Ministry for the Environment
Manatū Mō Te Taiao

Monitoring of PM_{10} in New Zealand

Prepared by Environet Limited for the Ministry for the Environment

August 2003

Air Quality Technical Report No. 40

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Foreword

Regional air quality monitoring programmes have increased significantly over the past 10 years so that we now have a reasonable picture of particle concentrations in many New Zealand towns and cities.

This technical report on the **concentrations of fine particles** (PM_{10} – particles less then 10 microns in diameter) summarises monitoring data from sites around New Zealand up until 2001/2002. It highlights that PM_{10} concentrations frequently breach the Ministry for the Environment's ambient air quality guideline values of 50 ug/m^3 (24 hour average) and 20 ug/m^3 (annual average) in many urban areas.

Some of the data presented have been extrapolated in order to make comparisons between locations and monitoring methods. For example, where only periodic or short term monitoring has been carried out, the potential number of guideline value exceedences has been estimated as if daily monitoring has been done. For this reason, readers should be aware that the data might appear to be different from that released by the respective council. Full explanations of how the extrapolations have been calculated are provided in the report.

Understanding the concentrations of PM_{10} and their health effects will help to set appropriate national environment standards for PM_{10} and enable the benefits of achieving them to be examined. The report forms part of the section 32 analysis required for standards development. It is one of four technical background reports on PM_{10}, with the others covering: emission inventory results, amenity issues and health effects.

I would like to thank all those councils who contributed data for this report.

Barry Carbon
Chief Executive

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The Ministry would like to thank the following for their contribution of data for the report:

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Executive Summary

Air quality monitoring for particles in New Zealand dates back to the 1960s when monitoring sites for total suspended particulate (TSP) were established in Christchurch and Auckland. A more extensive monitoring network was established in the 1980s with measurements of smoke carried out in many of the regions. In 1988, the first monitoring site measuring PM_{10} was established in Christchurch in the inner city suburb of St Albans. The 1990s saw increased monitoring of PM_{10} throughout the country and by 2001, concentrations of PM_{10} had been monitored in most regions.

These data for PM_{10} measurements in New Zealand have been collated and are presented in this report based on the monitoring methods outlined in the *Good Practice Guide for Air Quality Monitoring and Data Management* and the 24-hour and annual average ambient air quality guideline values in the *Ambient Air Quality Guidelines – 2002 Update* (MfE, 2000; MfE and MoH, 2002).

Air quality monitoring data supplied by regional councils indicates that exceedences of the guideline value of 50 μgm^{-3} (24-hour average) have occurred in:

- Auckland
- Taupo
- Upper Hutt
- Otaki
- Nelson
- Timaru
- Kaiapoi
- Mosgiel
- Dunedin
- Balclutha
- Hamilton
- Whangarei
- Lower Hutt
- Napier
- Richmond
- Ashburton
- Oamaru
- Arrowtown
- Cromwell
- Tokoroa
- Rotorua
- Masterton
- Wainuiomata
- Whakatane
- Blenheim
- Christchurch
- Rangiora
- Alexandra.

The sampling regimes in many locations are insufficient to determine a reliable annual average PM_{10} concentration estimate. Of the 15 areas where sufficient PM_{10} data were available, breaches of the annual average guideline value of 20 μgm^{-3} were found in Tokoroa, Nelson, Christchurch, Auckland, Timaru and Kaiapoi.

An extrapolation of existing PM_{10} data collected using the Tapered elemental operating microbalance (TEOM®) sampling method was carried out to determine the equivalent concentrations if an alternative approved sampling method had been used. These data indicated that additional breaches of the annual average PM_{10} guideline value may have occurred in Hamilton, Te Kuiti, Tauranga, Upper Hutt, Ashburton and Rangiora. The 24-hour average PM_{10} guideline value is also likely to have been breached in Te Kuiti.

The number of days the guideline value is breached varies from year to year and from location to location. In most areas these occur during the winter months and coincide with periods of low wind speed and temperature inversions. Exceptions include areas such as Gisborne, Otaki and Whangarei where guideline value breaches may have occurred as a result of sources such as sea spray, wind blown dust or localised industrial sources.

1 Introduction

This technical report comprises a review of PM_{10} monitoring in New Zealand. This includes characterising the particle problem in New Zealand by providing an overview of existing concentrations at ambient air quality monitoring sites. While historical information is considered briefly, the focus of this report is the PM_{10} size fraction and measurements made over the past 10 years.

The main legislation governing air quality in New Zealand is the Resource Management Act (RMA), which was introduced in 1991. Under this Act, air quality monitoring and management are the responsibility of regional councils. Sections 35 and 30 of the RMA specifically require regional councils to monitor and manage air quality. The Ministry for the Environment develops policy and tools to help councils to do this. For PM_{10} this includes ambient air quality guideline values and recommendations for monitoring and managing ambient air quality (MfE and MoH, 2002; MfE, 2000). The Ministry has also developed indicators to assess the state of New Zealand's air quality as part of the Environmental Performance Indicators programme.

Prior to the introduction of the RMA, air quality monitoring and management were the responsibility of the territorial local authorities and the then Department of Health. Of the minimal air quality monitoring that was carried out in New Zealand prior to 1991, there is little information relating to the PM_{10} size fraction. Historically measurements focused on total suspended particulate (TSP) which was often averaged over seven days, or measured "smoke" as a proxy for particulate.

During the 1980s a number of size selective inlets were designed for the TSP monitors to capture particles, with a cut point of 10 µm because of the greater health risk of this size fraction. By the late 1980s, monitoring of the PM_{10} size fraction had commenced at the Christchurch and Auckland GEMS (Global Environmental Monitoring Strategy) sites. Additional PM_{10} air quality monitoring sites were established throughout the country during the 1990s.

The first ambient air quality guideline values for New Zealand were published in 1994 by the Ministry for the Environment (MfE, 1994). These included a 24-hour average guideline value for PM_{10} of 120 μgm^{-3} and an annual average guideline value of 50 μgm^{-3}. These original values have been reviewed and the revised values were published in 2002 (MfE and MoH, 2002). This review includes new values for PM_{10} including a 24-hour average guideline value of 50 μgm^{-3} and an annual average guideline value of 20 μgm^{-3}. Data for the latter guideline value are only included in this report where PM_{10} monitoring was carried out on greater than 15% of the days per year.

The Ministry for the Environment has published a guide for air quality monitoring and data management which includes an outline of the recommended monitoring and reporting requirements for PM_{10} and other contaminants in New Zealand (MfE, 2000). For reporting PM_{10} data, the recommended averaging period is for a fixed period from midnight to midnight or a moving average that is recalculated every hour.

In this report, PM_{10} data is mostly reported for a fixed averaging period from midnight to midnight because this is the period that the 24-hour high volume samplers have been set to. However, for some locations (e.g. Wellington and Canterbury), data are presented for alternative averaging periods in accordance with the Councils' standard monitoring protocols. For example, Environment Canterbury reports data based on a fixed period from 9 am to 9 am and Greater Wellington (the Wellington Regional Council) uses a moving average approach for continuous data and a midday-to-midday monitoring period for gravimetric sampling. These alternative approaches are appropriate in these areas, owing to the typical daily variations in PM_{10} concentrations. If the midnight-to-midnight approach were used in these areas the pollution episode would be split between different reporting periods, resulting in an underestimate of PM_{10} concentrations relative to exposure. Where alternative averaging periods have been used, this is highlighted in the report.

A number of monitoring methods for PM_{10} are described as appropriate in the monitoring guide (MfE, 2000). These include gravimetric sampling, beta attenuation methods and the Tapered Elemental Oscillating Microbalance (TEOM).

Further guidance on monitoring methods is also provided in *Ambient Air Quality Guidelines* (MfE and MoH, 2002). This report specifies that monitoring should be carried out using US 40 CFR Part 50, Appendix J, which specifies the US reference method based on gravimetric sampling. Although not specified in Appendix J, it is assumed that methods meeting the USEPA 'equivalency' status are also acceptable, as the footnote to the recommended methods table in the guideline document specifies that "where a tapered elemental oscillating microbalance (TEOM®) is used to monitor PM_{10} and $PM_{2.5}$, another recommended monitoring method should be co-located at the site for at least one year to calculate an appropriate adjustment factor" (MfE and MoH, 2002, p.32).

The Ministry also recommends that data be reported using the air quality categories for assessing concentrations of contaminants relative to the guideline values (MfE, 1999; MfE and MoH, 2002). Table 1.1 describes the five categories for reporting air quality data.

Table 1.1: Ministry for the Environment air quality categories

Category	Measured value	Comment
Excellent*	Less than 10% of the guideline value	Of little concern: if maximum values are less than a tenth of the guideline, average values are likely to be much less
Good	Between 10% and 33% of the guideline value	Peak measurements in this range are unlikely to affect air quality
Acceptable	Between 33% and 66% of the guideline value	A broad category, where maximum values might be of concern in some sensitive locations but generally they are at a level which does not warrant urgent action
Alert	Between 66% and 100% of the guideline value	This is a warning level, which can lead to exceedences if trends are not curbed
Action	More than 100% of the guideline value	Exceedences of the guideline are a cause for concern and warrants action, particularly if they occur on a regular basis

Source: MfE (1999), MfE and MoH (2002).

* The 'excellent' category should not be applied to PM_{10} because the level of detection of most monitoring methods is not accurate enough.

2 Monitoring Methods for Particles in New Zealand

2.1 Total suspended particulate

Total suspended particulate (TSP) samplers have no size selective inlets and therefore include measurements of all airborne particles, which are typically in the range of 0–40 μm. The measurement methods are traditionally high-volume gravimetric sampling. Historically, samples of TSP have been collected in New Zealand for the purposes of analysing lead concentrations and have generally been collected as seven-day average concentrations.

Total suspended particulate include both fine and coarse mode particles. Particles greater and less than 2.5 microns in diameter are generally described as coarse and fine, respectively. Fine mode particles typically arise from combustion processes and atmospheric chemistry, whereas coarse mode particles tend to arise from mechanical processes such as grinding, sanding and abrasion. However, there is generally some overlap, with some of the finer mechanically derived particles existing in the fine fraction and conversely some of the larger combustion particles in the coarse fraction. Wind blown dusts, pollens and sea spray typically reside in the coarse fraction.

The relationship between TSP and PM_{10} concentrations will typically vary with location, season and meteorology. This is because of the differences in the processes giving rise to elevated concentrations of fine versus coarse mode particles. Consequently it does not follow that trends in TSP concentrations will reflect similar variations in PM_{10} concentrations.

2.2 Smoke monitoring

The British Standard definition for black smoke (BS 1747) is based on a non-gravimetric reflectance method in which air is sampled through a filter and the resulting blackening measured. A conversion from black smoke to mass equivalent was established in the United Kingdom in the 1960s, based on domestic coal smoke emissions, as that was the main source of emissions at that time.

It is likely, given the apparent absence of other conversion factors, that smoke monitoring carried out in New Zealand has been converted into mass concentration data based on the relationship derived in the UK for coal smoke. In most New Zealand locations this is likely to be inappropriate as coal burning is not likely to be a significant contributor to measured particle mass. Because the relationship between smoke blackness and mass will vary with different sources and compositions of particles, it is unlikely that the conversion derived for black smoke in the UK is suitable for New Zealand. Consequently historical smoke monitoring data for most New Zealand locations are unlikely to be indicative of actual PM_{10} concentrations.

2.3 Gravimetric sampling for PM_{10}

Gravimetric sampling for TSP, PM_{10} or $PM_{2.5}$ includes a number of methods that draw air across a filter for a specified period, typically 24-hours, and measure the mass collected by weighing the filter prior to and following the sampling period. The filter is preconditioned and reconditioned prior to weighing and reweighing.

These include both high-volume sampling methods that have flows of around 1133 litres per minute and low volume methods that have much lower flow rates. Filter sizes and materials also vary between methods. Samplers should be operated strictly in accordance with manufacturer's specifications as variations in filter media and flow rates can impact on collection efficiencies and the selection of appropriately sized particles.

The main advantages of the gravimetric methods are the relatively low sampler costs and the consistency with the USEPA reference method specifications. Disadvantages include no information on temporal distributions of data and high labour costs associated with changing, conditioning and weighing filters.

The USEPA reference method for PM_{10} described in US 40 CFR Part 50, Appendix J specifies gravimetric sampling. Alternative methods meeting equivalency specifications are also allowed for PM_{10} measurements. Gravimetric sampling for PM_{10} concentrations is one of the most common methods used for measuring PM_{10} concentrations in New Zealand.

2.4 Beta attenuation

The beta attenuation or beta gauge method operates by drawing air through a continuous glass or PTFE tape at a rate of 16.7 litres per minute. Beta particles are passed through the particles deposited on the tape and the attenuation of these particles is measured in a sensor located above the tape. The attenuation is converted to an estimate of mass based on the absorption coefficient.

Although the absorption coefficient will vary with different particle compositions, the instrument is typically calibrated using the mass absorption coefficient for quartz. In practice the mass absorption coefficient may vary by up to 20% (QUARG, 1996).

Advantages of the beta attenuation method include the provision of data at an hourly time resolution and the low labour and material costs associated with ongoing operation.

A number of different beta attenuation analysers have gained USEPA 'equivalency' status for measuring PM_{10} concentrations. Beta attenuation monitors are used in a number of ambient air quality monitoring programmes throughout New Zealand.

2.5 Tapered elemental oscillating microbalance (TEOM®)

The tapered elemental oscillating microbalance (TEOM) method provides a direct measure of the mass concentration of particles. The measurement is based on the frequency of mechanical oscillation of a tapered glass element. The element contains a filter upon which particles are deposited. Air is drawn through the analyser at a rate of 16.7 litres per minute to ensure an accurate cut point is achieved and 3 litres per minute of the air is passed across the filter.

The TEOM sensing system is heated to drive off water and to minimise the effects of thermal expansion and contraction of the mass sensor. This heating also results in loss of volatiles including nitrates and low molecular weight organic compounds. The amount of material volatilised will depend on the composition of the particulate aerosol and the temperature setting of the TEOM. In New Zealand, the standard temperature setting for this system is 40°C. The Ministry for the Environment recommends that where a TEOM is used to measure concentrations of PM_{10}, another recommended method shall be co-located with the TEOM for a period of one year to determine an adjustment factor for comparing results to guideline value concentrations (MfE, 2000).

The TEOM is one of the more technologically advanced instrumentation systems in place in New Zealand. Its operation is computerised and can be interrogated remotely for information on status, filter loadings and general operation. The filter requires changing about once every 2–4 weeks depending on loading. Data are also available at a 10-minute time resolution allowing detailed comparison with variations in concentrations of other contaminants and meteorological conditions.

The TEOM method is used extensively throughout the United Kingdom, Canada and Australia and is the main monitoring method used by at least two regional councils within New Zealand.

2.6 Optical sampling

Optical samplers, which use principles of light scattering to estimate particle mass include models such as the GRIMM, Data Ram and GT 1020. As there is not a direct relationship between light scattering and mass, the method is not overly accurate. In addition, problems can arise as a result of light scattering by atmospheric moisture and particle coincidence (coincidence dead-time) in heavily polluted areas.

