



Wairarapa Combined District Greenhouse Gas Inventory

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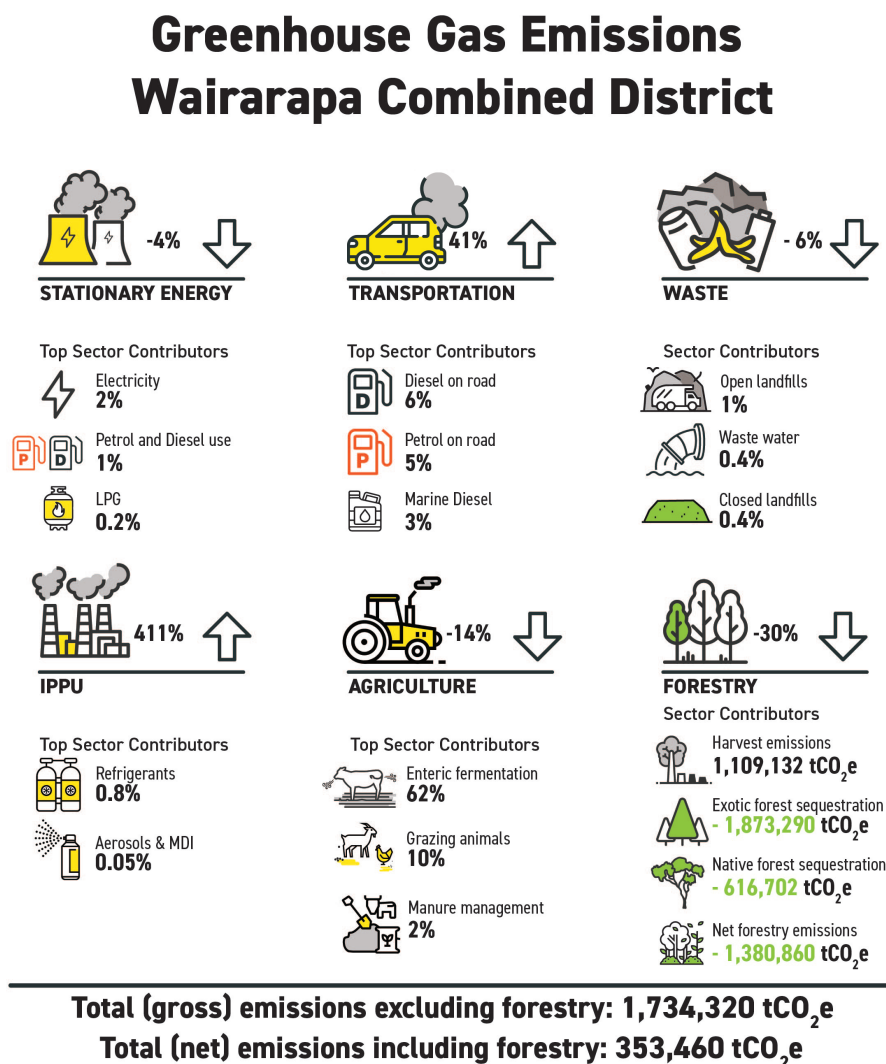
Table of Contents

Executive Summary	i
1.0 Introduction	1
2.0 Approach to analysis	1
3.0 2019 Emissions Inventory	3
3.1 Overall results	3
3.2 Biogenic emissions	6
3.3 Net emissions	6
3.4 Comparison with other districts in the region	7
4.0 Changes in Emissions Inventory, 2001 to 2019	9
4.1 Change in emissions	9
5.0 Comparison with other New Zealand cities and regions	12
6.0 Emissions and other metrics	13
7.0 Closing statement	13
8.0 Limitations	15
Appendix A	
Emission Breakdowns	A
Basic and Basic+ emissions reporting (Global Covenant of Mayors)	A-2
Per capita emissions	A-2
Appendix B	
Assumptions	B

Executive Summary

Carbon emissions for the Wairarapa Combined districts have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC). The method includes emissions from stationary energy, transportation, waste, industry (IPPU), agriculture and forestry sectors. Figure 1 summarises the rate of change in emissions and top contributors to emissions for different sectors.

Figure 1 Summary of change in emissions from 2001 to 2019 including top contributors to total gross emissions from each sector in 2019



The document is split into two parts. In Part 1 this document focusses on the results for the 2018/19 financial reporting year. Referred to hereafter more commonly as 2019 for ease. Part 2 centres on emission trends in the last two decades (2000/01 to 2018/19) or more simply 2001 to 2019. Major findings of the project include:

PART 1 – 2019 Emissions Inventory

- In the 2018/19 reporting year, the Wairarapa Combined Districts emitted **gross 1,734,320 tCO₂e**. This equates for approximately 41% of the Wellington region's total gross emissions, 4,190,050 tCO₂e for the reporting year.
- Agriculture is the biggest source of emissions accounting for 78% of total gross emissions. Transport (e.g. road, flights and rail) is the second largest emitter, 16% of total gross emissions. Stationary Energy, Waste and Industry are minor sources of emissions in the Wairarapa.
- After consideration of carbon sequestration (carbon stored in plants or soil by forests), the Wairarapa emitted **net 353,460 tCO₂e** emissions. This equates to 14% of the Wellington region's total net emissions of 2,552,727 tCO₂e.

PART 2 – Changes in Emissions Inventory, 2001 to 2019

- Wairarapa's emissions fell by 7%, from **gross 1,871,095 tCO₂e** to **gross 1,734,320 tCO₂e (136,775 tCO₂e)** between 2001 and 2019.
- Agriculture, waste and stationary energy emissions reduced between 2001 and 2019, by 14%, 6% and 4% respectively. The reason for the changes differs between sectors. Agriculture emissions reduced more than any sector due mainly to a reduction in the number livestock animals farmed within the area. The use of landfill gas capture has driven the fall in emissions from waste, while greater use of renewable energy to provide electricity has reduced the influence of stationary energy on total emissions.
- Transport and industry emissions increased between 2001 and 2019, by 41% and 411% respectively. Within the transport sector, petrol and diesel use increased by 26% from 2001 to 2019. In the industrial sector the vast majority of emissions are caused by industrial refrigerant use which has increased by 461% in this period.
- The reduction in agriculture emissions is the largest real change (rather than proportionate change) in emissions, decreasing by 221,399 tCO₂e between 2001 and 2019. The increase of 78,704 tCO₂e in emissions from transport was the second biggest real change.
- Net emissions for Wairarapa increased from net -91,460 tCO₂e to net 353,460 tCO₂e between 2001 and 2019. The increase in net emissions is due to forestry harvest emissions increasing dramatically, from 455,522 tCO₂e in 2001 to 1,109,132 tCO₂e in 2019, an increase of 143%.

1.0 Introduction

AECOM New Zealand Limited (AECOM) has been commissioned by the Wairarapa District Councils via a consortium of Wellington Region Councils, to assist in the development of a greenhouse gas footprint for the District for the 2018 / 2019 financial year. The study boundary incorporates the jurisdictions of the Masterton District Council, Carterton District Council and the South Wairarapa Council hereafter collectively referred to as Wairarapa Combined District (WCD).

The results of this study are split into two parts. The focus of Part 1 of this document is to explain the results for the 2018/19 financial reporting year. Referred to hereafter as 2019 for ease. Part 2 centres on emission trends in the last two decades (2000/01 to 2018/19), or more simply 2001 to 2019.

2.0 Approach to analysis

The methodological approach used to calculate emissions follows the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) published by the World Resources Institute (WRI) 2014. The GPC includes emissions from stationary energy, transport, waste, industry, agriculture and forestry activities within the District's boundary. The sector calculations for Agriculture, Forestry, Solid Waste and Wastewater are based on Intergovernmental Panel on Climate Change (IPCC) workbooks and guidance for emissions measurement. Sectors also use methods consistent with GHG Protocol standards published by WRI for emissions measurement when needed.

The same methodology was used for other community scale greenhouse gas (GHG) inventories around New Zealand, (e.g. Auckland, Christchurch, Dunedin, Tauranga and Southland) and internationally. The GPC methodology¹ represents international best practice for district and regional level GHG emissions reporting.

This inventory assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the location of consumption. An example of indirect emissions are those associated with the consumption of electricity, which is supplied by the national grid (Scope 2). All other indirect emissions such as cross-boundary travel (e.g. rail and flights), and energy transportation and distribution losses fit into Scope 3.

All assumptions made during data collection and analyses have been detailed within Appendix B– Assumptions. The following aspects are worth noting in reviewing the inventory:

- Emissions are expressed on a carbon dioxide-equivalent basis (CO₂e) including climate change feedback using the 100-year Global Warming Potential (GWP) values².
- Total emissions are reported as gross emissions (excluding forestry) and net emissions (including forestry)
- Where district-level data was not accessible, information was calculated via a per capita break-down of national or regional level data, this is further detailed in Appendix B.
- Transport emissions:
 - Transport emissions associated with air, rail and port activity were calculated using the induced activity method. Fuel consumption data was determined from the number of journeys taken, distance travelled and consumption rates for the appropriate transport mode.
 - Shipping emissions due to the movement of logs and timber were allocated based on the relative contribution of each district to harvested forest activity within the region.

