

# Palmerston North City Community Carbon Footprint 2016/17

Final

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Client: Palmerston North City Council

Prepared by

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25 January 2018

Job No.: 60554599

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## Quality Information

Document Palmerston North City Community Carbon Footprint 2016/17

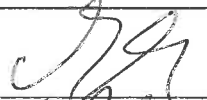

Ref 60554599

Date 01 February 2018

Prepared by Rita Martin and Sarah Lindberg

Reviewed by Kerry Griffiths and Maurice Marquardt

### Revision History

| Rev | Revision Date | Details                 | Authorised  |   |
|-----|---------------|-------------------------|---|---|
|     |               |                         | Name/Position   | Signature   |
| A   | 11/12/17      | Draft for Client Review | Maurice Marquardt<br>Principal Consultant<br>Sustainability |   |
| B   | 01/02/18      | Final                   | Kerry Griffiths<br>Technical Director -<br>Sustainability   |  |

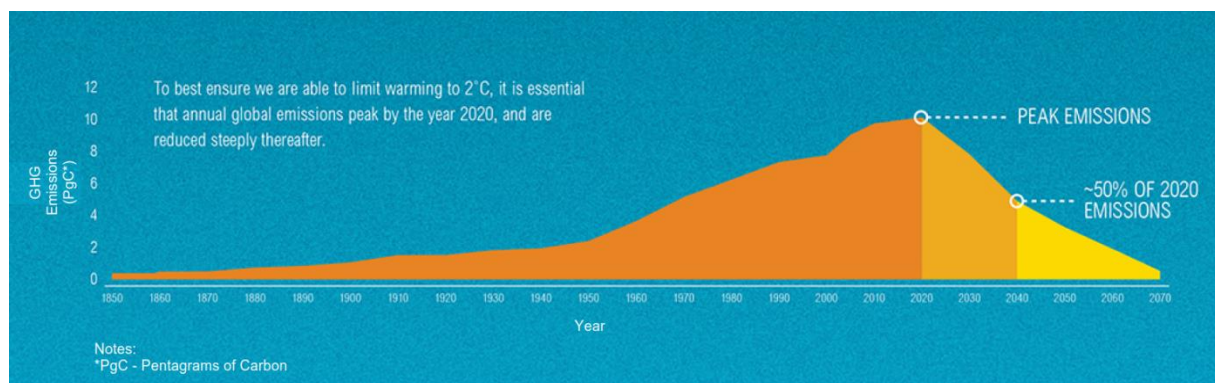
## 1.0 Introduction

AECOM New Zealand Limited (AECOM) has been commissioned by the Palmerston North City Council (Council) to assist in the development of a community carbon footprint for Palmerston North City (the City<sup>1</sup>).

### 1.1 Setting the scene

In 2016 representatives of 196 nations negotiated the Paris Agreement committing to reducing global climate change to less than 2 degrees and striving for no more than 1.5 degrees global warming<sup>2</sup>.

To achieve this ambitious goal, we as a global society need to transition towards a low carbon economy, by the second half of this century (refer Figure 1). This requires reducing global emissions by about 60-80% by 2050.



**Figure 1 Global Carbon Budget (Source: World Resources Institute)**

The New Zealand government signed the Paris Accord in 2016 and ratified it in 2017, supporting global action to reduce impacts from climate change. Action on climate change is however not limited to national governments and will require action on all levels from national government, to local government, cities, business and individuals. Over the last decade local governments globally have increasingly recognised their role in taking action on climate change both around mitigation and adaptation.

Globally more than 7,400 cities and local governments have signed up to the Global Covenant of Mayors for Climate and Energy<sup>3</sup> reporting on their community greenhouse gas emissions and emission reduction measures.

Fifty-four New Zealand Mayors and Regional Council Chairpersons have recently re-confirmed their 2015 Climate Change Declaration and the key commitments and actions that Councils plan to undertake<sup>4</sup>.

### 1.2 Report overview

This report provides the Council with a snapshot of the City's greenhouse gas (GHG) emissions profile for the 2016/17 financial year reporting period. The report also identifies key emission sources and their relative contribution to overall emissions.

The principal aims of this report are to:

- Help the Council understand the City's local emissions profile;
- Enable informed decision making and policy development;

<sup>1</sup> The physical boundary of the City is defined as the area under the Council's jurisdiction.

<sup>2</sup> As of August 2017 196 nations have signed and 160 have ratified the agreement. The agreement came into force in November 2016.

<sup>3</sup> Bringing together the Compact of Mayors and the Covenant of Mayors to advance city-level transition to a low emission and climate resilient economy ([www.globalcovenantofmayors.org](http://www.globalcovenantofmayors.org))

<sup>4</sup> LGNZ (2017), Local Government Leaders' Climate Change Declaration,

- Enable the Council to work with key emission sectors and stakeholders towards reducing local emissions.

Globally, emissions will need to reduce significantly over the next 30 years. Cooperating and working with stakeholders in each emission sector will be crucial to achieving this. This document summarises the findings from data collection and calculations and also outlines the underlying assumptions and limitations.

### 1.3 Scope and Approach for Community Carbon Footprint

This report follows the methodology outlined in the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC), published by the World Resources Institute (WRI 2015) and includes emissions from stationary energy, transport, waste, industry, agriculture and forestry activities within the City boundary. The GPC methodology represents international best practice for city and community level GHG emissions reporting. This is the same methodology used for other community scale greenhouse gas (GHG) inventories around New Zealand (e.g. Auckland, Dunedin, Tauranga and Wellington) and internationally.

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 geographic area. Examples of indirect emission sources include electricity from the national grid (Scope 2), and transport that originates or terminates outside the City area e.g. aviation (Scope 3). Examples of consumption-based emission sources are emissions from product use occurring within the City such as refrigerants used in air conditioning as well as petrol and diesel consumed within the City boundary.

The following aspects are worth noting in reviewing the emissions profile:

- GHG emissions are expressed on a carbon dioxide-equivalent basis using the 100-year Global Warming Potential values including climate-carbon feedback from the Intergovernmental Panel on Climate Change Fifth Assessment Report: Climate Change 2013<sup>5</sup>, allowing the global warming potential of other GHGs such as CH<sub>4</sub> and N<sub>2</sub>O to be compared. Carbon dioxide equivalent (CO<sub>2</sub>e) is a universal measurement which allows easy comparison between activities.
- Total emissions are reported as gross emissions (excluding forestry) and net emissions (including forestry).
- While emissions are reported by sector, the report should be read in full, including the assumptions and limitations section. Emissions from various sources should be assessed across the whole City, or at least with the overall City performance in mind.
- Due to data limitations, this inventory estimates emissions from industrial product use by scaling national emissions from industrial product use on a population basis.
- Due to data limitations, this inventory also estimates solid waste emissions from both open and closed landfills and national inventory figures on a population basis.
- 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.
- With regard to forestry activities, it is likely that the overall carbon balance of the City is relatively stable over a 50-100 year period; however on an annual basis the emissions and sequestration values vary significantly depending on the level of harvesting taking place.
- Emissions associated with land-use change have not been included, due to the lack of real time data. Only carbon sequestered in standing forests, grey shrubs (e.g. Matagouri), Gorse and Broom have been included (as per LCDB4).