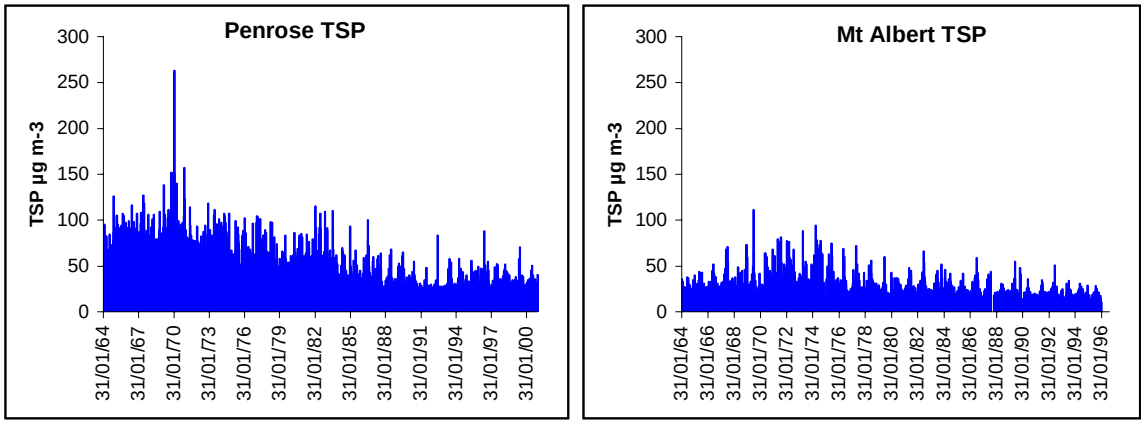
No samplers that estimate mass based on light scattering by particles have met the USEPA equivalency status for PM_{10} sampling. Optical samplers have not been used extensively throughout New Zealand.

3 Auckland Region

Air quality monitoring in Auckland dates back to 1964 when TSP and lead monitoring commenced at the Global Environmental Monitoring (GEMs) site in Penrose and at a site in Mt Albert. Additional monitoring at the Penrose GEMs site included sulphur dioxide (SO_2) and smoke monitoring in 1975, NO_x in 1987, PM_{10} in 1994 and $PM_{2.5}$ in 1997. Monitoring of smoke and SO_2 was discontinued during 2000. A second Auckland GEMs monitoring site was established in 1975 in Mt Eden, initially measuring lead and TSP, with the additions of NO_x in 1991 and PM_{10} and $PM_{2.5}$ in 1997.

The seven-day average TSP data from Auckland suggests some decrease in TSP concentrations since the 1970s, particularly at the Penrose monitoring site (Figure 3.1). The extent to which this reflects reductions in the PM_{10} component is uncertain.

Figure 3.1: The seven-day average TSP concentrations measured at Penrose and Mt Albert, Auckland since 1964



3.1 Monitoring sites and methods

Details of the air quality PM_{10} monitoring sites within the Auckland region up until December 2001 are shown in Table 3.1. These include a number of industrial and traffic monitoring sites as well as the Henderson, Takapuna, Mt Eden and Manukau residential sites.

Table 3.1: Ambient air quality monitoring sites for PM_{10} in Auckland

Location	Duration	Site classification	Monitoring method
Queen Street	From December 1998	Traffic dense	Partisol
Khyber Pass	From March 1998	Traffic peak	Partisol
Takapuna	From November 1996 to April 2002	Residential dense	High-volume
	May 1995 to March 1996, October 1996 to August 1999	Residential dense	TEOM
Henderson	From July 1998	Residential neighbourhood	Partisol
Henderson	From September 2000	Residential neighbourhood	Mini-volume
Glen Eden	From September 2000	Residential neighbourhood	Mini-volume
Manukau – East Tamaki Road	From July 1998	Residential neighbourhood	GRIMM (optical)
Penrose – 766 Great South Road	From April 1994	Industrial dense	High-volume
South Manurewa	From August 2001	Residential neighbourhood	Mini-volume
West Manurewa	From August 2001	Residential neighbourhood	Mini-volume
Mt Eden – 17 Kelly Street	From February 1997 to April 2002	Residential neighbourhood	Partisol

3.2 PM_{10} concentrations

Table 3.2 summarises the PM_{10} concentrations measured at the Auckland residential ambient air quality monitoring sites until December 2001. The table shows that exceedences of the 24-hour average guideline value occur at Takapuna (1997) and Henderson (1999). Extrapolations of this measured data show that if monitoring was undertaken every day during the winter months, it is likely that more exceedences of the guideline value would have occurred.

Because the proportion of days monitored at most sites is low, annual average results for some years and sites have not been reported owing to potential errors associated with limited sampling. For this report, a reporting criterion for annual averages of 15% has been used. The sample error associated with this is around 12%. Data indicates some annual average guideline value exceedences in Henderson and Mt Eden. Although the annual average concentrations for Takapuna using the TEOM method are below the annual average guideline value, this method tends to under-report PM_{10} concentrations relative to the required gravimetric method. Section 13.1 estimates the impact of the TEOM monitoring method on reported 24-hour and annual average concentrations. Data for Manukau are excluded because of potential inaccuracies associated with the optical monitoring method.

Figures 3.2 and 3.3 show the percentage of measured 24-hour average PM_{10} concentrations within the air quality categories at "residential neighbourhood" monitoring sites in Auckland. These figures show that the majority of concentrations are within the acceptable and good air quality categories for PM_{10}. Figures 3.4 and 3.5 show the percentage of measured 24-hour average PM_{10} concentrations within the air quality categories at the Penrose "industrial dense" and the Khyber Pass "traffic peak" monitoring sites. Both the annual and 24-hour average guideline values have been breached at these sites.

Table 3.2: Summary of PM_{10} concentrations at Auckland residential ambient monitoring sites

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Takapuna 1997	**50**	48	19	15%	1 measured 6 equivalent*	5%
Takapuna 1998	38	37	15	15%	0	0
Takapuna 1999	39	36	n/a	13%	0	0
Takapuna 2000	30	30	14	17%	0	0
Takapuna 1995 (TEOM)	39	36	17	56%	0	0
Takapuna 1996 (TEOM)	32	30	17	40%	0	0
Takapuna 1997 (TEOM)	47	40	18	93%	0	0
Takapuna 1998 (TEOM)	37	34	18	100%	0	0
Takapuna 1999 (TEOM)	46	41	17	63%	0	0
Mt Eden 1997	42	41	n/a	11%	0	0
Mt Eden 1998	40	39	**21**	17%	0	0
Mt Eden 1999	46	45	**20**	16%	0	0
Mt Eden 2000	43	42	18	16%	0	0
Henderson 1998 (partisol)	33	33	n/a	7%	0	0
Henderson 1999 (partisol)	**55**	53	**21**	15%	1 measured 6 equivalent*	5%
Henderson 2000 (partisol)	38	37	17	16%	0	0
Penrose 1994	**101**	95	**24**	10%	3 measured 23 equivalent	19%
Penrose 1995	**77**	69	**25**	17%	2 measured 12 equivalent	10%
Penrose 1996	48	47	**25**	15%	0	0
Penrose 1997	**66**	65	**25**	15%	3 measured 18 equivalent	15%
Penrose 1998	48	46	**24**	16%	0	0
Penrose 1999	**81**	73	**24**	16%	2 measured 12 equivalent	10%
Penrose 2000	**57**	53	19	16%	1 measured 6 equivalent	5%
Penrose 2001	72	64	18	27%	2 measured 7 equivalent	5%
Khyber Pass 1998	**121**	104	**30**	14%	2 measured 12 equivalent	10%

Khyber Pass 1999	**62**	58	**21**	16%	1 measured 6 equivalent	5%
Khyber Pass 2000	**95**	83	**28**	15%	2 measured 13 equivalent	11%
Khyber Pass 2001	**69**	58	**23**	23%	1 measured 3 equivalent	3%

Note: Guideline value exceedences are highlighted in bold.

* This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 3.2: The percentage of measured 24-hour average PM_{10} concentrations within air quality categories at Henderson and Mt Eden, Auckland

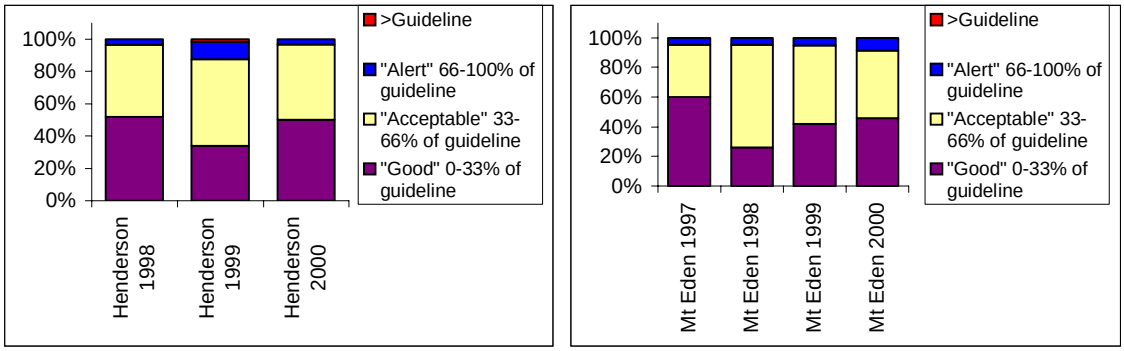


Figure 3.3: The percentage of measured 24-hour average PM_{10} concentrations within air quality categories at Takapuna, Auckland

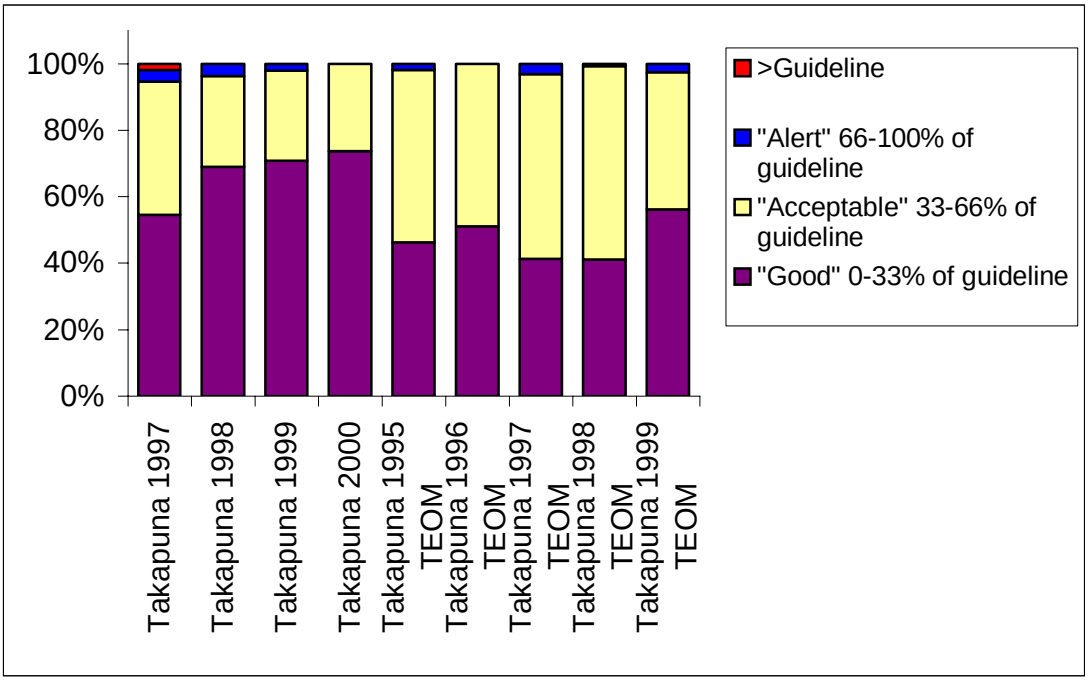


Figure 3.4: The percentage of measured 24-hour average PM10 concentrations within air quality categories at Penrose, Auckland

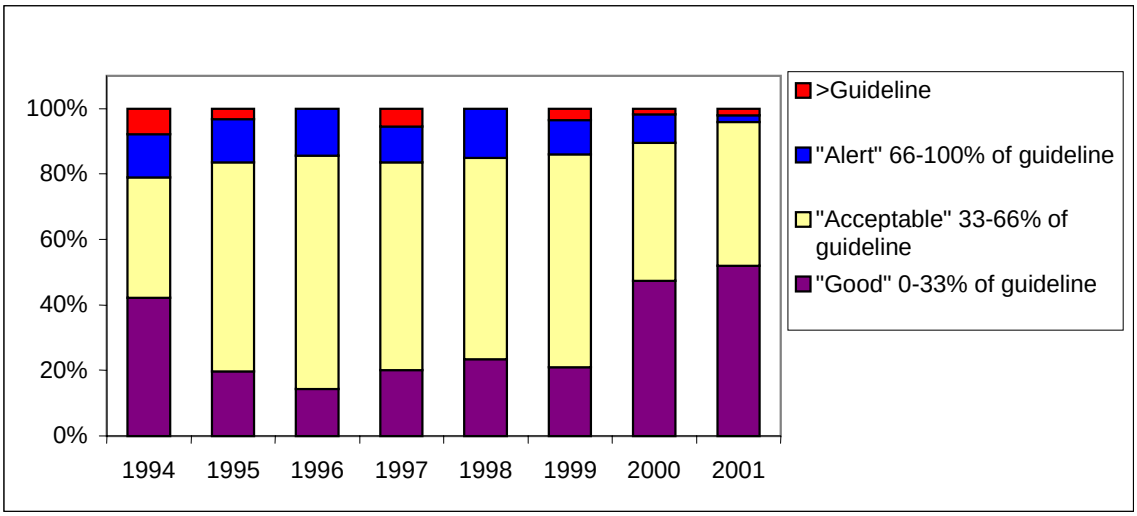
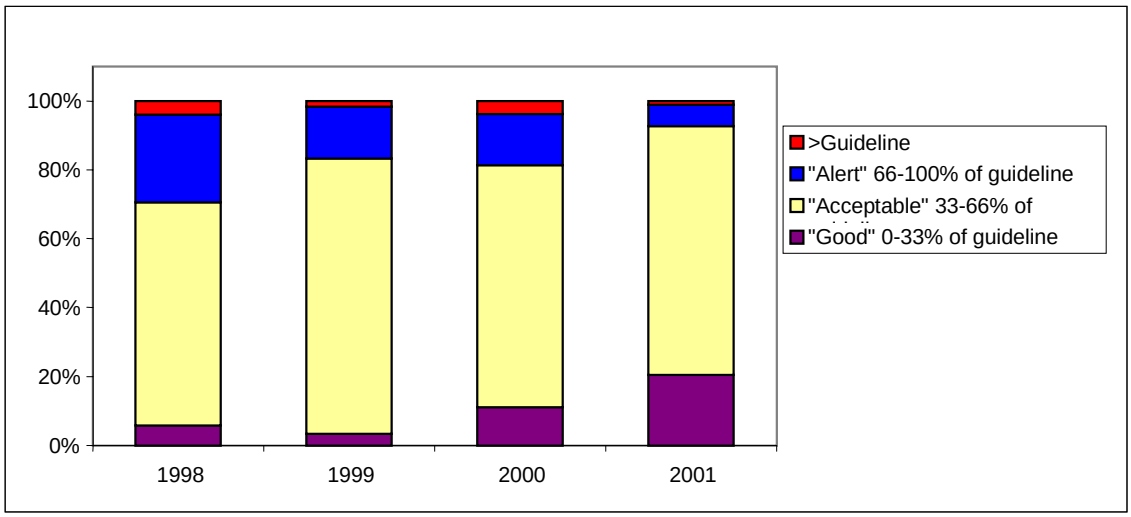


