Transport-Related Air emissions INventory Stocktake (TRAINS)

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NZ Transport Agency

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## List of abbreviations

<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AADT</td>
<td>Annual average daily traffic</td>
</tr>
<tr>
<td>AP42</td>
<td>Emission factor database published by the USEPA</td>
</tr>
<tr>
<td>ART</td>
<td>Auckland Regional Transport model</td>
</tr>
<tr>
<td>CAU</td>
<td>Census area units</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>DFEPFM</td>
<td>Domestic Fire Emissions Prediction Model</td>
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<tr>
<td>EF</td>
<td>Emission factor</td>
</tr>
<tr>
<td>LTNZ</td>
<td>Land Transport New Zealand (merged with Transit New Zealand in 2008 to form NZ Transport Agency)</td>
</tr>
<tr>
<td>MfE</td>
<td>Ministry for the Environment</td>
</tr>
<tr>
<td>MoT</td>
<td>Ministry of Transport</td>
</tr>
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<td>NPI</td>
<td>National Pollutant Inventory (Australia)</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Oxides of nitrogen</td>
</tr>
<tr>
<td>NZTA</td>
<td>NZ Transport Agency</td>
</tr>
<tr>
<td>NZTER</td>
<td>New Zealand Traffic Emission Rates database (MoT)</td>
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<td>PM₁₀</td>
<td>Particulate matter &lt;10µm in diameter</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Particulate matter &lt;2.5µm in diameter</td>
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<td>RAMM</td>
<td>Road Assessment and Maintenance Management database (NZTA)</td>
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<td>SOₓ</td>
<td>Oxides of sulphur</td>
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<td>TLA</td>
<td>Territorial local authority</td>
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<td>VEPM</td>
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<td>Vehicle Fleet Emission Model (MoT)</td>
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<td>VKT</td>
<td>Vehicle kilometres travelled</td>
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<tr>
<td>VOC</td>
<td>Volatile organic compounds</td>
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1.0 Introduction

1.1 Background and scope

Air emissions inventories are a critical component of managing air quality and are undertaken by regional councils regularly to gauge how emissions are tracking in the region. The inventories cover key emission sources and pollutants in the region, sometimes covering all major or focussing on one source/pollutant. In New Zealand, 17 local authorities (11 regional councils and six unitary authorities) have the responsibility for managing air quality in their areas.

This report compiles emission inventories prepared in New Zealand at the regional council, unitary council and national level since 2000, for the NZ Transport Agency in order to:

- Understand and catalogue where and how vehicle emissions (greenhouse gases and harmful air pollutants) from land transport have been estimated;
- Allow these estimates of vehicle emissions to be compared against other emission sources at the same geographical scale so as to contextualise the contribution of land transport relative to other sources.

This report includes the following major pollutants:

- Particulate matter <10µm in size (PM$_{10}$)
- Particulate matter <2.5µm in size (PM$_{2.5}$)
- Carbon monoxide (CO)
- Carbon dioxide (CO$_2$)
- Oxides of nitrogen (NO$_x$)
- Oxides of sulphur (SO$_x$) and sulphur dioxide (SO$_2$)
- Volatile organic compounds (VOCs)

For the purposes of this report, emission sources are categorised in the following sectors:

- Transport (includes motor vehicles, rail, aviation, shipping, off-road vehicles and re-suspended road dust)
- Domestic (includes home heating, lawn mowing, gardening equipment)
- Industry (includes consented industry, commercial activities)
- Outdoor burning
- Other sources (includes natural sources, agriculture, electricity)
1.2 Report structure

This report is structured as follows:

- Section 2 summarises all available emissions inventories that have been undertaken across New Zealand since 2000, indicating key pollutants and sources covered (anthropogenic and natural).
- Section 3 presents summary tables by pollutant for inventories since 2010 which include emissions from transport, domestic, industry, outdoor burning and other sectors for each region/airshed/urban area.
- Appendix 1 provides more detailed metadata for the latest complete inventory for each region/airshed/urban area (ie. inventories that include at least home heating, motor vehicles and consented industry sources, and more than one pollutant).

1.3 Limitations

This report collates and presents emission summaries for the most commonly reported sources and pollutants across the country. However, inconsistencies make it difficult to compare inventories, especially between regional and national estimates. The sources and pollutants covered by each inventory vary depending upon the region:

- Most inventories report on the major sources only (motor vehicles, domestic heating and industry) with other sources such as shipping or outdoor burning often excluded.
- Not all pollutants are included in each inventory (as most are PM$_{10}$ inventories).
- Oxides of sulphur are reported either as SO$_2$ or SO$_x$ which are not interchangeable (ie not the same thing) as it depends on the methodology and emission factors used in the inventory in question.
- Although the general method to calculate emissions is the same, the detailed methodologies for calculating emissions varies depending upon available data.
- There are different reporting requirements and periods (eg. annual emissions/daily winter average)
- The spatial extent and resolution differ between each inventory (region/airshed/urban area).
- Emissions are estimated for different base years and therefore do not reflect the same fuel specifications, emission standards, and regulations in place.

Any comparison made between inventories is indicative only and should be considered with caution.
2.0 Summary tables

The following section presents a summary of emissions inventories undertaken across New Zealand at the national and regional level since the year 2000.

The table covers the following information for each inventory:

- Region
- Area or airshed
- Pollutants
- Sources
- Years:
  - Actual base year (indicated as “A”)
  - Backcast year (indicated as “B”)
  - Forecast year (indicated as “F”)

Note: Inventory data presented in section of this report are shaded in grey.
Table 1: Summary table of pollutants and sources in each inventory.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Pollutants</th>
<th>Sources</th>
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<td>VOCs</td>
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<td>Smithson et al. 2006</td>
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<td>Canterbury</td>
<td>2006</td>
<td>CO99, CO2, VOCs, NOx, PM10, PM2.5, SO2, SOx</td>
<td>Transport, Domestic, Industrial, Outdoor Burning, Other</td>
<td>Smithson 2008</td>
<td></td>
</tr>
<tr>
<td>Canterbury</td>
<td>2014</td>
<td>CO99, CO2, VOCs, NOx, PM10, PM2.5, SO2, SOx</td>
<td>Transport, Domestic, Industrial, Outdoor Burning, Other</td>
<td>Sridhar &amp; Metcalfe 2014</td>
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</tr>
<tr>
<td>Canterbury</td>
<td>2014</td>
<td>CO99, CO2, VOCs, NOx, PM10, PM2.5, SO2, SOx</td>
<td>Transport, Domestic, Industrial, Outdoor Burning, Other</td>
<td>Salomon &amp; Smithson 2015</td>
<td></td>
</tr>
<tr>
<td>Otago</td>
<td>2005</td>
<td>CO99, CO2, VOCs, NOx, PM10, PM2.5, SO2, SOx</td>
<td>Transport, Domestic, Industrial, Outdoor Burning, Other</td>
<td>Wilton 2005c</td>
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</tr>
<tr>
<td>Otago</td>
<td>2016</td>
<td>CO99, CO2, VOCs, NOx, PM10, PM2.5, SO2, SOx</td>
<td>Transport, Domestic, Industrial, Outdoor Burning, Other</td>
<td>Wilton 2016c</td>
<td></td>
</tr>
<tr>
<td>West Coast</td>
<td>2012</td>
<td>CO99, CO2, VOCs, NOx, PM10, PM2.5, SO2, SOx</td>
<td>Transport, Domestic, Industrial, Outdoor Burning, Other</td>
<td>Wilton 2013</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td>Area/ Airshed</td>
<td>Year</td>
<td>Pollutants</td>
<td>Sources</td>
<td>Reference</td>
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<td></td>
<td></td>
<td></td>
<td>CO</td>
<td>CO2</td>
<td>VOCs</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill (urban) Gore (urban)</td>
<td>2004</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill (urban) Gore (urban)</td>
<td>2011</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
3.0 Source contributions

This section presents summary data from recent complete inventories in New Zealand since 2010.

Emission summaries are shown for the following pollutants:

- PM$_{10}$
- PM$_{2.5}$
- CO
- NO$_X$
- SO$_X$
- SO$_2$
- VOC
- CO$_2$

The sources and pollutants presented are the most common categories reported across the country in almost all inventories. Many inventories report on a broader range of sources and pollutants but, as mentioned earlier, the lack of consistency across the country makes comparing results between inventories difficult.

