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Air Quality Monitoring 2003 Environment Waikato

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Addendum to 2003 Air quality monitoring report

At the time the 2003 air quality monitoring report for the Waikato Region was prepared, the Ministry for the Environment had released proposed National Environmental Standards (NES) for ambient air quality. The proposed NES described in the 2003 air quality monitoring report (Table 1.3) were made regulatory in September 2004, with one revision to the PM_{10} guideline. This related to the number of allowable exceedences for PM_{10}, which was revised downwards from five in the proposed NES to one in the regulation.

In Hamilton, concentrations of carbon monoxide (CO) and nitrogen dioxide (NO_2) measured during 2003 were not in breach of the NES. Concentrations of suspended particles (PM_{10}) exceeded the standard of 50 µg m^{-3} (24-hour average) on three occasions. As the standard allows for only one breach per year, Hamilton would have been non-complaint with the PM_{10} NES had it been effective 2003.

Concentrations of ozone measured in Hamilton during the summer of 2003/ 04 have been reported separately[1]. Results indicated no breach of the NES for ozone (150 µg m^{-3}, 1 hour average – no allowable exceedences) would have occurred during the period from 25 November 2003 to 25 March 2004.

The NES for PM_{10} would have been breached in Tokoroa, Taupo and Te Kuiti in 2003, as concentrations were in excess of 50 µg m^{-3} on more than one occasion in each area. The number of measured exceedences in these locations for 2003 was 10, 4 and 4 respectively.

The number of exceedences reported in this addendum relate to measured PM_{10} concentrations only and do not include statistical extrapolations for times when monitoring was not being carried out. The latter are discussed and included in the 2003 air quality monitoring report. The NES relates to measured concentrations only and does not appear to allow for extrapolations based on missing data. All monitoring methods for PM_{10} were compliant with the NES specifications.

No monitoring of the other contaminants included in the ambient air quality national environmental standards was carried out in Tokoroa, Taupo or Te Kuiti. Based on monitoring carried out in other urban areas of New Zealand, it would seem unlikely that concentrations of CO, NO_2 or sulphur dioxide (SO_2) would exceed the NES in these locations.

[1] Wilton, E., 2004, Ozone concentrations in Hamilton – summer 2003/04. Unpublished Environment Waikato Report.

Executive Summary

Air quality monitoring was carried out by Environment Waikato at a number of sites within the region during 2003. These included Hamilton, Tokoroa, Te Kuiti and Taupo. Results from these monitoring sites are presented in this report.

In Hamilton, concentrations of suspended particles (PM_{10}), carbon monoxide (CO), nitrogen dioxide (NO_2) and benzene were measured at the Peachgrove Road air quality monitoring site. In addition, benzene monitoring was carried out at a "traffic peak" monitoring site in Bridge Street. In Taupo and Te Kuiti monitoring was carried out for PM_{10} and in Tokoroa both PM_{10} and benzene were measured.

The main contaminant of concern at the Hamilton monitoring site was PM_{10}, with an estimated four guideline breaches occurring during 2003. The maximum measured 24-hour average PM_{10} concentration was 62 µg m^{-3}, compared to a guideline of 50 µg m^{-3}. The annual average PM_{10} concentration in Hamilton during 2003 was 15 µg m^{-3}, which is less than the annual average guideline of 20 µg m^{-3}. It is likely that all concentrations of PM_{10} measured at the Hamilton monitoring site would be higher if data were adjusted for gravimetric equivalency.

Concentrations of CO measured in Hamilton during 2003 were well within air quality guidelines with most measurements falling within the "excellent" or "good" air quality indicator categories. The maximum hourly average CO concentration of 9 mg m^{-3} compares to an hourly guideline of 30 mg m^{-3} and the maximum 8-hour average concentration was 6 mg m^{-3}, half the 8-hour guideline of 10 mg m^{-3}. Concentrations of NO_2 were also within the guideline values of 100 µg m^{-3} (24-hour) and 200 µg m^{-3} (1-hour) with a maximum measured 24-hour average concentration of 34 µg m^{-3} and a maximum hourly average concentration of 102 µg m^{-3}.

In Hamilton, benzene concentrations measured at Peachgrove Road gave an annual average concentration of 3.7 µg m^{-3} compared to 5.8 µg m^{-3} for the Bridge Street site. These were less than the current benzene guideline of 10 µg m^{-3} but would breach the 2010 guideline of 3.6 µg m^{-3}.

In Tokoroa, the estimated number of guideline breaches for 24-hour average PM_{10} was 18. The annual average PM_{10} concentration, at 24 µg m^{-3}, was also in excess of the MfE guideline of 20 µg m^{-3}. Taupo and Te Kuiti had an estimated 12 and 5 breaches of the 50 µg m^{-3} guideline, with annual average concentrations less than the 20 µg m^{-3} guideline. Although benzene sampling in Tokoroa did not commence until 5 May 2003, results indicate that annual average concentrations of less than 2 µg m^{-3} are likely.

All areas show similar seasonal variations in PM_{10} concentrations, with higher values occurring during the winter months.

No clear trends in contaminant concentrations were apparent at any of the monitoring sites.

Results of air quality monitoring carried out in the Waikato Region during 2003 suggests that the proposed National Environmental Standards (NES) for PM_{10} are likely to be breached in Tokoroa and Taupo. The proposed NES for PM_{10} is a 24-hour average concentration of 50 µg m^{-3} with an allowable 5 breaches per year. It is possible that Hamilton may also be in breach of the NES once data are adjusted for gravimetric equivalency. Further monitoring in Te Kuiti is necessary to determine ongoing compliance with the proposed NES.

1 Introduction

The Environment Waikato air quality monitoring for 2003 included four main air quality monitoring sites located in Hamilton, Tokoroa, Te Kuiti and Taupo. Results from these sites are presented in this report and are compared to air quality guidelines (Table 1.1), the Ministry for the Environment's air quality indicator categories (Table 1.2) and considered in the context of the proposed National Environmental Standards (NES) for Air Quality (MfE, 2003). The proposed NES are summarised in Table 1.3. Reporting requirements are also specified in the proposed NES. These include the preparation of an annual air quality monitoring report detailing:

- key monitoring statistics - maximum values, percentiles, number of exceedences
- details about the monitoring site
- the extent to which the standards are or are not being met through air quality management plans and other strategies implemented by the regional council / unitary authority
- information about how the regional council / unitary authority intends to achieve the standard
- potential causes of exceedences recorded at each monitoring site, including sources and meteorological conditions
- the percentage of valid data that was available for the contaminant monitored at the site.

With the exception of bullet point four, this report addresses each of these requirements.

A basic description of the air quality monitoring sites, equipment and quality assurance procedures is included in this report. A more comprehensive review of air quality monitoring in the Waikato Region, including historical data up until 2001 and air quality monitoring sites and equipment is available in *"Air Quality Monitoring Report - Waikato Region 2002*" (Wilton, 2002a). Detailed results for 2002 are presented in *"Air Quality Monitoring 2002, Environment Waikato"* (Wilton, 2003a) and further information on quality assurance procedures for the monitoring is presented in the *"Quality Assurance Procedures Manual - for ambient air quality monitoring at Environment Waikato"* (Wilton 2003b).

Figure 1-1: Ambient air quality guideline for New Zealand (MfE, 2002

Contaminant	2002 guideline values	
	Concentration	**Averaging Period**
Carbon monoxide	30 mg m^{-3}	1-hour
	10 mg m^{-3}	8-hour
Particles (PM_{10})	50 µg m^{-3}	24-hour
	20 µg m^{-3}	Annual
Nitrogen dioxide	200 µg m^{-3}	1-hour
	100 µg m^{-3}	24-hour
Sulphur dioxide [b]	350 µg m^{-3}	1-hour
	120 µg m^{-3}	24-hour
Ozone	150 µg m^{-3}	1-hour
	100 µg m^{-3}	8-hour
Hydrogen sulphide [c]	7 µg m^{-3}	1-hour

Contaminant	2002 guideline values	
	Concentration	**Averaging Period**
Lead [d]	0.2 µg m^{-3} (lead content of PM_{10})	3-month-moving, calculated monthly
Benzene (year 2002) Benzene (year 2010)	10 μgm^{-3} 3.6 μgm^{-3}	Annual Annual
1,3-Butadiene	2.4 μgm^{-3}	Annual
Formaldehyde	100 μgm^{-3}	30-minutes
Acetaldehyde	30 μgm^{-3}	Annual
Benzo(a)pyrene	0.0003 μgm^{-3}	Annual
Mercury (inorganic) [d] Mercury (organic)	0.33 μgm^{-3} 0.13 μgm^{-3}	Annual Annual
Chromium VI [d] Chromium metal and chromium III	0.0011 μgm^{-3} 0.11 μgm^{-3}	Annual Annual
Arsenic (organic) [d] Arsine	0.0055 μgm^{-3} 0.055 μgm^{-3}	Annual Annual

Notes:
[a] All values apply to the gas measured at standard conditions of temperature (0° C) and pressure (1 atmosphere).
[b] The sulphur dioxide guideline values do not apply to sulphur acid mist.
[c] The hydrogen sulphide value is based on odour nuisance and may be unsuitable for use in geothermal areas.
[d] The guideline values for metals are for inhalation exposure only; they do not include exposure from other routes such as ingestion. These other routes should be considered in assessments where appropriate.

Figure 1-2: Ministry for the Environment's Environmental Performance Indicator categories for air quality

Category	Value relative to guideline	Comment
Excellent	Less than 10% of the guideline	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	Peak measurements in this range are unlikely to affect air quality
Acceptable	Between 33% and 66% of the guideline	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	This is a warning level, which can lead to exceedences if trends are not curbed
Action	More than 100% of the guideline	Exceedences of the guideline are a cause for concern and warrant action, particularly if they occur on a regular basis

Figure 1-3: Proposed NES for air quality (MfE, 2003)

Contaminant	Proposed NES values			
	Concentration	Maximum limit	Averaging Period	Allowable exceedences / year
Carbon monoxide	10 mg m^{-3}	None	8-hour	9
Particles (PM_{10})	50 µg m^{-3}	120 µg m^{-3}	24-hour	5
Nitrogen dioxide	200 µg m^{-3}	300 µg m^{-3}	1-hour	9
Sulphur dioxide [b]	350 µg m^{-3}	570 µg m^{-3}	1-hour	9
Ozone	150 µg m^{-3}	150 µg m^{-3}	1-hour	0

2 Air quality monitoring in Hamilton

The main air quality monitoring site for Hamilton for 2003 was Peachgrove Road, although some benzene monitoring was carried out at a site in Bridge Street. The Peachgrove Road site is located on the south-east side of Hamilton City and was established in late 1997. During 2003, PM_{10}, CO, NO_2 and benzene were measured at Peachgrove Road. During the latter months of 2003 ozone monitoring was also carried out at the site. However, results of that monitoring will be reported separately at the conclusion of the monitoring period. The site is consistent with the "Residential Peak" site classification as described in *Good Practice Guideline for Air Quality Monitoring and Data Management* (MfE, 1999).

The PM_{10} monitoring at Peachgrove Road was carried out using a Tapered Elemental Oscillating Microbalance (TEOM) with a sample temperature setting of 40°C. The ambient air quality guidelines for New Zealand (MfE, 2002) specify that if PM_{10} monitoring is carried out using a TEOM, then adjustments to data are required to determine the high-volume sampler equivalent PM_{10} concentrations. During 2004, the relationship between the TEOM and a high volume gravimetric sampler will be evaluated for the Peachgrove Road site. In the absence of this information, data for 2003 are presented as TEOM measurements, although some discussion on possible converted concentrations is included. In other locations, typical conversions for an operational temperature of 40 -°C are around a 40% increase.

