehorse Oil Consumption by End Use .....	14
Figure 12: City of Whitehorse Electricity Consumption by End Use.....	15
Figure 13: City of Whitehorse Propane Consumption by End Use .....	16
Figure 14: City of Whitehorse Landfill Emissions.....	19
Figure 15: City of Whitehorse Sewage Lagoon Emissions .....	20

## 1.0 Introduction

The City of Whitehorse buildings and fleets generate greenhouse gas emissions primarily through the consumption of electricity, heating oil, propane, gasoline, and diesel fuel. Fossil fuel based GHG emissions reductions can be achieved in two ways:

1. Reducing energy consumption.
2. Switching to a lower carbon or zero-carbon energy source.

From a financial perspective, reducing energy consumption results in long-lasting operational cost savings and thus is ideally implemented before switching to lower carbon energy sources. That said, switching energy sources can create large and immediate reductions in fossil fuel consumption, and as such is a valuable tool to reduce emissions.

This document also assesses GHG emissions from solid waste management at the landfill and wastewater treatment at the sewage lagoons. Due to the unique nature and high level of uncertainty associated with landfill and wastewater emissions, these are assessed separately from the fossil fuel-based emissions inventory, which comprises the bulk of this report.

## 2.0 Community and Corporate Emissions

Actions to reduce energy consumption and greenhouse gas emissions are frequently divided into the realm of corporate and community emissions.

- **Corporate emissions** – those that the local government creates through its activities (and which it has control over) such as local government building operations, recreation centres, vehicle fleets, and utility services; and
- **Community emissions** – those that the residents and businesses in the community create through their activities. The local government cannot directly control these emissions, but can influence them through city planning, infrastructure investments, and program activities.

This document provides an inventory of the City's corporate emissions. Community emissions are not addressed in this document.

## 3.0 What is a Greenhouse Gas Emissions Inventory

A greenhouse gas emissions inventory is a compilation of the following over the course of a year:

- Total energy consumed
- Money spent on energy
- Greenhouse gases emitted



City of Whitehorse

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The data is further broken down by end use to help the City identify our largest emissions sources, notable trends, and activities of high energy intensity. This inventory covers the years 2015 to 2020 so as to include all years since the City implemented GHG emissions reduction targets.

## 4.0 Unknown Emissions

There are a number of emissions sources for which the City does not have data. It is also of note that these emissions sources are not calculated as standard practice in the PCP Protocol for municipal corporate emissions inventories. These sources include:

- **Refrigerants:** refrigerants that leak out of equipment into the atmosphere have a significant Global Warming Potential (GWP).<sup>3</sup>
- **Air Travel:** The City of Whitehorse does not have a process to track air travel expenses or distances travels so currently there is no data upon which to base an emissions estimate. The addition of object/activity codes specific for air travel would be a valuable step toward quantifying the City's air travel emissions.
- **Employee Personal Vehicles:** Employees can submit their vehicle mileage but the fuel consumption is unknown.
- **Embedded Emissions:** Embedded emissions are those emissions generated in the creation of a product that the City purchases. Calculating embedded emissions is a complex field requiring a massive amount of data which the City does not have.

For the purposes of this inventory report, the above emissions sources are not included.

## 5.0 Data Sources

The City of Whitehorse utilizes an Energy Tracker software database, maintained by MakeIT, a local software development company. The City receives fuel/energy usage data periodically from suppliers, which is then uploaded into the Energy Tracker. The data is stored and can be viewed in the Energy Tracker. It can also be extracted for further analysis, as was done for the creation of this report. The City utilizes emissions factors for the various fuel types that are compiled by The Climate Registry. Electrical emissions factors were provided directly from Yukon Energy staff.

Landfill emissions were calculated by City staff using methodology provided by the Partners for Climate Protection (PCP) in the PCP Protocol document.<sup>4</sup> The PCP Protocol is a supplement to the International Emissions Analysis Protocol (IEAP), designed specifically for Canadian municipalities. As such, using the PCP Protocol methodology ensures that the City of Whitehorse's emissions inventory follows globally recognized standards. Additional information was extracted from the IPCC's GHG Inventory Guidelines.<sup>5</sup>

<sup>3</sup> Global Warming Potential is a multiplier that quantifies the potency of greenhouse gases. CO<sub>2</sub> has a GWP of 1. Some refrigerants have GWPs over 1000, making them over 1000 times more powerful greenhouse gases than CO<sub>2</sub>.

<sup>4</sup> <https://fcm.ca/sites/default/files/documents/resources/report/protocol-canadian-supplement-pcp.pdf>

<sup>5</sup> <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>





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Wastewater treatment emissions were calculated by City staff using methodology provided in the GHG Protocol's Global Protocol for Community-Scale Greenhouse Gas Emission Inventories<sup>6</sup> and the IPCC's GHG Inventory Guidelines.<sup>7</sup>

For further information on the emissions factors refer to Appendix A of this report.

## 6.0 Greenhouse Gas Emissions Reduction Commitments

Commitments to reduce greenhouse gas (GHG) emissions have been made in recent years by all levels of government. The reason for greenhouse gas emissions reduction efforts is stated simply by the Government of Canada as follows:<sup>8</sup>

Climate change is one of the most important environmental issues of our time. Climate change is caused by the increase in concentrations of greenhouse gases (GHGs) in the atmosphere. These increases are primarily due to human activities such as the use of fossil fuels or agriculture.

Under the 2015 Paris Agreements, the Government of Canada has committed to reducing Canada's greenhouse gas (GHG) emissions by 30% below 2005 levels by 2030.<sup>9</sup> In the spring of 2021, the Government of Canada strengthened their targets to 40-45% below 2005 levels by 2030.<sup>10</sup>

In the fall of 2020, Yukon government released its finalized climate change strategy titled "Our Clean Future". In this strategy, the territorial government targets a GHG emissions reduction of 30% below 2010 levels by 2030.<sup>11</sup>

The City of Whitehorse has also made commitments to reducing GHG emissions, however they are less ambitious than either Government of Yukon's or the Government of Canada's. The City's 2030 corporate reduction target is for 25% below 2014 levels.<sup>12</sup> Unfortunately, there are some gaps in the City's 2014 emissions data, so 2015 data is used as a proxy for 2014 emissions. The City is targeting an absolute reduction in emissions, and thus the target is not impacted by changes in the City's population.

<sup>6</sup> [https://ghgprotocol.org/sites/default/files/standards/GHGP\\_GPC\\_0.pdf](https://ghgprotocol.org/sites/default/files/standards/GHGP_GPC_0.pdf)

<sup>7</sup> <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>

<sup>8</sup> <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html>

<sup>9</sup> <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/progress-towards-canada-greenhouse-gas-emissions-reduction-target.html>

<sup>10</sup> <https://www.canada.ca/en/environment-climate-change/news/2021/04/canadas-enhanced-nationally-determined-contribution.html>

<sup>11</sup> <https://yukon.ca/sites/yukon.ca/files/env/env-our-clean-future-draft.pdf>

<sup>12</sup> <https://www.whitehorse.ca/home/showdocument?id=5313>

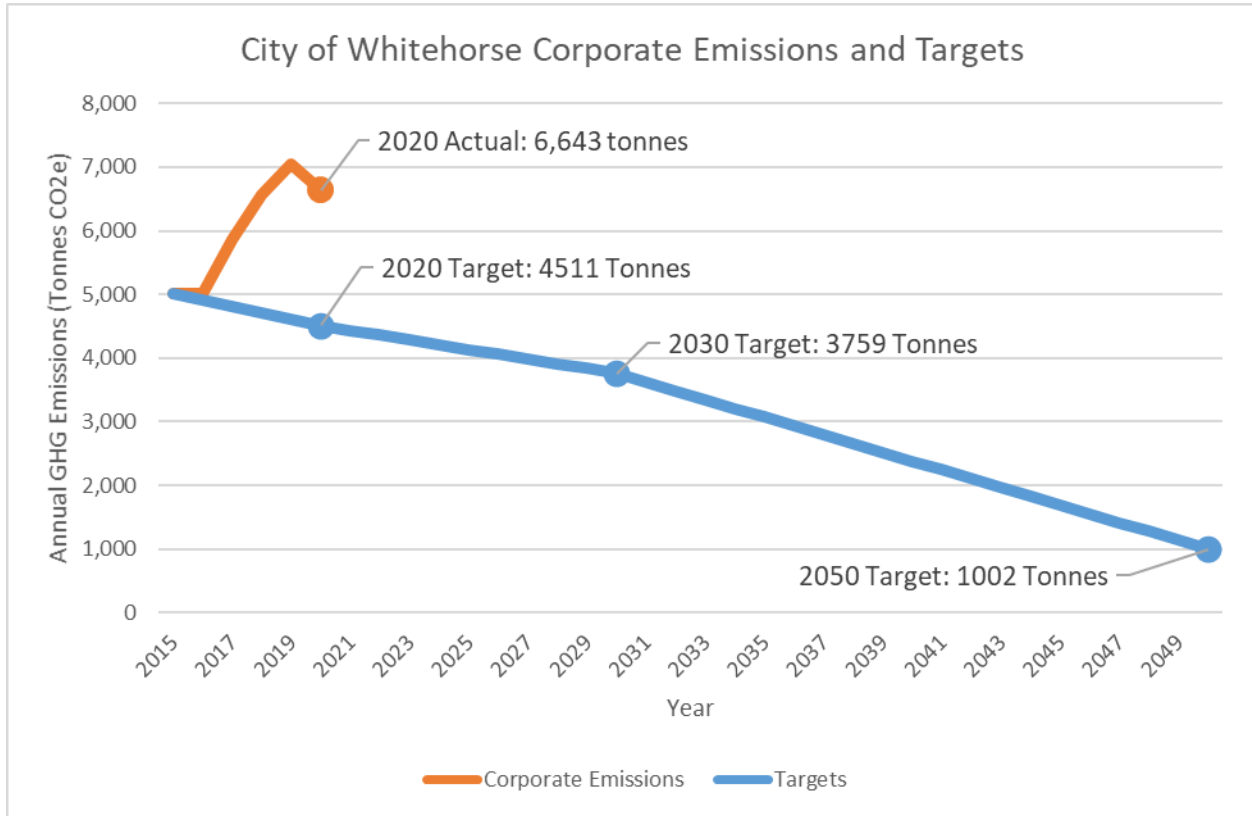


Figure 1: City of Whitehorse Corporate Emissions and Targets

As shown in the figure above, the reduction in 2020 emissions was not sufficient to approach the City’s 2020 target. A significant and coordinated effort is required to get back on track and meet the City’s 2030 target.

