EnviroStrat
Impact Investment Project Development

Hauraki District Council

Hauraki District Greenhouse Gas Emissions Inventory

For the period 1 July 2021 to 30 June 2022

Prepared by EnviroStrat Ltd

August 2023

Table of Contents

List of Figures and Tables

Acronyms and Abbreviations

AFOLU	Agriculture, Forestry, and Other Land Use
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EECA	Energy Efficiency and Conservation Authority
GHG	Greenhouse gas
GPC	Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and Product Use
k	Thousand
LPG	Liquefied petroleum gas
N_2O	Nitrous oxide
NF_3	Nitrogen trifluoride
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride
TAs	Territorial Authorities
WRC	Waikato Regional Council

Taituarā	Local Government Professionals Aotearoa (formerly SOLGM) is the national organisation that supports and develops local government professionals in New Zealand.

Glossary

Emission factor(s)	A factor that converts activity data into GHG emissions data (e.g., kg CO_2e emitted per litter of fuel consumed, kg CO_2e emitted per kilometre travelled, etc.).
Scope 1 emissions	GHG emissions from sources located within the territorial boundary.
Scope 2 emissions	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the territorial boundary.
Scope 3 emissions	All other GHG emissions that occur outside the Waikato region boundary as a result of activities taking place within the territorial boundary.
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.
Basic+	BASIC+ involves additional data collection and calculation processes to cover IPPU, emissions and removals from AFOLU, and emissions from transboundary transportation.

1 Executive Summary

This is the second inventory report for Hauraki District Council. The inventory was compiled following the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC) and it covers emissions from stationary energy, transportation, waste, industrial processes and product use (IPPU), agriculture and forestry sectors.

The inventory period is from 1 July 2021 to 30 June 2022. Key results are:

- Hauraki District emissions were 755,965 metric tonnes of carbon dioxide equivalent (t CO_2e) gross and 905,481 t CO_2e net emissions.
- The largest two sectors are Agriculture with 617,324 t CO_2e and Transportation with 80,577 t CO_2e.
- Activities within Hauraki District boundary generated 6 % of Waikato Region's emissions (approximately 12,023,719 t CO_2e).
- The emissions for Hauraki District have decreased by 3 % between 2018/19 and 2021/22.

2 Introduction and context

The New Zealand government ratified the Paris Agreement in April 2017, which is an international commitment to limit global warming to below 2 °C. To achieve this emissions reduction goal and make a fair contribution to global emissions reductions, in 2019 New Zealand adopted the Climate Change Response (Zero Carbon) Amendment Act[1] to develop and implement clear climate change policies that contribute to the commitments under the 2015 Paris Agreement. The Act sets mitigation targets committing New Zealand to:

- Reduce annual net emissions of all greenhouse gases (except biogenic methane) to zero by 2050, and
- Reduce annual emissions of biogenic methane to:
    - 10 % below 2017 levels by 2030
    - 24 % to 47 % per cent below 2017 levels by 2050.

Further to this, in May 2022, the Government launched the first climate Emissions Reduction Plan for NZ,[2] which contains strategies, policies, and actions towards achieving Aotearoa's first emissions budget, as required by the Climate Change Response Act 2002. Components of this plan include:

- Establishing green investment finance systems
- Ending offshore exploration of fossil fuels
- Switching fuels to reduce reliance of fossil fuels in the NZ transport fleet and
- Amending the ETS to price agricultural emissions with the aim of reducing emissions.

2.1 Role of regional and territorial authorities

It is recognised that finding solutions to climate change and transitioning to a low carbon economy cannot be pursued by central government without the involvement and actions of local government. In December 2022, it became a legal requirement for local government under the Resource Management Act 1991 (RMA) to 'have regard to' the National Adaptation Plan and the Emissions Reduction Plan when preparing or changing regional policy statements, regional plans, and district plans (MfE 2022). This requirement is to ensure that nationwide

[1] Climate Change Response (Zero Carbon) Amendment Act 2019 No 61, Public Act Contents – New Zealand Legislation
[2] Aotearoa New Zealand's first emissions reduction plan | Ministry for the Environment

planning is in-line with New Zealand's long-term climate strategies and goals – particularly the National Adaptation Plan and the Emissions Reduction Plan.[3]
Central government and Ministry for the Environment (MfE) have worked with local government (via Taituarā and local government networks) to accelerate the role of local government in understanding, preparing, and adapting to climate change around NZ. With clear science and multiple 'hottest years on record' events occurring in the last five years, alongside more regular tropical cyclones, councils are now increasing efforts to accelerate adaptive planning around coasts and lowland flood plains.

Alongside a focus on adaptation, territorial and regional authorities around New Zealand are exploring GHG reduction targets as part of their climate mitigation strategies. To develop their carbon reduction strategies, local government agencies need to have a good understanding of their emissions profiles (i.e., the sources of emissions by sectors and gases), and track emissions trends.

2.2 Hauraki District Council context

In June 2021, Hauraki District Council adopted the Zero Carbon Promise, which sets out how the council will work towards the goal of reducing or offsetting more of their organisational greenhouse gas emissions, as well as contributing towards a zero-carbon district.[4] This aligns with various other Waikato Region and national policies, strategies, and plans.

A range of projects and measures are outlined in the Zero Carbon promise that have the dual focus of reducing emissions as well as increasing sequestration opportunities – in conjunction with climate adaptation.

2.3 Purpose of the emissions inventory

The GHG emissions inventory is an estimate of GHGs emitted to, or removed from, the atmosphere over a given period. This inventory provides Hauraki District Council with an understanding of their emissions generation and removals profile for the 2021/22 (local government) financial year reporting period.

Specifically, the purpose of this report is to:

- Identify where the Hauraki District's 2021/22 emissions are coming from and calculate the changes in emissions generation/removal compared to the 2018/19 GHG inventory.
- Determine the emissions profile of individual sectors as basis for developing climate action plans, strategies, setting reduction targets or informing reduction activities in long term plans.
- Provide information and understanding to enable Hauraki District and regional council to engage with key sectors and stakeholders towards reducing GHG emissions.