The CO monitoring was carried out using an Advanced Pollution Instrumentation (API) series 300 analyser. The NO_2 monitoring was carried out using an API series 200 NO_2 analyser. Operational aspects of the CO and NO_2 monitoring including maintenance, calibration and quality assurance were carried out by NIWA for Environment Waikato.

Passive sampling for benzene was carried out using BTEX canisters for the period February 2003 to February 2004. The method used is as described in Stevenson *et al.,* (1999) with filters being deployed for periods of three months. The analysis was carried out by Hills Laboratory in Hamilton.

The PM_{10}, CO and NO_2 data were collected at the Peachgrove Road site as 10-minute averages and subsequent calculations of hourly and 24-hour averages were made from these data. These averages were only calculated if 85% of the 10-minute data for the given averaging period were available. This cut-point has not been used for the reporting of monthly concentrations (Figures 2.3, 2.7, 2.8, 2.11, 2.12, 3.3, 4.2, 5.2).

Air quality monitoring data for PM_{10} were collected for 91% of 2003, with the largest period of missing data occurring between 22 May and 16 June. For CO, 17% of the

data were not available. The main periods of missing data were from the 24 February to 19 March, from 18 April to 18 May and from 19 November to 26 November. Monitoring of NO_2 were only carried out for the period 30 April to 2 September. During this time data were missing for no more than 8 consecutive hours.

2.1 Meteorology

Meteorological data including wind speed and direction were also collected at the Hamilton air quality monitoring site during 2003. Figure 2.1 shows hourly average wind speed and wind direction for the months May to August.

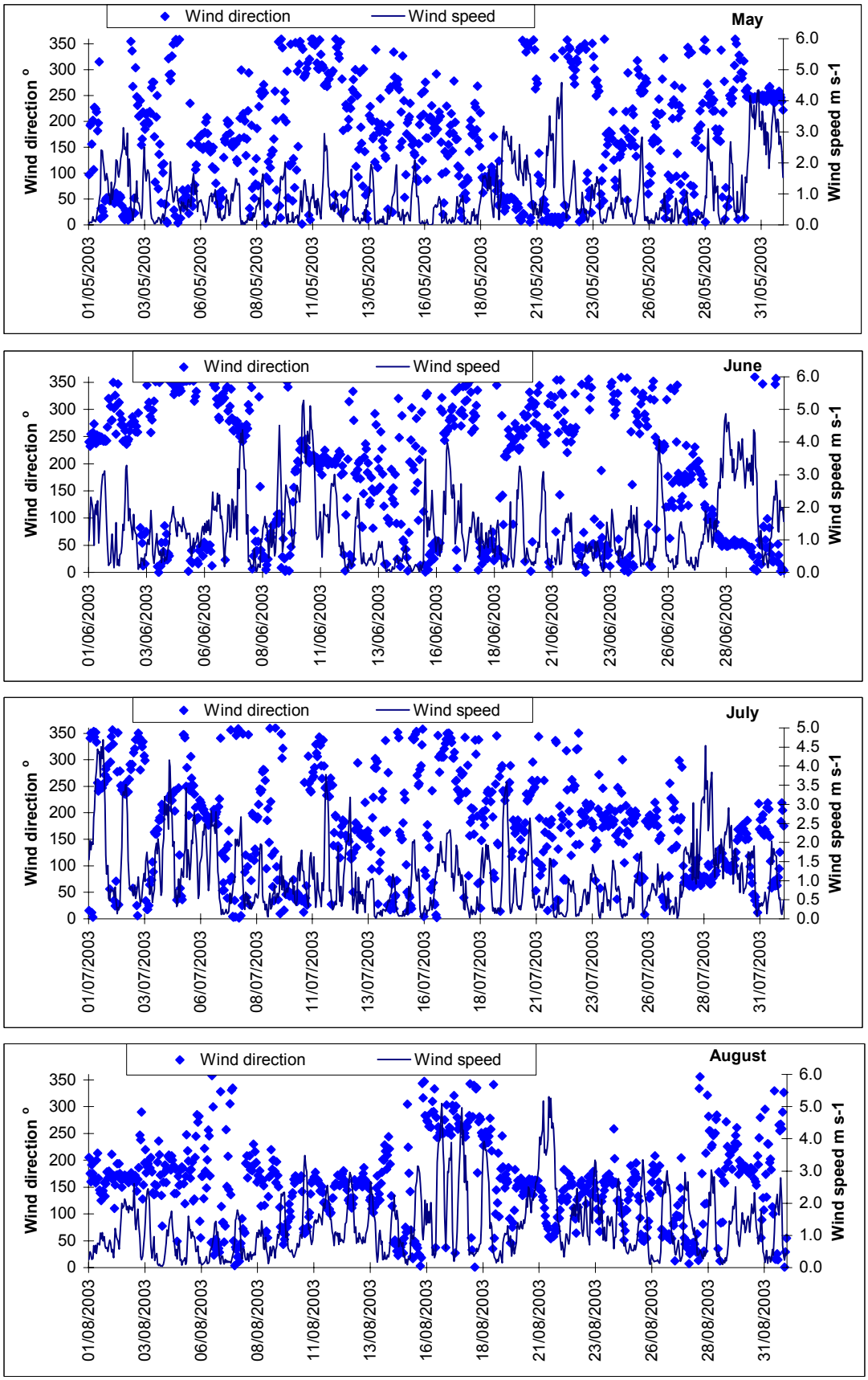

Figure 2-1: Hourly average wind direction and wind speed data for Hamilton from May to August 2003

(Wind direction is expressed with reference to true North, which is 0 ° and 360 ° on a compass, and refers to the direction from which the wind is blowing)

During May the wind speed was relatively low for about two weeks from the 3 May. The wind direction during this time was variable. It is possible that elevated pollution

would have occurred during this time. The wind speeds were generally higher in June, although a few calm days are evident from the 21 to 25 June. During this time the winds were primarily northerly. Calm periods also occurred from the 8 to 18 July and from the 21 to 27 July. In August wind speeds were low until around the 14 August and then again from the 22 August. The wind direction during these times was largely south to south-east.

2.2 Concentrations of PM_{10}

Concentrations of PM_{10} measured in Hamilton during 2003 are shown in Figure 2.2. This indicates three occasions when the air quality guideline of 50 µg m^{-3} was breached at the Peachgrove Road monitoring site. These breaches occurred between the 14 and 22 July, with the maximum measured PM_{10} concentration of 62 µg m^{-3} occurring on the 22 July. It is possible that the maximum concentrations may have been in the order of 80 µg m^{-3} for a high-volume equivalent concentration. Additional breaches of the guideline would be expected if high-volume equivalent measurements were taken. Similarly, concentrations in excess of the guideline may have occurred during the period May to June when the TEOM was not operational. If data are extrapolated for the latter missing data, an estimated four exceedences may have occurred during 2003.

An estimated four guideline exceedences for 2003 does not represent a breach of the proposed NES for PM_{10} of 50 µg m^{-3}, as the latter allows 5 exceedences per year. It is likely that a breach would have occurred if data were adjusted for gravimetric equivalency. Tests to be carried out during 2004 should provide information on the relationship between TEOM measurements in Hamilton and the gravimetric equivalent concentrations and this will allow subsequent estimates of gravimetric equivalent concentrations from TEOM data.

The annual average PM_{10} concentration for Hamilton for 2003 was 15 µg m^{-3}. This compares to the MfE annual guideline for PM_{10} of 20 µg m^{-3}. As with the 24-hour average concentrations, higher concentrations would be likely if data were adjusted to gravimetric equivalent measurements.

Figure 2.3 compares the measured PM_{10} concentrations for 2003 to the MfE air quality indicator categories. This indicates that for most of the year, concentrations of PM_{10} measured in Hamilton were within the MfE “good” or “acceptable” air quality categories. During the months May to August, concentrations within the alert category were measured between 6 and 16% of days, with concentrations in excess of the guideline occurring on 10% of days in July. Figure 2.4 compares the distribution of PM_{10} concentrations during 2003 to previous years PM_{10} monitoring in Hamilton. No trends in PM_{10} concentrations are evident from this.

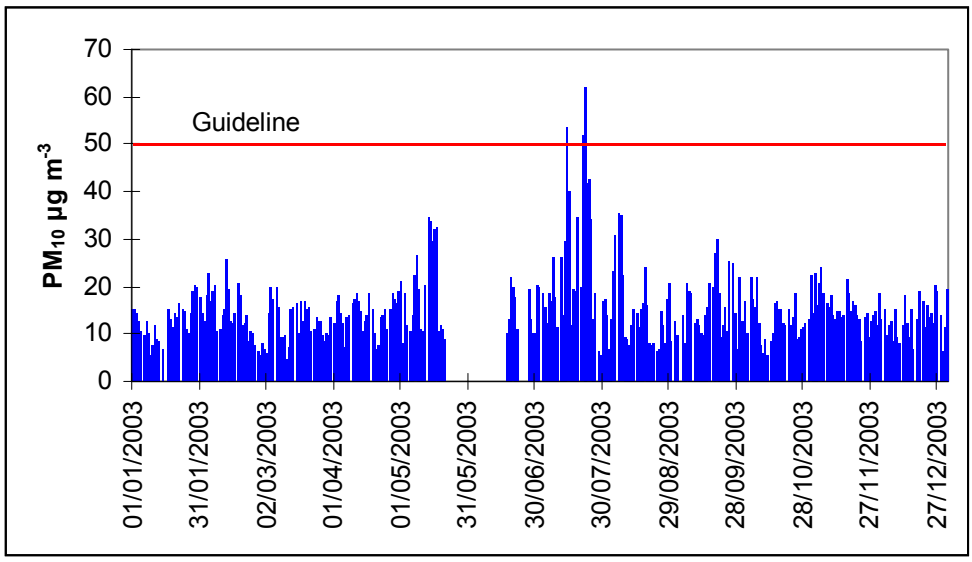

Figure 2-2: 24-hour average concentrations of PM10 in Hamilton during 2003

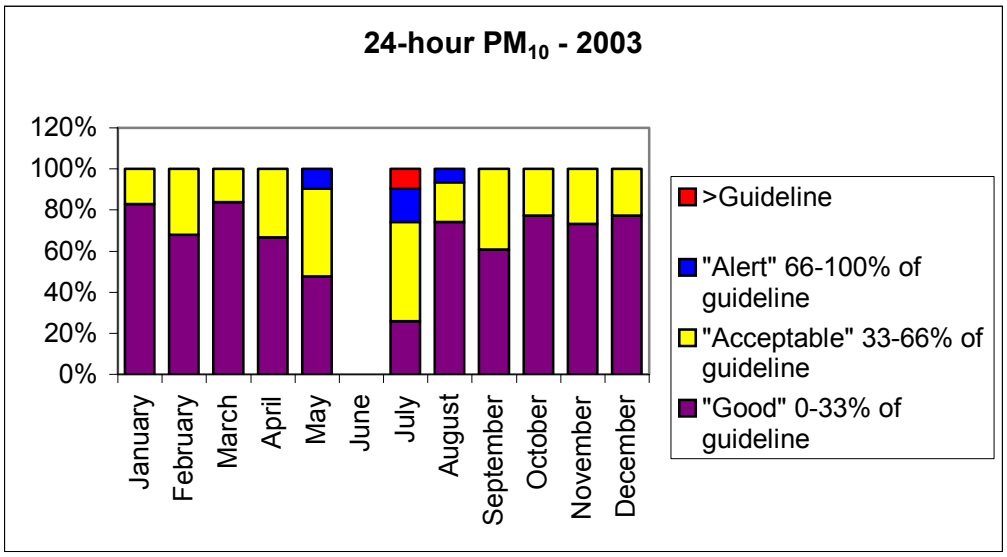

Figure 2-3: Comparison of PM10 concentrations measured in Hamilton during 2003 to MfE air quality indicator categories

