Environment Waikato Technical Report 2005/07

Air Quality Monitoring 2004

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ISSN: 1172-4005

24 February 2005

Document #: 979624

Environment Waikato
REGIONAL COUNCIL

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Executive Summary

This report presents results of ambient air quality monitoring carried out by Environment Waikato during 2004. Monitoring sites were located in Hamilton, Tokoroa, Te Kuiti and Taupo.

The main air contaminant of concern in the Waikato region is suspended particles (PM_{10}). In September 2004, the Ministry for the Environment introduced a National Environmental Standard (NES) for PM_{10} of 50 µg m^{-3} (24-hour average) with one allowable exceedence each year. The NES is effective from September 2005.

Concentrations of PM_{10} were measured at all locations, with the Hamilton site also measuring carbon monoxide (CO), and benzene. Benzene was also monitored at a "traffic peak" monitoring site in Bridge Street, Hamilton.

Tokoroa measured the worst PM_{10} concentrations in terms of both magnitude and frequency of exceedence. During 2004, the maximum measured PM_{10} concentration was 97 µg m^{-3} and 41 exceedences of 50 µg m^{-3} were measured. This compares with a previous maximum of 75 µg m^{-3} (measured in 2001) and a maximum of 15 measured exceedences (for 2002).

In Hamilton, measured PM_{10} concentrations exceeded 50 µg m^{-3} on one occasion reaching 55 µg m^{-3} (24-hour average). Monitoring was carried out using a TEOM analyser with a sample temperature of 40 ° C. Additional monitoring of PM_{10} at the Hamilton site was carried out using a high-volume sampler to determine the relativity between this reference method and the TEOM. Unlike other locations in New Zealand, the difference between the TEOM and high-volume sampling methods was not significant. No adjustments for gravimetric equivalency were therefore made to 2004 or historical TEOM data. The annual average PM_{10} concentration in Hamilton during 2004 was 17 µg m^{-3}, which is less than the annual average guideline of 20 µg m^{-3}.

Carbon monoxide concentrations in Hamilton during 2004 were well within air quality guidelines and the NES for CO. Results were consistent with previous years 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}. The maximum 8-hour average concentration was 7 mg m^{-3}, over two thirds of the 8-hour guideline of 10 mg m^{-3}.

In Te Kuiti, concentrations exceeded 50 µg m^{-3} (24-hour average) on 5 occasions with a maximum measured 24-hour average of 62 µg m^{-3}. In Taupo, monitoring was carried out every third day rather than daily. Two breaches of 50 µg m^{-3} were measured during 2004, with a maximum PM_{10} concentration of 65 µg m^{-3}. If data are extrapolated statistically for missing data, the number of breaches could be around 6.

Annual average PM_{10} concentrations in Te Kuiti and Taupo are estimated at less than the 20 µg m^{-3} guideline.

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.

1 Introduction

During 2004, air quality monitoring was carried out by Environment Waikato at the four locations monitored in 2003. These were in Hamilton, Tokoroa, Te Kuiti and Taupo. Results from these sites are presented in this report.

The main contaminant of concern in the Waikato Region is suspended particulate, commonly referred to as PM_{10}, which comprises particles in the air less than 10 microns in diameter. In September 2004, the Ministry for the Environment introduced a National Environmental Standard (NES) for PM_{10} of 50 µg m^{-3} (24-hour average) with one allowable exceedence each year (MfE, 2004). Table 1.1 shows the NES for PM_{10} and other air contaminants. The NES are effective from September 2005.

In addition to the NES, air quality can be compared with air quality guidelines (MfE, 2002) and air quality indicator categories. The air quality guidelines for PM_{10} include an annual average concentration of 20 µg m^{-3} as well as additional contaminants and averaging periods for carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (Table 1.2). In addition, it is common for air quality data to be presented relative to the MfE air quality indicator categories (Table 1.3).

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).

Table 1-1: National Environmental Standards for ambient air quality (MfE, 2004)

Contaminant	NES values		
	Concentration	Averaging Period	Allowable exceedences / year
Carbon monoxide	10 mg m^{-3}	8-hour	1
Particles (PM_{10})	50 µg m^{-3}	24-hour	1
Nitrogen dioxide	200 µg m^{-3}	1-hour	9
Sulphur dioxide [b]	350 µg m^{-3}	1-hour	9
Sulphur dioxide [b]	570 µg m^{-3}	1-hour	0
Ozone	150 µg m^{-3}	1-hour	0

Table 1-2: Ambient air quality guideline for New Zealand (MfE, 2002)

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

Table 1-3: 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

2 Air quality monitoring in Hamilton

Air quality in Hamilton has been measured at a monitoring site in Peachgrove Road since November 1997. In 2003 and 2004 an additional "traffic peak" monitoring site in Bridge Street was used to measure concentrations of benzene. The Peachgrove Road site is located on the south-east side of Hamilton City. During 2004, PM_{10}, CO, and benzene were measured at Peachgrove Road. The site was also used to measure concentrations of ozone during the January to March 2004. Ozone monitoring results are reported separately because of the timing of the period of interest. The Peachgrove Road monitoring site is consistent with the "Residential Peak" site classification as described in *Good Practice Guideline for Air Quality Monitoring and Data Management* (MfE, 1999).

During 2004, PM_{10} monitoring at Peachgrove Road was carried out using a Tapered Elemental Oscillating Microbalance (TEOM) with a sample temperature setting of 40°C and a gravimetric high-volume sampler. 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. This report compares PM_{10} concentrations measured using the TEOM and high-volume sampler in Hamilton and derives conversion factors for TEOM concentrations based on monitoring for 2004.

The CO monitoring was carried out using an Advanced Pollution Instrumentation (API) series 300 analyser. Operational aspects of the CO 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. 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 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 is higher than the 75% data requirement used to calculate 24-hour averages, which is the recommendation in the *Good Practice Guideline for Air Quality Monitoring and Data Management* (MfE, 1999). However the former criteria has been used because it is the value specified in the software used to

store 10-minute data. Neither cut-point has been used for the reporting of monthly concentrations (Figures 2.3, 2.7 and 2.8).

Air quality monitoring data for PM_{10} were collected for 94% of 2004. The main period of missing data was 8 – 22 March.

The main periods of missing data for CO were 24 February to 18 March, 17 April to 17 May and 18 to 25 November. Overall data were collected for 83% of the year.

2.1 Concentrations of PM_{10}

Concentrations of PM_{10} measured at the Hamilton monitoring site during 2004 are shown in Figure 2.1. On the 12 July, a PM_{10} concentration of 55 µg m^{-3} was recorded. This was the only exceedence of the 50 µg m^{-3} guideline value during 2004. As the NES allows for one guideline exceedence, PM_{10} concentrations at the site would not have exceed the NES had it been in effect in 2004.

