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Ngā ia o te āhuarangi me te kounga hau takiwā Climate trends and air quality

Te ao Māori

The atua, the primordial forces of nature, are not stagnant; they are in perpetual motion, and their domains are ever-changing.

Ranginui is the sky and atmosphere and rain, Tāwhirimātea is the weather, Rūaumoko is the unborn child within Papatūānuku whose movement causes earthquakes and so forth.

Within the domain of Ranginui, air is fundamental to sustaining life. The quality of the air we breathe directly influences the health and wellbeing of ngā tāngata, the people, and the wider environment – all descendants of the many atua. As emissions and contaminants are released into the domain of Ranginui, they affect the mana, the balance and integrity, of this domain. When the air is degraded through human activity, the impacts affect us in return through diminished environmental and human health outcomes.

Marlborough's climate

Marlborough's weather varies over time and by location. Just like Marlborough's diversity in landscapes, there is diversity in microclimates across the district.

For example, annual average rainfall is 500 mm on Marlborough's East Coast, but more than 2,800 mm in parts of the Richmond Ranges. Climate data has been collected for many years, enabling long-term climate trends to be examined.

To study the climate of an area, scientists look at averages of rainfall, temperature, sunshine, wind and other measures of weather over a long period, often 30 years or more.

Council maintains 28 rainfall monitoring sites for long-term climate and flood prediction, with 13 of these sites also measuring additional parameters like temperature, pressure, humidity and wind. Council also relies on outside partners for climate and weather data, such as Marlborough Research Centre, Earth Sciences New Zealand (formerly NIWA), and MetService Te Ratonga Tirorangi. These local climate indicators inform risk assessment, such as flooding, throughout the district. While this chapter is about climate monitoring and air quality, discussions on hazard risk and climate change can be found in other chapters of this report.

Air quality is influenced by wind speed and direction, temperature, rainfall and local landscape. It largely depends on what's released into the atmosphere and how quickly it disperses. Council is responsible for managing air quality under the Resource Management Act (RMA), including monitoring areas where pollution may exceed national standards. The Marlborough Environment Plan (MEP) sets out these rules, such as which activities are permitted and whether they need a resource consent.

Air quality affects far more than just comfort, also restricting outdoor activity and impacting health. Pollutants come from home fires and rural burns, spraying chemicals, as well as natural sources such as sea salt and windblown soil and dust. Monitoring and public education remain priorities for Council, as the most effective way to keep air clean is reducing the particles and gases released by humans.



Rainfall monitoring station being installed

Ngā ia o te āhuarangi
Climate trends

The Marlborough Research Centre's climate site is located just north of Blenheim and has a long-term record for trend analysis.



Picton annual site inspection

Council also operates a network of climate and rainfall monitoring stations across the region, improving understanding of how the climate varies spatially.

Rainfall

Blenheim receives, on average, 640 mm of rainfall annually. The lowest annual rainfall on record was 347 mm in 2014/15, and the highest was 1,084 mm in 1994/95. While there is no trend in annual rainfall over the 95-year record, there is a cyclical pattern, possibly linked to climate cycles such as the Interdecadal Pacific Oscillation (IPO) weather phenomenon.

Annual Blenheim rainfall

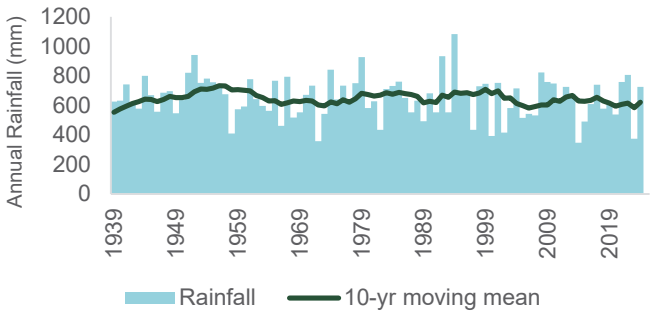


Figure 1: Annual Blenheim rainfall (June to July), 1939–2025

Cumulative rainfall in Blenheim

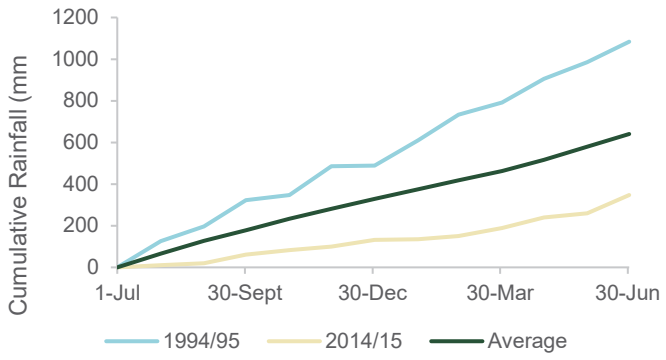


Figure 2: Cumulative rainfall for Blenheim in an average year compared to the wettest and driest years on record

Rainfall in the last 10 years

The highest monthly rainfall in Blenheim was recorded in July 2022, at 221 mm, and the second-highest in June 2025, at 192 mm. 2023/24 was the third-driest year on record, with 374 mm of rainfall.

Council installed a climate site in Picton in 2018, measuring wind speed, air temperature, humidity, barometric pressure and rainfall. This data is provided to MetService to improve weather reporting for Picton. Council has also installed three additional rain gauges across the region since 2015 to improve the spatial coverage of the monitoring network; at Lake Elterwater, Mt Morris (Branch River catchment) and the upper Te Hoiere / Pelorus catchment, a site shared with Tasman District Council.

Rainfall trends

Summer rainfall in Blenheim has decreased by 23% over 95 years. While there appears to be a slight increase in winter rainfall over time, the trend is not certain. These trends are consistent with Earth Sciences NZ's (formerly NIWA) climate change projections through 2090, which indicate that summer rainfall in Marlborough is likely to decrease, while winter rainfall is projected to increase.

Rainfall in northern Marlborough is increasing over time. For example, at the Tunakino site, annual rainfall has increased by just over 20% in 37 years. The trends observed in this area may be linked to interdecadal climate cycles, and continued data collection is important to confirm the trend or detect changes. Increasing trends in autumn and winter rainfall were also detected at sites in this area.