### 7.0 Updated Electrical GHG Calculation Methodology

A notable change was made to how electrical emissions are calculated for 2020. In the past, electricity emissions have been computed on a monthly basis using data supplied by Yukon Energy to determine the percentages of electricity generated by LNG, diesel, and renewable sources. The result is that the City’s emissions inventory can change significantly as a result of electrical load growth across the territory, mine openings/closures, and construction of new electrical generating infrastructure. These external factors were the primary driver of the observed electrical emissions increase from 2015 to 2019, and are not representative of changes to the City’s operations.

The release of Yukon Government’s Our Clean Future in 2020 and its commitment to a long term average of 93% renewable electricity creates an alternative reference for the City to base our electrical emissions calculations on.



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The calculation method for previous years is left unchanged.

As a result of this update, this inventory shows a decrease in electrical GHG emissions of approximately 523 tonnes CO<sub>2</sub>e from 2019 to 2020. The bulk of this decrease (approximately 507 tonnes) should be interpreted as the long-term impact of Government of Yukon's commitment to 93% renewable electricity, rather than the result of the City's energy conservation efforts.

By staying with the 93% renewable standard moving forward, future emissions inventory work will provide a more consistent comparison of the City's corporate GHG reduction efforts, while maintaining the recognition that there are GHG emissions associated with electricity consumption in Yukon.

## 8.0 City of Whitehorse Annual Corporate Greenhouse Gas Emissions

Since 2015, the City of Whitehorse municipal government has generated between 5011 and 7023 tonnes of CO<sub>2</sub>e per year. The chart below shows the City's annual emissions since 2015. In 2020, the City's corporate emissions were reduced in large part due to a change in how the City calculates electrical GHGs, described in the previous section. Total electrical energy consumption was reduced slightly however, contributing to the reduction in electrical GHG emissions.

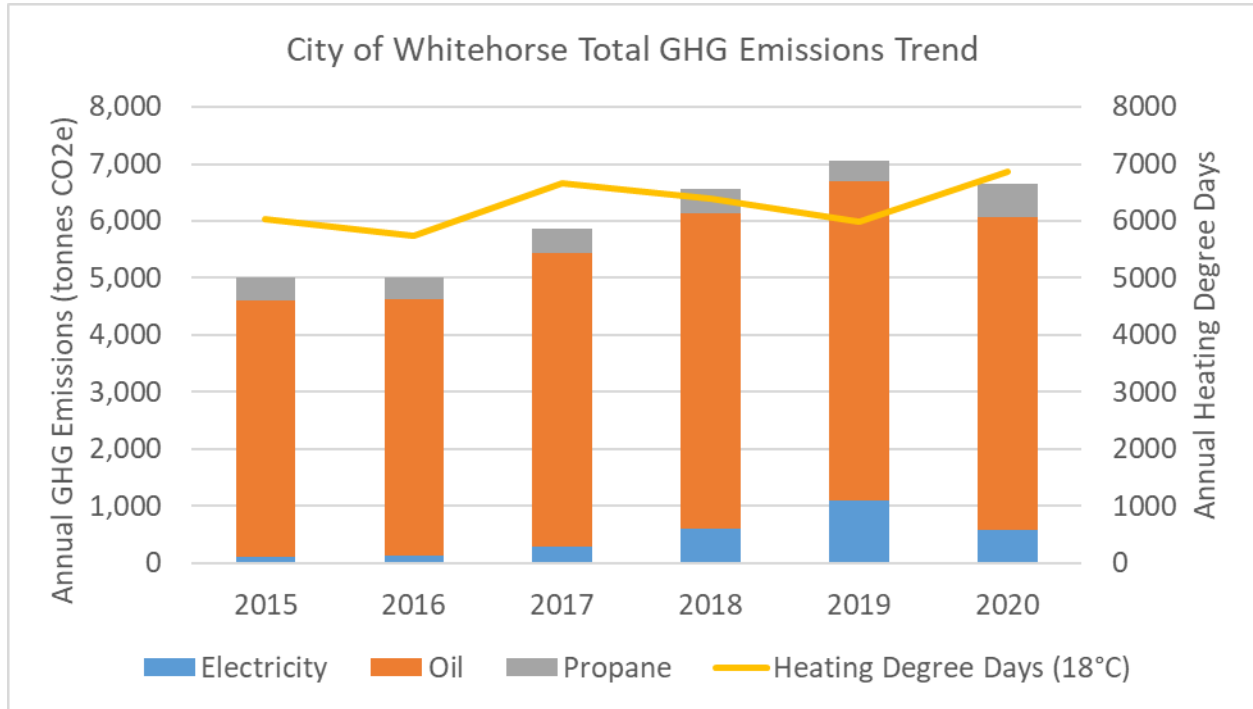


Figure 2: City of Whitehorse Corporate GHG Emissions Trend

The chart also shows the number of heating-degree-days each year. Fuel for heating buildings is a major energy use and source of GHG emissions for the City. The amount of fuel (or electricity) required to heat a building through the winter correlates linearly with the number of heating-degree-days in that year. Heating-degree-days allow us to normalize annual energy usage/ghg emissions and compare usage in a warm winter to that during a cold winter.<sup>13</sup>

<sup>13</sup> More information on heating-degree-days can be found at: [https://www.weather.gov/key/climate\\_heat\\_cool](https://www.weather.gov/key/climate_heat_cool)

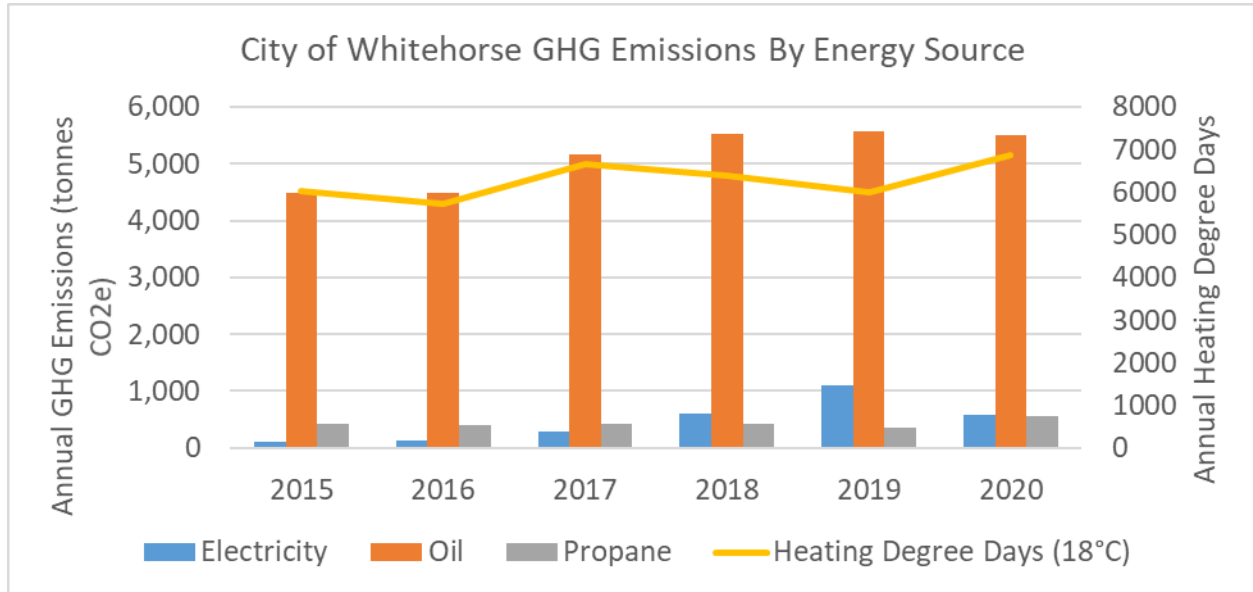


Figure 3: City of Whitehorse GHG emissions by energy source

Despite the colder winter and increased snow clearing requirements, the City of Whitehorse’s emissions from oil decreased slightly in 2020. Reduced oil consumption at the Canada Games Centre (CGC) for 2020 was the primary driver of this reduction, with a year-over-year fuel consumption reduction of 114,346 Litres at the CGC. The CGC shutdown and reduced occupancy due to Covid-19 was a likely a major contributing factor to this reduction.

Emissions from propane increased in 2020 due to the completion of the Whitehorse Operations Building and new Fire Hall #1.

### 9.0 Energy Usage Trend

The City’s total energy usage has remained relatively stable since 2015 despite the number of permanent City employees increasing by 9.6% from 301 in 2015 to 330 in 2020. The total energy usage trend is shown in Figure 4.

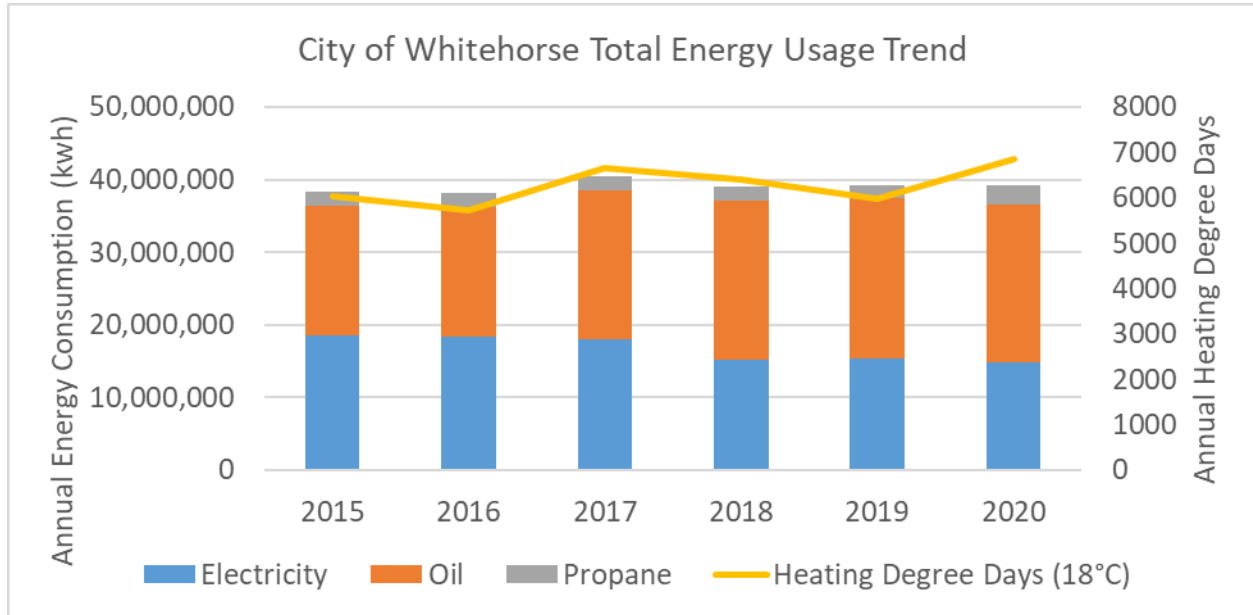


Figure 4: City of Whitehorse Total Energy Usage Trend

It is notable that in 2020, the City’s energy consumption did not increase despite the colder weather. It is unclear how much of this is due to changing work patterns and occupancy associated with COVID-19, versus genuine improvements in energy efficiency/conservation. This inventory does not consider any increases in household energy consumption associated with staff working from home. The chart in Figure 5 shows that 2020 was a significant improvement from 2019 when fuel consumption (oil and propane) is normalized by heating degree days.