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

² https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

- Solid waste emissions:
 - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day. Data for the Wairarapa Combined Districts prior to 2014 is estimated based on population figures and NZ average waste generation per person per year. From 2014, data includes waste sent to Bonny Glen Landfill in the Horizons Region. This volume is included in the Wairarapa Combined Districts inventory and subtracted from the Horizon Region's inventory to avoid double-counting.
- Wastewater emissions:
 - Wastewater is treated either using oxidation ponds or septic tanks and is included in the figures.
- Industrial emissions:
 - Due to data confidentiality, the inventory reports all the known industrial product use emissions as one single value and does not break-down emissions by product type. The availability of emissions associated with industry is also restricted due to confidentiality issues and constraints in communication from relevant stakeholders.
- Forestry emissions:
 - This inventory accounts for forest carbon stock changes from afforestation, reforestation, deforestation and forest management (i.e. it applies land-use accounting conventions under the UN Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
 - The inventory considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.
- Due to changes in data sources and methodology, emissions quoted for years prior to 2018/19 may be different to those previously reported.

3.0 2019 Emissions Inventory

This section deals with emission results for the reporting year 2018/19 (2019). The paragraphs, figures and tables below explain the overall emissions and emissions from each sector. The focus of the information presented are gross emissions that need to be addressed in local council policy and initiatives. Results in this section are supported by further information and data in Appendix A.

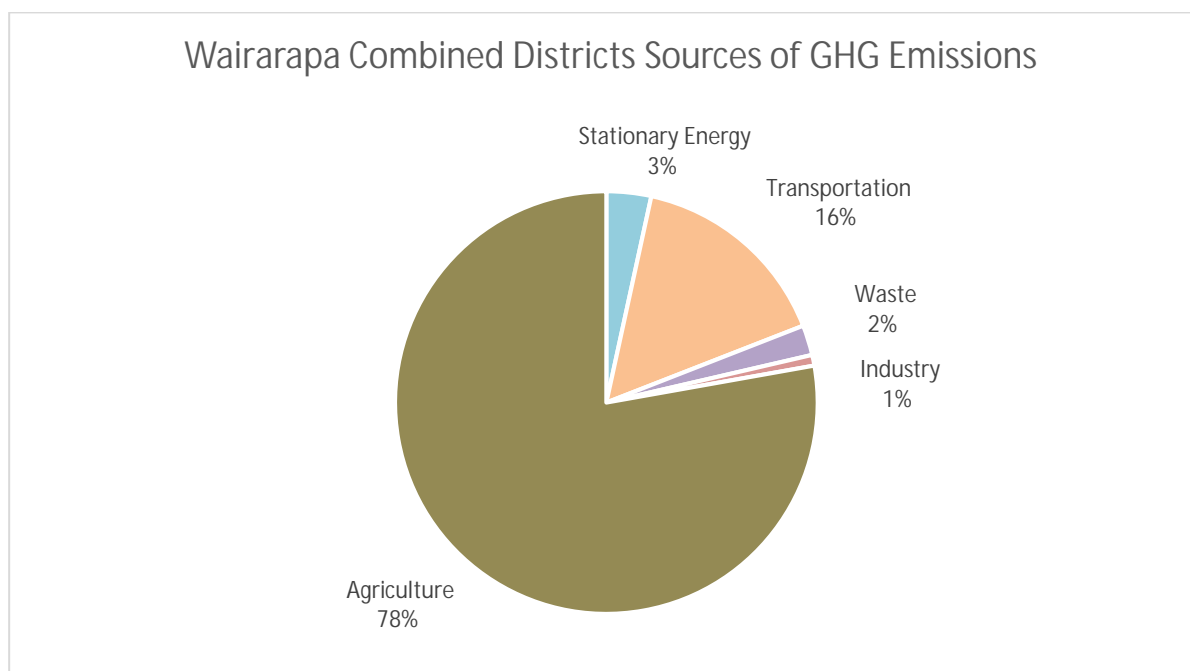
Discussion of per capita emissions is limited to when it is useful for comparing emission figures across the region or with other territorial authorities. Net emissions including results from forestry resources are reported separately.

3.1 Overall results

During the 2018/19 reporting period, the Wairarapa Combined Districts (WCD) emitted **gross 1,734,320 tCO₂e** and **net 353,460 tCO₂e** emissions. This equates for approximately 41% of the Wellington region's total gross emissions for the reporting year.

The population in 2019 was approximately **47,590** people, resulting in per capita gross emissions of **36.4 tCO₂e/person**. Agricultural emissions are the largest contributor to the inventory for the district, followed by Transport (refer to Figure 2 and Table 1).

Figure 2: Wairarapa Combined District's GHG gross emissions split by sector.



The district-level carbon footprint inventory comprises emissions for six different sectors, summarised below:

Stationary Energy: Producing 59,293 tCO₂e in 2019, stationary energy contributes to 3.4% of total gross emissions. Electricity consumption was the cause of 34,550 tCO₂e, or 2% of the Wairarapa's total gross emissions.

- Industrial stationary energy consumption accounts for 28% of stationary energy emissions (16,560 tCO₂e).
- Residential stationary energy consumption accounts for 22% of stationary energy emissions (13,124 tCO₂e).

- Commercial stationary energy consumption accounts for 16% of stationary energy emissions (9,450 tCO₂e).
- The remaining 34% of stationary energy emissions (20,159 tCO₂e) were produced by diesel and petrol, which were not allocated to the above categories.

Transportation: The second highest emitting sector, transport, produced 271,511 tCO₂e in the reporting year (15.7% of Wairarapa's gross total emissions). Most of these emissions can be attributed to On and Off-Road transportation (Petrol and Diesel) within the Wairarapa, which produced a total of 196,844 tCO₂e (73% of the sector's emissions and 11% of the Wairarapa's total gross emissions). The rest of the transport emissions are produced by Wairarapa's share of the emissions associated with air, rail, LPG, Bus Electricity and port activities totalling 74,666 tCO₂e (28% of the sector's total emissions and 4% of WC's total gross emissions).

Waste (solid & wastewater): Waste originating in the Wairarapa (solid waste and wastewater) produced 39,950 tCO₂e in 2019 which comprises 2.3% of the area's total gross emissions. Solid waste produced the bulk of this, 32,665 tCO₂e in 2019, making up 82% of total waste emissions.

Solid waste emissions include emissions from both open landfills and closed landfills that are still emitting GHGs. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill. Open landfills contributed 25,415 tCO₂e (1.5%) and closed landfills 7,251 tCO₂e (0.4%) to gross emissions respectively.

Wastewater produced 7,285 tCO₂e making up 0.4% of total waste emissions. Wastewater tends to be relatively small emission source compared to solid waste as advanced treatment of wastewater produce low emissions. In contrast, solid waste generates methane gas over many years as organic material enters landfill and emissions depend on the efficiency and scale of landfill gas capture.

Industrial Processes and Product Use (IPPU): This sector includes emissions associated with the consumption of GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. The IPPU sector also includes emissions associated with industrial activity within the Wairarapa, which due to confidentiality of data, are reported as a single value. 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).

IPPU in the Wairarapa produced 14,219 tCO₂e in 2019, contributing 0.8% to the area's total gross emissions.

Agriculture: The agricultural sector emitted 1,349,348 tCO₂e in 2019. This is the largest contributor to the area's total gross emissions (77.8%). Enteric fermentation produced 80% of the Wairarapa's agricultural emissions (1,081,636 tCO₂e). Most of the remaining agricultural emissions were produced from manure from grazing animals on pasture (164,862 tCO₂e).

Forestry: The Wairarapa has a regenerative native forested area which includes Manuka, Kanuka and Broadleaved Hardwoods. Regenerating natives occupy 98,983 ha with exotics occupying a further 51,541 ha of land. In total, 2,489,992 tCO₂e were sequestered by forests in the Wairarapa in 2019.

Of the total sequestered CO₂, native forests sequestered 616,702 tCO₂e while exotic forests sequestered 1,873,290 tCO₂e in 2019. With emissions from harvesting of forestry producing 1,109,132 tCO₂e, the forestry sector is a net-negative emitting sector (1,380,860 tCO₂e in 2019).

The detailed break-down of emissions into sub-categories for each sector is provided in Table 1, including the percentage contribution per sector and the total gross emissions (excl. forestry).

Table 1: Summary of Wairarapa Combined District's gross emissions split by Sector and associated sub-categories.