Similarly, only inventories with base years 2010 onwards are presented here. Inventories for base years prior to 2010 do not reflect the significant changes to various transport fuel specifications, vehicle emission standards, and other regulations that have taken effect since then.

As a result, not all regions in New Zealand have valid data that are able to be compared in this section.¹

**Note:**

- All values have been rounded to the nearest whole number (in some cases, the value is rounded down to zero).
- Some values are reported in their respective inventory as “zero”. These are reported as is in this report.
- Footnotes are used to indicate important differences between the inventories.

---

¹ Results for Auckland, Wellington and Canterbury region/airsheds are not presented here as the most recent published inventories were produced for base years prior to 2010.
### 3.1 PM$_{10}$

Table 2: Summary of emissions for PM$_{10}$ from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transport</td>
<td>Domestic</td>
</tr>
<tr>
<td>New Zealand</td>
<td>National</td>
<td>2013</td>
<td>5,226</td>
<td>103,401</td>
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<tr>
<td>Waikato</td>
<td>Hamilton</td>
<td>2012</td>
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<td>1,177</td>
</tr>
<tr>
<td>Waikato</td>
<td>Taupo</td>
<td>2014</td>
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<td>542</td>
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<td>Waikato</td>
<td>Te Kuiti</td>
<td>2015</td>
<td>1</td>
<td>165</td>
</tr>
<tr>
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<td>Putaruru</td>
<td>2015</td>
<td>2</td>
<td>124</td>
</tr>
<tr>
<td>Waikato</td>
<td>Tokoroa</td>
<td>2016</td>
<td>3</td>
<td>334</td>
</tr>
<tr>
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<td>Morrinsville</td>
<td>2016</td>
<td>2</td>
<td>137</td>
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<td>Hastings</td>
<td>2015</td>
<td>18</td>
<td>541</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Napier</td>
<td>2015</td>
<td>68</td>
<td>587</td>
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<tr>
<td>Hawke's Bay</td>
<td>Awatoto</td>
<td>2016</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Manawatu-Wanganui</td>
<td>Taumarunui</td>
<td>2010</td>
<td>6</td>
<td>259</td>
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<tr>
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<td>Taihape</td>
<td>2010</td>
<td>2</td>
<td>133</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson A</td>
<td>2014</td>
<td>7</td>
<td>149</td>
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<td>Richmond</td>
<td>2010</td>
<td>28</td>
<td>292</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Blenheim</td>
<td>2012</td>
<td>12</td>
<td>627</td>
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<tr>
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<td>Alexandra</td>
<td>2016</td>
<td>2</td>
<td>169</td>
</tr>
<tr>
<td>Otago</td>
<td>Arrowtown</td>
<td>2016</td>
<td>0</td>
<td>94</td>
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<tr>
<td>Otago</td>
<td>Milton</td>
<td>2016</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Otago</td>
<td>Mosgiel</td>
<td>2016</td>
<td>1</td>
<td>267</td>
</tr>
<tr>
<td>West Coast</td>
<td>Reefton</td>
<td>2012</td>
<td>0</td>
<td>117</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill</td>
<td>2011</td>
<td>51</td>
<td>3,792</td>
</tr>
</tbody>
</table>

* Includes road dust, shipping and aviation emissions

* Includes aviation emissions
### 3.2 PM$_{2.5}$

Table 3: Summary of emissions for PM$_{2.5}$ from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>Transport</td>
<td>Domestic</td>
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<td>101,377</td>
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<td>Putaruru</td>
<td>2015</td>
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<td>334</td>
</tr>
<tr>
<td>Waikato</td>
<td>Tokoroa</td>
<td>2016</td>
<td>2</td>
<td>136</td>
</tr>
<tr>
<td>Waikato</td>
<td>Morrinsville</td>
<td>2016</td>
<td>13</td>
<td>541</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>Hastings</td>
<td>2015</td>
<td>25</td>
<td>587</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>Napier</td>
<td>2015</td>
<td>2$^A$</td>
<td>0</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Blenheim</td>
<td>2012</td>
<td>2</td>
<td>169</td>
</tr>
<tr>
<td>Otago</td>
<td>Alexandra</td>
<td>2016</td>
<td>1</td>
<td>93</td>
</tr>
<tr>
<td>Otago</td>
<td>Arrowtown</td>
<td>2016</td>
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</tr>
<tr>
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<td>Milton</td>
<td>2016</td>
<td>2</td>
<td>263</td>
</tr>
</tbody>
</table>

$^A$ Includes road dust, shipping and aviation emissions
### 3.3 CO

Table 4: Summary of emissions for CO from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td>Transport</td>
<td>Domestic</td>
</tr>
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<td>National</td>
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<td>Hamilton</td>
<td>2012</td>
<td>12,338</td>
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<td>Waikato</td>
<td>Taupo</td>
<td>2014</td>
<td>885</td>
<td>5,787</td>
</tr>
<tr>
<td>Waikato</td>
<td>Te Kuiti</td>
<td>2015</td>
<td>94</td>
<td>1,970</td>
</tr>
<tr>
<td>Waikato</td>
<td>Putaruru</td>
<td>2015</td>
<td>155</td>
<td>1,548</td>
</tr>
<tr>
<td>Waikato</td>
<td>Tokoroa</td>
<td>2016</td>
<td>330</td>
<td>3,829</td>
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<tr>
<td>Waikato</td>
<td>Morrinsville</td>
<td>2016</td>
<td>179</td>
<td>1,623</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>Hastings</td>
<td>2015</td>
<td>1,534</td>
<td>7,080</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>Napier</td>
<td>2015</td>
<td>2,929&lt;sup&gt;A&lt;/sup&gt;</td>
<td>7,806</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>Awatoto</td>
<td>2016</td>
<td>181</td>
<td>2</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taumarunui</td>
<td>2010</td>
<td>328</td>
<td>2,535</td>
</tr>
<tr>
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<td>Taihape</td>
<td>2010</td>
<td>118</td>
<td>1,249</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson B1</td>
<td>2014</td>
<td>463&lt;sup&gt;B&lt;/sup&gt;</td>
<td>1,164</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson C</td>
<td>2014</td>
<td>885</td>
<td>2,206</td>
</tr>
<tr>
<td>Tasman</td>
<td>Richmond</td>
<td>2010</td>
<td>1,534</td>
<td>2,988</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Blenheim</td>
<td>2012</td>
<td>1,123</td>
<td>6,145</td>
</tr>
<tr>
<td>Otago</td>
<td>Alexandra</td>
<td>2016</td>
<td>150</td>
<td>2,342</td>
</tr>
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<td>Arrowtown</td>
<td>2016</td>
<td>45</td>
<td>1,274</td>
</tr>
<tr>
<td>Otago</td>
<td>Milton</td>
<td>2016</td>
<td>69</td>
<td>1,238</td>
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<tr>
<td>Otago</td>
<td>Mosgiel</td>
<td>2016</td>
<td>176</td>
<td>3,418</td>
</tr>
<tr>
<td>West Coast</td>
<td>Reefton</td>
<td>2012</td>
<td>38</td>
<td>895</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill</td>
<td>2011</td>
<td>3,595</td>
<td>25,473</td>
</tr>
<tr>
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<td>Gore</td>
<td>2011</td>
<td>626</td>
<td>5,836</td>
</tr>
</tbody>
</table>

<sup>A</sup> Includes road dust, shipping and aviation emissions
<sup>B</sup> Includes aviation emissions
## 3.4 NOx

