

Particulate matter concentrations (PM_{2.5})

This report presents concentrations of fine particulate matter (PM_{2.5}) at monitoring sites in Aotearoa New Zealand, between 2020 and 2023. Concentrations are measured against the World Health Organisation (WHO) guidelines for PM_{2.5} exposure, in lieu of a national standard.

Key facts

- In 2023, most (28 out of 31) monitoring stations exceeded the 2021 WHO guideline for annual average PM_{2.5} concentrations.
- Between 2020 and 2023, all 31 monitoring sites exceeded recommended daily levels of PM_{2.5} concentrations at least once.
- Between 2020 and 2023, over 90% of all exceedances of the daily average threshold occurred in colder months of autumn and winter, coinciding with periods where home heaters are most used.

How PM_{2.5} affects our health

Fine particulate matter consists of small airborne particles, including solid matter and liquid droplets. PM_{2.5} refers specifically to particles with a diameter of less than 2.5 micrometres. These particles are mainly produced by the combustion of various fuels (e.g. fossil fuels or wood/coal burning heaters) and through the transformation of other particles such as nitrogen oxides, sulphur dioxide, and organic matter. The finer-grained PM_{2.5} poses a relatively high health risk compared to coarser particulates, as it can pass further into the respiratory system, depositing in the tiny airways deep in the lungs.

Exposure to PM_{2.5} is associated with various health impacts. Mild impacts include shortness of breath or coughing. More severe effects include premature death from cardiovascular and respiratory problems and increased lung cancer risk. Exposure to PM_{2.5} is also associated with asthma, diabetes and adverse birth outcomes such as low birth weight, preterm birth and small-for-gestational-age births (Ministry for the Environment and Statistics NZ 2018; WHO 2013).

In 2016, anthropogenic PM_{2.5} was responsible for:



1,292 premature deaths



4,626 hospitalisations for cardiovascular
& respiratory disease



1.75 million restricted activity
days

Source: Kuschel, Metcalfe, Sridhar, Davy, Hastings, Mason et al 2022

The HAPINZ 3.0 project found that the bulk of PM_{2.5}-related deaths in 2016 was due to domestic wood and coal fires. PM_{2.5} produced by these accounted for 962 of the 1,292 premature deaths that year. PM_{2.5} for motor vehicles led to 222 deaths, 106 were caused by wind-blown dust and just two from industrial pollution (Kuschel et al 2022).