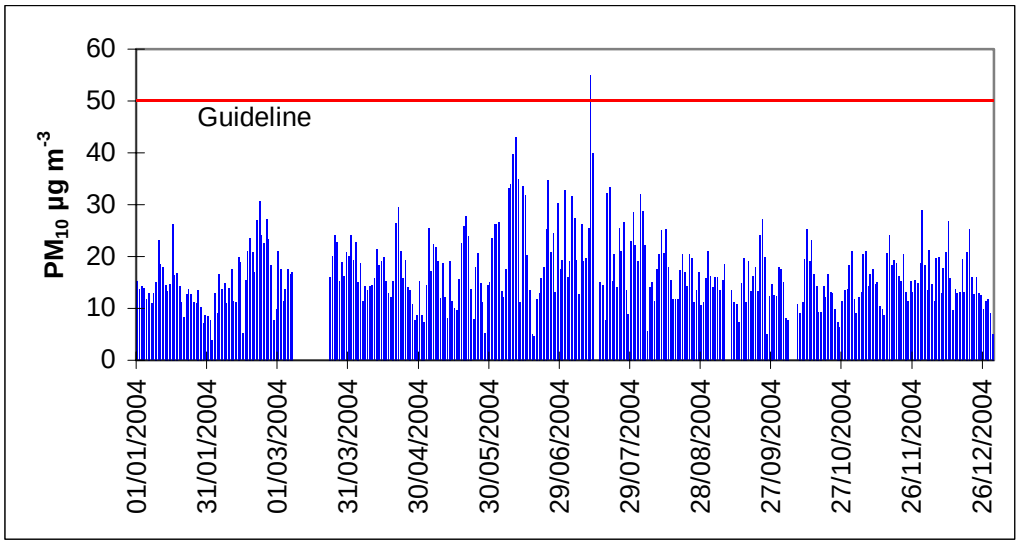

Figure 2-1: Daily PM10 concentrations measured in Hamilton during 2004

Figure 2.2 compares daily average PM_{10} concentrations measured in Hamilton using the TEOM and the high-volume sampling methods during May to August (winter) and September to December (summer). The r^2 value of 0.83 for the winter, compared with 0.43 for the summer indicates that during the winter, more of the variability in concentrations is explained by the relationship between the two measurements. That is, winter results are better correlated. This is consistent with similar studies carried out in Christchurch and Auckland (Wilton, 2002) and is likely to occur as a result of more variability in sources in summer compared to winter.

A significant point of difference between results for Hamilton and those for Christchurch and Auckland is the difference between the two measurements. In the latter areas, PM_{10} concentrations measured with the TEOM were significantly lower than those measured with the high-volume sampler.

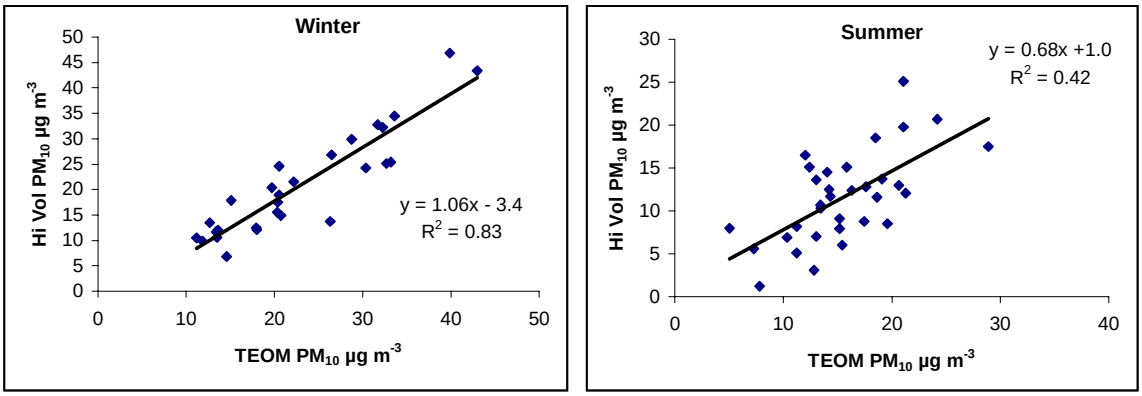

Figure 2-2: Comparison of PM10 concentrations measured using TEOM and high-volume sampler during 2004

Table 2.1 compares the mean percentage difference between the high-volume sampler results and the TEOM results in Hamilton to Christchurch (Coles Pl, 2002-2004) and Auckland (Takapuna, 1997 to 1999) for different PM_{10} concentrations (based on high-volume). The mean percent difference was calculated as (high-vol – TEOM)/high-vol so a negative value represents TEOM concentrations being higher than high-volume concentrations.

Table 2-1: Comparison of TEOM and high-volume sampler results to Auckland and Christchurch

	Hamilton	Auckland[1]	Christchurch
Good (PM_{10} >16.5 µg m^{-3})	-62%	-18%	-10%
Acceptable (PM_{10} >16.5 < 33 µg m^{-3})	-7%	12%	15%
Alert (PM_{10} >33 <50 µg m^{-3})	6%	18%	25%
Action (PM_{10} >50 µg m^{-3})	N/a	N/a	26%

The high-volume sampler was operating on a one-day-in-three sampling regime and was not operating on the 12 July when PM_{10} concentrations breached 50 µg m^{-3}.

In all areas, the greatest difference in the methods occurs when PM_{10} concentrations are highest. The extent of difference varies from area to area with Christchurch having the greatest difference. It is probable that the difference between these areas relates to sources contributing to PM_{10} concentrations at the monitoring site as the volatility of the PM_{10} changes with source. Domestic home heating has a reasonable proportion of low molecular weight organic species that are likely to volatilise under the heated sample line of the TEOM sampler. While the Hamilton emission inventories indicate that domestic home heating is the main source of PM_{10} in the city, the proximity of the Peachgrove Road monitoring site to the roadside is likely to result in a greater contribution from motor vehicles than for a “residential neighbourhood” site within Hamilton.

Given the inconsistency of the relationship across different PM_{10} concentrations and the small difference in methods, no adjustments for gravimetric equivalency were considered warranted.

The annual average PM_{10} concentration for Hamilton for 2004 was 17 µg m^{-3} based on TEOM data. This compares to the MfE annual guideline for PM_{10} of 20 µg m^{-3}. Annual average concentrations for Hamilton were 16 µg m^{-3} for 1999 and 15 µg m^{-3} from 2000 to 2003.

[1] The Auckland TEOM was operating at a sample temperature of 50 ° C, compared to 40 ° C in Hamilton and Christchurch. More loss of volatiles is likely to occur at a 50 ° C sample temperature.

A comparison of the PM_{10} concentrations to the MfE air quality indicator categories is shown in Figure 2.3. 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.

Figure 2.4 compares the distribution of PM_{10} concentrations during 2004 to previous years PM_{10} monitoring in Hamilton. No trends in PM_{10} concentrations are evident from these data.