Table 5: Summary of emissions for NOx from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
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<tbody>
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<td></td>
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<td>Domestic</td>
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<td>National</td>
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<td>82,262</td>
<td>8,083</td>
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<td></td>
<td>2012</td>
<td>1,525</td>
<td>85</td>
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<td></td>
<td>2014</td>
<td>151</td>
<td>40</td>
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<tr>
<td>Waikato Te Kuiti</td>
<td></td>
<td>2015</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Waikato Putaruru</td>
<td></td>
<td>2015</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Waikato Tokoroa</td>
<td></td>
<td>2016</td>
<td>56</td>
<td>29</td>
</tr>
<tr>
<td>Waikato Morrinsville</td>
<td></td>
<td>2016</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Hawke’s Bay Hastings</td>
<td></td>
<td>2015</td>
<td>202</td>
<td>52</td>
</tr>
<tr>
<td>Hawke’s Bay Napier</td>
<td></td>
<td>2015</td>
<td>779(^a)</td>
<td>58</td>
</tr>
<tr>
<td>Hawke’s Bay Awatoto</td>
<td></td>
<td>2016</td>
<td>30</td>
<td>0</td>
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<td></td>
<td>2010</td>
<td>64</td>
<td>16</td>
</tr>
<tr>
<td>Manawatu-Wanganui Taihape</td>
<td></td>
<td>2010</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Nelson Nelson B1</td>
<td></td>
<td>2014</td>
<td>64(^b)</td>
<td>8</td>
</tr>
<tr>
<td>Tasman Richmond</td>
<td></td>
<td>2010</td>
<td>296</td>
<td>21</td>
</tr>
<tr>
<td>Marlborough Blenheim</td>
<td></td>
<td>2012</td>
<td>152</td>
<td>39</td>
</tr>
<tr>
<td>Otago Alexandra</td>
<td></td>
<td>2016</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>Otago Arrowtown</td>
<td></td>
<td>2016</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Otago Milton</td>
<td></td>
<td>2016</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Otago Mosgiel</td>
<td></td>
<td>2016</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>West Coast Reefton</td>
<td></td>
<td>2012</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Southland Invercargill</td>
<td></td>
<td>2011</td>
<td>640</td>
<td>205</td>
</tr>
<tr>
<td>Southland Gore</td>
<td></td>
<td>2011</td>
<td>112</td>
<td>47</td>
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</tbody>
</table>

\(^a\) Includes road dust, shipping and aviation emissions
\(^b\) Includes aviation emissions
3.5 SOx

Table 6: Summary of emissions for SOx from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
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<td>National</td>
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<td>0 8,486 64,599</td>
<td>Wilton et al. 2015</td>
</tr>
<tr>
<td>Waikato</td>
<td>Hamilton</td>
<td>2012</td>
<td>4 43 4 2</td>
<td>Wilton 2012a</td>
</tr>
<tr>
<td>Waikato</td>
<td>Taupo</td>
<td>2014</td>
<td>1 15 0 0</td>
<td>Wilton 2015a</td>
</tr>
<tr>
<td>Waikato</td>
<td>Te Kuiti</td>
<td>2015</td>
<td>0 7 605 0</td>
<td>Wilton 2015b</td>
</tr>
<tr>
<td>Waikato</td>
<td>Putaruru</td>
<td>2015</td>
<td>0 4 0 0</td>
<td>Wilton 2015b</td>
</tr>
<tr>
<td>Waikato</td>
<td>Tokoroa</td>
<td>2016</td>
<td>0 13 0 2</td>
<td>Wilton 2016a</td>
</tr>
<tr>
<td>Waikato</td>
<td>Morrinsville</td>
<td>2016</td>
<td>0 8 0 0</td>
<td>Wilton 2016a</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Hastings</td>
<td>2015</td>
<td>1 19 0</td>
<td>Wilton 2015c</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Napier</td>
<td>2015</td>
<td>51a 22 1</td>
<td>Wilton 2015c</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taumarunui</td>
<td>2010</td>
<td>0 7 0 2</td>
<td>Wilton &amp; Baynes 2010c</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taihape</td>
<td>2010</td>
<td>0 4 34 1</td>
<td>Wilton &amp; Baynes 2010c</td>
</tr>
<tr>
<td>Tasman</td>
<td>Richmond</td>
<td>2010</td>
<td>1 9 46</td>
<td>Wilton &amp; Baynes 2010d</td>
</tr>
<tr>
<td>Otago</td>
<td>Alexandra</td>
<td>2016</td>
<td>0 7 0</td>
<td>Wilton 2016c</td>
</tr>
<tr>
<td>Otago</td>
<td>Arrowtown</td>
<td>2016</td>
<td>0 5 0</td>
<td>Wilton 2016c</td>
</tr>
<tr>
<td>Otago</td>
<td>Milton</td>
<td>2016</td>
<td>0 10 44</td>
<td>Wilton 2016c</td>
</tr>
<tr>
<td>Otago</td>
<td>Mosgiel</td>
<td>2016</td>
<td>0 22 0</td>
<td>Wilton 2016c</td>
</tr>
</tbody>
</table>

*a* Includes road dust, shipping and aviation emissions
### 3.6 **SO$_2$**

Table 7: Summary of emissions for SO$_2$ from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td>Transport</td>
<td>Domestic</td>
</tr>
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<td>Hawke's Bay</td>
<td>Awatoto</td>
<td>2016</td>
<td>0</td>
<td>353</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson B1</td>
<td>2014</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson C</td>
<td>2014</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Blenheim</td>
<td>2012</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>West Coast</td>
<td>Reefton</td>
<td>2012</td>
<td>0</td>
<td>59</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill</td>
<td>2011</td>
<td>2</td>
<td>290</td>
</tr>
<tr>
<td>Southland</td>
<td>Gore</td>
<td>2011</td>
<td>0</td>
<td>80</td>
</tr>
</tbody>
</table>
### 3.7 VOCs

Table 8: Summary of emissions for VOC from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (kg/day)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transport</td>
<td>Domestic</td>
</tr>
<tr>
<td>Waikato</td>
<td>Hamilton</td>
<td>2012</td>
<td>732</td>
<td>3,243</td>
</tr>
<tr>
<td>Waikato</td>
<td>Taupo</td>
<td>2014</td>
<td>56</td>
<td>1,371</td>
</tr>
<tr>
<td>Waikato</td>
<td>Te Kuiti</td>
<td>2015</td>
<td>6</td>
<td>592</td>
</tr>
<tr>
<td>Waikato</td>
<td>Putaruru</td>
<td>2015</td>
<td>9</td>
<td>445</td>
</tr>
<tr>
<td>Waikato</td>
<td>Tokoroa</td>
<td>2016</td>
<td>20</td>
<td>1,299</td>
</tr>
<tr>
<td>Waikato</td>
<td>Morrinsville</td>
<td>2016</td>
<td>11</td>
<td>471</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Hastings</td>
<td>2015</td>
<td>96</td>
<td>2,124</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Napier</td>
<td>2015</td>
<td>181A</td>
<td>2,342</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taumarunui</td>
<td>2010</td>
<td>26</td>
<td>753</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taihape</td>
<td>2010</td>
<td>9</td>
<td>364</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson C</td>
<td>2014</td>
<td>54</td>
<td>657</td>
</tr>
<tr>
<td>Tasman</td>
<td>Richmond</td>
<td>2010</td>
<td>119</td>
<td>961</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Blenheim</td>
<td>2012</td>
<td>68</td>
<td>1,828</td>
</tr>
<tr>
<td>Otago</td>
<td>Alexandra</td>
<td>2016</td>
<td>9</td>
<td>682</td>
</tr>
<tr>
<td>Otago</td>
<td>Arrowtown</td>
<td>2016</td>
<td>3</td>
<td>356</td>
</tr>
<tr>
<td>Otago</td>
<td>Milton</td>
<td>2016</td>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>Otago</td>
<td>Mosgiel</td>
<td>2016</td>
<td>10</td>
<td>822</td>
</tr>
<tr>
<td>West Coast</td>
<td>Reefton</td>
<td>2012</td>
<td>2</td>
<td>195</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill</td>
<td>2011</td>
<td>267</td>
<td>6,081</td>
</tr>
<tr>
<td>Southland</td>
<td>Gore</td>
<td>2011</td>
<td>47</td>
<td>1,263</td>
</tr>
</tbody>
</table>

A Includes road dust, shipping and aviation emissions
B Includes aviation emissions
### 3.8 CO₂

Table 9: Summary of emissions for CO₂ from inventories produced since 2010.