Seasonal rainfall variation

Marlborough is known for hot, dry summers. The primary cause of the dry summers is high evapotranspiration, coupled with slightly lower rainfall. The difference between evapotranspiration and rainfall in Blenheim in summer is typically 90 mm per month, but can reach 180 mm during a drought. This moisture deficit slows plant growth but can be alleviated through irrigation.

Average rainfall and evapotranspiration in Marlborough

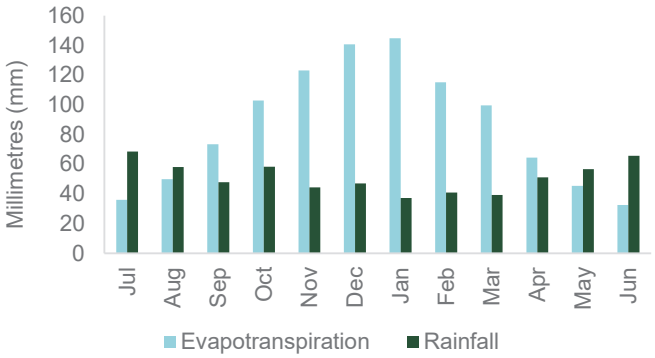
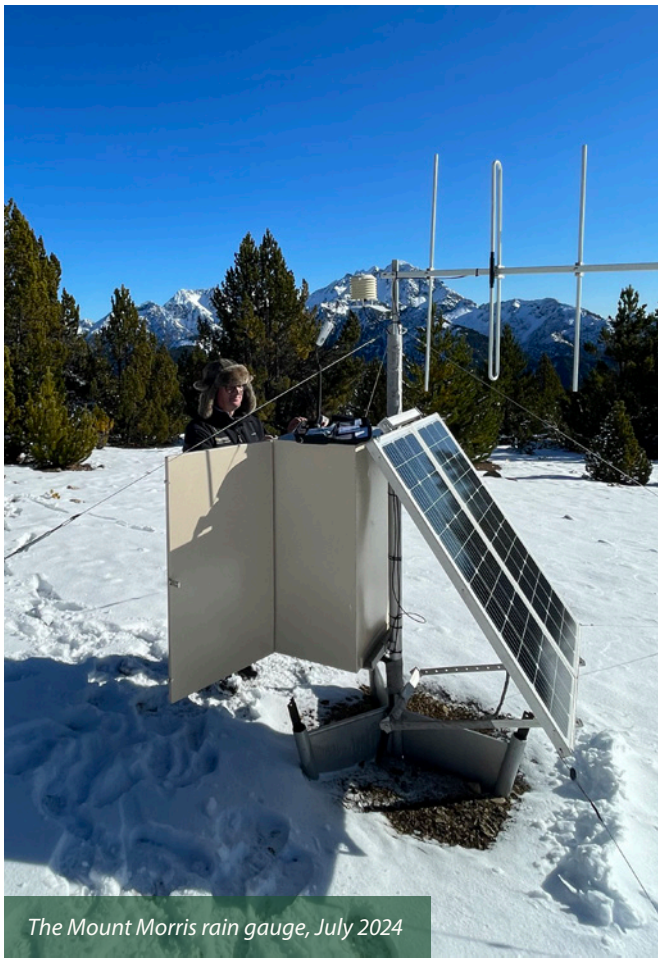


