District of Saanich 2017 GPC BASIC+ Community Greenhouse Gas (GHG) Emissions Inventory Report

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July 27, 2018

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Executive Summary

Global climate change resulting from emissions of carbon dioxide (CO_2) and other greenhouse gases (GHGs) is having a significant impact on the ecology of the planet. Delayed actions to respond to the effects of climate change are expected to have serious negative impacts on global economic growth and development.

Beyond the costs associated with delayed climate action, there are cost savings to be realized through efforts to improve energy efficiency, conserve energy, and reduce GHG emissions intensity. To make informed decisions on reducing energy use and GHG emissions at the community scale, community managers must have a good understanding of these sources, the activities that drive them, and their relative contribution to the total. This requires the completion of an energy and GHG emissions inventory. To allow for credible and meaningful reporting locally and internationally, the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (the GPC Protocol) was developed. The GPC Protocol has been adopted by the Global Covenant of Mayors—an agreement led by city networks to undertake a transparent and supportive approach to measure GHG emissions community-wide. The Global Covenant of Mayors promotes the use of the GPC Protocol as a standardized way for municipalities to collect and report their actions on climate change.

This project set out to compile a detailed GHG inventory for the District of Saanich (the District) for the 2017 reporting year using the GPC Protocol. Following the requirements of the GPC Protocol, the GHG inventories considered emissions from all reporting Sectors, including Stationary Energy, Transportation, Waste, Industrial Process and Product Use (IPPU), and Agriculture, Forestry and Other Land Use (AFOLU). The purpose of this document is to describe the quantification methodologies used by the District to calculate GHG emissions for the 2017 reporting year, and to present the District's 2017 community GHG emissions.

Following the requirements of the GPC Protocol BASIC+ reporting level, the District's 2017 community GHG emissions are estimated to be 512,901 tCO_2e. A summary of the 2017 GHG emissions is presented in Table E-1.

Table E-1 BASIC+ 2007 Baseline and 2017 Reporting Year GHG Emissions

Sector	Sub-Sector	2007 GHG Emissions (tCO_2e)	2017 GHG Emissions (tCO_2e)
Stationary Energy	Residential Buildings	93,458	89,302
	Agriculture, Forestry, And Fishing Activities	13,550	13,314
	Manufacturing Industries, and Construction		
	Non-Specified Sources		
	Commercial / Institutional Buildings	52,835	56,819
	Energy Industries		

Sector	Sub-Sector	2007 GHG Emissions (tCO_2e)	2017 GHG Emissions (tCO_2e)
	Fugitive Emissions: Oil and Natural Gas Systems	1,800	1,206
Transportation	On-Road Transportation	88,486	102,580
	Transboundary Transportation	151,977	169,961
	Off-Road Transportation: Aviation, Railways, and Other Off-Road	14,562	26,273
Waste	Waste: Solid Waste Disposal, Biological Treatment of Waste, Wastewater Treatment and Discharge	34,121	23,819
AFOLU	AFOLU: Livestock, Land, and Other Agriculture	20,071	(10,257)
IPPU	IPPU: Industrial Processes, and Product Use	24,524	39,884
Total GHG Emissions		**495,384**	**512,901**
Change from Baseline Year			**3.54%**
Total Per Capita GHG Emissions		4.44	4.48
Change from Baseline Year			**0.71%**

Data in the table above is depicted in Figure E-1.

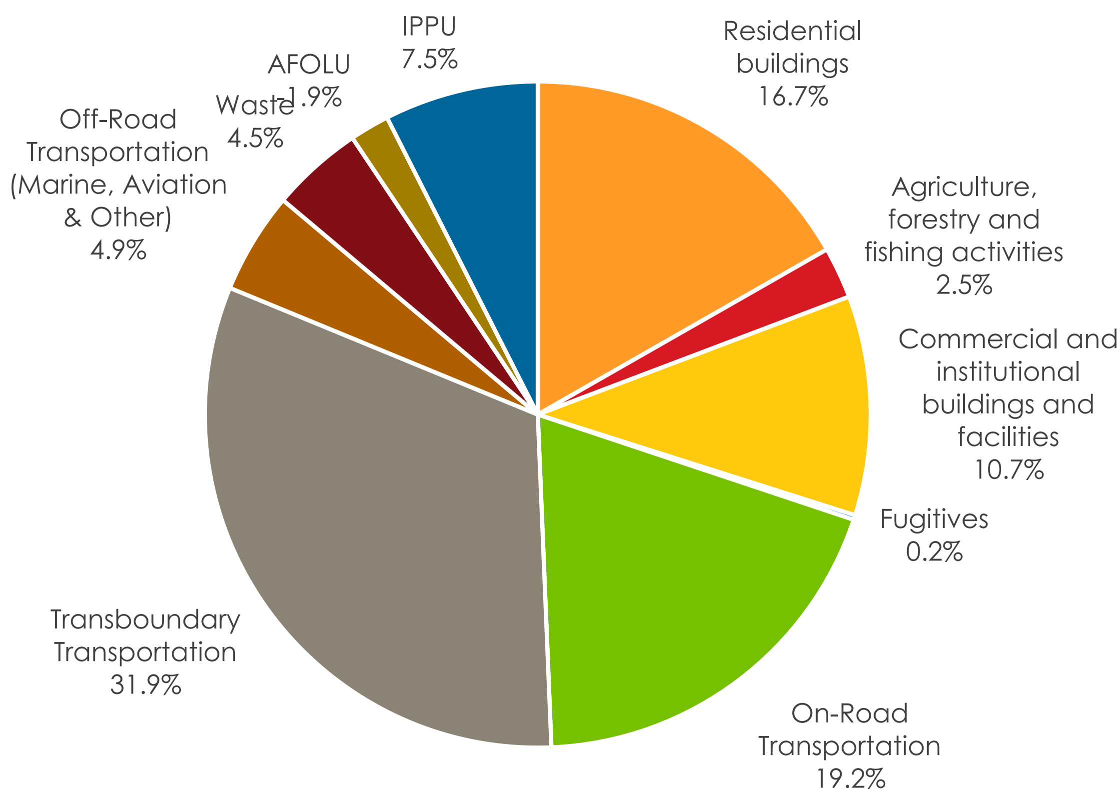

Figure E-1 Saanich BASIC+ GHG Emissions

Abbreviations

ACERT	Airport Carbon Emissions Reporting Tool
AFOLU	Agriculture, Forestry, and Other Land Use
C40	C40 Cities Climate Leadership Group
CH_4	Methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
VIA	Victoria International Airport
eMWh	megawatt hours equivalents
FCM	Federation of Canadian Municipalities
GDP	gross domestic product
GHG	greenhouse gas
GJ	Gigajoules
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GWP	global warming potentials
HDV	Heavy Duty Vehicle
HFC	Hydrofluorocarbons
ICAO	International Civil Aviation Organization
ICLEI	International Council for Local Environmental Initiatives
IE	included elsewhere
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and Product Use
ISO	International Organization for Standardization

kg	Kilograms
kW	Kilowatt
kWh	kilowatt hours
L	Litres
LDT	Light Duty Truck
LDV	Light Duty Vehicle
MWh	megawatt hours
N_2O	nitrous oxides
NE	not estimated
NIR	National Inventory Report
NF_3	Nitrogen Triflouride
NPRI	National Pollutant Release Inventory
NO	not occurring
ORVE	Off-Road Vehicle Equipment
PCP	Partnership for Climate Protection
PFC	Perfluorocarbons
SC	Other Scope 3
SF_6	sulfur hexafluoride
WIP	waste-in-place
WRI	World Resources Institute

Glossary

Air pollution	The presence of toxic chemicals or materials in the air, at levels that pose a human health risk.
Baseline	This is the reference or starting year to which targets and GHG emissions projections are based.
BASIC	An inventory reporting level that includes all Scope 1 sources except from energy generation, imported waste, IPPU, and AFOLU, as well as all Scope 2 sources (GPC, 2014).
BASIC+	An inventory reporting level that covers all Core (GPC BASIC) sources, plus Scope 1 AFOLU and IPPU, and Scope 3 in the Stationary Energy and Transportation Sectors (GPC, 2014).
Biogenic emissions	Emissions produced by living organisms or biological processes, but not fossilized or from fossil sources (GPC, 2014).
Carbon dioxide equivalent (CO_2e)	The amount of carbon dioxide (CO_2) emissions that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. The CO_2e emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for the given time horizon. For a mix of GHGs, it is obtained by summing the CO_2e emissions of each gas (IPCC 2014).
Climate change	Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014).
Emission	The release of GHGs into the atmosphere (GPC, 2014).
Emission factor(s)	A factor that converts activity data into GHG emissions data (GPC, 2014).
Flaring	The burning of natural gas that cannot be used.
Fossil fuels	A hydrocarbon deposit derived from the accumulated remains of ancient plants and animals which is used as an energy source.
Fugitive emission	Emissions that are released during extraction, transformation, and transportation of primary fossil fuels. These GHG emissions are not combusted for energy.

Geographic boundary	A geographic boundary that identifies the spatial dimensions of the inventory's assessment boundary. This geographic boundary defines the physical perimeter separating in-boundary emissions from out-of-boundary and transboundary emissions (GPC, 2014).
Gigajoule (GJ)	A gigajoule (GJ), one billion joules, is a measure of energy. One GJ is about the same energy as: • Natural gas for 3-4 days of household use • The electricity used by a typical house in 10 days
Global warming	A gradual increase in the Earth's temperature which is attributed to the greenhouse effect caused by the release of greenhouse gas (GHG) emissions into the atmosphere.
Global warming potential (GWP)	An index measuring the radiative forcing following an emission of a unit mass of a given substance, accumulated over a chosen time horizon, relative to that of the reference substance, carbon dioxide (CO_2). The GWP thus represents the combined effect of the differing times these substances remain in the atmosphere and their effectiveness in causing radiative forcing. The Kyoto Protocol is based on global warming potentials over a 100-year period (IPCC 2014).
Greenhouse gas (GHG)	GHGs are the seven gases covered by the UNFCCC: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3) (GPC, 2014).
GHG intensity	The annual rate to which GHG emissions are released in the atmosphere, relative to a specific intensity.
Gross domestic product (GDP)	An economic measure of all goods and services produced in an economy.
In-boundary	Occurring within the established geographic boundary (GPC, 2014).
Reporting year	The year for which emissions are reported (GPC, 2014).
Scope 1	Emissions that physically occur within a city.
Scope 2	Emissions that occur from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross City boundaries.
Scope 3	Emissions that occur outside a city but are driven by activities taking place within a city's boundaries.
Tonne of CO_2e	A tonne of greenhouse gases (GHGs) is the amount created when we consume: • 385 litres of gasoline (about 10 fill-ups) • $200 of natural gas (a month of winter heating) • Enough electricity for three homes for a year (38,000 kWh)

Transboundary GHG emissions	Emissions from sources that cross the geographic boundary (GPC, 2014).

1.0 INTRODUCTION

1.1 CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS

Global climate change resulting from emissions of carbon dioxide (CO_2) and other greenhouse gases (GHGs) is altering global climatic processes with far ranging impacts on human and natural systems. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), states the following consensus of scientific opinion about climate change and its causes and effects (IPCC, 2014):

- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Anthropogenic GHG emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in human-caused GHG concentrations.
- Continued emission of GHGs will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts for people and ecosystems.
- There is high agreement and much evidence that with current climate change mitigation policies and practices, global GHG emissions will increase over the next few decades.

1.2 CITIES AND GREENHOUSE GAS EMISSIONS

Cities are centers of communication, commerce, and culture. They are, however, also a significant and growing source of energy consumption and GHG emissions. On a global scale, cities are major players in GHG emissions: cities are responsible for more than 70% of global energy-related GHG emissions and thereby represent a significant opportunity for tackling climate change.

For a city to act on mitigating climate change and monitor its progress, it is crucial to have good quality GHG emissions data to build a GHG inventory. Such an inventory enables cities to understand the breakdown of their emissions and plan for effective climate action. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol) seeks to support exactly that, by giving cities the standards and tools that are needed to measure the emissions, build more effective emissions reduction strategies, set measurable and more ambitious emission reduction goals, and to track their progress more accurately and comprehensively.

Until recently there has been no internationally recognized way to measure city-level emissions. Inventory methods that cities have used to date around the globe vary significantly. This inconsistency has made comparisons between cities and over the years difficult. The GPC Protocol offers an internationally accepted, credible emissions accounting and reporting practice that will help cities to develop comparable GHG inventories.

1.3 PURPOSE OF THIS REPORT

The purpose of this document is to describe the quantification methodologies used by District to calculate its BASIC+ GHG emissions for the 2017 reporting year.

2.0 GLOBAL PROTOCOL FOR COMMUNITY (GPC) SCALE EMISSION INVENTORIES PROTOCOL

2.1 OVERVIEW

The GPC Protocol is the result of a collaborative effort between the GHG Protocol at the World Resources Institute (WRI), C40 Cities Climate Leadership Group (C40), and ICLEI—Local Governments for Sustainability (ICLEI). The GPC Protocol is recognized as one of the first set of standardized global rules for cities to measure and publicly report city-wide GHG emissions. It sets out requirements and provides guidance for calculating and reporting city-wide GHG emissions, consistent with the 2006 IPCC guidelines on how to estimate GHG emissions (IPCC, 2006). Specifically, the GPC Protocol seeks to:

- Help cities develop a comprehensive and robust GHG inventory to support climate action planning.
- Help cities establish a base year GHG emissions inventory, set GHG reduction targets, and track performance.
- Ensure consistent and transparent measurement and reporting of GHG emissions between cities, following internationally recognized GHG accounting and reporting principles.
- Enable city-wide GHG inventories to be aggregated at subnational and national levels.
- Demonstrate the important role that cities play in tackling climate change and facilitate insight through benchmarking—and aggregation—of comparable GHG data.

2.2 GPC PROTOCOL STRUCTURE

The GPC Protocol sets several assessment boundaries which identify the restrictions for gases, emission sources, geographic area, and time span covered by a GHG inventory:

- The GHG inventory is required to include all seven Kyoto Protocol GHGs occurring within the geographic boundary of a city. These include:
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
  - Hydrofluorocarbons (HFCs)
  - Perfluorocarbons (PFCs)
  - Sulfur hexafluoride (SF_6)
  - Nitrogen Triflouride (NF_3)
- The GHG emissions from city-wide activities must be organized and reporting under the following Sectors, based on the selected reporting level:
  - Stationary Energy
  - Transportation

- Waste
- Industrial Processes and Product Use (IPPU)
- Agriculture, Forestry, and Other Land Use (AFOLU)

The GPC Protocol also requires that a city define an inventory boundary, identifying the geographic area, time span, gases, and emission sources.

Under the GPC Protocol, a city has the option of reporting GHG emissions under three different levels:

- **GPC BASIC—**This level covers emissions Scopes 1 and 2, from stationary energy and transportation, as well as emissions Scopes 1 and 3 from waste. The BASIC level aligns with the Community Energy and Emissions Inventories (CEEI) that have been released in the past for local governments by the Province of BC.
- **GPC BASIC+—**This level covers the same scopes as BASIC and includes more in-depth and data dependent methodologies. Specifically, it expands the reporting scope to include emissions from Industrial Process and Product Use (IPPU), Agriculture, Forestry, and Other Land-Use (AFOLU), and transboundary transportation. The sources covered in BASIC+ also align with sources required for national reporting in IPCC guidelines.
- **GPC BASIC+ Scope 3 (SC)—** This inventory extends beyond the Expanded GHG inventory to include Other Scope 3 (SC) emissions such as GHG emissions from goods and services production and transportation.

Activities taking place within a city can generate GHG emissions that occur inside the District boundary as well as outside the District boundary. To distinguish between these, the GPC Protocol groups emissions into three categories based on where they occur: Scope 1, Scope 2, or Scope 3 emissions. The GPC Protocol distinguishes between emissions that physically occur within the District (Scope 1), from those that occur outside the District but are driven by activities taking place within the District's boundaries (Scope 3), from those that occur from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross city boundaries (Scope 2). Scope 1 emissions may also be termed "territorial" emissions, because they are produced solely within the territory defined by the geographic boundary (see Figure 1).