<table>
<thead>
<tr>
<th>Region</th>
<th>Area/ Airshed</th>
<th>Year</th>
<th>Sources (t/day)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transport</td>
<td>Domestic</td>
</tr>
<tr>
<td>Waikato</td>
<td>Hamilton</td>
<td>2012</td>
<td>213</td>
<td>543</td>
</tr>
<tr>
<td>Waikato</td>
<td>Taupo</td>
<td>2014</td>
<td>117</td>
<td>52</td>
</tr>
<tr>
<td>Waikato</td>
<td>Te Kuiti</td>
<td>2015</td>
<td>37</td>
<td>8</td>
</tr>
<tr>
<td>Waikato</td>
<td>Putaruru</td>
<td>2015</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>Waikato</td>
<td>Tokoroa</td>
<td>2016</td>
<td>92</td>
<td>21</td>
</tr>
<tr>
<td>Waikato</td>
<td>Morrinsville</td>
<td>2016</td>
<td>31</td>
<td>13</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Hastings</td>
<td>2015</td>
<td>136</td>
<td>85</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>Napier</td>
<td>2015</td>
<td>175(^a)</td>
<td>160</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taumarunui</td>
<td>2010</td>
<td>48</td>
<td>17</td>
</tr>
<tr>
<td>Manawatu-Wanganui</td>
<td>Taihape</td>
<td>2010</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson B1</td>
<td>2014</td>
<td>27(^b)</td>
<td>24</td>
</tr>
<tr>
<td>Tasman</td>
<td>Richmond</td>
<td>2010</td>
<td>61</td>
<td>84</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Blenheim</td>
<td>2012</td>
<td>118</td>
<td>52</td>
</tr>
<tr>
<td>Otago</td>
<td>Alexandra</td>
<td>2016</td>
<td>49</td>
<td>10</td>
</tr>
<tr>
<td>Otago</td>
<td>Arrowtown</td>
<td>2016</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Otago</td>
<td>Milton</td>
<td>2016</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Otago</td>
<td>Mosgiel</td>
<td>2016</td>
<td>53</td>
<td>10</td>
</tr>
<tr>
<td>West Coast</td>
<td>Reefton</td>
<td>2012</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Southland</td>
<td>Invercargill</td>
<td>2011</td>
<td>444</td>
<td>197</td>
</tr>
<tr>
<td>Southland</td>
<td>Gore</td>
<td>2011</td>
<td>107</td>
<td>34</td>
</tr>
</tbody>
</table>

\(^a\) Includes road dust, shipping and aviation emissions  
\(^b\) Includes aviation emissions
References


Appendix 1: Inventory metadata

New Zealand

Region: New Zealand
Area/airshed: National
Years: 2013 (actual)

Reference: Wilton et al. 2015
Population data: 2013 Census
Spatial resolution: Census area unit Airshed

Methodology assumptions

Transport sources: Motor vehicles
- VEPM 5.0 default values for 2013
  - Two speeds, more than and less than 80 km/hr (MoT)
- VKT by CAU for 2013 (NZTA)
  - CAU estimate divided by total for NZ for proportion of total emissions within each CAU
- Daily winter average and annual estimate

Domestic sources: Home heating
- EFs Varies based on appliance type, year of appliance and pollutant
  - Wood PM$_{2.5}$ EFs assumes 100% PM$_{10}$ is in PM$_{2.5}$ size fraction
  - Coal PM$_{2.5}$ proportion assumed to be 88% of PM$_{10}$
- 2013 census home heating methods (wood and coal)
  - Average fuel consumption (from recent inventories)
  - Distribution of wood burning appliances
  - Proportion of coal burnt on appliances
- Additional surveying for other (non-inventory) areas
- Average log weight of 1.6kg (mid-point of average range of values)
- Daily winter average and annual estimate

Industry sources: Consented industry
- Based on existing recent inventory data
- Focusses on combustion activities excludes many process emissions and industry-related fugitive dust emissions
- Results differ between summaries and those contained in emission inventories due to:
  - Limited nature of this assessment, and
  - Different spatial coverage (the airshed areas differ to the areas defined in the inventory)
- Daily winter average and annual estimate

Outdoor burning
- Emission rates based on existing recent inventory data where available
  - Survey (2014) responses for other areas
- Material burnt based on material density of 75 kg/m$^3$ and AP42 EFs for burning garden waste
- Daily winter average and annual estimate
**Northland**

**Region:** Northland  
**Reference:** Wilton 2007

**Area/airshed:** Whangarei airshed  
**Population data:** 2001 Census

**Years:** 2006 (actual)  
**Spatial resolution:** Census area unit Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles
- EFs (fleet weighted) from NZTER database (MoT)
  - Vehicle registration data for Whangarei from July 2006 (MoT).
- SO₂ and CO₂ emission rates derived from national vehicle fleet profile.
- 4 levels of congestion
  - Assumes 30% of VKTs occur under cold running conditions
- VKT estimated using VKT to household ratios (lower range of 28 VKT per household)
- Daily average

#### Domestic sources: Home heating
- EF varies based on appliance type, year of appliance and pollutant
- Home heating survey winter 2006 (heating methods & fuel use)
  - Households extrapolated for 2006 from 2001 Census
  - Based on a 12% increase in population by 2021 (Statistics NZ)
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

#### Industry sources: Consented industry
- Stack testing results used to estimate emissions over emission factors.
  - NZ specific EFs used for PM₁₀
  - AP42 database (USEPA) used everywhere else
- Surveyed blasting industries for types of emissions control technology.
- Monthly profile

### Outdoor burning
- EFs from AP42 database (USEPA)
- Home heating survey
- Monthly profile
## Auckland

**Region:** Auckland  
**Reference:** Xie *et al.* 2014  
**Area/airshed:** Auckland (region)  
Auckland (urban airshed)  
**Population data:** 2006 Census  
**Years:** 2006 (actual)  
2001 (backcast)  
2011 (forecast)  
**Spatial resolution:** Census area units  
Airshed Region

### Methodology assumptions

**Transport sources:** Motor vehicles

- VEPM 4.1  
  - Speeds between 10 and 99km/hr  
- SO$_2$ calculated based on methodology in VEPM3.0 user notes  
- PM$_{1.5}$ assumed 100% PM$_{10}$ exhaust emissions and 80% PM$_{10}$ for brake and tyre  
- VKT from Auckland Regional Transport model (ART) version 3.0  
  - 3 time periods (AM, IP and PM) extrapolated for daily profile  
  - Light and heavy vehicle proportions  
- Daily average and annual estimates

**Transport sources:** Shipping

- AP42 EFS (USEPA)  
- Ships, port vessels (tugs and pilot boats), ferries, and commercial fishing boats  
  - Includes land based port-related activities (cargo handling, dredging operations)  
  - Commercial fishing vessel data from Ministry of Fisheries  
- Vessel specific data collected (movements, gross tonnage, engine power, speed) from Ports of Auckland  
- Travel speeds from automatic identification system (AIS) transponder data  
- Annual estimates

**Transport sources:** Aviation

- EFs per aircraft movement from Auckland air emissions inventory: 2004 (Metcalfe *et al.* 2006)  
- Annual movements for 2006 from Auckland Airport Ltd  
- Annual estimates

**Transport sources:** Rail

- Kilolitre of fuel by type of engine (based on 1998 fleet)  
- Fuel consumption for 1998 supplied by the Auckland Regional Council (now Auckland Council)  
- Annual estimates

**Transport sources:** Off-road mobile sources

- Unregistered motorbikes, competition vehicles, farm, forestry, and defence vehicles  
- Based on vehicle type/equipment specific annual fuel consumption, load and emission factor as per Auckland air emissions inventory: 2004 (Metcalfe *et al.* 2006)  
- Annual estimates
Domestic sources: Home heating
- Woodburners EFs from NZ based emissions testing in New Zealand for PM$_{10}$
  - Other burners and contaminants updated based on review of international emission factors, and testing in New Zealand.
- Appliance numbers and emissions estimated from:
  - Domestic fire emission prediction model (DFEPM)
  - Natural gas and LPG from Auckland regional energy database.
  - Number of households using wood, coal, LPG or natural gas from 2006 Census (Statistics NZ)
- Daily winter average and annual estimate

Domestic sources: Lawn mowing
- EFs for PM (NPI)
  - For other contaminants, emission factors sourced from Priest et al (2000)
- 1993 domestic survey scaled by population projections for 2006 (Statistics NZ)
- Annual estimate