Figure 3: Blenheim rainfall and evapotranspiration averages across the year



The Mount Morris rain gauge, July 2024

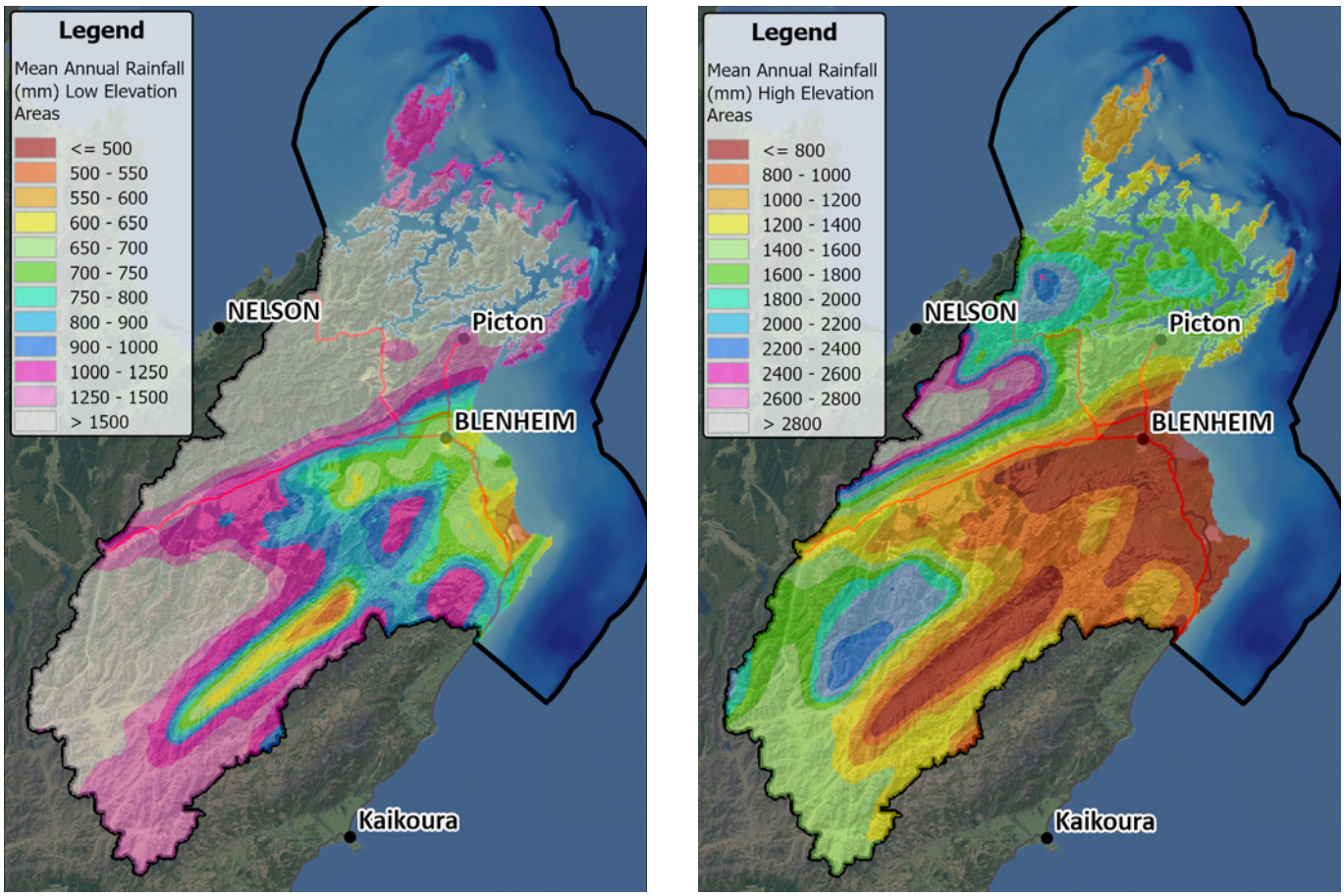


Figure 4: Map of mean annual rainfall (mm) in Marlborough (1961-2015) for low elevation areas (left) and high elevation areas (right). (Source: Interpolation of Mean Annual Rainfall for Marlborough District, NIWA 2017)

Rainfall variation across Marlborough

Rainfall varies across the region due to elevation, topography and exposure to different storm directions. Malbrough's position at the top of the South Island means some of the eastern catchments have the typical dry conditions of the New Zealand East Coast, while other catchments have rainfall more like the rainy West Coast. Annual average rainfall ranges from 500 mm on the East Coast to over 2,800 mm in parts of the Richmond Ranges. Data from Council's network of 28 rainfall monitoring sites was used to create a map of mean annual rainfall for both low and high elevation areas (above).

High-intensity rainfall events

Over the last 10 years, Marlborough has experienced a number of high-intensity rainfall events, the most extreme of which occurred in August 2022, when an atmospheric river brought widespread heavy rainfall, lasting for several days and causing widespread damage.

In October 2021, a thunderstorm delivered a deluge of heavy rain and hail to central Blenheim, which caused significant flooding in the CBD and nearby areas.

In one hour, 50.2 mm of rainfall was recorded at the Council building. This event has a less than 1% probability of occurring in any given year. In the CBD, 102 businesses reported impacts, primarily building damage caused by both water ingress through roofing and surface flooding.

Temperature

Temperature records for Blenheim date back to 1933. The annual mean temperature has increased by 0.91°C over 91 years, consistent with the national average rise of about 1°C over the past 100 years, as reported by Earth Sciences NZ. Seven of the ten warmest years on record have occurred since 2015, and 2025 was the warmest year on record in Blenheim, with a mean temperature of 14.19°C, 0.91°C above the long-term average.

Winter minimum temperatures are increasing faster than average temperatures, with a 1.5°C increase since the late 1940s, compared with a 0.8 °C increase in mean temperature over the same period.

Annual mean temperature in Blenheim

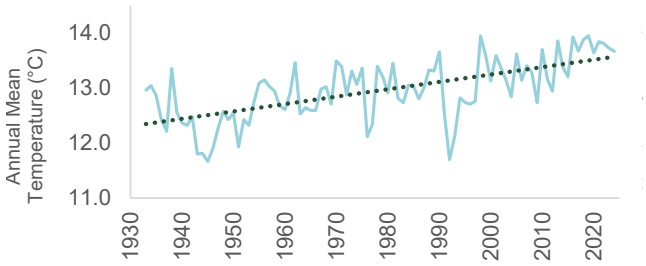


Figure 5: Blenheim mean annual temperature record, 1933–2024. Note: The large decline in annual mean temperature in the early 1990s is linked to the eruption of Mount Pinatubo in the Philippines. The eruption released millions of tonnes of sulphur dioxide into the atmosphere, which reflected solar energy and led to global cooling for a period of about two years.

Winter minimum temperature in Blenheim

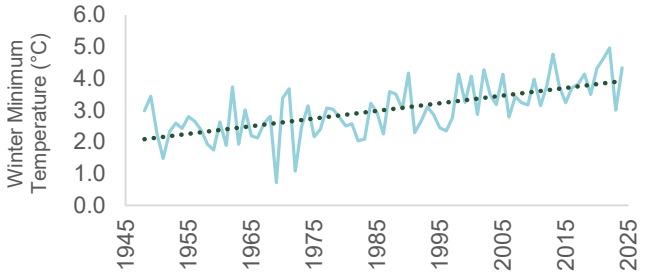


Figure 6: Blenheim winter minimum temperature record, 1948–2024

Frosts

Ground frosts occur when the overnight grass minimum temperature is minus 1°C or below. The number of ground frosts per year has halved over the past 90 years, with an average of 45 ground frosts each year since 2015. Decreasing frost frequency is consistent with rising temperatures.

Ground frosts in Blenheim

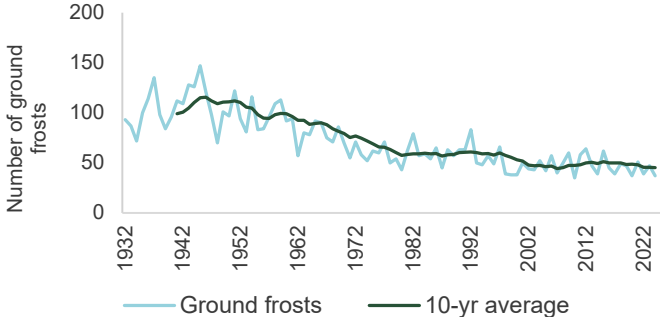


Figure 7: Annual ground frosts recorded at Blenheim Climate Station, 1932–2024

In the past decade, the decline in frost days per year has slowed, although there is still a declining trend present.

Sunshine

Blenheim is well-known as one of the sunniest places in New Zealand, with an average of 2,473 sunshine hours per year. It took the crown in 2024 with 2,767 sunshine hours. 2015 remains the sunniest year on record, with 2,814 sunshine hours. In almost 95 years of sunshine measurements in Blenheim, the three sunniest years have all been in the last 10 years: 2015, 2019 and 2024.