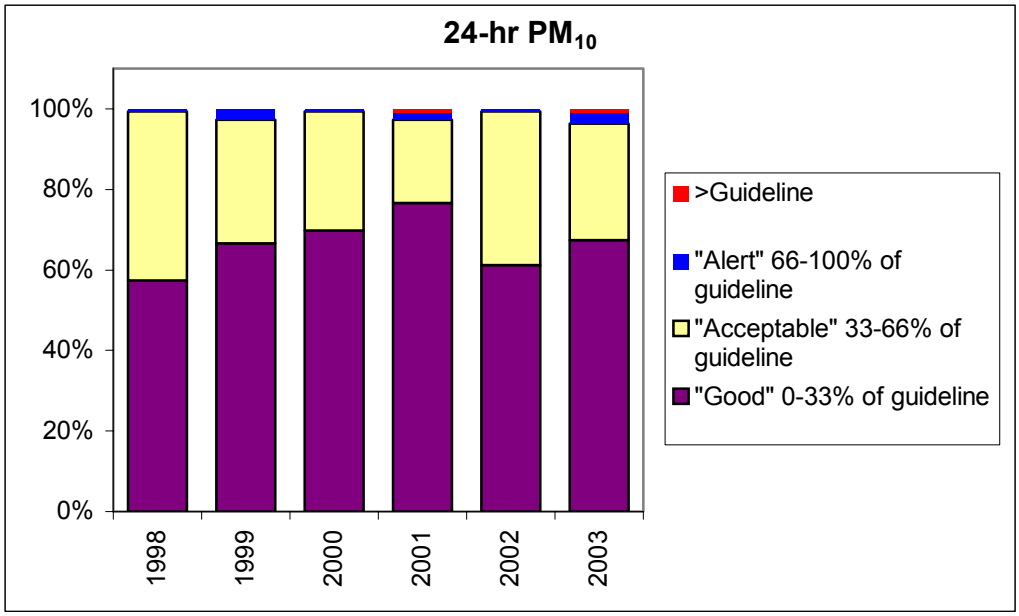

Figure 2-4: Comparison of PM10 concentrations measured at Hamilton from 1998 to 2003 to MfE air quality indicator categories

Figure 2.5 shows hourly average PM_{10} and CO concentrations on the three days when the 24-hour average PM_{10} concentration air quality guideline was exceeded. On all days, the wind speed was less than 1 m s^{-1} at times when PM_{10} concentrations were elevated. The wind direction was variable across the three episodes.

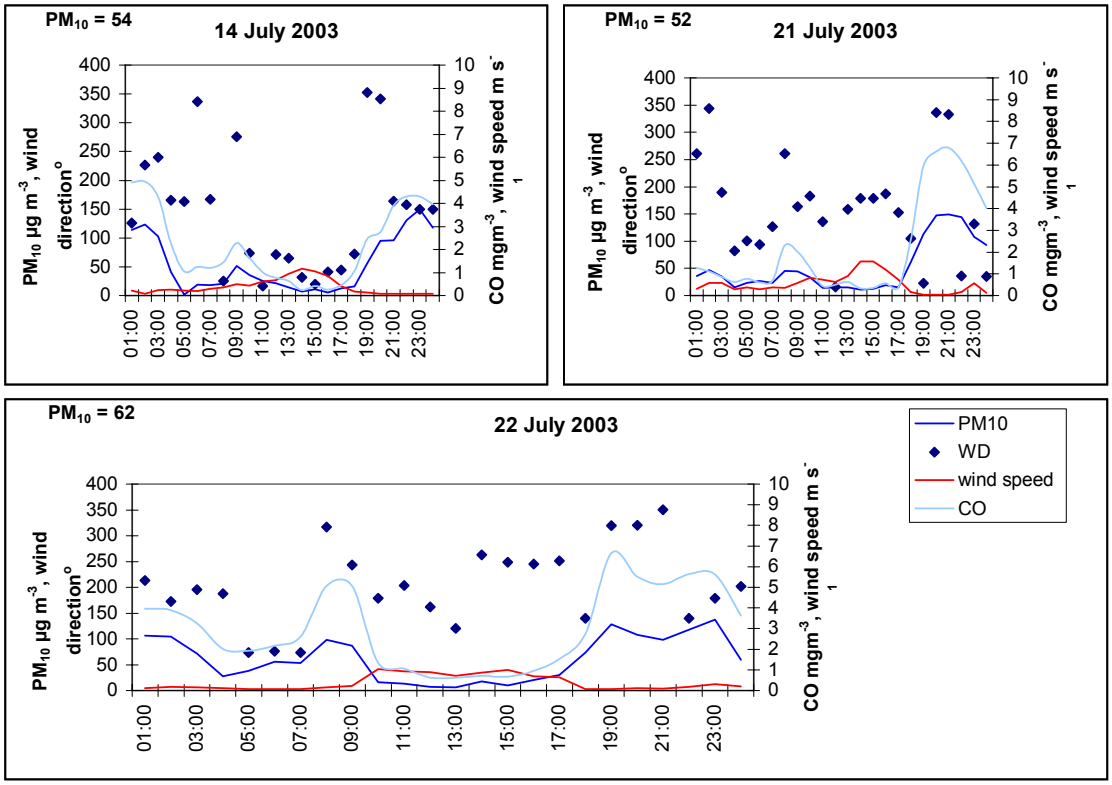

Figure 2-5: Daily variations in PM10, CO wind direction and wind speed on days when 24-hour PM10 concentrations exceeded the air quality guideline

Emission inventory studies show domestic home heating to be the main source of PM_{10} in Hamilton during the winter months (Wilton, 2002c).

2.3 Concentrations of CO

No guideline exceedences for CO were measured at the Hamilton air quality monitoring site during 2003 (Figure 2.6). The maximum measured hourly CO concentration was 9.1 mg m^{-3} compared to an hourly average guideline of 30 mg m^{-3}. The maximum eight hour average concentration for CO during 2003 was 6.6 mg m^{-3}. This is over half the 8-hour average guideline of 10 mg m^{-3}.

Figures 2.7 and 2.8 compare 2003 concentrations of CO in Hamilton to the MfE air quality indicator categories for each month of the year. The majority of data are within the "excellent" or "good" indicator categories. A small proportion of the 8-hour average data (9%) were within the "acceptable" category during July. A comparison to previous years (Figure 2.9) shows no discernable trends in CO concentrations in Hamilton.

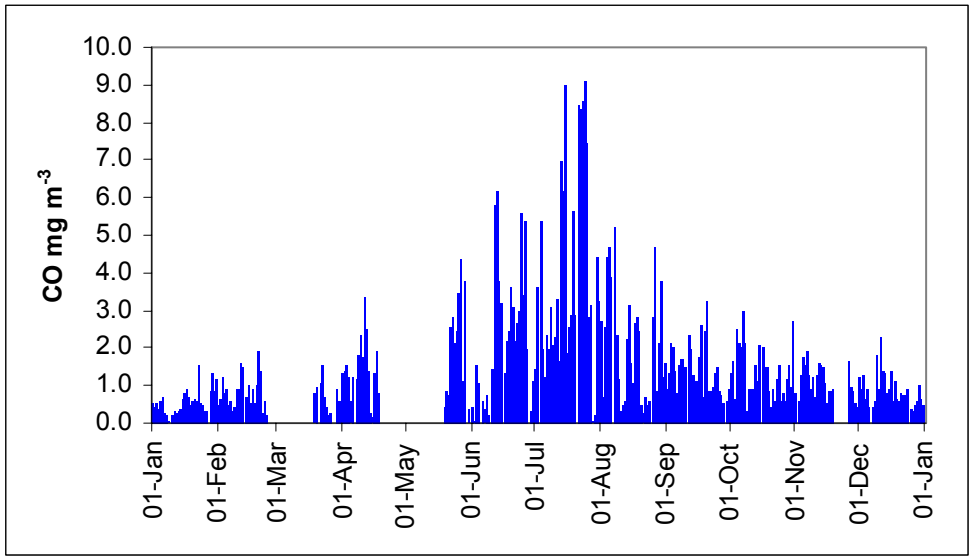

Figure 2-6: Concentrations of CO (hourly average) measured in Hamilton during 2003

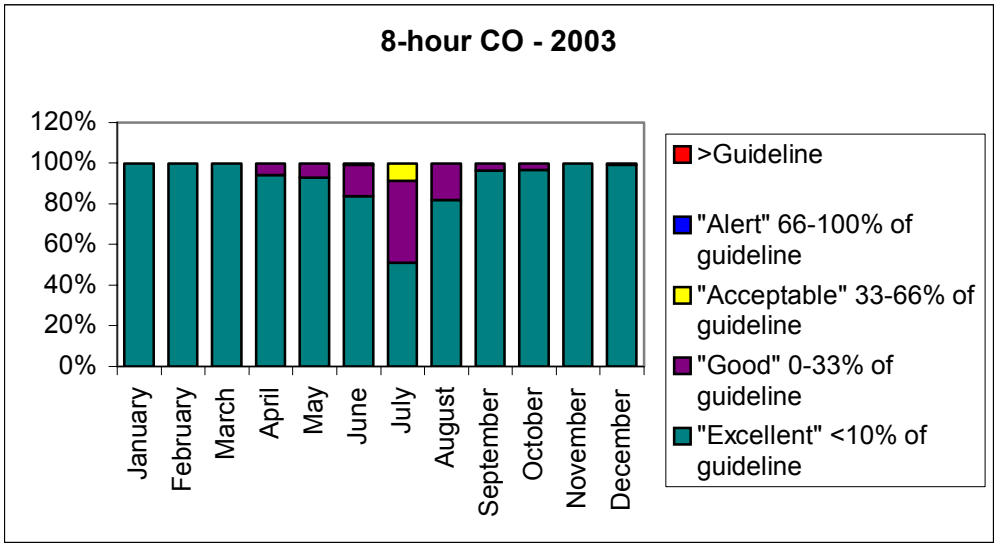

Figure 2-7: Comparison of 8-hour average CO concentrations measured in Hamilton during 2003 to MfE air quality indicator categories

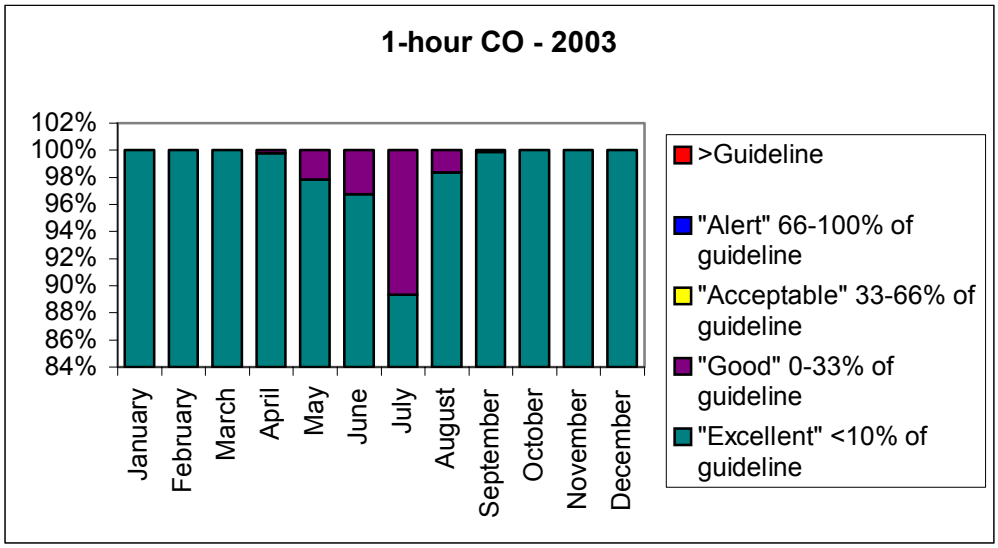

Figure 2-8: Comparison of 1-hour average CO concentrations measured in Hamilton during 2003 to MfE air quality indicator categories