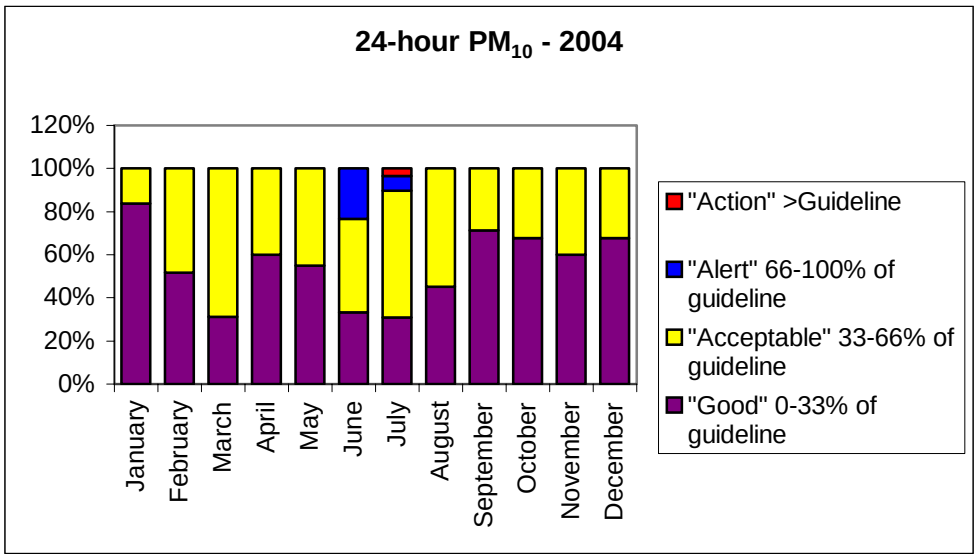

Figure 2-3: Comparison of PM10 concentrations measured in Hamilton during 2004 to MfE air quality indicator categories

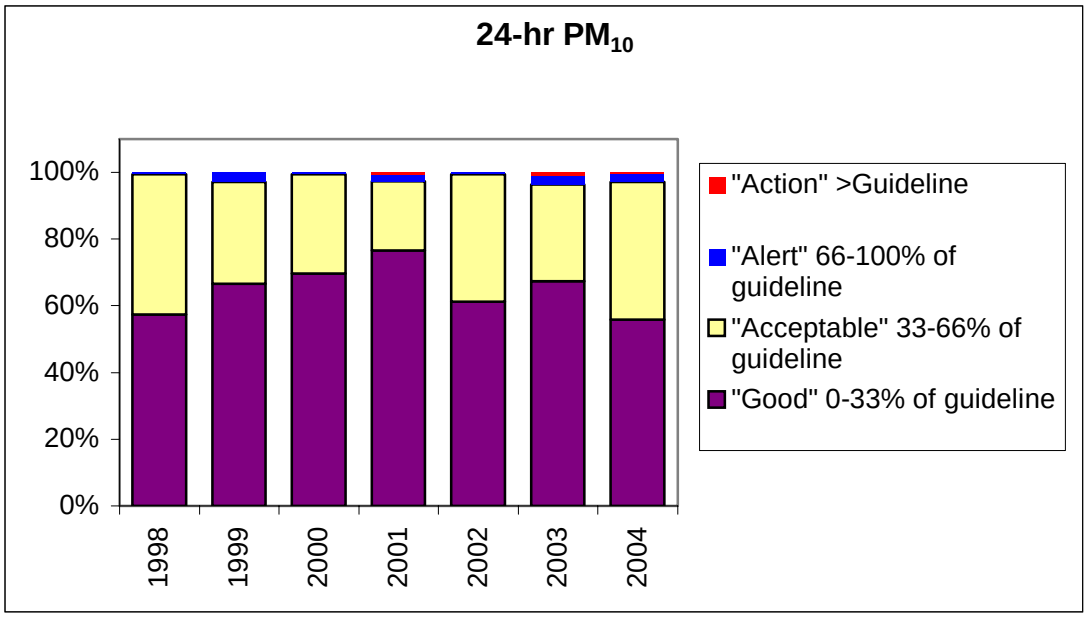

Figure 2-4: Comparison of PM10 concentrations measured at Hamilton from 1998 to 2004 to MfE air quality indicator categories

Figure 2.5 shows hourly average PM_{10} and CO concentrations on the 12 July when the 24-hour average PM_{10} concentration air quality guideline was exceeded. This shows the wind speed was very low, less than 0.5 m s^{-1}, particularly at times when PM_{10} concentrations were elevated. While the wind appears to be from the southerly direction for most of the day, the wind vanes are not accurate for wind speeds less than 0.5 m s^{-1}. Thus it is not possible to determine wind direction from these data except for the period from midday to around 6pm.

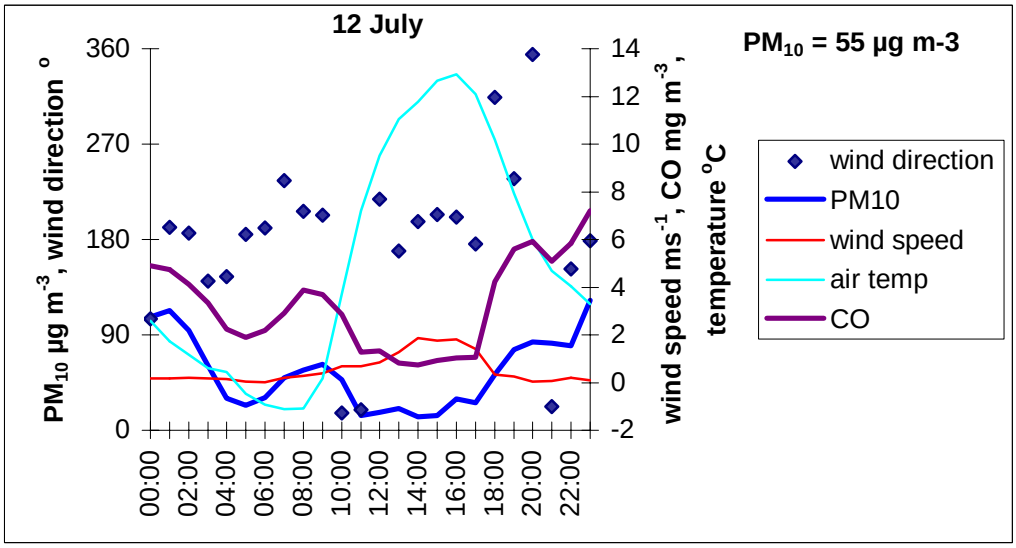

Figure 2-5: Daily variations in PM10, wind direction and wind speed on 12 July 2004

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

2.2 Concentrations of CO

Figure 2.6 shows CO concentrations measured at the Hamilton air quality monitoring site during 2004 were within the air quality guidelines and the NES for CO. The maximum measured hourly CO concentration was 9 mg m^{-3} compared to an hourly average guideline of 30 mg m^{-3}. The maximum eight hour average concentration for CO during 2004 was 7 mg m^{-3}. This is over two thirds of 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 (7%) were within the “acceptable” category during July. A comparison of 2004 data to previous years (Figure 2.9) shows no discernable trend in CO concentrations in Hamilton.