PM_{2.5} air quality guidelines

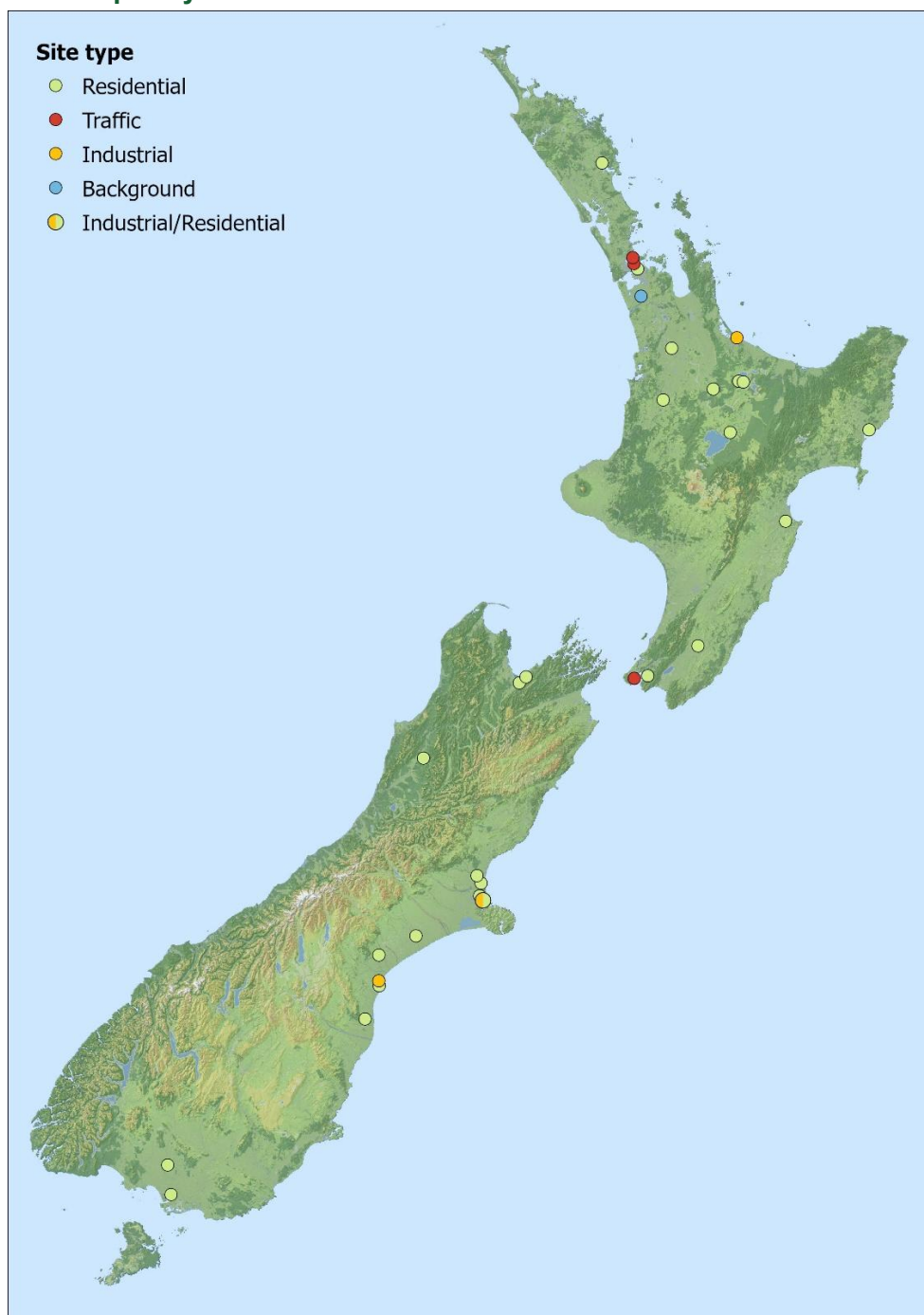
New Zealand does not currently have a National Environmental Standard for Air Quality (NESAQ) for PM_{2.5} as it does for other pollutants (e.g. PM₁₀ or NO₂). Instead, PM_{2.5} concentrations have been assessed against the World Health Organisation 2021 guidelines for air quality (WHO 2021). However, these guidelines do not currently carry any regulatory weight in New Zealand.

This report focuses on the stricter limits recommended in 2021, of 15 micrograms (µg)/m³ as an average over the course of a single day and 5 µg/m³ as an average for a calendar year. Though the new recommendations are stricter than previous guidelines (WHO 2013), there is no evidence for a threshold below which health effects do not occur (Ministry for the Environment & Statistics NZ 2018).

31 sites could be assessed against the 24-hour PM_{2.5} average WHO AQG between 2020 and 2023

Between 2020 and 2023, 31 monitoring stations had records of PM_{2.5} concentrations for at least three complete years. There are 17 sites in the North Island and 14 sites in the South Island. Of these, 24 out of 31 sites (77%) are located in residential areas, while the remaining seven sites are in other areas such as high road traffic sites, industrial areas, and mixed industrial/residential areas (Figure 1).

Figure 1: Monitoring stations with records of PM_{2.5} concentrations for at least three complete years between 2020 and 2023