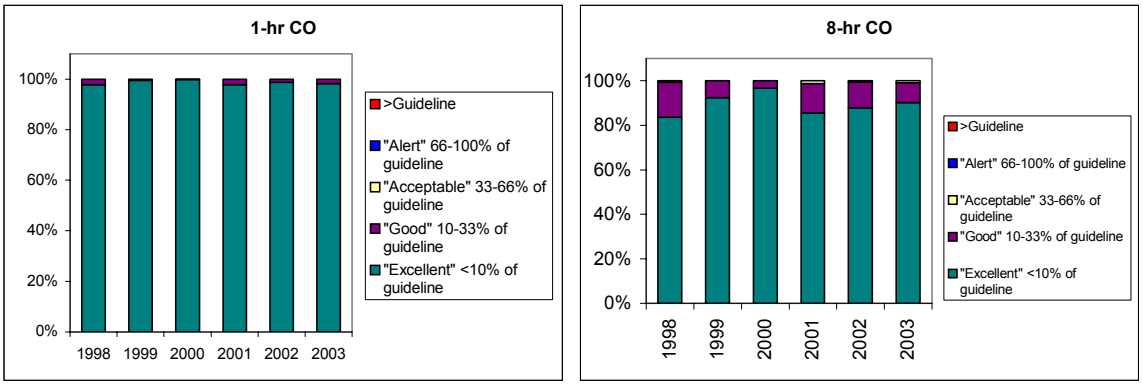

Figure 2-9: Comparison of CO concentrations measured in Hamilton from 1998 to 2003 to MfE air quality indicator categories

2.4 Concentrations of NO_2

Concentrations of NO_2 measured in Hamilton during 2003 were well within both the hourly and 24-hour average guidelines of 200 µg m^{-3} and 100 µg m^{-3} respectively. Figure 2.10 shows maximum concentrations of 102 and 34 µg m^{-3} for the hourly and 24-hour averages respectively.

Figures 2.11 and 2.12 compare hourly and 24-hour average NO_2 concentrations measured in Hamilton to MfE indicator categories for each month of monitoring. The majority of the concentrations are less than 33% of the guideline values, with only 2% of concentrations within the “acceptable” (33-66% of guideline) air quality category for the 24-hour average. This is slightly less than for previous NO_2 monitoring carried out at the same site in 1998 and 1999, which gave 4-16% of the monitored concentrations within the “acceptable” (33-66% of guideline) air quality category for the 24-hour average concentrations (Figure 2.13).

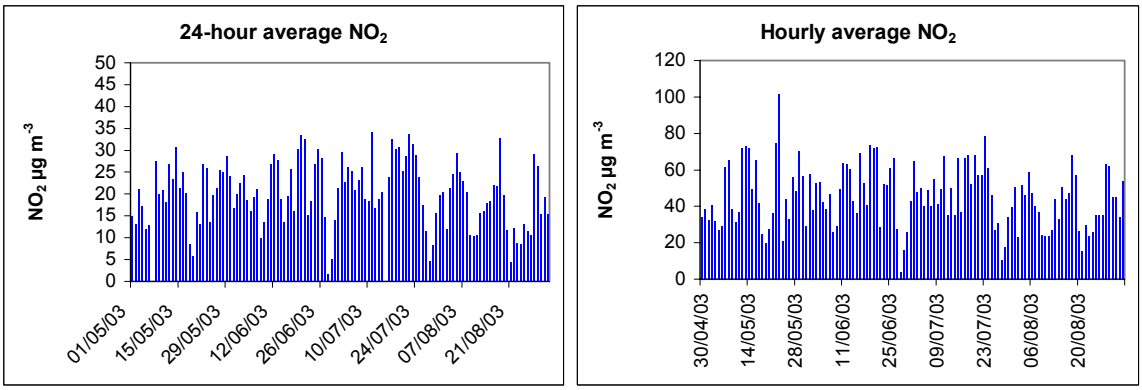

Figure 2-10: 24-hour and hourly average NO2 concentrations measured in Hamilton during 2003

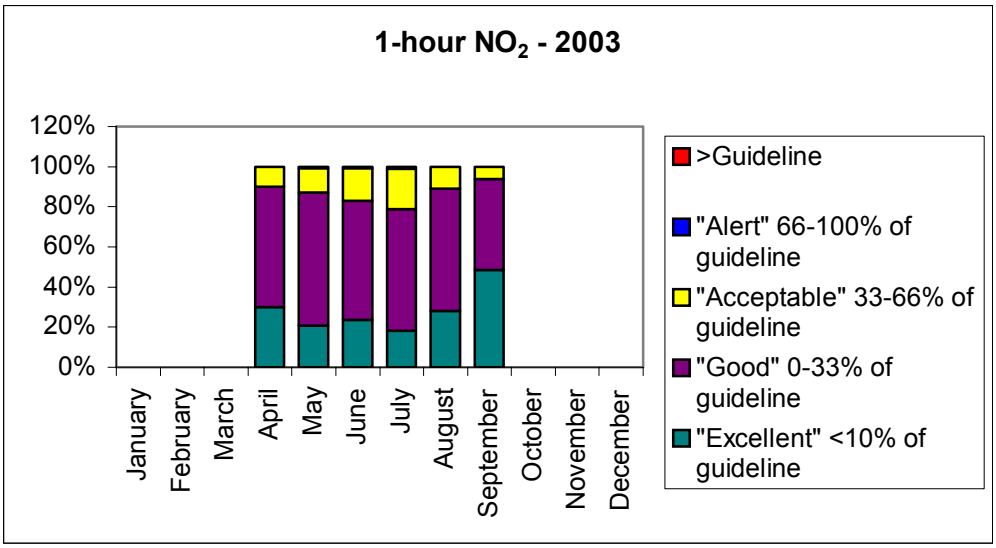

Figure 2-11: Comparison of 1-hour average NO2 concentrations measured in Hamilton during 2003 to MfE air quality indicator categories

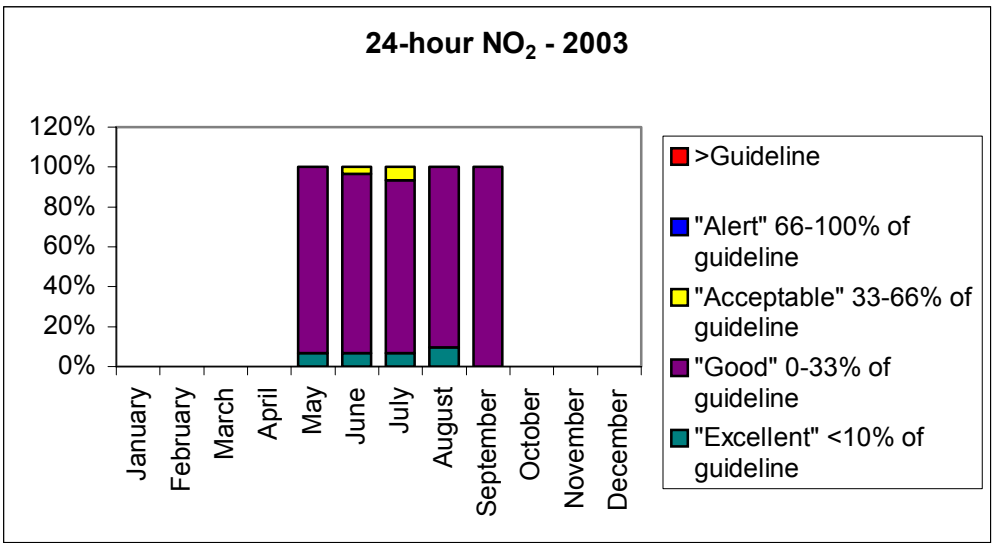

Figure 2-12: Comparison of 24-hour average NO2 concentrations measured in Hamilton during 2003 to MfE air quality indicator categories

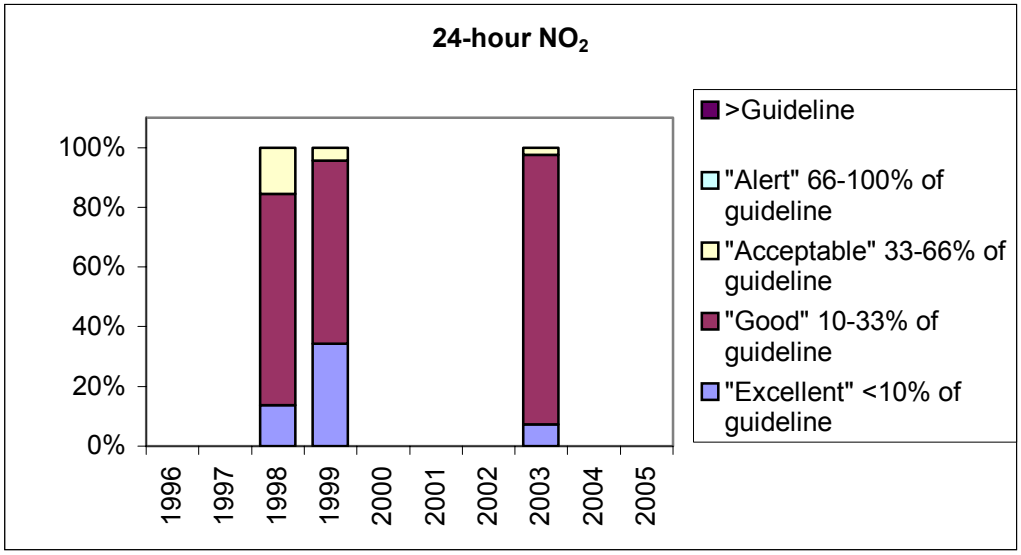

Figure 2-13: Comparison of 24-hour average NO2 concentrations measured in Hamilton from 1998 to 2003 to MfE air quality indicator categories

2.5 Concentrations of benzene, toluene, and xylene

Tables 2.1 and 2.2 show concentrations of benzene, toluene, ethyl benzene, m-xylene, o-xylene and p-xylene measured at the Peachgrove Road and Bridge Street monitoring sites during 2003. The main contaminant of interest from these is benzene. No ambient air quality guidelines exist in New Zealand for concentrations of the other contaminants, although overseas guidelines have been used for assessing the impact of point source discharges of these contaminants for resource consent purposes.

Average concentrations were measured using passive sampling across four sample periods. The dates of the sample periods were:

- Period 1 (3 Feb to 5 May)
- Period 2 (5 May to 4 Aug)
- Period 3 (4 Aug to 4 Nov)
- Period 4 (4 Nov to 4 Feb)

The annual average benzene concentration measured at the Peachgrove Road air quality monitoring site was 3.7 µg m^{-3}. This compares to a current air quality guideline of 10 µg m^{-3} and a 2010 guideline for benzene of 3.6 µg m^{-3}. Concentrations of benzene were higher at the Bridge Street site, with an annual average concentration of 5.8 µg m^{-3}.