Overtime, the emissions inventory assists with comparing emission trends and tracking progress in emissions reductions across the region.

This document summarises the findings and insights from the data collection and emissions calculations, and it also outlines the underlying assumptions and limitations associated with the compilation of the inventory. This emissions inventory was developed in conjunction with the emissions inventory preparation for Waikato Region and the other territorial authorities within the region.

For further insights and in-depth understanding of the inventory context for Hauraki District, please refer to the *Waikato Region Greenhouse Gas Emissions Inventory* report for 2022/23.

3 Inventory methodology

This inventory for Hauraki District (and the individual Territorial Authorities) follows the methodology outlined in the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC)[5], published by the

[3] See the guidance note for more details: National-adaptation-plan-and-emissions-reduction-plan-guidance-note.pdf (environment.govt.nz)

[4] https://www.hauraki-dc.govt.nz/community/climate-change

[5] The protocol is available at: http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities.

World Resources Institute in 2015. The GPC methodology represents international best practice for city and community level greenhouse gas (GHG) emissions reporting.

The inventory includes emissions from stationary energy, transport, waste, industry, agriculture and forestry activities within the regional (administrative) boundary of Hauraki District. It covers seven greenhouse gases: carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

The boundaries of the 2021/22 emissions inventory are the administrative boundaries of Hauraki District Council. The district covers 126,971 ha[6] and has 22,100 residents.

The emissions inventory methodologies are described fully in the regional inventory report. Where specific district-level data was not accessible, information was calculated via a per capita break-down of national level data.

Assumptions made during data collection and analysis are outlined in Appendix B – Assumptions and limitations. Data gaps are described in Appendix C.

3.1 Assumptions, limitations, and uncertainties

This inventory assesses both direct (production-based) emission sources within the geographic area (Scope 1) and indirect (consumption-based) emission sources associated with goods and services imported into the Hauraki District. Examples of indirect emission sources include electricity from the national grid (Scope 2), and transport into the area that originates or terminates outside the area e.g. aviation & railway (Scope 3).

Emissions inventories of this nature involve a range of sources, assumptions, limitations, and uncertainties. Examples of data limitations include:

- Emissions are reported for the period from 1 July 2021 to 30 June 2022
- Emissions are expressed on a carbon dioxide-equivalent basis including climate change feedbacks using the 100-year GWP (Global Warming Potential) values and climate-carbon feedback from the Intergovernmental Panel on Climate Change Fifth Assessment Report: Climate Change 2013
- Total emissions are reported for gross emissions (excluding forestry) and net emissions (including forestry)
- In line with the GPC, activity data for the various emission sources includes data from bottom-up sources (locally provided measurements or estimates) and top-down sources (based on national information), depending on data availability
- Where specific district-level data was not accessible, information was calculated via a per capita break-down of national level data. This method was applied to the following sectors:
    - Emissions from industrial product use by scaling national emissions from industrial product use on a population basis
    - Stationary energy fuel types such as LPG - numbers assumed on a per capita basis from national figures
    - This inventory estimates solid waste emissions from both open and closed landfills based on both the national inventory figures and a more recent Waikato-Bay of Plenty waste and recycling stocktake (2021), then allocated on a population basis
    - This inventory estimates emissions from wastewater treatment using top-down methods of scaling national emissions from the National GHG Inventory 2023 (1990-2021) and applies this to territorial authorities within the Waikato region on a population basis
- Uncertainties also exist where data is missing or has been estimated based on limited information (e.g., aviation data)

[6] Manaaki Whenua - Landcare Research 2021. LCDB v5.0 – Land cover database version 5.0, Mainland, New Zealand – (DOI: https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/).

- In addition to activity-related assumptions and uncertainties, the GPC methodology also includes assumptions in terms of calculations of sector emissions.

Assumptions and limitations made during data collection and analysis are included in the Appendix A and data sources and identified data gaps are listed in Appendix B.

4 Emissions results and analysis

4.1 Overall emissions

Hauraki District's emissions inventory provides an overview of emissions generated by the activities of residents, businesses and industries. During the July 2021 to June 2022 reporting period, Hauraki District generated a total of 755,965 t CO_2e gross emissions and 905,481 t CO2e net emissions (including forestry). This represents a 41 t CO_2e per capita (net)/ 34 t CO_2e per capita (gross) emissions and approximately 6 % of Waikato Region total gross emissions. Agriculture is the largest emissions source (over 81 %), followed by transport (11 %) (Figure 1).

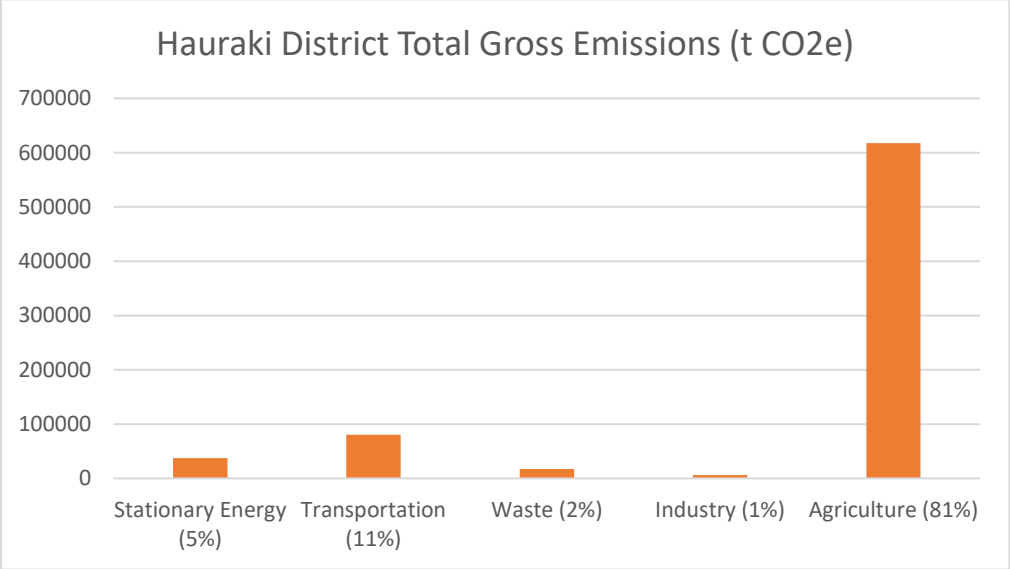

Figure 1. Total gross emissions by sector (excl. forestry) for Hauraki District, 2021/22