Sunshine hours in Blenheim

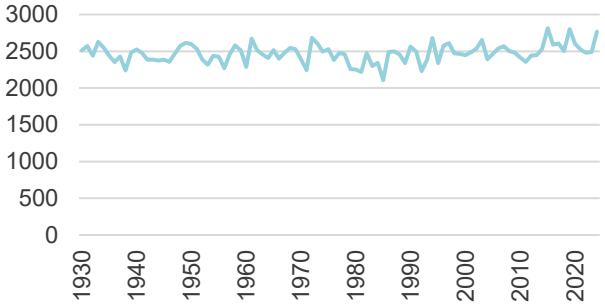


Figure 8: Blenheim annual sunshine hours, 1930–2024

Wind

Wind data has been collected continuously in Blenheim since 1997. The 2015 State of the Environment Report mentioned a possible declining trend in daily 'wind run', the amount of wind, in Blenheim and this has since been confirmed. From the 27 years between 1997 and 2024, there was a decrease in average daily wind run of just over 1% per year.

Blenheim wind run

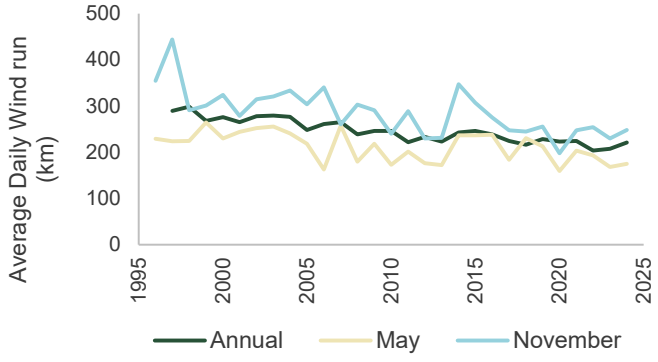


Figure 9: Average Daily wind run in Blenheim, 1997–2024

Wind Roses

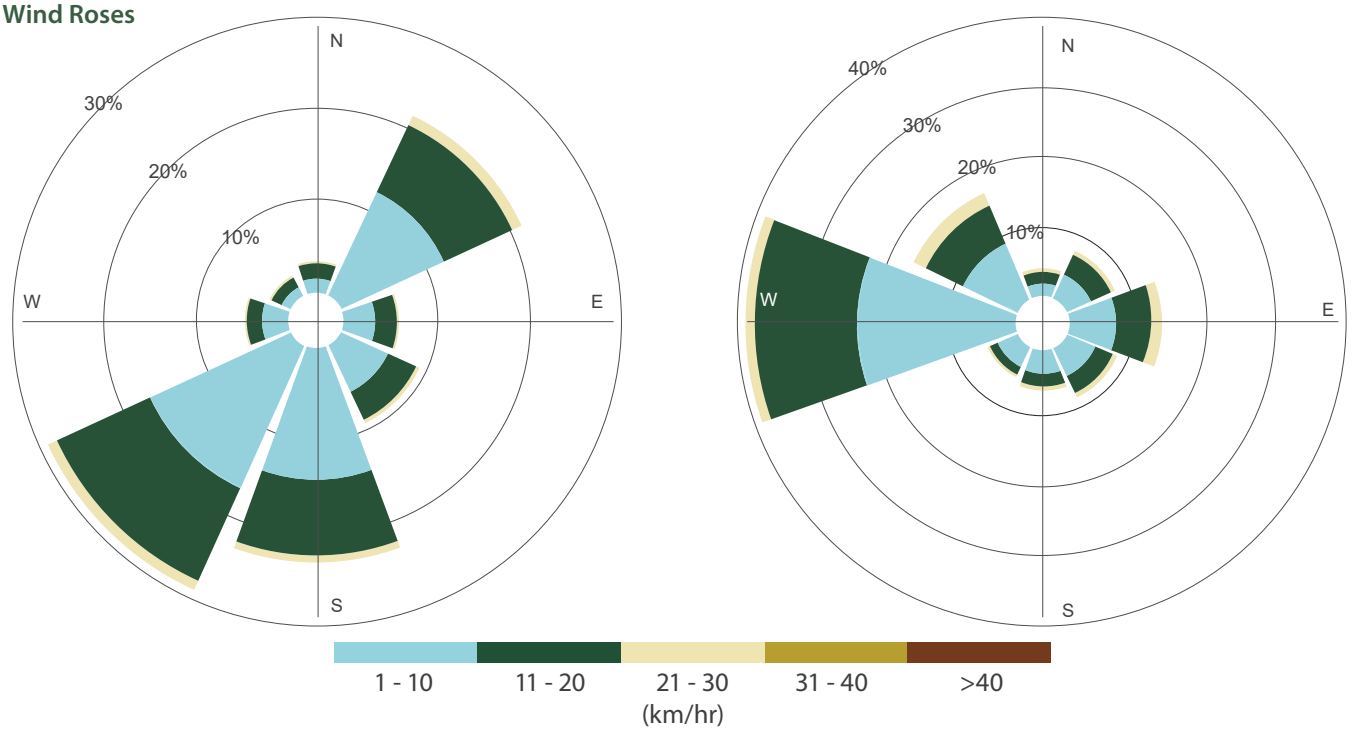


Figure 10: Wind roses showing the predominant wind direction and speed for Picton at Waitohi Domain (left) and Blenheim (right)

The greatest decrease in wind run is in summer, although all seasons show a decrease. On average, May is the calmest month, while November is the windiest. Climate change projections from Earth Sciences NZ in 2021 indicate that mean wind speed is likely to increase as a result of changes in atmospheric circulation and rising temperatures.

The dominant wind direction varies across the region, depending on the level of shelter or exposure provided by the local topography. For example, Picton is exposed to wind from the south to southwest and the northeast, while the predominant wind direction in Blenheim is westerly, with easterly sea breezes in the warmer months.

Moisture deficit

Moisture deficit is a measure of drought. It is calculated by subtracting potential evapotranspiration from rainfall and is sometimes called the Potential Evapotranspiration Deficit (PED). It shows how much extra water would be needed to maintain full soil moisture throughout the year.

In Blenheim, annual evapotranspiration exceeds rainfall, so the moisture deficit is always negative, with a long-term average of –minus 410 mm from July to the following June.