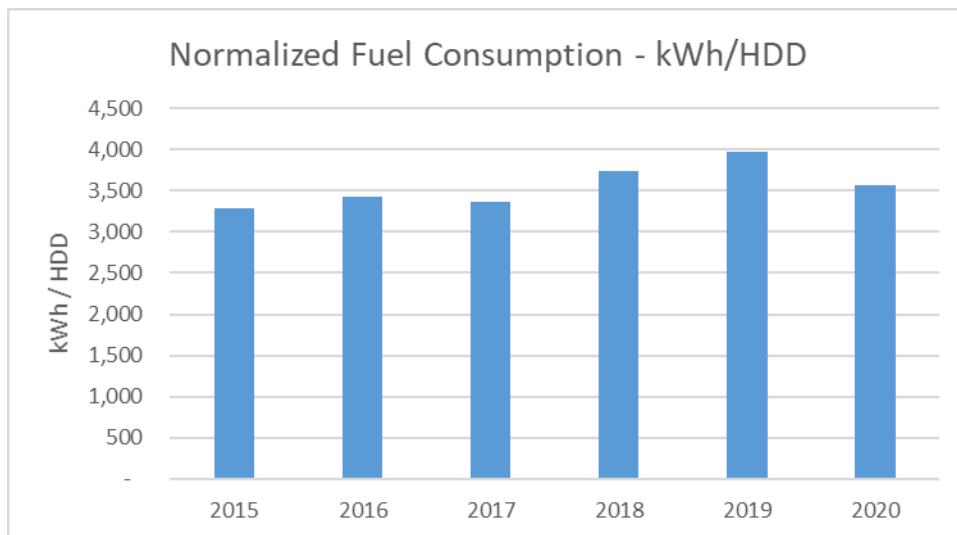


Figure 5: Weather Normalized Fuel Consumption

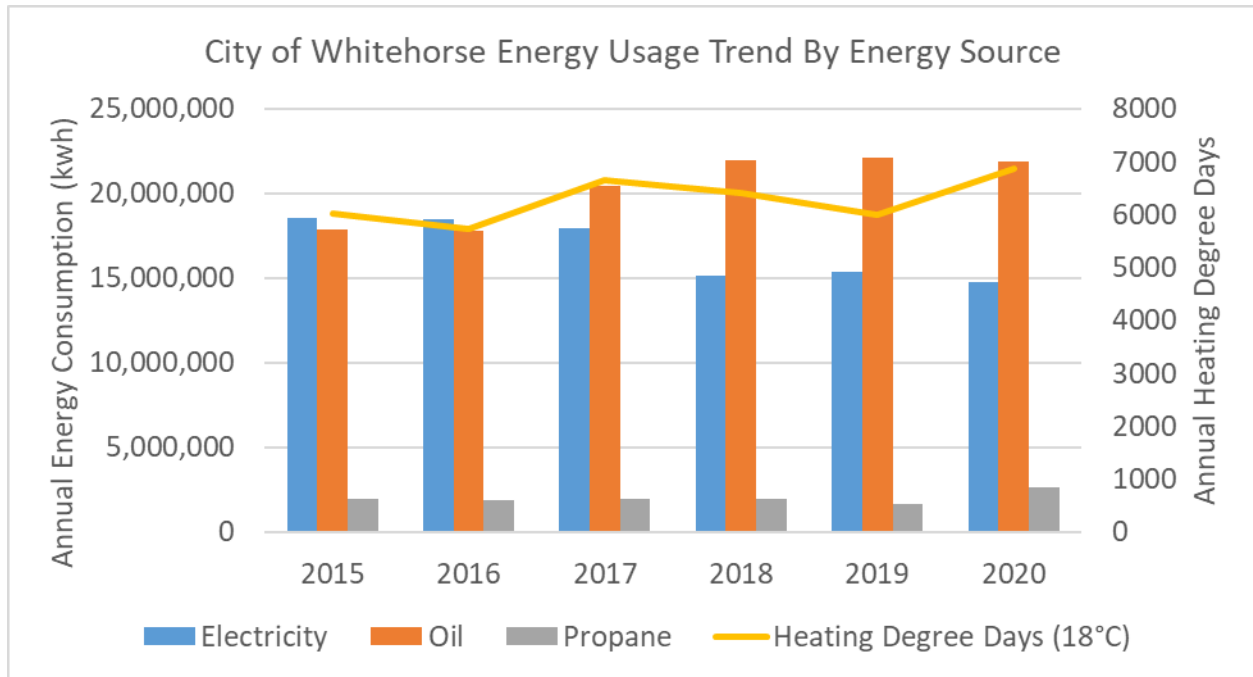


Figure 6: City of Whitehorse Energy Usage Trend by Energy Source

Figure 6 above more clearly illustrates the energy usage trend for each energy source. Some key observations include:

- Propane energy usage increased in 2020 with the addition of the new operations building.
- Electricity usage decreased slightly in 2020, despite the return of some secondary sales at the CGC.
- Oil usage has stabilized and observed a minor decrease in 2020.

## 10.0 Energy Costs

The City of Whitehorse spent nearly \$6 million on energy in 2019. This includes electricity, heating oil, gasoline, diesel fuel, and propane. Electricity accounts for 68% of the cost, while heating oil, gasoline, and diesel combine for 32%.

It should be noted that the Energy Tracker data does not include the various taxes on fuels which include Carbon Tax, Federal Excise Tax, and Gas Tax. City staff are working with the software supplier to add this capability; in the meantime the reader can assume that true cost of oil (including all taxes) is 5 - 10% higher than the total in the figure below.



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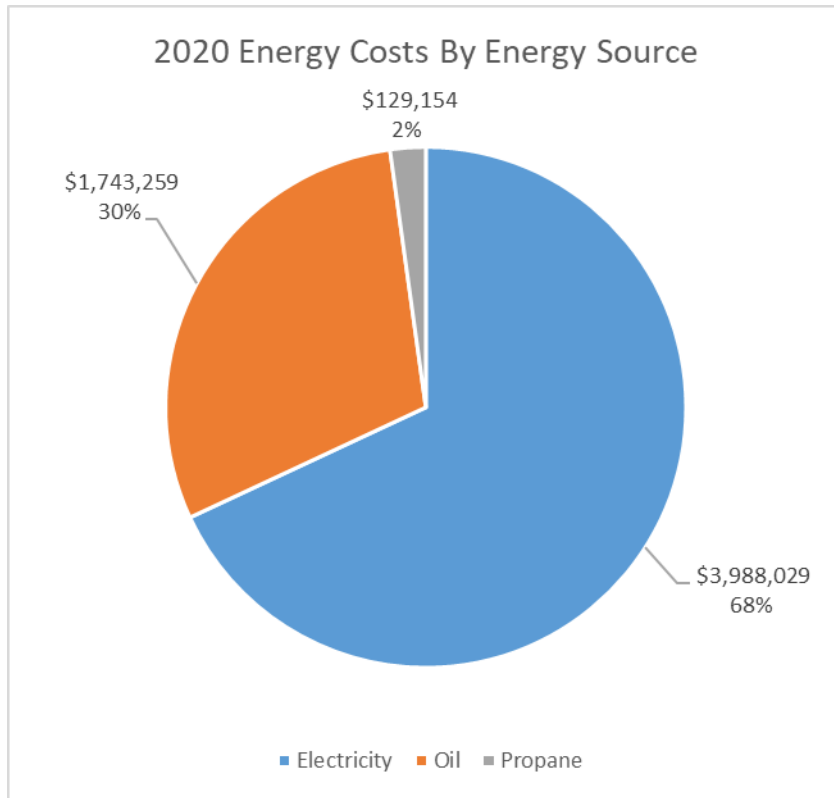


Figure 7: City of Whitehorse 2020 Energy Costs By Energy Source

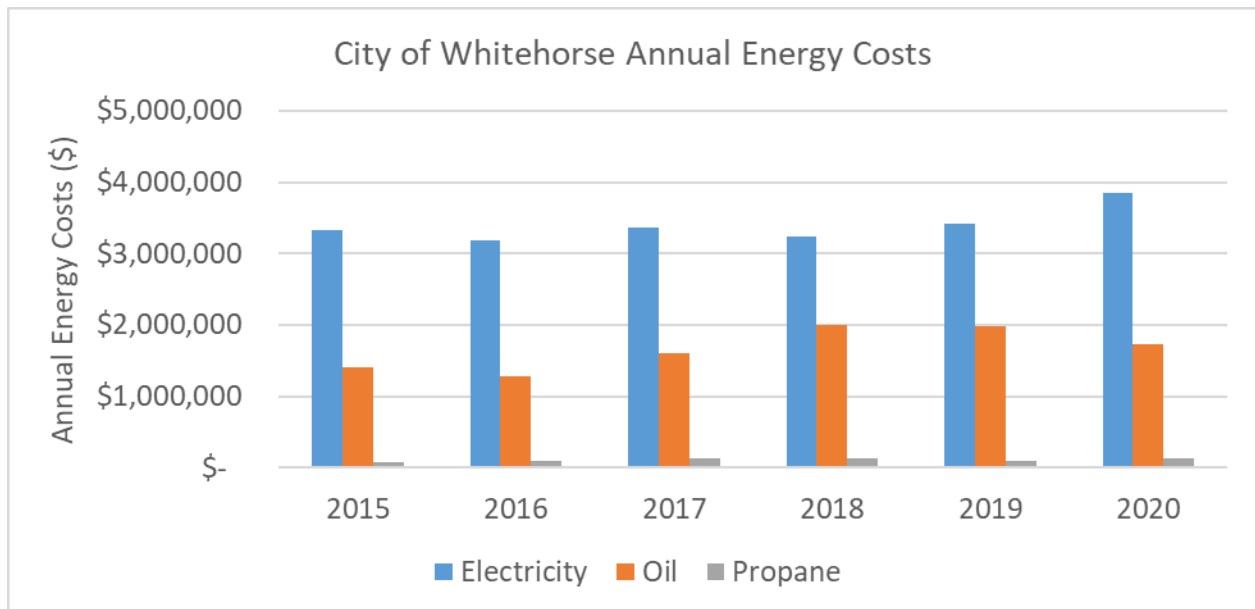


Figure 8: City of Whitehorse Total Energy Costs Trend





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The chart above illustrates the trend in the City's energy costs since 2015. Energy costs have been rising largely due to rising costs per unit of fuel and electricity. In 2020 the City experienced a drop in oil costs associated with the COVID-19 pandemic and reduced global demand/oil prices.