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<sup>5</sup> [https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5\\_Chapter08\\_FINAL.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf) (Table 8.7)

## 1.4 Key Messages

- During the 2016/17 reporting period, the City was responsible for 570,666 tCO<sub>2</sub>e gross emissions.
- Taking into account forestry related emissions and sequestration for 2016/17, the City was responsible for 501,008 tCO<sub>2</sub>e net emissions.
- The City's per capita gross emissions of 6.5 tCO<sub>2</sub>e/person are below the NZ national average of 17.8 tCO<sub>2</sub>e. See Section 3.1 for comparisons to other NZ cities.
- The City's gross emissions for Stationary Energy, Transport, Waste, Industry and Agriculture were below the national average per capita emission rates for these categories.
- Transport related emissions across the City represented 42% of the overall gross emissions, and were the City's largest emissions source. Transport emissions are mostly attributed to road transport (29.4%) and off-road transport (10.2%), e.g. for farm machines. Air travel contributed 2.1% of the travel emissions.
- Stationary energy related emissions represented 23% of the City's gross emissions, mainly from natural gas and electricity consumption.
- Agriculture related emissions represented 21% of the overall gross emissions. These emissions are attributed to enteric emissions from grazing animals. This percentage is lower than the national average but higher than some other urban areas.

## 1.5 Potential next steps

- The report findings will help the Council to understand the City's emissions profile and support the identification of key emission sources in the City. This in turn provides a solid basis for developing appropriate mitigation responses.
- This report provides a high level summary of the emission results. We encourage the Council to analyse the underlying data for a more complete picture of contributing activities and for identifying opportunities for emissions reduction.
- This carbon footprint provides a baseline for developing or enhancing low carbon policies and plans. We encourage the Council to share these results with key stakeholders in their communities and identify areas for action and collaboration.
- Regular reporting, e.g. every 3-4 years, aligning with the preparation of the long term plan will help the Council to measure emission trends and to assess the effectiveness of any mitigation responses implemented.

## 2.0 Overall Results

During the 2016/17 reporting period, Palmerston North was responsible for **570,666 tCO<sub>2</sub>e** gross emissions and **501,008 tCO<sub>2</sub>e** net emissions (refer Table 1).

The population in 2016/17 was approximately 87,300 people, meaning that the City's per capita gross emissions was **6.5 tCO<sub>2</sub>e/person**<sup>6</sup>.

Table 1 summarises the emissions results of the following sectors:

- Transportation includes emissions from petrol, diesel and LPG used for road and off road transport within the City boundary, rail diesel and electricity use, jet kerosene and aviation gas.
- Stationary energy includes emissions from electricity consumed by residential, commercial and industry users, electricity generated from non-renewable sources (i.e. landfill gas combustion), as well as consumption of petrol and diesel, coal, gas and wood for stationary energy.
- Agriculture includes emissions from livestock, crops and fertiliser use.
- Waste includes emissions from the treatment of waste water, the disposal solid waste and composting of organic material.
- Industrial processes and product use (IPPU) includes GHG emissions from industrial, chemical or physical processes, as well as emissions associated with the consumption (i.e. product use) of GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and sulphur hexafluoride (SF<sub>6</sub>) for electrical insulation and equipment production.
- The forestry sector includes carbon sequestered from commercial exotic forests and other native forest cover, as well as emissions from harvested trees. Carbon stored in mature forests is not included in the inventory.

**Table 1 Summary of Overall Results by Source 2016/17**

| Sector/Category Source |                         | Emissions (tCO <sub>2</sub> e) |         | % Gross Emissions Contribution |
|------------------------|-------------------------|--------------------------------|---------|--------------------------------|
| Stationary Energy      | Electricity Consumption | 42,893                         | 134,072 | 23%                            |
|                        | Petrol and Diesel       | 23,920                         |         |                                |
|                        | Electricity T&D Loss    | 4,468                          |         |                                |
|                        | Natural Gas             | 49,759                         |         |                                |
|                        | Natural Gas T&D Loss    | 5,678                          |         |                                |
|                        | LPG                     | 5,041                          |         |                                |
|                        | Landfill gas            | 9                              |         |                                |
|                        | Coal                    | 2,303                          |         |                                |
|                        | Biofuel/Wood            | 1                              |         |                                |
| Transportation         | Petrol                  | 137,066                        | 239,911 | 42%                            |

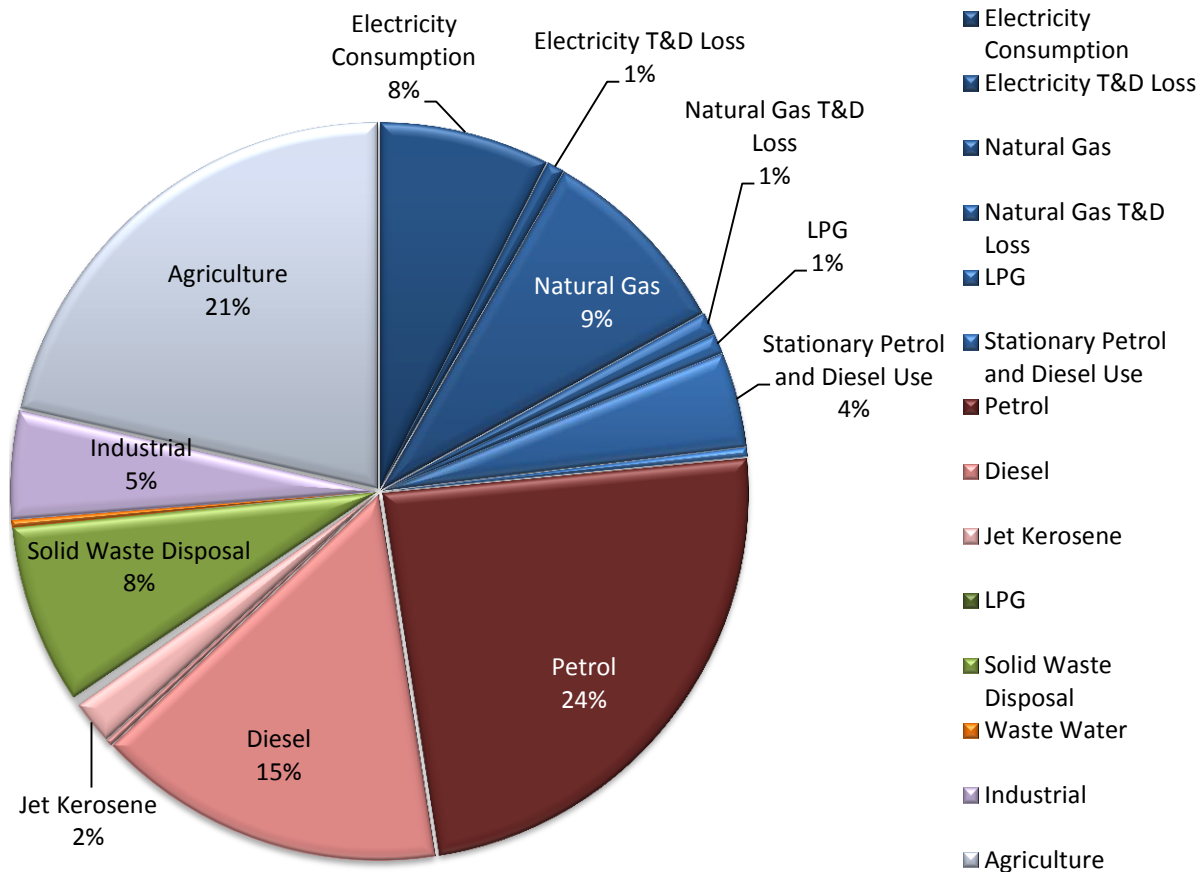
<sup>6</sup> Gross emissions exclude forestry related emissions, whilst net emissions also consider the effects of forestry (sinks and sources). This distinction has been made in the carbon footprints where the forestry sectors sequester more carbon than they emit and thereby offset some of the other city wide emissions.