There may be a trend toward increasing moisture deficit, but more data are needed to confirm. Climate change projections from Earth Sciences NZ suggest the deficit will grow regionally, with a potential 75 mm–250 mm increase by 2090, translating to 2–8 more weeks of reduced grass growth annually.

The 2023/24 year saw the highest moisture deficit at minus 726 mm, while 2014–2016 experienced a greater 24-month deficit of minus 1,380 mm, highlighting the impact of extended dry periods with little winter recharge.



An example of a council rain gauge site in Rai Valley, which has been upgraded to meet the NEMS Rainfall Recording standard.

Te kounga hau takiwā
Air quality and discharges

Clean air is vital for health and well-being but is often taken for granted until smoke from a neighbour's fire keeps people indoors or allergies and asthma flare up. Air quality affects far more than just comfort; if poor, it can restrict outdoor activity and impact human health.



Looking north across Blenheim with smoke from both domestic heating and rural burning sources

Air quality is influenced by wind speed and direction, temperature, local landscape and rainfall. The most effective way to keep air clean is to reduce the particles and gases we release.

These pollutants come from human activities such as home fires, rural burning and chemical spraying, as well as from natural sources such as sea salt and windblown soil and dust.

Pressure

Marlborough generally enjoys clean air thanks to its windy climate and spread-out population. Pressure on air quality can occur in urban areas during winter when people burn wood for heating during cold, still weather. Smoke can get trapped under a layer of warmer air, called an inversion layer, causing pollution to build up to unhealthy levels (Figure 1).



Inversion layer looking south over Blenheim during the winter, showing the trapped smoke from domestic heating

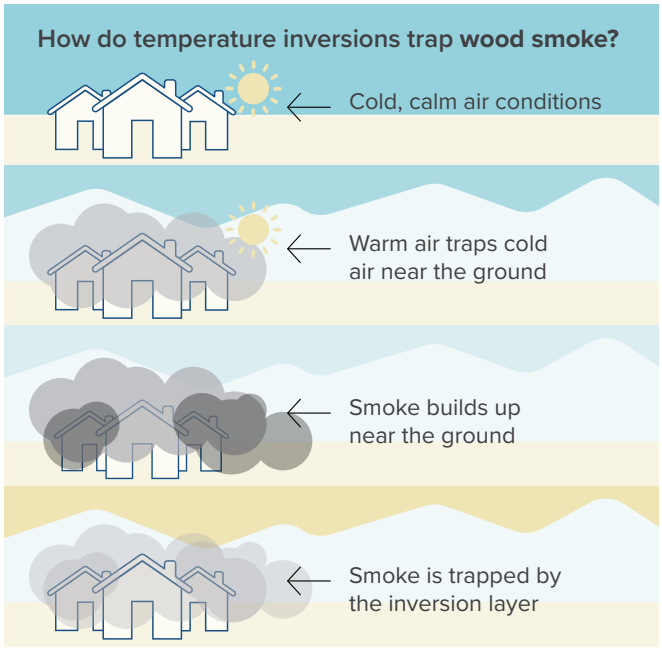


Figure 1: Inversion layers are typically formed when a layer of warm air acts like a lid over a layer of cooler air, trapping smoke

Odours, dust and emissions from human activities can also become a nuisance. Commercial operations, fuel burning for heat and energy, land development and transport pollute urban air. In rural areas, activities like burning vegetation, spraying agrichemicals, applying fertilisers or compost, and earthworks also affect air quality. Natural sources like sea salt and windblown dust contribute, especially near the coast or exposed riverbeds.



Rural burning in the Waihōpai Valley

The main air pollutant in towns is particulate matter (PM), tiny particles that can be inhaled. PM is classified by size, which determines how deeply it can enter the lungs and how harmful it is (Figure 2). PM_{10} particles are smaller than one-fifth the width of a human hair, and $PM_{2.5}$ particles are even smaller, posing greater health risks.

Size comparison for particulate matter

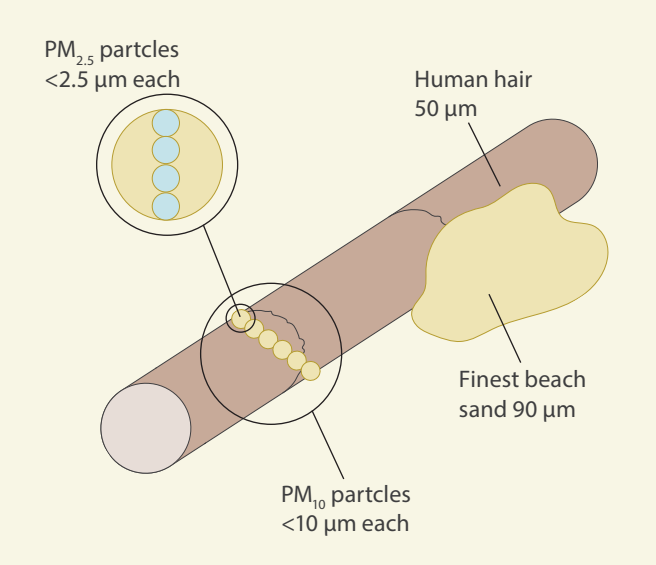


Figure 2: Size comparison for particulate matter particles. Particles are shown as µm, one-millionth of a metre. In air-quality monitoring, their mass is measured as micrograms per metre cube of air (µg/m$_3$) which is one-millionth of a gram. Source: Ministry for the Environment

New Zealand's air quality standards, set under the National Environmental Standards for Air Quality (NESAQ) 2004, currently focus on PM_{10} to ensure a minimum level of health protection.

The World Health Organization (WHO) introduced stricter limits for pollutants in 2021, including $PM_{2.5}$. A 2016 Health and Air Pollution in New Zealand (HAPINZ 3.0) study found that pollution from vehicles, domestic fires and industry affects nearly 30,000 New Zealanders each year, costing $15.6 b. Domestic fires were the biggest source of $PM_{2.5}$-related health costs in every region.

Under the Resource Management Act (RMA), councils are responsible for managing air quality and monitoring areas where pollution may exceed national standards. So far, the Government hasn't changed these standards, but upcoming RMA reforms could introduce new rules.

