



Auckland Air Emissions Inventory: 2004

May 2006

The Auckland Air Emissions Inventory estimates the emissions to air in the Auckland region in 2004 from four major sectors - transport, domestic, industry and biogenic (natural) - with emphasis on key ambient air pollutants. Emissions are broken down:

- Sectorally (for the four major source categories);
- Spatially (for the entire region versus the urban area only); and
- Seasonally (for a typical winter's day versus a typical summer's day)

An Auckland Air Emissions Inventory was first prepared in 1993 then upgraded by the Environment Protection Authority of Victoria in 1998. The 2004 report (TP292) updates the 1998 inventory to produce revised air emissions estimates for 1993, 2004, 2011 and 2021.

Emissions are estimated for fine particles (PM_{10}), oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs), sulphur dioxide (SO_2) and carbon dioxide (CO_2). The report focuses primarily on PM_{10} because ambient concentrations measured in Auckland have exceeded the National Environmental Standards (NES) threshold of $50\mu g m^{-3}$ at both peak traffic and urban monitoring sites.

Ambient air concentrations of both PM_{10} and NO_x in the Auckland region currently exceed accepted health guidelines and standards.

Breakdown of emissions by source

The annual estimates of the total emissions across the entire Auckland region in 2004 for the six contaminants are approximately:

- 5,900 t/yr PM_{10} (47% transport, 39% domestic, 14% industry)
- 35,000 t/yr NO_x (83% transport, 13% industry, 3% biogenic, 1% domestic)
- 171,200 t/yr CO (85% transport, 13% domestic, 2% industry)
- 64,200 t/yr VOC (52% transport, 26% industry, 13% biogenic, 9% domestic)
- 4,200 t/yr SO_2 (65% transport, 32% industry, 3% domestic)
- 8,930 kt/yr CO_2 (48% transport, 46% industry, 6% domestic)

Looking at the total annual emissions of all ambient air pollutants (excluding CO₂), the single largest individual sources are:

- Motor vehicles* at 70% and domestic heating+ at 10%

Breakdown of emissions for the urban area versus the entire region

The density of emissions varies across the region. The urban area, which represents less than 25% of the total regional landmass, contributes the majority of the total regional emissions for each pollutant as follows:

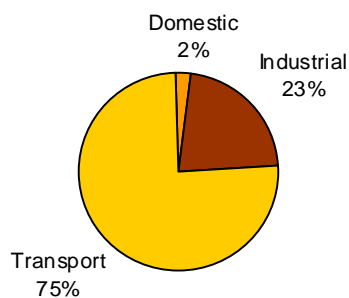
- 83% of regional PM₁₀ (4,900 t/yr)
- 82% of regional NO_x (28,600 t/yr)
- 91% of regional CO (155,600 t/yr)
- 82% of regional VOC (52,600 t/yr)
- 50% of regional SO₂ (2,100 t/yr)
- 78% of regional CO₂ (6,920 kt/yr)

Breakdown of emissions by season

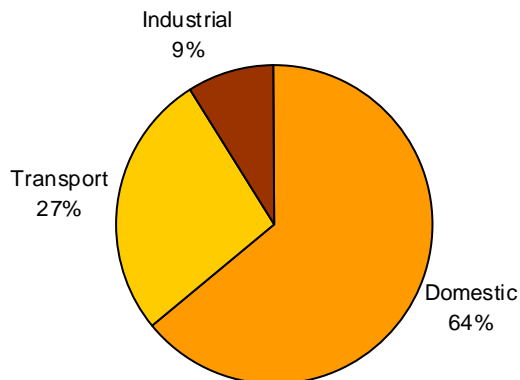
Seasonal variations in emissions are significant, both in terms of the amount as well as the relative contributions of sources, particularly for PM₁₀ as follows:

- PM₁₀ emissions in the entire region on a typical winter weekday (29 t/day) are nearly three times those of a typical summer weekday (10 t/day).
- Domestic sources (principally domestic heating) account for 64% of PM₁₀ on a typical winter weekday (June – August) but fall to 2% of PM₁₀ on a summer weekday (December – February).
- Transport sources (principally motor vehicles) account for 27% of PM₁₀ on a typical winter weekday (June – August) but rise to 75% of PM₁₀ on a summer weekday (December – February).