Industry sources: Consented industry
- Auckland Council consents database
  - Emissions testing, assessment of environmental effects, consent limits and AP42 USEPA EFs

Industry sources: Commercial sources
- Per capita emissions calculated based on Auckland air emissions inventory: 2004 (Metcalf et al. 2006).
  - Scaled by population for 2006 and 2011

Outdoor burning
- EFs for municipal refuse (USEPA)
  - CO$_2$ EFs assumed the same as for wood combustion
- 1993 domestic survey and scaled by population projections for 2006 (Statistics NZ)
- Annual estimate
Bay of Plenty

Region: Bay of Plenty  
Reference: Iremonger et al. 2007

Area/airshed: Rotorua (urban)  
Population data: 2006 Census

Years: 2005 (actual)  
Spatial resolution: Airshed

Methodology assumptions

Transport sources: Motor vehicles
- EFs (fleet-weighted) from NZTER version 1 (MoT)
  - SO2 not included in estimates
- Fleet profile for urban roads and state highways
  - Traffic counts from the RAMM traffic database (MoT)
  - Vehicle registration data (MoT)
- 3 levels of congestion

Transport sources: Aviation
- EFs from NPI (Environment Australia)
  - General aviation EFs used
- Number of take-offs and landings (Rotorua Regional Airport Limited) for 2005

Domestic sources: Home heating
- Rotorua home heating survey 2005
  - Schools included as a subgroup
  - Coal supply figures for 2005 and EFs for overfeed stoker boilers taken from AP42 (USEPA) and Coal Research Ltd
- Heating model developed

Industry sources: Consented industry
- Consent limits and hours of operation for PM10
  - Fuel consumption from consent application for other contaminants.
  - Maximum consented discharge limits used.

Industry sources: Small combustion
- Source emission rates allocated based on point source emission data
  - Based on facility type derived from Rotorua District Council database
Region: Bay of Plenty  
Reference: BOPRC 2008

Area/airshed: Whakatane (urban)  
Population data: 2006 Census

Years: 2007 (actual)  
Spatial resolution: Urban area

**Methodology assumptions**

**Transport sources: Motor vehicles**

- EFs (fleet-weighted) from NZTER version 1 (MoT)
  - SO2 not included in estimates
- Fleet profile for urban roads and state highways
  - Traffic counts from the RAMM traffic database (MoT)
  - Vehicle registration data for 2006 (MoT)
- 3 levels of congestion

**Domestic sources: Home heating**

- Data gathered from inventories (of similar geographical areas), household energy use studies, Statistics NZ 2006 census datasets
- 2006 census home heating methods
- Ratios of wood burning appliance from the Rotorua domestic heating survey (2005)
- Domestic annual coal volume (Solid Energy)
- Annual average daily wood use of 6.5 kg

**Industry sources: Consented industry**

- One consented industry within urban area: CHH Paperboard Limited
  - Total consented emission limit used.

**Industry sources: Small combustion**

- Source emission rates allocated based on point source emission data
  - Based on facility type derived from Whakatane District Council database
**Waikato**

**Region:** Waikato  
**Reference:** Wilton 2015b  
**Area/airshed:** Te Kuiti airshed  
**Population data:** 2013 Census  
**Years:** 2015 (actual)  
**Spatial resolution:** Census area unit Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles
- EFs from VEPM 5.0
- Fleet profile registration data for each area, year ending May 2015
- Annual average temperature of 15°C (Te Kuiti) and 11°C (Putaruru)
- SOx emission factors based on fuel sulphur content (0.01%)  
  - Assumed 100% conversion to SOx.
- NZTA VKT data for 2013 by census area unit
  - Distributed by time of day splits from the Taupo transport model
- Daily winter average and annual estimate

#### Domestic sources: Home heating
- EFs vary based on appliance type, year of appliance and pollutant
- Home heating survey (May & June 2015)  
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

#### Industry sources: Consented industry
- NZ specific coal fired boiler PM$_{10}$ EFs  
  - AP42 EF for all others (USEPA)
- Resource consent application data from council database
- Schools surveyed to determine source of heating
- Fugitive dust emissions not included
- Seasonal profile

#### Outdoor burning
- AP42 EFs (USEPA)
- 2015 home heating survey
- Emissions calculated based on assumption:  
  - Average weight of material per burn = 75kg
  - Average fire size = 1m$^3$
  - Burning is carried out evenly through winter
- Seasonal profile
Region: Waikato

Area/airshed: Tokoroa airshed
Morrinsville airshed

Population data: 2013 Census

Reference: Wilton 2016a

Years: 2016 (actual)

Spatial resolution: Airshed

Methodology assumptions

Transport sources: Motor vehicles

- VEPM 5.1
- Fleet profile from registration data for each area, year ending 20 June 2016
- 2015 annual average temperature of 11°C (Tokoroa)
- SOx emission factors based on fuel sulphur content of fuel (0.01%)
  - Assumed 100% conversion to SOx.
- NZTA VKT data for 2013 by census area unit
  - Distributed by time of day splits from the Taupo transport model
- Daily average

Domestic sources: Home heating

- EFs vary based on appliance type, year of appliance and pollutant
- Home heating survey (May & June 2016)
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average
- Monthly profile

Industry sources: Consented industry

- NZ specific coal fired boiler PM$_{10}$ EFs
  - AP42 emission factors for all others (USEPA)
- Resource consent application data from council database
- Fugitive dust emissions not included
- Seasonal profile

Outdoor burning

- AP42 EFs (USEPA)
  - Benzene and BaP based on wood burning for domestic heating and are indicative only
- 2016 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 159kg
  - Average fire size = 1.9m$^3$ (Tokoroa) and 0.6m$^3$ (Morrinsville)
  - Burning is carried out evenly through winter
- Seasonal profile
**Region:** Waikato  
**Reference:** Wilton 2015a  
**Area/airshed:** Taupo airshed  
**Population data:** 2013 Census  
**Years:** 2014 (actual)  
**Spatial resolution:** Census area unit Airshed

### Methodology assumptions

**Transport sources: Motor vehicles**
- VEPM 3.0
- Fleet profile based on Taupo registration data, year ending 31 May 2014
- Annual average temperature for Taupo
- SOx emission factors based on fuel sulphur content of fuel (0.01%)  
  - Assumed 100% conversion to SOx.
- NZTA VKT data for 2013 by census area unit  
  - Total VKT extrapolated based on additional households in the airshed
  - Time of day splits from Taupo transport model
- Daily average

**Domestic sources: Home heating**
- Varies based on appliance type, year of appliance and pollutant
- Home heating survey (June 2014)
- Assumes:  
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average
- Monthly profile

**Industry sources: Consented industry**
- NZ specific coal fired boiler PM$_{10}$ EFs  
  - AP42 emission factors for all others (USEPA)
- Resource consent application data  
  - Phone survey or provided by Council staff for missing data
- Schools surveyed by phone/email to determine source of heating
- Fugitive dust emissions not included
- Seasonal profile

**Outdoor burning**
- AP42 emission factors (USEPA)  
  - Benzene and BaP based on wood burning for domestic heating and are indicative only
- 2014 home heating survey
- Emissions calculated based on assumption:  
  - Average weight of material per burn = 75kg
  - Average fire size = 1m$^3$
  - Burning is carried out evenly through winter
- Seasonal profile
Region: Waikato

Reference: Wilton 2012a

Area/airshed: Hamilton airshed

Population data: 2006 Census

Years: 2012 (actual)

Spatial resolution: Airshed

Methodology assumptions

Transport sources: Motor vehicles
- VEPM 3.0
- Fleet profile based on Hamilton registration data, year ending 30 April 2012
- Annual average temperature for Taupo
- SOx emission factors based on fuel sulphur content (0.01%)
- Assumed 100% conversion to SOx.
- VKT data by census area unit for year ending 2010 (MoT)
  o Total VKT extrapolated based on additional households in the airshed
  o Time of day splits from 2005 Hamilton inventory
- Daily average

Domestic sources: Home heating
- Varies based on appliance type, year of appliance and pollutant
- Home heating survey (June 2012)
- Assumes:
  o Average log weight = 1.6kg
  o Average bucket of coal = 9kg
- Daily winter average & worst case scenario
- Monthly profile