| Sector/Category Source                        |                             | Emissions (tCO <sub>2</sub> e) |         | % Gross Emissions Contribution |
|---|-----------------------------|--------------------------------|---------|--------------------------------|
|   | Diesel                      | 88,242                         |         |                                |
|   | Rail Emissions              | 1,643                          |         |                                |
|   | Jet Kerosene                | 10,931                         |         |                                |
|   | Av Gas                      | 1,278                          |         |                                |
|   | Marine Diesel               | -                              |         |                                |
|   | LPG                         | 751                            |         |                                |
| Waste   | Solid Waste Disposal        | 45,360                         | 47,185  | 8%                             |
|   | Waste Water                 | 1,826                          |         |                                |
| IPPU (Industry)                               |                             | 26,889                         |         | 5%                             |
| Agriculture                                   |                             | 122,609                        |         | 21%                            |
| <b>Total gross emissions (excl. forestry)</b> |                             | <b>570,666</b>                 |         |                                |
| Forestry                                      | Exotic Forest Sequestration | -80,039                        | -69,658 |                                |
|   | Native Forest Sequestration | -19,491                        |         |                                |
|   | Total Harvest Emissions     | 29,873                         |         |                                |
| <b>Total net emissions (incl. forestry)</b>   |                             | <b>501,008</b>                 |         |                                |



Figure 2 summarises the percentage contribution to the overall gross emissions by source.



**Figure 2 Summary Gross Emissions by Source, excluding Forestry, 2016/17**

The transport sector represents the largest emissions source for Palmerston North City over the reporting period. The majority of the consumption is a result of petrol and diesel use for road and off-road transport. Petrol consumption contributes 24% and diesel 15% to the City’s gross emissions. Diesel consumed for rail is less than 1% of the total gross emissions. The stationary energy sector consumes small amounts of petrol and diesel.

Stationary energy related emissions represent the second largest emissions sector for the City, contributing 23% to the overall emissions. The majority of the stationary energy emissions result from electricity consumption and natural gas, which contribute 7.5% and 8.7% to the City’s gross emissions respectively (refer Figure 2). Agricultural emissions represent 21% of the City’s gross emissions. Waste emissions which consist of emissions from waste water and solid waste represent 8% of total gross emissions and are mostly from solid waste.

## 2.1 Stationary Energy Emissions

Stationary energy use in the City is responsible for **134,072 tCO<sub>2</sub>e** in 2016/17; representing 23% of the City's gross emissions. Stationary energy was the second highest sector contributor to the City's GHG emissions.

The main sources of emissions from stationary energy are natural gas (Scope 1) and electricity consumption (Scope 2) contributing 37% and 32% towards the total sector emissions respectively. The City generates almost twice as much electricity than is consumed within the City, predominantly from wind farms (Tararua and Te Rere Hau) and the Awapuni landfill gas turbine. However the City draws electricity from the national grid, therefore the national average emissions factors have been used to calculate the City's emissions from electricity consumption, a methodological requirement.

Petrol and diesel use contributed 18% of gross stationary energy emissions. This is attributed to commercial and industrial use of these fuels. A detailed breakdown of the stationary energy emission sources is provided in the table and chart below.

**Table 2 Summary of Stationary Energy Emissions by Source 2016/17**

| Sector/Category Source |                              | Emissions (tCO <sub>2</sub> e) |         | Sector Percentage Contribution |
|------------------------|------------------------------|--------------------------------|---------|--------------------------------|
| Stationary Energy      | Electricity consumption      | 42,893                         | 134,072 | 32%                            |
|                        | Electricity T&D Loss         | 4,468                          |         | 3%                             |
|                        | Natural gas                  | 49,759                         |         | 37%                            |
|                        | Natural gas T&D loss         | 5,678                          |         | 4%                             |
|                        | Stationary petrol and diesel | 23,920                         |         | 18%                            |
|                        | LPG                          | 5,041                          |         | 4%                             |
|                        | Landfill gas                 | 9                              |         | <1%                            |
|                        | Coal                         | 2,303                          |         | 2%                             |
|                        | Wood biofuel                 | 1                              |         | <1%                            |

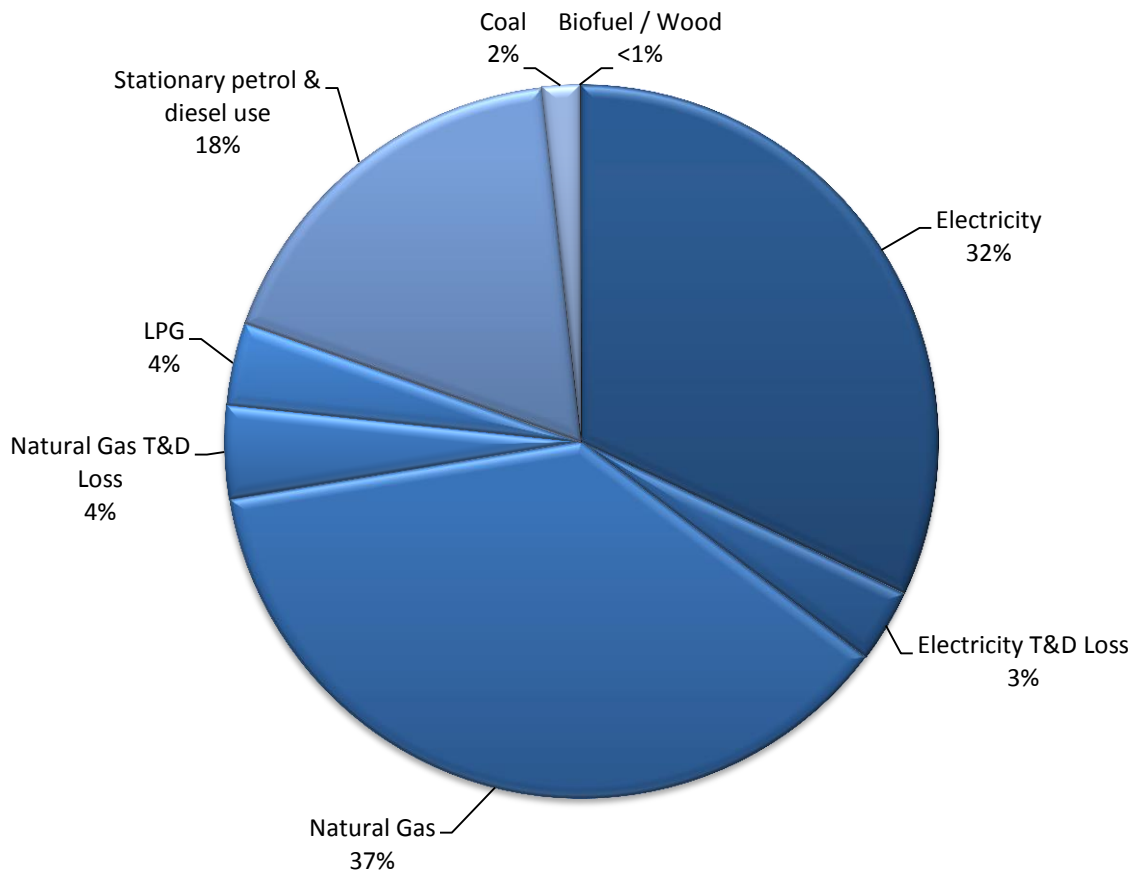


Figure 3 Summary of Stationary Energy Emissions by Source 2016/17

## 2.2 Transportation Emissions

In 2016/17 transportation sources contributed **239,911 tCO<sub>2</sub>e**, representing 42% of the City's overall gross emissions. Transportation was the highest sector contributor to the City's GHG emissions.