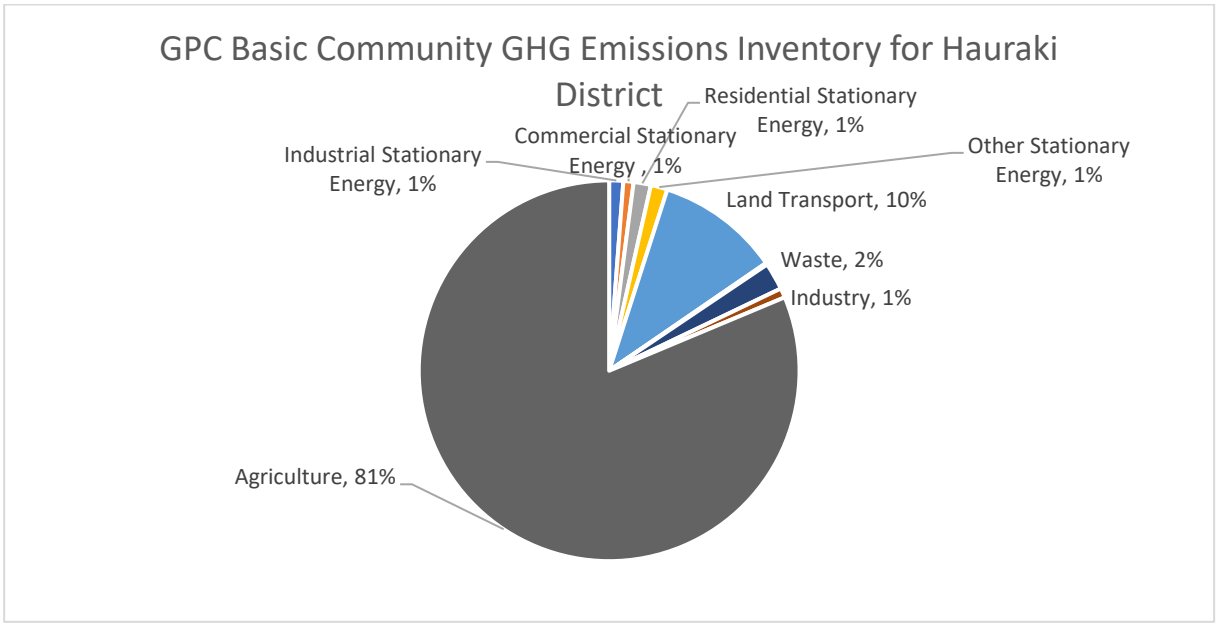

Figure 2. GPC BASIC community GHG gross emissions inventory for Hauraki District, 2021/22 Total Gross Emissions by Sub-Sector (%)

4.2 Transportation

Transportation contributed 80,577 t CO_2e (11 % of the district's gross emissions) making it the second largest contributor to the district's emissions. On-road petrol and diesel (70,996 t CO_2e) represents 88 % of total transport emissions,[7] followed by off-road at just over 10 % (Table 1).[8] Activities from aviation are responsible for just over 1 %. As switching fuels and increasing use of public transport occurs it will be useful to track these inventory categories (Figure 3).

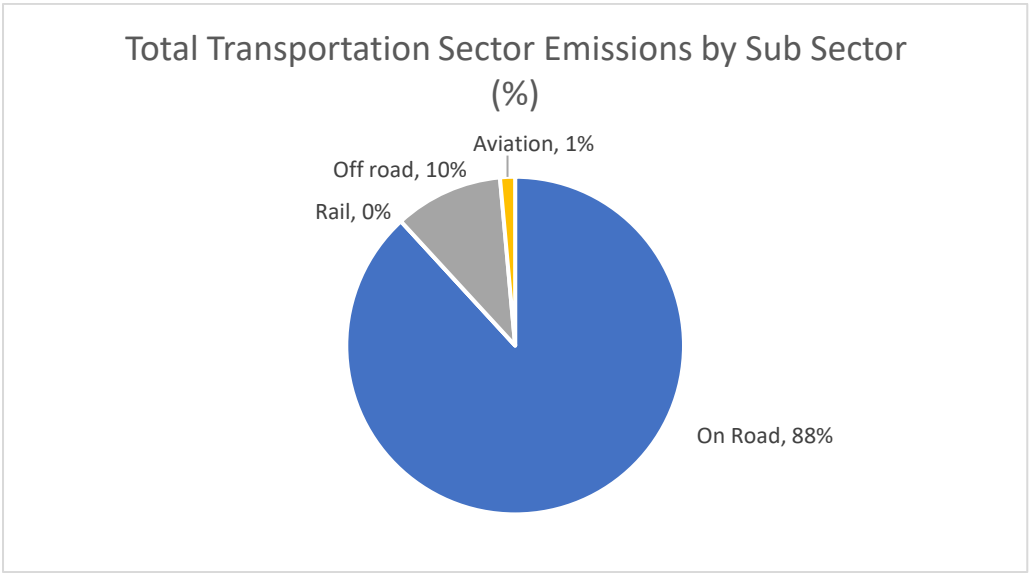

Figure 3. GPC BASIC community GHG emissions inventory for Hauraki District, 2021/22 Total Transportation Emissions by Sub-Sector (%)

[7] In this inventory, bus fuel was sourced from Waikato Regional Council for the Hamilton City bus fleet.

[8] This is likely to be over-estimated given that the general EECA guidance was applied to split consumption between on and off road. (because of the top-down approach when diesel consumed on farms).