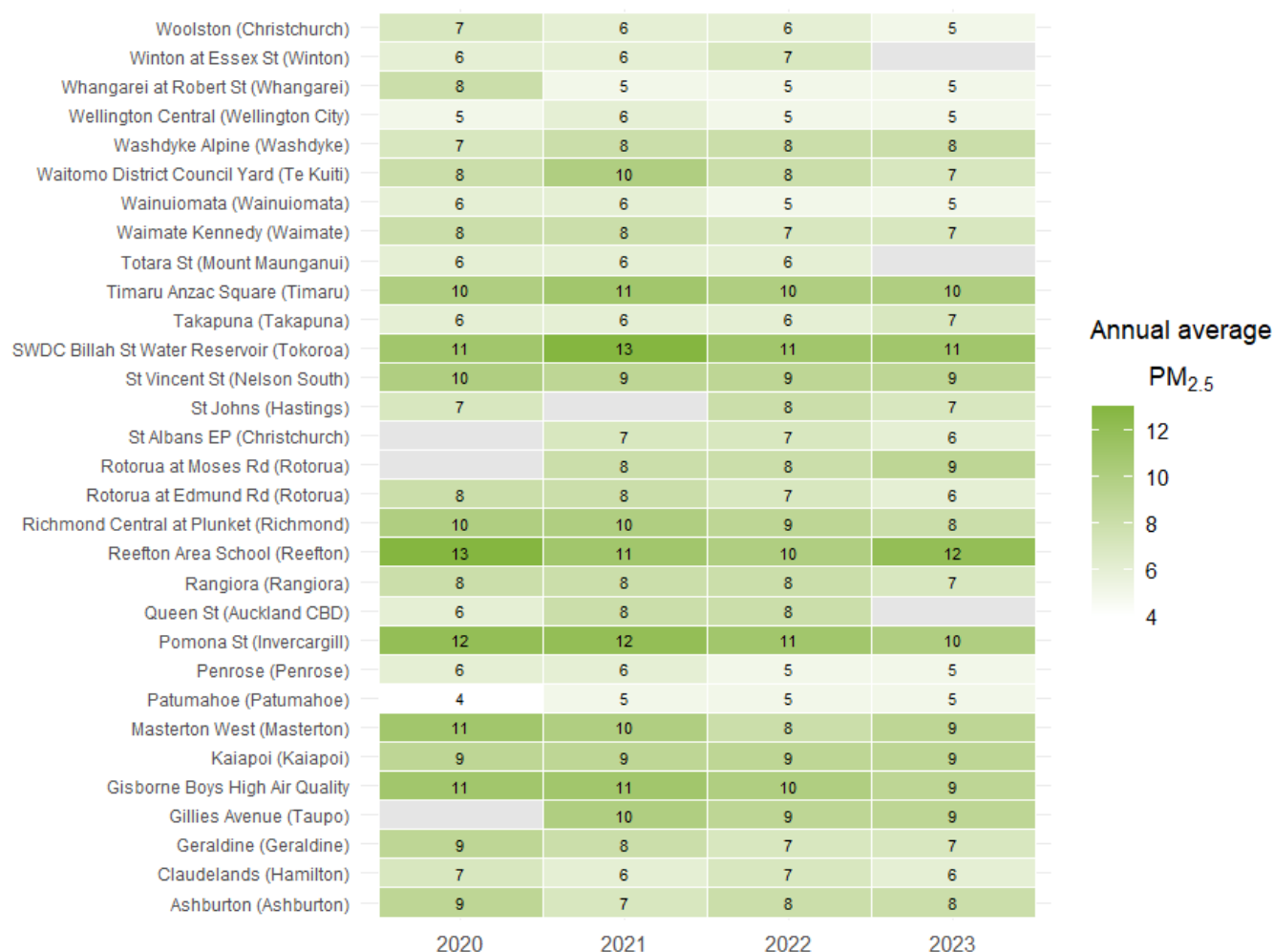
Source: Statistics New Zealand 2024

In 2023, almost all sites exceeded WHO guidelines for annual average concentrations of PM_{2.5}

In 2023, 28 out of 31 stations exceeded the WHO 2021 guideline for annual average PM_{2.5} concentrations. The highest concentration was recorded at the Reefton Area School station (12µg/m³), SWDC Billah St Water Reservoir - Tokoro (11 µg/m³), Pomona St - Invercargill (10µg/m³), and Timaru Anzac Square (10µg/m³). Between 2020 and 2023, Patumahoe is the only station that has not regularly

exceeded the 2021 guideline of $5\mu\text{g}/\text{m}^3$ in 2020 (Figure 2).

Figure 2: Annual average concentration of PM_{2.5} at monitoring sites, 2020–2023