Sector	tCO ₂ e	% Gross	% Sector
Stationary Energy			
Electricity Consumption	31,928	1.8%	53.8%
Electricity T&D Loss	2,622	0.2%	4.4%
Natural Gas	-	0.0%	0.0%
Natural Gas T&D Loss	-	0.0%	0.0%
LPG	3,130	0.2%	5.3%
Stationary Petrol & Diesel Use	20,159	1.2%	34.0%
Coal	718	0.0%	1.2%
Biofuel / Wood	737	0.0%	1.2%
Total:	59,293	3.4%	100%
Transportation			
Petrol	91,514	5.3%	33.7%
Diesel	105,330	6.1%	38.8%
Rail Emissions	696	0.0%	0.3%
Bus (Electric)	9	0.0%	0.0%
Jet Kerosene	23,367	1.3%	8.6%
Av Gas	51	0.0%	0.0%
Marine Diesel	47,294	2.7%	17.4%
Light Fuel Oil	3,018	0.2%	1.1%
LPG	232	0.0%	0.1%
Total:	271,511	15.7%	100%
Waste			
Solid Waste Disposal	32,665	1.9%	81.8%
Wastewater	7,285	0.4%	18.2%
Total	39,950	2.3%	100%
IPPU			
Industrial Emissions	14,219	0.8%	100.0%
Total	14,219	0.8%	100%
Agriculture			
Agriculture	1,349,348	77.8%	100%
Total	1,349,348	77.8%	100%
Forestry			
Exotic Forest Sequestration	-1,873,290	N/A	N/A
Native Forest Sequestration	-616,702	N/A	N/A
Harvest Emissions	1,109,132	N/A	N/A
Total	-1,380,860	N/A	100%

Total Emissions	tCO₂e
Total (net) incl. forestry	353,460
Total (gross) excl. forestry	1,734,320

3.2 Biogenic emissions

Biogenic CO₂ and methane emissions are stated in Table 2 and Table 3, respectively.

Biogenic CO₂ emissions from plants and animals are excluded from gross emissions as they are part of the natural carbon cycle. For example, wood biofuels originate from forestry and the Biogenic CO₂ from biofuels is excluded from gross emissions.

Biogenic CH₄ emissions are included in gross emissions due to their relatively large impact on warming relative Biogenic CO₂. For example, farmed cattle produce Biogenic CH₄ emissions via enteric fermentation that are included in gross emissions.

The importance of Biogenic CH₄ is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes targets to reduce Biogenic CH₄ between 24 percent and 47 percent below 2017 levels by 2050, and 10 percent reduction below 2017 levels by 2030. More information on the Act is available here: <https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act>

Table 2 Biogenic CO₂ (Excluded from gross emissions)

Biogenic Carbon Dioxide (Excluded from gross emissions)		
Biofuel	7,759	t CO ₂
Biodiesel	-	t CO ₂
Landfill Gas	-	t CO ₂
Total biogenic CO₂	7,759	t CO₂

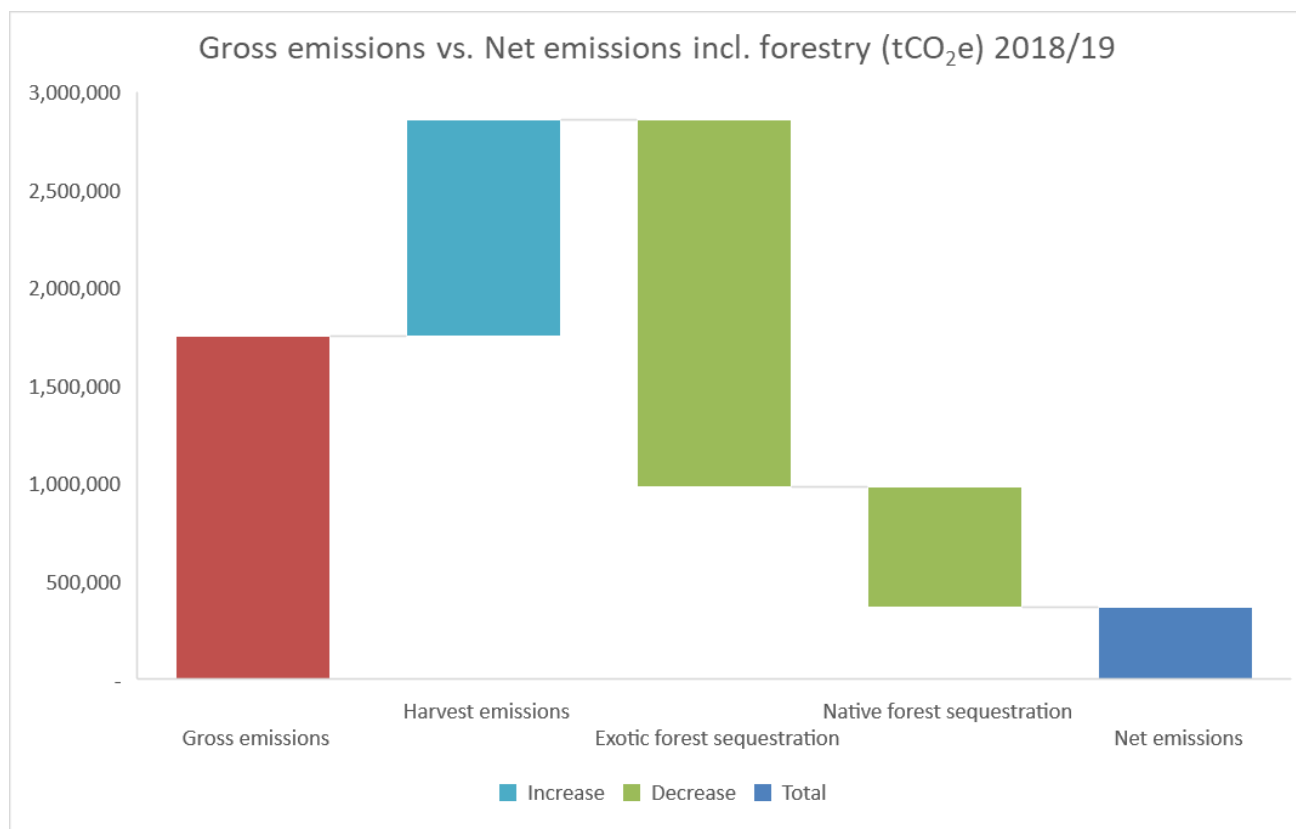
Table 3 Biogenic Methane (Included in gross emissions)

Biogenic Methane (Included in gross emissions)		
Biofuel	19	t CH ₄
Biodiesel	-	t CH ₄
Landfill Gas	961	t CH ₄
Wastewater Treatment	187	t CH ₄
Enteric fermentation	31,813	t CH ₄
Manure Management	992	t CH ₄
Total biogenic CH₄	33,972	t CH₄

3.3 Net emissions

Net emissions differ from gross emissions because they include emissions related to forestry activity within an area. Emissions from forestry include two main types of activity. Harvesting of forest increases emissions via the use of fuel by equipment and releasing carbon from plants and soils. Planting of native forest (e.g. Manuka, Kanuka), and exotic forest (e.g. pine), sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. When sequestration by forests exceeds emissions from harvesting, the extra quantity of carbon sequestered by forest reduces total gross emissions.

Overall, forestry is a net negative source of emissions of -1,380,860 tCO₂e due the sequestration of carbon mostly by exotic forest. Net negative emissions from forestry reduce gross emissions by 80% to a total of 353,460 tCO₂e net emissions. Figure 3 shows gross emissions versus net emissions in 2019 and the impact of sequestration by Forestry.

Figure 3 Gross versus Net emissions incl. forestry

Carbon sequestered by forestry can be viewed as a liability/risk needing careful consideration. For example, what happens if there is large downturn in exports of exotic pine? If plantations are not replanted or other land use change occurs to exotic forested areas, then emissions will quickly rise. Equally, if native forest is not protected from removal, and removal does happen, then emissions will rise. In summary, when a large amount of carbon is captured by forests, long-term planning is needed on how best to manage this carbon sink.

3.4 Comparison with other districts in the region

Table 4 shows gross emission results across the Wellington Region. The Wairarapa contributed to 41% of Wellington Region's total gross emissions for the 2019 reporting year.

With the largest population within the region, Wellington City contributes the highest overall emissions in comparison to the other Wellington Region districts (excluding Wairarapa). Wairarapa's high emissions are due to a large agricultural sector in that district.