Table 3 shows the transport emissions by fuel type. Consumption of petrol and diesel for road transport contributes the majority of the emissions with petrol contributing moderately more than diesel. Figure 4 shows which modes of transport generate the emissions. Transport emissions for petrol, diesel and LPG were estimated based on the amount of fuel sold within the City and is broken down between transport modes (e.g. cars, buses rail, heavy vehicles) based on a national split of petrol and diesel consumption for different transport modes provided by Energy Efficiency and Conservation Authority NZ. Rail emissions include both diesel and electricity related emissions from rail travel.

Table 3 Summary of Transportation Emissions by fuel type 2016/17

| Fuel type |                      | Emissions (tCO <sub>2</sub> e) |         | Sector Percentage Contribution |
|-----------|----------------------|--------------------------------|---------|--------------------------------|
| Transport | Light vehicle petrol | 85,861                         | 239,911 | 36%                            |
|           | Light vehicle diesel | 22,061                         |         | 9%                             |
|           | Heavy vehicle petrol | 7,945                          |         | 3%                             |

| Fuel type |                      | Emissions (tCO <sub>2</sub> e) |  | Sector Percentage Contribution |
|-----------|----------------------|--------------------------------|--|--------------------------------|
|           | Heavy vehicle diesel | 48,953                         |  | 20%                            |
|           | Bus diesel           | 2,311                          |  | 1%                             |
|           | Off-road diesel      | 14,917                         |  | 6%                             |
|           | Off-road petrol      | 43,261                         |  | 18%                            |
|           | Rail Emissions       | 1,643                          |  | 0.7%                           |
|           | Jet Kerosene         | 10,931                         |  | 5%                             |
|           | Av Gas               | 1,278                          |  | 0.5%                           |
|           | LPG                  | 751                            |  | 0.3%                           |

The emissions profile for transportation sources is dominated by road transport (light and heavy vehicles) followed by off-road transport (predominantly Scope 1). Air travel contributes 5% of the transport emissions.

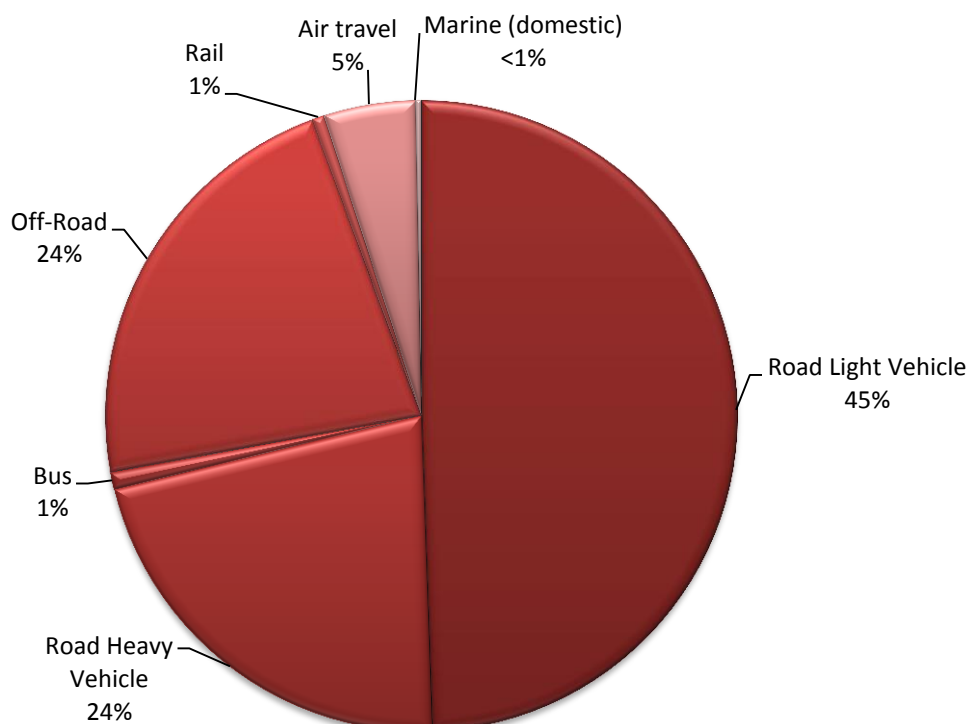


Figure 4 Summary of Transportation Emissions by Source 2016/17

## 2.3 Waste Emissions

In 2016/17 waste emissions contributed **47,185 tCO<sub>2</sub>e**, representing 8% of the City's overall gross emissions. Waste emissions are dominated by solid waste disposal contributing approximately 96% of the overall waste related emissions (refer Table 4).

**Table 4 Summary of Waste Emissions by Source 2016/17**

| Sector/Category Source |                      | Emissions (t CO <sub>2</sub> e) |        | Sector Percentage Contribution |
|------------------------|----------------------|---------------------------------|--------|--------------------------------|
| Waste                  | Solid Waste Disposal | 45,360                          | 47,185 | 96%                            |
|                        | Waste Water          | 1,826                           |        | 4%                             |

Solid waste emissions generated **45,360 tCO<sub>2</sub>e** which represents around 7.7% of the total gross emissions for the City. Solid waste emissions were estimated using a 1st-order decay model that requires waste volume estimates for the last 50 years. The City has two closed landfills: Ashhurst and Awapuni. All municipal solid waste is currently sent to the Bonny Glen landfill located near Marton.

Due to the lack of specific information for the Ashhurst and Awapuni landfills between 1967 and 1987 the national average, as reported by Ministry for the Environment (MfE), has been used to estimate the total waste volume for the City during this period. From 1988 to present, the waste volumes were provided by the Council. National and city population figures have been used as reported by Statistics New Zealand and extrapolated where necessary.

Waste water treatment generated **1,826 tCO<sub>2</sub>e** which represents around 0.3 % of the total gross emissions for the City.

Waste water treated within the City falls into two broad categories: waste water treated in wastewater treatment plants (WWTP) and individual rural treatment systems (i.e. septic tanks). The majority of waste water in the City is treated by advanced waste water treatment systems at one of the City's three WWTPs in Totara Road, Ashhurst, and Linton, resulting in very low emissions.

Around 29% of the waste water related emissions are emitted from individual rural treatment systems (i.e. septic tanks). These systems service less than 2% of the City's population.

Figure 5 summarises the solid waste and waste water emissions by source.