## 11.0 Energy Consumption By End Use

The chart below shows the City's past energy consumption by end use. The CGC is typically the largest energy user, however in 2020 it experienced a significant decrease in energy consumption associated with the Covid-19 shutdown.

We can also observe a large increase in fuel usage for the vehicle fleet. Approximately half of this increase is attributed to the transit fleet moving to the new Operations Building towards the end of 2020. Due to the way data was recorded, Transits fuel usage shows up under Fleet and Equipment for the last few months of 2020. A corresponding decrease in Transit's fuel usage is observable in Figure 9.

Even after accounting for this however, fuel usage was still up notably for the vehicle fleet. It is believed that this is largely due to the very high snowfall in Whitehorse, and the associated snow clearing/hauling effort.

For 2021, improvements have been implemented to record vehicle-specific fuel consumption, rather than fleet-wide data. This will help us more accurately identify the causes of changes in fleet fuel consumption in the future.

The increase observed for Buildings and Facilities can be attributed to the colder winter and the addition of the Operations Building. The Municipal Services Building was still operating throughout 2020, so the savings from decommissioning that building won't be observed until 2021.

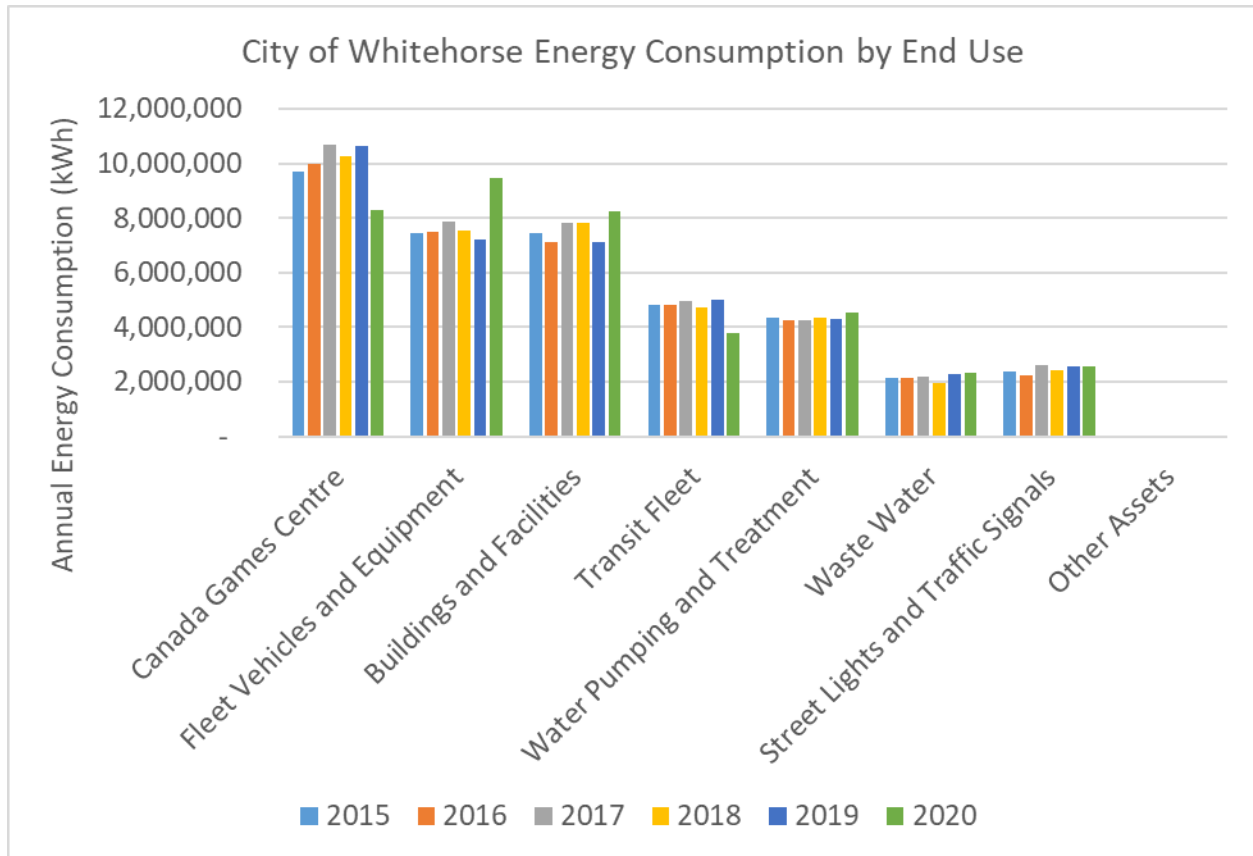


Figure 9: City of Whitehorse Total Energy Consumption by End Use

## 12.0 GHG Emissions by End Use

In 2020 the City’s vehicle fleet stands out as the largest source of GHG emissions, even after accounting for the fact that some transit fuel data is included in the Fleet Vehicles and Equipment column. The CGC observed a significant reduction in GHG emissions due to reduced fuel consumption, however the exact mechanism is not fully understood. We are however confident that it is associated with reduced occupancy and use in response to COVID-19.

The City’s Buildings and Facilities observed a minor increase in GHG emissions associated with the colder winter and the completion of the Operations Building and new Fire Hall #1.

Minor reductions in emissions for Water, Wastewater, and Streetlights are attributed to the change in electrical GHG calculation methodology for 2020.

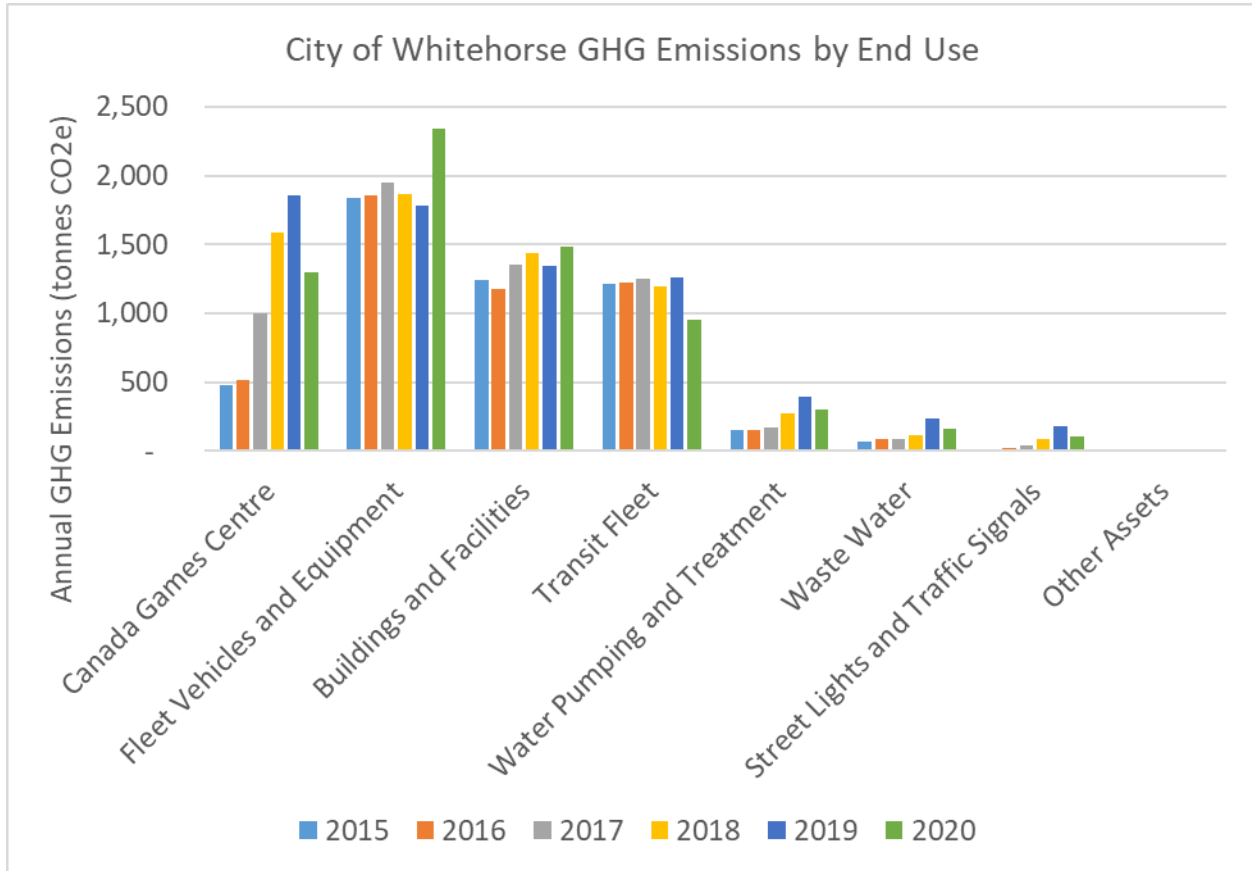


Figure 10: City of Whitehorse GHG Emissions Sources by Year

### 13.0 Oil Consumption by End Use

To better understand why the City’s GHG emissions have been increasing, it is helpful to dig deeper into our oil consumption. ‘Oil’ includes heating fuel, diesel, and gasoline.