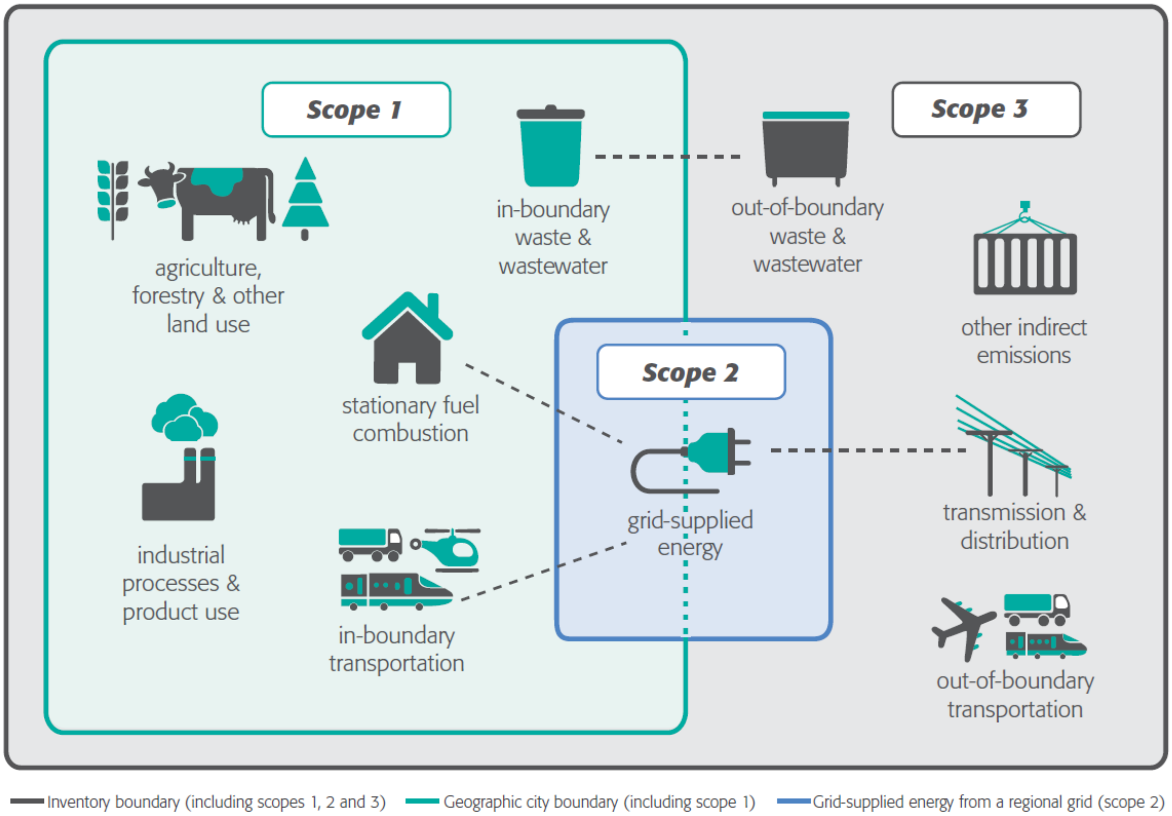

Figure 1 Sources and Boundaries of a City's GHG Emissions (GPC 2014)

2.3 GHG EMISSION CATEGORIES

As noted previously, the GPC Protocol requires that different emission sources be categorized into six main reporting Sectors. These high-level categories are described in more detail in Section 2.3.1 to Section 2.3.6. More information on how GHG emissions are captured within the GPC Protocol is available on the Greenhouse Gas Protocol website.[1]

2.3.1 Stationary Energy

Stationery energy sources are typically one of the largest contributors to a city's GHG emissions. In general, these emissions come from fuel combustion and fugitive emissions. They include the emissions from energy to heat and cool residential, commercial, and industrial buildings, as well as the activities that occur within these residences and facilities, such as off-road transportation emissions from construction equipment. Emissions associated with distribution losses from grid-

[1] http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

supplied electricity/steam/heating/cooling are also included, as are some fugitive emissions from sources such as coal piles, and natural gas distribution systems.

The Stationary Energy Sector includes the following Sub-Sectors:

- Residential buildings
- Commercial and institutional buildings and facilities
- Manufacturing industries and construction
- Energy industries
- Energy generation supplied to the grid*
- Agriculture, forestry, and fishing activities
- Non-specific sources
- Fugitive emissions from mining, processing, storage, and transportation of coal
- Fugitive emissions from oil and natural gas systems

*Emissions related with electricity generation activities occurring within a city's boundaries are to be reported; however, the GHG emissions from these sources are not included in the total GHG inventory to prevent double counting with other cities (GPC 2014). The rationale is that the power generated will be distributed into the electrical grid and also used by other cities to which they would be reporting on their portion of those GHG emissions.

Under the GPC Protocol, cities are to report off-road GHG emissions under the Off-road Transportation Sub-Sector if and only if the GHG emissions are occurring at transportation facilities (e.g., airports, harbors, bus terminals, train stations, etc.). Other off-road transportation GHG emissions that occur on industrial premises, construction sites, agriculture farms, forests, aquaculture farms, and military premises, etc., are to be reported under the most relevant Stationary Energy Sub-Sector (GPC, 2014). For example, GHG emissions from commercial building off-road construction equipment would be included in the Commercial and Institutional Buildings and Facilities Sub-Sector, whereas GHG emissions from residential lawn mowers would be reported under the Residential Buildings Sub-Sector.

2.3.2 Transportation

The GHGs released to the atmosphere to be reported in the Transportation Sector are those from combustion of fuels in journeys by on-road, railway, waterborne navigation, aviation, and off-road. GHG emissions are produced directly by the combustion of fuel, and indirectly using grid-supplied electricity. Unlike the Stationary Energy Sector, transit is mobile and can pose challenges in both accurately calculating GHG emissions and allocating them to a specific Sub-Sector. This is particularly true when it comes to transboundary transportation, which includes GHG emissions from trips that either start or finish within a city's boundaries (e.g., departing flight emissions from an airport outside the District boundaries) (GPC, 2014). Transboundary GHG emissions are only required for GPC BASIC+ GHG reporting.

The Transportation Sector includes the following Sub-Sectors:

- On-road
- Railways
- Waterborne
- Aviation
- Off-road

As noted previously, cities are to report off-road GHG emissions under the Off-road Transportation Sub-Sector if and only if the GHG emissions are occurring at transportation facilities (e.g., airports, harbors, bus terminals, train stations, etc.). For example, off-road railway maintenance support equipment GHG emissions are reported under the Off-Road Transportation Sub-Sector.

2.3.3 Waste

Cities produce GHG emissions that arise from activities related to the disposal and management of solid waste. Waste does not directly consume energy, but releases GHG emissions because of decomposition, burning, incineration, and other management methods.

The Waste Sector includes the following Sub-Sectors:

- Solid waste disposal
- Incineration and open burning
- Biological treatment of waste
- Wastewater treatment and discharge

Under the GPC Protocol, the Waste Sector includes all GHG emissions that result from the treatment or decomposition of waste regardless of the source of the waste (e.g., another city's waste in the District's landfill). However, the GHG emissions that are associated with waste from outside a City's boundary that is treated or decomposes within the District boundary are deemed to be "reporting only" emissions and do not contribute to the GHG inventory (GPC 2014).

Any GHG emissions that result from the combustion of waste or waste related gases to generate energy, such as a methane capture and energy generation system at a landfill, are reported under Stationary Energy Generation Supplied to the Grid Sub-Sector (GPC, 2014). Any waste related GHG emissions that are combusted but not related to energy generation are reported in the appropriate Waste Sub-Sector. Lastly, any waste GHG emissions that are released to the atmosphere are also captured in the appropriate Waste Sub-Sector.

2.3.4 Industrial Processes and Product Use (IPPU)

Emissions from this Sector are only required for BASIC+ GHG reporting under the GPC Protocol. This Sector encompasses GHG emissions produced from industrial processes that chemically or physically transform materials and using products by industry and end-consumers (e.g., refrigerants, foams, aerosol cans) (GPC, 2014).

The IPPU Sector includes the following Sub-Sectors:

- Industrial processes
- Product use

Any GHG emissions associated with energy use for industrial processes are not reported in the IPPU Sector; rather, they are reported under the appropriate Stationary Energy Sub-Sector.

2.3.5 Agriculture, Forestry, and Other Land Use (AFOLU)

Emissions from the AFOLU Sector are only required for BASIC+ GHG reporting. AFOLU GHG emissions are those that are captured or released because of land-management activities. These activities can range from the preservation of forested lands to the development of crop land. Specifically, this Sector includes GHG emissions from land-use change, manure management, livestock, and the direct and indirect release of nitrous oxides (N_2O) from soil management, rice cultivation, biomass burning, urea application, fertilizer, and manure application (GPC, 2014).

The AFOLU Sector is organized into the following Sub-Sectors:

- Livestock
- Land
- Aggregate sources and non-CO_2 emission sources on land

2.3.6 Other Scope 3 Emissions

Cities, by their size and connectivity, inevitably give rise to GHG emissions beyond their boundaries. The GPC Protocol already includes the following Scope 3 emissions in other Sectors:

- On-road, waterborne, and aviation transboundary transportation
- Transmission and distribution losses associated with grid-supplied energy
- Solid waste disposal
- Biological treatment of solid waste
- Wastewater treatment and discharge

Cities may voluntarily report on other Scope 3 emissions as they are estimated. In the case of the District, no other Scope 3 GHG emissions, other than those listed above, have been estimated for the purpose of this report. A Consumption Based Emissions Inventory was completed in 2018 for the 2015 reporting year and estimated other Scope 3 GHG emissions for Saanich (Saanich Ecocity Footprint Report, January 2018).

2.4 ACCOUNTING AND REPORTING PRINCIPLES

All GHG inventories following the GPC Protocol are required to meet GHG accounting principles. Specifically, these inventories should be relevant, consistent from year to year, accurate and transparent about methodologies, assumptions, and data sources. The transparency of inventories is fundamental to the success of replication and assessment of the inventory by interested parties.

The GHG inventories must also properly account for key energy and GHG emission sinks, sources, and reservoirs (SSR) that are occurring within municipal boundaries. The SSRs are a convenient way to identify and categorize all the GHG emissions to determine if they should be included or excluded from a GHG inventory. A "Source" is something that releases GHG emissions to the atmosphere, such as a diesel generator. A "Sink" is a process or item that removes GHG from the atmosphere, such as photosynthesis and tree growth. Finally, a "Reservoir" is a process or item with the capability to store or accumulate a GHG removed from the atmosphere by a GHG sink, such as a wetland or a peat bog. By assessing and reporting on the applicable SSRs, users of the GHG inventory can have confidence that the inventory is complete and representative of the types and quantities of the GHGs being released within city limits.

2.5 BASELINE AND REPORTING YEAR RECALCULATIONS

As cities grow and expand, significant changes to the GHG emissions profile of a community can alter materially thus making it difficult to meaningfully assess GHG emission trends and changes over time. The GPC Protocol has requirements on how to treat changes in a community's GHG profile—this is presented in Table 1.

Table 1 GPC Protocol Recalculation Thresholds

Threshold	Example Change	Recalculation Needed	No Recalculation Needed
Changes in the assessment boundary	A community is annexed in or removed from a city's administrative boundary	X	
	Change in protocol reporting method (e.g., from BASIC to BASIC+, addition of GHGs reported, etc.)	X	
	Shut down of a power plant		X
	Building a new cement factory		X
Changes in calculation	Change in calculation methodology for landfilled municipal solid waste (MSW)	X	

Threshold	Example Change	Recalculation Needed	No Recalculation Needed
methodology or improvements in data accuracy	Adoption of more accurate local emission factors, instead of a national average emission factors	X	
	Change in electricity emission factor due to energy efficiency improvement and growth of renewable energy utilization		X
Discovery of significant errors	Discovery of mistake in unit conversion in formula used	X	

2.6 DATA QUALITY

Data collection and the assessment of its quality is an integral component of compiling any GHG inventory. Like the IPCC, the GPC Protocol requires users to establish first whether a source exists, and then assess the data availability and quality. To support GHG reporting, the following notation keys are used.

- If the GHG sink, source or reservoir does not exist, a "NO" is used to indicate it is "not occurring". For example, in the District, there is no biomass burning and thus "NO" was reported.
- If the GHG sink, source or reservoir does occur in the District, and data is available, then the emissions are estimated. However, if the data is also included in another emissions source category or cannot be disaggregated, the notation key "IE" would be used to indicate "included elsewhere" to avoid double counting. For example, in the District, GHG emissions from stationary energy—agriculture is included in stationary energy—residential as the utility data provider does not disaggregate the energy use amongst these categories.
- When GHG emissions are occurring in the District, but data is not available, then the notation key "NE" would be used to indicate "not estimated".

For GHG data that does exist, in accordance with the GPC Protocol, an assessment of quality is also made on emission factors and GHG estimation methodologies deployed. The GPC Protocol data quality assessment notation keys are summarized in Table 2.

Table 2 GPC Protocol Data Quality Assessment Notation Keys

Data Quality	Activity Data	Emission Factor
High (H)	Detailed activity data	Site-specific emission factors
Medium (M)	Modeled activity data using robust assumptions	More general emission factors
Low (L)	Highly-modeled or uncertain activity data	Default emission factors

3.0 GHG ASSESSMENT BOUNDARIES

This section sets out the reporting boundaries of the District's GHG inventory.

3.1 SPATIAL BOUNDARIES

This GHG inventory is defined geographically by the District municipal boundaries, as shown in Figure 2.

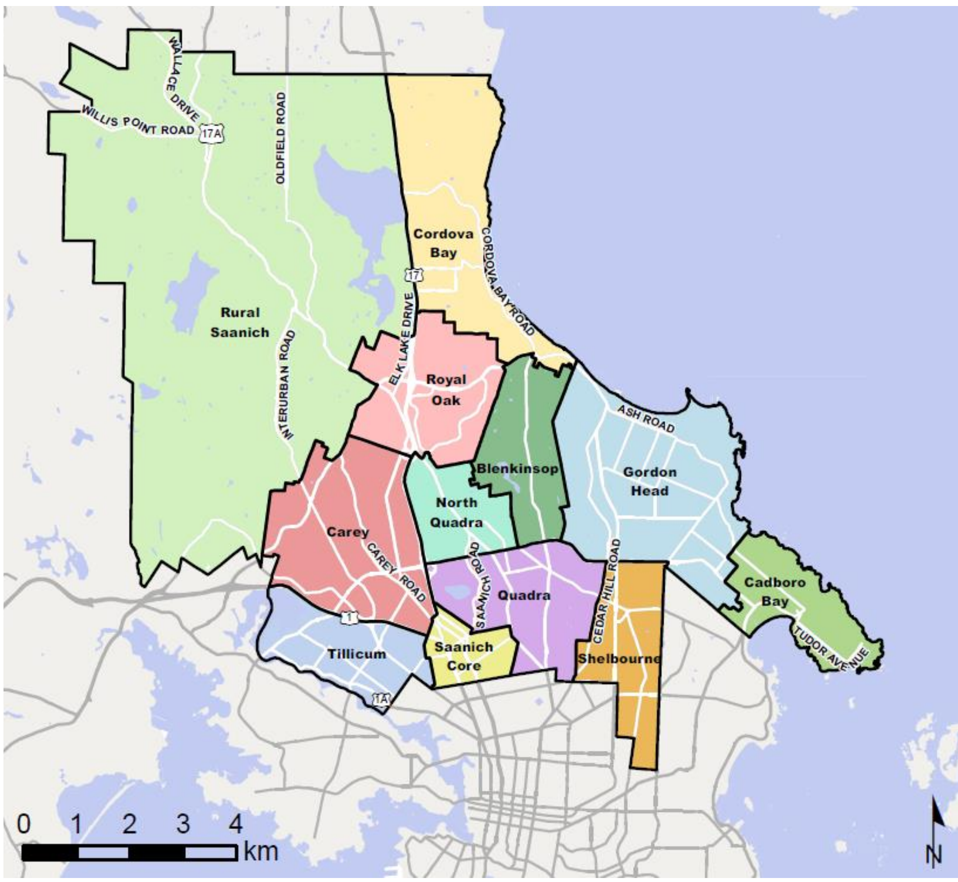

Figure 2 District of Saanich Municipal Boundary

Table 3 Inventory City Information for the District

Inventory Boundary	City Information
Name of City	District of Saanich
Country	Canada
Inventory Year	2017
Geographic Boundary	See Figure 2
Land Area (km^2)	107.16
Resident population	116,657
GDP (US$)	Unknown at time of reporting
Composition of Economy	Government
Climate	Temperate, warm summer

3.2 TEMPORAL BOUNDARIES

3.2.1 2007 Baseline

Federal and provincial initiatives and legislation have been implemented to support local governments in acting to advance energy efficiency, promote energy conservation, and reduce GHG emissions. The District has already been working to address sustainability and climate change through several initiatives over the past decade including the development of a Climate Action Plan in 2010 and the Climate Change Adaptation Plan in 2011. The Climate Action Plan established a baseline GHG emissions inventory in 2007 and committed to a corporate target of 50% GHG emission reductions by 2020 and a community target of 33% GHG emission reductions by 2020 from 2007 levels. Saanich is in the process of updating the Climate Plans and has recently committed to community-wide and corporate targets of reducing GHG emissions 80%, below 2007, by 2050, and has committed to becoming a community that operates on 100% renewable energy by 2050. The updated Climate Action Plan will measure the progress towards these targets using the GPC Basic+ inventory.

To maintain consistency with the current reporting year, and as required by the GPC Protocol, the District has updated its 2007 GHG baseline to be consistent with the GPC Protocol BASIC+ reporting level. Between the current reporting year and the 2007 baseline, there were no boundary changes (e.g., annexes) and thus no additional modifications were made. All methods and assumptions, adjusted for the 2007 reporting year, are the same.

Table 4 summaries the original 2007 baseline and the updated 2007 baseline. Like the reporting year (2017), the baseline also uses the same GWPs from the 4th IPCC report.

Table 4 Original And Updated BASIC+ Baseline

Aspect	Quantification Protocol	2007 GHG Baseline (tCO_2e)
Original Baseline	B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions	521,000
Updated Baseline	GPC Protocol BASIC+	495,384

3.2.2 2017 GHG Boundary

This inventory covers all GHG emissions for the 2017 reporting year. Where 2017 data was not available, the most recent year's data have been used, and the timescale noted accordingly. These are as follows:

- **Global Warming Potentials (GWP)**. The BC government is currently applying GWPs from the fourth IPCC report notwithstanding the fact that there are updated GWPs available in the fifth IPCC report. On this basis, the District is applying GWPs from the fourth IPCC report.
- **Emission Factors.** Environment and Climate Change Canada publishes emission factors annually in the National Inventory Report (NIR). Currently, these emission factors from the 2018 NIR are for the 2016 reporting year, and as such, any emission factors that are used in the 2017 reporting year have been carried forward from 2016 or have been recalibrated as necessary.
- **Stationary Energy: Residential, Commercial and Institutional Buildings.** Propane, and wood GHG emissions were estimated using linear regression methods. The data used in the estimate included historical propane and wood energy data published in the 2007, 2010 and 2012 CEEIs, and heating degree days (HDD) published by Environment Canada. Heating oil GHG emissions were estimated based on the number of known tanks, average heated floor areas and estimated average fuel volumes collected through onsite EnerGuide Rating System energy audits.
- **Stationary Energy: Fugitive Emissions.** Fortis BC, who provides the fugitive emission estimates from natural gas systems has not provided the 2017 data at the time of reporting. On this basis, the 2016 values are applied for the 2017 reporting year.
- **Transportation: On-Road.** The Insurance Corporation of BC (ICBC) has not been able to provide registered vehicle data post 2012. As such, 2012 CEEI screened data was used to estimate total number of registered vehicles using the change in Saanich's population between 2012 and 2017.
- **Transportation: Off-Road.** The off-road transportation emissions are based on the 1990–2018 NIR as prepared by Environment and Climate Change Canada. The 2016 BC reported off-road emissions in the NIR were prorated to the District on a per capita basis.
- **Transportation: Aviation**. 2017 GHG emissions were estimated using 2015 aircraft flight profiles, and the total number of aircraft movements reported in 2017.
- **Transportation: Waterborne.** BC Ferries has not yet published 2017 total diesel fuel values, and therefore the 2016 value was applied and pro-rated to the District on a per capita basis.