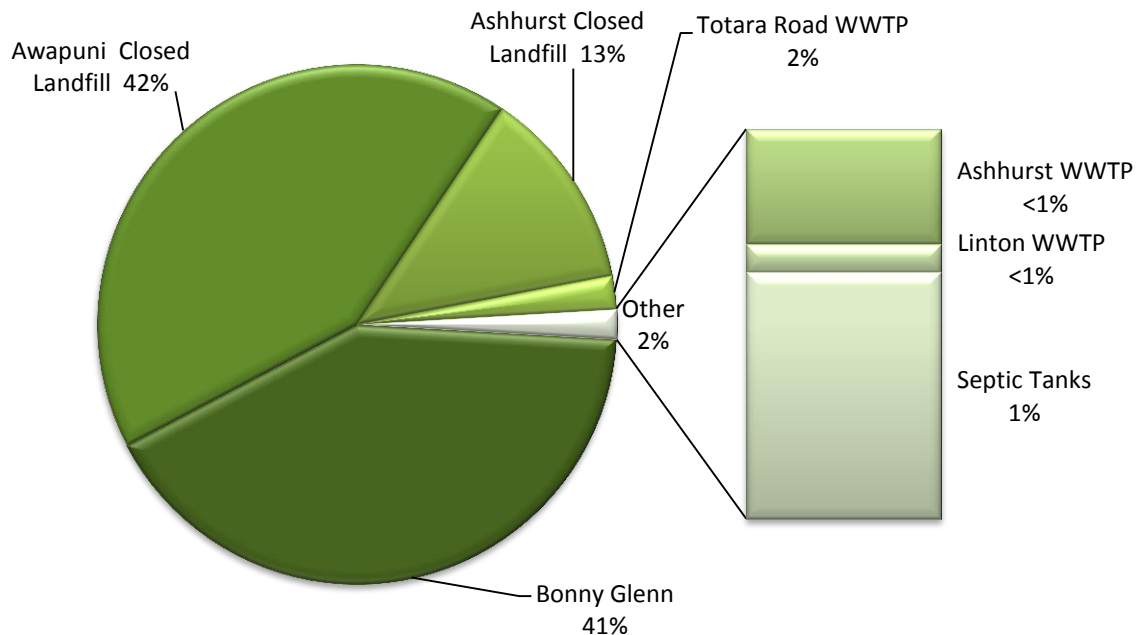


Figure 5 Summary of Waste Emissions by Source

## 2.4 Industrial Emissions

In 2016/17 industrial GHG emissions contributed **26,889 tCO<sub>2</sub>e** (5%) towards the City's gross emissions. The emissions for industrial product use include emissions from hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>) (Scope 1). Nitrogen trifluoride (NF<sub>3</sub>) emissions do not occur in New Zealand, and therefore are not included in this report.

Emissions from industrial product use were estimated based on New Zealand's average industrial product use emissions per capita and the population of the City.

No emissions from industrial processes have been included in the industrial emissions. It is understood that there are no large industrial operations within the City's boundary that result in significant GHG emissions such as cement production, glass manufacturing or urea production.

Energy used in industrial manufacturing processes has been included in the relevant stationary energy sector (e.g. coal and/or electricity) emissions.

## 2.5 Agricultural Emissions

In 2016/17 agricultural GHG emissions contributed **122,609 tCO<sub>2</sub>e** (21%) of the City's gross emissions.

Methane (CH<sub>4</sub>) is the most significant agricultural emission source (75%), predominantly from enteric fermentation of farmed animals (e.g. cows and sheep). Nitrous oxide (N<sub>2</sub>O) emissions from farming of animals, manure management and agricultural soils contributed approximately 25% of agricultural emissions in 2016/17. Figure 6 presents a breakdown of agricultural emissions by source.

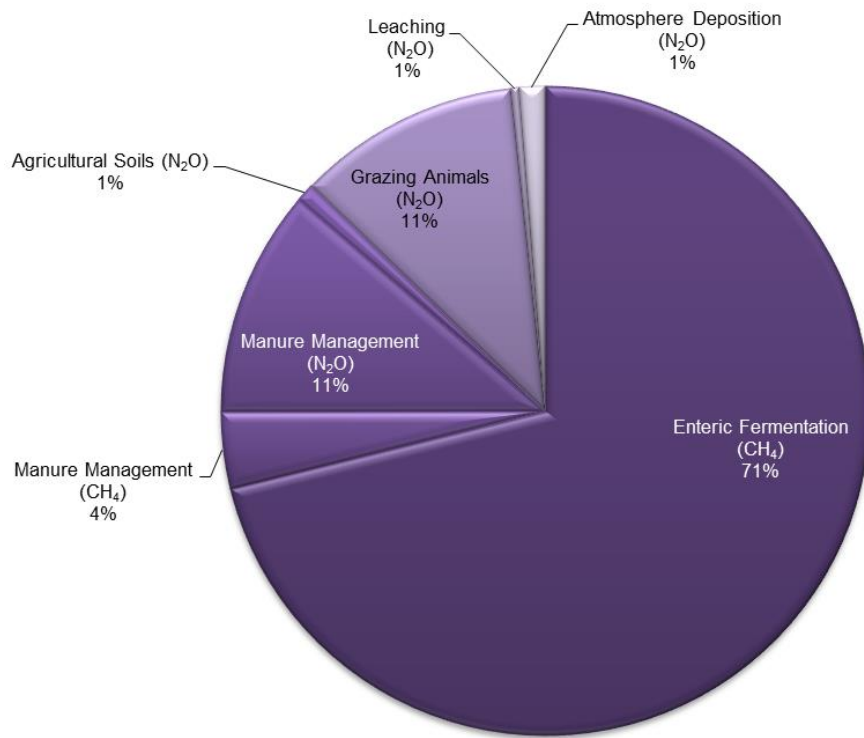


Figure 6 Summary of Agricultural Emissions by Source 2016/17



## 2.6 Forest Carbon Sequestration and Emissions

The net emissions from land use and forestry are **-69,658 tCO<sub>2</sub>e**. Figure 7 presents a breakdown of forestry emissions by source.

Indigenous and exotic forests sequester an estimated **99,531 tCO<sub>2</sub>e**. The majority of carbon is sequestered by exotic forest plantations (80%), while still maturing native forests (e.g. Mānuka/Kānuka and some broadleaved indigenous forest) sequestered the remaining 20%.

Harvesting related emissions were estimated based on harvesting volumes reported by Statistics New Zealand and the Ministry for Primary Industries (MPI) National Exotic Forest Description data for 2016, and resulted in **29,873 tCO<sub>2</sub>e**<sup>7</sup> of forestry emissions.