Industry sources: Consented industry
- NZ specific coal fired boiler PM10 EFs
  o AP42 emission factors for all others (USEPA)
- Resource consent application data
  o Phone survey or provided by Council staff for missing data
- Schools surveyed by phone/email to determine source of heating
- Fugitive dust emissions not included
- Seasonal profile

Outdoor burning
- AP42 emission factors (USEPA)
  o Benzene and BaP based on wood burning for domestic heating and are indicative only
- 2012 home heating survey
- Emissions calculated based on assumption:
  o Average weight of material per burn = 150kg
  o Average fire size = 1.2m³ (Hamilton)
  o Burning is carried out evenly through winter
- Seasonal (winter months)
Gisborne

Region: Gisborne  Reference: Sherman & Fisher 2005
Area/airshed: Gisborne (region)  Population data: 2001 Census
Years: 2005 (actual)  Spatial resolution: Census area unit

Methodology assumptions

Transport sources: Motor vehicles

- EFs (fleet weighted) from NZTER (MoT)
  - Exhaust emissions from on-road motor vehicles only
  - Vehicle fleet profile derived from vehicle registrations for 2002 (MoT)
  - SO\textsubscript{2} and CO\textsubscript{2} emission rates derived from national vehicle fleet profile.
  - Benzene emissions factors based on a weight fraction of motor vehicle VOC emissions from NPI
  - Apportioned using the Gisborne vehicle fleet profile.
  - Average driving speeds 36-70 km/h (suburban) and >71 km/h (rural highway)
- Dynamic On-Road Transport (D.O.T.) Model Fleet Hub (MoT)
- Daily winter average

Transport sources: Marine

- EFs assumed to apply to all shipping travelling through a 12 NM zone
- Heavy fuel oil (HFO) sulphur content = 1.5%
- Port calls and harbour vessel work hours (Eastland Port Ltd)
- Annual estimates

Transport sources: Aviation

- Fuel used assumed to apply for all aircraft
  - Aviation fuel (Air BP)
- Percent fuel used for each category assumed same as 1996 taking into account current total fuel used
- Assumes 20% of the fuel loaded is burnt in the Gisborne region
- Annual estimate

Transport sources: Off-road vehicles

- Off-road vehicle use assumed to be twice that of Auckland

Domestic sources: Home heating

- EFs vary based on appliance type, year of appliance and pollutant
- Based on the Environment Protection Authority of Victoria’s Auckland air emissions inventory upgrade (2005-draft).
  - Emissions scaled according Gisborne’s population.
  - 2004 Taupo emissions inventory percentages matched with Gisborne household data to estimate combustion methods for Gisborne.
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average

**Industry sources: Consented industry**
- Resource consent data from council:
  - Amount of fuel used
  - Nature of raw material used
  - Operating hours and capacity
- Additional information obtained from industry.
- Annual estimate

**Outdoor burning**
- Rate of domestic waste combustion assumed three times that of Auckland.
- Particulate size distribution assumed same as Auckland
  - 98% of all particulate matter assumed to be PM$_{10}$.
- Annual estimate

**Other sources: Bush fires**
- Assumed biomass density for scrub and forested areas = 50 T/ha
- 75% of biomass was burnt
  - 90% is oxidized to carbon (carbon fraction = 45%)
- Data recorded and estimated by the Rural Fire Authority
  - Includes areas of forest, scrub and grass burned by accident or for clearance purposes.
- Assumed in addition, 50 ha burned each year but unreported.
- Emissions from grass fires assumed negligible.
- Annual estimate

**Other sources: Natural**
- 1996 Natural Emissions Inventory for New Zealand (NIWA).
  - Mostly based on overseas data, adjusted in some cases for New Zealand temperatures.
- 1996 inventory land type classification data.
- Annual estimate
## Hawke’s Bay

**Region:** Hawke’s Bay  
**Reference:** Wilton 2015c  
**Area/airshed:** Napier  
- Hastings  
- Havelock North  
**Population data:** 2013 Census  
**Years:** 2015 (actual)  
**Spatial resolution:** Census area unit

### Methodology assumptions

**Transport sources:** Motor vehicles

- EFs from VEPM 5.1
  - Fleet profile based on registration data for each area, year ending March 2015
  - Average winter temperature of 8.5°C
  - Assumed 42km/hr average speed
- SOx emission factors based on fuel sulphur content (0.01%)
  - Assumed 100% conversion to SOx.
- VKT data for 2013 by census area unit (NZTA)
- Daily average

**Transport sources:** Motor vehicles (re-suspended road dust)

- Tracer component method used to separate exhaust and non-exhaust emissions in Auckland.
- Ratios used to estimate non-exhaust PM$_{10}$ and PM$_{2.5}$ emissions from motor vehicles.

**Transport sources:** Marine

- EFs have the following assumptions:
  - Total harbour transit times for each journey in and out of one hour
  - Operating power during harbour transit of 50%
  - SOx emission rate based on average sulphur content of 1%.
  - PM$_{2.5}$ to PM$_{10}$ ratio of 0.87
- Number and types of vessels entering and leaving Port of Napier
  - Data supplied by the Harbourmaster
- Average kW per ship based on gross tonnage of vessels within each weight category
- Annual estimates

**Transport sources:** Aviation

- EFs from combination of sources
- 2010 annual landing and take-off cycles by time of day for Hawke’s Bay airport
- Time of day profile and annual estimates

**Domestic sources:** Home heating

- EFs varies based on appliance type, year of appliance and pollutant
- Home heating survey June 2015 (heating methods & fuel use)
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile
Industry sources:  Consented industry

- NZ specific coal fired boiler PM$_{10}$ EFs
  - AP42 emission factors for all others (USEPA)
- Combination of resource consent database and 2010 air emission inventory industry to identify emitters.
- Phone and email survey
  - Schools surveyed to determine source of heating
- Fugitive dust emissions not included
- Small commercial activities such as spray painting, dry cleaning etc not included in inventory
- Seasonal profile
Region: Hawke’s Bay  
Reference: Wilton 2016b  
Area/airshed: Awatoto airshed  
Population data: N/A  
Years: 2016 (actual)  
Spatial resolution: Census area unit Airshed

Methodology assumptions

Transport sources: Motor vehicles
  - MFE database using national vehicle emissions estimates (NIWA)
    - Distributed to CAUs based on VKT data (Wilton et al. 2015)
  - Estimates include tail pipe emissions, brake and tyre wear
  - Daily average and annual estimate

Domestic sources: Home heating
  - Weighted average solid fuel burner for Napier from (Wilton 2015c)
    - Average daily fuel use during winter = 16.8 kg per night
  - Aerial survey of dwellings;
  - Proportion of dwellings using solid fuel for home heating by CAU.
  - Daily winter average and monthly profile

Industry sources: Consented industry
  - Emission factors/emission rates from industrial testing or consent files.
  - Resource consents data
  - Historical emissions inventory information obtained through industry surveys.
Manawatu-Wanganui

Region: Manawatu-Wanganui  Reference: Wilton & Baynes 2010c
Area/airshed: Taumarunui airshed  Taihape airshed  Population data: Census 2006
Years: 2010 (actual)  Spatial resolution: Airshed

Methodology assumptions

Transport sources: Motor vehicles
- VEPM 3.0 EFs
  - Fleet profile based on registration data for each area, year ending April 2010
  - Assumed average 50km/hr speeds
  - SOx emission factors based on fuel sulphur content (0.005%) and assumed 100% conversion to SOx.
- Population based estimate derived from relationship between VKT and dwelling numbers
  - VKT estimate based on the average ratio of VKT/households for Timaru and Havelock North
- Daily average estimate

Domestic sources: Home heating
- Varies based on appliance type, year of appliance and pollutant
- Home heating survey June 2010 (heating methods & fuel use)
- 2010 household estimates made using 2007 Statistics NZ population projections
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

Industry sources: Consented industry
- NZ specific coal fired boiler PM10 EFs
  - AP42 EFs for all others (USEPA)
- Consents data used to identify possible emitters.
- Fugitive dust emissions not included
- Small commercial activities such as spray painting, dry cleaning etc not included in inventory
- Seasonal profile

Outdoor burning
- AP42 EFs (USEPA)
- 2010 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 120kg
  - Average fire size = 1.2m³ (Hamilton)
  - Burning is carried out evenly through winter
- Seasonal - winter months
Wellington