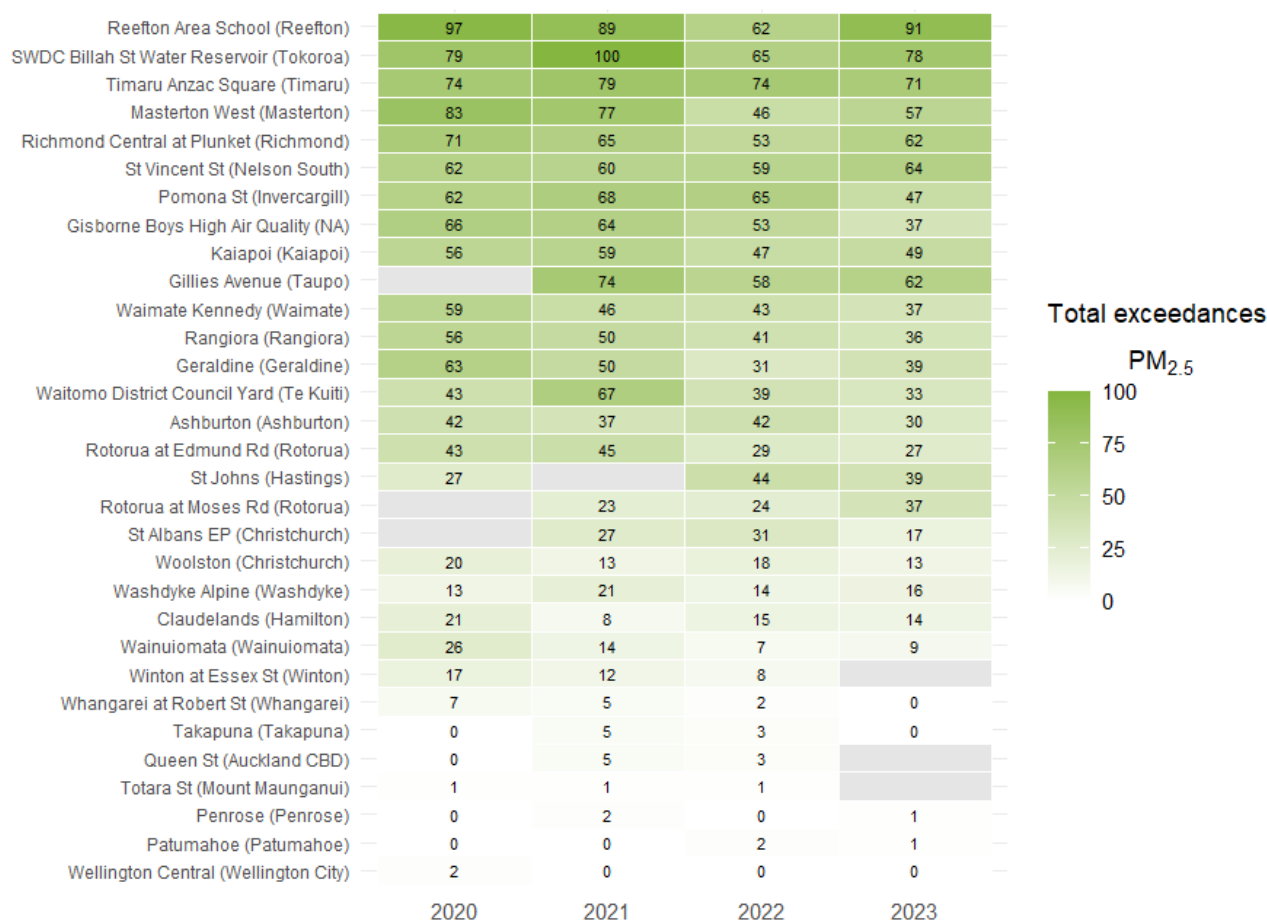
Notes: Grey colour indicates data was unavailable or insufficient in that year.
Source: Statistics New Zealand 2024

Most monitoring sites exceeded recommended daily levels of PM_{2.5}

In 2023, 25 out of 31 stations recorded at least one exceedance of the 2021 WHO daily guideline for PM_{2.5} concentrations ($15\mu\text{g}/\text{m}^3$). In total, this guideline was exceeded 967 times in 2023. Notably, 9.4% of these exceedances occurred at a single site — Reefton Area School, which exceeded the guideline on 91 days. SWDC Billah St Water Reservoir and Timaru Anzac Square also recorded high numbers of exceedances in 2023, with 78 and 71 days, respectively.

Between 2020 and 2023, all 31 monitoring sites exceeded the daily guideline at least once. The average number of exceedance days from 2020 to 2023 was highest at Reefton Area School, SWDC Billah St Water Reservoir, and Timaru Anzac Square, with averages of 85, 81, and 75 days per year, respectively (Figure 3).