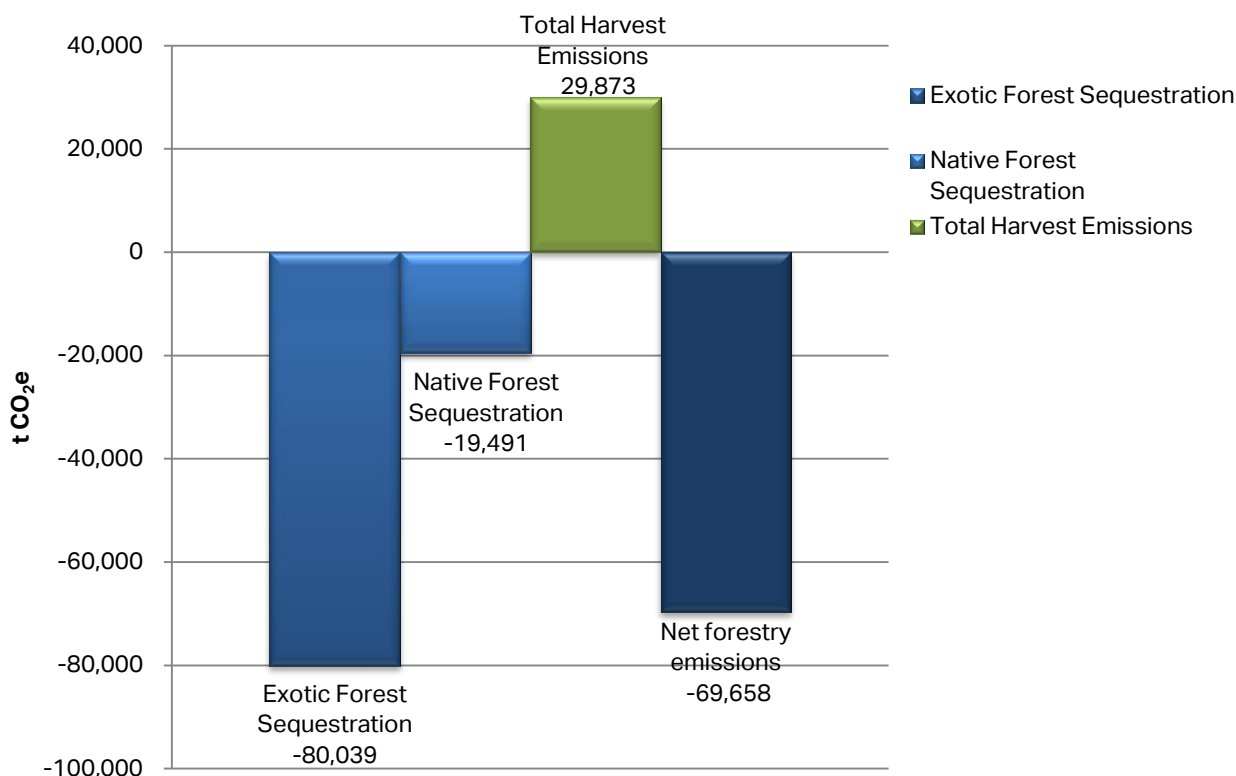


Figure 7 Summary of Forestry Emissions and Sequestration by Source 2016/17

## 2.7 Biogenic emissions

Biogenic CO<sub>2</sub> emissions, such as the combustion or digestion of biological materials, are part of the natural carbon cycle and do not directly contribute to climate change. The GPC Standard recommends reporting these emissions outside of the total greenhouse gas emissions. The City generated approximately **2,586 tCO<sub>2</sub>** from biogenic sources (e.g. from combustion of firewood and flaring of landfill gas). While biogenic is excluded, CH<sub>4</sub> and N<sub>2</sub>O emissions are included in the overall GHG emissions, due to their higher radiative forcing. Emissions from CH<sub>4</sub> and N<sub>2</sub>O associated with agriculture and landfills are calculated under the appropriate sector.

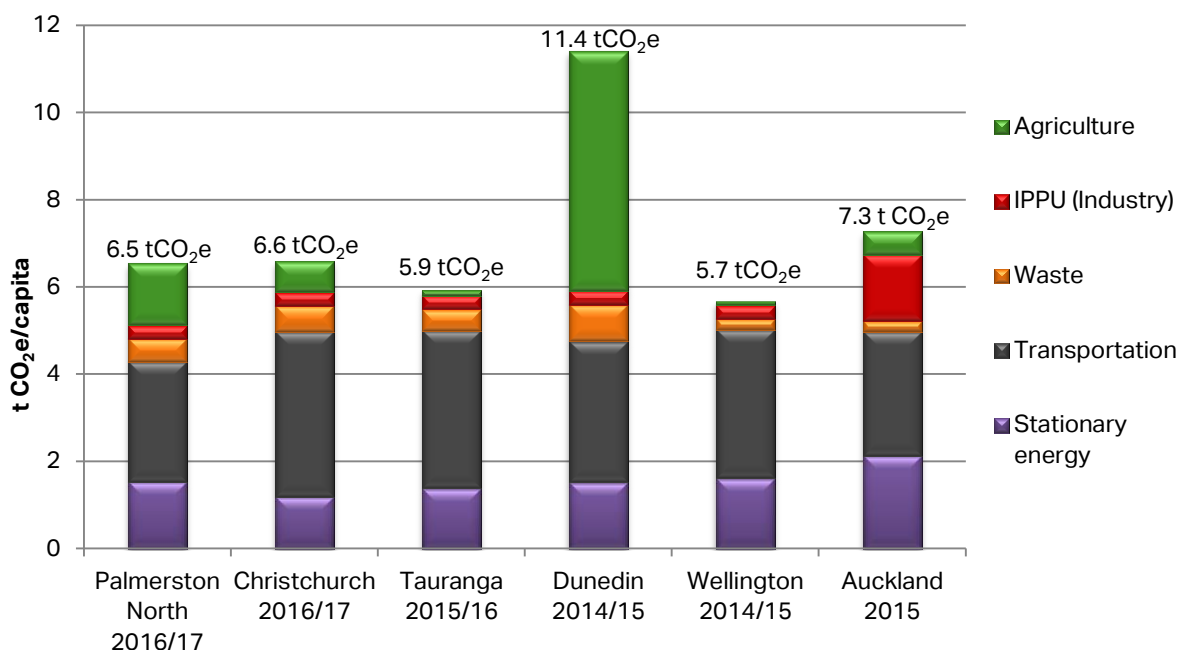
<sup>7</sup> Due to the accounting method chosen for this report, all carbon stored in harvested trees, including in the wood products removed, below ground and in residues left on site, is assumed to result in emissions in the harvesting year. Carbon stored in mature forests has not been accounted for in this carbon footprint.

### 3.0 Discussion and Data Comparison

#### 3.1 New Zealand Context

The per capita gross emissions for the City during the 2016/17 reporting period were 6.5t tCO<sub>2</sub>e compared to the national figure of 17.8 tCO<sub>2</sub>e. This is mainly due to the lower agricultural emissions from the City compared to the national emissions profile.

Figure 8 shows a comparison of the gross per capita emissions (excluding forestry) for Palmerston North City with other cities in New Zealand per sector. The City's per capita gross emissions are similar to Christchurch but slightly higher than Tauranga and Wellington



**Figure 8 Comparison of Palmerston North City's per capita emissions with selected New Zealand cities.**

Figure 8 suggests the main difference between these cities and Palmerston North is the greater amount of agricultural emissions generated within the City. Palmerston North City's per capita agricultural emissions are higher than in Tauranga, Wellington and Auckland, but are significantly lower than in Dunedin and the national average. Agricultural emissions are measured at the point of production and do not reflect agricultural product consumption patterns of the community.

Similarly to other cities in New Zealand, there is a significant opportunity for reducing emissions by addressing transport emissions, specifically road transport. Other cities such as Auckland and Wellington have lower waste emissions per capita than Palmerston North, suggesting that there are also some opportunities to reduce emissions from waste.

## 4.0 Data Sources

Data for the community carbon footprint was collected from a number of data sources. Key data sources are detailed below in **Table 5**:

**Table 5 Palmerston North Council GHG Inventory 2016/17 - Data Sources**

| Emissions Category |             | Data Source  |
|--------------------|-------------|--|
| Stationary Energy  |             | <ul style="list-style-type: none"> <li>• Electricity Consumption:               <ul style="list-style-type: none"> <li>○ PowerCo</li> <li>○ Kiwi Rail</li> </ul> </li> <li>• Gas               <ul style="list-style-type: none"> <li>○ LPG Association NZ</li> <li>○ PowerCo</li> </ul> </li> <li>• Ministry of Business, Innovation &amp; Employment (MBIE) (2015) Energy in NZ, Section K, Coal               <ul style="list-style-type: none"> <li>○ Mid central health district health board</li> </ul> </li> <li>• Petrol and diesel               <ul style="list-style-type: none"> <li>○ Palmerston North City Council</li> <li>○ EECA Energy End Use Database (2017)</li> </ul> </li> <li>• Other:               <ul style="list-style-type: none"> <li>○ Ministry of Business, Innovation &amp; Employment (MBIE) (2015) Energy in NZ, Section K</li> <li>○ MfE (2017) 1990-2015 National Greenhouse Gas Inventory Report</li> </ul> </li> </ul> |
| Transportation     |             | <ul style="list-style-type: none"> <li>• Palmerston North Airport</li> <li>• Kiwi Rail</li> <li>• LPG Association NZ</li> <li>• Massey University School of Aviation</li> <li>• AECOM estimates (air travel)</li> </ul>  |
| Waste              | Solid Waste | <ul style="list-style-type: none"> <li>• Palmerston North City Council</li> <li>• MfE (2017) 1990-2015 National Greenhouse Gas Inventory Report</li> </ul>   |
|                    | Waste Water | <ul style="list-style-type: none"> <li>• Palmerston North City Council,</li> <li>• MfE (2017) 1990-2015 National Greenhouse Gas Inventory Report</li> </ul>  |
| Industrial         |             | <ul style="list-style-type: none"> <li>• MfE (2017) 1990-2015 National Greenhouse Gas Inventory Report</li> <li>• Statistics New Zealand</li> </ul>  |
| Agriculture        |             | <ul style="list-style-type: none"> <li>• MfE (2017) 1990-2015 National Greenhouse Gas Inventory Report</li> <li>• Statistics New Zealand:               <ul style="list-style-type: none"> <li>○ Agricultural Production June 2016,</li> <li>○ Livestock Numbers by Regional Council as at June 2016,</li> <li>○ Livestock Numbers by Type and Region at 30 June 2012,</li> <li>○ Grain and Seed Crops by Territorial Authority Year to June 2012,</li> <li>○ Fertiliser and Lime Applied by Territorial Authority and Type Year to June 2012.</li> </ul> </li> <li>• Statistics New Zealand (2016a &amp; 2016b)</li> </ul>  |
| Forestry           |             | <ul style="list-style-type: none"> <li>• Palmerston North City Council (Land cover data)</li> <li>• MPI (2015, 2016) National Exotic Forest Description</li> <li>• Statistics New Zealand Agricultural Production (2016c)</li> </ul>   |

## 5.0 Report - Standard Limitations

AECOM New Zealand Limited (AECOM) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Palmerston North City Council and only those third parties who have been authorised in writing by AECOM to rely on this Report.

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## 6.0 References

- LGNZ 2017            Local Government New Zealand (2017), Local Government Leaders' Climate Change Declaration.
- MBIE 2017a           Ministry for Business, Innovation and Employment (2017)  
<http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-in-new-zealand>
- MBIE 2017b           Ministry for Business, Innovation and Employment (2017)  
<http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/statistics/electricity>
- MfE 2017            Ministry for the Environment (2017), New Zealand Greenhouse Gas Emissions 1990 - 2015
- MfE 2016            Ministry for the Environment (2016), Guidance for voluntary greenhouse gas reporting - 2016: Data and methods for the 2014 calendar year
- MPI, 2016            Ministry for Primary Industries (2016), National Exotic Forest Description as at 1 April 2016
- StatsNZ 2016a       Agricultural Production Census (Final Results): Summary of Livestock Numbers by Type and Territorial Authority 2012
- StatsNZ 2016b       Agricultural Production Statistics: June 2016
- StatsNZ 2016c       Total Regional Harvest Volume for 2016
- WRI 2015            World Resources Institute (2015), *Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC)*, World Resources Institute
- WRI 2014            World Resources Institute (2014), Infographic: The Global Carbon Budget, World Resources Institute  
<http://www.wri.org/resources/data-visualizations/infographic-global-carbon-budget>

# Appendix A

## Data Assumptions and Limitations

## Appendix A Data Assumptions and Limitations

| Sector/Category  | Assumptions and Exclusions   |
|--|--|
| <b>Stationary Energy Emissions</b>                                 |  |
| Residential, commercial and industrial stationary energy emissions | <ul style="list-style-type: none"> <li>- 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 except were specific coal consumption figures were provided by specific users e.g. MidCentral District Health Board.</li> <li>- Consumption of natural gas and electricity data are based on total energy distributed within the City. The energy provided to the City is based on information provided by FirstGas and PowerCo, as part of their distribution networks. This may in some instances mean that energy used outside the City may be counted as part of the City's Footprint, depending on the distribution network for gas and electricity, which may not fully match the City's boundaries in all cases.</li> <li>- 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).</li> </ul> |
| Electricity Generation   | <ul style="list-style-type: none"> <li>- National emission factor for electricity generation was estimated based on data published by MBIE in their quarterly electricity and liquid fuel emissions table (MBIE 2017b).</li> <li>- It is understood from the Electricity Authority Generating Station List, September 2012 that more electricity is generated in the Region than is consumed.</li> <li>- No emissions from electricity generation have been included in the carbon footprint, as these are already accounted for as part of the national emissions factor. All of the electricity generated within the City limits was assumed to be from renewable sources.</li> <li>- CH<sub>4</sub> and N<sub>2</sub>O emissions from the combustion of landfill gas at Awapuni and Bonny Glen landfills has been included under waste emissions, as it is not clear if or how much of the landfill gas is used for electricity generation.</li> </ul>  |
| Electricity Consumption  | <ul style="list-style-type: none"> <li>- Consumption of electricity is based on total electricity distributed to the City by PowerCo.</li> <li>- This may in some instances mean that energy used outside the City may be counted as part of the City's Footprint, depending on PowerCo's electricity distribution network, which may not fully match the City's boundaries in all cases.</li> </ul>   |
| LPG  | <ul style="list-style-type: none"> <li>- LPG consumption in Palmerston North is based on the total amount of LPG supplied to the North Island and calculated on a per capita basis using 2016 population estimates.</li> <li>- LPG stationary energy estimates are based on the national share of 9kg and 45kg gas bottles, and bulk sales as outlined in New Zealand's GHG Inventory 1990-2015.</li> </ul>  |
| Petrol and Diesel  | <ul style="list-style-type: none"> <li>- Petrol and diesel consumption per user group (residential, commercial and industrial) was estimated based on the total amount of fuel sold within the City and the fuel split outlined in the Energy Efficiency and Conservation Authority Energy End Use Database.</li> </ul>  |
| Natural Gas  | <ul style="list-style-type: none"> <li>- Natural gas consumption is based on total gas distributed to the delivery point for Palmerston North City supplied by FirstGas</li> <li>- The natural gas distribution network does not follow local authority boundaries. However, it is assumed that the difference is relatively small and therefore the impact to the City's natural gas consumption is not likely to be significant.</li> </ul>  |