Table 4: Wellington Region overall emissions - a comparison of districts

	Wellington Region	Wellington City	Porirua City	Kāpiti Coast	Lower Hutt	Upper Hutt	Wairarapa
Total Gross Emissions (tCO₂e)	4,190,050	1,061,383	304,431	351,245	532,339	206,331	1,734,320
% of Region Gross Emissions	100%	25%	7%	8%	13%	5%	41%

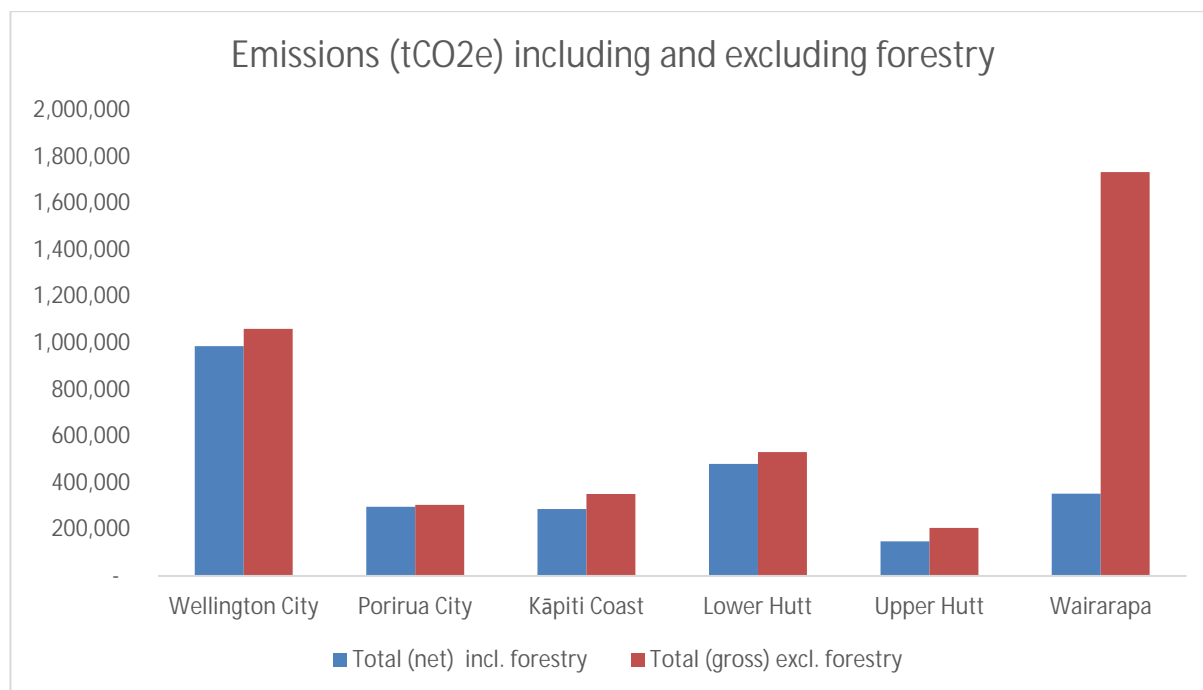
Table 5 shows figures for net emissions including sequestration from forestry. Net emissions produce a widely different pattern of results across the region than gross emissions. For example, net emissions for the Wairarapa, which has the highest gross emissions, are lower than both Lower Hutt and Wellington City.

Table 5 Net emissions (incl. forestry) in the Wellington Region

	Wellington Region	Wellington City	Porirua City	Kāpiti Coast	Lower Hutt	Upper Hutt	Wairarapa
Total Net Emissions (tCO₂e)	2,552,727	986,196	296,815	286,560	480,834	148,862	353,460
% of Region Net Emissions	100%	39%	12%	11%	19%	6%	14%

The influence sequestration of carbon by forests, on gross emissions for The Wairarapa Combined District's, and on other parts of the region, can be seen clearly in Figure 4.

Figure 4 Gross emissions and net emissions (incl. forestry) in the Wellington Region



4.0 Changes in Emissions Inventory, 2001 to 2019

PART 2 considers the trends in emissions from 2001 to 2019. The focus of these results remains on gross emissions. However, per capita emissions are included when useful. Net emissions are discussed in the context of managing carbon sequestration by forest. Results in this section are supported by further results and data visualisations in Appendix A.

4.1 Change in emissions

Wairarapa's GHG inventory data covers 2001 to 2019. Figure 5 shows the change in gross emissions for each sector in the years between 2001 and 2019. The 2019 results can be directly compared with calculated data back to 2001 by using the same data and methodology as this study.

Total gross emissions fell by 7%, from 1,871,095 tCO₂e in 2001 to 1,734,320 tCO₂e in 2019. Reductions in emissions from stationary energy, waste and agriculture are responsible for the fall in total gross emissions. As the area's population has risen (by 22%, from 39,090 to 47,590), per capita gross emissions have reduced by 24% from 47.9 tCO₂e in 2001 to 36.4 tCO₂e in 2019.

The rest of this section briefly summarises major changes in the sectors that make up community-scale emissions.

- **Stationary Energy:** Emissions from stationary energy decreased in number in this time, from 62,053 tCO₂e to 59,293 tCO₂e, a fall of 4%.

Emissions from commercial stationary energy consumption shrank the most over the measurement period by 21% (13,881 tCO₂e to 9,450 tCO₂e). Emissions from residential stationary energy consumption also decreased by 19% (18,417 tCO₂e to 13,123 tCO₂e). Industrial stationary energy emissions dropped by the least, 14% (22,417 tCO₂e to 16,560 tCO₂e). In real terms however, industrial emissions reduced by the largest amount (5,857 tCO₂e).

The changes in stationary energy emissions are explained most noticeably by the changes in electricity and diesel consumption between 2001 and 2019. Electricity consumption increased by 27% between 2001 and 2019 while associated emissions reduced by 17% (41,501 tCO₂e to 34,550 tCO₂e). The fall in stationary energy electricity emissions is largely due to changes in the mix of fuels used for electricity generation in New Zealand e.g. the greater use of renewable energy including wind rather than fossil fuels e.g. oil, gas and coal. The use of fossil fuel to generate electricity in New Zealand has decreased since 2010 and has been replaced by renewable sources. For example, oil for electricity production was phased out and the use of wind power increased.

The emissions from petrol and diesel used for stationary energy have different trends between 2001 and 2019. Petrol emissions increased slightly from 584 tCO₂e to 678 tCO₂e. In the same time, diesel emissions increased from 10,953 tCO₂e to 19,480 tCO₂e, a rise of 39% and 8,528 tCO₂e.

LPG, coal and biofuel emissions all reduced between 2001 and 2019.

- **Transport:** Emissions from transport increased in number, and as a proportion of total gross emissions between 2001 and 2019, from 192,807 tCO₂e (10% of total gross emissions) to 271,511 tCO₂e (16% of total gross emissions), an increase of 41%.

Road transport is the highest emitting activity within the transport sector. Road emissions increased overall by 24% (34,440 tCO₂e) during the measurement period. Both on and off-road petrol and diesel emissions increased during this period. Petrol emissions increased by 26% (40,061 tCO₂e), from 156,783 tCO₂e in 2001 to 196,844 tCO₂e in 2019 and diesel emissions rose by 39% (29,732 tCO₂e), from 75,608 tCO₂e to 105,339 tCO₂e.

Marine transport is the Wairarapa's second highest emitting transport sector. Marine transport emissions increased by 192% (33,053 tCO₂e) between 2001 and 2019, from 17,258 tCO₂e to 50,312 tCO₂e. The rise in emissions from marine transport is driven mainly by the increase in the international export of logs from the Wairarapa.

Air travel emissions increased by 33% (5,794 tCO₂e) from 17,624 tCO₂e to 23,418 tCO₂e with rail emissions also increasing, but by a relatively small real amount (269 tCO₂e) between 2001 and 2019.

- **Waste (solid & wastewater):** Waste emissions are an important measure of progress for reducing environmental impact for many stakeholders. Overall waste emissions decreased by 6% from 42,709 tCO₂e in 2001 to 39,950 tCO₂e in 2019. The change in emissions reflects the impact of greater use of landfill gas capture. Gas capture reduces the warming effect of emissions from landfill by either using the methane captured for electricity production or breaking it down by flaring.

Waste continues to emit methane for many years after entering a landfill site. We have calculated annual emissions from currently open, and currently closed, landfill sites (as of 2019). Solid waste emissions from closed landfill sites reduced by 69% (16,192 tCO₂e) from 23,442 tCO₂e in 2001 to 7,251 tCO₂e in 2019. In 2001 solid waste in closed landfill sites made up 55% of total waste emissions for the Wairarapa. By 2019 emissions closed landfill sites accounted for 18% of total waste emissions.

Emissions from open landfills managing solid waste are the biggest single source of total waste emissions in 2019 (64% of total waste emissions). Solid waste emissions from open landfill sites increased by 90% from 13,342 tCO₂e in 2001 to 25,415 tCO₂e in 2019. However, since reaching a peak in 2014, emissions have fallen by 30% (10,950 tCO₂e). The reduction in open landfill emissions indicates the improved management of landfill gases since 2014.

Wastewater emissions are the smallest cause of emissions in the waste sector. As the population of the city has grown (by 22% between 2001 and 2019), associated emissions from the treatment of wastewater have trended upward. Wastewater emissions increased from 5,924 tCO₂e in 2001 to 7,285 tCO₂e in 2019, 23% higher.