Table 2-1: Concentrations of benzene, toluene and xylene measured at the Peachgrove Road air quality monitoring site (sample A)

Peachgrove Road A	Benzene	Toluene	Ethyl-benzene	m-xylene	o-xylene	p-xylene	Total xylenes
Period 1	2	8	1	6	2	1	6
Period 2	8	23	4	15	5	5	21
Period 3	3	8	1	8	2	2	4
Period 4	1	4	1	3	1	1	3
Yearly average	3.7	10.7	1.8	7.9	2.4	2.2	8.7

Table 2-2: Concentrations of benzene, toluene and xylene measured at the Bridge Street air quality monitoring site

Peachgrove Road B	Benzene	Toluene	Ethyl-benzene	m-xylene	o-xylene	p-xylene	Total xylenes
Period 1	5	16	3	6	3	2	12
Period 2	10	28	5	14	7	6	27
Period 3	6	16	3	7	4	3	6
Period 4	2	6	1	3	1	1	6
Yearly average	5.8	16.5	3.0	7.7	4.0	3.3	12.8

2.6 Summary of 2003 air quality monitoring in Hamilton

The main contaminant of concern in Hamilton during 2003 was concentrations of PM_{10}, which exceeded air quality guidelines on three occasions during the winter months. It is likely that the number of breaches would have been higher if a gravimetric equivalent method were used to measure PM_{10} and if monitoring had been carried out for the whole of the month of June. Concentrations of benzene were less than the current air quality guideline but were in excess of the 2010 guideline for this contaminant. Concentrations of other contaminants were all within air quality guidelines and were generally less than 33% of the air quality guideline (Table 2.3).

Table 2-3: Summary statistics for PM10, CO and NO2 concentrations in Hamilton for 2003

MfE Indicator categories	CO 1-hour average 2003	CO 8-hour average 2003	PM_{10} 24-hour average 2003	NO_2 1-hour average 2003	NO_2 24-hour average 2003
"Excellent" <10% of guideline	99%	93%	0%	93%	52%
"Good" 10-33% of guideline	1%	6%	67%	7%	48%
"Acceptable" 33-66% of guideline	0%	1%	29%	0%	0%
"Alert" 66-100% of guideline	0%	0%	3%	0%	0%
>Guideline	0%	0%	1%	0%	0%
Percentage of valid data	79%	79%	91%	34%	33%
Annual average (µg m-3)			15		
Guideline exceedences (extrapolated)	0	0	4	0	0
99.5 (for 24 hr averages) or 99.9 %ile concentration (µg m-3)	6.2	4.7	53	36	17
Annual maximum (µg m-3)	7.3	5.3	62	50	17

3 Air quality monitoring in Tokoroa

Air quality monitoring for PM_{10} has been carried out in Tokoroa since 2001 at the Billah Street Reserve air quality monitoring site. This site is located in central Tokoroa to the west and was established in 2001. Prior to this, in 1999 monitoring was carried out in Tokoroa at the South Waikato Council Offices, on the east side of the town. Results of the 1999 monitoring are not included because of uncertainties surrounding the monitoring method. The new site is consistent with the “Residential Neighbourhood”

site classification as described in *Good Practice Guideline for Air Quality Monitoring and Data Management* (MfE, 1999).

The monitoring method used to measure PM_{10} concentrations in Tokoroa during 2003 was a MET ONE series 1020 Beta Attenuation Monitor. The Tokoroa air quality monitoring site is operated by Environment Waikato.

Air quality monitoring data for PM_{10} were collected at hourly intervals. Significant periods of missing data occurred during April, May and June (from 18 April to 26 June) and October and November (7 October to 4 December). Overall data were collected for 55% of the year.

3.1 Meteorology

Meteorological data including wind speed and direction were also collected at the Billah Street Reserve air quality monitoring site in Tokoroa during 2003. Wind direction data prior to 25 June were invalidated as a result of uncertainties in instrument settings. Wind direction data reported for Tokoroa for 2002 in the annual monitoring report is also likely to be invalid. Figure 3.1 shows hourly average wind speed and wind direction data for the months May to August 2003.

Data shows June is windier than May overall, although calm periods are evident from the 13 to 15 June and from 21 to 26 June. During July calm periods occurred between 13 and 15 July and from 21 to 28 July. Wind directions are predominantly south-east during these times. In August winds were predominantly from the south-east and wind speeds were typically less than 4 m s^{-1}.

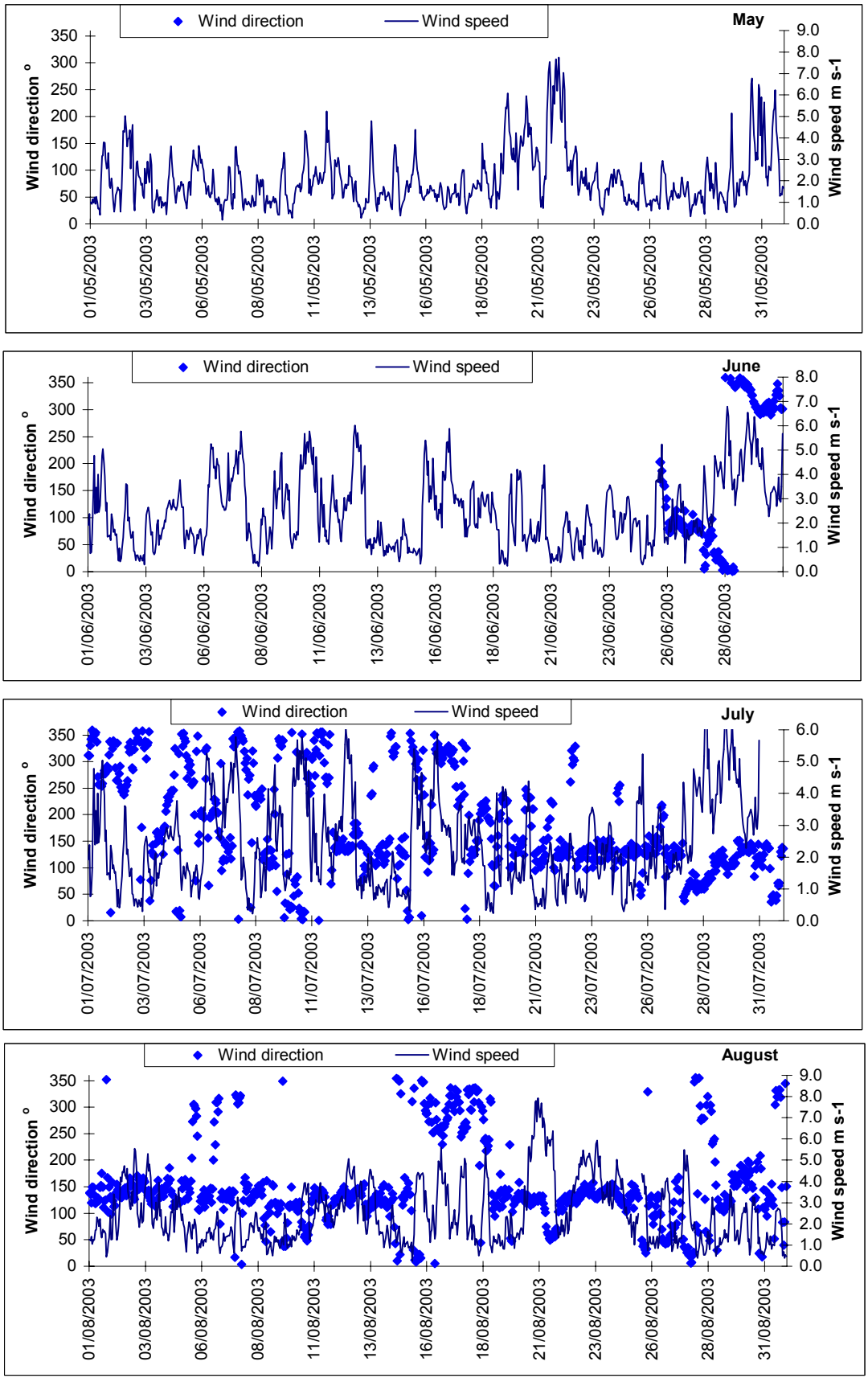

Figure 3-1: Hourly average wind speed and wind direction data measured at Tokoroa during 2003

3.2 Concentrations of PM_{10}

During 2003, the 24-hour average PM_{10} guideline of 50 µg m^{-3} was breached on 10 occasions during the months of July and August (Figure 3.2). Because monitoring was not carried out in May and the majority of June, the likely number of guideline exceedences for 2003 is 18. This compares to around 15 exceedences during 2002. The maximum 24-hour average PM_{10} concentration for 2003 was 62 µg m^{-3} and was measured on the 15 July 2003.

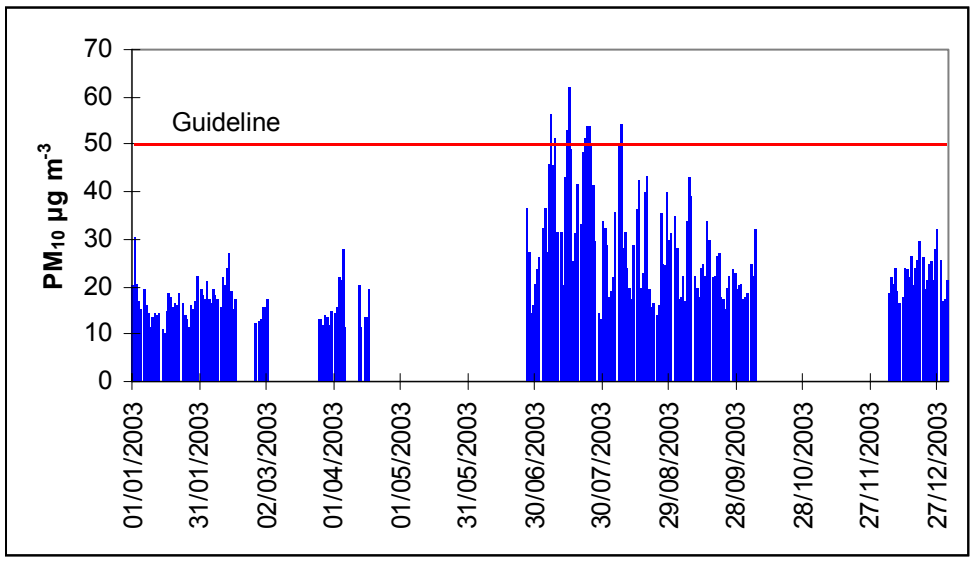

Figure 3-2: 24-hour average concentrations of PM10 in Tokoroa during 2003

The annual average PM_{10} concentration for Tokoroa during 2003 was 24 µgm^{-3}. The 2002 annual average PM_{10} concentration at the Tokoroa monitoring site was also 24 µg m^{-3}. This exceeds the annual average guideline for PM_{10} of 20 µg m^{-3} (MfE, 2002).

Figure 3.3 compares PM_{10} concentrations measured in Tokoroa during 2003 to MfE air quality indicator categories for each month of the year. Only limited data are available for the months May to August, when PM_{10} concentrations are typically highest. During July, the majority of the PM_{10} concentrations measured in Tokoroa were within the "acceptable" and "alert" air quality categories, with 26% of data greater than the guideline and 6% at less than 33% of the guideline.

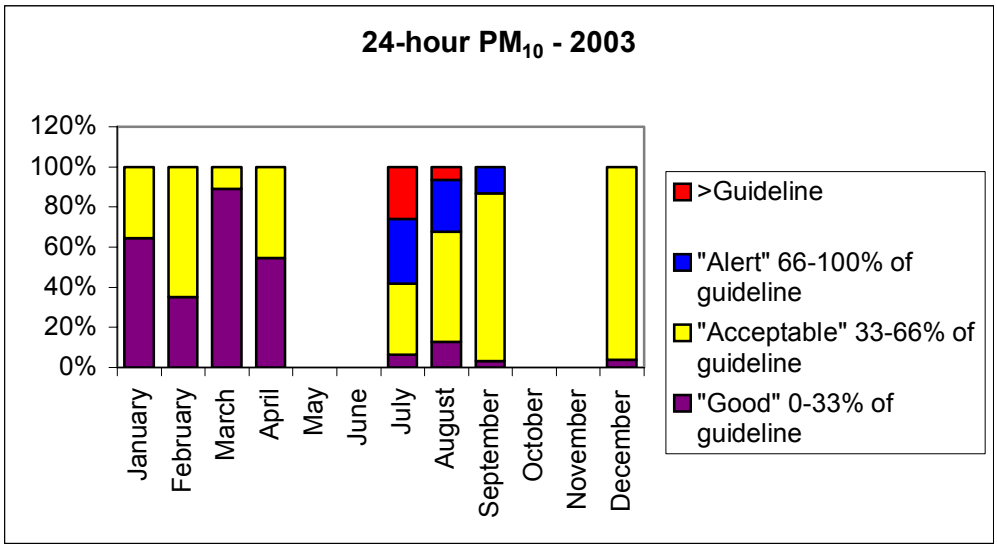

Figure 3-3: Comparison of PM10 concentrations measured in Tokoroa to MfE air quality indicator categories

A comparison of PM_{10} concentrations measured in Tokoroa during 2003 to the 2002 and 2001 data are shown in Table 3.1 and Figure 3.4. This indicates that the proposed NES of 50 µg m^{-3} with 5 allowable exceedences has been breached each year since 2001.