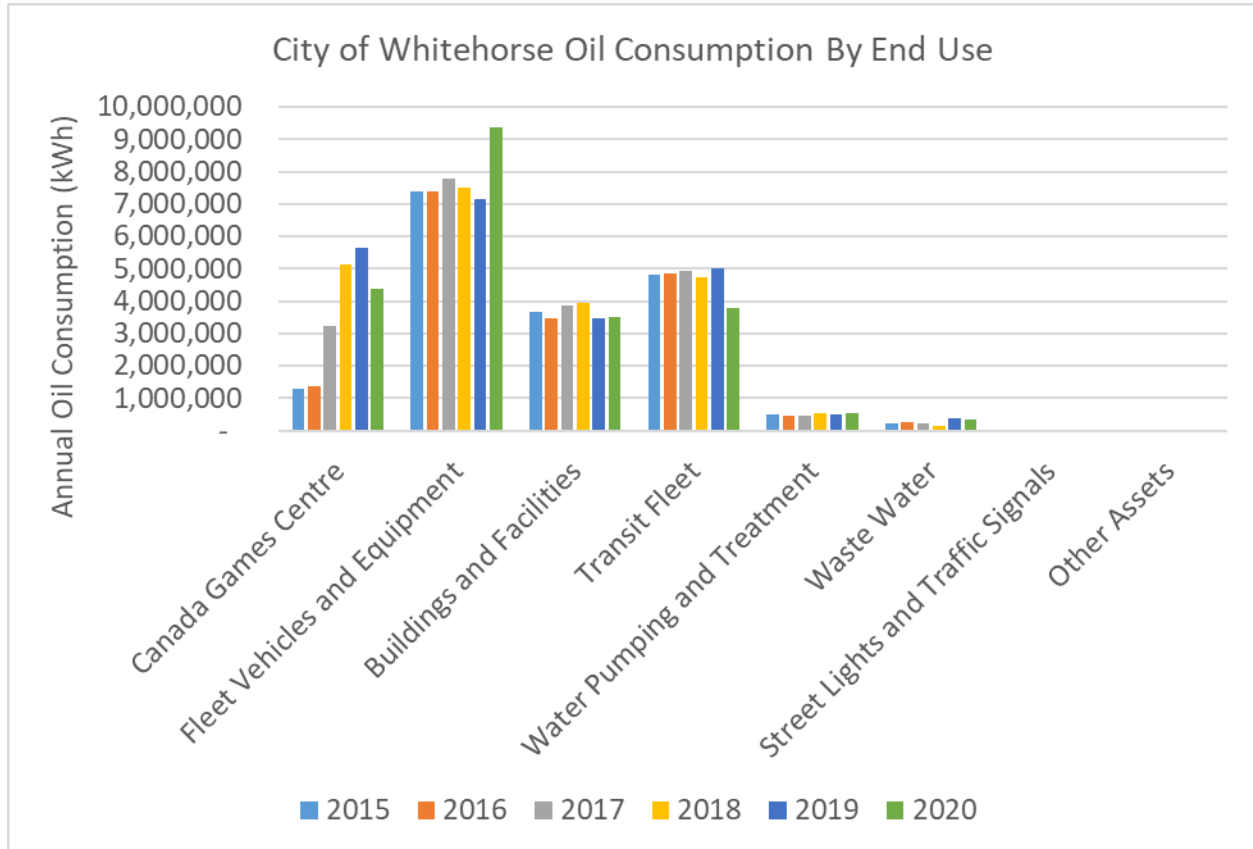


Figure 11: City of Whitehorse Oil Consumption by End Use

The City’s vehicle fleet and equipment stands out as the largest consumer of fossil fuels, and as such will be an important piece of an emissions reduction strategy. The other significant changes are as described in previous sections.

### 14.0 Electricity Consumption by End Use

Electricity consumption for 2020 was relatively unchanged, though the CGC observed a notable reduction, likely associated with reduced occupancy/services in the building.

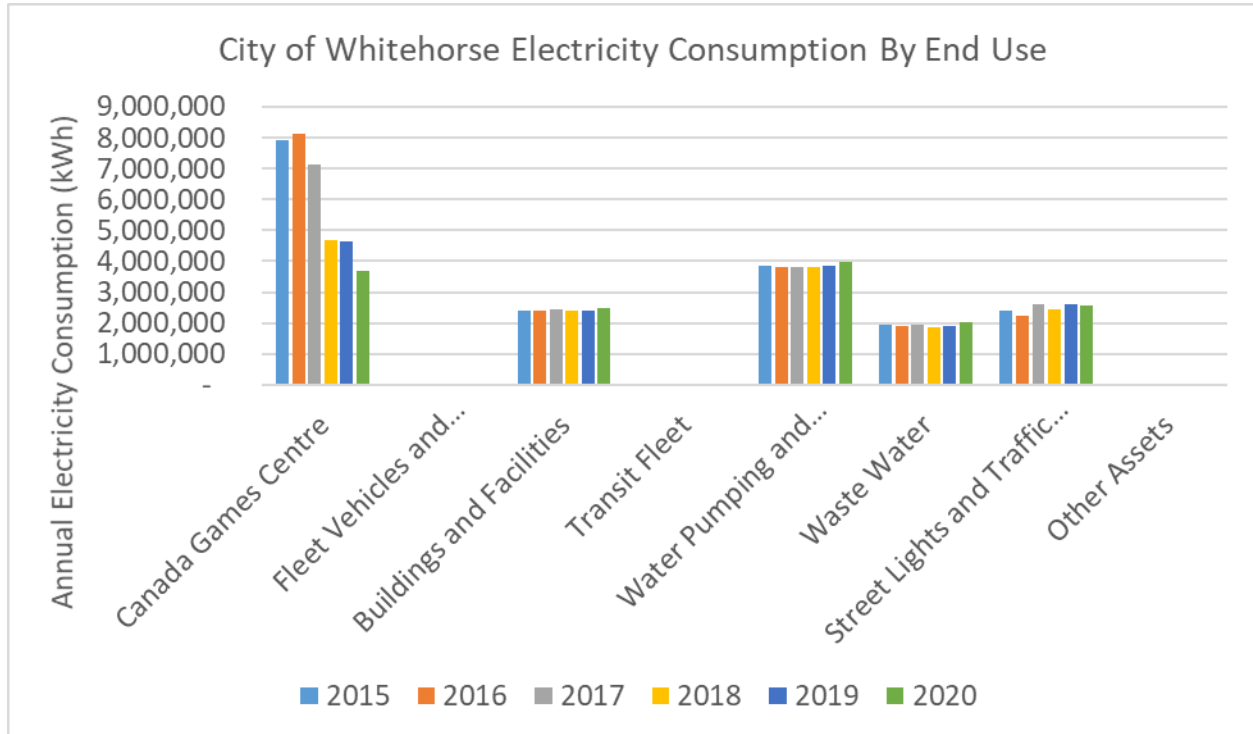


Figure 12: City of Whitehorse Electricity Consumption by End Use

### 15.0 Propane Consumption by End Use

Propane consumption increased substantially in 2020 due to the completion of the Operations Building, and to a lesser degree Fire Hall #1.

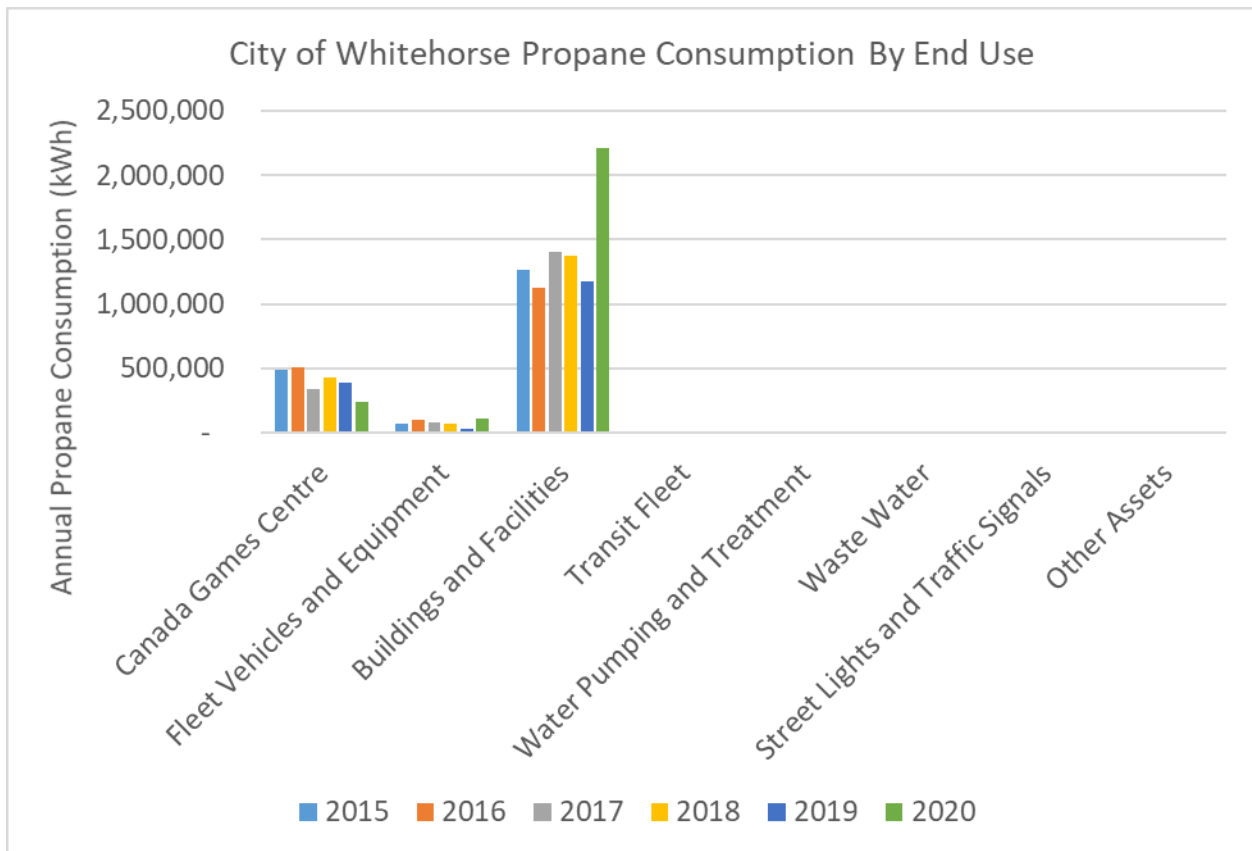


Figure 13: City of Whitehorse Propane Consumption by End Use

### 16.0 Looking Ahead to 2021

The City has moved all staff out of the old Municipal Services Building and the building will not be heated in the fall/winter of 2021, so we are anticipating significant heating oil and electricity savings from that effort. We are also anticipating the completion of a waste heat recovery upgrade at the CGC which should reduce fuel and energy consumption at the CGC in the fall/winter of 2021 as well.