- **Industry (IPPU):** Industrial Processes and Product Use (IPPU) emissions between 2001 and 2019 were a relatively small part of total gross emissions (representing 0.1% and 0.8% of total emissions in 2001 and 2019 respectively). Emissions from industrial sources jumped to 2,780 tCO₂e from 14,219 tCO₂e in this time, an increase of 411%. The increase in the industrial emissions follows developments at the national level in NZ where emissions have risen.
- **Agriculture:** Agriculture contributed by far the most to emissions in the Wairarapa's footprint and dropped by 14%, from 1,570,746 tCO₂e to 1,349,348 tCO₂e, between 2001 and 2019. The number of farm animals within the area (e.g. cattle (both dairy and non-dairy), sheep and pigs) fell from 1,984,638 to 1,652,099 in this period. Agricultural emissions are an important source of Biogenic Methane targeted as a reduction opportunity in the Climate Change Response (Zero Carbon) Amendment Act.
- **Forestry:** For the last two decades sequestration levels from regenerating forest have been relatively steady. Sequestration by exotic forest was main source of capturing carbon in this time. Carbon stored by exotic forestry (e.g. pine) rose by 4%, sequestering 1,801,044 tCO₂e in 2001 compared to 1,873,290 tCO₂e in 2019. Native forests (e.g. Manuka and Kanuka) stored 617,033 tCO₂e and 616,702 tCO₂e, in 2001 and 2019 respectively; a change of just 0.1%.

Data availability and quality of data for harvest emissions has rapidly improved in recent years meaning we can calculate these emissions for the last 20 years. Harvesting emissions increased by 143% from 455,522 tCO₂e in 2001 to 1,109,132 tCO₂e in 2019. The growth in harvesting emissions potentially means exotic trees are being removed in greater numbers.

Figure 5 Gross emissions per year (excluding forestry) from 2001 to 2019

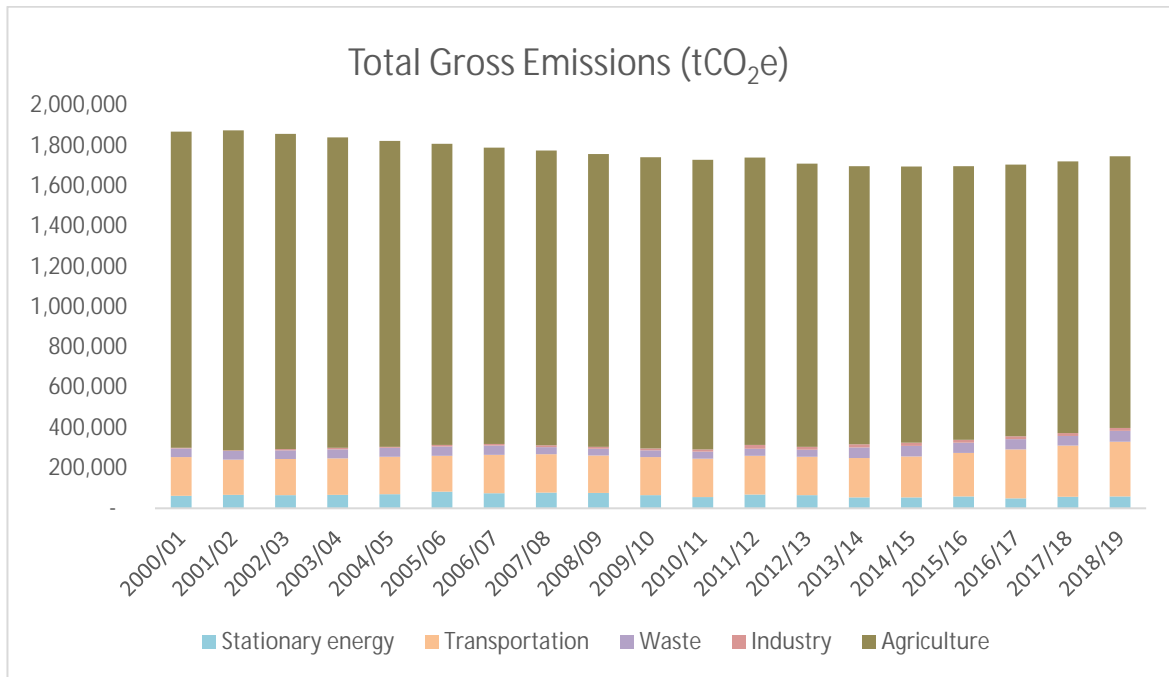
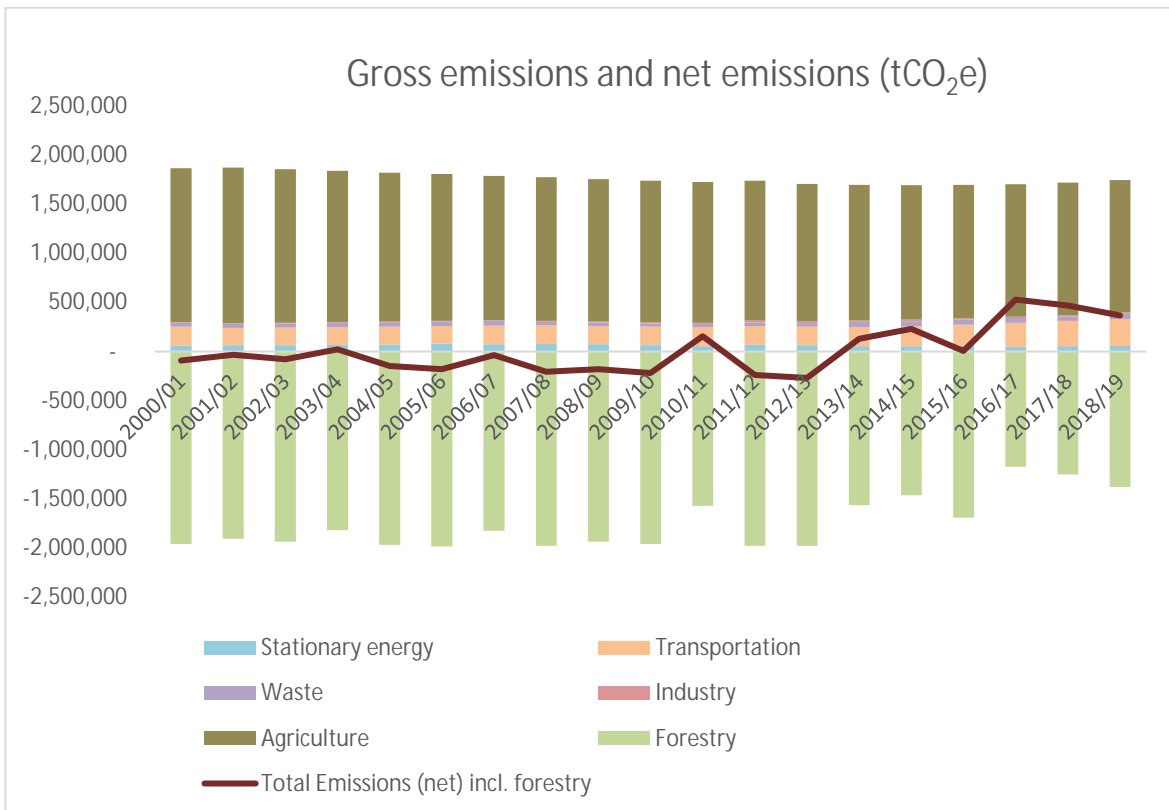


Figure 6 shows the impact of sequestration in the forestry sector on reducing net emissions. Net forestry sequestration reduced by 30% between 2001 and 2019 causing net emissions to increase from net-negative total emissions (-91,460 tCO₂e in 2001) to net-positive emissions (353,460 tCO₂e in 2019).