PM_{10} monitoring began in Blenheim in the early 2000s, becoming continuous in 2006. $PM_{2.5}$ monitoring began in 2017. Since then, domestic heating has remained the largest annual PM contributor in Blenheim, followed by transport, outdoor burning and industry, though outdoor burning in 2017 was higher at 8%, compared to 2% in 2022.

A continuous PM_{10} site was set up in Picton in 2024 and $PM_{2.5}$ monitoring is planned for next year. Picton's primary PM sources were domestic heating, outdoor burning, motor vehicles, industrial and commercial operations, and port activities like shipping and cargo handling. Earlier reports noted methyl bromide fumigation affected Picton's air quality, but that practice ended in 2012.

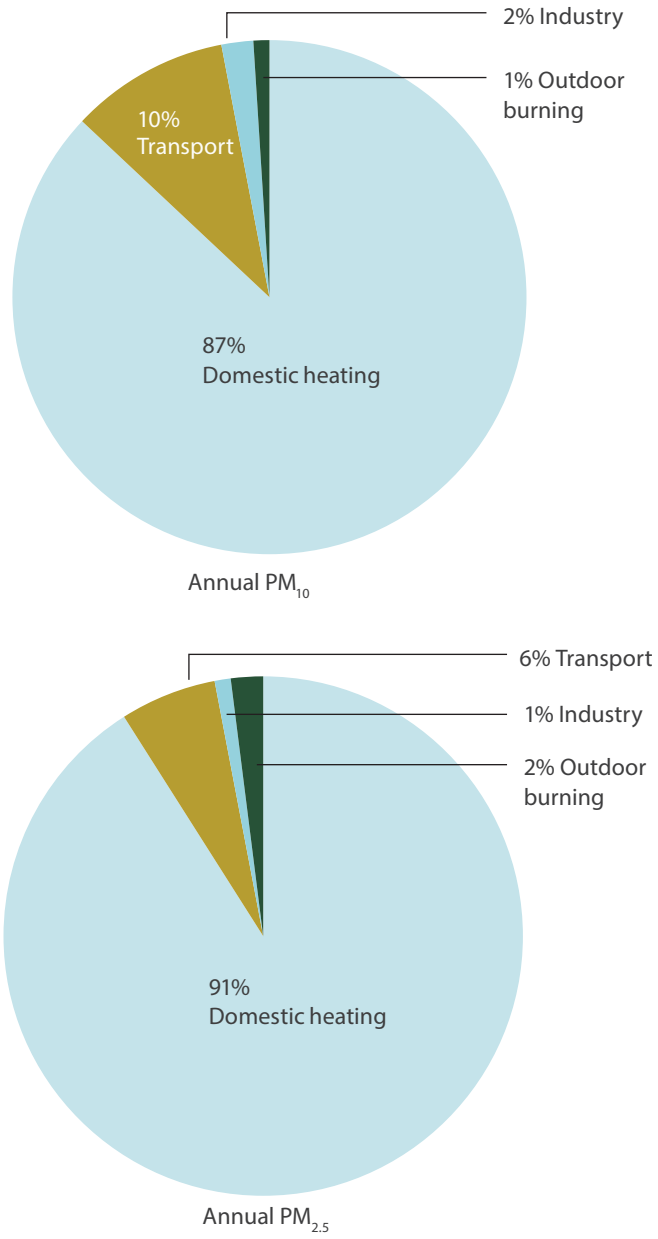


Figure 3: Relative contribution of sources to annual PM_{10} and $PM_{2.5}$ emissions for Blenheim in 2022

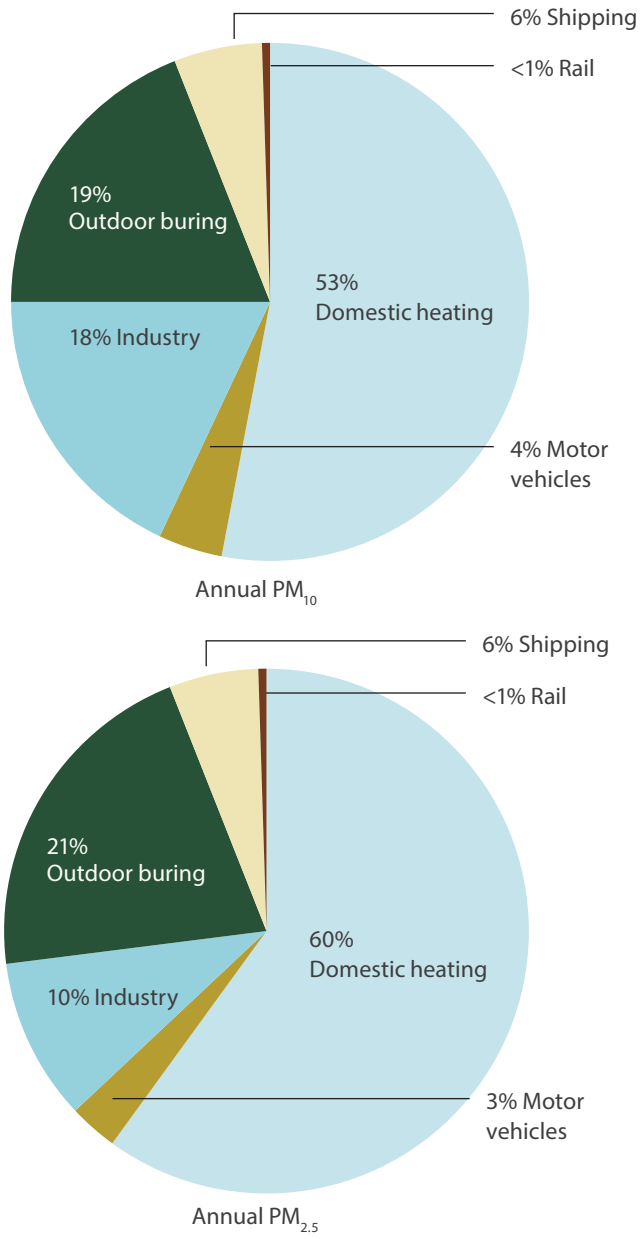


Figure 4: Relative contribution of sources to annual PM_{10} and $PM_{2.5}$ emissions for Picton in 2022

Odour and air pollution can arise from many sources, including winery and aquaculture waste, landfills and composting, mussel and animal processing, and burning plastics or other prohibited items. Smoke complaints are frequent and can stem from rural burns, backyard rubbish or green waste fires, wood burners using inappropriate fuel or commercial activities like industrial boilers.