No trends in PM_{10} concentrations in Tokoroa are evident from these data.

Table 3-1: Summary statistics for PM10 data for Tokoroa from 2001 to 2003

	PM_{10} 2001	PM_{10} 2002	PM_{10} 2003
"Good" 0-33% of guideline	12%	15%	25%
"Acceptable" 33-66% of guideline	64%	71%	58%
"Alert" 66-100% of guideline	17%	10%	11%
>Guideline	8%	4%	5%
Percentage of valid data	47%	98%	55%
Annual average (µg m-3)	27	24	24
Guideline exceedences (extrapolated)	24	15	18
99.5 %ile concentration (µg m-3)	67	65	56
Annual maximum (µg m-3)	75	70	62

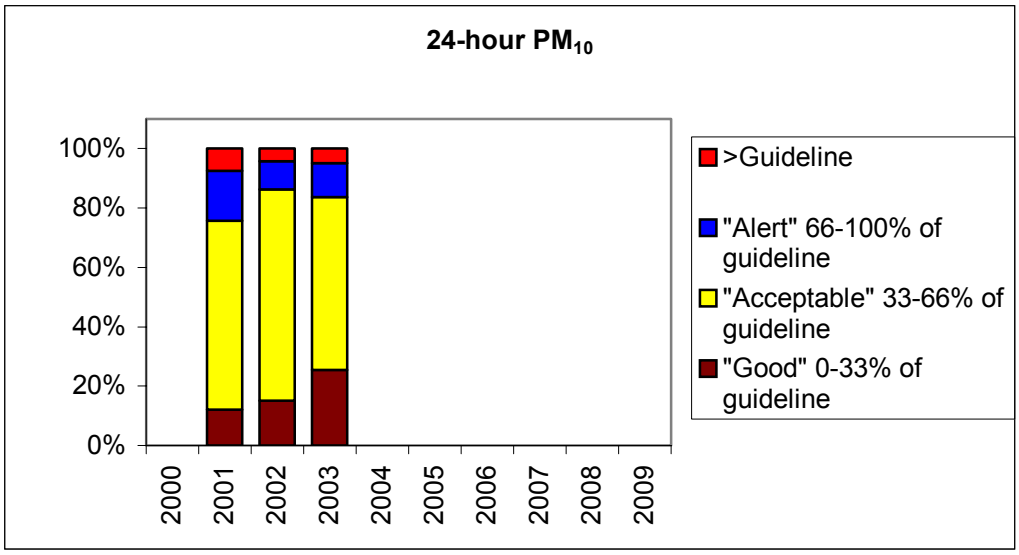

Figure 3-4: Comparison of PM10 concentrations measured in Tokoroa from 2001 to 2003 to MfE air quality indicator categories

Figures 3.5, 3.6 and 3.7 show wind speed, wind direction and hourly average PM_{10} concentrations on days when the guideline was exceeded during July and August 2003. Concentrations of PM_{10} were elevated when wind speeds were typically less than 1 m s^{-1}. These low wind speeds occurred most often when the wind was blowing from the southeast direction. The highest hourly average PM_{10} concentration in Tokoroa during 2003 was recorded on the 8 July at 9am. The peak occurred when the air temperature was very low (0.1 degrees C) and the wind speed was around 0.8 m s^{-1}. It is likely given the high concentrations and low temperature that a strong temperature inversion occurred at this time.

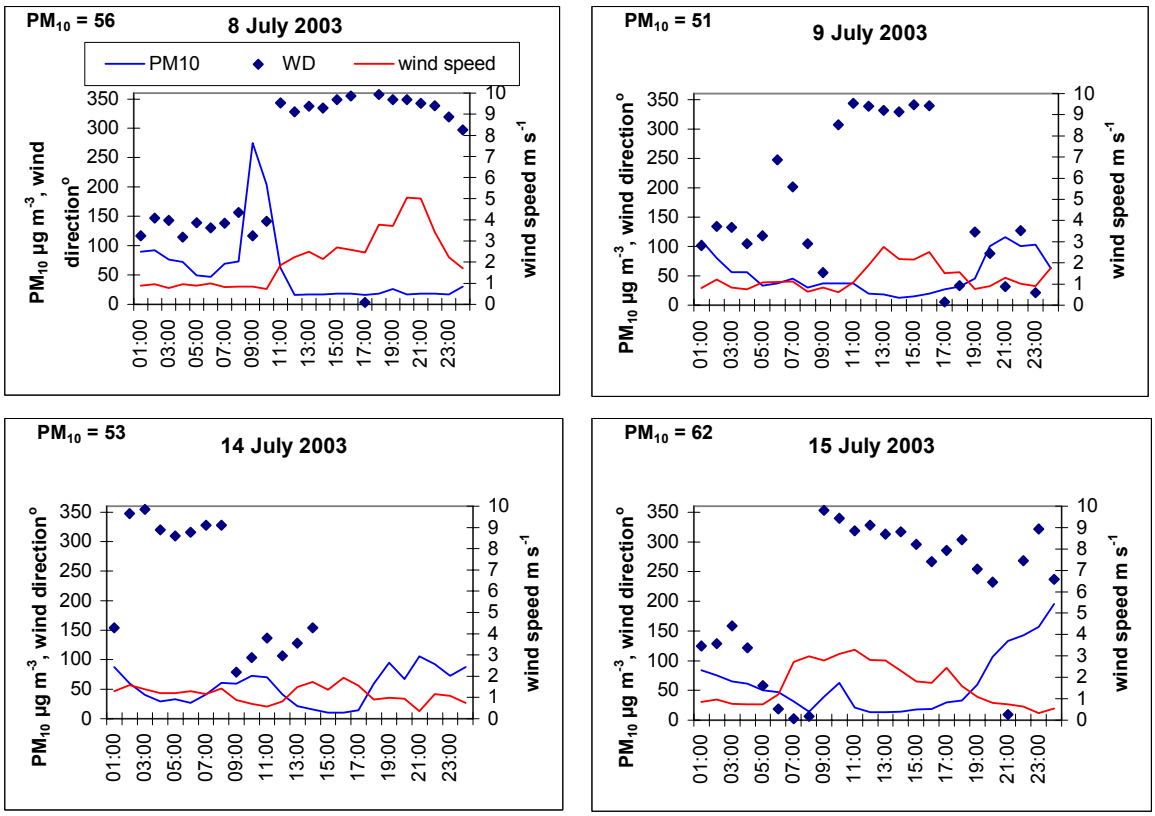

Figure 3-5: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded from 8 July to 15 July 2003

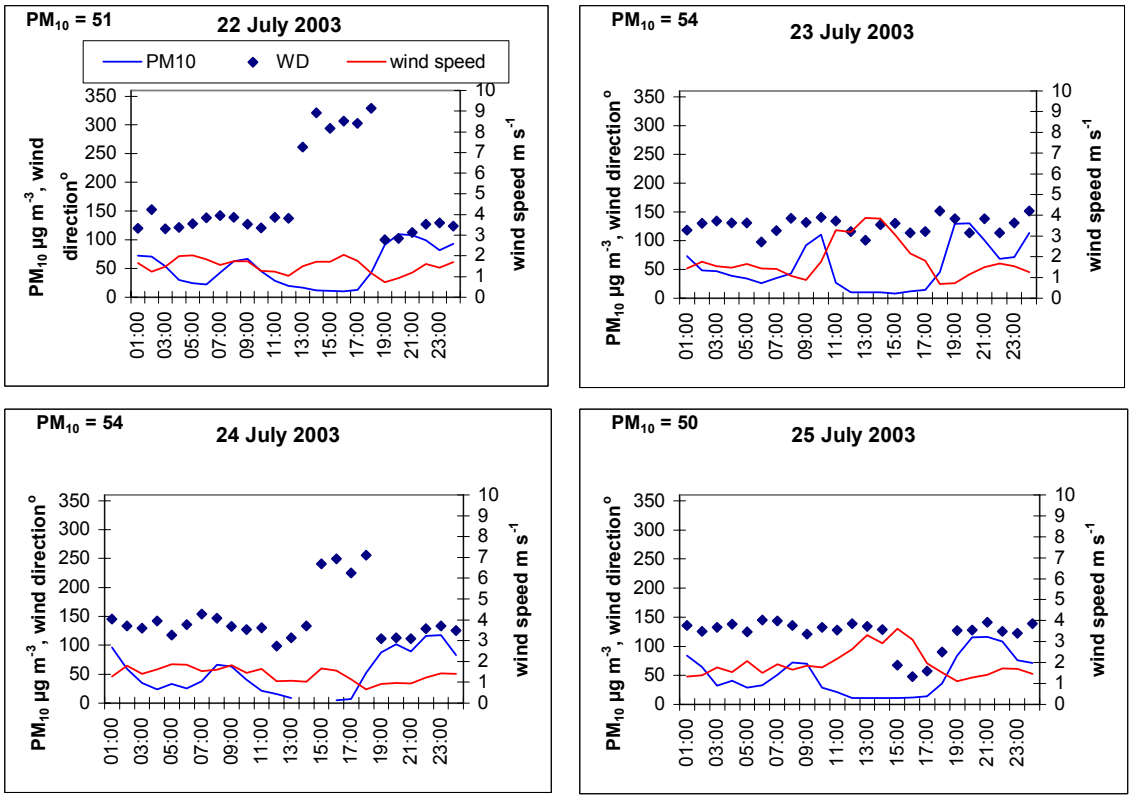

Figure 3-6: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded during 22 to 25 July 2003

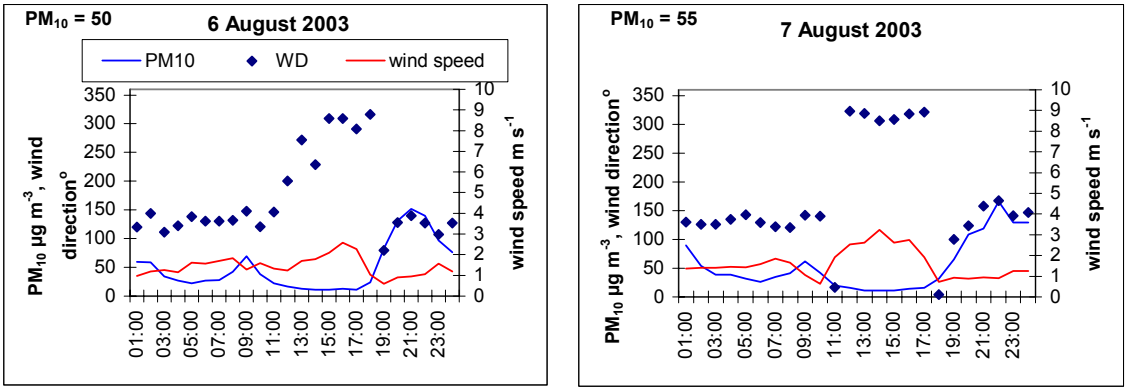

Figure 3-7: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded during August 2003

Emission inventory studies indicate that domestic heating is likely to be the main source of wintertime PM_{10} in Tokoroa contributing an estimated 58% of PM_{10} emissions (Wilton, 2002b).