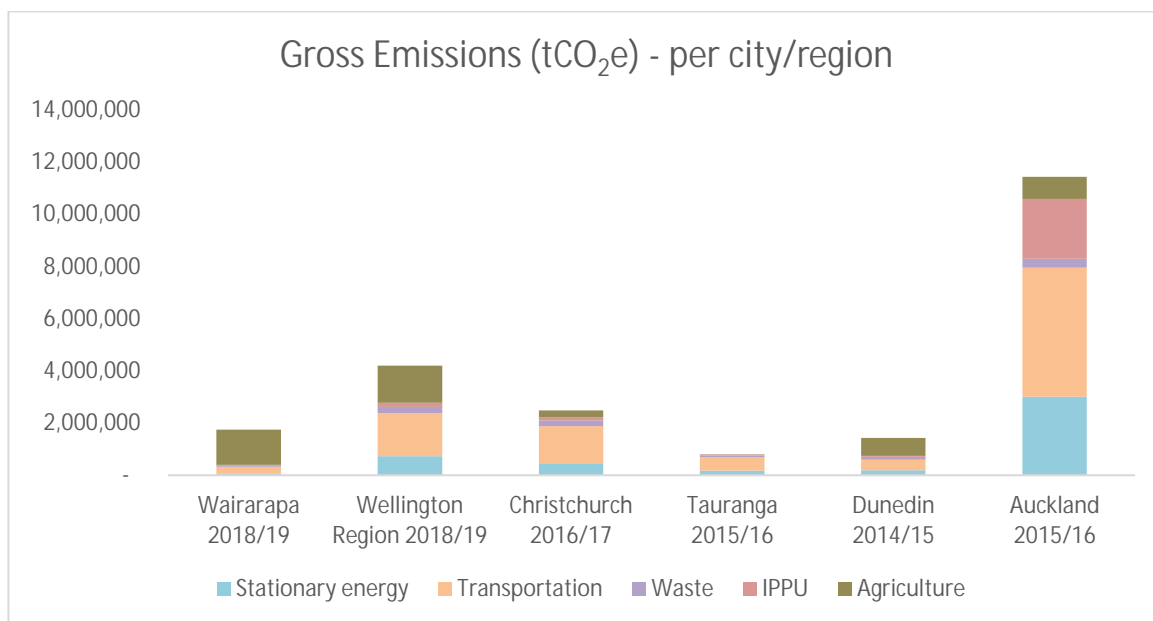
Figure 6 Annual emissions showing gross and net emissions (including forestry) from 2001 to 2019



5.0 Comparison with other New Zealand cities and regions

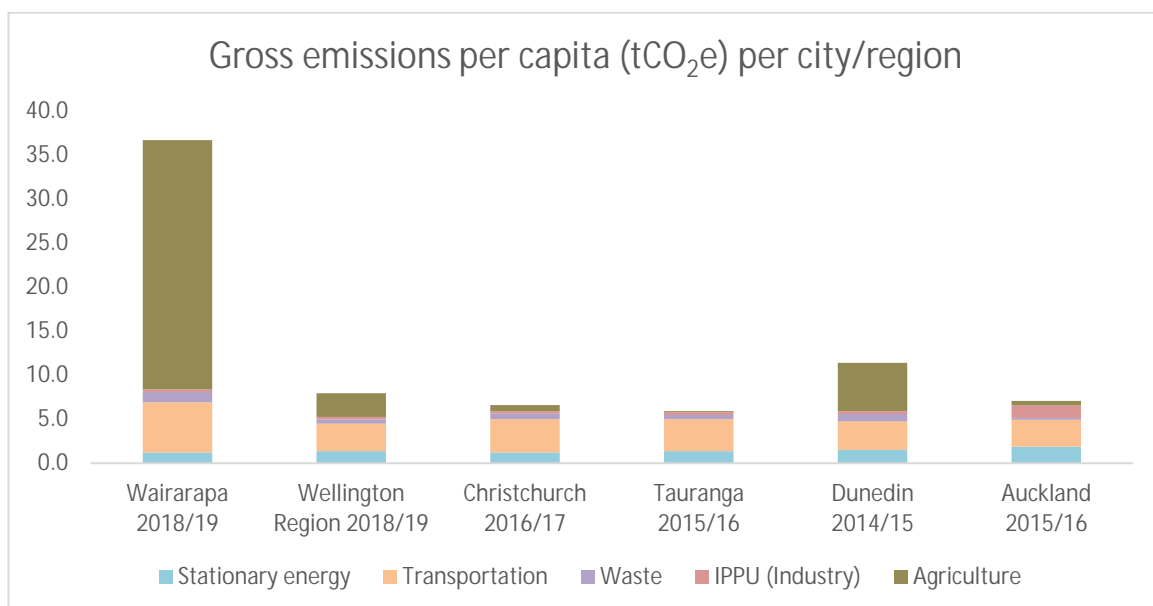
When compared with gross emissions from the Wellington region and other GHG Inventory studies, The Wairarapa has higher gross emissions compared to Tauranga and Dunedin, and lower gross emissions than the other areas. Note that the compared studies were conducted at differing geographic levels and in differing timeframes.

Figure 7 Comparison of gross emissions by area/region



When comparing different regional carbon footprints, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. The Wellington region has substantially lower per capita gross emissions than the Wairarapa mostly due to the large agricultural sector and small population in the Wairarapa. Per capita emissions in the Wairarapa are higher than in the other recent footprint studies presented in Figure 8, even when not considering agriculture.

Figure 8 Comparison of per capita gross emissions by area/region



6.0 Emissions and other metrics

Figure 9 shows the change in gross emissions when compared to changes in other metrics of interest between 2001 and 2019. Total gross emissions have reduced by 7%, against the backdrop of a 22% growth in population within the Wairarapa. Per capita emissions have fallen roughly in line with the rise in population observed (by 24%).

When emissions grow less rapidly than Gross Domestic Product (GDP) as a measure of income then this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 9 suggest at a high-level decoupling has occurred in the last two decades. GDP was 42% higher in 2019 than in 2001 while emissions per unit of GDP declined by 35%.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transport and housing will all contribute. In this case, both direct local actions including reducing the emissions from landfill gas and indirect national trends e.g. reduction of emissions from electricity generation will have contributed to the trends noted.

7.0 Closing statement

Wairarapa's updated GHG inventory provides information for the Council to demonstrate progress in emissions reductions as well as providing a continuing platform for action by the District Council, their stakeholders and the wider community. Sector-level data allows the District Council to target and work with those sectors, e.g. transport, which contribute the most emissions to the footprint.

Understanding of the extensive and long-lasting effects of climate change are improving all the time. The database the Council has developed over the last two decades provides an excellent foundation to implement informed decisions and policies to reduce emissions and to address climate change adaptation across the region.

We encourage councils to use the results of this study to update current climate actions plans. For example, results clearly highlight the need for rapid action to tackle the growth in emissions from air travel, marine shipping, and diesel consumption. Stationary Energy accounts for around a third of emissions; facilitating improvements in energy efficiency within this sector may be an effective method of reducing overall emissions.

Figure 9 Change in total gross emissions compared to other metrics of interest

Wairarapa Emissions change over time 2001 – 2019



8.0 Limitations

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Appendix A

Emission Breakdowns

Appendix A Emission Breakdowns

The pie charts below show a breakdown of the proportion of gross emissions from each sector and source. The second pie chart is focussed on the sources of emissions from stationary energy and transport emission sources.

Note: Emission sources lower than 1% of total emissions are not shown but can displayed, if needed.

Figure 10 Total gross emissions breakdown, by source (emissions representing less than 1% of total emissions are not shown)

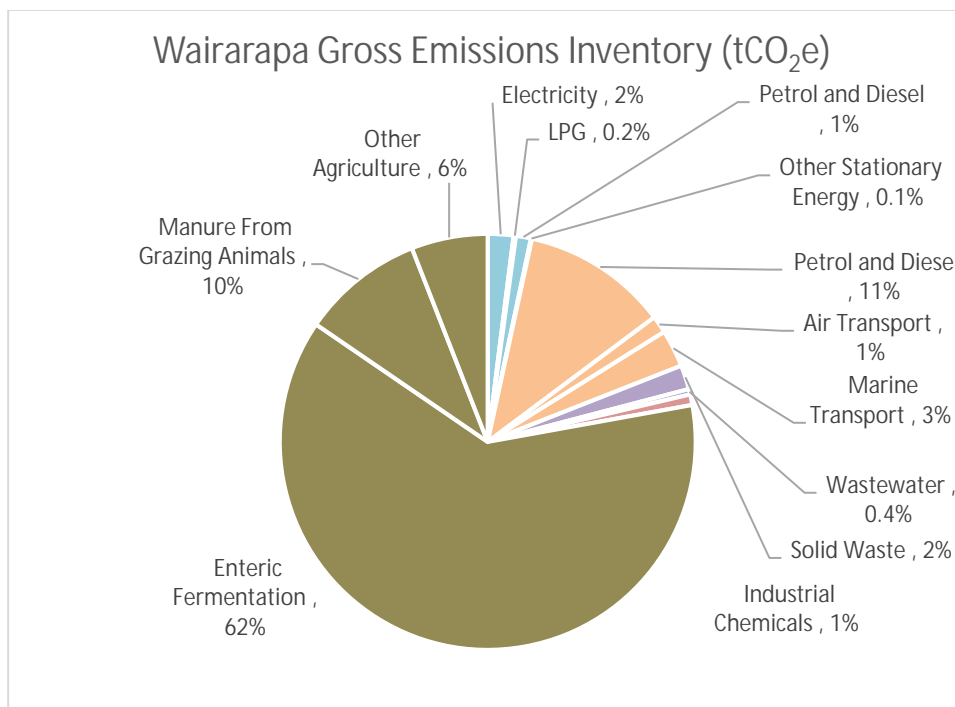


Figure 11 Total gross emissions breakdown, by source, highlighting agriculture emissions