These savings will be partially offset by the new Operations Building, and City staff are monitoring that building to see how its real-world performance compares to the energy modelling. No other major changes are anticipated for 2021, however a number of energy reduction projects are in the design stage.

A major energy retrofit at 139 Tlingit Street is the design stage. This project will reduce energy consumption and GHG emissions, as well as allow the Parks department to move out of their current

building and into 139 Tlingit. The other building can then be sold or decommissioned, further reducing energy consumption.

The expansion and energy upgrade at City Hall is also in the design stage and will allow the closure of some smaller facilities and significantly reduce GHG emissions at City Hall. Completion of this project is not anticipated until 2023.

## 17.0 Electric Vehicles

In late 2020, the City purchased its first fully electric passenger car, a Chevy Bolt. This vehicle is used primarily by the engineering department to attend meetings and site visits throughout the City. GHG reductions associated with using this vehicle instead of a gasoline vehicle are estimated at 0.1 tonnes for 2020. We anticipate that the emissions reductions for this vehicle will be substantially higher once the vehicle is used for a full year in 2021.

The City is also in the process of procuring two electric ice resurfaces (Zambonis) for the CGC for 2021. These will replace propane units and result in reduced GHG emissions and air pollution within the rinks.

## 18.0 Landfill Emissions

The City of Whitehorse Waste Management Facility includes a transfer station, landfill, and compost facility. Emissions from these facilities are calculated as per the PCP Protocol methodology, and thus are consistent with IEAP standards. The following excerpt from the PCP Protocol describes how landfill emissions are assessed:

“The corporate solid waste sector tracks methane (CH<sub>4</sub>) emissions that enter the air directly as waste decomposes at landfills as well as CH<sub>4</sub>, nitrous oxide (N<sub>2</sub>O) and non-biogenic carbon dioxide (CO<sub>2</sub>) emissions associated with the combustion of solid waste at incineration facilities.

When solid waste is landfilled, its organic components (e.g. paper, food and yard waste, etc.) decompose over time into simpler carbon compounds by bacteria in an anaerobic (oxygen poor) environment generating CH<sub>4</sub> and CO<sub>2</sub> emissions. The CO<sub>2</sub> emissions associated with the decomposition of the organic waste are considered to be of biogenic origin and are excluded from the GHG inventory. Landfill emissions are unique in that the disposed solid waste generates emissions over many years.”<sup>14</sup>

For the purposes of this report, the City is using a Methane Commitment Model to evaluate changes in landfill emissions from one year to the next.

“The methane commitment model (also known as 'total yield gas') estimates the total downstream methane (CH<sub>4</sub>) emissions generated over the course of the waste's decomposition i.e. future CH<sub>4</sub> generation is attributed to the inventory year in which the solid waste was

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<sup>14</sup> <https://fcm.ca/sites/default/files/documents/resources/report/protocol-canadian-supplement-pcp.pdf>



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generated and disposed. This approach is typically the simplest for local governments in terms of data collection requirements and methodology. It is also the most comparable approach.”<sup>15</sup>

The limitation of the Methane Commitment Method is that the calculated emissions are those that will be released in the future, rather than the emission that were released this year (due to the waste from previous years). The result is that the calculated emissions shouldn't be added or compared directly to the City's annual fossil fuel based emissions. That said, the Methane Commitment Method is useful because it helps us understand the long-term emissions reductions associated with changes in waste management such as organics separation.

The chart below shows the Methane Committed in each year due to the landfilled waste. The chart also shows the Avoided Methane Emissions due to the City's compost and clean wood separation programs. In 2020, the composting program reduced the committed methane by about 12%.<sup>16</sup> City staff are currently continuing the roll out a significant expansion of the composting program into multi-residential and commercial compost.

In 2020, the City achieved a new record for organics collection, diverting 2760 tonnes of organics from the landfill. However, significantly less wood chips were composted in 2020, likely due to reduced land clearing efforts in Whistle Bend. The reduction in wood chips resulted in a drop in avoided emissions for 2020.

The total landfilled waste was reduced again for the 3<sup>rd</sup> straight year, despite Whitehorse's continually growing population.

The calculation spreadsheet is attached in Appendix B.

In response to the potentially high levels of GHG emissions at the landfill, the City is incorporating a Landfill Gas Management plan into our 2023-2033 Solid Waste Management Plan. This work will provide us with a revised GHG emissions estimate, as well as preliminary feasibility of various options to mitigate the release of landfill gas (methane).

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<sup>15</sup> <https://fcm.ca/sites/default/files/documents/resources/report/protocol-canadian-supplement-pcp.pdf>

<sup>16</sup> Compared to a base case that assumes all the organics are landfilled.



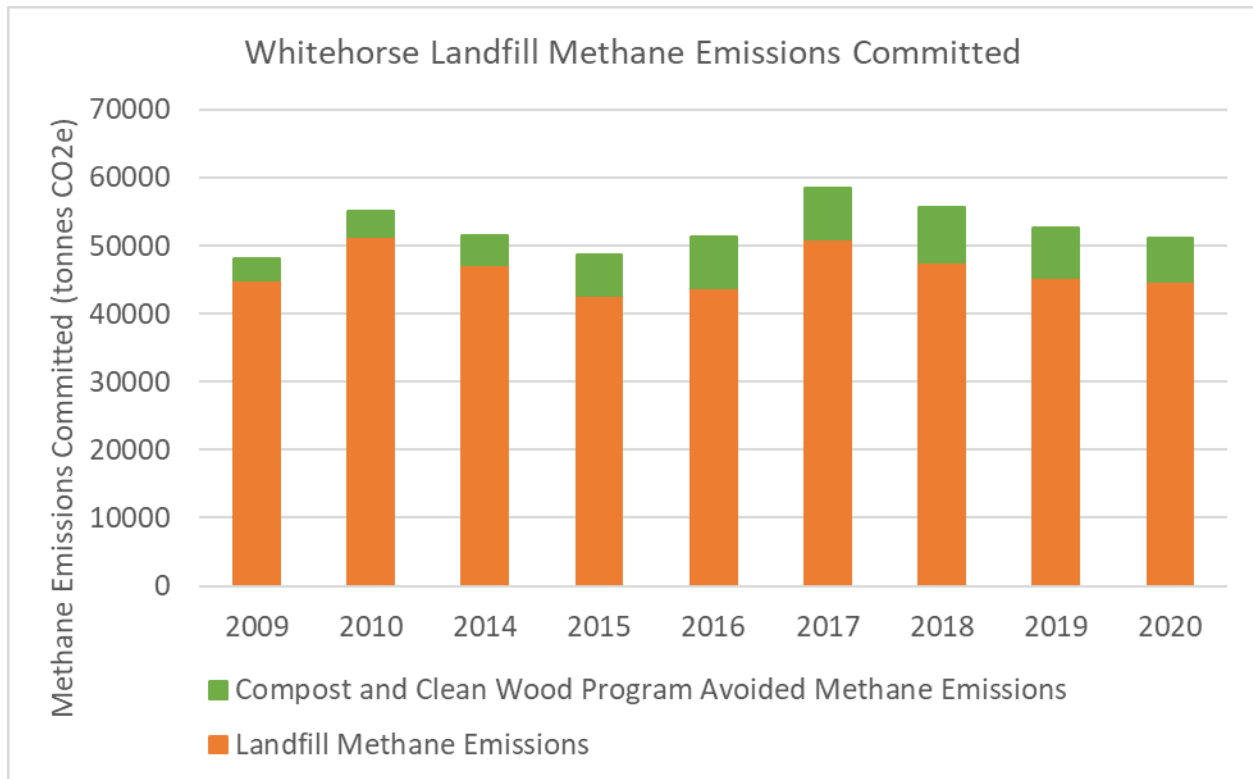


Figure 14: City of Whitehorse Landfill Emissions

## 19.0 Wastewater Emissions

Wastewater can be a source of methane emissions when treated anaerobically. It can also be a source of nitrous oxide (N<sub>2</sub>O) emissions. In accordance with IPCC emissions inventory guidelines, CO<sub>2</sub> from wastewater treatment is not included in the inventory because it is of biogenic origin. This is consistent with how CO<sub>2</sub> emissions are dealt with for landfills.

The City of Whitehorse operates sewage lagoons to treat wastewater. Treating wastewater in a lagoon typically results in anaerobic conditions and the generation of methane.<sup>17</sup> The City of Whitehorse’s Wastewater emissions were estimated using the methodology presented by the GHG Protocol for Cities<sup>18</sup>. It must be noted that these calculations are estimates based on standard parameters and correction factors. Population is the only factor that changes from one year to the next, so the calculated emissions rise as Whitehorse’s population increases. There is a high degree of uncertainty in these numbers, but they are still a useful tool to guide and identify opportunities for the City’s GHG emissions reduction efforts.

<sup>17</sup> IPCC Guidelines for National Greenhouse Gas Inventories, Vol 5, Section 6.1 <https://www.ipcc-nggip.iges.or.jp/public/2006gl/>

<sup>18</sup> Section 8.6, pg 99-103, <https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities>

The calculation spreadsheet is attached in Appendix C.