- **Waste: Solid Waste Disposal.** The 2016 fugitive GHG emissions from the Hartland Landfill were used for the reporting year as the 2017 data is not yet available.
- **IPPU: Product Use.** The product use emissions are based on the published 2016 values in the NIR as prepared by Environment and Climate Change Canada. These are pro-rated to the District on a per capita basis.
- **AFOLU**: **Livestock, and Aggregate Sources And Non-CO_2 Emission Sources On Land.** The total area of farm land for Canada and provinces is from the Statistics Canada Census of Agriculture and is from 2016. The 2016 data was used to estimate urea application, indirect and direct emissions from N_2O under the AFOLU Sector.

3.3 GHG EMISSION SOURCES AND SCOPES

The following table summarizes the District's GHG emissions by source and GHG emission scope.

Table 5 Summary of Emissions Scope and GPC Protocol Reporting Sector

GHG Emissions Scope	GPC Protocol Reporting Sector
Scope 1	The GHG emissions occurring from sources located within District limits: • Stationary fuel combustion: – Residential buildings – Agriculture, forestry, and fishing activities – Commercial and institutional buildings, and facilities – Fugitive emissions from oil and natural gas systems • Transportation: – On-road – Off-road • Industrial processes and product use (IPPU): – Product use • Agriculture, Forestry, and Other Land Use (AFOLU): – Livestock – Land – Aggregate sources and non-CO_2 emission sources on land
Scope 2	The GHG emissions occurring from using grid-supplied electricity, heating and/or cooling within the District boundary: • Stationary fuel combustion: – Residential buildings – Commercial and institutional buildings, and facilities • Transportation: – On-road
Scope 3	Other GHG emissions occurring outside of the District limits as a result of District activities: • Stationary Energy: – Transmission, Distribution, and Line Losses • Transportation: – On-road – Aviation – Waterborne

GHG Emissions Scope	GPC Protocol Reporting Sector
	– Off-road • Waste: – Solid waste disposal – Biological treatment of solid waste – Wastewater treatment and discharge

3.4 GHG REPORTING

Where relevant, the GPC Protocol recommends using methodologies that align with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The GHG inventory is required to include all seven Kyoto Protocol GHGs occurring within the geographic boundary of the District. These include:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)
- Nitrogen Triflouride (NF_3)

Each GHG listed above has a different global warming potential (GWP) due to its ability to absorb and re-emit infrared radiation. This chemical property is recognized by the GWP set out by the IPCC Fourth Assessment Report. A larger GWP value means the substance has a greater affinity to absorb and re-emit infrared radiation. The GWP of these GHGs are CO_2 = 1.0, CH_4 = 25, N_2O = 298 (IPCC, 2007).

Total GHG emissions are normally reported as CO_2e, whereby emissions of each of the GHGs are multiplied by their GWP and are reported as tonnes of CO_2e.

The GHG inventory results following the GPC Protocol reporting table format are presented in Appendix A. The GPC Protocol reporting format is presented in Table 6 below which also indicates the reporting level (BASIC / BASIC+) for each source.

Table 6 GPC Protocol Summary Table

GPC Protocol Reference Number	Reporting Level	Emissions Scope	GHG Emissions Source
I	**Stationary Energy Sources**		
I.1	**Residential Buildings**		
I.1.1	BASIC	1	Emissions from in-boundary fuel combustion
I.1.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.1.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.2	**Commercial and Institutional Buildings/Facilities**		
I.2.1	BASIC	1	Emissions from in-boundary fuel combustion
I.2.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.2.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.3	**Manufacturing Industry and Construction**		
I.3.1	BASIC	1	Emissions from in-boundary fuel combustion
I.3.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.3.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.4	**Energy Industries**		
I.4.1	BASIC	1	Emissions from in-boundary production of energy used in auxiliary operations
I.4.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.5	**Agriculture, Forestry, and Fishing Activities**		
I.5.1	BASIC	1	Emissions from in-boundary fuel combustion
I.5.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.5.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.7	**Fugitive Emissions from Mining, Processing, Storage, And Transportation of Coal**		
I.7.1	BASIC	1	In-boundary fugitive emissions
I.8	**Fugitive Emissions from Oil and Natural Gas Systems**		
I.8.1	BASIC	1	In-boundary fugitive emissions
II	**Transportation**		
II.1	**On-road Transportation**		
II.1.1	BASIC	1	Emissions from in-boundary transport
II.1.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.1.3	BASIC+	3	Emissions from transboundary journeys
II.2	**Railways**		
II.2.1	BASIC	1	Emissions from in-boundary transport
II.2.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.2.3	BASIC+	3	Emissions from transboundary journeys

Table 6 GPC Protocol Summary Table

GPC Protocol Reference Number	Reporting Level	Emissions Scope	GHG Emissions Source
II.3	**Water-borne Navigation**		
II.3.1	BASIC	1	Emissions from in-boundary transport
II.3.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.3.3	BASIC	3	Emissions from transboundary journeys
II.4	**Aviation**		
II.4.1	BASIC	1	Emissions from in-boundary transport
II.4.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.4.3	BASIC+	3	Emissions from transboundary journeys
II.5	**Off-road**		
II.5.1	BASIC	1	Emissions from in-boundary transport
II.5.2	BASIC	2	Emissions from consumption of grid-supplied energy
III	**Waste**		
III.1	**Solid Waste Disposal**		
III.1.1	BASIC	1	Emissions from waste generated and treated within the District
III.1.2	BASIC	3	Emissions from waste generated within but treated outside of the District
III.2	**Biological Treatment of Waste**		
III.2.1	BASIC	1	Emissions from waste generated and treated within the District
III.2.2	BASIC	3	Emissions from waste generated within but treated outside of the District
III.3	**Incineration and Open Burning**		
III.3.1	BASIC	1	Emissions from waste generated and treated within the District
III.3.2	BASIC	3	Emissions from waste generated within but treated outside of the District
III.4	**Wastewater Treatment and Discharge**		
III.4.1	BASIC	1	Emissions from wastewater generated and treated within the District
III.4.2	BASIC	3	Emissions from wastewater generated within but treated outside of the District
IV	**Industrial Processes and Product Use (IPPU)**		
IV.1	BASIC+	1	In-boundary emissions from industrial processes
IV.2	BASIC+	1	In-boundary emissions from product use
V	**Agriculture, Forestry, and Other Land Use (AFOLU)**		
V.1	BASIC+	1	In-boundary emissions from livestock
V.1	BASIC+	1	In-boundary emissions from land

Table 6 GPC Protocol Summary Table

GPC Protocol Reference Number	Reporting Level	Emissions Scope	GHG Emissions Source
V.1	BASIC+	1	In-boundary emissions from other agriculture
VI	**Other Scope 3 Emissions**		
VI.1	BASIC / BASIC+	3	Other indirect emissions

4.0 GHG METHODOLOGIES BY SOURCE CATEGORY

The following sections describe the reporting source category, assumptions, activity data applied, and quantification methodology. The results of the analysis is presented in Section 5.0.

4.1 STATIONARY ENERGY

4.1.1 Overview

Stationery energy sources are one of the largest contributors to the District's community GHG emissions. For the District, the Stationary Energy Sector encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - Residential buildings
  - Commercial and institutional buildings, and facilities
  - Agriculture, forestry, and fishing activities
  - Fugitive emissions from oil and natural gas systems
- Scope 2 Emissions:
  - Emissions from the consumption of grid-supplied electricity, steam, heating, and cooling.
- Scope 3 Emissions:
  - Transmission and distribution losses of electricity, steam, heating, and cooling.

4.1.2 Scope 2: Market Based Method

As per the GPC Protocol, cities can report on Scope 2 GHG emissions using either the market-based, or the location-based method. A market-based method utilizes utility-specific grid emission intensity factor, whereas a location-based method uses a regional or Provincial average grid emission intensity factor. At present, the fuel mix and GHG emissions data relative to the District's energy consumption is not available. As such, the District is defaulting to the BC Provincial electricity grid consumption intensity factor of 0.0117 tCO_2e/MWh reported by Environment and Climate Change Canada in the 2018 National Inventory Report (NIR).

4.1.3 Activity Data

BC Hydro and Fortis BC provided the electricity and natural gas consumption data in MWh and GJ, respectively. Based on the utility provider descriptions of the data, each is categorized as follows:

- Residential Buildings based on the BC Hydro and Fortis BC descriptor: "Residential"
- Commercial and Institutional Buildings/Facilities based on BC Hydro and Fortis BC descriptors: "Commercial", and "CSMI"

The Province developed residential propane and wood GHG energy use estimates from the number and type of dwellings and the average dwelling consumption by authority and region from the BC Hydro Conservation Potential Review. This data was used to estimate the reporting year GHG emissions.

To calculate heating oil use, the District provided a heating oil tracking database, which contained addresses, size of tank, and whether a tank had been removed or not based on permitting data and additional assumptions. Heating oil GHG emissions were estimated based on the number of known tanks, average heated floor areas and estimated average fuel volumes collected by the District through EnerGuide Rating System energy audits.

Fortis BC, who provides the fugitive emission estimates from natural gas systems has not provided the 2017 data at the time of reporting. On this basis, the 2016 values are applied for the 2017 reporting year.

Applicable, off-road GHG emissions included in the Stationary Energy Sector are based on the 1990–2018 NIR as prepared by Environment and Climate Change Canada. These emissions are pro-rated to the District on a per capita basis.

4.1.4 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2017 GHG emissions:

- It is assumed that the all data provided to the District from third party providers is accurate.
- As the energy utilities do not provide energy data on agriculture, forestry, and fishing activities, it is assumed that this activity data (mainly agricultural) is lumped into the residential category. The notation key for "Included Elsewhere" has been used to indicate that the data for this category is included in District-wide electricity and natural gas consumption.
- BC Hydro estimates that the combined energy losses- transmission and distribution- to be approximately 7.5%. This value was used to calculate the Scope 3 emissions for each Stationary Energy Sub-Sector. It is assumed that this is accurate.
- It is assumed that the 2016 natural gas fugitive emissions will be similar in nature to the 2017 emissions.
- The off-road transportation emissions included in the Stationary Energy Sector are based on the 1990–2018 NIR as prepared by Environment and Climate Change Canada. This is deemed to be the best available data.
- Propane and wood GHG emissions were estimated using linear regression methods. The data used in the estimate included historical propane and wood energy data published in the 2007, 2010 and 2012 CEEIs, and heating degree days (HDD) published by Environment Canada.

- Heating oil GHG emissions were estimated based on the number of known tanks, average heated floor areas and estimated average fuel volumes collected by the District through energy audits.

4.1.5 Calculation Methodology

The Province of BC developed residential propane and wood GHG energy use estimates for the 2007, 2010 and 2012 reporting years, using the number and type of dwellings and the average dwelling consumption by authority and region contained in the BC Hydro Conservation Potential Review. Actual electricity and natural gas consumption values were subtracted from the total energy use, with the remainder assumed to be heating oil, propane, and wood. To estimate 2017 propane and wood energy use, historical 2007, 2010 and 2012 values and the number of heating degree days (HDD) were linearly regressed to estimate future propane and wood energy use using reporting year HDD values. This resulted in the development of the following equations:

- Propane (L) = 31853.29 + 21.86097 * HDD
- Wood (GJ) = 84682.76 + 58.11731 * HDD

To calculate total heating oil use for the reporting year, the District provided BC Assessment building data, zoning GIS data, and a database of addresses with heating oil tanks. This data was used to estimate the total oil heated square footage for the District. The District also provided an estimated annual average residential heating oil fuel consumption volume (3,170 Liters) and the average square footage (ft^2) of a residential home using heating oil (2,271.27 ft^2) which was used to develop a residential heating oil energy intensity factor (0.05415 GJ/ft^2). As there was no heating oil energy consumption data available for commercial or institutional buildings, the difference between the 2014 average BC residential and commercial energy intensity values in the NRCAN Comprehensive Energy Use Database (14.97%) was applied to the District based residential value to derive a commercial and institutional building heating oil energy intensity value (0.06226 GJ/ft^2). This data is presented in Table 7.

Table 7 Heating Oil Units, Estimated Heating Oil Floor Space, and Heating Oil Energy Intensity Values

Stationary Energy Sub-Sector	Number of Heating Oil Units	Total Estimated Square Feet Heated (ft^2)	Energy Intensity (GJ/ft^2)
Residential buildings	4,571	8,193,609.66	0.054152986
Commercial and institutional buildings and facilities	52	326,066.82	0.062262033

To calculate GHG emissions from electricity, natural gas, heating oil, propane, and wood, the total net annual energy values (where applicable, less transmission, distribution, and line losses of 7.5%) were multiplied by applicable emissions factors. These values were then multiplied by the pollutant's GWP to give total CO_2e emissions in tonnes.

These quantification methods are captured as follows:

$$Energy_{\text{Stationary Energy – Electricity}} = Electricity * (1 – Line\ Loss\ (\%)$$

$$Energy_{\text{Stationary Energy – Transmission, Distribution, and line Losses}} = Electricity * Line\ Loss\ (\%)$$

$$Emissions_{\text{Stationary Energy – Electricity}} = Fuel\ (MWh) * EF_{tCO2e}$$

$$Emissions_{\text{Stationary Energy – Natural Gas}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

$$Emissions_{\text{Stationary Energy – Propane}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

$$Emissions_{\text{Stationary Energy – Wood}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

$$Emissions_{\text{Stationary Energy – Heating Oil}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

The emission factors used in the 2017 reporting year are from the 2018 NIR. These are summarized in Table 8.

Table 8 Stationary Energy GHG Emission Factors

Emission Factor	Units	CO_2	CH_4	N_2O	tCO_2e
Electricity (BC Hydro)	Tonne / MWh				0.0117000
Natural Gas	Tonne /m3	0.0019260	0.0000000	0.0000000	0.0019374
Propane	Tonne /L	0.0015150	0.0000000	0.0000001	0.0015478
Heating Oil	Tonne /GJ	0.0681200	0.0000007	0.0000008	0.0683759
Wood	Tonne / kg	-	0.0000150	0.0000002	0.0004227

Fortis BC estimated the GHG emissions based upon the number of customer meter sets at the municipality relative to the total region. This factor was then applied to the total vented and fugitive emission to determine the fugitive and vented related emission for the District.

4.2 TRANSPORTATION

4.2.1 Overview

Transportation covers all GHG emissions from combustion of fuels in journeys by on-road, railways, waterborne navigation, aviation, and off-road. GHG emissions are produced directly by the combustion of fuel, and indirectly using grid-supplied electricity. For the District, the Transportation Sector encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:

  - On-road
  - Off-road
- Scope 2 Emissions:
  - Emissions from the consumption of grid-supplied electricity.
- Scope 3 Emissions:
  - On-road
  - Waterborne
  - Aviation
  - Off-road

4.2.2 Activity Data

The Province of BC provided the 2012 vehicle registration data which was used in conjunction with reported population counts from the Province of BC to estimate the District's 2017 vehicle registration count.

BC Transit provided total diesel fuel use for the reporting year. Published GHG Emissions Per Service Hour, and BC Transit Service Hours for the reporting year were pulled from published BC Transit documents. This data was used to estimate GHG emissions from busses serving the District.

The 2017 CRD Origin Destination Travel Survey was used to estimate on-road in-boundary and transboundary split for registered vehicles and busses. It was also used to reduce the VKT values for personal vehicles. The CRD Origin Destination Travel Survey is based on travel patterns observed in the Capital Regional District (CRD) level.

Aviation GHG emissions from the Victoria International Airport were estimated using 2015 aircraft flight profiles, and the total number of aircraft movements reported in 2017. These data sets were provided by the Victoria International Airport.

Victoria harbour aviation GHG emissions were estimated using Victoria harbor aircraft movement statistics, estimated taxi times, and estimated fuel use for the DHC-6 Twin Otter type of plane. This data was taken from Statistics Canada.

Marine watercraft GHG emissions were estimated using published BC Ferries fuel statistics (fuel use and passengers).

Off-road transportation emissions are based on the 2018 NIR as prepared by Environment and Climate Change Canada.