Figure 3: Number of exceedances of the WHO 2021 guideline (daily average PM_{2.5} concentrations) at monitoring stations, 2020–2023

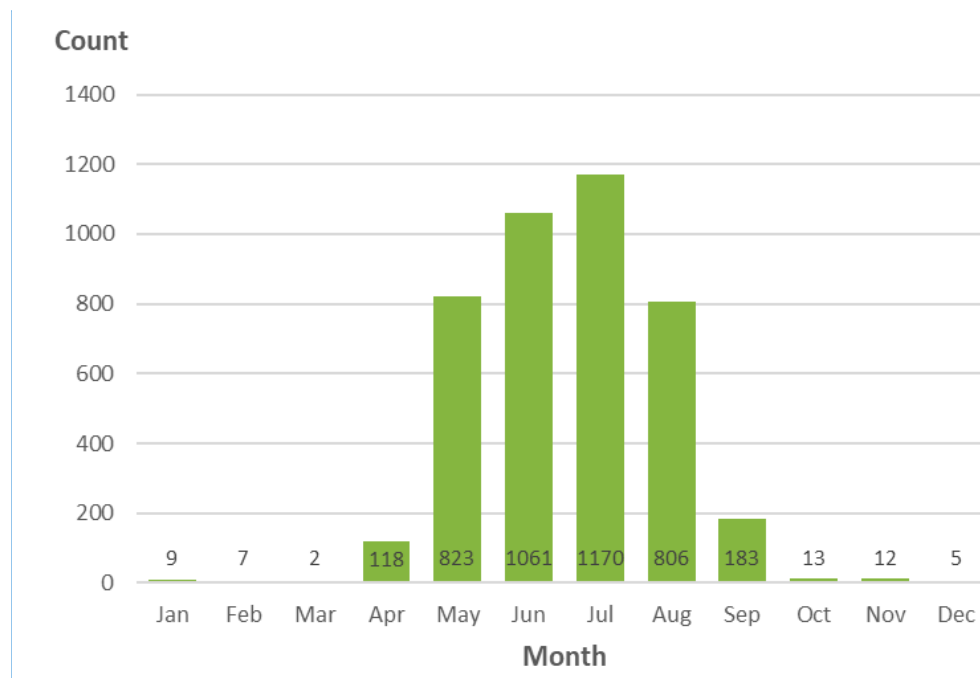


Notes: Grey colour indicates data was unavailable or incomplete in that year.
Source: Statistics New Zealand 2024

Most exceedances occur in colder months

Between 2020 and 2023, 72% (3,037) of all exceedances of the 24-hour average threshold occurred during the winter months (June–August) (Figure 4). A further 22.4% (941) occurred in autumn, predominantly in May. Therefore, most exceedances (91.7%) occurred during the colder months. During the cooler months, home heating emissions increase, contributing to worse PM_{2.5} concentrations. Furthermore, calm and frosty weather conditions in the winter months more easily allow for a build-up of air pollutants (Ministry for the Environment and Statistics NZ 2021).

Figure 4: Number of exceedances of the WHO guideline for daily PM_{2.5} concentrations, by month, 2020–2023



Source: Statistics New Zealand 2024

Data for this indicator

Number of days per year above WHO guideline ($15 \mu\text{g}/\text{m}^3$) and sites exceeding the annual average WHO guideline, 2020–2023 is collated and published by the Statistics New Zealand (Statistics New Zealand 2024 and published in 2024). Further information is available on the [PM_{2.5} concentrations \(air quality\): Data to 2023 | Stats NZ](#). The raw data for the period discussed in this report was provided to EHINZ by analysts at Statistics New Zealand.

EHINZ calculated the number of exceedances of the WHO guideline for daily PM_{2.5} concentrations by month based on the data provided by Statistics New Zealand.

A complete year is defined as a year in which:

- Each season is at least 75% comprised of complete days, and
- **A complete day** is defined as one with at least 18 out of 24 hours of valid data recorded for the daily (24-hour) average.

A site is required to have a 75% completion rate for a given period of time for the data to be considered valid.

For additional information, see the [Metadata](#) sheet.

References

Kuschel G, Metcalfe J, Sridhar S, Davy P, Hastings K, Mason, K et al. 2022. [Health and air pollution in New Zealand 2016 \(HAPINZ 3.0\): Volume 1 –Findings and implications](#). Report prepared by G Kuschel, J Metcalfe, S Sridhar, P Davy, K Hastings, K Mason, T Denne, J Berentson-Shaw, S Bell, S Hales, J Atkinson and A Woodward for Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency.

Ministry for the Environment and Statistics New Zealand. 2018. [Our air 2018. Data to 2017](#). Wellington: Ministry for the Environment.

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Citation

Environmental Health Intelligence. 2025. *Particulate matter concentrations (PM_{2.5})*. [Surveillance Report]. Wellington: Environmental Health Intelligence NZ, Massey University.

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