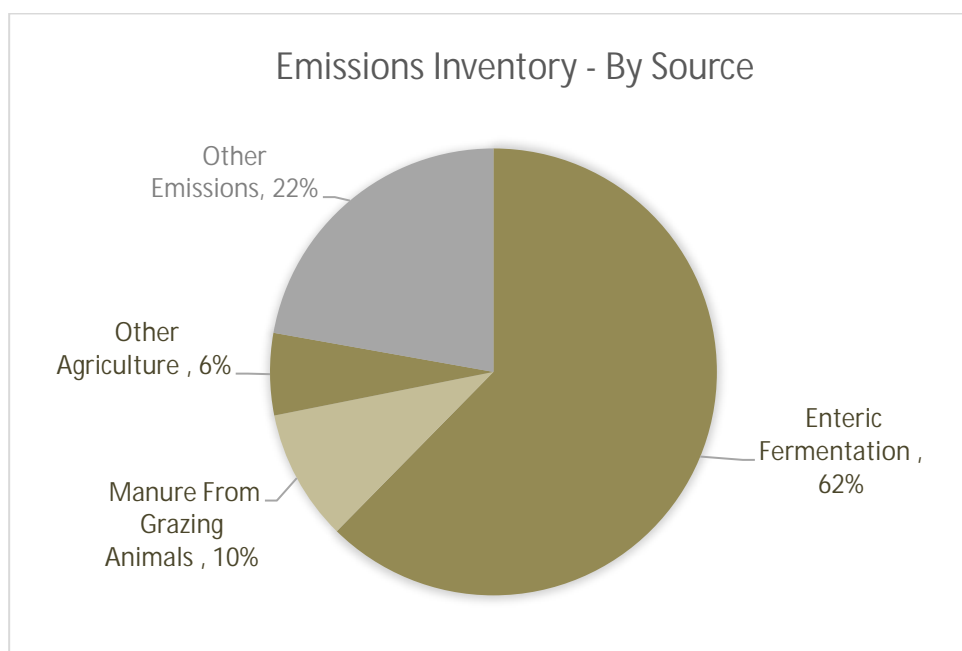
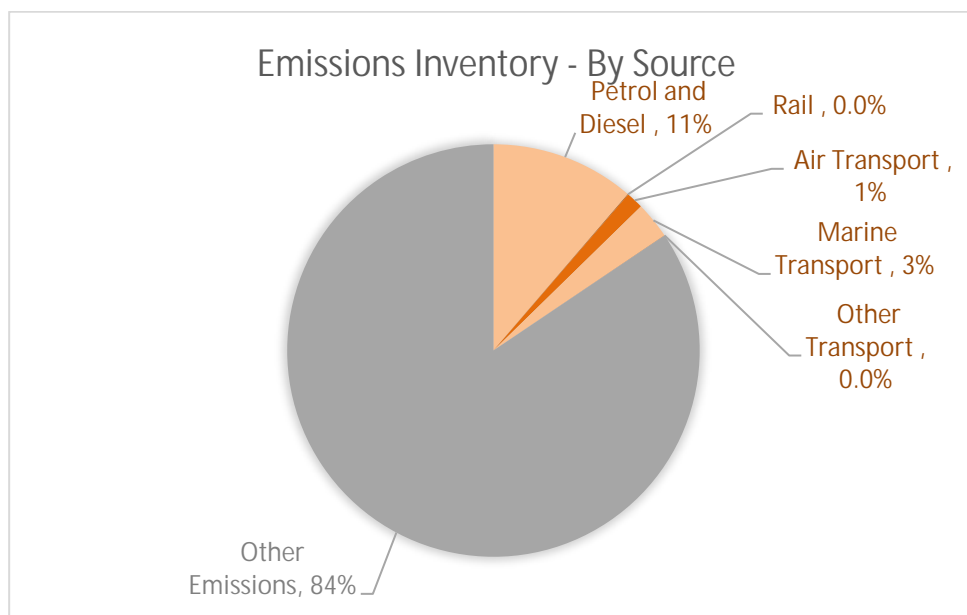


Figure 12 Total gross emissions breakdown, by source, highlighting transport emissions



Basic and Basic+ emissions reporting (Global Covenant of Mayors)

BASIC and BASIC+ emissions reporting are standardised reporting methods used by the Global Covenant of Mayors for Climate and Energy for comparison of emissions with other cities around the world and to demonstrate the importance of district-level climate action at a local and global scale. BASIC and BASIC+ emissions are reported as outlined in the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC).

BASIC emissions reporting excludes emissions from Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use and greenhouse gas emissions occurring outside the district boundary as a result of activities taking place within the district boundary. BASIC+ emissions reporting includes those emissions excluded from BASIC emissions reporting (which is equal to the total gross emissions reported in this study).

Table 6 BASIC and BASIC+ emissions

	Emissions tCO ₂ e
BASIC	368,132
BASIC per capita	7.7
BASIC+	1,734,320
BASIC+ per capita	36.4

Per capita emissions

On a per capita basis, Wairarapa (36.4 tCO₂e) has by far the highest gross emissions compared to the other areas of the Wellington region. The Wairarapa’s particularly high per capita emissions are predominantly due to a large agricultural sector in the region, combined with a small population. However, even when not considering agricultural emissions, the Wairarapa still has the highest per capita emissions.

Figure 13 A comparison of per capita gross emissions (tCO₂e) between territorial areas in the Greater Wellington Region.

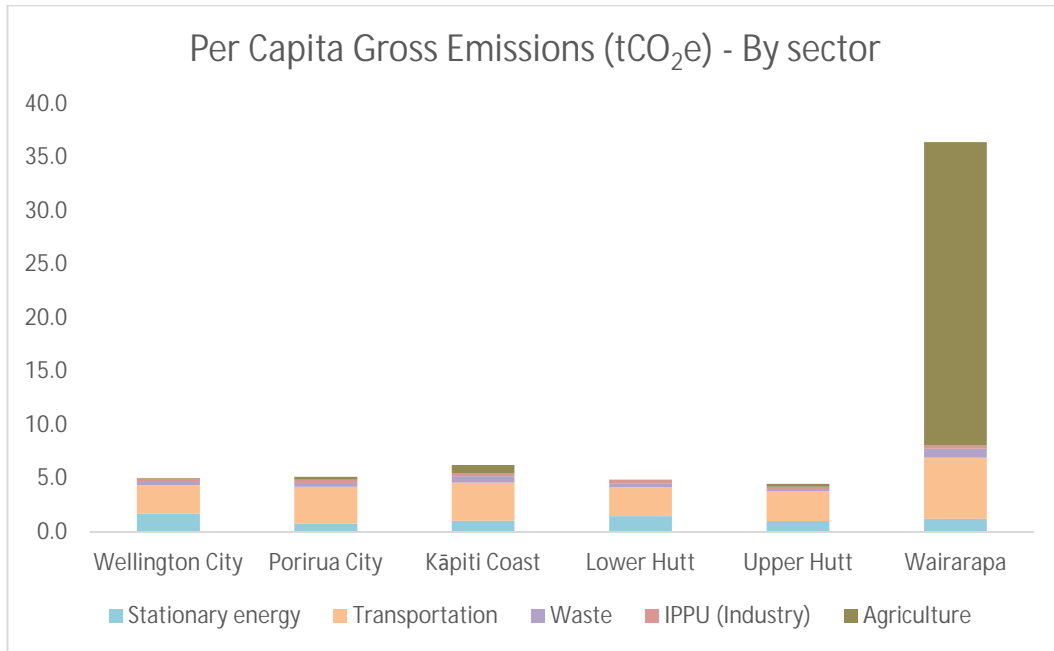
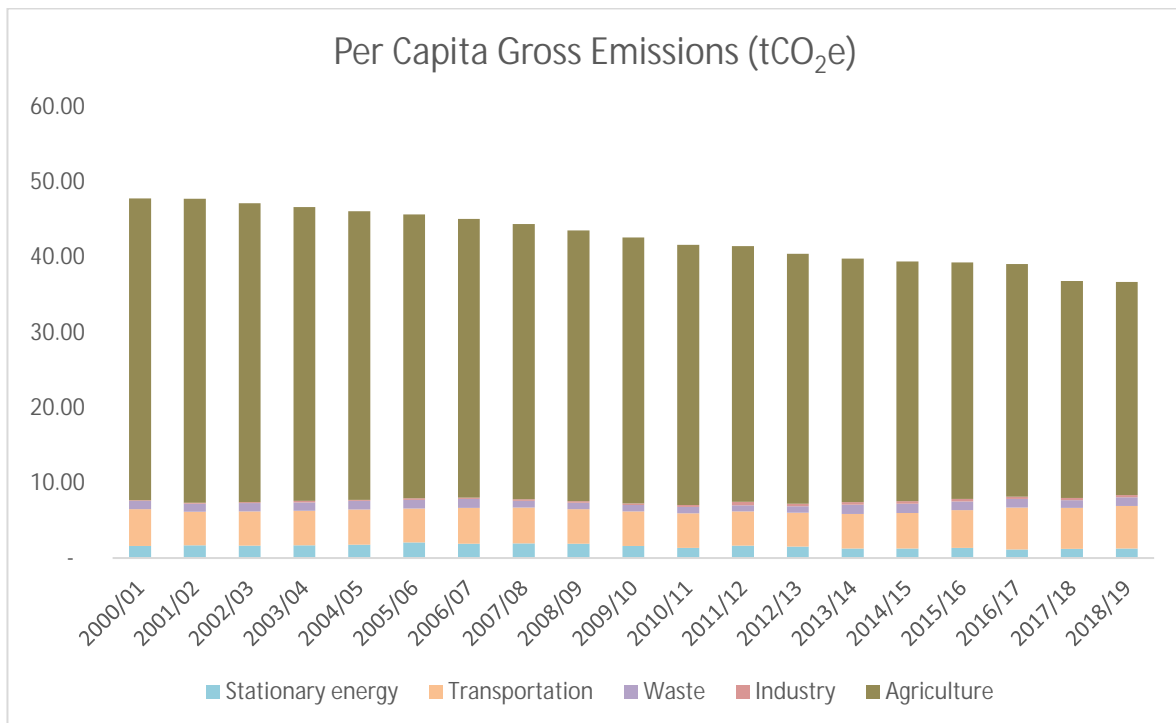