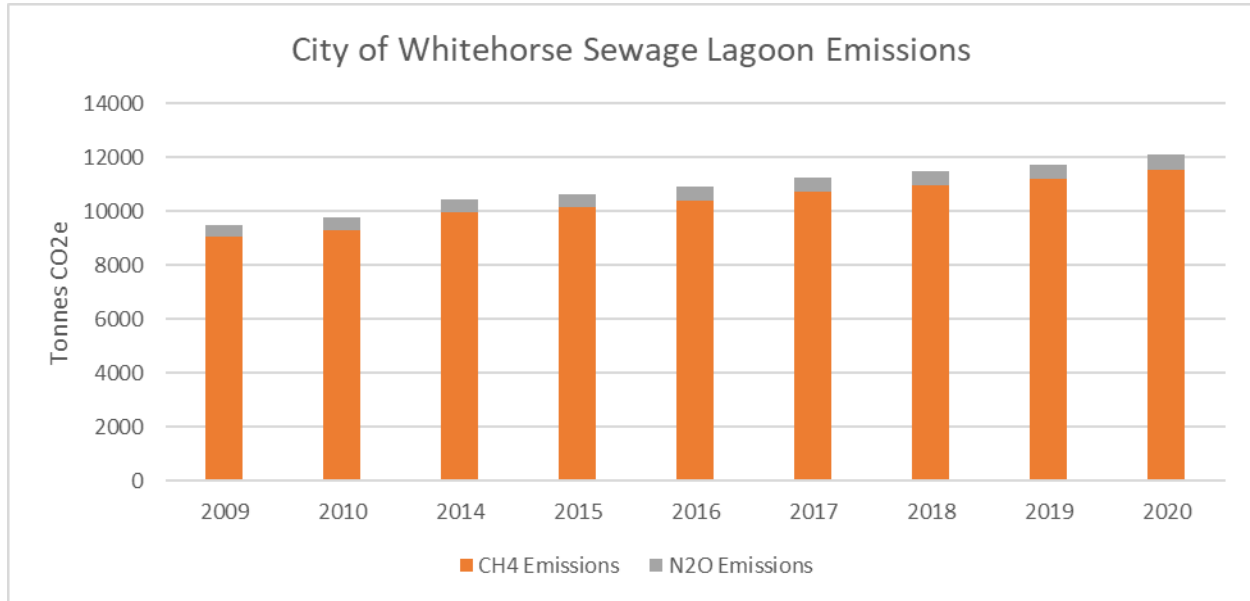


Figure 15: City of Whitehorse Sewage Lagoon Emissions

## 20.0 Conclusion

The City of Whitehorse’s corporate energy consumption was relatively unchanged for 2020, with reduced energy consumption due to COVID-19 offset by increases associated with a colder winter and new building construction. A new calculation method was applied to electrical emissions to reflect Yukon Government’s commitment to 93% renewable electricity. This new method will provide consistency for the emissions inventory in the future, and allow the City to focus on changes that are within its jurisdiction, rather than macro forces beyond the City’s control. The new calculation method resulted in an emissions reduction of approximately 507 tonnes, demonstrating the significant positive impact of Yukon Government’s policy commitment to renewable electricity. It should be noted that if the calculation method was unchanged, electrical GHG emission would still have been reduced for 2020 due to higher than usual rainfall and snowfall supplying the hydro reservoirs.

A number of energy and GHG reduction projects are in progress, and the City hopes to see some notable reductions in GHG emissions in coming years. Notably, all staff have moved out of the old Municipal Services Building and it will not be heated in the fall of 2021, resulting in significant oil consumption savings. Other ongoing work includes:

- Waste Heat Recovery Upgrade at the CGC (Completion Summer 2021)
- 139 Tlingit Street (Old Transit Garage) energy retrofit and biomass heating (Completion in 2022)
- City Hall renovation and energy upgrade (Completion in 2023)

Additional projects will be required to get the City back on track with its emissions reduction targets.



City of Whitehorse

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## Appendix A: Emissions Factors

The City of Whitehorse uses emissions factors provided by The Climate Registry (TCR). TCR produces an annually updated report (2019 Default Emissions Factors) with emissions factors for a wide range of fuel types. The annual report also includes Global Warming Potential (GWP) factors for various greenhouse gases including CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. The GWP factors are original produced by the Intergovernmental Panel on Climate Change (IPCC), via their Assessment Reports. The City of Whitehorse has used the latest GWP factors, which originate in the IPCC's Fifth Assessment Report (AR5).

<https://www.theclimateregistry.org/>

A summary of the Emissions Factors used in the City's Energy Tracker can be found on the next page.

# Public Buildings Energy Tracker Emissions Factors Update

Prepared By: Cody Reaume

December 5<sup>th</sup> 2019

Verifying the emission factors and formulas was identified as part of my workplan for the 2019-2021 Climate Change Staff Grant from FCM. This document summarizes the steps I took and changes made to the emissions factors in the City of Whitehorse's Energy Tracker software.

## Emissions from Burning Fossil Fuels Directly

To ensure that our GHG emissions inventory is comparable to other jurisdictions, it is important to use standard calculation methods and emission factors. The Yukon government was selected as the reference organization to which the City's emissions factors should match.

I reached out to the Yukon Government's Energy Manager and subsequently the Climate Change Secretariat to request the source for their emissions factors. Staff at the Climate Change Secretariat sent me an emissions factors document produced annually by The Climate Registry (TCR), a non-profit organization from California.<sup>1</sup> The document has been saved at:

[R:\Development\\_Services\Environmental\\_Sustainability\Internal\Energy\Energy Tracker Data\Information on Emissions Factors](R:\Development_Services\Environmental_Sustainability\Internal\Energy\Energy Tracker Data\Information on Emissions Factors)

The Climate Change Secretariat uses this annually updated document to calculate the GHG emissions associated with burning diesel fuel, gasoline, liquefied natural gas (LNG), propane, and home heating fuel, as well as other fossil fuels.

The previous and new (from TCR) emissions factors are summarized in the table below. These updated factors have been input into the Energy Tracker database and thus any data extracted from the Energy Tracker after December 5<sup>th</sup> 2019 will have these updated emission factors attached.

Fuel Type	Unit	Previous Energy Density (MJ/unit)	Previous Emissions Factor (tonnes CO2e/unit)	TCR 2019 Energy Density (MJ/unit)	TCR 2019 Emissions Factor (tonnes CO2e/unit)
Propane	Litres	25.31	0.001548	25.31	0.001515
Heating Oil	Litres	38.40	0.0027306	38.80	0.002753
Diesel Fuel	Litres	38.40	0.0027306	38.30	0.002681
Gasoline	Litres	38.40	0.00236189	35.00	0.002307

## Emissions From Electricity

The Energy Tracker calculates emissions associated with electricity used by the City of Whitehorse. These emissions are dependent on the mix of fossil fuels and renewables that Yukon Energy Corporation (YEC) used to generate that electricity. YEC's monthly average mix of fossil fuels and renewables is used to estimate the emissions associated with that month's electricity usage. Individual emissions factors are

<sup>1</sup> <https://www.theclimateregistry.org/tools-resources/reporting-protocols/general-reporting-protocol/>

then applied to electricity produced by diesel generators and to electricity produced by LNG generators. The old and updated factors are presented below. The updated emissions factors were supplied by Travis Ritchie, Manager of Environment, Assessment, & Licensing at Yukon Energy. It is of note that the emissions factors supplied by Travis are less precise than the old emissions factors. According to Travis, the reason for the reduced precision is that “Individual units will vary around these numbers depending on a variety of unit condition and operating factors...”.

Electricity Generated From:	Unit	Previous Emissions Factor (tonnes CO2e/unit)	New Emissions Factors from YEC (tonnes CO2e/unit)
<b>Diesel Generators</b>	kWh	0.00050954	0.000700
<b>LNG Generators</b>	kWh	0.00043585	0.000450

It is of note that Yukon government uses a single emissions factor for all electricity in a given year. This value is pulled from Table 3.2 in The Climate Registry’s Default Emissions Factors Document. For 2019, the factor is 41g CO<sub>2</sub>/ kWh. This works out to an assumption of roughly 7% fossil fuel generation, with the rest coming from zero emissions sources (hydroelectricity).<sup>2</sup> Using this standard figure provides a simpler calculation that will be consistent with Yukon government’s calculation and easy to compare from one year to the next, but may sacrifice precision compared to the City’s current methodology.

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<sup>2</sup> This was calculated assuming a 50/50 split of diesel and LNG generation, resulting in a combined emissions factor of 575gCO<sub>2</sub>/kWh for fossil fuel electricity. The Yukon value of 41gCO<sub>2</sub>/kWh results in  $41/575 = 7.1\%$ . So 7.1% comes from fossil fuels, and the other 92.9% comes from hydroelectricity with an emissions intensity of zero.



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## Appendix B: Landfill Emissions Calculations

**City of Whitehorse 2020 GHG Emissions Inventory - Landfill Emissions Calculation**

Prepared By: Cody Reaume and Sarah Preiksaitis

May 27th 2021

Updated: June 3rd 2021

This spreadsheet calculates an estimate of the City's landfill emissions using the Methane Commitment model described in the Partners for Climate Protection (PCP) PCP Protocol document. R:\Development\_Services\Environmental\_Sustainability\Internal\2.Active\Climat Change and Adaptation\GHG inventory\2019 Emissions Inventory\References

Additional details and information can be found here: R:\Development\_Services\Environmental\_Sustainability\Internal\Climat Change and Adaptation\GHG inventory\2019 Emissions Inventory\References\GHG Protocol

The City of Whitehorse's landfill does not currently have a landfill gas (LFG) collection system.

**From the PCP Protocol, the calculation steps are:**

Determine quantity of solid waste landfilled during the inventory year.

Determine the composition of the waste stream.

Calculate the degradable organic carbon content from the waste stream.

Calculate the methane generation potential of the landfilled waste.

Calculate the emissions of CO2e.

**City of Whitehorse Landfill Emissions**

Category	Carbon Fraction	North American Waste Fractions	2009	2010	2014	2015	2016	2017	2018	2019	2020	Unit
<b>Total Mass</b>			19297	22089	20293	18299	18805	21910	20432	19492	19234	tonnes waste
<b>Food</b>	0.15	34%	14%	14%	24%	24%	24%	24%	24%	24%	24%	N/A
<b>Garden</b>	0.2	0%	5%	5%	0%	0%	0%	0%	0%	0%	0%	N/A
<b>Paper/Cardboard</b>	0.4	23%	14%	14%	10%	10%	10%	10%	10%	10%	10%	N/A
<b>Wood Products</b>	0.43	6%	15%	15%	19%	19%	19%	19%	19%	19%	19%	N/A
<b>Textiles</b>	0.24	4%	3%	3%	2%	2%	2%	2%	2%	2%	2%	N/A
<b>Inert Materials (Glass, metal, plastic, etc.)</b>	0.15	33%	50%	50%	44%	44%	44%	44%	44%	44%	44%	N/A
<b>Degradable Organic Carbon (DOC)</b>		0.228	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	tonnes carbon/tonne waste
<b>Estimate Methane Generation Potential (Lo)</b>			0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	tonnes CH4 / tonne waste
<b>Estimate of Methane Committed</b>			1604	1836	1687	1522	1564	1822	1699	1621	1599	tonnes CH4 committed
<b>Estimate of CO2e</b>			44904	51400	47246	42603	43781	51010	47569	45381	44780	tonnes CO2e committed
<b>Waste Data Reference</b>			2009 -10 Waste Audit	2009 -10 Waste Audit	2017-18 Waste Audit	2017-18 Waste Audit	2017-18 Waste Audit	2017-18 Waste Audit	2017-18 Waste Audit	2017-18 Waste Audit	2017-18 Waste Audit	
<b>Whitehorse Population</b>			26078	26872	28794	29325	29991	30984	31687	32304	33285	Data from: <a href="http://www.sewp.gov.yk.ca/data?regionId=YK.WH&amp;subjectId=POPCOM&amp;groupId=POPCOM.POP&amp;dataId=YBS_HCRF_POP_AGE_SEX&amp;tab=region">http://www.sewp.gov.yk.ca/data?regionId=YK.WH&amp;subjectId=POPCOM&amp;groupId=POPCOM.POP&amp;dataId=YBS_HCRF_POP_AGE_SEX&amp;tab=region</a>
<b>Waste Generation / Person (tonnes)</b>			0.740	0.822	0.705	0.624	0.627	0.707	0.645	0.603	0.578	
<b>GHG's / Person (tonnes CO2e)</b>			1.722	1.913	1.641	1.453	1.460	1.646	1.501	1.405	1.345	