Table 1. Summary of Hauraki District's transportation emissions by source, 2021/22

Sector/Category		Emissions (t CO_2e)		Sector Percentage Contribution (%)
Transportation	On-road petrol and diesel	70,996	Σ 80,577	88
	Rail emissions	-		-
	LPG	35		0.04
	Aviation gas	43		0.05
	Jet kerosene	1,117		1
	Off-road petrol and diesel	8,386		10
	Biodiesel	0		0
	Bus	-		-

4.3 Stationary energy

Stationary Energy is responsible for 34,371 t CO_2e of the district's gross emissions (5 %) in 2021/22, the third largest emitting sector. Residential consumption is responsible for 24 % of emissions, and industry (manufacturing and construction) accounts for about 31 % of stationary energy emissions. The "other sector" emissions for stationary energy represent emissions from fuel combustion (26 %), as shown in Figure 4. See Table 2 for a full district breakdown.

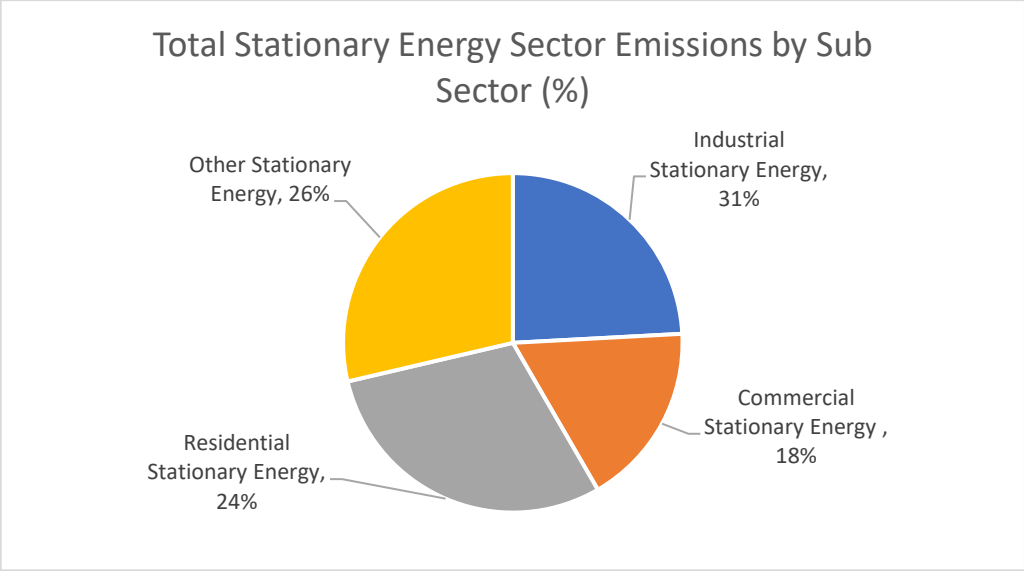

Figure 4. GPC BASIC community GHG emissions inventory for Hauraki District, 2021/22 Total Stationary Energy Emissions by Sub-Sector (%)

Table 2. Summary of Hauraki District Council's Stationary Energy emissions by source, 2021/22

Sector/Category Source		Emissions (tCO_2e)		Sector Percentage Contribution (%)
Stationary Energy	Electricity	20,493	Σ 34,371	55
	Electricity T&D Loss	1,683		4
	Natural Gas	-		-
	Natural Gas T&D Loss	-		-
	LPG	1,621		4
	Diesel	8,831		23
	Petrol	239		1
	Coal	1,205		3
	Biofuel use	299		0.9

4.4 Agriculture

Agriculture is the largest source of emissions, responsible for 617,324 t CO_2e in 2021/22, or around 81 % of total gross emissions of Hauraki District. A breakdown of agricultural emissions is shown in Table 3. Livestock living within the district boundary is the primary source of agricultural emissions. For all territorial authorities, enteric methane emissions from livestock are the most significant and are driven by animal production of (ruminant) methane.

Table 3. Summary of Hauraki District Council's agricultural emissions by source and gases 2021/22

Sector/Category		Emissions (t CO_2e)		Sector Percentage Contribution (%)
Agriculture	**Emissions from livestock**	**484,838**	Σ 617,324	**79**
	Enteric fermentation (CH4)	442,447		72
	Manure management (CH4)	42,392		7
	Manure management (N2O)	1		0
	Emissions from aggregate sources	**132,484**		**21**
	Liming and dolomite	41,277		7
	Agricultural soils	8,502		1
	Manure from grazing animals	71,389		12
	Agricultural leaching	5,101		1
	Agricultural atmospheric deposition	6,214		1

4.5 Waste (solid & wastewater)

Hauraki District generates a total of 17,581 t CO_2e from waste, of which 91 % is as result of solid waste disposal and 9 % from wastewater (Table 4). Solid waste emissions from landfills are measured using the IPCC First Order Decay method (accounting for landfill activity since 1950 to present day). Data for Hauraki District was estimated based on population figures (average for 2021/2022) and average waste volume generation for Waikato and Bay of Plenty. It was assumed that all solid waste is sent to landfill to Tirohia (which has been collecting landfill gas since 2001). Wastewater emissions (treatment plants and septic tanks) generated an estimate of 1,630 t CO_2e and were calculated using the 2023 NIR (1990-2021) per capita wastewater treatment and disposal emissions values for domestic wastewater.

Table 4. Summary of Hauraki District Council waste emissions by source 2021/22

Sector/Category Source		Emissions (t CO_2e)		Sector Contribution (%)
Waste	Solid Waste Disposal	15,951	Σ 17,581	91
	Wastewater	1,630		9

4.6 Industrial Processes and Product Use (IPPU)

Hauraki District Council contributes 6,112 t CO_2e of industrial emissions, or just 0.8 % of total gross emissions for the district.

This sector includes emissions associated with the consumption of refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production (Table 5). The method for estimating these emissions is a top-down approach (based on average national per capita emissions). IPPU emissions do not include energy use from industrial manufacturing, which is included in the relevant stationary energy sub-category (e.g. coal, electricity and/or petrol and diesel).