4.2.3 Assumptions and Disclosures

The following assumptions were made in the calculation of the Transportation Sector GHG emissions:

- The Insurance Corporation of BC (ICBC) has not been able to provide registered vehicle data. As such, 2012 CEEI screened data was used to estimate total number of registered vehicles using the change in Saanich's population between 2012 and 2017. This method is not likely to result in a material overstatement (>10%) in the total GHG inventory but it is likely to have a misstatement between vehicle fuel use categories.
- Electric vehicle adoption has increased in the District to which the number of registered vehicles was based on the CRD Origin Destination Travel Survey (0.8% of gasoline powered vehicles). Using this data, the reporting year, 433 vehicles were removed from the gasoline powered light duty vehicles (LDV) category and placed in the electric vehicle category.
- Vehicle fuel consumption rates were taken from the document entitled "2017 Community Energy and Emissions Inventory (CEEI) Initiative - Technical Methods and Guidance Document 2007-2012 Reports". These fuel consumption rates are estimated and will vary on a vehicle by vehicle basis.
- The estimated Vehicle Kilometer Travelled (VKT) data, by vehicle type, was taken from the "2009 Canadian Vehicle Survey" completed by Natural Resources Canada. This was a Canada wide study and likely over-estimates the VKT, and thus GHG emissions for the District. The VKT values for LDVs were reduced by 3% based on the findings of the CRD Origin Destination Travel Survey.
- BC Transit tracks total diesel use, but not total gasoline use. Gasoline use from busses was estimated by calculating total GHG emissions using reported GHG emissions per service hour factor, and BC transit service hours, and by backing out GHG emissions from diesel. This is likely to result in an over estimate of gasoline use as the GHG emissions per service hour factor also include natural gas and electricity use.
- Gasoline and diesel GHG emissions from BC Transit busses are pro-rated to the District based on the District's proportion of population in the CRD. A more accurate estimation method would be to prorate fuel use based on total bus service kilometers in the District. However, this data is not available, and thus the method applied provides the best estimate at the time of reporting.
- It is assumed that the 2015 aircraft flight profiles at the Victoria International Airport are representative of the 2017 reporting year.
- Statistics Canada stopped collecting Victoria Harbor aircraft movement data in 2016. To estimate 2017 marine aviation GHG emissions, the 2016 Victoria data was applied and adjusted using the change in aircraft traffic between the 2016 and 2017 reporting years at the Victoria International Airport. It is assumed that the activity at both airports would be correlated, but not causational.
- The Aviation GHG emissions are prorated based on the total Saanich population relative to the CRD population.
- BC Ferries has not published its 2017 fuel statistics, and thus 2016 fuel statistics were applied to estimate Marine GHG emissions. These GHG emissions are prorated based on the total Saanich population relative to the total BC Ferries passenger population for the reporting year.

- It is known that a percentage of Saanich residents own and operate personal watercraft to which these emissions would be attributable to the District. However, there is no publicly available registry tracking personal watercraft and thus this emissions source was not estimated.
- No Railway GHG emissions are occurring in the District and the notation key "Not Occurring" was used.
- The off-road transportation emissions are based on the 2018 NIR as prepared by Environment and Climate Change Canada. This is deemed to be the best available data.

4.2.4 Calculation Methodology

4.2.4.1 On-Road

The GPC Protocol identifies several methods for determining on-road emissions. The vehicle kilometers travelled (VKT) methodology was utilized to estimate the GHG emissions from on-road transportation (Scope 1) and transboundary transportation (Scope 3). The VKT uses the number and type of vehicles registered in a geopolitical boundary, the estimated fuel consumption rate of individual vehicles, and an estimate of the annual vehicle kilometres traveled (VKT) by various vehicle classes. ICBC provided the number of registered vehicles in the District by style, and by fuel type for 2012. To estimate the split between on-road in-boundary and transboundary traffic, data from the 2017 CRD Origin Destination Survey was applied. The results of the survey as it applies to Saanich is presented in Table 9.

Table 9 On-Road In-Boundary/Transboundary Split

Aspect	By Vehicle	By Transit
Estimated proportion of inner District travel	38%	29%
Estimated proportion of transboundary travel	62%	71%

To quantify on-road and transboundary GHG emissions, the following steps were taken:

1. Screen ICBC dataset to pull out only Saanich registered vehicles, and to eliminate duplicates. Any changes to a vehicle's insurance policy in a reporting year can create another occurrence of the vehicle in the same dataset. As such, if a vehicle record included a change of location during a quarter, the vehicle was assigned to the location where it was insured for the greatest portion of the quarter. The objective of this screening is to increase the accuracy of the GHG estimate.
2. Identify vehicle characteristics using Identification Number (VIN) and other data fields to assign a fuel class and vehicle sector. As the 2012 data was used, the Province completed steps 1 and 2 of this process.
3. Grow the 2012 vehicle population based on the change between the District's 2012 and 2017 population.

4. Assign estimated NRCan vehicle fuel consumption rates, and modified VKT from the Transport Canada study to each of the registered vehicle classes (Table 10). The estimated vehicle fuel consumption rates were taken from the document entitled "2017 Community Energy and Emissions Inventory (CEEI) Initiative - Technical Methods and Guidance Document 2007-2012 Reports". The estimated VKT data, by vehicle type, was taken from the 2009 Canadian Vehicle Survey completed by Natural Resources Canada and modified based on the CRD Origin Destination Survey.
5. Calculate the estimated number of electric vehicles based on the CRD Origin Destination Survey, and remove these from the LDV gasoline population.
6. Estimate total fuel use by vehicle classification (Table 11).
7. Summate and allocate estimated fuel use, by vehicle class using the applicable in-boundary and transboundary split (Table 12).
8. Estimate total gasoline use from BC Transit busses. Gasoline use from busses was estimated by calculating total GHG emissions using reported GHG emissions per service hour factor (28.8 kg CO2e/hr), and BC transit service hours (941,000), and by backing out GHG emissions from diesel (based on 8,383,509 Liters of diesel). It is estimated that BC Transit used 1,783,692 liters of gasoline in the reporting year.
9. Pro-rate the gasoline and diesel fuel use from busses to the District based on the total District population relative to the total CRD population.
10. Summate and allocate estimated bus fuel use using the applicable in-boundary and transboundary split (Table 12).

Table 10 Estimated VKT And Fuel Efficiencies by Vehicle Class

Vehicle Classification	Estimated VKT / Year	Estimated Fuel Efficiency (L/100 km)
Diesel-HDV	67,213.2	33.7
Diesel-LDT	14,672.6	10.8
Diesel-LDV	10,836.5	7.2
Diesel-ORVE	3,500.0	8.9
E10-LDT	16,005.0	13.2
E10-LDV	11,503.6	8.9
Electric	10,691.0	12.8
Gasoline-HDV	42,575.2	32.9
Gasoline-HYBRID-LDT	16,005.0	10.0
Gasoline-HYBRID-LDV	13,968.0	7.0
Gasoline-LDT	10,742.5	12.3
Gasoline-LDV	37,225.6	9.2
Gasoline-ORVE	3,500.0	8.9
Motorcycle - Non catalyst	4,053.9	5.7
Natural Gas-LDT	12,583.4	8.3
Natural Gas-LDV	63,057.8	5.4

Vehicle Classification	Estimated VKT / Year	Estimated Fuel Efficiency (L/100 km)
Natural Gas-ORVE	3,500.0	8.9
Propane-HDV	56,587.8	34.5
Propane-LDT	13,090.2	12.6
Propane-LDV	37,516.1	8.2
Diesel-HDV	67,213.2	33.7
Diesel-LDT	14,672.6	10.8
Diesel-LDV	10,836.5	7.2

Table 11 Total Registered Vehicles & Estimated Fuel Use For Reporting Year

Vehicle Classification	Total Registered Vehicles	Total Estimated Fuel Use	Units
Electric	433	481,318	Kilowatt Hours (kWh)
Diesel-LDV	773	613,525	Liters (L)
Diesel-LDT	1,812	3,055,617	Liters (L)
Diesel-HDV	289	10,249,952	Liters (L)
Gasoline-HDV	749	2,380,452	Liters (L)
Gasoline-LDT	11,213	13,826,842	Liters (L)
Gasoline-LDV	42,179	41,074,465	Liters (L)
Gasoline-HYBRID-LDV	19	18,182	Liters (L)
Gasoline-HYBRID-LDT	18,810	30,105,056	Liters (L)
E10-LDV	2	1,934	Liters (L)
E10-LDT			Liters (L)
E10-HDV			Liters (L)
Propane-LDV	34	54,387	Liters (L)
Propane-LDT	90	118,271	Liters (L)
Propane-HDV	5	11,940	Liters (L)
Natural Gas-LDV			kilograms (kg)
Natural Gas-LDT	2	1,571	kilograms (kg)
Natural Gas-HDV			kilograms (kg)
Motorcycle - Non-catalyst	2,246	518,986	Liters (L)
Motorcycle - Electric			Liters (L)
Gasoline-ORVE			Liters (L)
Diesel-ORVE			Liters (L)
Natural Gas-ORVE			kilograms (kg)
Total	**78,656**	**N/A**	**N/A**

Table 12 Reporting Year Fuel Use Allocation by Vehicle Classification and Split

Vehicle Class	In-Boundary	Transboundary	Total	Units
Electric	182,419	298,898	481,318	Kilowatt Hours (kWh)
Diesel-LDV	232,526	380,999	613,525	Liters (L)
Diesel-LDT	1,158,079	1,897,538	3,055,617	Liters (L)
Diesel-HDV	3,664,168	6,585,784	10,249,952	Liters (L)
Diesel-ORVE				Liters (L)
Gasoline-LDV	15,567,222	25,507,243	41,074,465	Liters (L)
Gasoline-LDT	5,240,373	8,586,469	13,826,842	Liters (L)
Gasoline-HDV	855,264	1,525,189	2,380,452	Liters (L)
Gasoline-HYBRID-LDV	6,891	11,291	18,182	Liters (L)
Gasoline-HYBRID-LDT	11,409,816	18,695,240	30,105,056	Liters (L)
Gasoline-ORVE				Liters (L)
E10-LDV	733	1,201	1,934	Liters (L)
E10-LDT				Liters (L)
E10-HDV				Liters (L)
Propane-LDV	20,613	33,774	54,387	Liters (L)
Propane-LDT	44,825	73,446	118,271	Liters (L)
Propane-HDV	4,525	7,415	11,940	Liters (L)
Natural Gas-LDV				kilograms (kg)
Natural Gas-LDT	595	976	1,571	kilograms (kg)
Natural Gas-HDV				kilograms (kg)
Natural Gas-ORVE				kilograms (kg)
Motorcycle - Non-catalyst	196,696	322,290	518,986	Liters (L)

Once the fuels were allocated amongst the vehicle classes and sectors, the GHG emissions were calculated accordingly. The GHG quantification method is captured, for all fuel types, is as follows:

$$\textbf{Emissions}_{\text{On-road}} = \text{In-Boundary Split \%} * ((\text{Vol. Fuel} * EF_{CO2}) + (\text{Vol. Fuel} * EF_{CH4} * GWP_{CH4}) + (\text{Vol. Fuel} * EF_{N2O} * GWP_{N2O}))$$

$$\textbf{Emissions}_{\text{Transboundary}} = \text{Transboundary Split \%} * ((\text{Vol. Fuel} * EF_{CO2}) + (\text{Vol. Fuel} * EF_{CH4} * GWP_{CH4}) + (\text{Vol. Fuel} * EF_{N2O} * GWP_{N2O}))$$

The emission factors used in the reporting year GHG inventory are from the 2018 NIR. These are summarized in Table 13.

Table 13 Vehicle GHG Emission Factors

Vehicle Class	Units	CO_2	CH_4	N_2O	tCO_2e
Electricity (BC Hydro)	tonne / MWh	-	-	-	0.0117000
Diesel-LDV	tonne / L	0.0026810	0.0000001	0.0000002	0.0027478
Diesel-LDT	tonne / L	0.0026810	0.0000001	0.0000002	0.0027483
Diesel-HDV	tonne / L	0.0026810	0.0000001	0.0000002	0.0027287
Diesel-ORVE	tonne / L	0.0026810	0.0000001	0.0000000	0.0026894
Gasoline-LDV	tonne / L	0.0023070	0.0000001	0.0000002	0.0023761
Gasoline-LDT	tonne / L	0.0023070	0.0000001	0.0000002	0.0023761
Gasoline-HDV	tonne / L	0.0023070	0.0000001	0.0000002	0.0023683
Gasoline-HYBRID-LDV	tonne / L	0.0027380	0.0000130	0.0000005	0.0032031
Gasoline-HYBRID-LDT	tonne / L	0.0027380	0.0000130	0.0000005	0.0032031
Gasoline-ORVE	tonne / L	0.0027380	0.0000130	0.0000005	0.0032031
E10-LDV	tonne / L	0.0020763	0.0000001	0.0000002	0.0021454
E10-LDT	tonne / L	0.0020763	0.0000001	0.0000002	0.0021454
E10-HDV	tonne / L	0.0020763	0.0000001	0.0000002	0.0021376
Propane-LDV	tonne / L	0.0015150	0.0000006	0.0000000	0.0015393
Propane-LDT	tonne / L	0.0015150	0.0000006	0.0000000	0.0015393
Propane-HDV	tonne / L	0.0015150	0.0000006	0.0000000	0.0015393
Natural Gas-LDV	tonne / kg	0.0000019	0.0090000	0.0000600	0.2428819
Natural Gas-LDT	tonne / kg	0.0000019	0.0090000	0.0000600	0.2428819
Natural Gas-HDV	tonne / kg	0.0000019	0.0090000	0.0000600	0.2428819
Natural Gas-ORVE	tonne / kg	0.0000019	0.0090000	0.0000600	0.2428819
Motorcycle - Non-catalyst	tonne / L	0.0023160	0.0000023	0.0000000	0.0023878

4.2.4.2 Aviation: Victoria International Airport

The Victoria International Airport (VIA) estimated its 2015 airplane GHG emissions following the ACI ACERT standard. This includes GHG emissions from aircraft and GHG emissions from auxiliary power units (APU). APUs provides electricity to the aircraft prior to the engine start up. Within the ACERT model, it is assumed all aircraft have APUs and the duration of the APU operation (of five minutes per aircraft) was generically applied to every landing take-off (LTO) cycles. It should also be noted that the EIA has quantified aircraft GHG emissions from planes up to 3,000 ft. to avoid double counting with other airports and cities. This is consistent with the ACERT standard.

The District's 2017 aviation emissions estimate is based on the 2015 aircraft flight profiles, which included the estimated landing and takeoff (LTO) and auxiliary power unit (APU) fuel use, and an estimated percentage allocation of total flights to the following aviation class groupings (Table 14). The total reported flight movements for the reporting year (123,078) provided by the VIA and the aircraft flight profile data was used to estimate aviation GHG emissions for the reporting year at the VIA.

Table 14 Aircraft Type, Estimated Percentage of Total Reported Movements, And Estimated Fuel Use

Aviation Class	Aircraft Type	Estimated Percentage of Annual Movements	Estimated LTO Fuel Use by Aircraft Type (kg)	Estimated APU Fuel Use by Aircraft Type (kg/min)
Jet	Large: 2-aisle, long-haul	0.01%	1,853	4.00
	Medium: 2-aisle, medium-haul	0.01%	1,321	4.00
	Small: 1-aisle, small/medium haul	7.95%	565	1.78
	Regional: 1-aisle, short-haul	0.01%	315	1.78
	Business: 2-eng business jets	0.01%	41	1.78
Turboprop	Turboprop (all engines)	22.29%	46	1.78
Piston	Piston (all engines)	66.30%	41	0.00
Helicopter	Helicopter small (1 engine/turbine)	1.72%	13	0.00
	Helicopter large (2 engine/turbine)	1.72%	8	0.00

Calculating fuel use for each aviation class applied the following equation:

Fuel Use $_{\text{Per Aviation Class}}$ = *Number of Aircraft Movements * (LTO Fuel Use + (APU Fuel Use * 15 minutes))*

Lastly, as the VIA does not collect origin traveler data, aviation emissions were prorated based on the District population relative to the CRD population. These were reported in the Scope 3 category as the VIA is located outside of the District boundaries.

The GHG quantification method, that was applied to each aviation class, is as follows:

Emissions $_{\text{Per Aviation Class}}$ = *(District Population / CRD Population) * ((Vol. Fuel * Aviation Class* EF_{CO2}*) + (Vol. Fuel * Aviation Class* EF_{CH4} * GWP_{CH4}*) + (Vol. Fuel * Aviation Class* EF_{N2O} * GWP_{N2O}*))*

The ACERT GHG calculator used by the VIA utilized emission factors from the 2018 NIR. Actual airplane emission factors are from the International Civil Aviation Organization (ICAO) GHG database. These are summarized in Table 15.

Table 15 Aviation GHG Emission Factors

Airplane Type	Units	CO_2	CH_4	N_2O	tCO_2e
Jet	tCO_2e/kg fuel	0.0031380	0.0000001	0.0000003	0.0032254
Turbo Propeller	tCO_2e/kg fuel	0.0031380	0.0000001	0.0000003	0.0032254
Piston	tCO_2e/kg fuel	0.0032530	0.0000031	0.0000003	0.0034154
Helicopter	tCO_2e/kg fuel	0.0031380	0.0000001	0.0000003	0.0032254

4.2.4.3 Aviation: Victoria Harbour

Victoria harbor aviation emissions were estimated using 2016 NAV Canada airplane movement statistics, estimated taxi times, and estimated fuel use for the DHC-6 Twin Otter type of plane (Table 14).

Table 16 Aircraft Type, Estimated Percentage of Total Reported Movements, And Estimated Fuel Use

Aviation Class	Aircraft Type	Estimated Percentage of Annual Movements	Estimated LTO Fuel Use by Aircraft Type (kg)	Estimated APU Fuel Use by Aircraft Type (kg/min)
Turboprop	DHC-6 Twin Otter	100%	56	0.00

Statistics Canada stopped collecting Victoria Harbor aircraft movement data in 2016. To estimate 2017 Victoria harbor aviation GHG emissions, the 2016 Victoria data was applied and adjusted using the change in aircraft traffic between the 2016 and 2017 reporting years at the Victoria International Airport. This amounted to an increase of 9.95% between 2016 and 2017 which resulted in an estimated 30,456 movements.