**PM₁₀ Summer Weekday
for the entire region
(total = 10 tonnes/day)**



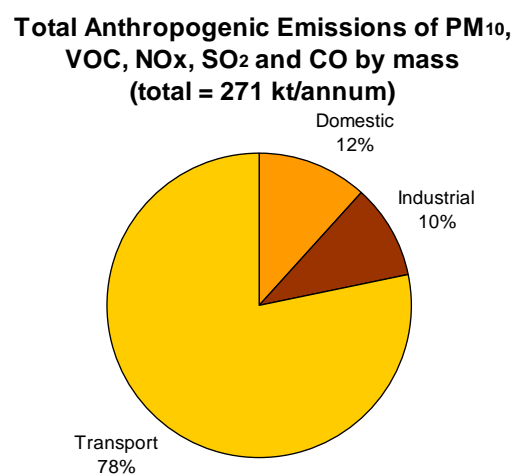
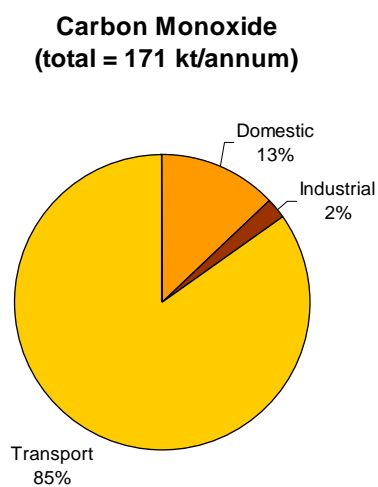
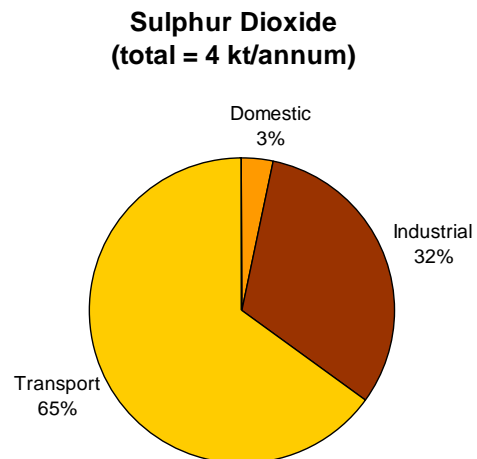
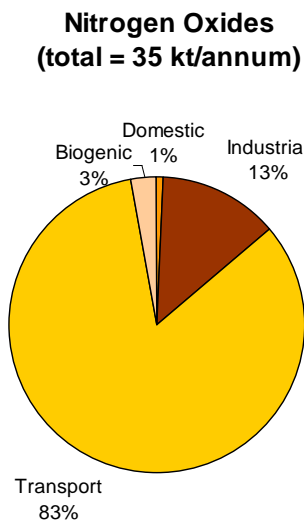
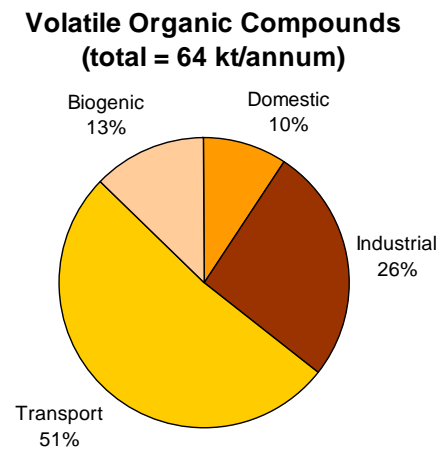
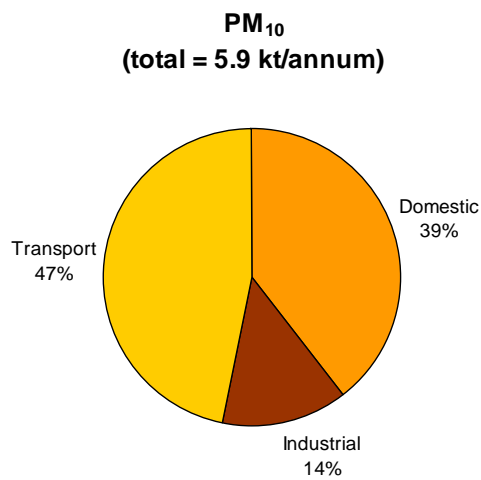
**PM₁₀ Winter Weekday
for the entire region
(total = 29 tonnes/day)**



* motor vehicles are responsible for approximately 91% of the total transport sector emissions

+ domestic heating is responsible for approximately 85% of the total domestic sector emissions

Annual emissions for the entire Auckland region in 2004 for key ambient air pollutants



Note: the **anthropogenic** (man-made) emissions equal the **total** emissions less the **biogenic** (natural) emissions.