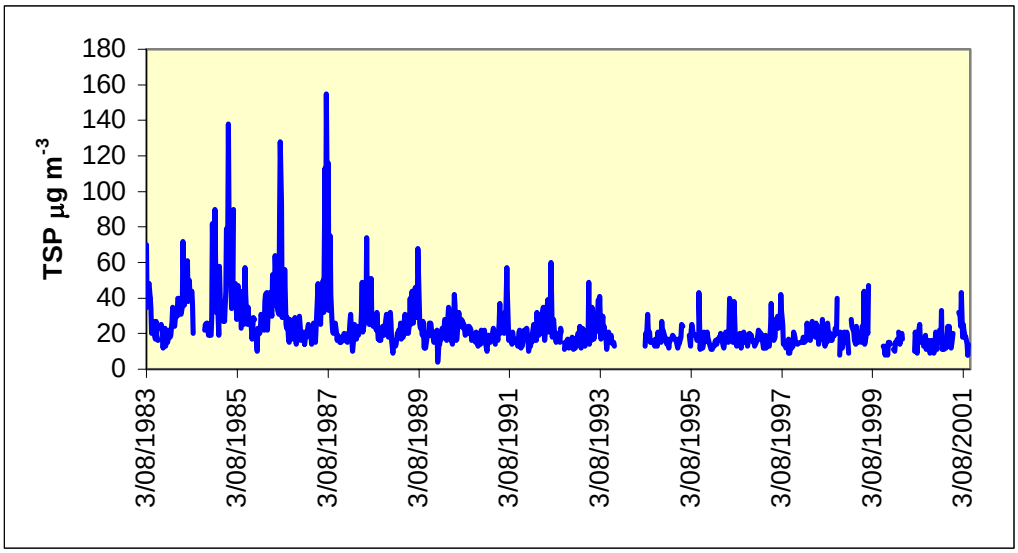
Figure 3.5: The percentage of measured 24-hour average PM10 concentrations within air quality categories at Khyber Pass, Auckland



4 Waikato Region

Air quality monitoring for particles in the Hamilton region includes total suspended particulate monitoring since 1983 and since 1998, and PM_{10} monitoring at the Peachgrove Road site. A permanent PM_{10} air quality monitoring site was established in Tokoroa in 2001 following an initial investigation during 1999. Shorter-term PM_{10} monitoring programmes have been undertaken in Taupo in 2001 and 2002 and in Te Kuiti in 1998. Figure 4.1 shows a decline in TSP concentrations measured in Hamilton since 1983. The extent to which this reflects reductions in the PM_{10} component is uncertain.

Figure 4.1: Seven-day average concentrations of TSP measured in Hamilton since 1983



4.1 Monitoring sites and methods

Details of the four ambient air quality PM_{10} monitoring sites in the Waikato region are shown in Table 4.1. In addition to these sites, some PM_{10} monitoring has been carried out by industry. These include continuous PM_{10} monitoring using an Anderson FH62 BAM in Huntly and gravimetric sampling using a high-volume sampler south of Tokoroa.

Table 4.1: Ambient air quality monitoring sites for PM_{10} in the Waikato region

Area	Location	Duration	Site classification	Monitoring method
Hamilton	Peachgrove Road	From June 1998	Residential peak	TEOM
Tokoroa (a)	South Waikato District Council	1999	Residential neighbourhood	MetOne GT640
Tokoroa (b)	Billah Street Reservoir	From January 2001	Residential neighbourhood	Met One 1020 BAM
Te Kuiti	Te Kuiti City Council Offices	April–November 1998	Residential neighbourhood	TEOM
Taupo	Gillies Street Reserve	2001 and 2002	Residential neighbourhood	Gravimetric partisol sampler

4.2 PM_{10} concentrations

Table 4.2 summarises the PM_{10} concentrations measured at each monitoring site in Waikato. The table shows that exceedences of the 24-hour average guideline value occurred at Hamilton, Tokoroa and Taupo in 2001. Extrapolations of this measured data show that if monitoring was undertaken every day during the winter months, more exceedences of the guideline value may have occurred. This table also shows that the annual average guideline value for PM_{10} was exceeded in Tokoroa. Other areas are within the alert (66–100% of the guideline) category for the annual average PM_{10} concentrations although it is possible given the low sampling regime in Taupo, that the annual guideline value was exceeded in this area also. Data for Tokoroa for 1999 are excluded because of uncertainties regarding the accuracy of the optical monitoring method.

Figure 4.2 shows that in the Waikato region, PM_{10} concentrations are within the good and acceptable categories for most of the year. For a few days each year the 24-hour average concentrations approach (alert) or go above (action) the guideline value. This happens mostly in winter when wind speeds are low and temperature inversions restrict the dispersion of PM_{10}.

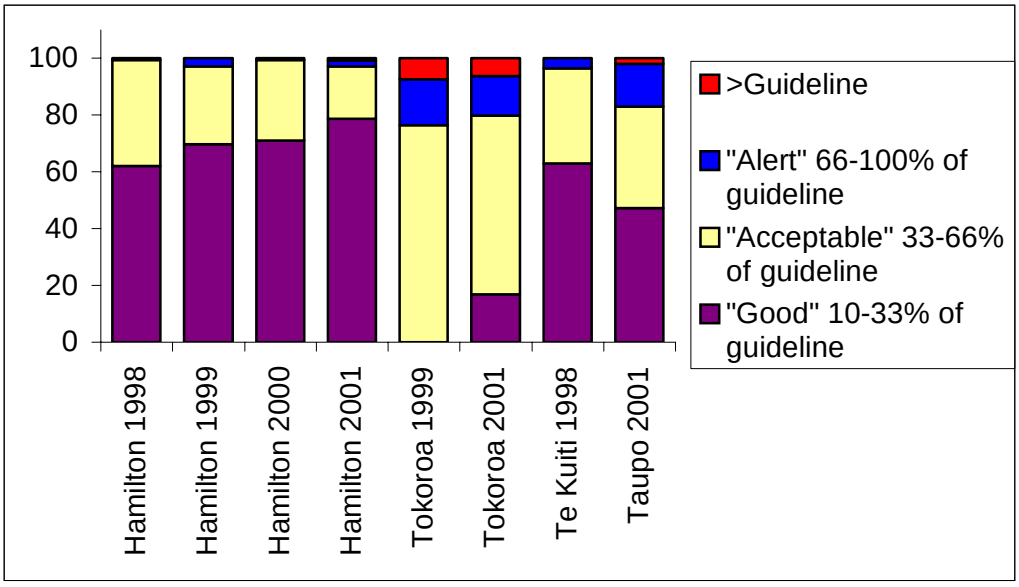
Table 4.2: Summary of PM_{10} concentrations at ambient monitoring sites in the Waikato region

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Hamilton – 1998	35	33	15	47%	0	0
Hamilton – 1999	44	42	16	99%	0	0
Hamilton – 2000	43	33	15	91%	0	0
Hamilton – 2001	**67**	53	14	70%	2 measured 3 equivalent*	3%
Te Kuiti – 1998	42	42	16	53%	0	0
Tokoroa – 2001	**75**	66	**26**	47%	13 measured 24 equivalent*	20%
Taupo – 2001	**57**	54	18	15%	1 measured 2 equivalent*	2%

Note: Guideline value exceedences are highlighted in bold.

* This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 4.2: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in the Waikato region



5 Bay of Plenty Region

Air quality monitoring for PM_{10} in the Bay of Plenty region commenced in December 1997 with the establishment of monitoring sites in Rotorua, Tauranga, Whakatane and Pongakawa.

5.1 Monitoring sites and methods

Details of the six ambient air quality PM_{10} monitoring sites within the Bay of Plenty region are shown in Table 5.1. These include two traffic-monitoring sites in both Rotorua and Tauranga and one background PM_{10} monitoring site in Pongakawa.

Table 5.1: Ambient air quality monitoring sites for PM_{10} in the Bay of Plenty

Area	Location	Duration	Site classification	Monitoring method
Rotorua	Pererika Street	From December 1997	Residential neighbourhood	TEOM
Rotorua	Fenton Street	December 1998 – February 1999	Traffic peak	TEOM
Tauranga	Otumoetei Road	From December 1997	Residential neighbourhood	TEOM
Tauranga	Marsh Street	March 2000 – February 2001	Traffic peak	TEOM
Whakatane	Quay Street	From December 1997	Residential neighbourhood	Partisol
Pongakawa	Pongakawa Bush Road	From December 1997	Background – special (rural)	Partisol

5.2 PM_{10} concentrations

Figure 5.1 shows that concentrations of PM_{10} (24-hour average) in the Bay of Plenty are typically within the good or acceptable air quality categories with concentrations occasionally reaching the alert category in Rotorua and Whakatane. These towns have each recorded one exceedence of the 24-hour average guideline value, both during 1998 (Table 5.2). With the exception of Whakatane, Table 5.2 shows the annual average PM_{10} concentration in these Bay of Plenty towns ranges from 12 – 14 μgm^{-3}, falling within the acceptable and alert air quality categories. In Whakatane the annual average ranged from 13 to 19 μgm^{-3} indicating some potential for annual average guideline value exceedences in this area.

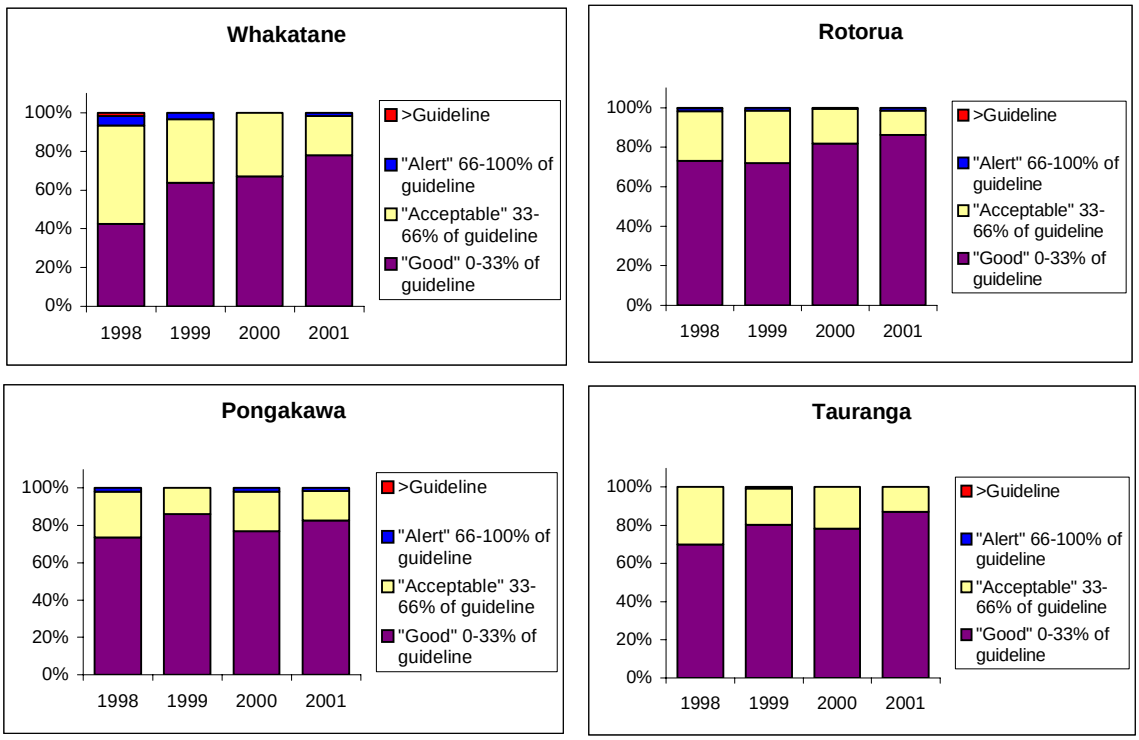
Table 5.2: Summary of PM_{10} concentrations at ambient monitoring sites (24-hour average)

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Rotorua 1998	**52**	40	14	100%	1	0.8%
Rotorua 1999	43	35	14	99%	0	0
Rotorua 2000	36	32	12	98%	0	0
Rotorua 2001	38	37	12	98%	0	0
Tauranga 1998	32	29	14	100%	0	0
Tauranga 1999	34	31	13	100%	0	0
Tauranga 2000	29	26	13	97%	0	0
Tauranga 2001	28	23	12	89%	0	0
Whakatane 1998	**53**	48	19	17%	1 measured 6 equivalent*	5%
Whakatane 1999	38	37	16	17%	0	0
Whakatane 2000	31	31	14	17%	0	0
Whakatane 2001	45	41	13	16%	0	0
Pongakawa 1998	44	41	12	15%	0	0
Pongakawa 1999	28	26	11	16%	0	0
Pongakawa 2000	45	41	13	15%	0	0
Pongakawa 2001	49	42	11	16%	0	0

Note: Guideline value exceedences are highlighted in bold.

* This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 5.1: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in the Bay of Plenty region



6 Taranaki and Northland Regions

Air quality monitoring for PM_{10} in the Taranaki and Northland regions is limited to monitoring of PM_{10} in Whangarei and Kaitaia and some screening monitoring in New Plymouth. The Kaitaia monitoring site was located near State Highway One and was limited to three samples only. Because of the low sampling frequency, results are not reported. Further monitoring in Kaitaia was also carried out during 2002. The New Plymouth monitoring was carried out using the GRIMM optical sampling method. No results for the latter site have been reported because of the limited period of monitoring and uncertainties associated with the monitoring method.

6.1 Monitoring sites

Details of the ambient air quality PM_{10} monitoring sites within the Northland and Taranaki regions until December 2001 are shown in Table 6.1.