Calculating aviation fuel use in the Victoria harbor for applied the following equation:

***Fuel Use** Per Aviation Class* = *Number of Aircraft Movements * (LTO Fuel Use + (APU Fuel Use * 15 minutes))*

Lastly, as there is no publicly available origin traveler data for harbor flights, the aviation GHG emissions were prorated based on the District population relative to the CRD population. These were reported in the Scope 3 category as the Victoria Harbor is located outside of the District boundaries.

The GHG quantification method is as follows:

Emissions $_{\textit{Per Aviation Class}}$ **=** *(District Population / CRD Population) * ((Vol. Fuel * Aviation Class* EF_{CO2}*) + (Vol. Fuel * Aviation Class* EF_{CH4} * GWP_{CH4}*) + (Vol. Fuel * Aviation Class* EF_{N2O} * GWP_{N2O}*))*

The airplane emission factors are from the International Civil Aviation Organization (ICAO) GHG database. These are summarized in Table 17.

Table 17 Marine Aviation GHG Emission Factors

Airplane Type	Units	CO_2	CH_4	N_2O	tCO_2e
Turbo Propeller	tCO_2e/kg fuel	0.0031380	0.0000001	0.0000003	0.0032254

4.2.4.4 Waterborne Transportation: BC Ferries

Marine waterborne transportation emissions encompass GHG emissions from the use of the BC Ferries. As noted previously, no personal watercraft GHG emissions were estimated based on a lack of available data. GHG emissions from BC Ferries are estimated using total reported fuel use 115,400,000 liters of diesel for the 2016 reporting year (as 2017 is not yet available), and a provincially derived GHG emissions factor (Table 18).

Table 18 BC Ferries GHG Emission Factors

Aspect	Units	CO_2	CH_4	N_2O	tCO_2e
Ferry	tCO_2e / L	0.0025820	0.0000002	0.0000011	0.0029136

As BC Ferries operate outside of the District's boundary, the GHG emissions were allocated to Scope 3 based on the proportion of the District population relative to the total reported passengers travelling on BC ferries for the reporting year (21 million).

4.2.4.5 Off-Road

Currently, there is limited data available on off-road GHG emissions. As such, a GHG emissions per capita estimate for each off-road category was developed using Provincial emissions data from the 2018 NIR, and BC's population from Statistics Canada. To develop each off-road factor, the total BC GHG emissions for each reporting category was divided by the BC population for the NIR reporting year (2016). Each derived per-capita value was applied to the current reporting year District population (2017) to estimate off-road GHG emissions.

The NIR currently reports the following off-road emissions:

- Total BC off-road agriculture and forestry GHG emissions
- Total BC off-road commercial and institutional GHG emissions

- Total BC off-road manufacturing, mining, and construction GHG emissions
- Total BC off-road residential GHG emissions
- Total BC other off-road GHG emissions

Other than other off-road GHG emissions, which is reported in the Off-Road Transportation Sub-Sector, the remaining off-road GHG emissions are reported in the Stationary Energy Sector as required by the GPC Protocol.

The GHG quantification method is presented below:

***Emissions** $_{\text{Off-Road Transportation Category}}$ = (NIR Off-Road GHG Emissions $_{BC}$ / NIR Population $_{BC}$) * Current Reporting Year Population $_{Saanich}$*

4.3 WASTE

Cities produce GHG emissions because of the disposal and management of solid waste, incineration and open burning of waste, the biological treatment of waste, and through wastewater treatment and discharge. Waste does not directly consume energy, but releases GHG emissions because of decomposition, burning, incineration, and other management methods.

For the District, the Waste Sector encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 3: Emissions:
  - Solid waste disposal
  - Biological treatment of waste
  - Wastewater treatment and discharge

GHG emissions from incineration and open burning are occurring, but have not been estimated, and thus the notation key for “Not Estimated” has been used to indicate this.

4.3.1 Activity Data

The CRD provided landfill and GHG related data for the Hartland landfill, the estimated proportion of District solid waste, total CRD wastewater volumes and annual biological oxygen demand (BOD) average of the wastewater for both the Macaulay and Clover Outfalls for the reporting year, and a baseline/forecast wastewater study estimating each of the CRD local governments proportion of wastewater.

Some GHG emissions from incineration and open burning are occurring in the District, but cannot readily be estimated, and thus the notation key for "Not Estimated" has been used to indicate this.

4.3.2 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2017 GHG emissions:

- To quantify GHG emissions from the Hartland Landfill, the CRD utilized the waste-in-place method which is accepted under the GPC Protocol. The Waste-in-place (WIP) assigns landfill emissions based on total waste deposited during that year. It counts GHGs emitted that year, regardless of when the waste was disposed. GHG emissions from the Hartland Landfill for the reporting year are allocated based upon the percentage of District waste, relative to total waste received at to the Hartland Landfill. Using this allocation method, the District may over, or underestimate associated solid waste GHG emissions as the current year landfill GHG emissions are based upon cumulative waste over time, and the District may have contributed more waste in past years than the current year (and vice versa).
- The estimated 2017 fugitive emissions at the Hartland Landfill were not available, and thus the 2016 value was applied.
- Composting GHG emissions are estimated based on the total tonnage reported by the District. This is likely to be an underestimate of GHG emissions as the District does not have a mechanism in place to track how much organic waste is being collected by third party waste haulers at commercial and multi-unit residential facilities.
- Wastewater is not currently treated. Rather, wastewater is sent to one of two outfalls: Macaulay and Clover. As such, IPCC wastewater methane (CH_4) producing capacity and methane correction default factors were used. These factors used are for untreated wastewater being deposited into deep or moving waters. It is likely that ocean sequesters more CH_4 than is estimated.
- Wastewater allocation volumes to the District are taken from the 2015 Report "Capital Regional District Core Area Liquid Waste Management Plan - Wastewater Treatment System Feasibility and Costing Analysis. Technical Memorandum #1". It is assumed that these volumes are reasonably estimated for the 2017 reporting year. It was also assumed that the proportion of District wastewater is the same in the baseline.

4.3.3 Calculation Methodology

4.3.3.1 Solid Waste

The Hartland Landfill serves most of the CRD. There is a landfill gas (LFG) collection and destruction system at the Hartland Landfill to which the LFG is either combusted in a flare, or in an engine to generate electricity which is exported to the grid. This information was provided by the CRD and is a reporting item only.

The GHG emissions estimates have been generated using the waste-in-place (WIP) method which is accepted under the GPC Protocol. The WIP assigns landfill emissions based on emissions during that year. It counts GHGs emitted that year, regardless of when the waste was disposed. The District's proportion of landfill GHG emissions for the reporting year are based on the recorded allocation of District waste delivered, relative to the total regional waste delivered. In 2017, this amounted to 25,578 tons or 19.1%.

As the Hartland Landfill is inside the District's city limits, the GHG emissions were assigned to the solid waste Scope 1 category. The District's proportion of stationary energy GHG emissions are assumed to all be flared and thus are reported in solid waste scope 1 as well.

The GHG quantification methods are captured as follows:

$$Emissions_{\text{Solid Waste}} = Percent_{\text{District Waste}} * Hartland\ Landfill\ Fugitive_{CH4} * GWP_{CH4}$$

4.3.3.2 Biological Treatment of Solid Waste

The District collects and diverts all organic waste from entering the landfill – in 2017, the District estimates that 20,713,900 kg of organic waste was diverted from the landfill. It is assumed that the current treatment method is an anaerobic method.

The composting emission factors used in the estimation of GHG emissions from the biological treatment of solid waste is from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5, Chapter 4: Biological Treatment of Solid Waste) (Table 19).

Table 19 Composting Emission Factor

Emission Factor	Units	CO_2	CH_4	N_2O	tCO_2e
Composting	t / kg waste		0.0000010	-	0.0000250

As the treatment facility is outside of the District city limits, the GHG emissions were assigned to the Scope 3 category. To quantify GHG emissions from the biological treatment of solid waste, the following GHG quantification methods are deployed:

$$Emissions_{\text{Organic Waste}} = Waste_{\text{Total}} * EF_{CH4} * GWP_{CH4}$$

4.3.3.3 Wastewater Treatment And Discharge

Wastewater is not currently treated on Vancouver Island. Rather, wastewater is sent to one of two ocean-based outfalls: Macaulay and Clover. Wastewater allocation volumes to the District are taken from the 2015 Report "Capital Regional District Core Area Liquid Waste Management Plan - Wastewater Treatment System Feasibility and Costing Analysis. Technical Memorandum #1". It is assumed that the volumes proportioned to the District are reasonably estimated for the 2017 reporting year. It was also assumed that the proportion of District wastewater is the same in the baseline. For the reporting year, it was assumed that 39% of the District's wastewater volumes are sent to the Macaulay outfall, and that 19% of the District's wastewater is sent to the Clover outfall. The CRD provided the 2017 wastewater volumes (m^3), and annual biological oxygen demand (BOD) average of the wastewater (mg/L) for both the Macaulay and Clover Outfalls. Total wastewater volumes and BOD were used to calculate the total BOD in kg as summarized in Table 20 for the 2017 reporting year.

Table 20 Wastewater Volumes and BOD Values

Aspect	Volume (m^3)	BOD (mg/L)	BOD (kg)
Macaulay Outfall	16,447,764	286	4,704,061
Clover Outfall	16,490,311	254	4,188,539

IPCC default wastewater methane (CH_4) producing capacity (0.6 kg CH_4/kg BOD) and methane correction factor (MCF) (0.1 – unit less) were used to estimate CH_4 from the wastewater. These factors used are for untreated wastewater being deposited into deep or moving waters. It is likely that ocean sequesters more CH_4 than what has been estimated.

To estimate N_2O from the wastewater, the Total Kjeldal Nitrogen (TKN) sampled values (mg/L) from the wastewater study was used in conjunction with the total wastewater volumes to calculate the total TKN in kg as summarized in Table 20 for the 2017 reporting year.

Table 21 Wastewater Volumes and TKN Values

Aspect	Volume (m^3)	TKN (mg/L)	TKN (kg)
Macaulay Outfall	16,447,764	54.4	894,758
Clover Outfall	16,490,311	40.0	659,612

The IPCC default conversion value of 0.01 kg N_2O-N/kg sewage-N was used to estimate N_2O from the wastewater.

To quantify GHG emissions from the wastewater treatment, the following GHG quantification method is deployed:

$$Emissions_{Wastewater\ CH4} = ((Percent_{District\ Wastewater} * Wastewater_{m^3} * (BOD_{ml/L} / 1000) * (0.06_{kg\ CH4/kg\ BOD} * 0.01)) / 1000) * GWP_{CH4}$$

$$Emissions_{Wastewater\ N2O} = ((Percent_{District\ Wastewater} * Wastewater_{m^3} * (TKN_{ml/L} / 1000) * 0.01_{kg\ N2O\text{-}N/kg\ sewage\text{-}N}) / 1000) * GWP_{N2O}$$

4.4 INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)

4.4.1 Overview

Emissions from the IPPU Sector are only required for BASIC+ GHG reporting under the GPC Protocol. This Sector encompasses GHG emissions produced from industrial processes that chemically or physically transform materials and using products by industry and end-consumers (e.g., refrigerants, foams, and aerosol cans) (GPC, 2014).

For the District, the IPPU encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - Product use

No GHG emissions from Industrial Processes are occurring and thus the notation key for "Not Occurring" has been used to indicate this.

4.4.2 Activity Data

As there is limited data available on Product Use GHG emissions, the GHG Emissions estimate was derived on a per capita basis using the NIR 2018 GHG data and Statistics Canada population data for the reporting year.

4.4.3 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2017 GHG emissions:

- The product use emissions are based on the 2018 NIR product use GHG emissions as prepared by Environment and Climate Change Canada.
- The NIR uses the Tier 1 methodology to estimate these emissions and thus uncertainty around their accuracy remains quite high.

4.4.4 Calculation Methodology

4.4.4.1 Product Use Emissions

For the 2017 reporting year, only the emissions estimated were production and consumption of halocarbons, SF_6 and NF_3 were estimated for the Province. To estimate product use GHG emissions for the District, a per capita estimate was developed using the Provincial emissions data from the 2018 NIR, and BC's NIR reporting year (2016) population from Statistics Canada. This value was applied to the 2017 reporting year District population for the reporting year to estimate the total product use emissions for the District.

The GHG quantification method is presented below:

$$\textbf{Emissions}_{\textbf{Product Use}} = (\textit{NIR Product Use GHG Emissions}_{BC} \,/\, \textit{NIR Population}_{BC}) * \textit{Current Reporting Year Population}_{District}$$

4.5 AGRICULTURE, FORESTRY, AND OTHER LAND USE (AFOLU)

4.5.1 Overview

The AFOLU Sector includes emissions from livestock, land-use, and all other agricultural activities occurring within a city's boundaries. For the District, the AFOLU encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - Livestock
  - Land
  - Emissions from Aggregate Sources and Non-CO2 Emission Sources on Land

4.5.2 Activity Data

The District used remotely sensed imagery to estimate land-cover change. This data included building metadata from Saanich, and 2007-2011 land use data prepared by the Habitat Acquisition Trust (HAT), both of which are publicly available for use.

Livestock, aggregate sources and non-CO_2 emissions sources on land were estimated using the Agriculture and Agri-Food Canada (AAFC) Holos GHG emissions model (V3.1), and 2016 Statistics Canada Agriculture Census Data.

4.5.3 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2017 GHG emissions:

- It is assumed that the Agriculture and Agri-Food Canada (AAFC) Holos model provides reasonable estimates of GHG emissions.
- It is conservatively assumed that all cropland applies urea on agricultural lands.
- The following assumptions are made in the land-use change emissions category:
  - For land uses that result in the complete conversion of natural capital to settlements, or other, the total loss of natural capital is reported as the sink as it is assumed to no longer exist (this includes soil).

- Following IPCC guidance, below-ground biomass is assumed to remain constant after a disturbance when the conversion is from one ecosystem class to another. This is consistent with the treatment of GHG emissions in the NIR.
- For land uses that were not converted (colored in red in Table 24), only the applicable sequestration factor was applied. For lands that were converted, the change in land use is accounted for by taking the converted land-class emissions storage factor and dividing by 20 (years) to account for the time it takes to re-accumulate the capital after the land use change occurs. The rationale is that it is not conservative to use the land use emission factor (storage, not annual sequestration) for the newly converted land as the emission factor is based on "established" land. Therefore, for instances where land use changes, the IPCC requires dividing the emission factor by 20 years.
- Land-use emissions estimates do not account for harvested wood products (HWP), which may have been generated with the deforestation of forested areas. Not accounting for HWP results in a more conservative estimate of GHG emissions.
- There are no active peat extraction wetlands within the District.

4.5.4 Calculation Methodology

4.5.4.1 Livestock

Livestock GHG emissions were estimated using the Agriculture and Agri-Food Canada (AAFC) Holos GHG emissions model (V3.1) using 2016 Statistics Canada Agriculture Census Data. For the 2017 reporting year, the following data (Table 22) was entered in the Holos GHG emissions model with Vancouver Island being identified as the ecodistrict (for the purposes of identifying soil type and precipitation).

Table 22 Agriculture and Agri-Food Canada (AAFC) Holos GHG Emissions Model Data Inputs For The Reporting Year

Data Point	Total	Units
Heifers For Beef Herd Replacement	103	Number of Animals
Cattle And Calves	1,300	Number of Animals
Sheep And Lambs	701	Number of Animals
Pigs	99	Number of Animals
Hens And Chickens	8,412	Number of Birds
Turkeys	26	Number of Birds
Other Poultry	409	Number of Birds
Other Livestock (Horses, Ponies, Goats, Llamas, Rabbits)	500	Number of Animals
Land in Wheat	13	Hectares
Land in Spring Wheat (Excluding Durum)	13	Hectares
Land Producing Fruits, Berries And Nuts	86	Hectares
Summerfallow Lands	2	Hectares

Data Point	Total	Units
Land in Crops (Excluding Christmas Tree Farms)	945	Hectares

Using the above information, the Holos Model estimated:

- CH_4 emissions from enteric fermentation
- CH_4 emissions from manure management
- Livestock direct N_20 GHG emissions

4.5.4.2 Land Use

Remotely sensed imagery was used to estimate land-cover changes during the 2011-2017 period. Using the remotely sensed imagery, which included building metadata from Saanich, and 2007-2011 land use data prepared by the Habitat Acquisition Trust (HAT), an annual average land-use change between land classes (e.g. cropland forestland, etc.) was determined and applied to BC-based emission factors to estimate GHG emissions resulting from changes between land-uses for the reporting year.

To align with the IPCC land classification definitions (as required by the GPC Protocol), the following HAT data categories were re-assigned to the most appropriate IPCC land class. This is summarized in Table 23 below.

Table 23 Hierarchal Land-Cover Classification of HAT Forest and Land Cover Mapping and its Relation to IPCC Land Use Category

Primary Class	Land Class	HAT Forest and Land Cover Mapping	GHGE Land use
Vegetated Landscape (VEG)	Modified (MOD)	Agricultural fields	Cropland
	Naturally Wooded(NAW)	Tree	Forest
	Wetland (WET)	Riparian Tree	Wetland
		Riparian Herb	Wetland
	Naturally Non-Wooded (NNW)	Grass	Grassland
		Herb	Grassland
Non-Vegetated(NVE)	Natural (NAT)	Shadow	Other
		Ocean	Other
		Lake	Other
		Pond	Other
		River	Other
		Sand/Gravel Shoreline	Other
		Bedrock Shoreline	Other
		Exposed Soil	Other

Primary Class	Land Class	HAT Forest and Land Cover Mapping	GHGE Land use
		Exposed Bedrock	Other
	Developed(DEV)	Dock	Settlement
		Pavement/Building	Settlement

The analysis resulted in the following land use change table where the bottom total (in orange) represents the total land in hectares (ha) for each class as of the 2017 reporting year, and the right outermost column total (in green) represents the total land in hectares (ha) for each class as of the 2011 reporting year. The data within the table (white cells) represents the total change in land use between 2011 and 2017. For example, 4.8 hectares (ha) of cropland was converted to settlements between 2011 and 2017.