Breakdown of annual emissions by sector (entire Auckland region)

| Category/ Source | CO (kt/yr) | NOx (kt/yr) | SO ₂ (kt/yr) | PM ₁₀ (kt/yr) | VOC (kt/yr) | CO ₂ (kt/yr) |
|---------------------|---------------|----------------|----------------------------|-----------------------------|----------------|----------------------------|
| Domestic | | | | | | |
| Coal | 0.91 | 0.01 | 0.10 | 0.33 | 0.16 | 27.8 |
| Mowing | 3.05 | 0.02 | 0.00 | 0.01 | 0.63 | 4.6 |
| LPG | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 46.7 |
| Gas | 0.03 | 0.07 | 0.00 | 0.01 | 0.01 | 90.1 |
| Waste | 0.55 | 0.04 | 0.01 | 0.10 | 0.20 | 22.2 |
| Wood | 18.02 | 0.11 | 0.04 | 1.86 | 5.15 | 310.9 |
| Total | 22.56 | 0.28 | 0.14 | 2.33 | 6.15 | 502.3 |
| Industry | | | | | | |
| Aerosol | 0.00 | 0.00 | 0.00 | 0.00 | 4.40 | 0.0 |
| Dry clean | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.0 |
| Gas Leak | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 0.2 |
| Industrial | 3.44 | 4.51 | 1.25 | 0.78 | 3.94 | 3959.2 |
| Service stn | 0.00 | 0.00 | 0.00 | 0.00 | 2.68 | 0.0 |
| Surf. coats | 0.00 | 0.00 | 0.00 | 0.00 | 4.84 | 0.0 |
| Unallocated | 0.04 | 0.10 | 0.07 | 0.03 | 0.00 | 146.9 |
| Total | 3.48 | 4.61 | 1.32 | 0.81 | 16.71 | 4106.3 |
| Transport* | | | | | | |
| Aviation | 2.52 | 0.87 | 0.06 | 0.07 | 0.61 | 191.5 |
| Bitumen | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.0 |
| Locomotive | 0.20 | 0.64 | 0.07 | 0.04 | 0.19 | 31.6 |
| Motor veh. | 134.22 | 24.72 | 1.09 | 2.45 | 30.78 | 3929.8 |
| Off-road | 5.77 | 0.82 | 0.03 | 0.02 | 0.65 | 45.1 |
| Pleas. craft | 2.28 | 0.19 | 0.02 | 0.01 | 0.63 | 26.2 |
| Ships - berth | 0.04 | 0.24 | 0.20 | 0.03 | 0.02 | 15.4 |
| Ships - sea | 0.14 | 1.63 | 1.25 | 0.16 | 0.04 | 79.5 |
| Total | 145.17 | 29.12 | 2.71 | 2.78 | 33.03 | 4319.1 |
| Biogenic* | | 0.95 | | | 8.28 | |
| All Sources | 171 | 35.0 | 4.16 | 5.92 | 64.2 | 8,928 |

* these estimates do not include secondary particulate, natural sources of particles or road dust.

Summary of annual emissions breakdown in 2004 (entire Auckland region)

| | CO | NOx | SO ₂ | PM ₁₀ | VOC | CO ₂ |
|------------------|-------|-------|-----------------|------------------|-------|-----------------|
| Domestic | 13.2% | 0.8% | 3.4% | 39.4% | 9.6% | 5.6% |
| Industry | 2.0% | 13.2% | 31.6% | 13.7% | 26.0% | 46.0% |
| Transport | 84.8% | 83.3% | 65.0% | 46.9% | 51.5% | 48.4% |
| Biogenic | | 2.7% | | | 12.9% | |

Breakdown of annual emissions by sector (urban area only)