Table 6.1: Ambient air quality monitoring sites for PM_{10} in Taranaki and Northland

Area	Location	Duration	Site classification	Monitoring method
New Plymouth	New Plymouth Central	30 May 2000 – 1 May 2000	Residential neighbourhood	GRIMM (optical)
New Plymouth	New Plymouth Central	20 February 2000 – 20 March 2000	Residential neighbourhood	GRIMM (optical)
New Plymouth	New Plymouth Central	13 November 2000 – 30 December 2000	Residential neighbourhood	GRIMM (optical)
Whangarei	Robert St Boat Garage	October 2000 – August 2001	Residential neighbourhood	High volume
Kaitaia	State Highway One	November–December 2001 – three samples only	Traffic peak	High volume

6.2 PM_{10} concentrations

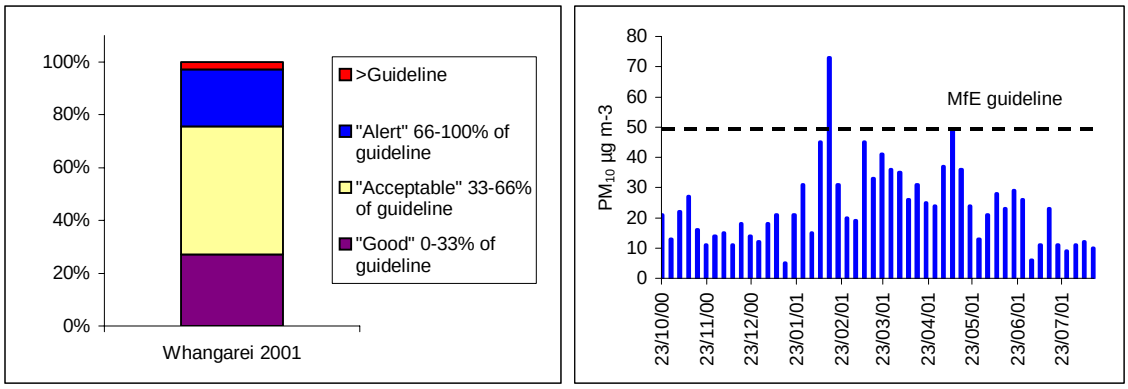
Air quality monitoring in Whangarei (Northland) for 2000 and 2001 shows one exceedence of the 24-hour average ambient air quality guideline value for PM_{10} on the 14 February 2001 (Figure 6.1 and Table 6.2). This exceedence is unlike those at most other locations in New Zealand where high PM_{10} concentrations typically occur during the winter months. Other elevated concentrations also occur during the summer months and may be attributed to a local industrial source of PM_{10}. Elevated PM_{10} concentrations during the winter months are also apparent with a near guideline value exceedence of 49 μgm^{-3} on 9 May 2001.

Table 6.2: Summary of PM_{10} concentrations at ambient monitoring site in Whangarei, Northland

Area	Maximum	99.5 percentile	Annual average	% of days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Whangarei 2001	**73**	69	n/a	10%	1 measured	0%

Note: Guideline value exceedences are highlighted in bold.

Figure 6.1: The percentage of measured 24-hour average PM_{10} concentrations for Whangarei within air quality categories (left) and measured concentrations (right)



7 Gisborne and Hawkes Bay Regions

Air quality monitoring for PM_{10} in the Gisborne and Hawkes Bay regions is limited to the towns of Gisborne and Napier. In each of these areas data are available for one ambient air quality monitoring site and one background air quality monitoring site.

7.1 Monitoring sites

Details of the four ambient air quality PM_{10} monitoring sites within the Gisborne and Hawkes Bay regions are shown in Table 7.1. These include one background PM_{10} monitoring site in Gisborne and one regional monitoring site in Napier.

Table 7.1: Ambient air quality monitoring sites for PM_{10} in Gisborne and Hawkes Bay

Area	Location	Duration	Site classification	Monitoring method
Gisborne	Oates Road	From April 1993 to December 2000	Residential neighbourhood	High-volume
Gisborne	McDonalds Road	From November 1993	Background – special (rural)	High-volume
Napier	Nelson Park	From July 2001	Residential neighbourhood	High-volume
Napier	Guppy Road	February 1996 to June 1999	Residential Regional	High-volume

7.2 PM_{10} concentrations

Concentrations of PM_{10} measured in Napier suggest that 24-hour average PM_{10} concentrations may exceed the air quality guideline values on around 13% of the winter days (Table 7.2). In Gisborne one exceedence of the guideline value was measured on 28 October 1998 and coincided with northwest winds and elevated wind speeds of around 8 ms^{-1} on average. Dusts and/ or sea spray are potential sources under these types of conditions. Extrapolations of this measured data show that if monitoring was undertaken every day during the winter months, it is likely that more exceedences of the guideline value may have occurred. For Napier, this extrapolation was based on the proportion of the amount of data available for the period from May to August inclusive, but for Gisborne because the exceedence was not seasonal, the extrapolation was based on the data available for the whole year.

Figures 7.1 and 7.2 show the percentage of measured 24-hour average PM_{10} concentrations within the air categories at the sites in Gisborne and Napier. These graphs show that the majority of concentrations were within the good air quality categories for all sites.

Table 7.2: Summary of PM_{10} concentrations at ambient monitoring sites in Gisborne and Napier

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% of days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Gisborne (Oates Road) 1993	35	35	n/a	11%	0	0
Gisborne (Oates Road) 1994	24	24	9	15%	0	0
Gisborne (Oates Road) 1995	20	19	8	16%	0	0
Gisborne (Oates Road) 1996	25	25	9	15%	0	0
Gisborne (Oates Road) 1997	26	25	9	15%	0	0
Gisborne (Oates Road) 1998	**70**	61	12	15%	1 measured 7 equivalent*	Exceedence occurred during summer
Gisborne (Oates Road) 2000	16	16	n/a	10	0	0
Napier (Guppy Road) 1998	24	23	n/a	10%	0	0
Napier (Guppy Road) 1999	17	17	n/a	6%	0	0
Napier (Nelson Park) 2000	**64**	64	n/a	7%	2 measured 15 equivalent*	13%
Napier (Nelson Park) 2001	33	33	n/a	7%	0	0

Note: Guideline value exceedences are highlighted in bold.

* This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 7.1: The percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Gisborne

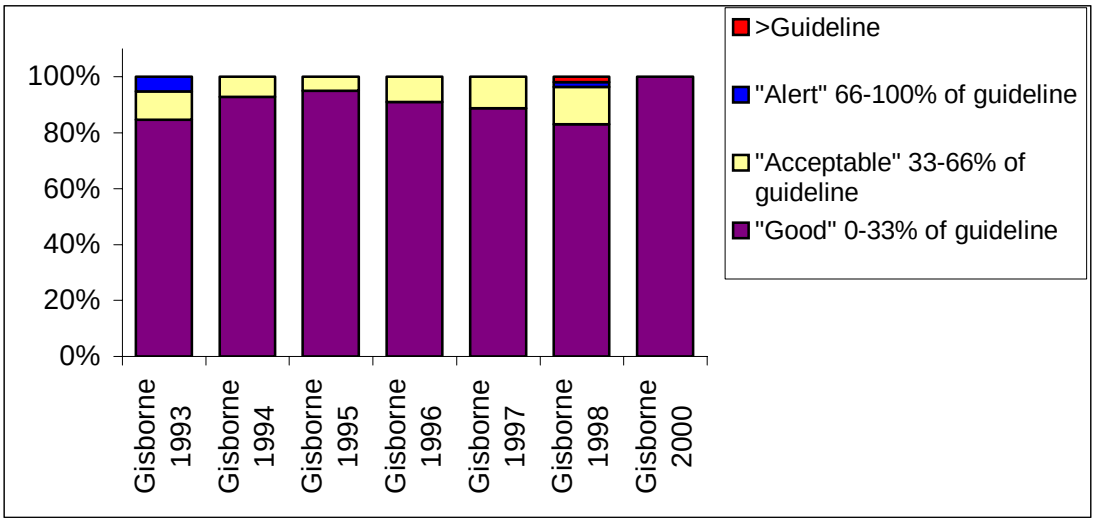
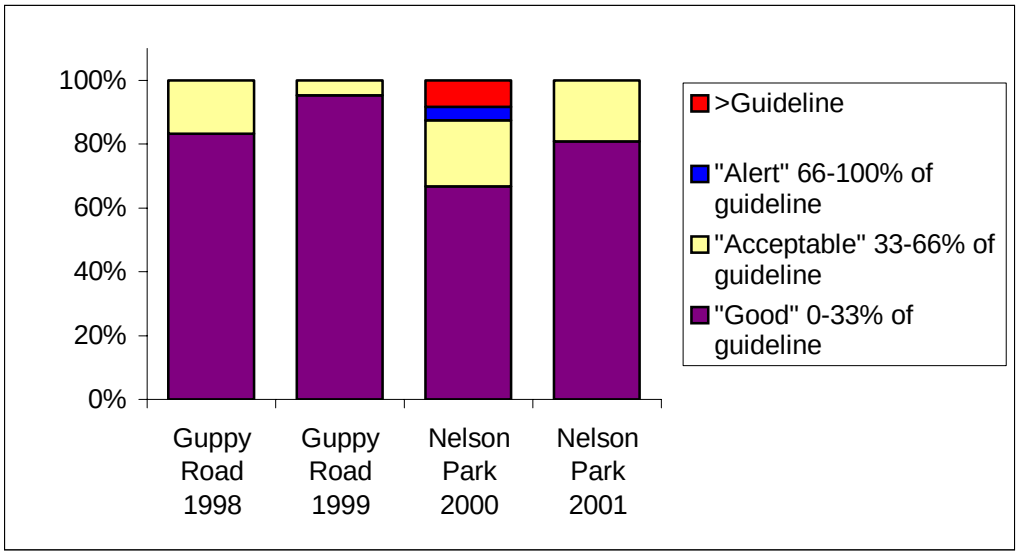


Figure 7.2: The percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Napier



8 Wellington Region

Air quality monitoring for PM_{10} has been carried out in the Wellington region since at least 1998. The main monitoring sites are located outside Wellington City, in areas such as Lower and Upper Hutt, because PM_{10} concentrations in these areas are elevated during the winter months.

8.1 Monitoring sites and methods

Details of the five ambient air quality PM_{10} monitoring sites within the Wellington region are shown in Table 8.1. These are all residential neighbourhood air quality monitoring sites using either the TEOM operating at a temperature setting of 40°C or high-volume sampling.

Table 8.1: Ambient air quality monitoring site for PM_{10} in the Wellington region

Area	Location	Duration	Site classification	Monitoring method
Wellington	Drummond Road, Newtown	March to October 1998	Residential neighbourhood	High-volume sampler
Rural Otaki		October 1998 to February 2000	Background rural	High-volume sampler
Lower Hutt	Birch Lane	From April to June 2001	Residential neighbourhood	TEOM
Lower Hutt	Huia Street	May 1998 to June 1999	Residential neighbourhood	TEOM
Upper Hutt	Trentham Fire Station	From May 2000	Residential neighbourhood	TEOM
Wainuiomata	Moohan Street	From September 2000	Residential neighbourhood	High-volume sampler
Masterton	Memorial Park	1999	Residential neighbourhood	TEOM

8.2 PM_{10} concentrations

The main method of monitoring for PM_{10} in the Wellington region is continuous monitoring using the TEOM. In Wellington, a moving 24-hour average is calculated from these data and results are reported based on the moving average. As indicated previously, this method is consistent with the *Good Practice Guide for Air Quality Monitoring and Data Management* (MfE, 2000), although tends to measure concentrations less than the gravimetric method recommended in the air quality guidelines. Table 8.2 shows a summary of the PM_{10} concentrations based on moving PM_{10} averages.

While no data are available for Wellington on the relationship between the TEOM monitoring method and the high volume sampling method specified in the Guidelines document (MfE and MoH, 2002), data for other areas indicates the TEOM underestimates PM_{10} concentrations relative to the high volume sampler. For example, studies in Christchurch and Auckland show differences of around 20–30%. Consequently the PM_{10} data reported for Lower and Upper Hutt are likely to underestimate PM_{10} concentrations relative to the method specified in the guidelines (MfE and MoH, 2002).

Unlike PM_{10} concentrations in most of New Zealand, the exceedence of the guideline value at the Otaki air quality monitoring site occurred during the summer months. This site is located near the sea and it is likely that the cause of elevated concentrations during the summer months is a combination of sea spray and wind blown dusts. Further work on the filter samples is being carried out by Greater Wellington to characterise the source of elevated PM_{10} concentrations in rural Otaki.

As well as showing the number of 24-hour average guideline value exceedences, Table 8.2 also shows extrapolations of the data for Rural Otaki (1999), Wainuiomata (2001) and Masterton (1999). For Wainuiomata and Masterton, this shows that if monitoring was undertaken every day during May to August inclusive, and for Otaki during the summer months, it is likely that more exceedences of the guideline value may have occurred.

Table 8.2: Summary of PM_{10} concentrations at ambient monitoring sites in the Wellington region

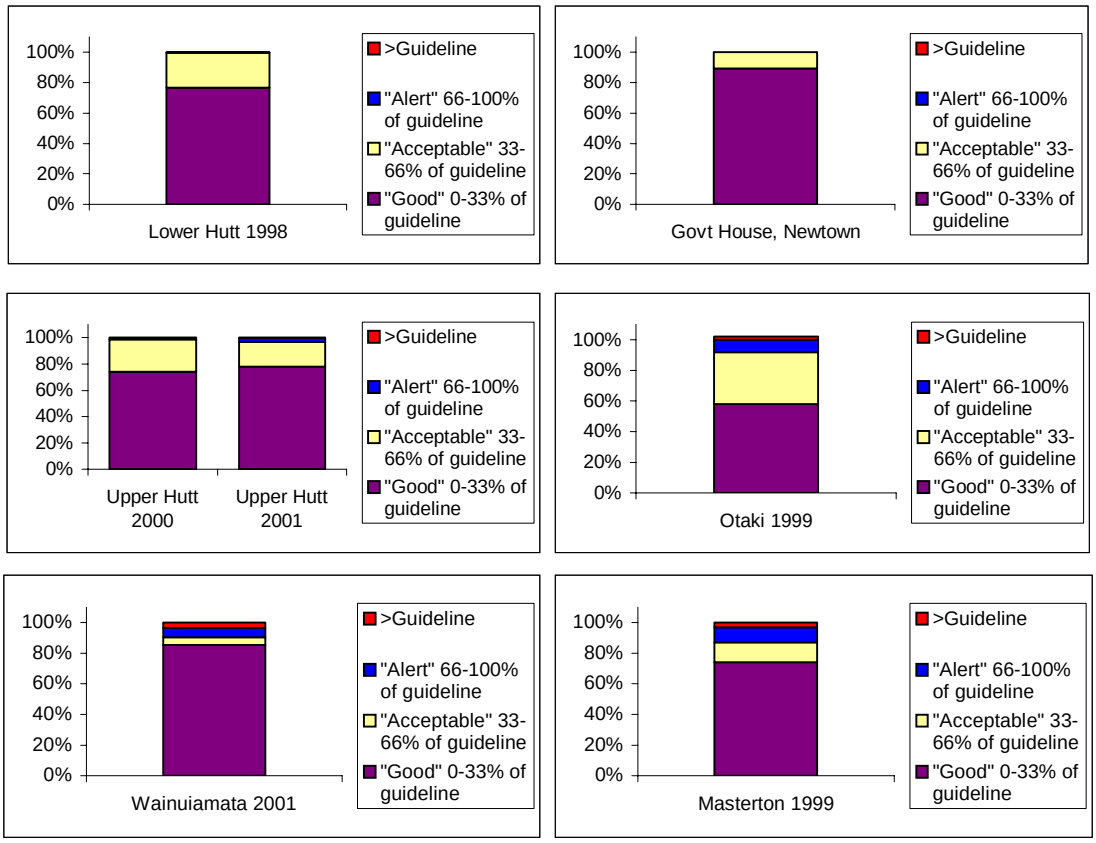
Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Newtown, Wellington 1998	18	18	n/a	10%	0	
Rural Otaki 1999	**50**	48	n/a	14%	1 measured 9 equivalent[2]	
Lower Hutt Huia Street 1998	38	33	13	65%	0	
Lower Hutt Huia Street 1999	20	19	11	40%	0	
Lower Hutt Birch Lane 2001	30	26	n/a[1]	17%	0	
Upper Hutt 2000	**52**	49	14	57%	2 measured	2%
Upper Hutt 2001	**61**	57	14	56%	4 measured	3%
Wainuiomata 2001	**57**	57	13	22%	3 measured 10 equivalent[2]	10%
Masterton 1999	**87**	74	16	87%	8 measured 11 equivalent[2]	9%

Note: Guideline value exceedences are highlighted in bold.