Figure 14 Per capita gross emissions, by sector (2001-2018/19)



Appendix B

Assumptions

Nova Sector / Category	Assumption and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied
Population	Where district-level data was not accessible, information was calculated via a per capita break-down of national or regional level data. This is detailed in each emission section below.
Transport Emissions	
Petrol and Diesel:	<p>Regional sales figures were used. A per capita split was then applied to distribute the sales figures between each district by population.</p> <p>The transport vs stationary energy share of the fuel was calculated using national inventory data.</p> <p>The on-road and off-road split of petrol and diesel was calculated using the Energy Efficiency and Conservation Authority (EECA) national percentage split.</p> <p>On-road is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses.</p> <p>Off-road is defined as machinery for agriculture, construction and other industry used off-roads.</p>
Rail Diesel	<p>Consumption was calculated by Kiwi Rail using the Induced Activity method for system boundary. The following assumptions were made:</p> <ul style="list-style-type: none"> - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carries multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. <p>Using the induced activity method, the trans-boundary routes were determined, and the number of stops taken along the way derived. The total amount of litres of diesel consumed per route was then split between the departure district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated.</p>
Jet Kerosene	<p>Calculated using the Induced Activity method as per rail diesel.</p> <p>Wellington Airport serves the entire Wellington Region and therefore its associated emissions have been split on a per capita basis across each district.</p> <p>An estimate was calculated for flights departing and arriving from Wellington Airport:</p>

	<ul style="list-style-type: none"> - Departures and arrivals information, and aircraft models, were used to calculate flight numbers and represent the models of aircraft for the years between 2016 and 2019. - All flight-path distances between Wellington and the destination / origin airport were calculated. - A density for kerosene of 0.81g/cm³ was applied to all trips. - Fuel Burn (kgCO₂e/km) for each model of aircraft was sourced where accessible. Where not available, the national inventory average figures were applied. - As per the induced activity method, only 50% of emissions calculated per one-way arrivals and departures were allocated to Wellington Airport. The remaining 50% of each leg was allocated to the originating or destination airport. - Light aircraft emissions were not calculated. Only a very small number occur, so assumed to be insignificant. - Fuel use data for aviation was also collected and used when possible to provide consistency with previous reporting. <p>Scope 2 electricity use by airport / planes are incorporated within the general electricity consumption data for the district.</p>
Aviation Gas	<p>The total volume of aviation gas consumed by Wellington Airport has been split between the districts on a per capita basis. This reflects the assumption made that Wellington Airport serves the entire Wellington region and not just the district in which it is situated.</p> <p>Av Gas consumption was estimated based on community carbon footprints developed for other regions in New Zealand.</p>
Marine Diesel	<p>Port Operations:</p> <ul style="list-style-type: none"> - As per the induced activity method, only 50% of emissions calculated per one-way arrivals and departures were allocated to Wellington Port (CPL). The remaining 50% of each leg was allocated to the originating or destination port. - Wellington City Council and Hutt City Council share equally the emissions generated by the East by West ferries. - International shipping passing through Wellington Port (CPL) was split by weight of cargo into 'Logs' and 'All other cargo'. Emissions generated by 'All other cargo' has been allocated on a per capita basis between all districts in the Wellington Region. Emissions generated by 'logs' (over 50% of total international shipping emissions) was split between districts, proportionally, by the percentage share of district forest area of harvest age (>26 years old).
Light Fuel Oil	<p>Calculated using the Induced Activity method as per the rail and aviation data.</p> <p>Does not include fuel use for private boating</p>
LPG	<p>North Island national consumption figures were used.</p> <p>LPG consumption and associated emissions have been split on a per capita basis across each district.</p>
Bitumen	Not calculated
Lubricants	Not calculated
Stationary Energy Emissions	
Electricity Demand	<p>Electricity demand has been calculated using national-level demand figures (kWh) from the MBIE, broken down on a per capita basis across each district, and district-specific Grid Exit Point data from the Electricity Authority (New Zealand).</p>

	The breakdown into sectors is based on NZ average consumption per sector (residential, commercial and industrial).
Electricity Generation	There is electricity generation in the Wellington region, however, emissions produced in electricity generation are not required to be reported for the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) standard.
Public transport electricity	There are electrified public transport systems in the Wellington region. Data has been provided at the regional level and broken down on a per capita basis for each district as public transport systems cross district boundaries.
Coal production	Not Calculated: There are no active coal mines within the region. (NZP&M 2019)
Coal Consumption	Consumption estimates based on national Commercial and Residential consumption for reporting years. Consumption and associated emissions have been split on a per capita basis across each district.
Biofuel and Wood Consumption	Consumption estimates based on national Commercial and Residential emissions for biofuel use (provided New Zealand Greenhouse Gas Emissions 1990 -2015 (MfE 2017)). Consumption and associated emissions have been split on a per capita basis across each district.
LPG Consumption	National LPG sales data has been provided by the LPG Association. Consumption and associated emissions have been split on a per capita basis across each district.
Natural Gas Consumption	No assumptions were made around the district's general consumption data received from Vector. This information includes gas consumed by industrial, commercial and residential activities.
Coal Fugitive Emissions	Not Calculated: There are no active coal mines within the region. (NZP&M 2019)
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Biogenic Emissions	Consumption estimates based on national Commercial and Residential emissions for biofuel use (New Zealand Greenhouse Gas Emissions 1990 -2017 (MfE 2019)). Consumption and associated emissions have been split on a per capita basis across each district.
Agricultural Emissions	
General	No assumptions were made during the collection of agricultural data as it was sourced from district-specific data provided by Statistics NZ and the Ministry for the Environment National Inventory.
Solid Waste Emissions	
Open Landfills	Wairarapa Combined Districts data prior to 2014 is estimated based on population figures and NZ average waste generation per person per year. From 2014, data includes waste sent to Bonny Glen Landfill in the Horizons Region. This volume is included in the Wairarapa Combined Districts inventory and subtracted from the Horizon Region's inventory to avoid double-counting.
Landfill Gas Recovery	LFG efficiency has been estimated based on LFG generation from waste deposited and reported LFG extraction volumes.
Closed Landfills	Data provided at the district level.
Waste Water Emissions	

Waste Water Volume	Estimate based on resource consents data for Wairarapa Waste Water Treatment systems.
Biochemical Oxygen Demand (BOD)	The biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in water. It is used as a surrogate to measure the degree of organic pollution in water. BOD has been assumed using influent composite samples and inlet flow metres.
Population connected to WWTP or Septic tanks	Population connected to waste water treatment plant or septic tanks has been provided at the district level.
Industrial Emissions	
Industry & Solvent Emissions	Calculated from MfE National Inventory data, as this the latest, most recently available data on the required solvents for the calculations to be undertaken. Emissions are estimated on a per capita basis.
Industrial Activity	No information could be obtained from Industry representatives within the district. National level data has been used and split on a per capita basis across each district.
Forestry Emissions	
Exotic Wood harvested	District figures were calculated using the assumed percentage share of district forest area of harvest age (>26 years old) in the region, in the reporting year.
Roundwood removal	It has been assumed that only 70% of the tree is removed as roundwood and that the above ground tree makes up approximately 74% of the total carbon stored.
Emission Factors	
General	All emission factors have detailed source information in the calculation tables within which they are used – where possible, the most up to date, NZ specific EF have been applied.