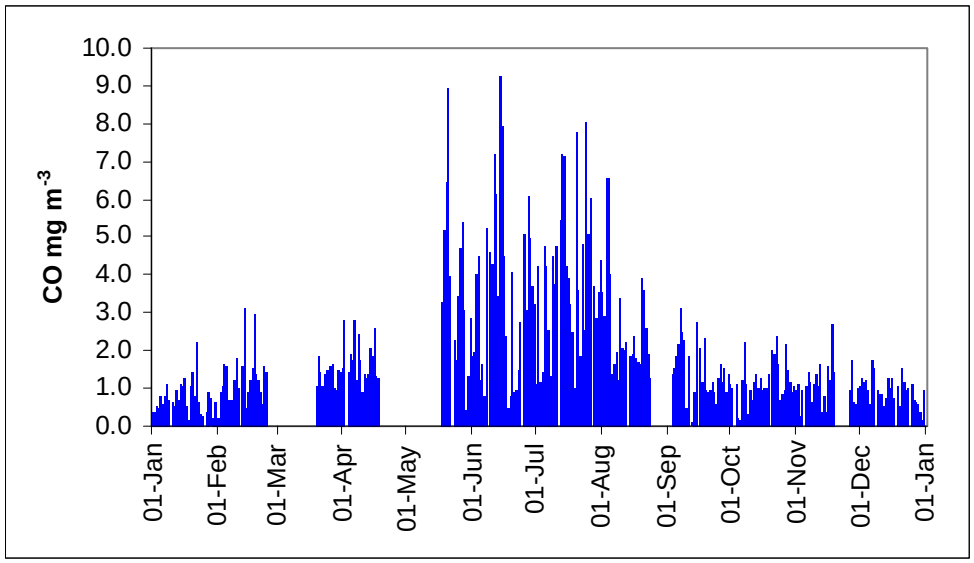

Figure 2-6: Concentrations of CO (hourly average) measured in Hamilton during 2004

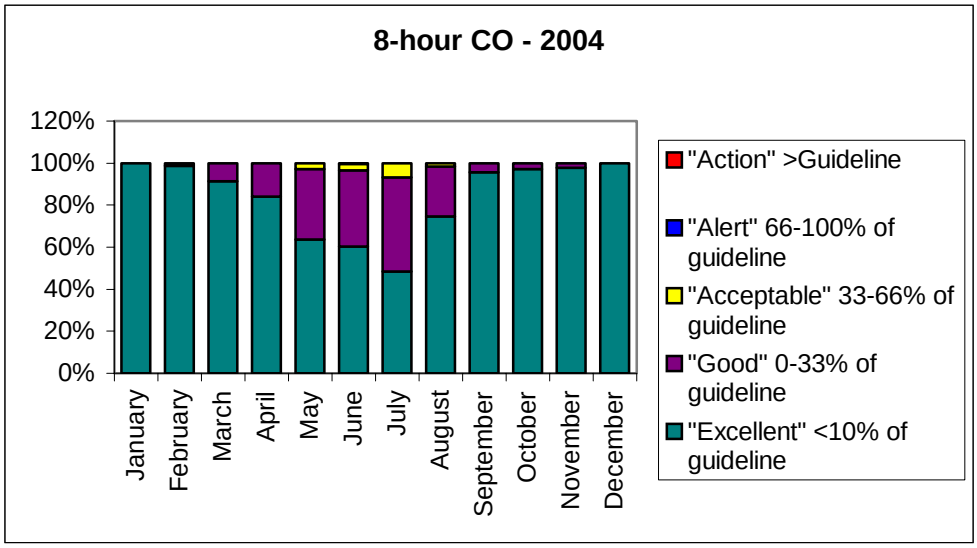

Figure 2-7: Comparison of 8-hour average CO concentrations measured in Hamilton during 2004 to MfE air quality indicator categories

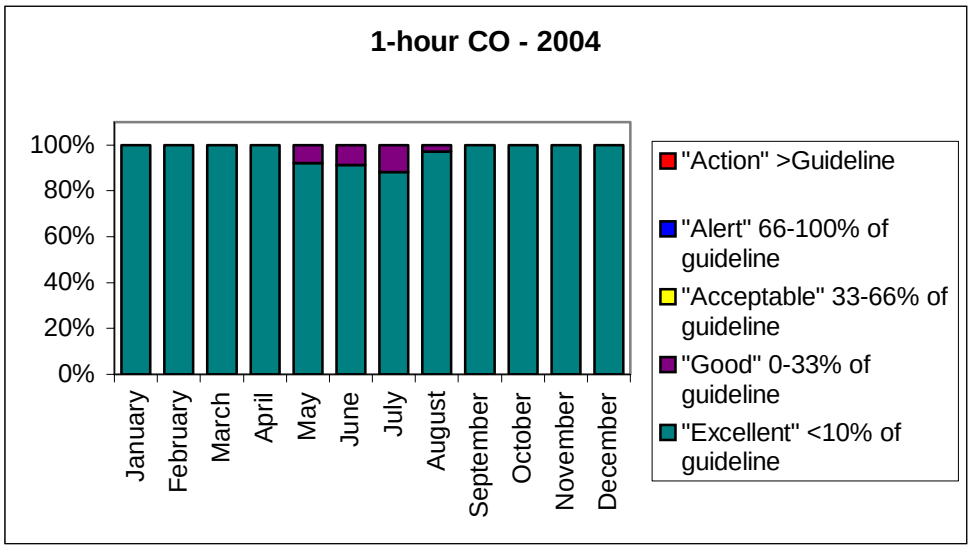

Figure 2-8: Comparison of 1-hour average CO concentrations measured in Hamilton during 2004 to MfE air quality indicator categories

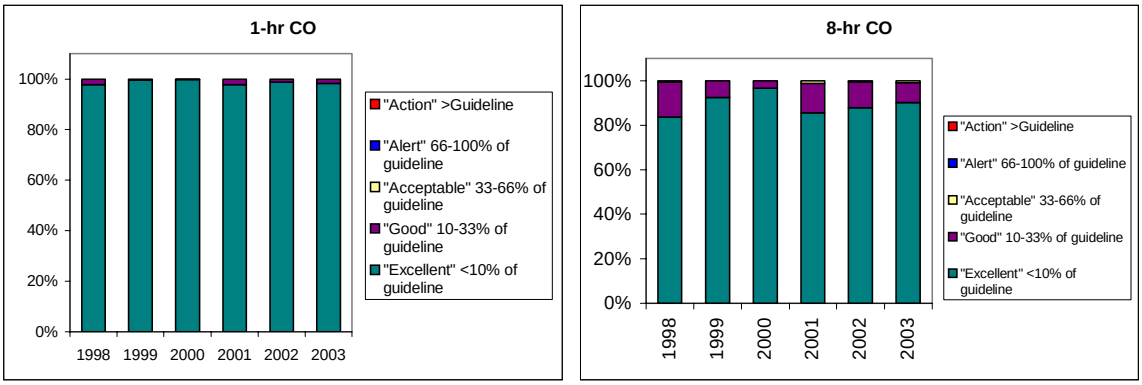

Figure 2-9: Comparison of CO concentrations measured in Hamilton from 1998 to 2004 to MfE air quality indicator categories

2.3 Meteorology

Figure 2.10 shows hourly average wind speed and wind direction for the months May to August. These data were collected at the Peachgrove Road monitoring site during 2004.

The wind speed was elevated for most of the months of May and August and therefore not conducive to episodes of elevated pollution. Wind speeds were also elevated at times during June although calm periods occurred from 9 to 16 June and 24 to 28 June. Days when the wind speed was predominantly less than 2 m s^{-1} occurred frequently during July.