Table 5. Summary of industrial product use emissions for Hauraki District

Sector/Category		Emissions (t CO_2e)		Sector Percentage Contribution (%)
IPPU	Refrigerants	5,698	Σ 6,112	93
	Foam Blowing	25		0.4
	Fire extinguishers	10		0.2
	Aerosols & MDI*	317		5
	SF_6	62		1

4.7 Forestry

There is a net 149,516 t CO_2e emissions from forestry with some harvest estimated creating more harvest emissions than current sequestration. For sequestration, the majority is from exotic forest cover within the district boundary. The breakdown is shown in table 6. While this carbon sink offsets a decent proportion of the total harvest emissions, it was not sufficient to offset all harvest emissions for the inventory period (Table 6).

Table 6. Summary of forest emissions/removals by source 2021/22 for Hauraki District

Sector/Category Source		Emissions (t CO_2e)		Sector Contribution (%)
Forestry	Exotic forest sequestration	-121,799	Σ 149,516	91
	Native forest sequestration	-46,460		9
	Total Forest Sequestration	-168,258		
	Total harvest emissions	317,774		

4.8 Emissions' contribution to Waikato Region and Hauraki District

To provide a perspective into Hauraki District's emissions profile, a summary overview is presented below for 2021/22 inventory – for entire Waikato Region and the other territorial authorities. The overview below is intended as an indicative framework of reference – recognising that the TAs have diverse emissions profile (Table 7).

Hauraki District has a large gross footprint on a per capita basis compared to Waikato region (34 vs 24 t CO_2e respectively) and the district accounts for 6 % of the regional gross emissions. When forestry is included, Hauraki District sequesters a relatively small amount which has a small increase to 9 % of net emissions (see Table 8).

Table 7. Overall emission estimates for Waikato Region and breakdown by territorial authorities (2021/22), t CO_2e

t CO_2e	Waikato Region 2021/22	Hamilton City 2021/22	Hauraki 2021/22	Matamata-Piako 2021/22	Otorohanga 2021/22	South Waikato 2021/22	Taupō 2021/22	Thames-Coromandel 2021/22	Waikato District 2021/22	Waitomo 2021/22	Waipā 2021/22
Stationary energy	1,514,506	280,747	34,371	142,784	16,428	349,186	74,956	44,570	392,019	41,332	138,114
Transportation	1,903,581	675,802	80,577	138,106	40,601	96,240	160,957	122,108	328,152	36,336	224,703
Waste	326,619	49,089	17,581	29,394	22,108	37,406	84,142	26,649	24,011	19,790	16,450
Industry	140,356	49,647	6,112	10,220	2,994	7,122	11,395	9,266	24,284	2,680	16,636
Agriculture	8,138,656	71,295	617,324	1,347,153	783,964	705,615	1,037,853	204,493	1,550,479	843,484	976,999
Forestry	-1,749,712	512	149,516	45,005	186,467	-740,165	-1,960,210	-350,978	393,600	983,671	-457,130
Total net (incl. forestry)	10,274,006	1,127,092	905,481	1,712,662	1,052,562	455,404	-590,907	56,108	2,712,545	1,927,293	915,772
Total gross (excl. forestry)	12,023,719	1,126,579	755,965	1,667,657	866,094	1,195,569	1,369,303	407,086	2,318,945	943,621	1,372,902
Population (2021-22 average)	507,465	179,500	22,100	36,950	10,825	25,750	41,200	33,500	87,800	9,690	60,150
Per capita net emission (incl Forestry)	20	6	41	47	97	18	-14	2	31	199	15
Per capita gross emission (excl Forestry)	24	6	34	45	80	46	33	12	26	97	23

Table 8. Hauraki District as proportion of Waikato Region emissions estimates (2021/22 inventory)

t CO_2e	Waikato Region	Hauraki District	% of Regional Emissions
Stationary energy	1,514,506	34,371	2
Transportation	1,903,581	80,577	4
Waste	326,619	17,581	5
Industry	140,356	6,112	4
Agriculture	8,138,656	617,324	8
Forestry	-1,749,712	149,516	-9
Total net (incl. forestry)	**10,274,006**	**905,481**	**9**
Total gross (excl. forestry)	**12,023,719**	**755,965**	**6**

4.9 Changes in emissions over time (2018/19 to 2021/22)

Total gross emissions for Hauraki District decreased by 3 %, from 775,892 tCO_2e in 2018/19 to 755,965 t CO_2e in 2021/22. Three sectors (Transportation, Industry and Agriculture) have seen a decrease in emissions since 2018/19 inventory (Table 9). Total net emissions (including forestry sector) have increased by 23 % since 2018/19 - from 733,443 to 905,481 t CO_2e in 2021/22. This significant change in net emissions is due to the important role forestry sector plays in carbon sequestration, and the cyclical nature of forest planting and harvesting.

The population has increased by 6 %, from 20,800 to 22,100 for Hauraki District, and per capita gross emissions decreased from 37.3 t CO_2e/per person in 2018/19 to 34 t CO_2e/per person. The order of magnitude increase in waste emissions is due to a calculation error in 2018/19 inventory as well as increase in population numbers.[9]

Given the relative short timeframe comparison and data changes, the inventory changes described above should be treated as indicative and not seen as long-term trends yet.

Table 9. Comparison between Hauraki District inventories for 2018/19 and 2021/22

t CO_2e	Hauraki District 2018/19	Hauraki District 2021/22	% difference
Stationary energy	35,802	34,371	-4
Transportation	110,175	80,577	-27
Waste	3,843	17,581	357
Industry	6,274	6,112	-3
Agriculture	619,799	617,324	-0.4
Forestry	-42,449	149,516	452
Total net (incl. forestry)	733,443	905,481	23
Total gross (excl. forestry)	775,892	755,965	-3
Population	20,800	22,100	6
Per capita net emission	35	41	-

[9] This assignment did not involve updating previous inventory calculations. However, it appears that emissions for 2018/19 have been underestimated due to wrong assumption regarding landfilling.