Region: Wellington  Reference: Wilton 2006c
Area/airshed: Wainuiomata airshed  Population data: 2001 Census
Upper Hutt airshed

Years: 2006 (actual)  Spatial resolution: Airshed

Methodology assumptions

Transport sources: Motor vehicles
- EFs (fleet-weighted) from NZTER (MoT)
  - Vehicle registrations data year ending December 2005 (Land Transport NZ)
  - Distribution light, medium and heavy-duty vehicles based on the 1998 New Zealand fleet profile
  - 3 levels of congestion
  - Brake & tyre emission factors for PM$_{10}$ and PM$_{2.5}$ from the British Colombia Lower Fraser Valley and adjusted for the Wellington vehicle fleet profile
- Greater Wellington Region road network model
- Assumes 27% VKT in Wainuiomata and 12% of the VKTs in Upper Hutt
- Daily average

Domestic sources: Home heating
Emission factors:
- Varies based on appliance type, year of appliance and pollutant
  - Reviewed to include “in-situ” burner testing
- Phone home heating survey May 2006 (heating methods & fuel use)
  - Number of households extrapolated for 2006 from 2001 census population projections (Statistics NZ)
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

Industry sources: Consented industry
- AP42 EFs (USEPA)
- Natural gas factors derived by NIWA for the Christchurch 1996 emission inventory
- List of industries discharging to air from consents information (Greater Wellington Regional Council)
  - Stack testing results used where available
  - Activity data collected from local industrial and commercial activities and local schools
- Monthly profile

Outdoor burning
- AP42 EFs (USEPA)
- Domestic home heating survey
- Emissions calculated based on assumption that average weight of material per burn = 180kg
- Monthly profile
Nelson

Region: Nelson  
Reference: Wilton 2014

Area/airshed: Nelson A airshed
Nelson B1 airshed
Nelson B2 airshed
Nelson C airshed

Population data: N/A

Years: 2014 (actual)
Spatial resolution: Census area units

Airsheds

Methodology assumptions

Transport sources: Motor vehicles

- EFs from VEPM 5.0
  - Vehicle fleet profile based on Nelson vehicle registration data (year ending 31 May 2014)
  - Average temperature for Nelson used
  - 42 km/hr average speed assumed
  - SOx emission factors for diesel vehicles based on fuel sulphur content and assumed 100% conversion to SOx.
- VKT data for 2013 by CAU (NZTA)
- Daily average

Transport sources: Aviation

- Assumed 4kg/day of PM$_{10}$ emitted

Domestic sources: Home heating

- Varies with type of appliance, type of fuel, and pollutant.
- July 2014 home heating survey (heating methods & fuel use)
- Daily winter average

Industry sources: Consented industry

- NZ specific coal fired boiler PM$_{10}$ EFs
  - AP42 EFs for all others (USEPA)
  - Combination of consents data, 2006 air emissions inventory and information from Nelson City Council used to identify possible emitters
  - Site specific emissions data used where available
- Schools surveyed for heating method used
- Seasonal profile
Tasman

Region: Tasman
Area/airshed: Richmond (urban)
Years: 2010 (actual)
Reference: Wilton & Baynes 2010d
Population data: 2006 Census
Spatial resolution: Census area units

Methodology assumptions

Transport sources: Motor vehicles
• VEPM 3.0 EFs
  o Vehicle fleet profile based on vehicle registration data year ending April 2010
  o Winter average temperature 2006 - 2009 for Richmond of 8.4°C
  o SOx emission factors based on fuel sulphur content (0.005%) and assumed 100% conversion to SOx
• Population based estimate:
  o Relationship between VKT and dwelling numbers
  o Ratio of VKT/households based on road network modelling for Nelson (2006 inventory)
• Daily average

Domestic sources: Home heating
• Varies with type of appliance, type of fuel, and pollutant.
• Digipol home heating survey June 2010 (heating methods & fuel use)
• 2010 households estimated using 2007 population projections for Tasman (Statistics NZ)
  o Average log weight = 1.6kg
  o Average bucket of coal = 9kg
• Daily winter average and monthly profile

Industry sources: Consented industry
• NZ specific coal fired boiler PM$_{10}$ EFs
  o AP42 EFs for all others (USEPA)
• Phone survey
  o Additional data provided by Tasman District Council
  o Schools surveyed to determine heating methods
• Fugitive dust emissions not included
• Seasonal profile
Marlborough

Region: Marlborough       Reference: Wilton 2012b
Area/airshed: Blenheim     Population data: 2006 Census
Years: 2012 (actual)       Spatial resolution: Census area units

Methodology assumptions

Transport sources: Motor vehicles

- VEPM 5.0 EFs
  - Vehicle fleet profile based on Marlborough vehicle registration data (year ending 30 April 2012)
  - Average winter temperature for Blenheim (8°C) in 2011
  - 42 km/hr average speed assumed
  - SOx emission factors for diesel vehicles based on fuel sulphur content (0.01%) and assumed 100% conversion
- VKT by CAU for the year ending 2010 (MoT)
  - VKT adjusted down by 8% to align estimates with vehicle registration data
  - Time of day breakdown from Havelock North 2005 (no data available for Blenheim)
- Hourly profile and daily averages

Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
- Home heating survey June 2012 (heating methods & fuel use)
- 2012 estimate based on population projection for Marlborough district (Statistics NZ)
  - Average log weight = 1.6kg
- Daily winter average and monthly profile

Industry sources: Consented industry

- NZ specific coal fired boiler PM$_{10}$ EFs
  - AP42 EFs for all others (USEPA)
- Phone survey and additional data provided by Marlborough District Council staff
- Activities such as spray painting or dry cleaning not included
- Schools with discharge consents surveyed by phone to determine source of heating.
- Fugitive dust emissions not included

Outdoor burning

- AP42 EFs (USEPA)
- Assumed:
  - Average weight of material per burn = 75kg
  - Burning is carried out evenly through winter
- 2012 domestic home heating survey
- Collected for winter months
**Canterbury**

**Region:** Canterbury  
**Reference:** McCauley & Scott 2006

**Area/airshed:** Waimate, Ashburton, Kaiapoi & Rangiora  
**Population data:** 2001 Census

**Years:** 2004 (actual)  
**Spatial resolution:** Census area units

### Methodology assumptions

**Transport sources: Motor vehicles**
- Non-tailpipe emissions (ie. brake and tyre wear) not included in the inventory
- NZTER version 1.0 (MoT)
  - Base year 2004 for PM$_{10}$, NOx and CO
  - PM$_{2.5}$ calculated as proportions of PM$_{10}$ values using Canadian lower Fraser Valley emissions inventory
  - SOx and CO$_2$ emission factors sourced from 2002 Christchurch emissions inventory
- Single car emission rates calculated for all vehicle types
- AADT traffic count and road link lengths from RAMM database for local roads
  - Transit New Zealand for state highways
- Hourly traffic count used AADT estimate proportion of VKT occurring throughout the day VKT split by vehicle type based on 2004 vehicle registrations to calculate emissions.
  - Daily average

**Transport sources: Rail**
- EFs (baseline in service) from MoT
  - SOx based on mass balances with the fuel sulphur content of 0.06 wt%
- Data from rail network owner (Toll Rail) for:
  - Train movement data
  - Engine type, time and number per day
- Assumed average train speed = 30km/hr
  - Daily average

**Domestic sources: Home heating**
- EFs from 2002 Christchurch emissions inventory
  - PM$_{10}$ and PM$_{2.5}$ EFs gas fired appliances altered based on emission test results
- Household telephone survey
- Hourly profile and daily average

**Industry sources: Consented industry**
- AP42 EFs (USEPA)
- Resource consent files & site visits to identify potential sources.
  - Industrial survey undertaken
  - Seasonal profile

**Outdoor burning**
- Collected for May to September 2004
- No other details (ie mass of material burnt, frequency or duration of burns) collected
Region: Canterbury  
Area/airshed: Timaru airshed  
Years: 2005 (actual)  
1996 (backcast)  
2001 (backcast)  
Reference: Smithson et al. 2006  
Population data: N/A  
Spatial resolution: Airshed

**Methodology assumptions**

Washdyke included within Timaru airshed.