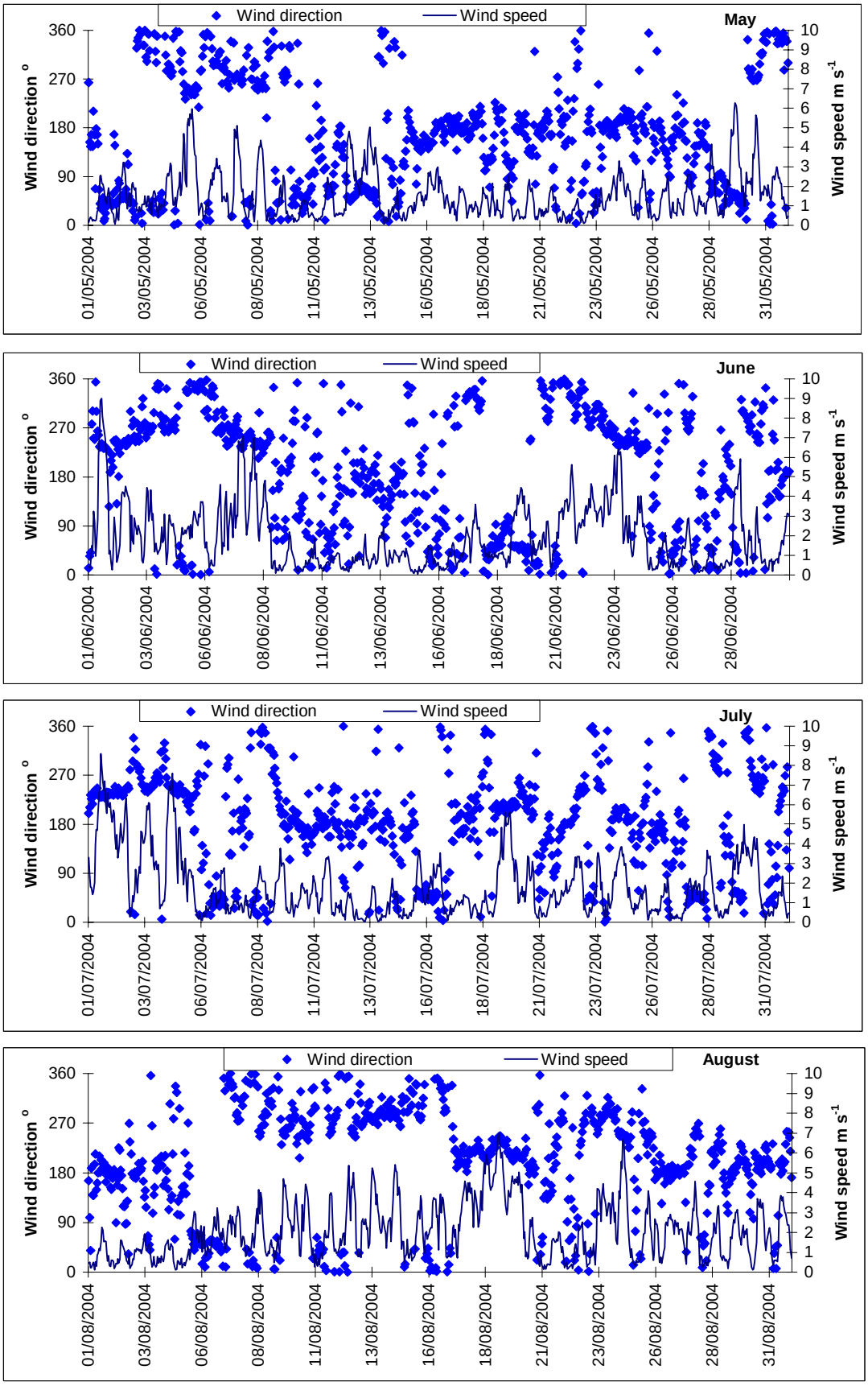

Figure 2-10: Hourly average wind direction and wind speed data for Hamilton from May to August 2004

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

2.4 Summary of 2004 air quality monitoring in Hamilton

The maximum measured PM_{10} concentration in Hamilton during 2004 was 55 µg m^{-3} (24-hour average) and was measured on the 12 July. No other breaches of the 50 µg m^{-3} guideline for PM_{10} were measured.

Results of co-located TEOM and high-volume sampling for PM_{10} during 2004 suggests that differences in monitoring methods may not be significant for Hamilton at this monitoring site. This may be in part a result of the proximity of the site to the roadway, which may result in more PM_{10} from motor vehicles rather than domestic fires. The latter source has a greater proportion of volatiles and therefore results in greater differences between the TEOM and high-volume samplers. Consideration should be given to the position of this monitoring site or the establishment of an additional residential neighbourhood monitoring site in Hamilton.

Concentrations of CO were within air quality guidelines and the NES.

Table 2-2: Summary statistics for PM10 and CO concentrations in Hamilton for 2004

MfE Indicator categories	CO 1-hour average	CO 8-hour average	PM_{10} 24-hour average
"Excellent" <10% of guideline	97%	84%	56%
"Good" 10-33% of guideline	3%	14%	41%
"Acceptable" 33-66% of guideline	0%	1%	3%
"Alert" 66-100% of guideline	0%	0%	0%
“Action” >Guideline	0%	0%	56%
Percentage of valid data	83%	83%	94%
Annual average (µg m-3)	0		17
Guideline exceedences (extrapolated)	0	0	1
99.7 (for 24 hr averages) or 99.9 %ile concentration (µg m-3)	7	6	43
Annual maximum (µg m-3)	9	7	55

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 2004 was a MET ONE series 1020 Beta Attenuation Monitor. The Tokoroa air quality monitoring site is operated by NIWA for Environment Waikato.

Air quality monitoring data for PM_{10} were collected at hourly intervals. Data collection at the site was much higher during 2004 than for previous years with only one period of significant data loss from 8 to 22 March.

3.1 Concentrations of PM_{10}

Concentrations of PM_{10} during 2004 breached the ambient air quality guideline of 50 µg m^{-3} (24-hour average) on 41 occasions. This would equate to 40 breaches of the NES, had it been effective in 2004. The annual maximum number of exceedences was previously 15, although this was based on a year with significant periods of missing data. Figure 3.1 shows the majority of the breaches occurring during the months May to August. The maximum PM_{10} concentration measured in Tokoroa during 2004 was 97 µg m^{-3} and was measured on the 8 June. This was not a one off peak as concentrations of 92 and 90 µg m^{-3} were also recorded in May and June 2004. These peaks compare with a previous maximum concentration of 75 µg m^{-3}, measured in 2001.