1 Although more than 15% of data were available, all data were for winter months.

2 This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 8.1: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in the Wellington region



9 Nelson, Tasman and Marlborough Districts

Historically, air quality monitoring in Nelson and Tasman was based on measurements of black smoke (BS) and dates back to around 1983. The monitoring programme was initially set up by the then Department of Health, which was in part responsible for air quality. Monitoring was carried out at three locations in Nelson: the inner city, Vanguard Street and Quarantine Road during the months May to August inclusive from 1983, and at one location in Richmond (Tasman).

The 98th percentile smoke concentrations (seventh highest reading) in Nelson per year were typically within 50–120 μgm^{-3} for the Vanguard Street site, between 40 and 80 μgm^{-3} for the Quarantine Road site and less than 60 μgm^{-3} for the inner city site.

The first PM_{10} monitoring programme for Nelson commenced in May 2000 using a high volume gravimetric sampler which was situated at the Nelson fire station. A similar sampler was located in Tasman in the urban area of Richmond. Further PM_{10} monitoring was carried out in Nelson in 2001 using a gravimetric partisol sampler located at a monitoring site at Swift Suzuki.

The air quality monitoring programme in Marlborough, which included PM_{10} monitoring, commenced during 2000. This initially involved monitoring using a gravimetric high-volume sampler in Picton and Blenheim.

9.1 Monitoring sites and methods

Details of the seven ambient air quality PM_{10} monitoring sites within the Nelson, Tasman and Marlborough Districts are shown in Table 9.1. These are all residential neighbourhood monitoring sites and use predominantly gravimetric high and low volume sampling methods.

Table 9.1: Ambient air quality monitoring site for PM_{10} in Nelson, Tasman and Marlborough

Area	Location	Duration	Site classification	Monitoring method
Nelson	Fire Station	May – September 2000	Residential neighbourhood	High-volume sampler
Nelson	117 St Vincent Street	From March 2001	Residential neighbourhood	Partisol
Nelson	Vincent Street	April to September 2001	Residential neighbourhood	High-volume
Nelson	Waimea Road	March to December 2001	Residential peak	TEOM
Tasman	Richmond	May–September 2000	Residential neighbourhood	High-volume sampler
Blenheim	106 Middle Renwick Road	From February 2000	Residential neighbourhood	High-volume sampler
Picton	High Street Fire Station	March to September 2000	Residential neighbourhood	High-volume sampler

9.2 PM_{10} concentrations

Concentrations of PM_{10} have exceeded the 24-hour ambient air quality guideline value in Nelson, Richmond and Blenheim (Table 9.2 and Figure 9.1). Of these areas, the highest concentrations and greatest number of guideline value exceedences have occurred in Nelson. Only one guideline value exceedence has been measured in Blenheim. Extrapolations of this measured data show that if monitoring was undertaken every day during the winter months, it is likely that more exceedences of the guideline value may have occurred at these monitoring sites.

Monitoring data for Nelson for 2001 also indicates that PM_{10} concentrations exceeded the annual average PM_{10} guideline value, with an annual average value of 36 μgm^{-3} being measured. This was estimated based on combining a summer and winter average to remove seasonal bias associated with the commencement of monitoring in March 2001.

Table 9.2: Summary of PM_{10} concentrations at ambient monitoring sites in Nelson, Tasman and Marlborough

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Nelson Fire Station 2000	**142**	139	n/a[1]	15%	27 measured 66 equivalent[2]	54%
Nelson Swift Suzuki 2001	**165**	156	**36**	70%	81	66%
Richmond 2000	**111**	111	n/a[1]	15%	23 measured 60 equivalent[2]	49%
Nelson Vincent Street Kindergarten 2001	**94**	91	n/a	14%	10 measured 35 equivalent[2]	29%
Nelson Waimea Road 2001	**81**	65	**26**	59%	12 measured	10%
Blenheim 2000	**56**	51	19	15%	1 measured 6 equivalent[2]	5%
Blenheim 2001	38	38	17	20%	0	0
Picton 2000	27	27	n/a	10%	0	0

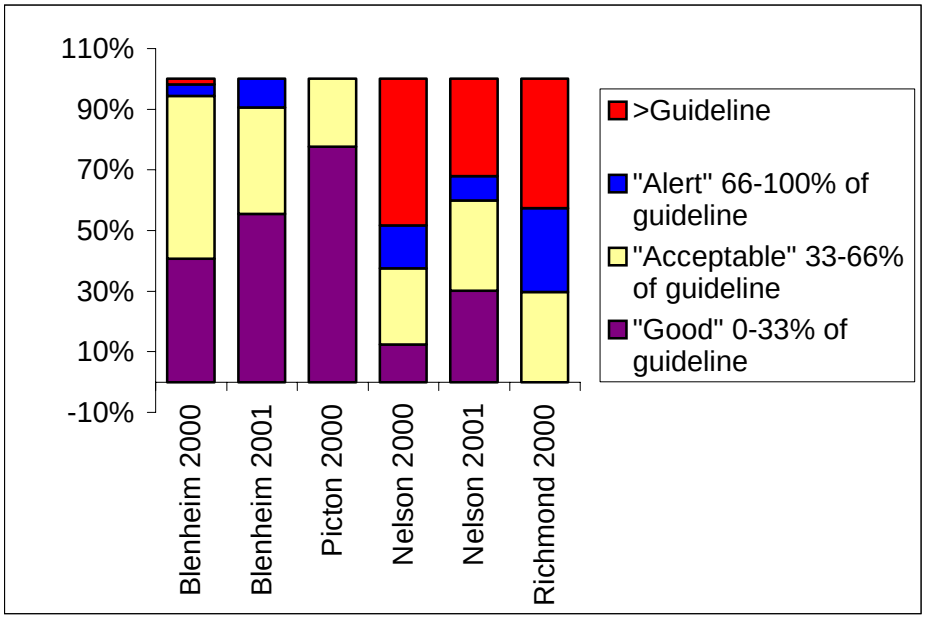
Note: Guideline value exceedences are highlighted in bold.

1 Although more than 15% of data were available, all data were for winter months.

2 This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 9.1 shows the percentage of measured PM_{10} concentrations in Nelson, Richmond, Blenheim and Picton within the air quality categories. This shows a large percentage of the concentrations fall within the alert and action categories for the Nelson and Richmond sites. For the sites in Blenheim and Picton the majority of concentrations are within the good and acceptable categories. Although concentrations in Nelson and Richmond during 2000 appear worse than during 2001, the former monitoring periods included primarily the winter months (i.e. from May to September), whereas monitoring during 2001 was for the period March to December.

Figure 9.1: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Nelson, Tasman and Marlborough



10 Canterbury Region

10.1 Monitoring sites and methods

Details of the eleven ambient air quality PM_{10} monitoring sites within the Canterbury region are shown in Table 10.1. All sites meet the neighbourhood residential criteria and the main monitoring method used is the TEOM. Other monitoring methods used in Canterbury include a beta attenuation monitor at the St Albans Packe Street monitoring site in Christchurch from 1989 to 1993 and from 1996. This analyser was operated in conjunction with a TEOM for a number of years allowing an assessment of the relationship between the two methods at that site. Additional monitoring using a high-volume sampler at the same site was also carried out during 1997 to provide three-way comparison of the monitoring methods (Foster, 1998).

Table 10.1: Ambient air quality monitoring sites for PM_{10} in Canterbury

Area	Location	Duration	Site classification	Monitoring method
Christchurch	St Albans – Coles Place	From 1998	Residential neighbourhood	TEOM
Christchurch	St Albans – Packe Street	1989–1993	Residential neighbourhood	BAM
Christchurch	St Albans – Packe Street	From 1994	Residential neighbourhood	TEOM
Christchurch	Opawa – Mary McLean Place	From July 1996 to June 1999	Industrial neighbourhood	BAM (1996) TEOM
Christchurch	Hornby – South Hornby School	From June 1995 to December 1998	Residential neighbourhood	TEOM
Christchurch	Beckenham – 66 Colombo Street	From June 1995 to March 1997	Residential neighbourhood	TEOM
Kaiapoi	41A Peraki Street	From April 2001	Residential neighbourhood	TEOM
Timaru	Timaru Main School	From Jan 1997	Residential neighbourhood	TEOM
Ashburton*	Ashburton Domain	December 1997–December 1998	Residential neighbourhood	TEOM
Ashburton	14 Cambridge Street	March 1999 to December 2000	Residential neighbourhood	TEOM
Rangiora	St Joseph's School	January 1999 to December 2000	Residential neighbourhood	TEOM

* This site was discontinued because of the impact of nearby trees on windflow.

10.2 PM_{10} concentrations

Table 10.2 shows the results of PM_{10} monitoring carried out in the Canterbury region based on a fixed monitoring period from 9 am to 9 am. Results in Table 10.2 indicate the guideline value for PM_{10} is exceeded on around 20–30% of the winter days per year. The main monitoring method for PM_{10} is the TEOM (Table 10.1). Data from co-located sampling methods in 1997 indicates that the TEOM in Christchurch measures about 20–30% less PM_{10} than the high volume sampling method when pollution levels are elevated. Consequently most of the PM_{10} data reported for Canterbury are likely to underestimate PM_{10} concentrations relative to the high volume sampling method specified in the MfE ambient air quality guidelines (MfE and MoH, 2002).

Monitoring results show 24-hour average guideline value exceedences in all of the urban centres where air quality monitoring has been carried out. Christchurch has recorded the highest PM_{10} concentrations measured in the region with a maximum 24-hour average concentration of 283 μgm^{-3}. In Timaru maximum concentrations in the order of 100 μgm^{-3} are common with slightly lower maximums recorded in the other urban towns. Annual average PM_{10} concentrations range from around 18 to 23 μgm^{-3}.

Extrapolations of the measured number of guideline value exceedences show that if monitoring was undertaken every day during the winter months, it is likely that more exceedences of the guideline value may have occurred. This is shown in Table 10.2 as the equivalent number of days the guideline value may have been exceeded.

Figures 10.1 to 10.3 show the percentage of measured PM_{10} concentrations in urban areas of Canterbury within the air quality categories. Although annual fluctuations in PM_{10} concentrations are apparent, the data does not indicate any long-term trends in PM_{10} concentrations in Christchurch or Timaru. Some apparent variations in PM_{10} concentrations in Christchurch from the early to late 1990s is likely to reflect differences in monitoring methods rather than trends in PM_{10} concentrations.

Table 10.2: Summary of PM_{10} concentrations at ambient monitoring sites in Canterbury

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
St Albans Packe Street 1994	**283**	192	n/a[1]	61%	19 measured 23 equivalent[2]	18%
St Albans Packe Street 1995	**161**	116	**21**	96%	31 measured 33 equivalent[2]	26%
St Albans Packe Street 1996	**139**	102	**21**	96%	28 measured 30 equivalent[2]	24%
St Albans Packe Street 1997	**211**	173	**22**	95%	27 measured 31 equivalent[2]	25%
St Albans Packe Street 1998	**155**	127	**23**	99%	27 measured	22%
St Albans Packe Street 1999	**152**	139	**23**	97%	27 measured	22%
St Albans Packe Street 2000	**96**	84	18	67%	9 measured 18 equivalent[2]	15%
St Albans Packe Street 2001	**129**	122	**22**	46%	13 measured 31 equivalent[2]	25%

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
St Albans Coles Place 1998	**83**	82	n/a[1]	38%	2 measured 12 equivalent[2]	10%
St Albans Coles Place 1999	**158**	140	**23**	99%	31 measured	25%
St Albans Coles Place 2000	**154**	105	19	100%	21 measured	17%
St Albans Coles Place 2001	**183**	130	**23**	93%	39 measured 40 equivalent[2]	32%
Beckenham 1995	**81**	54	16	50%	3 measured 4 equivalent[2]	3%
Beckenham 1996	**106**	81	15	99%	8 measured	7%
Hornby 1995	**71**	60	19	51%	3 measured 6 equivalent[2]	5%
Hornby 1996	**75**	51	16	99%	2 measured	2%
Hornby 1997	**80**	64	**22**	98%	13 measured 13 equivalent[2]	11%
Hornby 1998	**75**	64	**22**	87%	13 measured 13 equivalent[2]	11%
Opawa 1995	**137**	134	n/a	41%	28 measured 44 equivalent[2]	36%
Opawa 1996	**148**	140	n/a	29%	23 measured 49 equivalent[2]	40%
Opawa 1997	**150**	108	**22**	85%	22 measured 18 equivalent[2]	15%
Opawa 1998	**196**	97	**23**	98%	21 measured	17%
Timaru 1997	**95**	70	**23**	79%	21 measured 23 equivalent[2]	18%
Timaru 1998	**89**	80	**25**	77%	27 measured	22%
Timaru 1999	**108**	77	**23**	99%	32 measured	26%
Timaru 2000	**111**	94	**23**	100%	31 measured	25%
Timaru 2001	**100**	92	**23**	100%	29 measured	24%
Ashburton 1999	**67**	55	18	98%	5 measured	4%
Ashburton 2000	**72**	56	18	99%	4 measured	4%
Rangiora 1999	**57**	54	15	85%	4 measured	3%
Rangiora 2000	**74**	55	14	100%	3 measured	2%
Kaiapoi 2001	**97**	87	**23**	78%	25 measured	20%

Note: Guideline value exceedences are highlighted in bold.