(incl forestry)			
Per capita gross emission (excl forestry)	37	34	-

4.10 Conclusions

The development of the 2021/22 emissions inventory provides Hauraki District with an increased understanding of emissions sources to inform decision making. The process for developing the inventory as part of the Waikato Region's wide emissions assessment was effective and helped leverage engagement with data holders. Because the inventory is prepared in accordance to GPC, this enables the Council to benchmark internally (changes over time), and target those sectors that have the greatest contribution to emissions and that the District has the ability to influence them.

While changes can be ascertained in relation to 2018/19 inventory, they do not represent long term trends at this point. Hauraki District emissions' profile is dominated by agriculture (81% of gross emissions), which is also a key source of emissions for the Region as a whole.

Within the development of this inventory, new information and activity data collection opportunities are emerging. Territorial authorities are leading some of the efforts for more detailed GHG inventory calculations. For example, plans are in place for emissions' work on wastewater and solid waste to be carried out more widely throughout the Waikato (and nationally) over time. As this work becomes more embedded, GHG inventory calculation methods should be updated to reflect new learnings and localised emission results.

Considerations for future inventories include:

- Consider how transportation and forestry activity data may be enhanced that would inform and refine significant aspects of the emissions inventory. This can be done in coordination with regional council and other territorial authorities in order to be more efficient and impactful.
- Seek (timely) data collection and form agreements with partner agencies (such as waste management services) to ensure data is able to be shared freely without commercial sensitivities.
- Include and build in learning, data and results from local detailed studies (e.g. wastewater and GHG emissions study) to enhance areas identified for improvement.
- Explore the role of nature-based solutions that provide for climate mitigation and adaptation – especially in relation to agriculture, forestry and land use.

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Appendices

Appendix A - Assumptions and limitations

Table 10. Assumptions and exclusions

Sector/Category	Assumptions and Exclusions
Stationary Energy Emissions	
Residential, commercial, and industrial stationary energy emissions	• Coal and biomass related emissions have been estimated using a top-down approach, applying the national average consumption for commercial and residential coal use, estimated based on population figures. • Consumption of natural gas and electricity data are based on total energy distributed to grid exit points within the region. The energy provided to these grid exit points have then been allocated to the entire region. This may in some instances mean that energy used outside the region may be counted as part of the region's footprint, depending on the distribution network for gas and electricity, which may not fully match the region's boundaries in all cases. • Emission per user group (i.e., residential, commercial, and industrial) was estimated based on national average energy use split between these groups as reported by MBIE (2017a). • Coal and natural gas consumption for the Huntly Power Station have been excluded from the regional emissions estimates, as this is already reflected in the national emissions factor for electricity generation.
Electricity Generation	• National emission factor for electricity generation was estimated based on data published by MBIE in their quarterly electricity and liquid fuel emissions table (MBIE 2020). • The emissions from stationary energy generation (e.g. from the Huntly Power Station) occurring within the region have not been included in the Waikato Region carbon footprint, as these are part of the national emissions calculations for electricity generation. Waikato's share of the emissions from stationary energy generation is already accounted for as part of the emissions estimated for the region's electricity consumption.
Electricity Consumption	• Consumption of electricity data is based on total energy distributed to grid exit points within the Transpower Network. The methodology for electricity consumption matches the 2018/19 methodology based on grid exit points. • The electricity consumption figure used for the Waikato Region is likely to be conservative, as the total energy distributed to the exit-grid points does not follow regional boundaries. However, it is likely that the affected population/area is relatively small and therefore the impact to the energy consumption to the Waikato Region is not likely to be significant.
LPG	• LPG consumption in the Waikato region is based on the total amount of LPG supplied to the North Island and calculated on a per capita basis using 2021/22 population estimates.

	• LPG stationary energy estimates are based on the national share of 9 kg and 45 kg gas bottles, and bulk sales provided by the LPG Association of New Zealand.
Natural Gas	• Natural gas consumption is based on total gas distributed to exit grid points within the Waikato region as supplied by First Gas (excludes sites that have direct connections to the transmission network). • Natural gas used by Huntly Power station and the Te Rapa cogeneration plant has not been included as these are already reflected in the national emissions factor for electricity generation. • The natural gas distribution network does not follow regional boundaries and may include some of the surrounding rural areas. However, it is assumed that the population in these areas is relatively small and therefore the impact to the regional natural gas consumption is not likely to be significant. • Emissions of 6.34 kg CO2e/GJ during distribution was applied, based on the national average reported for distribution loss of reticulated natural gas (MfE 2019).10
Industrial Stationary Energy Emissions	• No specific data was available for industrial stationary energy consumption with the exception of natural gas use for co-generation plants at the Fonterra Te Rapa & Lichfield Dairy plants and fugitive emissions from mining. • Industrial stationary petrol and diesel use have been estimated based on total fuel sold within the region and the EECA Energy Enduse Database.
Fugitive Emissions	• Not included in the Inventory as there is no production of oil or gas within the Waikato region. • Fugitive emissions from coal have been included in industrial stationary energy emissions.
Coal	• Emissions relating to the use of coal from residential, commercial, as well as from agriculture, forestry, and fishery activities have been included for the Waikato region. • Coal consumption for heavy industry was not included (e.g., dairy processing) as these are not relevant for the region (no heavy industry) or use natural gas as fuel source. • Fugitive emissions from coal mining have been included under stationary energy (industrial emissions), based on the national average emissions factor for fugitive emissions from sub-bituminous coal mining reported by MfE.
Transportation Emissions	
Road	• Total volume of fuel sold within the Waikato region and the breakdown by region in FY2021/22 was provided by nine of the ten territorial authorities. The data for Taupō district was taken from the last inventory. • Fuel consumption figures (petrol and diesel) also include fuel used for off-road transport and recreational water transport, as these are sold through the same network. Due to lack of data these could not be reported separately. • Bus diesel was included in the total diesel figures. It only includes Hamilton City Bus consumption FY2021/22 and contributes only to the regional and Hamilton city council calculations.