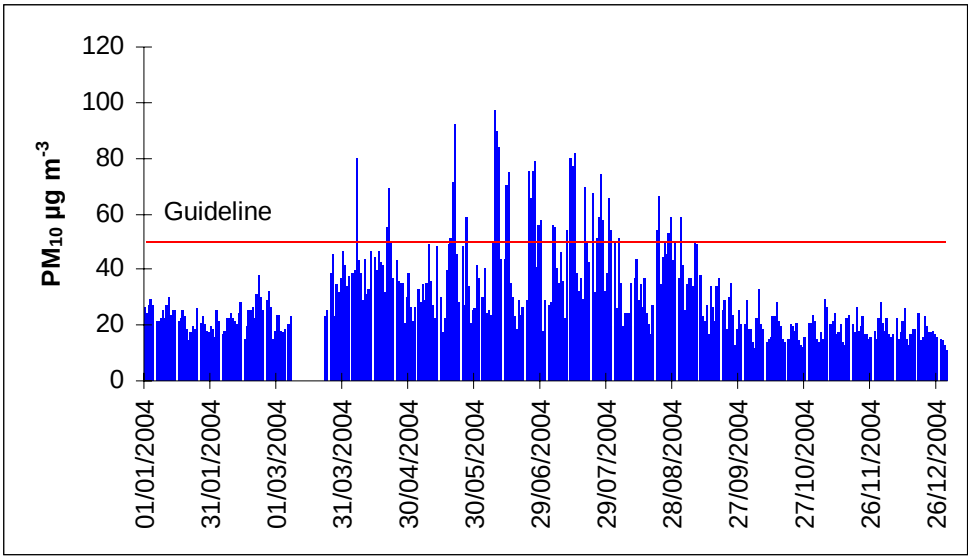

Figure 3-1: 24-hour average concentrations of PM10 in Tokoroa during 2004

The annual average PM_{10} concentration for Tokoroa during 2004 was 31 µgm^{-3}. The 2003 and 2002 annual average PM_{10} concentrations at the Tokoroa monitoring site were both 24 µg m^{-3}. Annual average PM_{10} concentrations in Tokoroa have exceeded the annual average guideline for PM_{10} of 20 µg m^{-3} (MfE, 2002) since monitoring commenced in 2001.

Figure 3.2 compares PM_{10} concentrations measured in Tokoroa during 2004 to MfE air quality indicator categories for each month of the year. This shows a reasonable proportion of exceedences as early as April, with PM_{10} concentrations in excess of 50 µg m^{-3} on over a third of days during June and July.

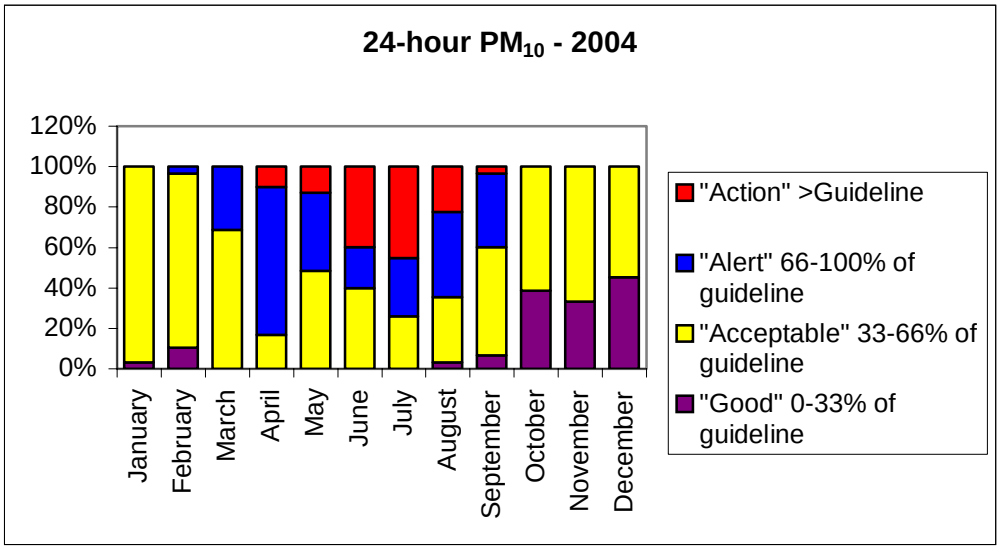

Figure 3-2: Comparison of PM10 concentrations measured in Tokoroa to MfE air quality indicator categories

Table 3.1 and Figure 3.3 compare PM_{10} concentrations measured in Tokoroa during 2004 to previous years data. Based on these data it is likely that the NES for PM_{10} will be breached in Tokoroa, unless management methods are used to reduce PM_{10} emissions.

Table 3-1: Summary statistics for PM10 data for Tokoroa from 2001 to 2004

	PM_{10} 2001	PM_{10} 2002	PM_{10} 2003	PM_{10} 2004
"Good" 0-33% of guideline	12%	15%	25%	12%
"Acceptable" 33-66% of guideline	64%	71%	58%	54%
"Alert" 66-100% of guideline	17%	10%	11%	23%
“Action” >Guideline	8%	4%	5%	12%
Percentage of valid data	47%	98%	55%	96%
Annual average (µg m-3)	27	24	24	31.0
Guideline exceedences (extrapolated)	24	15	18	41
99.7 %ile concentration (µg m-3)	67	65	56	92
Annual maximum (µg m-3)	75	70	62	97

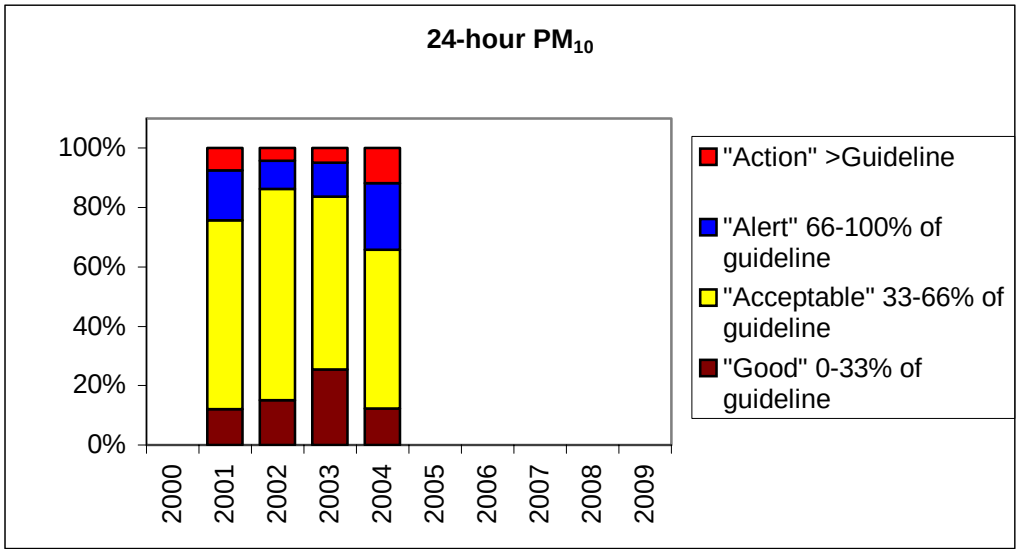

Figure 3-3: Comparison of PM10 concentrations measured in Tokoroa from 2001 to 2004 to MfE air quality indicator categories

Concentrations of PM_{10} in Tokoroa during 2004 were significantly higher than for previous years, both in terms of magnitude of concentration and frequency of exceedence. Variations in concentrations of air contaminants from one year to the next often occur as a result of variations in meteorological conditions. The other influencing factor is variations in emissions, although generally the magnitude of emissions is unlikely to vary significantly over the space of a year. No new sources or increases in existing sources for 2004 have been identified.