| Category/ Source | CO (kt/yr) | NOx (kt/yr) | SO ₂ (kt/yr) | PM ₁₀ (kt/yr) | VOC (kt/yr) | CO ₂ (kt/yr) |
|---------------------|---------------|----------------|----------------------------|-----------------------------|----------------|----------------------------|
| Domestic | | | | | | |
| Coal | 0.79 | 0.01 | 0.08 | 0.29 | 0.14 | 24.0 |
| Mowing | 2.69 | 0.02 | 0.00 | 0.01 | 0.55 | 4.1 |
| LPG | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 40.3 |
| Gas | 0.03 | 0.06 | 0.00 | 0.01 | 0.00 | 77.7 |
| Waste | 0.49 | 0.03 | 0.01 | 0.09 | 0.17 | 19.7 |
| Wood | 15.54 | 0.10 | 0.03 | 1.61 | 4.45 | 268.1 |
| Total | 19.53 | 0.25 | 0.12 | 2.01 | 5.32 | 433.9 |
| Industry | | | | | | |
| Aerosol | 0.00 | 0.00 | 0.00 | 0.00 | 3.91 | 0.0 |
| Dry clean | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.0 |
| Gas Leak | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 | 0.2 |
| Industrial | 2.47 | 2.41 | 0.29 | 0.34 | 3.76 | 2320.2 |
| Service stn | 0.00 | 0.00 | 0.00 | 0.00 | 2.48 | 0.0 |
| Surf. coats | 0.00 | 0.00 | 0.00 | 0.00 | 4.27 | 0.0 |
| Unallocated | 0.04 | 0.09 | 0.06 | 0.03 | 0.00 | 130.6 |
| Total | 2.51 | 2.50 | 0.35 | 0.37 | 15.18 | 2450.9 |
| Transport* | | | | | | |
| Aviation | 2.52 | 0.87 | 0.06 | 0.07 | 0.61 | 191.5 |
| Bitumen | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.0 |
| Locomotive | 0.14 | 0.44 | 0.05 | 0.03 | 0.13 | 21.8 |
| Motor veh. | 128.71 | 23.67 | 1.04 | 2.35 | 29.64 | 3767.7 |
| Off-road | 0.27 | 0.04 | 0.00 | 0.00 | 0.03 | 2.1 |
| Pleas. craft | 1.88 | 0.16 | 0.01 | 0.01 | 0.52 | 21.6 |
| Ships - berth | 0.04 | 0.24 | 0.20 | 0.03 | 0.02 | 15.4 |
| Ships - sea | 0.03 | 0.32 | 0.25 | 0.03 | 0.01 | 15.7 |
| Total | 133.58 | 25.74 | 1.61 | 2.52 | 31.07 | 4035.8 |
| Biogenic* | | 0.14 | | | 1.04 | |
| All Sources | 156 | 28.6 | 2.08 | 4.90 | 52.6 | 6,921 |

* these estimates do not include secondary particulate, natural sources of particles or road dust.

Summary of annual emissions breakdown in 2004 (urban area only)

| | CO | NOx | SO ₂ | PM ₁₀ | VOC | CO ₂ |
|------------------|-------|-------|-----------------|------------------|-------|-----------------|
| Domestic | 12.6% | 0.9% | 5.8% | 41.0% | 10.1% | 6.3% |
| Industry | 1.6% | 8.7% | 16.8% | 7.6% | 28.8% | 35.4% |
| Transport | 85.8% | 89.9% | 77.4% | 51.4% | 59.1% | 58.3% |
| Biogenic | | 0.5% | | | 2.0% | |

Trends

Emissions have been estimated from 1993 out to 2021, based on the current inventory methodology, to indicate trends. In the period 1993 to 2004:

- CO emissions have fallen and are predicted to continue to fall in future, mainly due to an increasing number of vehicles in the fleet with improved emission control equipment.
- NO_x emissions have risen slightly, mainly due to an increasing number of diesel vehicles in the fleet, but are predicted to fall slightly in future as diesel emission control technology improves.
- SO₂ emissions have risen, mainly due to increased diesel fuel consumption resulting from an increasing number of diesel vehicles, but are predicted to fall in future as fuel sulphur levels continue to decrease.
- PM₁₀ and VOC emissions have fallen slightly, mainly due to a shift away from coal and wood for both domestic heating and industrial use, and are predicted to fall in future with fuel trends and technology improvements.
- CO₂ emissions have risen and are predicted to continue to rise in future, mainly due to increasing fuel consumption resulting from an increasing number of vehicles in the region and increasing vehicle kilometres travelled.

Further work

There are other potentially significant sources of PM₁₀ that are not estimated by the current inventory, including secondary particulates, sea salt, and wind blown or re-suspended dust. Estimation of these sources is uncertain. However, preliminary investigations suggest that these sources could account for up to 20% of the total ambient PM₁₀ on days of high air pollution (calm days, with 24-hour concentrations higher than 40µg m⁻³). Further work is necessary to validate assumptions in the existing inventory and confirm key trends.

Key conclusions

Ambient air concentrations of both PM₁₀ and NO_x in the Auckland region currently exceed accepted health guidelines and standards.

From the inventory, the largest single contributors to annual emissions of PM₁₀ are motor vehicles (41%) and domestic heating (38%). For NO_x emissions, the main source is motor vehicles (71%). Consequently, emissions management strategies that target these sources will have the greatest impact on improving air quality in Auckland.

For a full copy of the Auckland Air Emissions Inventory: 2004 report (TP292) and further information about Auckland's air quality, visit www.arc.govt.nz or phone 09 366 2000



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