[10] For more details, see https://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/2019-emission-factors-summary.pdf

Rail	• Emissions from rail transport are estimated based on length of rail network and average fuel consumption per km. Freight volume as provided by Kiwi Rail for the 2021/22 financial year. • The rail network in the Waikato is electric and diesel. • The total volume of rail diesel accounts for fuel used to shift freight via the Waikato region rail network. • It was assumed that diesel sold for rail transport is not included in the Waikato fuel sales data for road transport.
Aviation	• Attempts were made to seek primary data on fuel from fuel companies and Hamilton airport was in the process of gathering such data but not complete within the time of this study. • The 2018/19 aviation emissions, from jet kerosene, were estimated using the average number of plane movements understood to take place via the flightaware.com website. The number of flights estimated was likely to be conservative as movements of large jet planes and some smaller planes. Planes departing and arriving at the same airport (e.g., tourist flights) were not included. • Actual flight data was sought through Hamilton Airport and FlightAware or was not available for the 2021/22 inventory. Estimations were applied to 2018/19 aviation fuel data and fuel use was apportioned based on reductions seen in the NIR between 2018 and 2021 for jet kerosene and aviation fuel; (26.2 % and 24.4 % respectively) based on percentage reductions of aviation emissions (for both types of aviation fuels) referenced in 2023 National GHG inventory.
LPG	• LPG consumption in the Waikato region is based on the total amount of LPG supplied to the North Island and calculated on a per capita basis using 2021/22 population estimates. • LPG transportation energy estimates are based on the national share of automotive and forklift sales as provided by the LPG Association of New Zealand. • LPG consumption estimate does not take into account automotive and forklift sales in the region that may then be taken out of the region or individual territorial authority boundaries.
Biodiesel	• Assumed that 5.4% of total diesel is biodiesel in line with the National GHG Inventory. Since the last inventory, refining in NZ has stopped. All biodiesel is now imported and dispersed across suppliers. For that reason, we have applied the National GHG Inventory 2023 assumption rather than collecting primary data which was not easily sourced. • The National GHG Inventory 2023 denotes a change in feedstock and calculation method, and with feedstock being assumed as fossil origin, part of the CO2 emissions previously reported as biomass memo items is now included in the national total emissions.
Off-Road	• Estimated based on EECA – End-Use Energy Database applying a national average split to the total amount of petrol and diesel sold within the region.
Waste Emissions	
Solid Waste Disposal	• Solid waste emissions were estimated using a 1st-order decay model (which requires waste volume estimates for the last 50 years).

	• Reliable historic population figures, provided by StatsNZ, only go back to 1986 therefore 30 years of data has been estimated for the Waikato region solid municipal waste emissions. • Due to limited specific current and/or historic data for the region, waste volumes sent to landfill for the Waikato region have been estimated by applying the New Zealand national average waste generation per capita (reported by MfE, 2017 Inventory) and using historic population figures reported by StatsNZ. • Landfill gas emissions were estimated for landfills with and without landfill gas capturing systems. The majority of solid waste emissions (54 %) were released from landfills without landfill gas collection. These are predominantly from closed landfills that have been used in the past but are still emitting landfill gas. • Data on specific waste composition was not available therefore this data has been modelled based on the national average waste composition reported by MfE 2019. • For 2021/22 fate of waste for Waikato was based on the Waikato and Bay of Plenty region waste and recycling stock take (WAIBoP stocktake) 2021. This denotes Waikato, Hamilton and Waipā districts send all their waste to landfill at Hampton Downs. Hauraki district, Thames-Coromandel, Matamata-Piako and some South Waikato district waste is sent to landfill at Tirohia. Otorohanga and Waitomo and some South Waikato waste is sent to Waitomo landfill site. Taupō district sends all their waste to Broadlands Road landfill site. See Figure 2 of the WAIBoP stocktake report for landfill locations and waste flows for further detail. • Hampton Downs has been collecting landfill gas since 2006 and Tirohia has been collecting landfill gas since 2001. All other landfill sites in the Waikato region do not collect landfill gas. • From the Waikato and Bay of Plenty region waste and recycling stock take 2021 this also denotes waste inclusions from Auckland, Bay of Plenty and Gisborne district council to Hampton Downs and Tirohia landfills. As accurate historical data is not available this has not been included in this inventory, but may be useful to capture further data on for the next inventory. • In the development of this inventory when seeking data, it became clear that there are significant solid waste transfers to landfill coming into the Waikato region from both Auckland, and Bay of Plenty. The 2021 Waikato Bay of Plenty documents the contemporary Bay of Plenty (and Gisborne) inclusions, and some data was sought from EnviroNZ who manage Auckland waste streams. While some data was gained, without a long-term history of waste inclusions it was not possible to back calculate waste emissions using IPCC/GPC methodologies. Looking forward, it will be important to seek further historical data and calculate emissions for these waste inclusions ahead of the next GHG inventory.
Incineration	• No emissions from industrial processes have been included due to the lack of specific activity data. It is understood there are very few large industrial operations resulting in emissions from chemical or physical processes taking place within the Waikato Region.
Wastewater Treatment	• No data for the specific type of wastewater treatment methods or number of individuals in the region using different wastewater treatment methods was available for the Waikato region at the time of deriving the wastewater emissions. • National wastewater emissions from 2023 Inventory (MfE 2023) and population data from 2021/22 were used to calculate the per capita wastewater treatment and disposal emissions, and the total wastewater emissions from the Waikato region. 2023 data was the most up to date information available from the New Zealand Greenhouse Gas Inventory 1990-2021.