Table 24 2011–2017 Land-use Change Vector Table (Hectares)

Category	Cropland	Forestland	Grassland	Other	Settlements	Wetlands	Total
Cropland	916.5				4.8		921.3
Forestland		4,483.5			23.5		4,507.0
Grassland			1,907.4		13.5		1,920.9
Other				533.1	1.0		534.2
Settlements					2,556.9		2,556.9
Other					0.4	275.7	276.1
Total	916.5	4,483.5	1,907.4	533.1	2,600.1	275.7	-

Using the data in the land-use matrix table above, an annual average change in hectares' value for each conversion type (where applicable) was determined. Once the land use change values were determined for the reporting year, BC-based and IPCC emission factors were applied to estimate the GHG emissions from land use (Table 25). The treatment ranged for three different scenarios:

- For land uses that were not converted (colored in red in Table 24), only the applicable sequestration factor was applied.
- For lands that were converted from one class to another (e.g. forestland converted to settlements), the change in land use was accounted for by taking the converted land-class emissions storage factor and dividing by 20 to account for the time it takes to re-accumulate the capital after the land use change occurs. The 20-year factor is applied under guidance from the IPCC.
- For land uses that result in the complete conversion of natural capital to settlements, or other, the total loss of natural capital is reported as the sink as it is assumed to no longer exist (this includes soil).

Table 25 Land-Use Change Emission Factors

Sector	Emission Factor	Units	Source / Notes
Forestland	556.33	tonnes / ha	Coastal Douglas-fir uproot and decay emission factor developed by Caroline Dymond (Forests, Lands, and Natural Resource Operations), using deforestation data, for Vancouver Island (2013). https://www.for.gov.bc.ca/hfd/pubs/Docs/Srs/Srs06.pdf
Cropland	239.80	tonnes / ha	David Suzuki Foundation - http://www.davidsuzuki.org/publications/DSF_Peace_natcap_web_July_29%20copy.pdf
Grassland	205.70	tonnes / ha	David Suzuki Foundation - http://www.davidsuzuki.org/publications/DSF_Peace_natcap_web_July_29%20copy.pdf. Treed wetlands were assumed (this is a more conservative estimate than shrubbed wetlands).
Wetlands	471.50	tonnes / ha	David Suzuki Foundation - http://www.davidsuzuki.org/publications/DSF_Peace_natcap_web_July_29%20copy.pdf. Perennial cropland/pasture was assumed.
Settlements	0.00	tonnes / ha	No land use sink assumed.
Other	0.00	tonnes / ha	No land use sink assumed.
Forestland	0.66	tonnes / ha / year	2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 4 - Agriculture, Forestry, and Other Land Use - Chapter 4: Forests
Cropland	9.79	tonnes / ha / year	2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 4 - Agriculture, Forestry, and Other Land Use - Chapter 5: Grasslands
Grassland	8.05	tonnes / ha / year	2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 4 - Agriculture, Forestry, and Other Land Use - Chapter 7: Wetlands
Wetlands	6.50	tonnes / ha / year	2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 4 - Agriculture, Forestry, and Other Land Use - Chapter 5: Croplands
Settlements	0.00	tonnes / ha / year	No land use sink assumed.
Other	0.00	tonnes / ha / year	No land use sink assumed.

The GHG quantification methods for land use change is presented below:

$$Emissions_{Lands\ Not\ Converted} = Land\ Type_{ha} * EF_{Sequestration\ Original\ Land\text{-}Use}$$

$$Emissions_{\text{Lands Converted to Forestland, Cropland, or Grassland, excluding Wetlands}} = (Land\ Type_{ha} * (EF_{\text{Storage Original Land-Use}} - EF_{\text{Storage New Land-Use}}) / 20_{Years})) + (Land\ Type_{ha} * EF_{\text{Sequestration New Land-Use}})$$

$$Emissions_{\text{Wetlands Converted to Forestland, Cropland, or Grassland}} = (-) * (Land\ Type_{ha} * (EF_{\text{Storage Original Land-Use}} - EF_{\text{Storage New Land-Use}}) / 20_{Years})) + (Land\ Type_{ha} * EF_{\text{Sequestration New Land-Use}})$$

$$Emissions_{\text{Lands Converted to Settlement or Other}} = (-) * Land\ Type_{ha} * EF_{\text{Storage Original Land-Use}}$$

4.5.4.3 Emissions from Aggregate Sources and Non-CO_2 Emission Sources on Land

Emissions from Aggregate Sources and Non-CO_2 Emission Sources on Land includes direct N_2O emissions from agricultural soil management and indirect N_2O emissions from applied nitrogen. Using the same inputs in Table 22, GHG emissions are estimated using the Holos model, which provided the GHG emissions estimates for:

- Direct N_2O from managed soils (e.g. crops direct)
- Indirect N_2O from managed soils

The Holos model does not estimate GHG emissions from urea application. To calculate GHG emissions from urea application, the calculated total crop land in hectares – 916.5 ha for the reporting year – was applied against an IPCC GHG emissions factor of 0.20 tCO_2e / ha. This emission factor is also applied in the 2018 NIR.

The GHG quantification method is presented below:

$$Emissions_{\text{Urea Application}} = Cropland_{ha} * 0.66\ tCO_2e / ha$$

5.0 2017 GHG REPORTING YEAR RESULTS

5.1 OVERVIEW

This section presents the 2017 reporting year GHG emissions for the District. The following table classifies each of the GPC Protocol GHG emission categories by scope and reporting level. Note that these are cumulative.

Table 26 District of Saanich 2017 GHG Emissions by GPC Reporting Method

GHG Emissions Scope	BASIC Reporting Level	BASIC+ Reporting Level
Scope 1	• Emissions from in boundary fuel combustion • In boundary fugitive emissions • Emissions from in boundary transport • Emissions from solid waste	Everything in the box at left, plus in-boundary emissions from: • Industrial process and product use • Livestock • Land use • Emissions from Aggregate Sources and Non-CO_2 Emission Sources on Land
Scope 2	• Emissions from consumption of grid-supplied energy	• Emissions from consumption of grid-supplied energy
Scope 3	• Emissions from composting and wastewater generated within but treated outside of the District	Everything in the box at left, plus: • Transmission, distribution, and line losses from grid-supplied energy • Emissions from transboundary journeys
Outside of Reporting Scopes & GPC Protocol	• Upstream fuel emission extraction, processing, and transport • Food and drink imports • Construction materials (imports) • Other supply chain emissions • Vehicle fuel exports	

5.2 SUMMARY

Total BASIC, and BASIC+ emissions for the District for the 2017 reporting year are presented in the Figure 3 below.

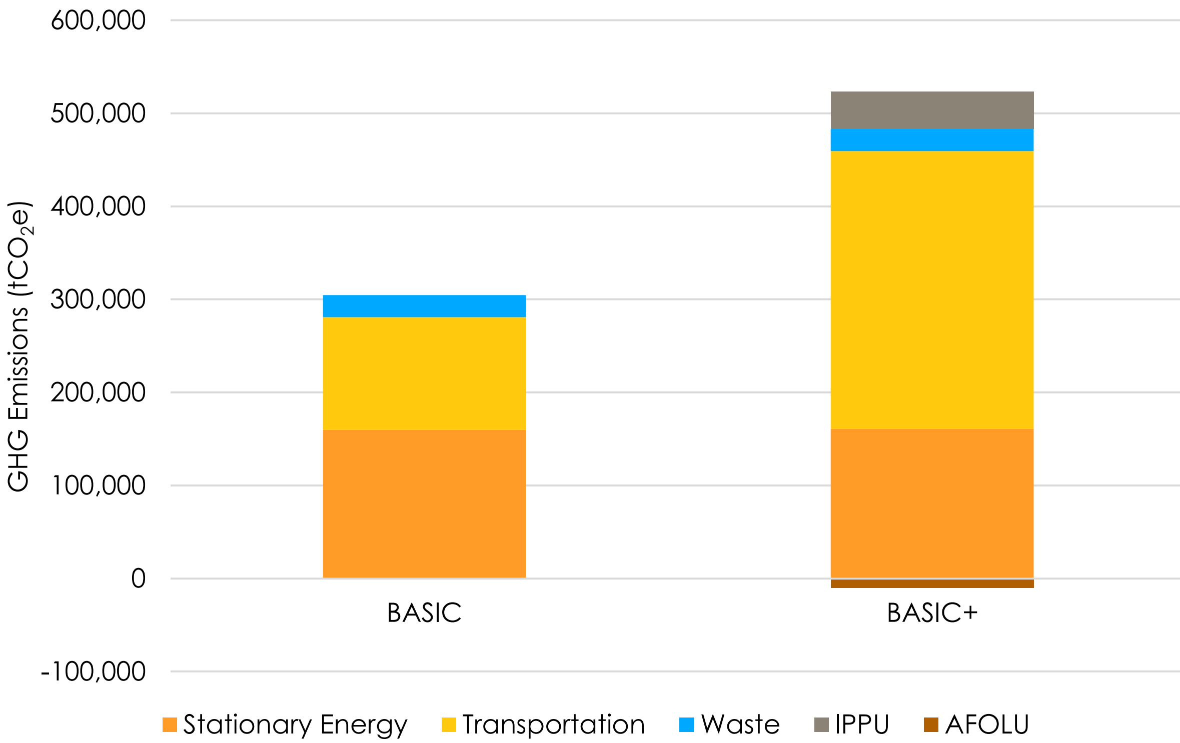

Figure 3 2017 GHG Emissions Summary by GPC Reporting Level

Emission by reporting level are presented in the Table 27 below which shows a difference in emissions under the GPC Protocol's BASIC, and BASIC+ reporting levels. This is due to the inclusion of additional sources in BASIC+ which are very significant for almost any growing city. These additional emissions include transboundary emissions, industrial and product use emissions, and emissions from land-use change. Under the GPC Protocol, emissions included within each higher reporting level are cumulative from lower levels.

Table 27 Breakdown of Saanich's 2017 GHG Emissions in GPC Reporting Format

GHG Emissions Source (by Sector)		Total GHGs (metric tonnes CO_2e)					
		Scope 1	Scope 2	Scope 3	BASIC	BASIC+	BASIC+ S3
Stationary Energy	Energy use (all emissions except I.4.4)	149,846	9,991	810	159,837	160,647	160,647
	Energy generation supplied to the grid (I.4.4)	7,147					
Transportation	(all II emissions)	121,070	6	177,738	121,075	298,814	298,814
Waste	Waste generated in the District (III.X.1 and III.X.2)	14,477		9,342	23,819	23,819	23,819
	Waste generated outside city (III.X.3)	61,462					
IPPU	(all IV emissions)	39,884				39,884	39,884
AFOLU	(all V emissions)	-10,257				-10,257	-10,257
Other Scope 3 (S3)	(all VI emissions)						0
TOTAL		**383,629**	**9,997**	**187,890**	**304,731**	**512,906**	**512,906**

NOTES:
Notation Keys: IE = Included Elsewhere; NE = Not Estimated; NO = Not Occurring.
Cells in green are required for BASIC reporting
Cells in green and blue are required for BASIC+ reporting
Cells in purple are for disclosure purposes only but are not included in the summary totals as required by the GPC Protocol.
Cells in orange are not required for BASIC or BASIC+ reporting

Table 28 presents the breakdown of the District's BASIC+ GHG emissions by Sector and Sub-Sector. The full GPC Protocol disclosure table has been included in Appendix A.

Table 28 Breakdown of District 2017 BASIC+ GHG Emissions in the GPC Protocol Reporting Format

GPC ref No.	GHG Emissions Source (by Sector and Sub-Sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
I	**Stationary Energy**				
I.1	Residential buildings	82,099	6,668	541	89,308
I.2	Commercial and institutional buildings and facilities	53,227	3,323	269	56,819
I.3	Manufacturing industries and construction	IE	IE	IE	0
I.4.1/2/3	Energy industries	NO	NO	NO	NO
I.4.4	Energy generation supplied to the grid	7,147			
I.5	Agriculture, forestry, and fishing activities	13,314	IE	IE	13,314
I.6	Non-specified sources	IE	IE	IE	IE
I.7	Fugitive emissions from mining, processing, storage, and transportation of coal	NO			NO
I.8	Fugitive emissions from oil and natural gas systems	1,206			1,206
Sub-Total	(city induced framework only)	**149,846**	**9,991**	**810**	**160,647**
II	**Transportation**				
II.1	On-road transportation	102,578	6	169,957	272,541
II.2	Railways	NO	NO	NO	NO
II.3	Waterborne navigation	NO	IE	1,835	1,835
II.4	Aviation	NO	IE	5,946	5,946
II.5	Off-road transportation	18,492	IE	IE	18,492
Sub-total	(city induced framework only)	**121,070**	**6**	**177,738**	**298,814**
III	**Waste**				
III.1.1/2	Solid waste generated in the District	14,477		NO	14,477
III.2.1/2	Biological waste generated in the District	NO		3,923	3,923
III.3.1/2	Incinerated and burned waste generated in the District	NE		NE	NE
III.4.1/2	Wastewater generated in the District	NO		5,419	5,419
III.1.3	Solid waste generated outside the District	61,462			
III.2.3	Biological waste generated outside the District	NO			
III.3.3	Incinerated and burned waste generated outside city	NO			
III.4.3	Wastewater generated outside the District	NO			

Table 28 Breakdown of District 2017 BASIC+ GHG Emissions in the GPC Protocol Reporting Format

GPC ref No.	GHG Emissions Source (by Sector and Sub-Sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
Sub-total	(city induced framework only)	**14,477**		**9,342**	**23,819**
IV	**Industrial Processes and Product Uses**				
IV.1	Emissions from industrial processes occurring in the District boundary	NO			NO
IV.2	Emissions from product use occurring within the District boundary	39,884			39,884
Sub-Total	(city induced framework only)	**39,884**			**39,884**
V	**Agriculture, Forestry, and Other Land Use**				
V.1	Emissions from livestock	11,397			11,397
V.2	Emissions from land	-22,747			-22,747
V.3	Emissions from aggregate sources and non-CO_2 emission sources on land	1,092			1,092
Sub-Total	(city induced framework only)	**-10,257**			**-10,257**
VI	**Other Scope 3**				
VI.1	Other Scope 3			NE	NE
Total	(city induced framework only)	**315,019**	**9,997**	**187,890**	**512,906**

NOTES:
Cells in green are required for BASIC reporting
Cells in green and blue are required for BASIC+ reporting
Cells in purple are for disclosure purposes only but are not included in the summary totals as required by the GPC Protocol.
Cells in orange are not required for BASIC or BASIC+ reporting

5.3 TOTAL GHG EMISSIONS

Under the BASIC+ method, the District's GHG emissions totaled 522,872 tCO_2e. On a per capita basis, this works out to 4.58 tCO_2e per person.

Table 29 Total Energy and GHG Emissions Per Person by Sector

Sector	Sub-Sector	Energy (GJ)	GHG Emissions (tCO_2e)	GJ Per Capita	tCO_2e Per Capita
Stationary Energy	Residential Buildings	3,719,843	89,302	32.46	0.78
	Agriculture, Forestry, And Fishing Activities		13,314		0.12
	Manufacturing Industries and Construction				-
	Non-Specified Sources				-
	Commercial and Institutional Buildings and Facilities	2,021,813	56,819	17.64	0.50
	Energy Industries				-
	Fugitives		1,206		0.01
Transportation	On-Road Transportation	1,351,374	102,580	11.79	0.90
	Transboundary Transportation	2,241,059	169,961	19.55	1.48
	Off-Road Transportation: Railways, Aviation, and Other Off-Road	102,353	26,273	0.89	0.23
Waste	Waste: Solid Waste Disposal, Biological Treatment of Waste, Wastewater Treatment and Discharge		23,819		0.21
AFOLU	AFOLU: Livestock, Land, and Other Agriculture		(10,257)		(0.09)
IPPU	IPPU: Industrial Processes, and Product Use		39,884		0.35
Total		**9,436,442**	**512,901**	**82.34**	**4.48**

Total GHG emissions for 2017 are 512,901 tCO_2e and have increased 3.5% from the 2007 baseline reporting year as shown in Table 30. Scope 1 and 2 Emissions are 62.2% and 1.9% of the total GHG inventory. Scope 1 emissions are the GHG emissions that result from the combustion of fuel in sources within the District limits, primarily from Stationary Energy and Transportation. Scope 1 GHG emissions also include Solid Waste, IPPU and AFOLU GHG emissions. Scope 2 emissions result from the use of electricity supplied to the District which includes emissions associated with the generation of electricity and other forms of energy (e.g., heat and steam). Scope 2 emissions are low compared to other geographies, due to the predominance of hydroelectric generation technologies in the BC. Scope 3 emissions are emissions from electricity line losses, transboundary traffic, and emissions associated with District that are occurring outside of the District limits. For 2017, Scope 3 GHG emissions make up 35.9% of the GHG inventory. This breakdown by emission scope is depicted in Figure 4.