Figure 3.4 shows seasonal variations in PM_{10} concentrations for 2002 and 2003. The similar graph for 2004 (Figure 3.2) shows less than 10% of summer PM_{10} concentrations were within the “good” air quality category, compared with more than 20% during previous years, suggesting that the poorer air quality may not be limited to winter results for 2004.

Section 3.2 compares PM_{10} concentrations and meteorological conditions during 2003 and 2004 to determine the extent to which meteorological data collected may help explain the higher concentrations for 2004.

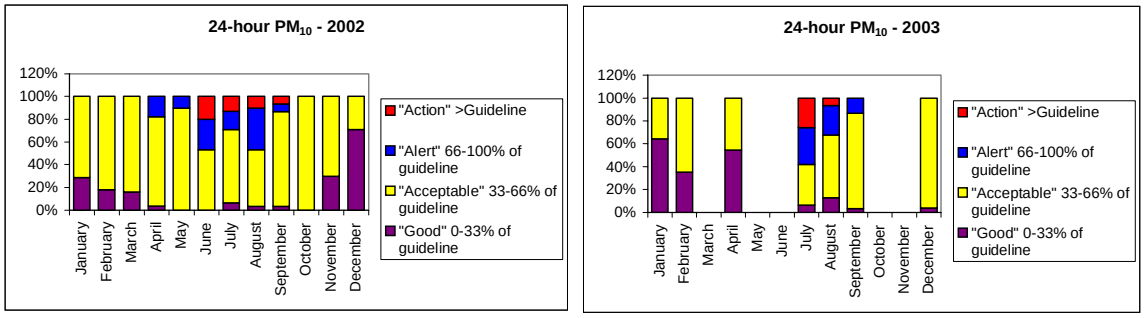

Figure 3-4: Seasonal variations in PM10 concentrations in Tokoroa during 2002 and 2003

Daily variations in wind speed, wind direction and hourly average PM_{10} concentrations on days when the guideline was exceeded 50 µg m^{-3} during 2004 are shown in Figures 3.5 to 3.10. Concentrations of PM_{10} were elevated when wind speeds were typically less than 2 m s^{-1}. The most common wind direction when PM_{10} concentrations were elevated was south-east, although high concentrations were observed under a range of wind directions. An evaluation of the contribution of sources to PM_{10} concentrations in Tokoroa suggests that emissions from Kinleith, located 5 km to the south-east of the monitoring site, are unlikely to be a significant contributor (Wilton, 2004).

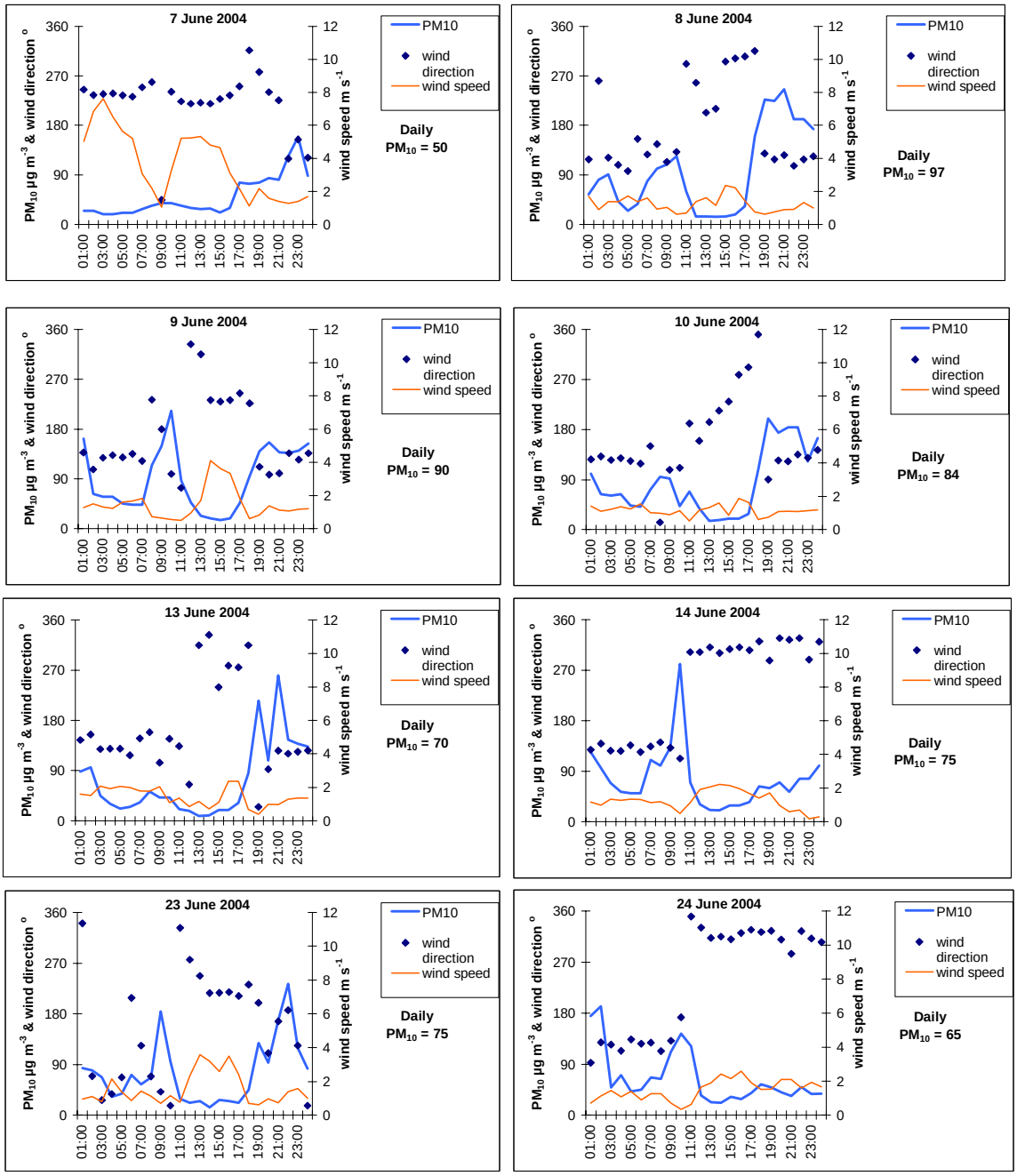

Figure 3-5: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded from 6 April to 26 May 2004