Industrial Emissions	
Industrial Processes	• No emissions from industrial processes have been included due to the lack of specific activity data. It is understood there are very few large industrial operations resulting in emissions from chemical or physical processes taking place within the Waikato region.
Product Use including: HFC, PCFs and SF_6	• Emissions for refrigerants, fire extinguishers, foam blowing, aerosols and metered dose inhalers, as well as SF6 in electrical equipment are estimated based on New Zealand average per capita emissions (Table 1.A(a)s4) data provided in the New Zealand Greenhouse Gas Emissions 1990-2021 report (MfE, 2023).
Agricultural Emissions	
Agriculture	• Agricultural emissions are based on agricultural production statistics (2022 FINAL) data available online from Statistics New Zealand. This data provides census level data of animal and cropping farm system variables at territorial authority scale. • Emission Factors (for most sources) were sourced from 2023 release of the NZ Greenhouse Gas Inventory (1990-2021). This has a mix of NZ specific emission factors and application of IPCC 2006 where NZ based science has not been undertaken for minor livestock categories. Most significant animal and farming losses (dairy, non-dairy cattle, sheep and deer) have NZ based studies and specific emission factors. • Emissions for field burning of agricultural residues have not been included in the calculations above, due to lack of data and methodological guidance by the IPCC 2006 Guidelines. These emissions are assumed to be insignificant within the Waikato context.
Forestry Emissions	
Forestry	• Exotic forest volumes are based on data provided in the National Exotic Forest Description (NEFD) published by MPI (MPI 2022). The data is provided on a territorial authority level. • Carbon sequestration for exotic forests include above ground, below ground, dead wood, and litter. • Carbon sequestration rates for exotic forest are based on yield tables provided by MfE, assuming a 50/50 split between pre 1990 and post 1989 forests within the Waikato region. • Harvest data has been calculated from NZ Forest Growers Levy Trust (NZFGLT) data from actual levy collected per tonne harvested. This provides levy data for Central north island wood supply region, and data was then apportioned using mature age forests found within the NEFD 2022. • Once data on export and domestic harvest was extracted from NZFGLT for Central North Island wood region was then apportioned to the Waikato and associated territorial authorities (excluding Bay of Plenty and other region districts) using mature age forests (26-40 years) found within the NEFD. • Due to insufficient data for land use changes, no emissions from land use change of cropland, wetlands, settlements, and other land have been estimated. • Maturing native forests (i.e., Manuka and Kanuka), as well as grassland with woody biomass have been included as native forests. Data for native forests is based on LCDB vol. 5 data (2018). • Sequestration rates for native forest were based on advice from MfE (2017).

	• Emissions from forest harvesting activities are included in the Inventory as part of the LULUCF emissions. • For the purpose of this report, it was assumed that all carbon stored in tree biomass (above and below ground as well as in dead wood and litter) become an emission in the year of the tree harvest.
Emission Factors	
Emission Factors – Mobile and Stationary Energy	• Emissions factors are based on published New Zealand specific emission factors where possible. Sources include the New Zealand National GHG Inventory (MfE 2023) and Guidance for Voluntary GHG Reporting for Organisations (MfE 2023), National Energy File data (MBIE 2019) and the 5th IPCC Assessment Report (IPCC 2013). A detailed list of emission factors is provided in the individual emissions calculations table in the Excel tables prepared as part of this project. • Advice received by MfE (for a previous report) supported the use of the most recently published emissions factors for all reporting years and emissions calculations. • The Global Warming Potential used to convert CH4 and N2O to CO2e are based on the IPCC Fifth Assessment Report (AR5) for 100-year GWP including climate-carbon feedbacks. These conversion factors are 34, 298, and 1 respectively.

Appendix B - Data Sources and Gaps

Data for the community carbon footprint was collected from a number of data sources. Key data sources are detailed below:

Table 11. Waikato Region GHG Inventory Data Sources – 2021/22

Emissions Category		Data Source
Stationary Energy		First Gas Limited Transpower Electricity Authority KiwiRail Genesis Energy (Huntly Power Station coal and gas use) LPG Association NZ MBIE (2023) Energy in NZ, Section K MBIE (2023) Data Tables for Coal National GHG Inventory (2023) 1990-2021
Transportation		KiwiRail LPG Association NZ Hamilton City Council for Fuel tax data (6 districts) Ministry of Business, Innovation & Employment (fuel properties)
Waste	Solid Waste	Waikato Bay of Plenty Waste and recycling stocktake, 2021 Waste Management Envirowaste Individual City and District Councils Internal Waste data
	Waste Water	1990-2021 National GHG Inventory Report (2023)
Industrial		1990-2021 National GHG Inventory Report (2023)
Agriculture		1990-2021 National GHG Inventory Report (2023) Statistics New Zealand (Agricultural production data – 2022 census)
Forestry		National Exotic Forest Description 2022 – provides data on standing volume, ag distribution, and planting of exotic (and some native planning) at territorial authority. NZ Forest Growers Levy Trust – tables on Export and domestic forest harvest tonnages (converted to cubic metres) for harvest volume. Harvest volume was apportioned to Territorial Authority by calculating mature age forests from NEFD.

A data gap analysis was undertaken during the data collection stage of the project. The following data gaps and alternative data sources were identified:

Table 12. Waikato Region GHG Inventory Data Gaps – 2021/22

Emissions Category	Data Gap	Alternative Data Source
Stationary Energy	Specific biofuel use/consumption City residential consumption	No alternative data source (assumed in line with National GHG Inventory 2023) National average (on per capita basis)

Transportation		Aviation fuel use Taupo Fuel use Specific Biodiesel use	Estimated based on National GHG Inventory (2023). Re-used 2018/19 Taupo fuel data in this instance. Applied national Biodiesel mandate (5.4%)
Waste	Solid Waste	Diversion of waste statistics per landfill site	Assume all waste landfilled
	Waste Water	Further detailed data on influent/effluent and biochemical oxygen demand (BOD) to enable use of WaterNZ methods	WaterNZ growing inventory of WWTP sites, and working directly with TA's.
Industrial		Significant industrial (physical & chemical) process activity resulting in GHG emissions Industrial product use (e.g. asthma inhaler, aerosols, etc.)	No sources identified – assumed not to be relevant or significant Emissions were estimated based on national emissions data on a per capita basis
Agriculture		Cropping on organic soils	Work with WRC to consider LUCAS GIS datasets and assess organic soil losses
Forestry		Waikato specific studies on forest plantings and harvest	Some coverage with MPI Wood availability forecast but not Waikato Specific Applied apportioning calculations from NEFD mature age forests.