1 Annual averages were not calculated because of seasonal bias in the data,

2 This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 10.1: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories at St Albans, Christchurch

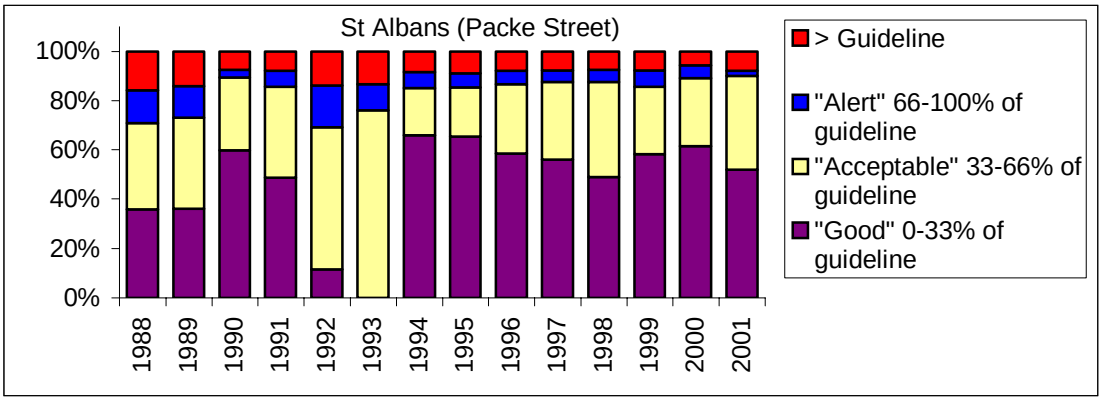


Figure 10.2: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Timaru

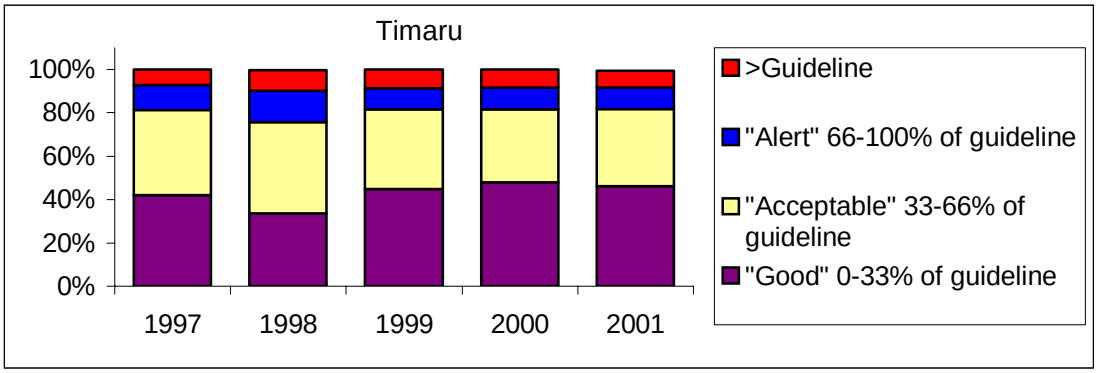
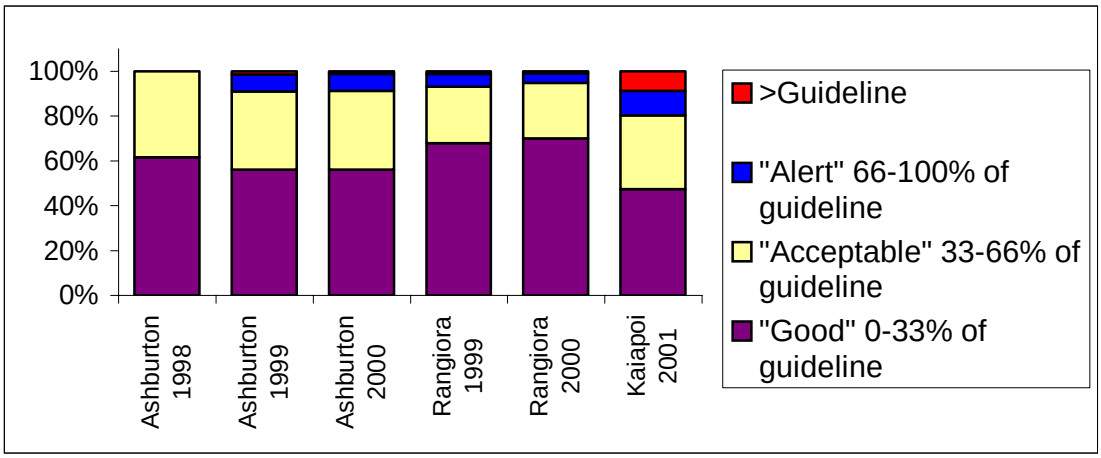


Figure 10.3: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Ashburton, Rangiora and Kaiapoi



11 West Coast and Southland Regions

Limited monitoring of PM_{10} has been carried out in the West Coast and Southland regions. However, some smoke monitoring has been carried out in Greymouth in 1994 and 1995, in Reefton in 1995 and in Invercargill in 1983, 1985, 1986 and from 1990 to 1997. Smoke monitoring has also been carried out in the Southland areas of Winton and Wyndham in 1974, in Bluff in 1985 and in Mataura in 1996 and 1997. A monitoring strategy to measure PM_{10} concentrations in urban areas on the West Coast is underway with initial monitoring in Greymouth during 2001. The Southland region is currently preparing a monitoring strategy to assess concentrations of PM_{10} within the region. Monitoring for PM_{10} in that region is scheduled to commence during winter 2003.

11.1 Monitoring sites and methods

Details of the ambient air quality PM_{10} monitoring site in Greymouth are shown in Table 11.1. This is a residential neighbourhood site that measures concentrations of PM_{10} using high-volume gravimetric sampling.

Table 11.1: Ambient air quality monitoring site for PM_{10} in the West Coast region

Area	Location	Duration	Site classification	Monitoring method
Greymouth	49 Palmerston Street	May–August 2001	Residential neighbourhood	High-volume sampler
Westport	Derby Street	31 May – 3 September 2002	Residential neighbourhood	High-volume sampler

11.2 PM_{10} concentrations

Figure 11.1 shows that concentrations of PM_{10} measured in Greymouth during 2001 did not exceed the ambient air quality guideline values on any of the 21 sampling days during the winter monitoring period. The maximum measured 24-hour average PM_{10} concentration of 46 μgm^{-3} is within the alert air quality category.

Concentrations of PM_{10} measured in Greymouth during 2001 did not exceed the ambient air quality guideline values on any of the 21 sampling days during the winter monitoring period. The maximum measured 24-hour average PM_{10} concentration of 46 μgm^{-3} is within the alert category. In Westport, the ambient air quality guideline value was breached on around 9% of the days monitored (Figure 11.1). Summary statistics for both monitoring sites are shown in Table 11.2.

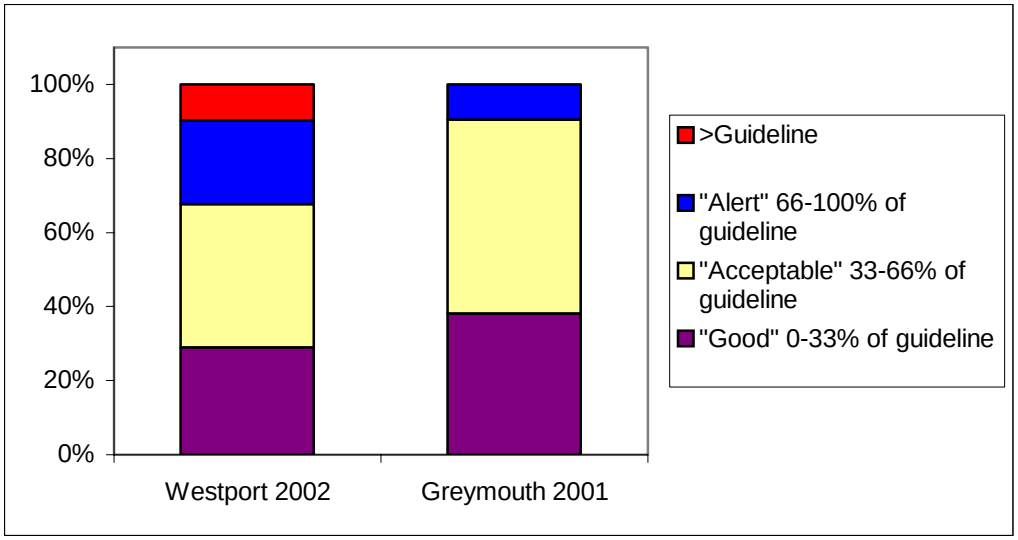
Table 11.2 includes an indication of the number of days PM_{10} concentrations exceeded the 24-hour average PM_{10} guideline value of 50 μgm^{-3}. For Westport, this shows the number of exceedences that were measured and an estimate of the number that may have been measured if monitoring had been carried out on all days. This estimate is shown in the table as the equivalent number of exceedences.

Table 11.2: Summary of PM_{10} concentrations at ambient monitoring sites in Greymouth and Westport

Area	24-hour maximum	24-hour 99.5 percentile	Annual average	% of days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Greymouth	46	45	n/a	6%	0	0%
Westport	56	55.4	n/a	8%	3 measured 12 equivalent*	9%

* This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 11.1: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Westport (2002) and Greymouth (2001)



12 Otago Region

Air quality monitoring for PM_{10} in the Otago region has been carried out by the Otago Regional Council since 1997. A variety of gravimetric methods have been used including both low and high-volume sampling. Concentrations of PM_{10} have been measured in nine urban centres.

12.1 Monitoring sites and methods

Details of the 13 ambient air quality PM_{10} monitoring sites within the Otago region are shown in Table 12.1. The sites are mainly residential neighbourhood and use either high volume gravimetric sampling or the low volume mini-vol samplers.

Table 12.1: Ambient air quality monitoring sites for PM_{10} in the Otago region

Area	Location	Duration	Site classification	Monitoring method
Oamaru	Harlich	June–August 1998	Residential neighbourhood	Mini-volume sampler
Alexandra	Ventry Street	From April 1997–September 1998	Residential neighbourhood	Mini-volume sampler
Alexandra	Ventry Street	From April 1998 onwards	Residential neighbourhood	High-volume sampler
Cromwell	30 Ray Street	June–August 1999 and June–August 2001	Residential neighbourhood	Mini-volume sampler
Dunedin	Albany Street	From January 1997	Residential neighbourhood	High-volume sampler
Dunedin	North Road North East Valley	From January 1997	Residential neighbourhood	High-volume sampler
Mosgiel	Church Street	June–August 1998 and June 2000–September 2001	Residential neighbourhood	Mini-volume sampler
Mosgiel	Factory Road	From June 2000	Residential neighbourhood	High-volume sampler
Milton	Union SH1	June–September 1999	Residential neighbourhood	Mini-volume sampler
Balclutha	Cnr Lanark and Paisley	June–September 1997 and June–September 2000	Residential neighbourhood	Mini-volume sampler
Arrowtown	Bush Creek Road	July–September 1999	Residential neighbourhood	Mini-volume sampler
Queenstown	Camp and Shotover	June–August 1999	Commercial/ residential	Mini-volume sampler
Dunedin Green Island	Irmo	June–September 1997, June–August 2000, July–August 2001	Residential neighbourhood	Mini-volume sampler

12.2 PM_{10} concentrations

Concentrations of PM_{10} are of concern in many of the urban centres where air quality monitoring has been carried out in Otago. In particular, guideline value exceedences are observed in Alexandra on around 40–65% of the days monitored during the months May to August inclusive (Table 12.2). Other areas also experience regular guideline value exceedences during the winter months. Annual average PM_{10} concentrations in excess of the ambient air quality guidelines are also likely for a number of areas within the Otago region. However, the limited number of samples collected each year precludes a detailed assessment of annual average concentrations in most areas. Estimates of annual average PM_{10} concentrations in Alexandra indicate breaches of the guideline value during both 1999 and 2000.

Table 12.2 also shows an estimate of the number of days that the guideline values may have been exceeded if monitoring had been carried out on all days. This is referred to in the table as the 'equivalent' number of exceedences.

Figure 12.1 shows 24-hour average PM_{10} concentrations are regularly within the alert and action air quality categories for most areas. With the exception of the Alexandra and Dunedin North monitoring sites, data represent winter monitoring only.

Table 12.2: Summary of PM_{10} concentrations at ambient monitoring sites in Otago

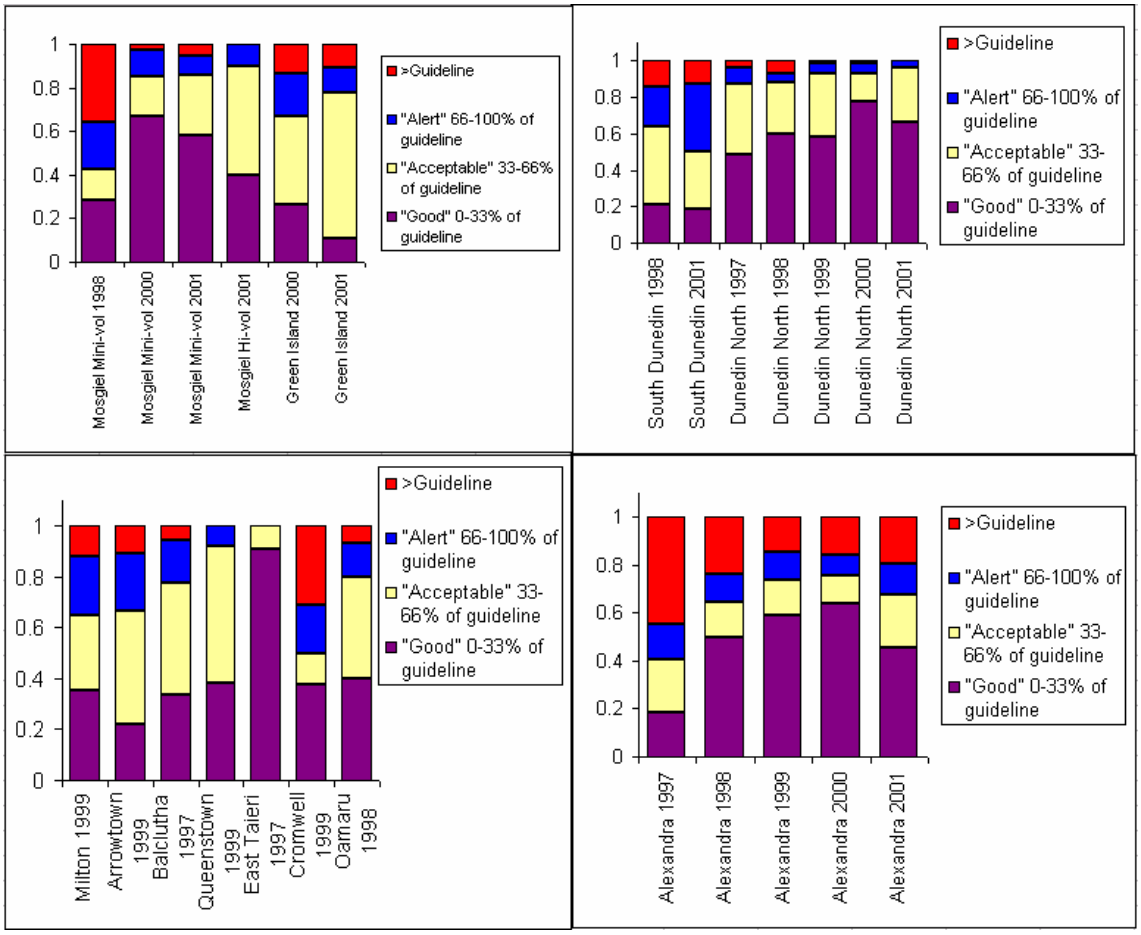
Area	Maximum	99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Oamaru 1998	**61**	59	n/a	4%	1 measured 8 equivalent[1]	7%
Alexandra 1997	**178**	168	n/a	7%	12 measured 78 equivalent[1]	63%
Alexandra 1998	**134**	129	n/a	9%	8 measured 66 equivalent[1]	53%
Alexandra 1999	**87**	84	**22**	17%	9 measured 53 equivalent[1]	43%
Alexandra 2000	**108**	105	**23**	16%	9 measured 55 equivalent[1]	45%
Alexandra 2001	**193**	173	n/a	13%	9 measured 65 equivalent[1]	53%
Cromwell 1999	**73**	73	n/a	4%	5 measured 38 equivalent[1]	31%
South Dunedin 1998	**84**	83	n/a	4%	2 measured 18 equivalent[1]	14%
South Dunedin 2001	**55**	55	n/a	4%	2 measured 15 equivalent[1]	13%
Dunedin North 1997	**72**	67	19	15%	2 measured 12 equivalent[1]	10%
Dunedin North 1998	**88**	82	18	16%	4 measured 25 equivalent[1]	20%
Dunedin North 1999	**51**	50	18	16%	1 measured 6 equivalent[1]	5%
Dunedin North 2000	**57**	52	14	16%	1 measured 6 equivalent[1]	5%