3.3 Concentrations of benzene

Concentrations of benzene were also measured in Tokoroa from 5 May 2003 until 4 February 2004. Although data did not include a whole year, it is unlikely given the results presented in Table 3.2 that annual average concentrations of benzene would exceed 2 µg m^{-3}. This is well within both the current MfE guideline for benzene of 10 µg m^{-3} and the 2010 guideline of 3.6 µg m^{-3}.

Table 3-2: Concentrations of benzene, toluene and xylene measured at Tokoroa during 2003

Tokoroa	Benzene	Toluene	Ethyl-benzene	m-xylene	o-xylene	p-xylene	total xylenes
Period 2 (5 May to 4 Aug)	4	5	1	2	1	1	4
Period 3 (4 Aug to 4 Nov)	2	2	<0.9	1	<0.9	<0.9	1
Period 4 (4 Nov to 4 Feb)	<0.4	1	< 0.6	< 0.6	< 0.6	< 0.6	<1.7
Max average (May to Feb)*	2.1	2.6	0.8	1.4	0.9	0.8	2.2

*assuming the detection limit for all concentrations reported as less than a value

4 Air quality monitoring in Taupo

During 2003, air quality monitoring in Taupo was carried out at the Gillies Street Reserve air quality monitoring site. The site is located in central Taupo and was established in November 2000. The site is consistent with the "Residential Neighbourhood" site classification as described in *Good Practice Guideline for Air Quality Monitoring and Data Management* (MfE, 1999).

Concentrations of PM_{10} were measured at the site using a Partisol gravimetric PM_{10} sampler. The sampling regime during 2003 was approximately one day in three. The sampling was carried out by the Institute of Geological & Nuclear Sciences (GNS) on behalf of Environment Waikato.

Air quality monitoring data for PM_{10} were collected over a 24-hour period from midnight to midnight. A total of 106 samples were collected during 2003.

4.1 Concentrations of PM_{10}

Figure 4.1 shows 24-hour average PM_{10} concentrations measured at Taupo during 2003. Four guideline exceedences were measured, indicating that around 12 breaches may have occurred if data are extrapolated for missing values. This is greater than the estimate of 6 guideline exceedences for 2002 and is in excess of the proposed NES for PM_{10} of 50 µg m^{-3} with 5 allowable breaches.

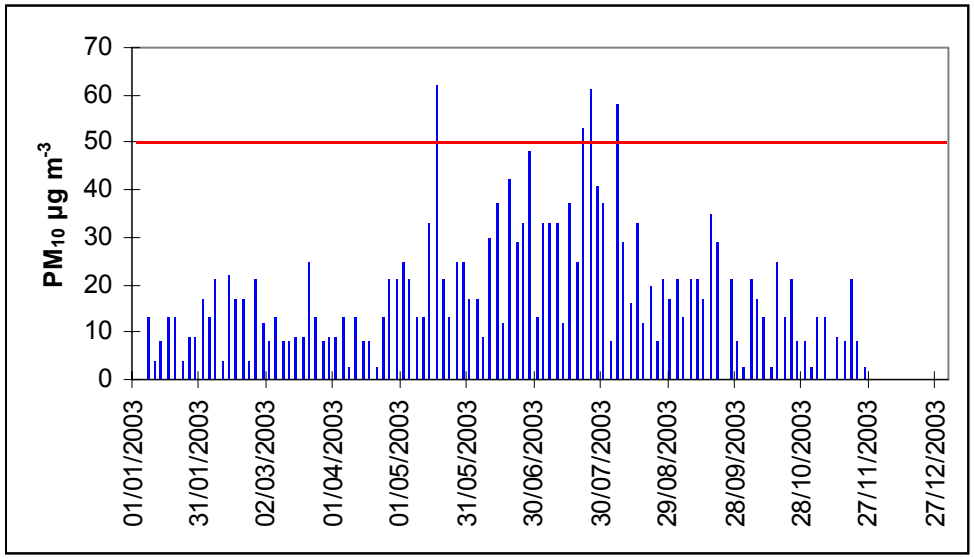

Figure 4-1: 24-hour average concentrations of PM10 in Taupo during 2002

The maximum measured PM_{10} concentration at Taupo during 2003 was 62 µg m^{-3}. This compares to 57 µg m^{-3} in 2001 and 53 µg m^{-3} in 2002. The estimated annual average PM_{10} concentration for Taupo for 2003 is 18 µg m^{-3} and is less than the annual average guideline for PM_{10} of 20 µg m^{-3} (MfE, 2002).

Figure 4.2 compares the PM_{10} concentrations measured during each month of 2003 to MfE air quality indicator categories. This indicates that the guideline exceedences occurred during the months May, July and August 2003. The poorest air quality occurred during July when 73% of the measurements were greater than 66% of the air quality guideline (33 µg m^{-3}).

Sources of PM_{10} in Taupo include domestic home heating and industry. The relative contribution of each is uncertain as historical inventory data may contain unreliable estimates from some sources. An inventory update scheduled for 2004 should clarify the extent of contribution from each source to PM_{10} emissions in Taupo.

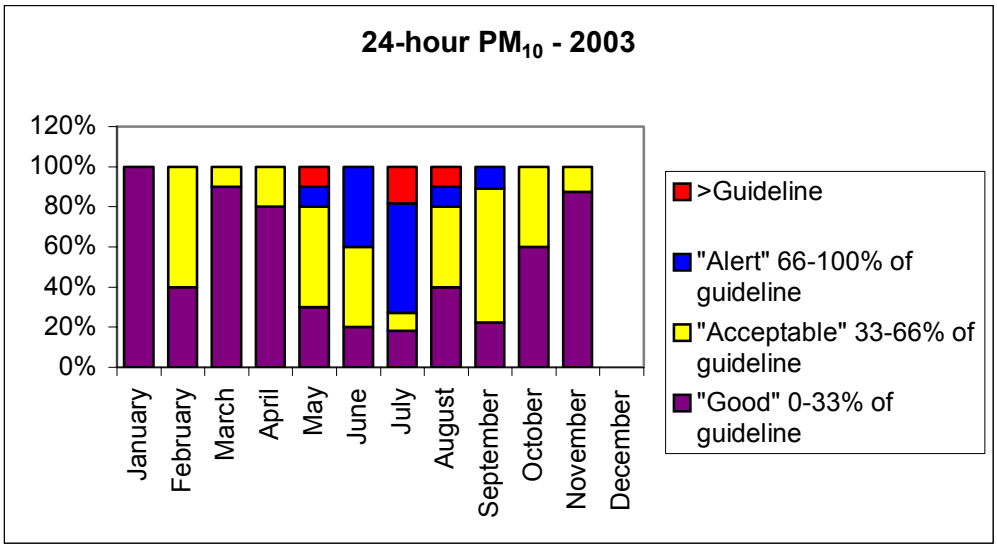

Figure 4-2: Comparison of PM10 concentrations measured in Taupo to MfE air quality indicator categories

A comparison of PM_{10} data for Taupo from 2001 to 2003 is shown in Table 3.1 and Figure 4.3. No trends in PM_{10} concentrations are evident from these data.

Table 4-1: Summary statistics for PM10 data for Taupo from 2001 to 2003

	PM_{10} 2001	PM_{10} 2002	PM_{10} 2003
"Good" 0-33% of guideline	43%	59%	52%
"Acceptable" 33-66% of guideline	36%	33%	32%
"Alert" 66-100% of guideline	18%	7%	12%
>Guideline	2%	1%	4%
Percentage of valid data	12%	21%	29%
Annual average (µg m-3)	20	16	18
Guideline exceedences (extrapolated)	7	6	12
99.5 %ile concentration (µg m-3)	54	49	61
Annual maximum (µg m-3)	57	54	62

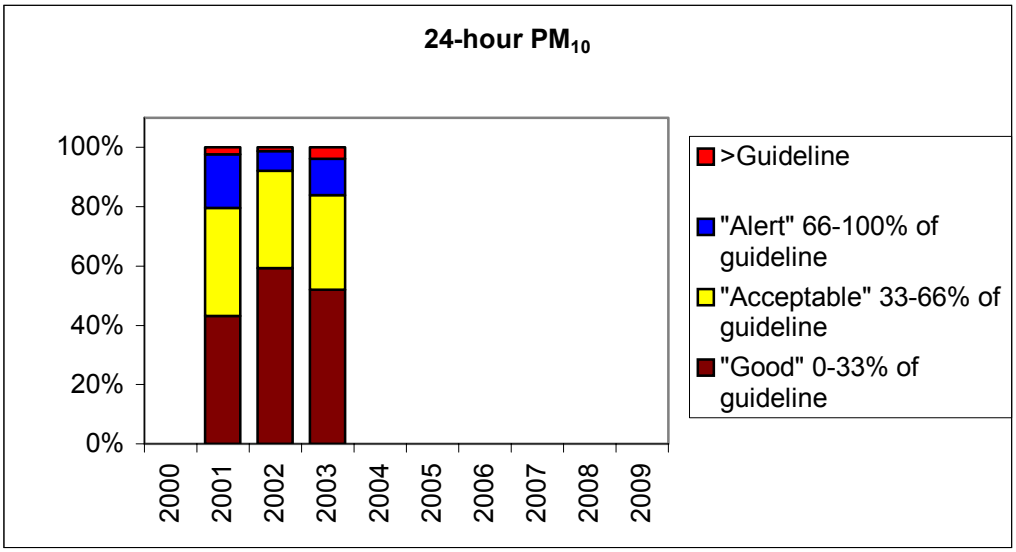

Figure 4-3: Comparison of PM10 concentrations measured in Taupo from 2001 to 2003 to MfE air quality indicator categories

5 Air Quality Monitoring in Te Kuiti

During 2003 air quality monitoring in Te Kuiti was carried out at the Te Kuiti City Council Offices off Queen Street. This is the same site as used in the 1998 PM_{10} monitoring in Te Kuiti. Further descriptions of the air quality monitoring site, including a map and site layout are given in the *"Air Quality Monitoring Report – Waikato Region*" (Wilton, 2002). The site is consistent with the "Residential Neighbourhood" site classification as described in *Good Practice Guideline for Air Quality Monitoring and Data Management* (MfE, 1999).

Concentrations of PM_{10} were measured at the site using an ESM (Anderson) FH 62 C14 Beta Attenuation Monitor (BAM). Hourly average PM_{10} concentrations were collected from 14 May 2003. The site was operated and maintained by Environment Waikato.

5.1 Concentrations of PM_{10}

The 24-hour average PM_{10} concentrations measured at Te Kuiti during 2003 are shown in Figure 5.1. Extrapolation for missing data during the winter indicates that about five guideline exceedences are likely to have occurred in Te Kuiti during 2003. However, only 4 breaches were measured. These occurred during July. The maximum measured PM_{10} concentration in Te Kuiti during 2003 of 59 µg m^{-3} was recorded on the 24 July. While 2003 data suggests compliance with the proposed NES, additional monitoring is required to account for annual variables such as meteorological conditions.