During the growing season, spray drift complaints become more common. With over 30,000 ha of vineyards in Marlborough, pest and disease control, general vegetation spraying and fertiliser application are common.

Reverse sensitivity can also play a role. For example, when new housing is built near industrial or mixed-use areas, residents may complain about smells that are normal for those locations.

Response

Council manages air quality through monitoring, education, policy, and compliance. Under the RMA, air discharges are prohibited unless allowed by the Marlborough Environment Plan (MEP) or a resource consent. The MEP sets rules for air discharges from rural and urban activities. Smoke and odour must not be objectionable beyond the property boundary, and burning treated wood, plastics or other synthetic materials is prohibited.

The MEP allows the use of agrichemicals, compost and fertilisers, provided standards are met to reduce adverse effects and encourage best practice.

The viticulture industry has cut agrichemical use through research and better targeting, with spray recapture systems now standard. Sustainable Winegrowing New Zealand certification promotes best-practice by requiring training, equipment calibration and avoiding spraying in high winds. The updated 2021 New Zealand Standard for Agrichemical Management provides clear guidance, which the MEP supports.

Other MEP rules require that discharges to air avoid hazardous substances, limit concentrations and ensure chimneys are high enough for smoke to disperse well above ground level.

Specific zone rules help reduce smoke, odour and air pollution from outdoor burning. In Marlborough's designated Blenheim airshed, open burning is banned unless it's for cooking food for non-commercial purposes, braziers can't be used between May and August, and prohibited fuels must not be burned at any time.

To manage home heating emissions, the MEP sets strict rules to ensure burners are efficient and produce low levels of PM.

Current state

Blenheim has one monitoring site in Redwoodtown that meets national standards and continuously tracks both PM_{10} and $PM_{2.5}$. A second site in Springlands was decommissioned in 2018 as it didn't meet the required standards.

The National Environmental Standard for PM_{10} is 50 µg/m^3 (micrograms per metre cubed), with one exceedance allowed annually. Blenheim aimed to meet this by 2016 but exceeded it for years. No exceedances were recorded for 2024 and 2025. If this continues for the next two years, Blenheim will no longer be classed a 'polluted air-shed'. This improvement is due to measures in MEP to cut emissions from home heating.

There is currently no national standard for $PM_{2.5}$, however, in the past the Ministry for the Environment (MfE) proposed a limit of 25 µg/m^3. The WHO has a daily $PM_{2.5}$ guideline of 15 µg/m^3. Council's monitoring shows an improving $PM_{2.5}$ trend for Blenheim with fewer exceedances in 2025 compared to 2017, shown in the table below:

$PM_{2.5}$	MfE proposed limit of 25 µg/m^3	WHO daily guideline of 15 µg/m^3
2017	72	120
2025	14	71



The Blenheim Redwoodtown monitoring site showing the monitoring equipment for both PM_{10} and $PM_{2.5}$

To address community concerns about emissions from ships near the Picton foreshore, studies were carried out between 2019 and 2023 to understand local air quality and its sources better.

A 2019/20 screening study found PM_{10} levels were close to national standards under certain weather conditions, peaking in winter due to domestic heating. Motor vehicle emissions also showed elevated levels along busy routes like Wairau Road.

Two monitoring sites detected sulphur dioxide (SO_2) levels that appeared to be linked to ferry arrivals and ship visits; however, a detailed study in 2023 measured nitrogen dioxide (NO_2) and SO_2 at the Picton foreshore for a year and found both pollutants were well below national and WHO guidelines.



Early winter morning in Picton with the smoke from domestic heating moving down towards Waikawa

Marlborough has about 75 permits for air discharges, 60% for boilers using diesel and 22% for biomass. Coal is generally kept as a backup, and several operations have recently switched from coal and other fossil fuels to biomass.

Council receives around 140 air discharge complaints per year, around half involving smoke, a third relating to odours, and 10% each for dust and spray drift, from a variety of sources. The most common smoke complaints relate to outdoor burning and chimney smoke on residential properties.



Industrial site discharge. This activity has now ceased.

Complaints related to industry dropped sharply after 2020 when the Timberlink mill closed, highlighting how industrial activities can clash with nearby housing over time.

Industrial or commercial activities dominated odour complaints, mostly from a few sites that drew repeated complaints. Dust complaints mainly stem from unsealed roads, yards and earthworks, often from subdivision developments. Vineyard spraying complaints range from 4–11 annually, but spiked to 40 in 2018/19, mostly from one area.

PM_{10} levels in Blenheim have varied since monitoring began. Between 2015 and 2018, winter concentrations exceeded the NESAQ threshold of 50µg/m³ on 5–11 days annually. From 2019, exceedances dropped to 0–3 days per year (an exception in 2021 was due to equipment calibration errors (Figure 5). Annual average PM_{10} concentrations increased from 17µg/m_3 to 20µg/m3 between 2015 and 2017, but have steadily declined to 13–14 µg/m_3 in 2024 and 2025. Since 2022, data shows a decline in maximum concentrations.

Because weather affects PM levels, trend analysis was used to minimise this effect. Results for PM_{10} show two periods of increase: 2015–2018 and 2019–2021, followed by a sharp decline in 2022/23 and further reduction in 2024 (Figure 6). Analysis confirms a significant downward trend from 2017 –2024.