Area	Maximum	99.5 percentile	Annual average	% days monitored	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Dunedin North 2001	41	39	15	15%	0	
Mosgiel 1998	**95**	95	n/a	4%	5 measured 44 equivalent[1]	36%
Mosgiel 2000	**70**	67	n/a	9%	1 measured 8 equivalent[1]	7%
Mosgiel 2001	**60**	59	n/a	10%	2 measured 14 equivalent[1]	11%
Mosgiel 2001 (hi-vol)	49.9	49	n/a	8%	0	
Milton 1999	**57**	57	n/a	5%	2 measured 19 equivalent[1]	15%
Balclutha 1997	**54**	53	n/a	5%	1 measured 8 equivalent[1]	6%
Arrowtown 1999	**55**	55	n/a	2%	1 measured 18 equivalent[1]	14%
Queenstown 1999	36	35	n/a	4%	0	
Green Island 1997	**65**	65	n/a	6%	2 measured 15 equivalent[1]	13%
Green Island 2000	**107**	107	n/a	4%	2 measured 16 equivalent[1]	13%
Green Island 2001	**58**	57	n/a	2%	1 measured 14 equivalent[1]	11%
East Taieri 1997	22	21	n/a	3%	0	

Note: Guideline value exceedences are highlighted in bold.

1 This is an estimate of the number of days PM_{10} concentrations may have exceeded the guideline value if monitoring had been carried out on all days during winter (May to August inclusive). It is extrapolated from the number of measured exceedences and the number of days when monitoring did occur.

Figure 12.1: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in Otago



13 Trends in PM_{10} Concentrations in New Zealand

The distribution of guideline value exceedences and maximum PM_{10} concentrations across the country is shown in Figure 13.1 and Table 13.1. These data are based on conversions to a gravimetric equivalent for data collected using the TEOM (see Section 13.1) and extrapolations to annual estimates. With the exception of Wellington and Canterbury, they are for 24-hour averages based on a fixed monitoring period from midnight to midnight. For Wellington, data are based on a rolling 24-hour average for Lower and Upper Hutt and a fixed period from midday to midday for other sites. In Canterbury, all results are for the period 9 am to 9 am. Both reporting times are likely to provide a better indication of the PM_{10} concentrations for these areas than a midnight-to-midnight averaging period. This is because the latter approach would split the pollution episodes across two days, providing an estimate of the PM_{10} concentrations, which is less than the maximum 24-hour average exposure. Figure 13.2 shows the PM_{10} monitoring results for each site within the air quality categories.

Results indicate that the PM_{10} ambient air quality guideline value of 50 μgm^{-3} (24-hour average) has been exceeded at the following locations:

- Auckland
- Hamilton
- Tokoroa
- Taupo
- Whangarei
- Rotorua
- Upper Hutt
- Lower Hutt
- Masterton
- Otaki
- Napier
- Wainuiomata
- Nelson
- Richmond
- Whakatane
- Timaru
- Ashburton
- Blenheim
- Kaiapoi
- Oamaru
- Christchurch
- Mosgiel
- Arrowtown
- Rangiora
- Dunedin
- Cromwell
- Alexandra
- Balclutha

In most areas, guideline value exceedences occur during the winter months under low wind speed and temperature inversion conditions. Emission inventory studies suggest domestic home heating is the main source of PM_{10} emissions in most areas, although it is likely that motor vehicles are a key contributor in Auckland where a large proportion of the countries population resides. Air quality monitoring for that area indicates that the 24-hour average guideline value has been or is likely to have been exceeded at both the Henderson and Takapuna monitoring sites. Although annual average data for Auckland are limited, results suggest concentrations in excess of guideline values are likely to occur at Mt Eden, Takapuna and Henderson.

In the areas of Otaki and Whangarei, the measured guideline value exceedences have occurred during the summer months. Likely sources of these elevated levels include sea spray and dusts in Otaki (Perry Davy, WRC, personal communication, 2002) and dusts from local industry in Whangarei (Paul Baynham, NRC, personal communication, 2002).

It should also be noted that air quality monitoring in the areas of Canterbury, Lower Hutt, Upper Hutt, Hamilton, Te Kuiti, Rotorua and Tauranga have been carried out using the TEOM method, which underestimates PM_{10} concentrations relative to the high-volume sampling method proposed in the ambient air quality guidelines (MfE and MoH, 2002). It is therefore possible that the areas of Tauranga and Te Kuiti also measure PM_{10} concentrations in excess of the 2002 ambient air quality guideline values. An estimate of potential PM_{10} concentrations in these locations based on relationships between the TEOM and high volume sampling methods for Christchurch is presented in Section 13.1.

The annual average ambient air quality guideline value is also likely to have been exceeded at a number of locations. However, the low sampling frequency of many of the sampling regimes makes annual average PM_{10} concentration estimates difficult. Table 13.2 summarises the annual average concentrations in areas where PM_{10} concentrations were measured on greater than or equal to 15% of the days per year. From these data, exceedences of the annual average PM_{10} guideline value have been measured in Alexandra, Mt Eden, Henderson, Tokoroa, Nelson, Christchurch, Kaiapoi and Timaru.

Table 13.1: Maximum measured PM_{10} concentrations and annual guideline exceedences

	Maximum PM_{10} (24-hour)	Guideline exceedences
Alexandra	87–193	53–78
Arrowtown	55	18
Ashburton	94–100	23–24
Auckland	30–72	6–12
Balclutha	54	8
Blenheim	38–56	0–6
Christchurch	88–310	17–58
Cromwell	73	38
Dunedin	22–107	0–25
Gisborne	16–70	8
Greymouth	46	0
Hamilton	49–93	1–10
Kaiapoi	136	50
Lower Hutt	42–53	1
Masterton	87	11
Milton	57	19
Mosgiel	50–95	8–44
Napier	17–64	0–15

	Maximum PM_{10} (24-hour)	Guideline exceedences
Nelson	81–165	66–81
Oamaru	61	8
Otaki	50	9
Pongakawa	28–49	0
Picton	27	0
Queenstown	36	0
Rangiora	79–104	11–19
Richmond	111	60
Rotorua	50–72	2–4
Taupo	57	2
Tauranga	39–48	0
Te Kuiti	59	5
Timaru	104–156	42–62
Tokoroa	75	24
Upper Hutt	72–85	7–15
Newtown, Wellington	31–53	6
Whakatane	73	1
Whangarei	57	10

Note: See Figure 13.1 for spatial distribution.

Figure 13.1: Maximum PM_{10} concentrations and guideline value exceedences from 1990 to 2001

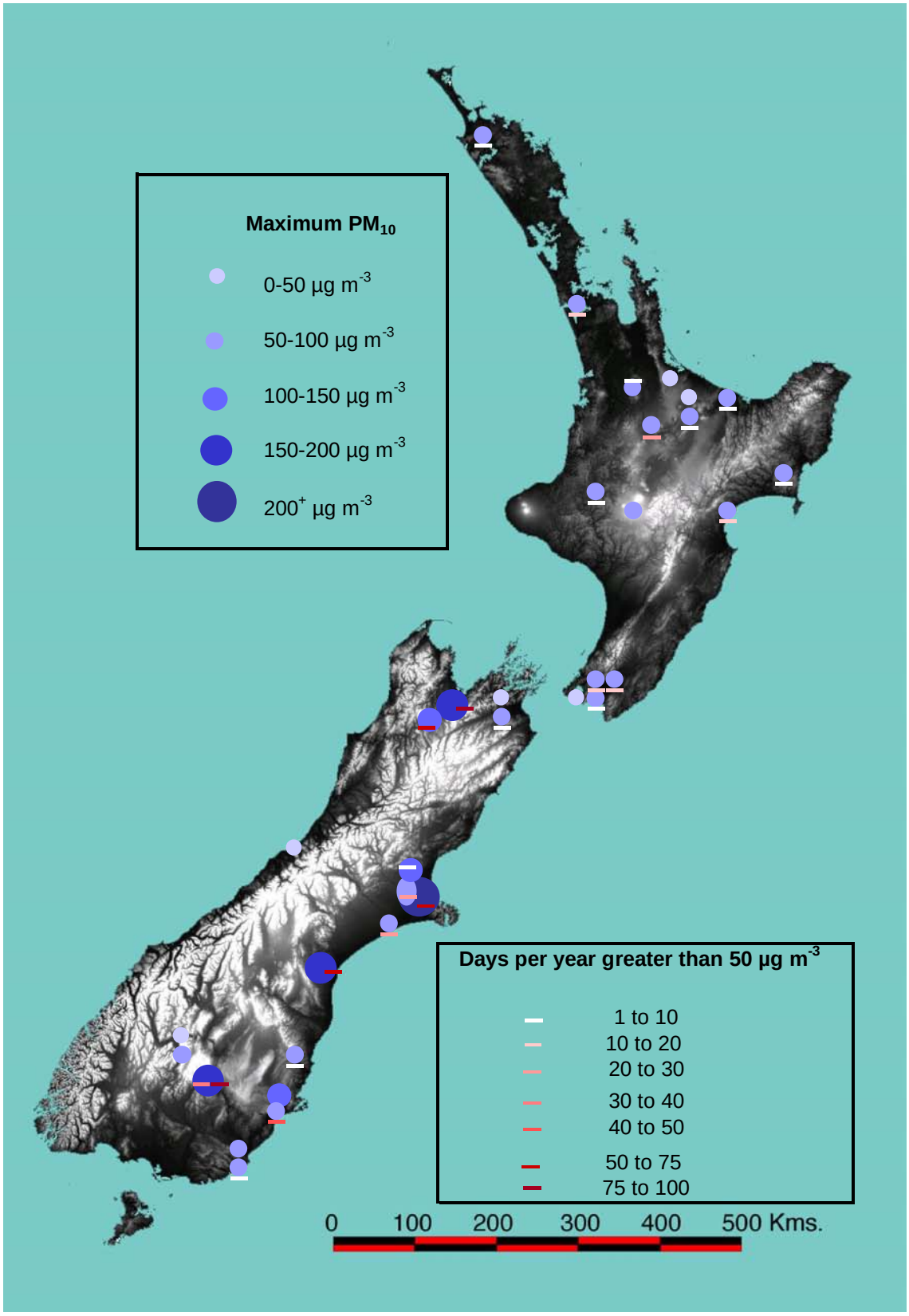


Figure 13.2: Percentage of measured 24-hour average PM_{10} concentrations within air quality categories in New Zealand

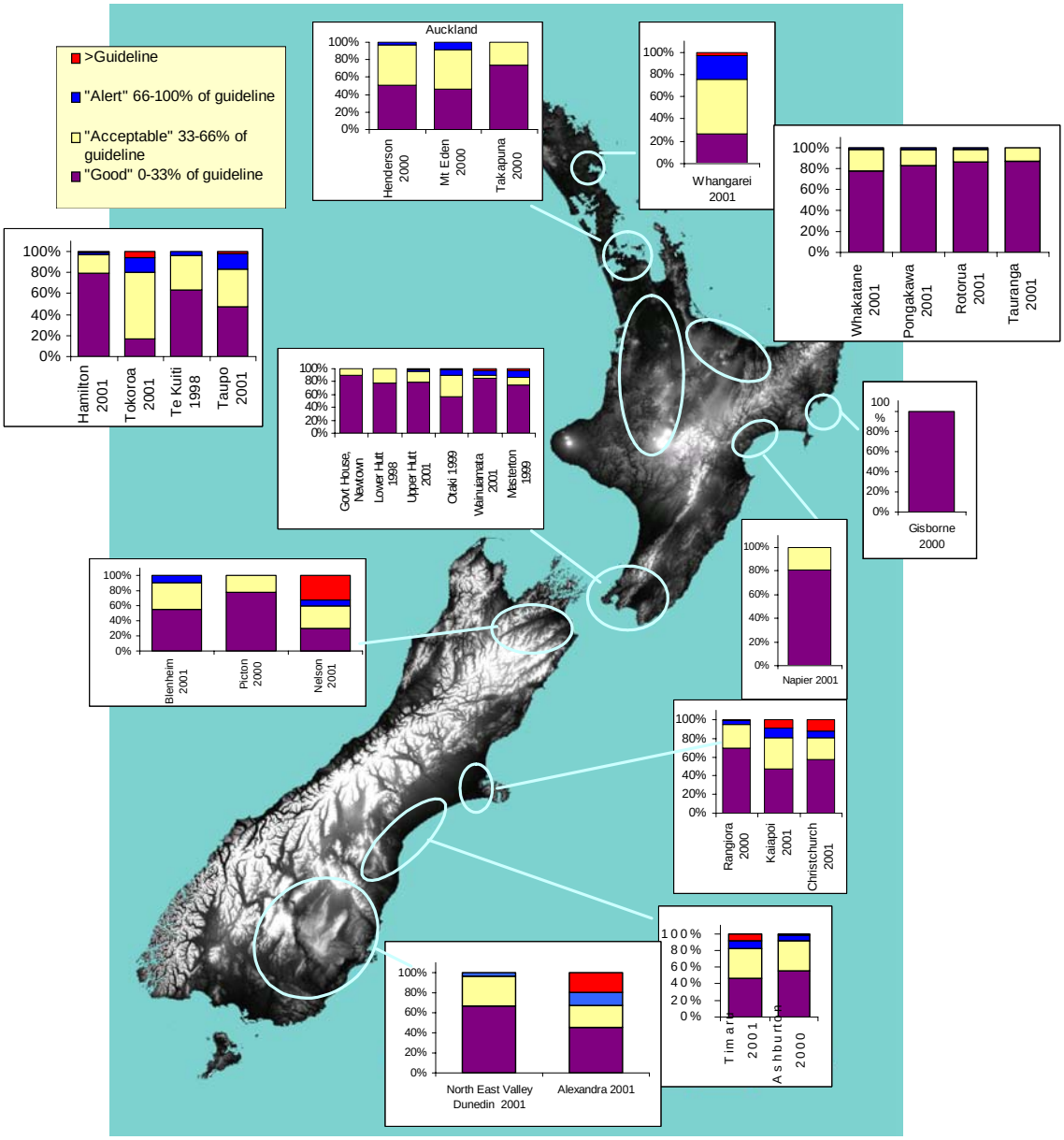


Table 13.2: Annual average PM_{10} concentrations within New Zealand

Location	Method	1995	1996	1997	1998	1999	2000	2001
Mt Eden	Hi-vol				**21**	**20**		
Henderson	Hi-vol			**21**				
Takapuna	TEOM	17	17		18	17		
Takapuna	Hi-vol			19	15	14		
Gisborne	Hi-vol	8	9	9	12			
Hamilton	TEOM				15	16	15	14
Te Kuiti	TEOM				16			
Taupo	Partisol							18
Tokoroa	BAM							**26**
Rotorua	TEOM				14	14	12	12
Tauranga	TEOM				14	13	13	12
Whakatane	Partisol				19	16	14	13
Pongakawa	Partisol				12	11	13	11
Lower Hutt	TEOM				13	11		
Upper Hutt	TEOM						14	14
Masterton	TEOM						16	
Wainuiomata	Hi-vol							13
Nelson	Partisol							**36**
Blenheim	Hi-vol						19	17
Alexandra	Hi-vol					**22**	**23**	
Dunedin North	Hi-vol			19	18	18	14	15
Christchurch (St Albans)	TEOM	**21**	**21**	**22**	**23**	**23**	18	**22**
Timaru	TEOM			**23**	**25**	**23**	**23**	**23**
Ashburton	TEOM					18	18	
Rangiora	TEOM					15	14	
Kaiapoi	TEOM							**23**

Note: Guideline value exceedences are highlighted in bold.