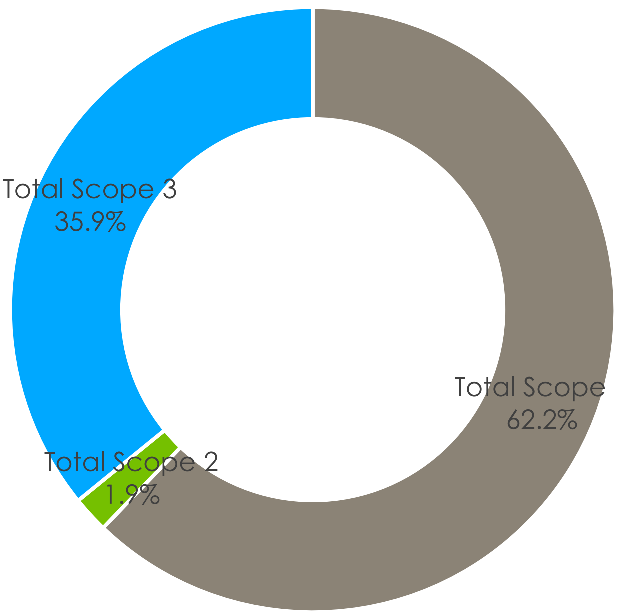

Figure 4 Total District BASIC+ GHG Emissions by Emissions Scope

5.4 COMPARATIVE ANALYSIS

Compared to the 2016 reporting year, the District's 2017 GHG emissions have increased 11,688 tCO_2e or 2.2% (Table 30).

Table 30 Change in GHG Emissions from Prior Year

Emissions Scope	2016 GHG Emissions (tCO_2e)	2017 GHG Emissions (tCO_2e)	Change
Scope 1	305,088	318,943	4.5%
Scope 2	9,467	9,992	5.5%
Scope 3	187,108	183,966	-1.7%
Total	**501,663**	**512,901**	**2.2%**

5.5 SECTORAL GHG EMISSIONS ANALYSIS

5.5.1 Stationary Energy

Stationary energy sources are one of the largest contributors to the District's GHG emissions. In 2017, it contributed 31.3% of the community's GHG emissions. In general, stationary energy emissions include the energy to heat and cool residential, commercial, and industrial buildings, as well as the activities that occur within these residences and facilities. Fugitive methane emissions from natural gas pipelines and other distribution facilities, and related off-road GHG emissions, are also reported in this Sector. The table below shows the breakdown of energy use in the stationary energy reporting category.

Table 31 summarizes the energy and GHG emissions for the 2017 reporting year.

Table 31 2017 Energy and GHG Emissions by Stationary Energy Sector

Sector	Electricity (tCO_2e)	Natural Gas (tCO_2e)	Heating Oil (tCO_2e)	Propane (tCO_2e)	Wood (tCO_2e)	Other Sources (tCO_2e)	**Total GHG Emissions (tCO_2e)**	**Total Energy (GJ)**
Residential Buildings	7,209	37,430	30,339	5,877	5,002	3,489	89,346	**3,721,576**
Commercial Institutional Buildings	3,592	44,689	1,388			7,228	56,897	**2,021,813**
Agriculture Activities						13,460	13,460	**-**
Fugitives						1,206	1,206	
Total GHG Emissions (tCO_2e)	**10,801**	**82,118**	**31,727**	**5,877**	**5,002**	**25,383**	**160,909**	
Total Energy (GJ)	**3,323,524**	**1,646,731**	**464,010**	**96,103**	**213,022**			**5,743,389**

It can be seen in Figure 5 that heating oil and natural gas use contribute to 70.8% of total Stationary Energy GHG emissions.

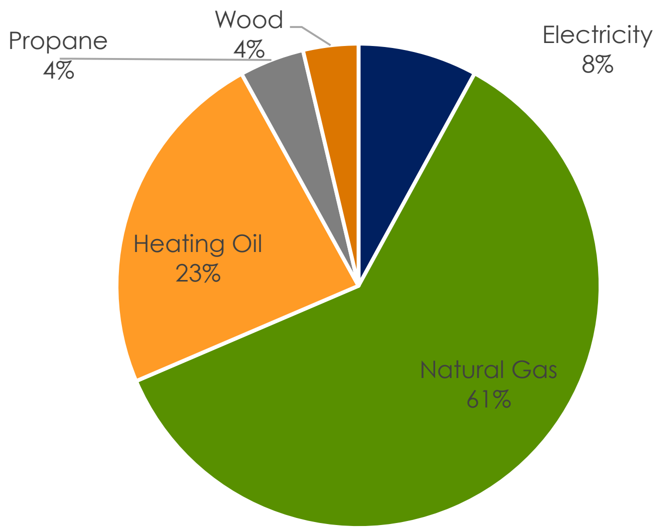

Figure 5 Stationary Energy GHG Emissions Contribution to the GHG Inventory

Figure 6 shows that more than 55.5% of the stationary GHG emissions arise from the operation of residential buildings.

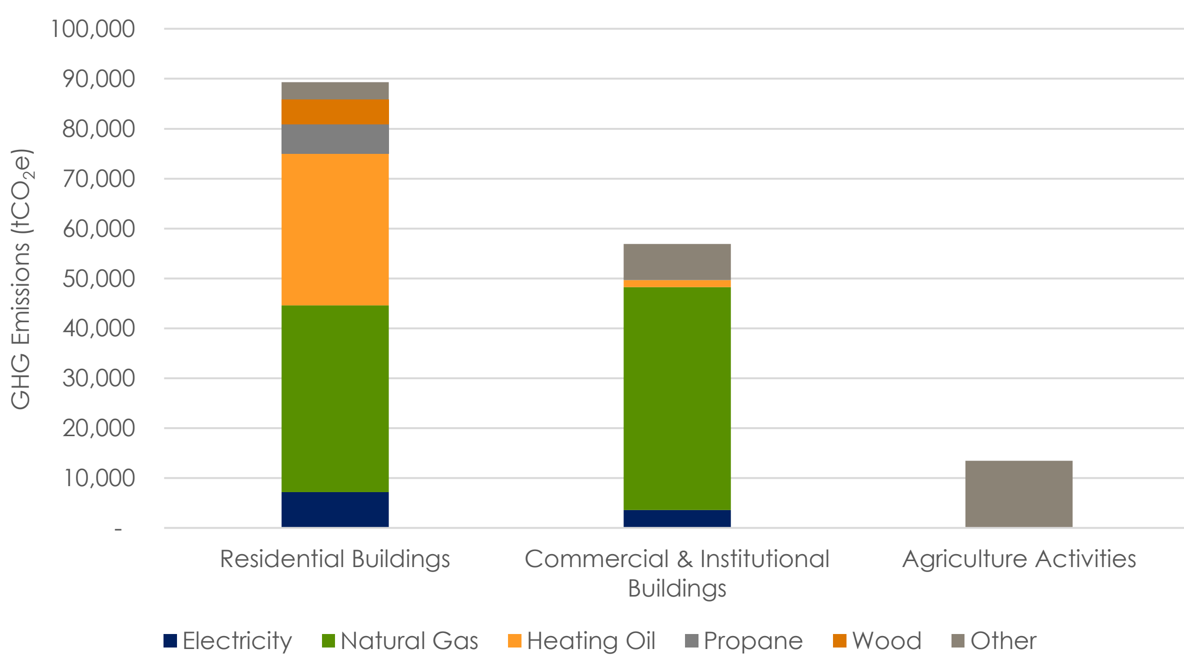

Figure 6 Total Stationary Energy Use By Sub-Sector

Stationary energy GHG emissions have increased by 3.6% since the baseline year. Between the reporting years, there has been a 10.3% increase in GHG emissions and an 8.9% increase in energy (Table 32). Overall, there was more natural gas use and electricity use between the reporting years which is most likely the result of the prior winter. There is also a downward trend in heating oil use through the tank replacement program. In 2007, there were 5,337 tanks, and in the reporting year, it is estimated that 4,623 tanks remain, a decline of 13.4%.

Table 32 Stationary Energy—Energy and GHG Emissions Trends

Sector	Change in GJ: 2007 & 2017	Change in GJ 2016 & 2017	Change in tCO_2e: 2007 & 2017	Change in tCO_2e: 2016 & 2017
Residential Buildings	-2.0%	9.8%	-3.5%	11.3%
Commercial & Institutional Buildings	4.2%	7.4%	20.5%	11.6%
Agricultural Activities	0.0%	0.0%	-1.7%	0.4%
Fugitives			-33.0%	0.0%
Total	**0.1%**	**8.9%**	**3.6%**	**10.3%**

5.5.2 Transportation

Transportation covers all emissions from combustion of fuels in journeys by road, rail, water, and air, including inter-city and international travel. For the 2017 reporting year, transportation GHG emissions accounted for 58.2% of the community GHG inventory with the bulk of transportation GHG emissions resulting from the on-road transportation sub-sector. The transportation GHG emissions are produced directly by the combustion of fuel or indirectly because of the use of grid-supplied electricity. Unlike stationary emission sectors, transit is mobile and can pose challenges in both accurately calculating emissions and allocating them to the cities linked to the transit activity. The following sections summarize energy and GHG emissions by on-road transportation, which is then followed by off-road transportation (marine, aviation, and other).

Table 33 summarizes the on-road energy and GHG emissions for the 2017 reporting year.

Table 33 2017 On-Road Transportation Energy And GHG Emissions by Fuel Type

Fuel Type	Total	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Electricity	481,318	KWh	1,733	5.63
Gasoline	87,925,919	Liters (L)	3,047,511	233,816
Diesel	13,919,094	Liters (L)	538,391	38,053
Propane	184,598	Liters (L)	4,713	284
Compressed Natural Gas (CNG)	1,571	kilograms (kg)	86	382
Total			**3,592,433**	**272,541**

Overall, on-road GHG emissions have increased by 13.3% compared to the 2007 baseline. On a per capita basis, the number of registered vehicles per person has increased by 0.7% since 2007. The majority of these GHG emissions (89.0%) are from passenger vehicles, light trucks, and SUVs (Figure 7).

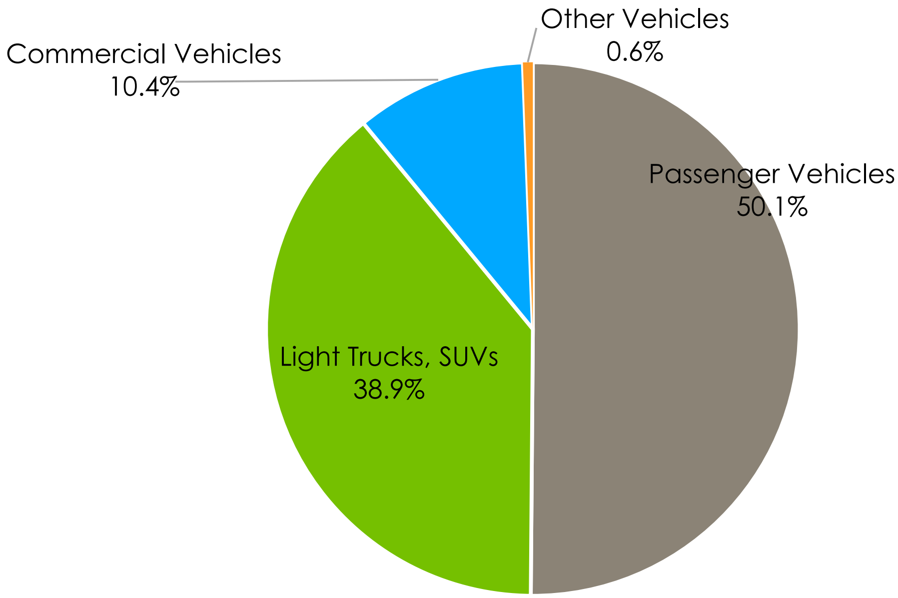

Figure 7 Breakdown of On-Road GHG Emissions by Vehicle Type

Table 34 summarizes the aviation, waterborne, and off-road transportation energy and emissions by fuel type. These GHG emissions contribute to 8.8% of the total transportation GHG emissions, and 5.1% to the total inventory (Figure 8).

Table 34 2017 Aviation, Waterborne, and Off-Road Transportation Energy and Emissions by Fuel Type

Fuel Type	Total	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Marine Diesel	629,782	Liters (L)	24,360	1,835
Aviation Diesel	2,247,634	Liters (L)	77,993	5,946
Off-Road Fuels			Not Reported	18,492
Total			**102,353**	**26,273**

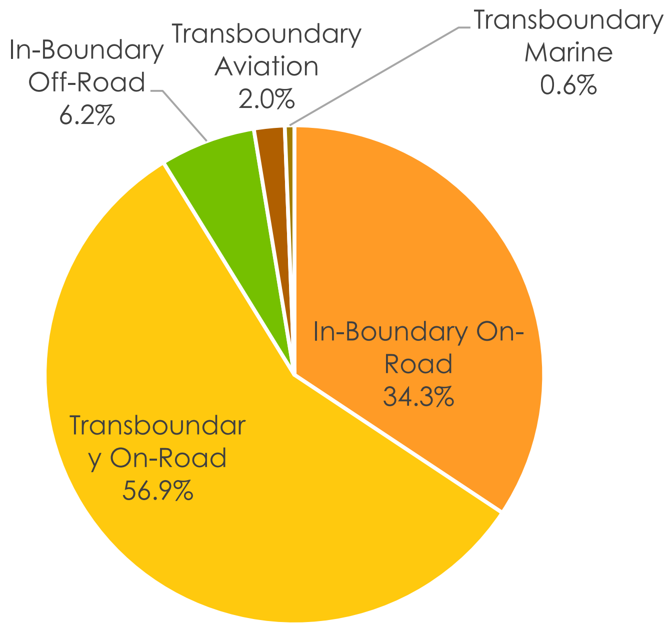

Figure 8 Summary of Transportation GHG Emissions by Sub-Sector

Table 35 below summarizes the total energy and GHG emissions by reported Transportation Sub-Sector. As noted previously, no personal watercraft GHG emissions were estimated due to a lack of available data to quantify these GHG emissions.

Table 35 2017 Energy and Emissions by Transportation Sub-Sector

GPC Reporting Category	Energy (GJ)	GHG Emissions (tCO_2e)
On-road GHG emissions occurring in the District	1,351,374	102,580
On-road GHG emissions occurring outside the District	2,241,059	169,961
Off-road GHG emissions occurring in the District	Not Estimated	18,492
Off-road GHG emissions occurring outside the District	*Included Elsewhere (IE)*	*Included Elsewhere (IE)*
Aviation GHG emissions occurring in the District	*Not Occurring (NO)*	*Not Occurring (NO)*
Aviation GHG emissions occurring outside the District	77,993	5,946
Rail GHG emissions occurring in the District	*Not Occurring (NO)*	*Not Occurring (NO)*
Rail GHG emissions occurring outside the District	*Not Occurring (NO)*	*Not Occurring (NO)*
Waterborne GHG emissions occurring in the District	*Not Occurring (NO)*	*Not Occurring (NO)*
Waterborne GHG emissions occurring outside the District	24,360	1,835
Total	**3,694,786**	**298,814**

Overall, GHG emissions from transportation have increased by 17.2%, compared to the 2007 baseline reporting year, and have decreased 1.5% compared to the prior reporting year. The increase in GHG emissions from the baseline is largely due to the increased off-road vehicle use (e.g. construction equipment) and the increased number of vehicles on the road in 2017 (78,656 vehicles) compared to 2005 (73,751 vehicles) - a 6.65% increase in the number of registered vehicles over the past decade. There have been notable declines in the aviation and waterborne emission sub-categories which is more likely attributable to changes in population in the District (compared to the CRD and Vancouver Island), rather than actual reduction in fuel usage and GHG emissions. These changes are presented in Table 36.

Table 36 Transportation—Energy and GHG Emissions Trends

Sector	Change in GJ: 2007 & 2017	Change in GJ 2016 & 2017	Change in tCO_2e: 2007 & 2017	Change in tCO_2e: 2016 & 2017
On-road transportation journeys occurring in the District	8.2%	0.4%	15.9%	-1.4%
On-road transboundary journeys occurring outside the District	4.5%	0.4%	11.8%	-1.4%
Off-road transportation occurring in the District			520.3%	0.4%
Off-road transportation occurring outside of the District				
Aviation traffic journeys occurring in the District				
Aviation traffic transboundary journeys occurring outside the District	-39.2%	-10.7%	-39.0%	-10.2%
Rail traffic journeys occurring in the District				
Rail traffic transboundary journeys occurring outside the District				
Waterborne traffic journeys occurring in the District				
Waterborne traffic transboundary journeys occurring outside the District	0.3%	0.4%	0.3%	-10.2%
Total	**4.2%**	**0.1%**	**17.2%**	**-1.5%**

5.5.3 Waste

Cities produce solid waste, compost, and wastewater. Waste does not directly consume energy, but when deposited into landfills, or left exposed to the atmosphere, it decomposes and releases methane (CH_4) gas which is a potent GHG. The GHG emissions from the solid waste, composting, and waste water facilities for the reporting year is summarized in the following table. For the 2017 reporting year, the total waste emissions contribute to 4.6% of the GHG inventory.

A breakdown of the Waste Sub-Sector GHG emissions is presented in Table 37.

Table 37 Summary of Waste Sub-Sector GHG Emissions

Sector	2017 GHG Emissions (tCO_2e)	GHG Emissions Per Capita (tCO_2e / Capita)	Change from Baseline (2010)	Change from Prior Year (2016)
Wastewater Treatment And Discharge	5,419	0.05	9.4%	-1.77%
Biological Treatment of Solid Waste	3,923	0.03	0.0%	3.16%
Solid Waste	14,477	0.12	-50.4%	3.59%
Total	**23,819**	**0.20**	**-30.2%**	**2.25%**

For the 2017 reporting year, in scope GHG emissions from waste have increased by 30.2% compared to the baseline and has increased by 2.3% compared to the prior reporting year. Fluctuations in waste will occur over the reporting periods as waste is driven by both the population, as well as economic prosperity in the region. The Solid Waste Sub-Sector contributes more than 60% of waste GHG emissions (Figure 9). To reduce the amount of waste landfilled, and thus GHG emissions, the District is making a significant effort to reduce waste going to landfills through organics diversion, and recycling.