**Transport sources:** Motor vehicles

- EFs from NZTER version 1.0 (MoT)
  - Base year 2005 for PM$_{10}$, NOx and CO
  - PM$_{2.5}$ based on proportions of PM$_{10}$ values
  - Fleet averaged SOx EF
  - Timaru fleet profile from vehicle registration data (MoT)
- Assumed 30% of all driving is under cold start conditions
- VKT from Timaru Transportation Model
- 3 level of service categories
- Hourly profile & daily average

**Transport sources:** Rail

- EFs for PM$_{10}$, CO & NOx from MoT
  - SOx based on mass balances with the fuel containing 0.05% by weight sulphur
- Data from Toll Holdings for:
  - Average monthly fuel use
  - Engine type and capacity
  - Individual train movements
  - Engine power, throttle settings and distance travelled.
- Monthly profile

**Domestic sources:** Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
  - EFs for open fires from 2002 Christchurch emissions inventory (except for benzene)
- 2005 Timaru home heating survey
- Figures from 2002 Christchurch home heating diary for woodburners used
- Assumes:
  - Coal bucket = 9kg mass
  - Log burnt wood = 1.9kg
- Hourly profile and daily average

**Industry sources:** Consented industry

- EFs AP42 and additional data from Air Chief 12 (USEPA)
  - NZ specific coal fired boiler PM$_{10}$ EFs
- Activity data collected based on process rather than industry type
- Questionnaires distributed to air discharge consent holders
- Follow-up phone calls
- Resource consent files
- Hourly profile, daily average and monthly profile
Region: Canterbury Reference: Smithson 2011

Area/airshed: Christchurch (urban) Population data:

Years: 2009 (actual) Spatial resolution: TLA
1999 (backcast) 10 sub areas
2002 (backcast)
2006 (backcast)

Methodology assumptions

Transport sources: Motor vehicles

• EFs from NZTER v 1.0 (MoT)
  o Base year 2009 for PM₁₀, NOx and CO
  o PM₂.₅ based on proportions of PM10 values
  o Brake and tyre factors included

• SOx, benzene (Environment Australia)

• Assumed 30% of all driving is under cold start conditions

• Christchurch Transport Model (CTM)
  o 4 model periods (AM, IP, PM & overnight)
  o 3 level of service categories

• Traffic count used to disaggregate VKT into hourly values

• 24 vehicle classes using Ministry of Transport registration data from Environment Canterbury.

• Hourly profile and daily average

Transport sources: Rail

• EFs for PM₁₀, CO & NOx calculated from MoT

• SOx based on mass balances with the fuel containing 50 mg/kg sulphur

• Based solely on fuel use data from KiwiRail

• Monthly diesel tank readings

• Monthly profile

Transport sources: Aviation

• EFs from 2006 Christchurch inventory

• Landing & take-off cycles for June 2009, Christchurch International Airport Ltd

• Assumed no. arrivals = no. departures

• Annual estimates

Domestic sources: Home heating

• EFs vary with type of appliance, type of fuel, and pollutant.

• Household telephone survey

• Pellet burn rate data provided by Solid Energy

• Assumes:
  o Coal bucket = 9kg mass
  o Log burnt wood = 1.9kg

• Hourly profile and daily weekday average
Domestic sources: Garden equipment
- Includes lawn mowing, chain saws and petrol driven equipment
- Methodology and assumptions from 2002 Christchurch inventory
- Number of households in each area
- Assumes equipment used once every 8 weeks for 20 mins in winter

Industry sources: Consented industry
- EFs from AP42 and additional data from Air Chief 12 (USEPA)
  - NZ specific coal fired boiler PM$_{10}$ EFs
- Activity data collected based on process rather than industry type
- Questionnaires distributed to air discharge consent holders
- Follow-up phone calls
- Resource consent files
- Hourly profile and daily average
- Monthly profile
Otago

Region: Otago  Reference: Wilton 2016c

Area/airshed: Airzone One airsheds: Alexandra Arrowtown Mosgiel Milton

Population data: 2013 Census

Years: 2016 (actual)  Spatial resolution: Census area units

Methodology assumptions

Transport sources: Motor vehicles

- EFs from VEPM 5.1
  - Vehicle fleet profile based on vehicle registration data for year ending 30 June 2016
  - Winter average temperature for each area (Otago Regional Council)
  - SOx emission factors based on fuel sulphur content (0.01%) and assumed 100% conversion to SO2
- VKT for 2013 by CAU (NZTA)
- Daily average

Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
- Home heating survey June and July 2016 (heating methods & fuel use)
- 2016 households estimated using 2013 census data and estimated changes in population for each area (Statistics NZ)
- Log weight of 1.6kg
- Daily winter average & monthly profile

Industry sources: Consented industry

- EFs from AP42 (USEPA)
- NZ specific coal fired boiler PM10 EFs
- Resource consent database (Otago Regional Council) to identify potential emitters
  - Phone and email survey
- Fugitive dust emissions not included
- Seasonal profile
**West Coast**

<table>
<thead>
<tr>
<th>Region</th>
<th>West Coast</th>
<th>Reference:</th>
<th>Wilton 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area/airshed:</td>
<td>Reefton</td>
<td>Population data:</td>
<td>2006 Census</td>
</tr>
<tr>
<td>Years:</td>
<td>2012 (actual)</td>
<td>Spatial resolution:</td>
<td>Census area units</td>
</tr>
</tbody>
</table>

**Methodology assumptions**

**Transport sources:** Motor vehicles

- EFs from VEPM 5.0
  - Vehicle fleet profile based on vehicle registration data for 2010 (MoT)
  - SOx emission factors for diesel vehicles based on fuel sulphur content (0.01%) and assumed 100% conversion.
- VKT by CAU for the year ending 2010 (MoT)
- Time of day breakdown from Havelock North - 2005 (no data available for Reefton)
- Daily average

**Domestic sources:** Home heating

- EFs vary with type of appliance, type of fuel, and pollutant
- Home heating survey November 2012 (heating methods & fuel use)
- 2012 estimated dwellings based on proportional increase in population for Reefton (Buller District Council)
- Assumed average log weight of 1.6kg
- Daily winter average & monthly profile

**Industry sources:** Consented industry

- EFs from AP42 (USEPA)
  - NZ specific coal fired boiler PM10 EFs
- Activity data provided by West Coast Regional Council staff
- Fugitive dust emissions not included
- Seasonal profile

**Outdoor burning**

- AP42 EFs (USEPA)
- Assumed burning is carried out evenly through winter
- 2012 home heating survey
- Seasonal - collected for winter months
**Southland**

<table>
<thead>
<tr>
<th>Region:</th>
<th>Southland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference:</strong></td>
<td>Wilton 2015e</td>
</tr>
<tr>
<td><strong>Area/airshed:</strong></td>
<td>Invercargill (urban) Gore (urban)</td>
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<tr>
<td><strong>Population data:</strong></td>
<td>2006 Census</td>
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<td><strong>Years:</strong></td>
<td>2011 (actual)</td>
</tr>
<tr>
<td><strong>Spatial resolution:</strong></td>
<td>Census area units</td>
</tr>
</tbody>
</table>

**Methodology assumptions**

**Transport sources:** Motor vehicles
- EFs from VEPM (version not indicated)
  - Vehicle fleet profile based on Invercargill vehicle registration data, year ending 31 July 2011
  - Average temperature of 9.5°C
  - Travel speed of 50km/hr
  - 100% conversion of sulphur in fuel
- VKT for year ending 2006 (MoT)
  - Scaled up to 2010 based on national % increase in VKT between 2006 & 2010
- Daily average

**Domestic sources:** Home heating
- EFs vary with type of appliance, type of fuel, and pollutant.
- Home heating survey June and July 2011 (heating methods & fuel use)
- Assumed average log weight = 1.6kg
- Daily winter average & monthly profile

**Industry sources:** Consented industry
- AP42 EFs (USEPA)
  - NZ specific coal fired boiler PM10 EFs
- Industry phone survey
- Additional data provided by Environment Southland
- Fugitive dust emissions not included
- Seasonal profile

**Outdoor burning**
- AP42 EFs (USEPA)
- Assumed burning is carried out evenly through winter
- 2011 home heating survey
- Seasonal - collected for winter months