13.1 Impact of monitoring methods

The 2002 ambient air quality guidelines for PM_{10} specify US 40 CFR Part 50, Appendix J as the designated monitoring method for measuring PM_{10} and allow methods that meet the USEPA equivalency requirements (MfE and MoH, 2002). The guidelines specify, however, that if a TEOM is used, then another recommended monitoring method should be co-located with the analyser for a period of one year to calculate an appropriate adjustment factor. This specification is included in the guidelines because the sample line of the TEOM is heated to remove moisture and also results in some loss of volatiles.

The difference between the TEOM method and a gravimetric method is likely to vary with location, particularly for areas where the sources of PM_{10} vary. Greater differences are likely to occur in areas where wood smoke comprises a substantial proportion of the PM_{10} as this source contains a significant fraction of low molecular weight volatile organic compounds that will not be captured using the heated sample line of the TEOM.

Comparisons between PM_{10} concentrations measured using a TEOM and a co-located alternative PM_{10} sampling method are limited to the Christchurch St Albans site and the Auckland Takapuna site for the period 1997 to 1999. Figures 13.3 to 13.6 show some seasonal variations in the relationship between the TEOM and the alternative sampling methods at both monitoring sites, as well as the impact of different TEOM sample temperatures at the Christchurch monitoring site. Seasonal variations are likely to reflect differences in sources contributing to PM_{10} concentrations.

Although the Christchurch comparisons are made using a beta attenuation monitor (BAM) rather than a gravimetric method, a comparison of PM_{10} concentrations measuring using a BAM and a high volume sampler in 1998 showed a good correlation (r^2=0.98) with an average difference in concentrations of about 4% (Foster, 1998).

Figure 13.3: Comparison between PM_{10} concentrations measured using a high-volume sampler and TEOM with a 50°C sample temperature at Takapuna, Auckland

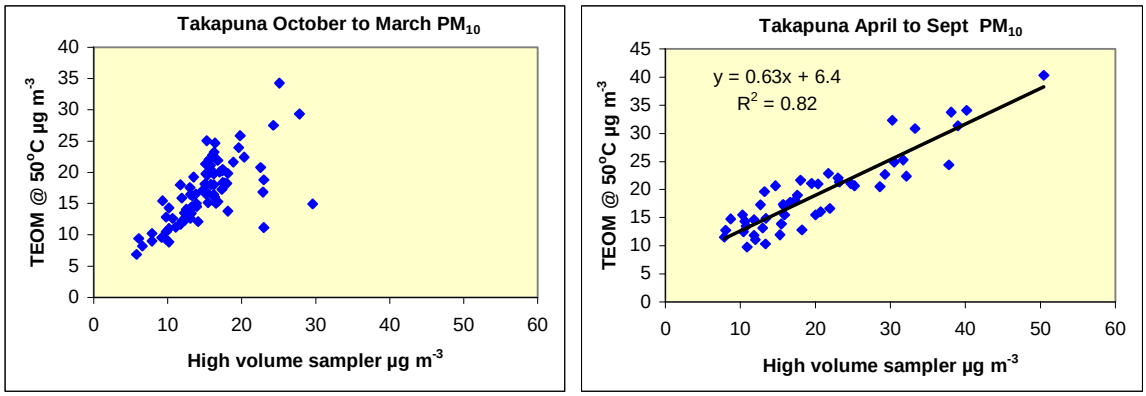


Figure 13.4: Comparison between PM_{10} concentrations measured using a beta attenuation monitor and a TEOM with a 50°C sample temperature at St Albans, Christchurch

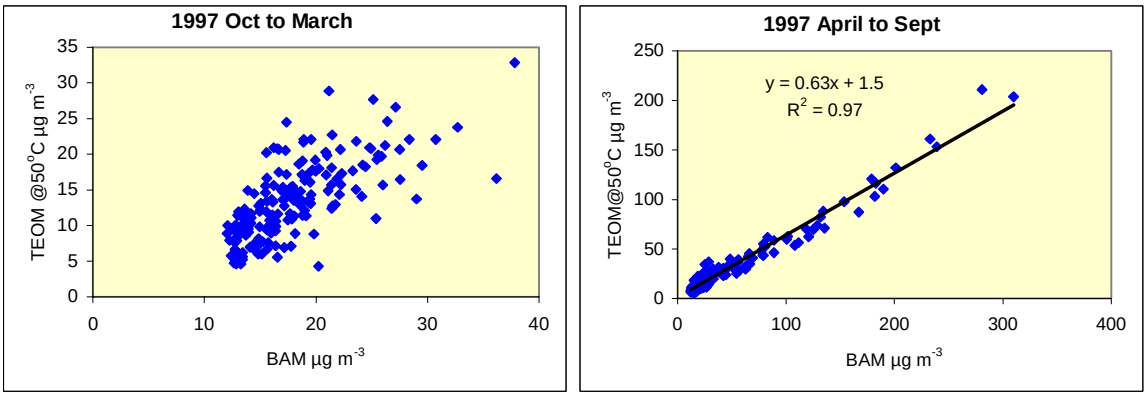


Figure 13.5: Comparison between PM_{10} concentrations measured using a beta attenuation monitor and a TEOM with a 30°C sample temperature at St Albans, Christchurch

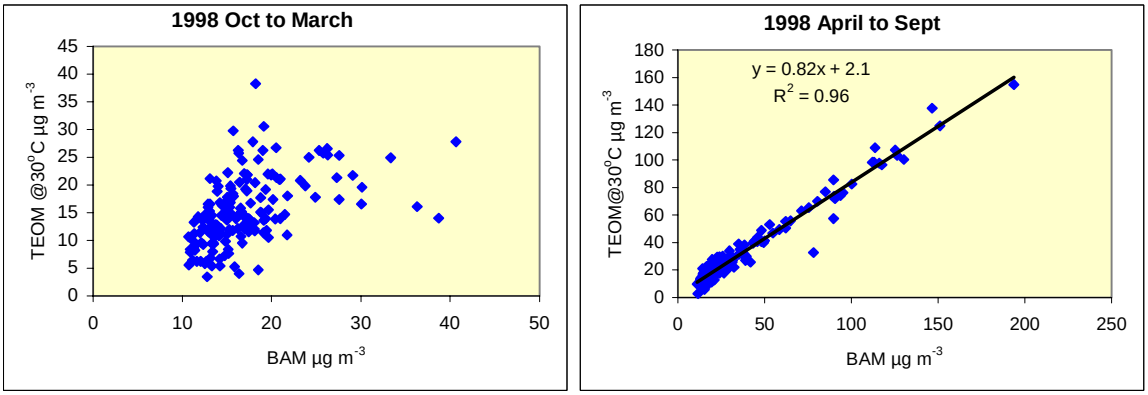
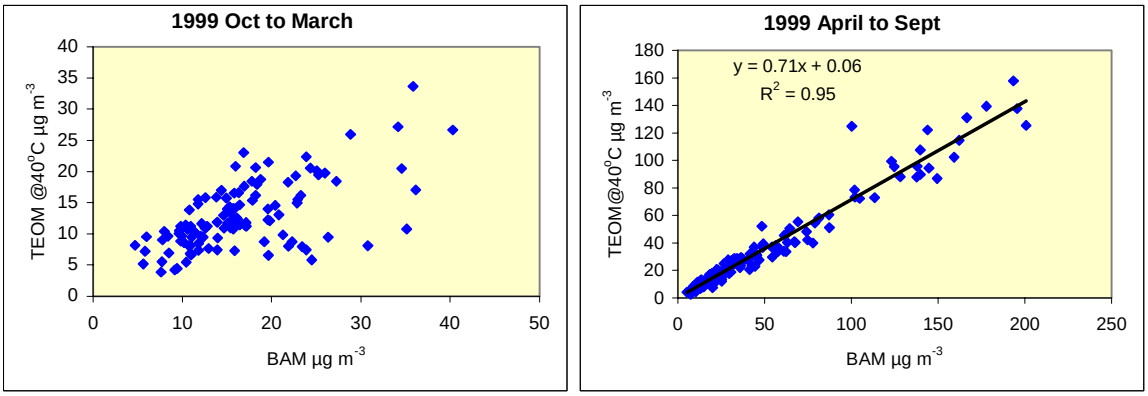


Figure 13.6: Comparison between PM_{10} concentrations measured using a beta attenuation monitor and a TEOM with a 40°C sample temperature at St Albans, Christchurch



Other areas that have measured PM_{10} using a TEOM in New Zealand include Timaru, Ashburton, Rangiora, Kaiapoi, Lower Hutt, Upper Hutt, Hamilton, Te Kuiti, Rotorua and Tauranga. Table 13.3 shows estimates of PM_{10} concentrations and guideline value exceedences based on the following equations derived from relationships observed in Christchurch and Auckland:

- PM_{10} = 1.18 (TEOM) –0.25 (for TEOM at 30 ° C)
- PM_{10} = 1.4 (TEOM) +0.06 (for TEOM at 40 ° C)
- PM_{10} = 1.53 (TEOM) –1.6 (for TEOM at 50 ° C)

Table 13.3: Summary data estimates based on the conversion of TEOM data

Area	Maximum	99.5 percentile	Annual average	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Takapuna 1997	**72**	61	**28**	12 estimated 13 equivalent	11%
Takapuna 1998	**56**	52	**28**	6 estimated	5%
Takapuna 1999	**70**	63	**26**	6 estimated	5%
Hamilton 1998	**49**	46	**20**	0	0
Hamilton 1999	**61**	58	**22**	8 estimated	7%
Hamilton 2000	**61**	46	**21**	1 estimated	1%
Hamilton 2001	**93**	73	**20**	6 estimated 10 equivalent	8%
Te Kuiti 1998	**59**	59	**22**	5 estimated	4%
Rotorua 1998	**72**	56	19	3 estimated	2%
Rotorua 1999	**61**	49	19	2 estimated	2%
Rotorua 2000	**50**	44	17	2 estimated	2%
Rotorua 2001	**53**	51	17	4 estimated	4%
Tauranga 1998	44	40	**20**	0	0
Tauranga 1999	48	43	19	0	0
Tauranga 2000	40	37	19	0	0
Tauranga 2001	39	32	17	0	0
Lower Hutt 1998	**53**	44	18	1 estimated	1%
Lower Hutt 2001	42	37	18	0	0
Upper Hutt 2000	**72**	68	**20**	6 estimated 7 equivalent	6%
Upper Hutt 2001	**85**	79	**20**	10 estimated 15 equivalent	12%
Christchurch 1997	**310**	251	**33**	45 estimated 52 equivalent	42%
Christchurch 1998	**194**	148	**26**	30 estimated 32 equivalent	26%
Christchurch 1999	**201**	95	**34**	43 estimated 44 equivalent	36%
Christchurch 2000	**224**	168	**29**	36 estimated 39 equivalent	32%

Area	Maximum	99.5 percentile	Annual average	Days > 50 μgm^{-3}	% of winter days guideline was exceeded
Christchurch 2001	**257**	182	**32**	58 estimated	48%
Timaru 1997	**143**	106	**34**	53 measured 57 equivalent	46%
Timaru 1998	**104**	94	**30**	42 measured	34%
Timaru 1999	**151**	108	**32**	62 estimated	50%
Timaru 2000	**156**	132	**33**	60 estimated	49%
Timaru 2001	**140**	128	**32**	58 estimated	48%
Ashburton 1999	**94**	77	**25**	26 estimated	21%
Ashburton 2000	**100**	78	**25**	23 estimated	19%
Rangiora 1999	**79**	75	**21**	19 estimated	15%
Rangiora 2000	**104**	78	**20**	11 estimated	9%
Kaiapoi 2001	**136**	122	**33**	50 estimated	41%

Note: Guideline value exceedences are highlighted in bold.

These data suggest that the 24-hour average PM_{10} guideline value may also have been exceeded in Te Kuiti. Exceedences of the annual average guideline value are also possible in Auckland, Hamilton, Te Kuiti, Tauranga, Upper Hutt, Ashburton and Rangiora. Additional studies examining the relationships between the TEOM method and other approved PM_{10} sampling methods are required for these areas to determine site-specific adjustment factors.

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About the Ministry

The Ministry for the Environment works with others to identify New Zealand's environmental problems and get action on solutions. Our focus is on the effects people's everyday activities have on the environment, so our work programmes cover both the natural world and the places where people live and work.

We advise the Government on New Zealand's environmental laws, policies, standards and guidelines, monitor how they are working in practice, and take any action needed to improve them. Through reporting on the state of our environment, we help raise community awareness and provide the information needed by decision makers. We also play our part in international action on global environmental issues.

On behalf of the Minister for the Environment, who has duties under various laws, we report on local government performance on environmental matters and on the work of the Environmental Risk Management Authority and the Energy Efficiency and Conservation Authority.

Besides the Environment Act 1986 under which it was set up, the Ministry is responsible for administering the Soil Conservation and Rivers Control act 1941, the Resource Management Act 1991, the Ozone Layer Protection Act 1996, and the Hazardous Substances and New Organisms Act 1996.

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