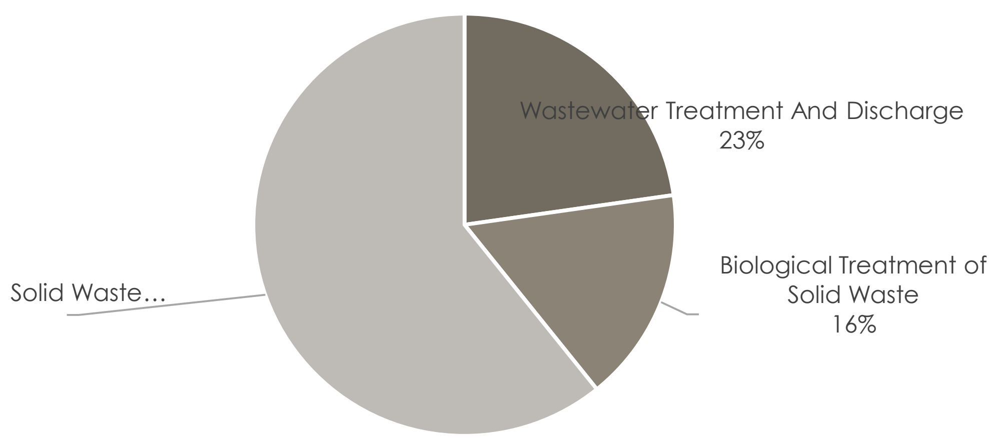

Figure 9 2017 GHG Emissions from Waste (tCO_2e)

5.5.4 Industrial Processes and Product Use (IPPU)

Reporting on IPPU GHG emissions are required for BASIC+ reporting only. Industrial GHG emissions are produced from a wide variety of non-energy related industrial activities which are typically releases from industrial processes that chemically or physically transform materials. During these processes, many different GHGs can be produced. There are no industrial GHG emissions occurring within the District's boundaries, and a "Not Occurring" notation is used.

Also included in the IPPU Sector is Product Use GHG emissions. Certain products used by industry and end-consumers, such as refrigerants, foams or aerosol cans, also contain GHGs which can be released during use and disposal and thus, as with best-practice, must be accounted for. For the reporting year, only the emissions estimated were production and consumption of halocarbons, SF_6 and NF_3 were estimated for the District on the basis that other GHG emissions sources identified in the NIR are not likely to be occurring in the District. To estimate Product Use GHG emissions for the District, a per capita estimate was developed using the Provincial emissions data from the 2018 NIR, and BC's NIR reporting year (2016) population from Statistics Canada. This value was applied to the 2017 reporting year District population to estimate the total Product Use emissions for the District.

It should be noted that the District has little influence over product use GHG emissions as these are consumption driven emissions.

Between the 2007 and 2017 reporting years, IPPU GHG emissions have increased 62.4%. The reason for the increase is more attributed to Environment Canada having better data available to make the estimate, than the actual GHG emissions increasing such an amount.

Table 38 Product Use GHG Emissions for the 2007 and 2017 Reporting Years

Sub-Sector	2007 (tCO_2e)	2017 (tCO_2e)	Change
Product Use Emissions	24,524	39,884	62.4%
Total	**24,524**	**39,884**	**62.4%**

5.5.5 Agriculture, Forestry, and Other Land Use

The AFOLU Sector includes GHG emissions from livestock, land use, and all other agricultural activities occurring within the District's boundaries. Using remotely sensed imagery, land cover data was used to estimate land use changes between the reporting years.

Overall, compared to the prior reporting year, land use development has resulted in the release of 2,930 tCO_2e, whereas greenspace has sequestered and stored approximately 25,676 tCO_2e, leaving a net reduction of 22,747 tCO_2e (Table 39).

Table 39 Summary of Land-Use Change Between 2016 and 2017

Land-Use Type	Average Change in Hectares (ha)	Sequestered (-) / Released (+) GHG Emissions in tCO_2e
Crop Land	(0.68)	(7,465)
Forest Land	(3.35)	(2,963)
Grassland	(1.93)	(12,553)
Other Land	(0.15)	(0)
Settlements	6.17	2,930
Wetlands	(0.06)	(2,695)
Total	**0.00**	**(22,747)**

The following figure presents the change in land use by sub Sector between the reporting years. Positive orange bars show the addition of land to a land type, whereas negative orange bars show losses of a land-type. Changes in land use directly affect if GHG emissions can continue to be sequestered, or whether they will be released as a result of a loss of this ecological function.

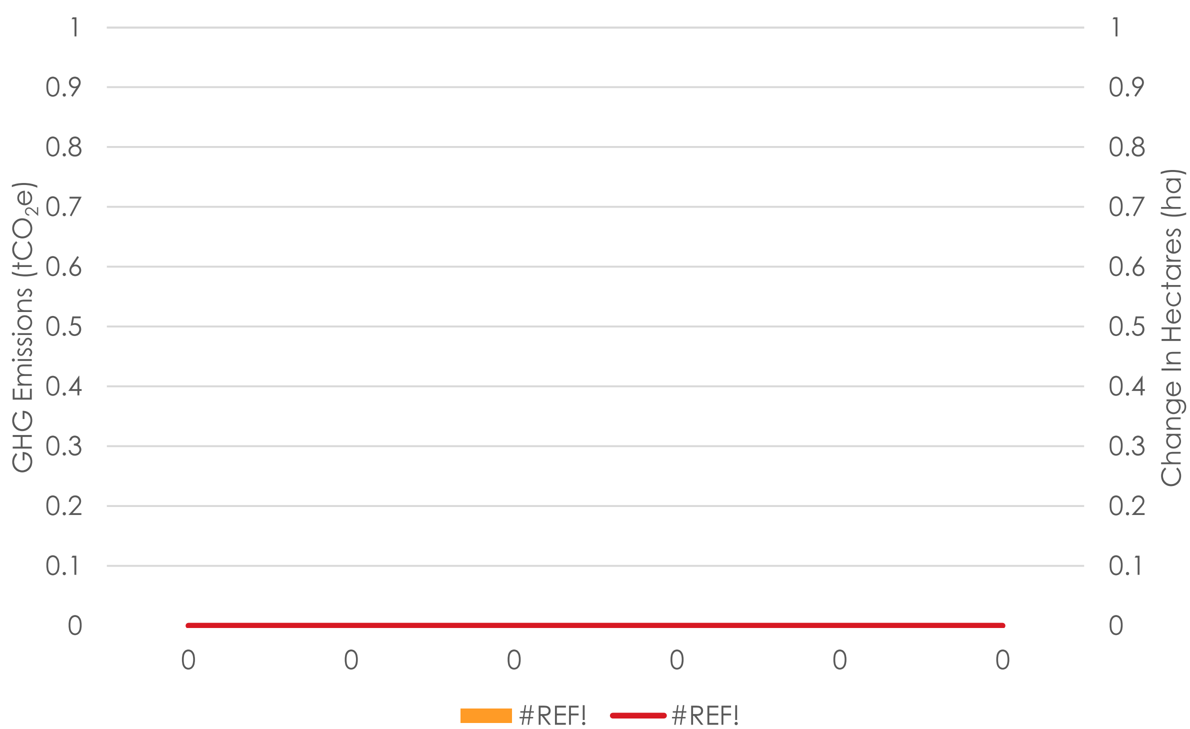

Figure 10 Comparison of GHG Emissions from Land-use Change

5.5.5.1 Livestock and Other Agriculture

In addition to land use change, GHG emissions from the AFOLU Sector are produced through a variety of non-land use pathways, including livestock (enteric fermentation and manure management), and aggregate sources and non-CO_2 emission sources on land (e.g., fertilizer application). Under this Sector, the District is reporting on GHG emissions from the following sources, and Sub-Sectors:

- Scope 1 GHG Emissions:
  - Livestock:
    - Methane (CH_4) Emissions from Enteric Fermentation
    - Methane (CH_4) Emissions from Manure Management
    - Direct Nitrous Oxide (N_2O) GHG Emissions
  - Aggregate Sources and Non-CO_2 Emissions Sources on Land
    - Direct Nitrous Oxide (N_2O) Emissions from Agricultural Soil Management
    - Indirect Nitrous Oxide (N_2O) Emissions from Applied Nitrogen

These GHG emissions were derived using the Agriculture and Agri-Food Canada (AAFC) Holos GHG Emissions Model (V3.1) and using 2016 Statistics Canada Agriculture Census Data.

Table 40 summarizes AFOLU GHG emissions for the 2016 reporting year.

Table 40 Total AFOLU GHG Emissions for 2017

AFOLU Sub-Sector	GHG Emissions (tCO_2e)
Land Use Change	(22,747)
Livestock	11,397
Aggregate Sources and Non-CO_2 Emissions Sources on Land	1,092
Total	**(10,257)**

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance and Quality Control (QA/QC) procedures are applied to add confidence that all measurements and calculations have been made correctly and to reduce uncertainty in data. Examples include:

- Checking the validity of all data before it is processed, including emission factors
- Performing recalculations to reduce the possibility of mathematical errors
- Recording and explaining any adjustments made to the raw data
- Documenting quantification methods, assumptions, emission factors and data quality

With respect to the GHG inventory, the data was subject to various quality assurance and quality control checks throughout the collection, analysis, and reporting phases. Specifically, the following procedures were followed:

- Upon receipt of data from third parties and the District, the data was checked for completeness (e.g., all months of data are present) and relevancy (e.g., the correct calendar year is presented). Incorrect or incomplete datasets were queried directly with the data provider
- Where estimates were used (e.g., per capita rail GHG emissions), all possible data sources were considered for their accuracy and relevance to the community before a final method and data source was selected
- All manual data transfers were double-checked for data transfer accuracy

7.0 RECOMMENDATIONS

To remain accurate and reflective of the current community conditions, the District should revise and improve its GHG emissions inventory annually, to which there are the following aspects should be focused on:

- Improving activity data collection and management, including Sector and Sub-Sector allocations
- Performing recalculations, where applicable, and tracking GHG emissions over time

The next section provides a summary of specific GHG inventory improvement recommendations.

7.1 INVENTORY ASSUMPTIONS, ASSESSMENT, AND RECOMMENDATIONS

In the preparation of the 2017 GHG emissions inventory, there are several assumptions were made in the analysis that will have some influence on accuracy of the District's estimate of community GHG emissions. Most emission sources have been calculated with a high level of confidence, due to the presence of utility records, and direct energy and emissions data being provided by District stakeholders. Data sources and assumptions with medium to high uncertainty are presented in Table 41 which summarizes the main assumptions, possible impacts on the data, and recommended improvement. It is recommended that the District prioritize improvements for that are likely to have a material (>10%) improvement in the GHG inventory estimate.

Table 41 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
All Sectors	This GHG inventory relied on emission factors from the 2018 NIR which reported on emissions from 1990-2016. As such, the emission factors for 2016 is preliminary may be updated in the 2019 NIR.	Immaterial impact on the GHG Inventory as the NIR emission factors do not change materially from year to year.	The District is using the best available data at the time. It will endeavor to update the emission factors as new information is available.
Stationary Energy	The energy utility providers provide energy in lump sum amounts for: residential, commercial, and industrial. As such, other sectors, like agricultural buildings, could not	No impact on the GHG inventory. The change would only happen between emission sub-sectors.	Work with the utility provider to get a more detailed breakdown of energy use by sub-sector.

Table 41 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
	be split out. A related accuracy issue is the assignment of mixed use buildings without separate metering.		
Stationary Energy	Propane, and wood GHG emissions were estimated based on 2007, 2010, and 2012 CEEI GHG emissions. Heating oil emissions were estimated based on the number of known tanks and the estimated square footage based on BC Assessment data, and the estimated average annual energy usage.	Immaterial impact on the GHG inventory (<5%)	Consider completing aa residential energy labelling program. With such a program, an energy and fuel profile for buildings could be developed so that a reasonable estimate of other fuel use be determined. Work with the Province on developing a methodology to estimate wood fuel use.
Transportation	ICBC has not been collecting off-road vehicle data so this source could not be estimated.	Possible material impact on the GHG inventory (>10%)	Work with ICBC to begin collecting this data regionally.
Transportation	ISBC did not provide reporting year vehicle registration data for the District. As such, 2012 vehicle registration data was used to estimate GHG emissions. Specifically, for the reporting year, the 2012 CEEI vehicle registration data was grown using the change in the District's population between 2012 and 2017.	It is likely that the estimate is within the materiality threshold (10%). However, the categories of vehicles and GHG emissions are likely to be materially different.	Work with ICBC to understand the data error and request a detailed registry database, that includes dates so that a better estimate of GHG emissions can be determined.
Transportation	Although annual fuel sales data was provided, only taxable fuel volumes are recorded at the Regional scale, and not municipal scale and only represents about 67% of taxable fuel sales (a value that fluctuates yearly). Without more detailed information, a fuel allocation amount could not be allocated to the District. As such, the District had to rely on vehicle registration data and estimated vehicle kilometers travelled (VKT) from a 2009 vehicle travel study for Canada.	Using the estimated VKT data, it is more than likely that the District is over-estimating the GHG emissions from transportation. This is the most conservative approach available to the District at this point.	If the District can get fuel sales data for Victoria, a more robust estimate of fuel use and GHG emissions, using vehicle registration data, can be determined. If the CRD can incorporate estimated travel data, in VKT, this data could be used to replace the 2009 study and be more specific to Victoria.

Table 41 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
Transportation	The Victoria International Airport does not collect origin traveler data. Therefore, the airport emissions were prorated based on the total City of Victoria population relative to the CRD population.	The impact will be immaterial to the GHG Inventory.	Work with the Victoria International Airport to determine a method (e.g. passenger survey) to better refine the onboarding number specific to the District of Victoria
Transportation	The Victoria International Airport does not report on GHG emissions from tenants or aircraft. Keeping in line with the GPC Protocol, only the aircraft GHG emissions were estimated using NAV Canada airplane movement statistics, estimated taxi times, and estimated fuel use. The fuel use only accounts for departing and arriving planes up to 3,000ft to avoid double counting with other cities.	The impact will be immaterial to the GHG Inventory.	The Victoria International Airport will not be collecting or reporting on GHG emissions from tenants or aircraft. This is the best available data at this point.
Transportation	No personal watercraft GHG emissions were estimated due to a lack of available data.	The impact will be immaterial to the GHG Inventory.	No recommended improvement currently.
Transportation	The GHG emissions from marine aviation are estimated based on Victoria Harbor NAV Canada air traffic movements for 2016. Statistics Canada stopped collecting Victoria Harbor aircraft movement data in 2016. To estimate 2017 marine aviation GHG emissions, the 2016 Victoria data was applied and adjusted using the change in aircraft traffic between the 2016 and 2017 reporting years at the Victoria International Airport. It is assumed that the activity at both airports would be corelated, but not causational.	The impact will be immaterial to the GHG Inventory.	No recommended improvement currently.

Table 41 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
Waste	Composting GHG emissions are estimated based on the total tonnage reported by the District. This is likely to be an underestimate of GHG emissions as the District does not have a mechanism in place to track how much organic waste is being collected by third party waste haulers	The impact will be immaterial to the GHG Inventory.	Complete waste audits and work with third party waste haulers to get a better grasp on the volume of organic waste leaving the District.
Waste	To quantify GHG emissions from the Hartland Landfill, the CRD utilized the waste-in-place method which is accepted under the GPC Protocol. The Waste-in-place (WIP) assigns landfill emissions based on total waste deposited during that year. It counts GHGs emitted that year, regardless of when the waste was disposed. GHG emissions from the Hartland Landfill for the reporting year are allocated based upon the percentage of District waste, relative to total waste received, sent to the Hartland Landfill. Using this allocation method, the District may over, or underestimate associated solid waste GHG emissions as the current year landfill GHG emissions are based upon cumulative waste over time, and the District may have contributed more waste in past years than the current year (and vice versa).	The impact will be immaterial to the GHG Inventory.	The District could re-run the waste in place model with only District waste (in tonnes) to determine a better estimate of District only GHG emissions from the landfill.
Waste	The District's proportion of wastewater is based on the CALWMP WWT System Feasibility and Costing Analysis - Technical Memorandum #1 which was completed in 2015. Due to a lack of information, the same proportion was used	The impact is likely to be immaterial.	No recommendations currently.

Table 41 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
	in the baseline and may or may not be accurate.		
Waste	Hartland landfill stationary combustion emissions were available for the 2016 reporting year only. As such, it was assumed that the baseline and reporting year would have similar emissions.	The impact is likely to be immaterial.	Work with the CRD to get the stationary combustion emissions data, and energy generation data so that the GHG inventory can be more accurate.
IPPU	Product use emissions were estimated on a per capita basis using the 2018 National Inventory Report (NIR) estimates. The NIR is one year behind and as such, a 2016 value was applied to estimate 2017 GHG emissions. The product use emissions were estimated by the NIR using an IPCC Tier 1 approach and thus will have high uncertainty.	The impact is likely to be immaterial.	No recommendations currently.
AFOLU	GHG estimates for land use change are based on a period of years (2011-2017) and thus were averaged for each period. As there was no current data, land use change for the reporting year was estimated using the average value from 2011.	Immaterial impact on the GHG Inventory.	Work with the planning department to track land-use change annually so that a more refined estimate can be made.
AFOLU	The land-use sequestration and storage GHG emission factors are taken from the literature, for BC ecozones, and may not reflect the productivity, or lack thereof, of land uses in the District limits. The use of non-site emission factors may result in an over or underestimate of GHG emissions.	Immaterial impact on the GHG Inventory.	No recommendations currently.

8.0 REFERENCES

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APPENDIX A
GPC REPORTING TABLE

Appendix A GPC REPORTING TABLE