Year	Carbon Fraction	N/A	2009	2010	2014	2015	2016	2017	2018	2019	2020	Source / Notes
Organics Diverted from Landfill Annually (tonnes)	-	-	1828	2149	2222	2758	2517	2316	2739.01	2648	2760	The City operates a compost pickup program for residents. The program currently expanding into multi-residential, and subsequently commercial.
Clean Wood Diverted from Landfill Annually (tonnes)	-	-	0	0	2	31	235	141	337	396	424	The diverted clean wood is chipped and added to the compost to improve the carbon ratio for composting.
Wood Chips Diverted from Landfill Annually (tonnes)	-	-	0	0	160	599	2066	2959	2189	1304	305	
Organics/Wood Ratio	-	-	N/A	N/A	13.7	4.4	1.1	0.7	1.1	1.6	3.8	
Estimated Carbon Fraction of Diverted Organics	0.175	-	-	-	-	-	-	-	-	-	-	The mass fractions of the compost stream are unknown, so we have assumed it to be 50% Food and 50% garden waste, resulting in a Carbon Fraction of 0.175.
Carbon Fraction of Diverted Clean Wood and Wood Chips	0.43	-	-	-	-	-	-	-	-	-	-	
DOC of Compost (organics + clean wood)	-	-	0.175	0.175	0.192	0.222	0.297	0.321	0.297	0.275	0.228	
Methane Generation Potential of Organics (Lo)	-	-	0.070	0.070	0.077	0.089	0.119	0.128	0.119	0.110	0.091	
CH4 Avoided from Organics and Clean Wood Diversion	-	-	115	135	154	221	269	268	293	262	227	Assumes that the compost is 100% aerobic and no methane is released from the compost piles.
CO2e Avoided from organics and clean wood diversion	-	-	3225	3791	4308	6183	7530	7493	8209	7332	6351	Applying GWP for CH4 of 28 (from IPCC AR5).
% Emissions Reduction	-	-	6.7%	6.9%	8.4%	12.7%	14.7%	12.8%	14.7%	13.9%	12.4%	

**Commercial Compost 2021 Forecast**

Add'l Mass Diverted (tonnes)	150	From Water and Waste Department's Program Forecasting
Carbon Fraction	0.175	
DOC	0.175	
Lo	0.070	
CH4 Avoided	9	
CO2e Avoided	265	
% of 2019 Landfill Emissions	0.6%	

More Below - Continue Scrolling Down



**Factors for estimating methane emissions.**

The factors below and calculation formulas were extracted from the PCP Protocol document: [R:\Development\\_Services\Environmental\\_Sustainability\Internal\Climate Change and Adaptation\GHG inventory\2019 Emissions Inventory\References\protocol-canadian-supplement-pcp](R:\Development_Services\Environmental_Sustainability\Internal\Climate Change and Adaptation\GHG inventory\2019 Emissions Inventory\References\protocol-canadian-supplement-pcp)

Additional information and details can be found here: [R:\Development\\_Services\Environmental\\_Sustainability\Internal\Climate Change and Adaptation\GHG inventory\2019 Emissions Inventory\References\GHG Protocol](R:\Development_Services\Environmental_Sustainability\Internal\Climate Change and Adaptation\GHG inventory\2019 Emissions Inventory\References\GHG Protocol)

	<b>Methane Correction Factor (MCF)</b>
<b>managed</b>	1
<b>Unmanaged (&gt;5m deep)</b>	0.8
<b>unmanaged (&lt;5m deep)</b>	0.4
<b>uncategorized</b>	0.6

<b>Fraction of DOC dissimilated</b>	0.6	Default value is 0.6
<b>Fraction of methane in landfill gas</b>	0.5	Default value is 0.5
<b>Stoichiometric ratio between methane and carbon</b>	1.33	16/12
<b>GWP of CH4</b>	28	From IPCC Assessment Report 5
<b>Fraction recoved by LFG system</b>	0	No LFG system in place
<b>Oxidation Factor</b>	0.1	0.1 for well managed lanfills, ~0 for unmanaged landfills



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## Appendix C: Wastewater Emissions Calculations

**City of Whitehorse 2020 GHG Emissions Inventory - Sewage Lagoon Emissions Calculation**

Prepared By: Cody Reaume

June 3rd 2021

Updated:

This spreadsheet calculates an estimate of the City's sewage lagoon emissions using the methodology presented in Section 8.6 of the Greenhouse Gas Protocol's Global Protocol for Community-Scale Greenhouse Gas Emission Inventories document. Document can be found here: R:\Development\_Services\Environmental\_Sustainability\Internal\Climate Change and Adaptation\GHG inventory\2019 Emissions Inventory\References\GHG Protocol

The City of Whitehorse's sewage lagoons are a passive wastewater treatment system, with no aeration, agitation, or other energy inputs.

This spreadsheet calculates a simple estimate of methane (CH4) emissions from the lagoons. N2O emissions are assumed to be insignificant and are not included.

CO2 emissions from the lagoon are of biogenic origin and are thus not included in the GHG emissions inventory, as per Section 8.6 of the GHG Protocol document.

**From the GHG Protocol document, the calculation steps are:**

Determine the TOW (Total Organics, kg BOD/year)

Determine the EF (Methane Emissions Factor, unitless)

Calculate CH4 emissions

Calculate CO2e emissions

Factor	Quantity	Unit	Source
<b>BOD (Biochemical Oxygen Demand)</b>	56.5	g/person/day	City of Whitehorse 2019 Annual Report, Water License #: MN18-059, yukonwaterboard.ca
<b>I (Correction factor for industrial BOD)</b>	1.25	-	Default value from Equation 8.10 in GHG Protocol Document
<b>B (Maximum CH4 producing capacity)</b>	0.6	kgCH4/kg BOD	Default value from Equation 8.10 in GHG Protocol Document
<b>MCF (Methane Correction Factor)</b>	0.8	-	Table 6.3 , page 6.13, <a href="https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf">https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf</a>
<b>U (Fraction of Pop. in Income Group)</b>	1.0	-	Assumed a single income group for the entire City of Whitehorse.
<b>T (Degree of utilization of treatment/discharge pathway or system)</b>	1.0	-	All of Whitehorse's sewage goes through the same lagoons. There are no alternative treatment pathways. See 2006 IPCC GHG Inventory Guidelines, <a href="https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf">https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf</a>
<b>GWP of Methane</b>	28.0	-	From IPCC AR5

**City of Whitehorse Sewage Lagoon CH4 Emissions Calculation**

Category	2009	2010	2014	2015	2016	2017	2018	2019	2020	Unit	Source
<b>Whitehorse Population</b>	26078	26872	28794	29325	29991	30984	31687	32304	33285	people	Data from: <a href="http://www.sewp.gov.yk.ca/data?regionId=YK.WH&amp;subjectId=POPCOM&amp;groupId=POPCOM.POP&amp;dataId=YBS_HCRF_POP_AGE_SEX&amp;tab=region">http://www.sewp.gov.yk.ca/data?regionId=YK.WH&amp;subjectId=POPCOM&amp;groupId=POPCOM.POP&amp;dataId=YBS_HCRF_POP_AGE_SEX&amp;tab=region</a>
<b>TOW (Total Organics In Wastewater)</b>	672	693	742	756	773	799	817	833	858	tonnes BOD	Calculated
<b>EF (Methane Emissions Factor)</b>	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	N/A	Calculated
<b>S (Organics Removed as Sludge)</b>	0	0	0	0	0	0	0	0	0	tonnes BOD	Sludge removal only applicable for aerobic treatment
<b>R (Methane Recovered)</b>	0	0	0	0	0	0	0	0	0	tonnes CH4	The sewage lagoons do not have methane recovery
<b>Estimated CH4 Emissions</b>	323	333	356	363	371	384	392	400	412	tonnes CH4	Calculated
<b>Estimated CO2e</b>	9038	9313	9979	10163	10394	10738	10982	11195	11535	tonnes CO2e	Calculated
<b>GHG's / Person</b>	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	tonnes CO2e/capita	Calculated

Category	2009	2010	2014	2015	2016	2017	2018	2019		Unit	Source
Whitehorse Population	26078	26872	28794	29325	29991	30984	31687	32304	33285	people	
Annual per capita protein consumption	36.50	36.50	36.50	36.50	36.50	36.50	36.50	36.50	36.50	kg/person/year	~ 100 g/capita/day (developed countries) <a href="https://doi.org/10.3390/foods6070053">https://doi.org/10.3390/foods6070053</a>
Estimate of N2O Emissions	1.65	1.70	1.82	1.85	1.89	1.95	2.00	2.04	2.10	tonnes N2O/year	Calculated
Estimated CO2e	436	449	481	490	501	518	530	540	557	tonnes CO2e/year	

Factors for N2O Emissions Calculation	Value	Unit	Source
Non-consumed protein factor	1.1	N/A	1.1 for locations without garburators - Waste grinding devices are banned in the City's Sewer and Storm Utility Bylaw 2013-56
Nitrogen Fraction in Protein	0.16	kg N/kg protein	Default value is 0.16kgN/kg protein - IPCC Guidelines for GHG Inventories, pg 6.25
Industrial/Commercial protein discharge factor	1.25	-	Default value is 1.25 - IPCC Guidelines for GHG Inventories, Table 6.11
Nitrogen removed in sludge	0	kg N/year	No sludge removal
Emission factor for N2O in wastewater	0.005	-	Default Factor is 0.005 - IPCC Guidelines for GHG Inventories, Table 6.11
Stoichiometric factor for N2O-N to N2O	1.57	kg N2O-N / kg N2O	IPCC Guidelines for GHG Inventories, pg 6.25
GWP of N2O (Nitrous Oxide)	265.00	-	From IPCC AR5