Number of days when 50µg/m³ was exceeded



Figure 5: Number of days when 50µg/m_3 was exceeded, the maximum concentration and the second-highest concentration from 2006–2025

Trends in PM_{10} concentrations

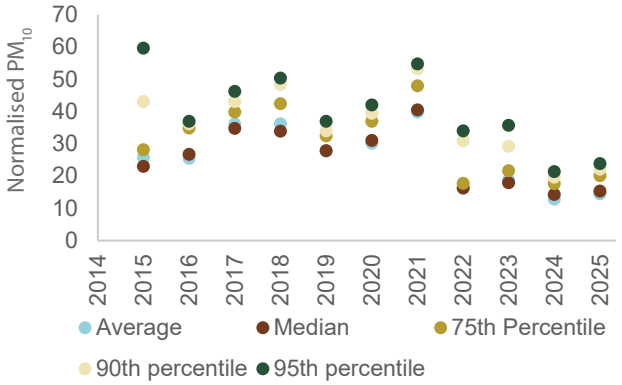


Figure 6: Trends in PM_{10} concentrations after adjusting for meteorological conditions, 2015–2025

Kilograms of emission discharge

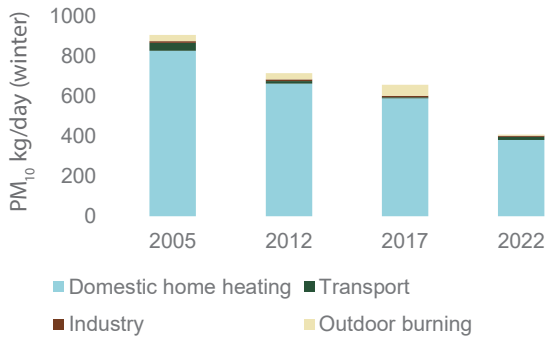


Figure 7: Kilograms of emission discharge from all sources on an average winter's night, 2005–2022

Domestic heating is the main source of daily PM emissions in Blenheim and Picton. Estimated PM_{10} emissions in Blenheim reduced by around 57% between 2005 and 2022, with the greatest reduction between 2017 (658 kgs) and 2022 (409 kgs).

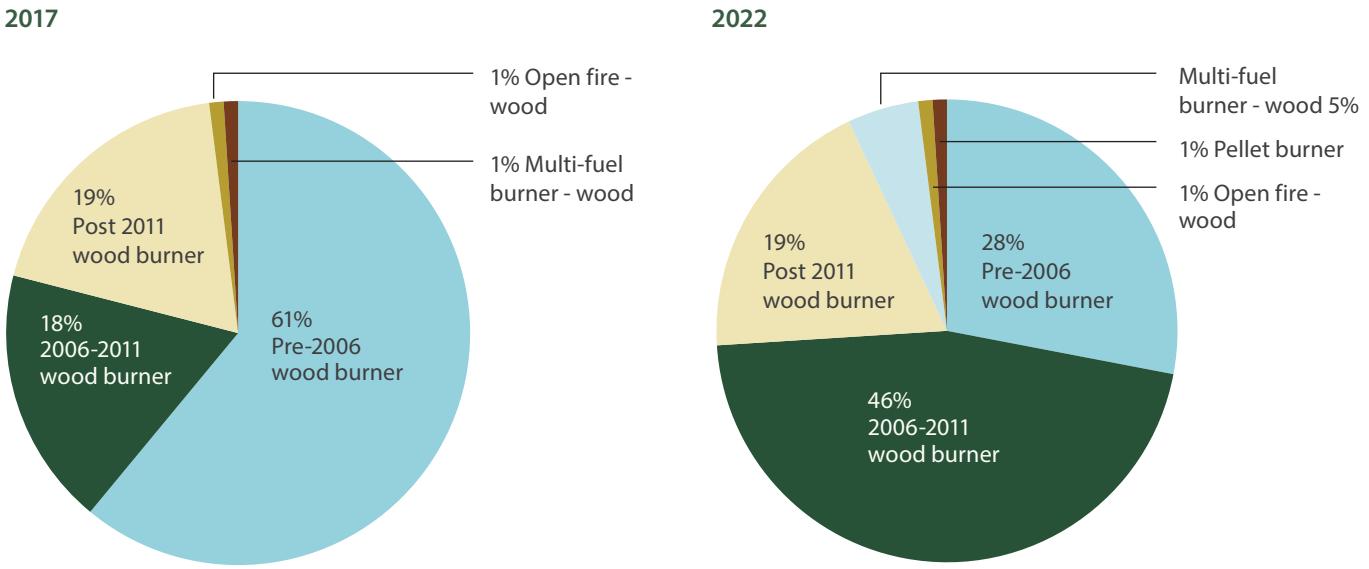


Figure 8: Relative contribution of different heating methods to the average daily PM_{10} (winter average) from domestic heating

This 38% decrease likely results from MEP measures targeting domestic heating and residential outdoor burning.

Household wood burner use remained similar, but many switched to NESAQ-compliant models by 2022. In 2017, emissions mainly came from pre-2006 burners; now, most comes from 2006–2016 models (Figure 8). Fuel use per household also declined between 2017 and 2022.

Overall, the data indicates improvements in PM_{10} and $PM_{2.5}$ concentrations from 2017–2024 showing the effectiveness of regulatory methods in the MEP to reduce emissions.

Future response

Council will continue working to keep Marlborough's air clean by helping people switch to cleaner heating, promoting proper burner use and encouraging recycling instead of burning waste. Council will share clear information on heating options, waste disposal and available incentives, and look to partner with firewood suppliers to ensure dry wood is easy to get. The MEP rules will help limit harmful emissions, and monitoring air discharge consents and responding to complaints will continue. Council is also looking to work with local industries to cut pollution and promote best practices.

Monitoring air quality remains a priority. New PM monitoring in Picton will give Council a better picture of this complex environment and could lead to new ways to reduce emissions.

If national standards change to include $PM_{2.5}$ guidelines, significant urban reductions will be needed, managed through updates to MEP rules.

CHANGES SINCE 2015

- Methyl bromide fumigation treatment for timber and logs has stopped in Marlborough.
- No breaches of the National Environmental Standards for Air Quality (NESAQ) PM_{10} standard (50 µg/m^3) have occurred since 2021.
- PM_{10} levels have dropped significantly in both winter and non-winter periods from 2017–2024, and $PM_{2.5}$ is also trending down.
- $PM_{2.5}$ monitoring began in Blenheim in 2017.
- The Springlands PM_{10} monitoring site was decommissioned in 2018.
- A new PM monitoring site was established in Picton in 2024.
- A study of nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) in Picton (2023/24) found low public health risk along the foreshore.
- The Timberlink mill in Blenheim closed in 2020.
- The International Maritime Organization (IMO) Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI took effect in 2022, requiring lower sulphur content in ship fuels.