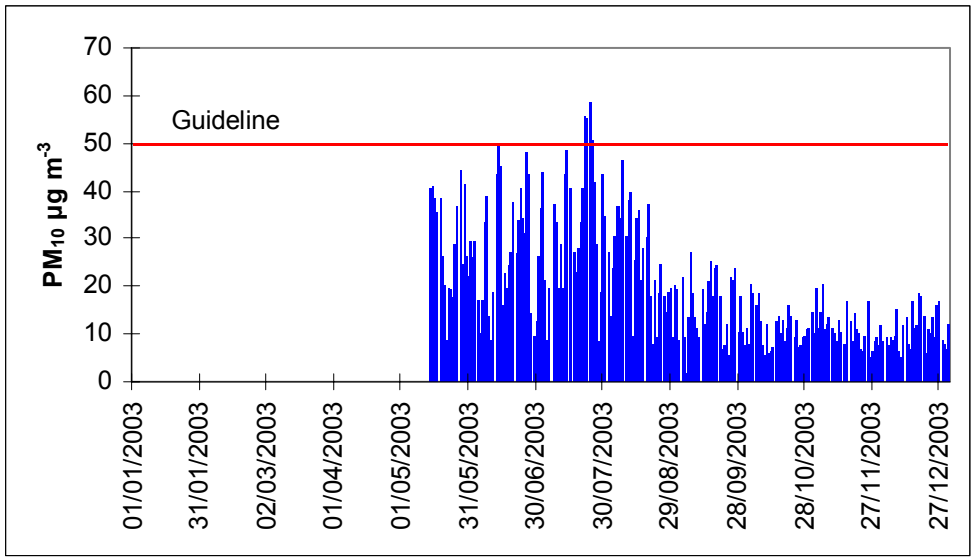

Figure 5-1: 24-hour average concentrations of PM10 in Te Kuiti during 2003

An estimate of the annual average PM_{10} concentration in Te Kuiti, allowing for seasonal variations in sampling frequency, was 18 µg m^{-3} for 2003. This is less than the MfE annual average guideline (MfE, 2002) of 20 µg m^{-3}.

Figure 5.2 compares the PM_{10} concentrations measured during each month of 2003 to MfE air quality indicator categories. As with other locations within the region, the poorest air quality occurs during the months May to August.

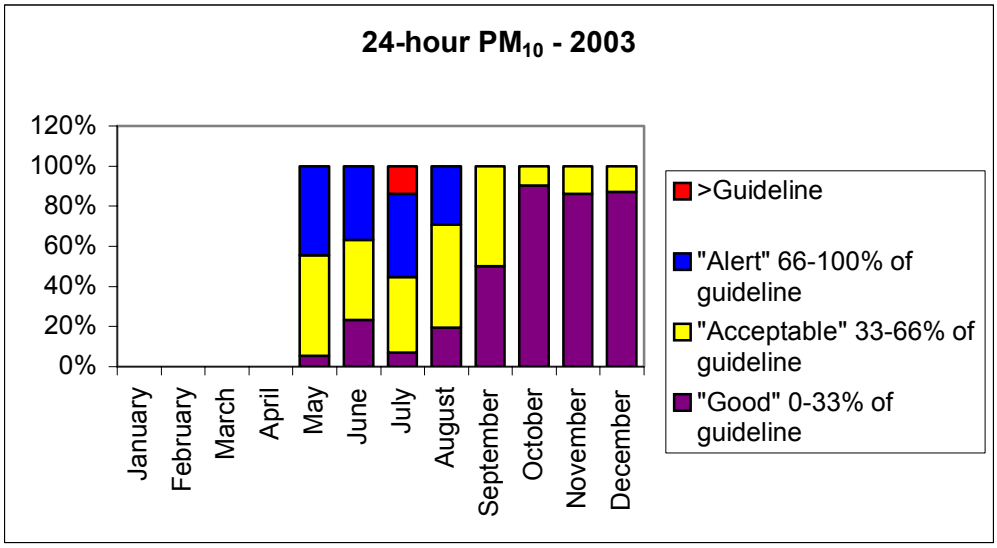

Figure 5-2: Comparison of PM10 concentrations measured in Te Kuiti to MfE air quality indicator categories

The four measured guideline exceedences in Te Kuiti occurred on the 22 to the 25 July. Daily variations in PM_{10} and meteorological data on these days are shown in Figure 5.2. Episodes of elevated PM_{10} appear to have occurred under a range of wind directions, although the southeast direction is probably the most prevalent. Pollution episodes are associated with wind speeds of up to 2 m s^{-1} in most instances.

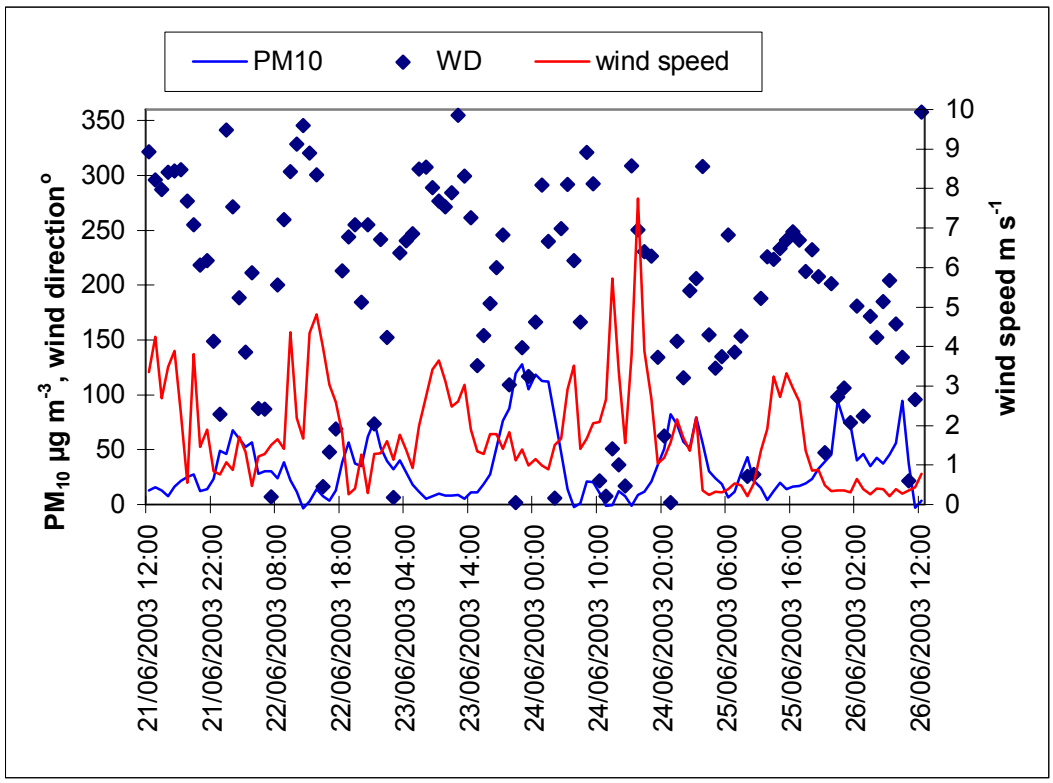

Figure 5-3: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded at Te Kuiti during 2003

Figure 5.4 compares PM_{10} concentrations measured in Te Kuiti in 2003 to those measured in 1998. These results are not directly comparable, however, as the latter measurements were made with a TEOM operating with a sample temperature of 50°C. Data for 2003 would be expected to be higher than 1998 data because of these differences in monitoring methods. Summary statistics for both years are shown in Table 5.1.

Historical emission inventory studies suggest that domestic home heating is the main source of PM_{10} in Te Kuiti (Noonan, 1997a and 1997b).

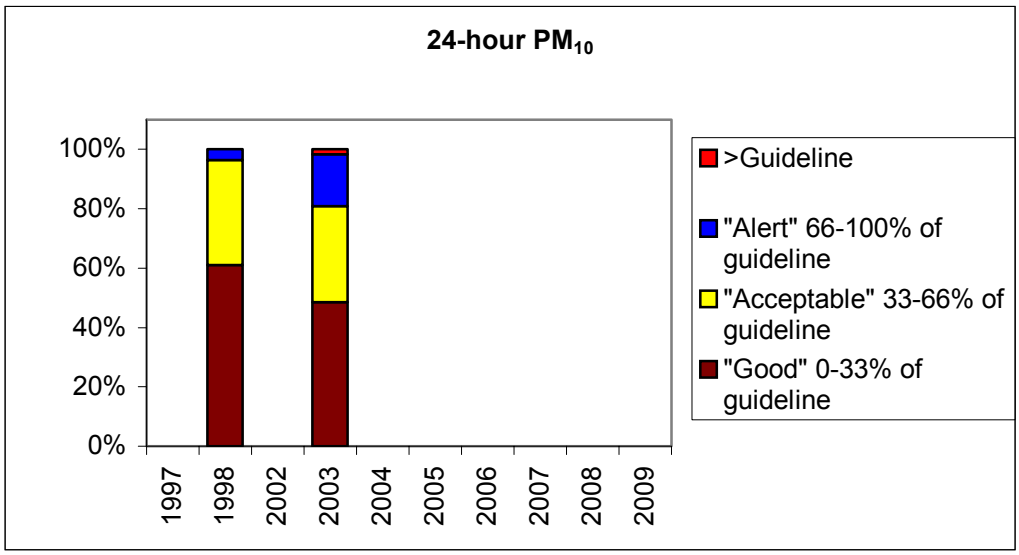

Figure 5-4: Comparison of PM10 concentrations in Te Kuiti to MfE air quality indicator categories for 1998 and 2003

Table 5-1: Summary statistics for PM10 data for Te Kuiti for 1998 and 2003

	PM_{10} 1998	PM_{10} 2003
"Good" 0-33% of guideline	61%	48%
"Acceptable" 33-66% of guideline	35%	32%
"Alert" 66-100% of guideline	4%	17%
>Guideline	0%	2%
Percentage of valid data	53%	63%
Annual average (µg m-3)	16	18
Guideline exceedences (extrapolated)	0	5
99.5 %ile concentration (µg m-3)	42	56
Annual maximum (µg m-3)	42	59

6 Summary

During 2003 air quality monitoring in the Waikato was carried out in Hamilton, Tokoroa and Taupo and Te Kuiti. In Hamilton monitoring included measurements of PM_{10}, CO, NO_2 and benzene. In Taupo and Te Kuiti monitoring was carried out for PM_{10} and in Tokoroa both PM_{10} and benzene were measured.

Tokoroa recorded the poorest air quality, with an estimated 18 breaches of the 24-hour average guideline for PM_{10} of 50 µg m^{-3}. The annual average PM_{10} concentration, at 24 µg m^{-3}, was also in excess of the MfE guideline of 20 µg m^{-3}. Taupo and Te Kuiti had an estimated 12 and 5 breaches of the 50 µg m^{-3} guideline, with annual average concentrations less than the 20 µg m^{-3} guideline. In Hamilton, measured concentrations of PM_{10} were also within the annual average guideline of 20 µg m^{-3} but the 24-hour average guideline was estimated to be breached on 4 occasions.

Concentrations of CO measured in Hamilton were well within both the 1-hour and 8-hour guidelines of 30 mg m^{-3} and 10 mg m^{-3} respectively. The majority of CO concentrations were less than 33% of the guideline, falling within the “excellent” or “good” air quality categories.

Monitoring of NO_2 at the Hamilton site also showed concentrations well within guideline values, with maximum hourly and 24 hour average concentrations of 102 and 34 µg m^{-3} respectively. These compare with MfE guidelines of 200 µg m^{-3} (1 hour average) and 100 µg m^{-3} (24-hour average).

Concentrations of benzene were measured at two monitoring sites in Hamilton and one monitoring site in Tokoroa. In Hamilton, concentrations measured at Peachgrove Road gave an annual average concentration of 3.7 µg m^{-3} compared to 5.8 µg m^{-3} for the Bridge Street site. This compares to a current annual average guideline of 10 µg m^{-3} and a 2010 guideline of 3.6 µg m^{-3}. Although sampling of benzene did not commence until 5 May 2003 in Tokoroa, results indicate that annual average concentrations less than 2 µg m^{-3} are likely.

All areas show similar seasonal variations in PM_{10} concentrations, with higher values occurring during the winter months.

No clear trends in contaminant concentrations were apparent at any of the monitoring sites.

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