| Sector/Category                        | Assumptions and Exclusions  |
|--|---|
|  | <ul style="list-style-type: none"> <li>- Assumes distribution loss emissions of 6.36 kgCO<sub>2</sub>e/ GJ during distribution, based on the national average reported for distribution loss of reticulated natural gas (MfE 2016 - voluntary GHG reporting guidelines).</li> </ul>   |
| Landfill gas (& WWTP gas)              | <ul style="list-style-type: none"> <li>- CH<sub>4</sub> and N<sub>2</sub>O emissions from the combustion of landfill gas and gas collected from the Totara Road waste water treatment plant are reported under stationary energy (a requirement of the GPC framework).</li> <li>- CO<sub>2</sub> emissions are reported under biogenic emissions, outside of the community carbon footprint.</li> </ul>   |
| Industrial Stationary Energy Emissions | <ul style="list-style-type: none"> <li>- Emissions from industrial consumption of coal, diesel, petrol, natural gas and electricity for production and operation processes have been estimated within the respective emission categories.</li> </ul>  |
| Fugitive Emissions                     | <ul style="list-style-type: none"> <li>- Not included in the Inventory as there is no production of oil or gas within the City.</li> </ul>  |
| <b>Transportation Emissions</b>        |   |
| Road                                   | <ul style="list-style-type: none"> <li>- Total volume of fuel sold within the City in FY2015/2016 was provided by the Council.</li> <li>- Fuel sales data was provided for Palmerston North, Manawatu and Horowhenua Districts combined. The fuel data was allocated to Palmerston North based on the share of vehicle kilometres travelled (VKT) in Palmerston compared to the Manawatu &amp; Horowhenua Districts. The VKT data was supplied by NZTA.</li> </ul>  |
| Rail                                   | <ul style="list-style-type: none"> <li>- Emissions from rail transport are estimated based on length of rail network and average fuel consumption per tonne km and freight volume as provided by Kiwi Rail for the 2015/16 financial year.</li> <li>- The rail network in the City used Electricity and Diesel.</li> <li>- Rail diesel use is estimated based on the average fuel consumption per km travelled within the City boundaries. Due to lack of more detailed data it is not possible to estimate what portion of the rail related diesel use was purchased in- or outside the City.</li> <li>- Unable to confirm whether diesel sold for rail transport is already included in the City fuel sales data for road transport.</li> </ul>   |
| Aviation                               | <ul style="list-style-type: none"> <li>- Aviation fuel data sold/pumped at Palmerston North Airport could not be obtained during the data collection.</li> <li>- Aviation emissions, from Jet Kerosene, have been estimated using the data supplied on flight departures from Palmerston North Airport</li> <li>- The estimated aviation emissions represent 50% of aviation related emissions associated with movements at Palmerston North Airport in line with the GPC framework.</li> <li>- Aviation gas fuel consumption for smaller aircraft and helicopters were estimated based on conversation with aviation fuel experts.</li> <li>- Aviation gas consumption was estimated using data supplied from the Massey University School of Aviation on the number of flight hours and the fuel burn of the aircraft types.</li> </ul> |
| LPG                                    | <ul style="list-style-type: none"> <li>- LPG consumption is based on the total amount of LPG supplied to the North Island and calculated on a per capita basis using 2016 population estimates.</li> <li>- LPG transportation energy estimates are based on the national share of automotive and forklift sales as outlined in New Zealand's GHG Inventory 1990-2015.</li> </ul>  |
| <b>Waste Emissions</b>                 |   |
| Solid Waste Disposal                   | <ul style="list-style-type: none"> <li>- Solid waste emissions were estimated using a 1st-order decay model</li> </ul>  |

| Sector/Category                                      | Assumptions and Exclusions  |
|--|---|
|  | <p>(which requires waste volume estimates for the last 50 years).</p> <ul style="list-style-type: none"> <li>- Reliable historic population figures, provided by Statistics New Zealand, only go back to 1986 therefore 30 years of data has been estimated for the City's Solid Municipal Waste emissions.</li> <li>- Due to limited specific current and/or historic data for the region, waste volumes sent to landfill have been estimated by applying the New Zealand national average waste generation per capita (reported by MfE, 2017) and using historic population figures reported by Statistics New Zealand.</li> <li>- Landfill gas emissions were estimated for landfills with and without landfill gas capturing systems. Bonny Glenn and Awapuni collect landfill gas.</li> <li>- CH<sub>4</sub> and N<sub>2</sub>O emissions from landfill gas combustion are reported under stationary energy. CO<sub>2</sub> emissions are reported under biogenic emissions, outside the community carbon footprint.</li> <li>- Data on specific waste composition was not available therefore this data has been modelled based on the national average waste composition reported by MfE (2017).</li> <li>- The City sends its waste to Bonny Glenn landfill. Awapuni landfill closed in 2007 and Ashhurst closed in 1995</li> </ul> |
| Incineration   | <ul style="list-style-type: none"> <li>- Emissions from waste incineration have not been included, as only small quantities of clinical and hazardous waste is incinerated in New Zealand. Emissions from these sources are assumed to be insignificant<sup>8</sup>.</li> </ul>   |
| Waste Water Treatment                                | <ul style="list-style-type: none"> <li>- Population serviced by each treatment plant (Totara Rd, Ashhurst, and Linton) was provided by the Council.</li> <li>- Septic tank numbers were estimated using the number of dwellings in the City minus the number of waste water connections serviced by the three waste water treatment plants.</li> <li>- CH<sub>4</sub> and N<sub>2</sub>O emissions from natural gas collected from the Totara Road waste water treatment plant and combusted for energy generation are reported under stationary energy. CO<sub>2</sub> emissions are reported under biogenic emissions, outside the community carbon footprint.</li> </ul>   |
| <b>Industrial Emissions</b>                          |   |
| Industrial Processes                                 | <ul style="list-style-type: none"> <li>- 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 City.</li> </ul>   |
| Product Use including: HFC, PCFs and SF <sub>6</sub> | <ul style="list-style-type: none"> <li>- Emissions for refrigerants, fire extinguishers, foam blowing, aerosols and metered dose inhalers, as well as SF<sub>6</sub> in electrical equipment are estimated based on New Zealand average per capita emissions (MfE 2017).</li> </ul>   |
| <b>Agricultural Emissions</b>                        |   |
| Agriculture  | <ul style="list-style-type: none"> <li>- Agricultural emissions are based on agricultural production data provided by Statistics New Zealand.</li> <li>- Emissions from 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.</li> </ul>   |
| <b>Forestry Emissions</b>                            |   |

<sup>8</sup> Nationally, emissions from incineration of waste represent about 0.1% of the total waste emissions.

| Sector/Category                                 | Assumptions and Exclusions   |
|---|--|
| Forestry  | <ul style="list-style-type: none"> <li>- Exotic forest volumes are based on data provided in the National Exotic Forest Description published by MPI (MPI 2016 and MPI 2015). The data is provided on a Territorial Authority (TA) level.</li> <li>- Carbon sequestration for exotic forests include above ground, below ground, dead wood and litter.</li> <li>- 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.</li> <li>- Harvest data has been calculated using the Manawatu harvest data for 2016 and allocating Palmerston North's share of forest of harvestable age (&gt;26years old).</li> <li>- Due to insufficient data for land use changes, no emissions from land use change of cropland, wetlands, settlements and other land have been estimated.</li> <li>- Maturing native forests (e.g. Mānuka and Kānuka), as well as grassland with woody biomass and broadleaved indigenous hardwood forest have been included as native forests.</li> <li>- Data for native forests is based on LCDB vol. 4 data.</li> <li>- Sequestration rates for native forest were based on advice from MfE (2017).</li> <li>- Emissions from forest harvesting activities are included in the Inventory as part of the LULUCF emissions.</li> <li>- 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.</li> </ul> |
| <b>Emission Factors</b>                         |  |
| Emission Factors – Mobile and Stationary Energy | <ul style="list-style-type: none"> <li>- Emissions factors are based on published New Zealand specific emission factors where possible. Sources include the New Zealand National Greenhouse Gas Inventory (MfE 2017) and Guidance for Voluntary Greenhouse Gas Reporting for Organisations (MfE 2016), National Energy File data (MBIE 2017) 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.</li> <li>- 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.</li> <li>- The Global Warming Potential used to convert CH<sub>4</sub> and N<sub>2</sub>O to CO<sub>2</sub>e are based on the IPCC Fifth Assessment Report for 100 year Global Warming Potential including climate-carbon feedbacks.</li> </ul>   |