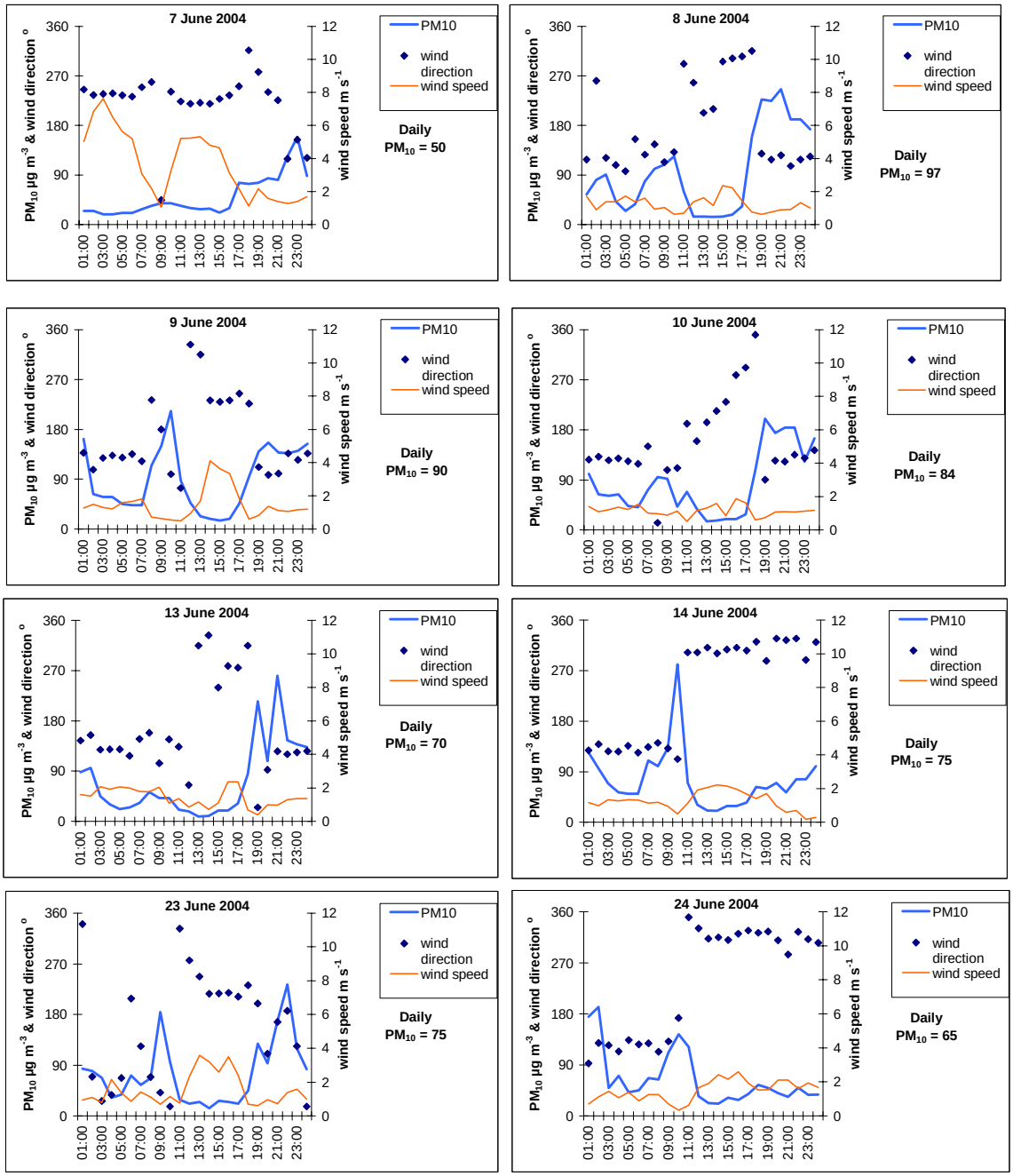

Figure 3-6: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded during 26 May to 24 June 2004

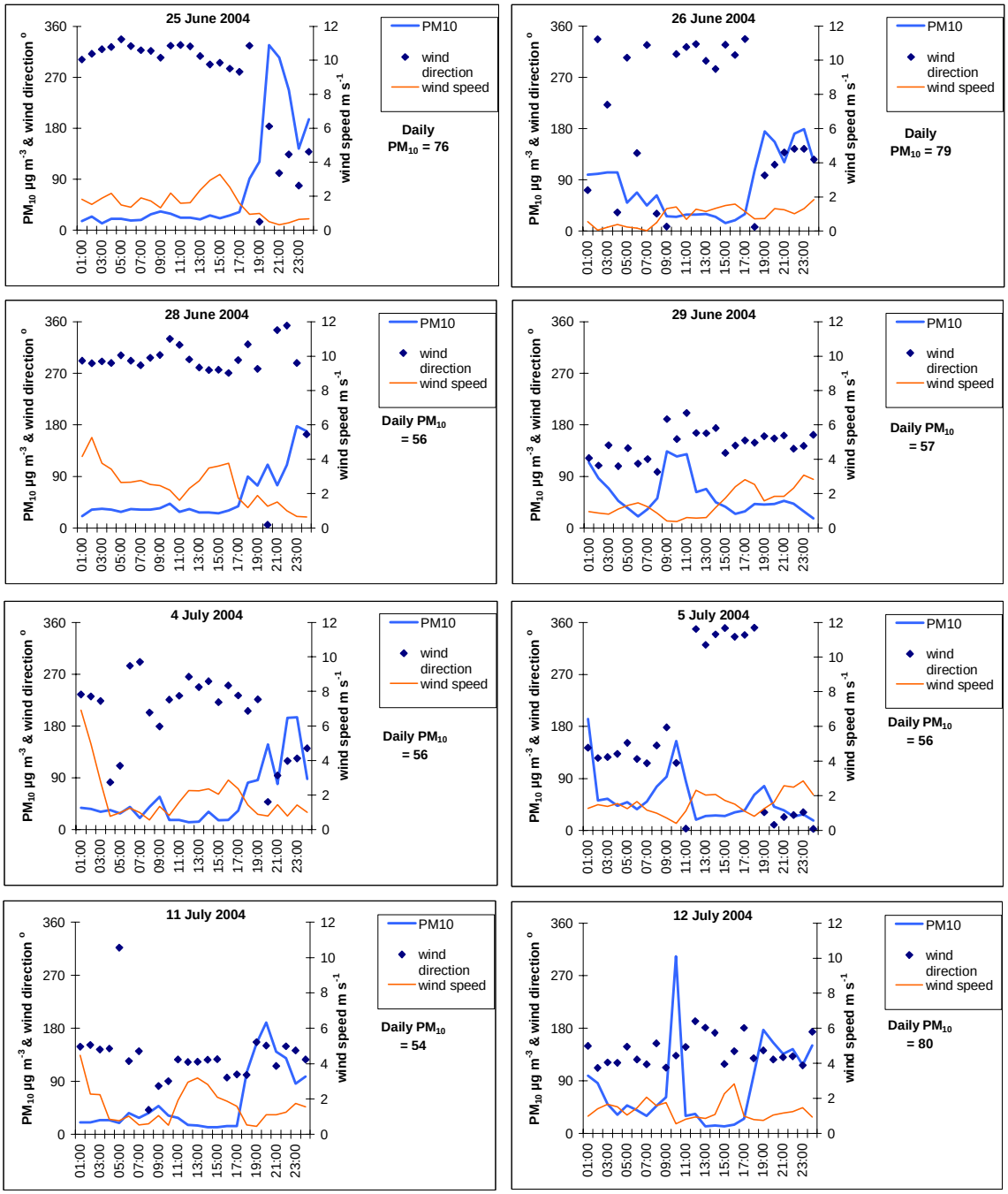

Figure 3-7: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded from 24 June to 12 July 2004

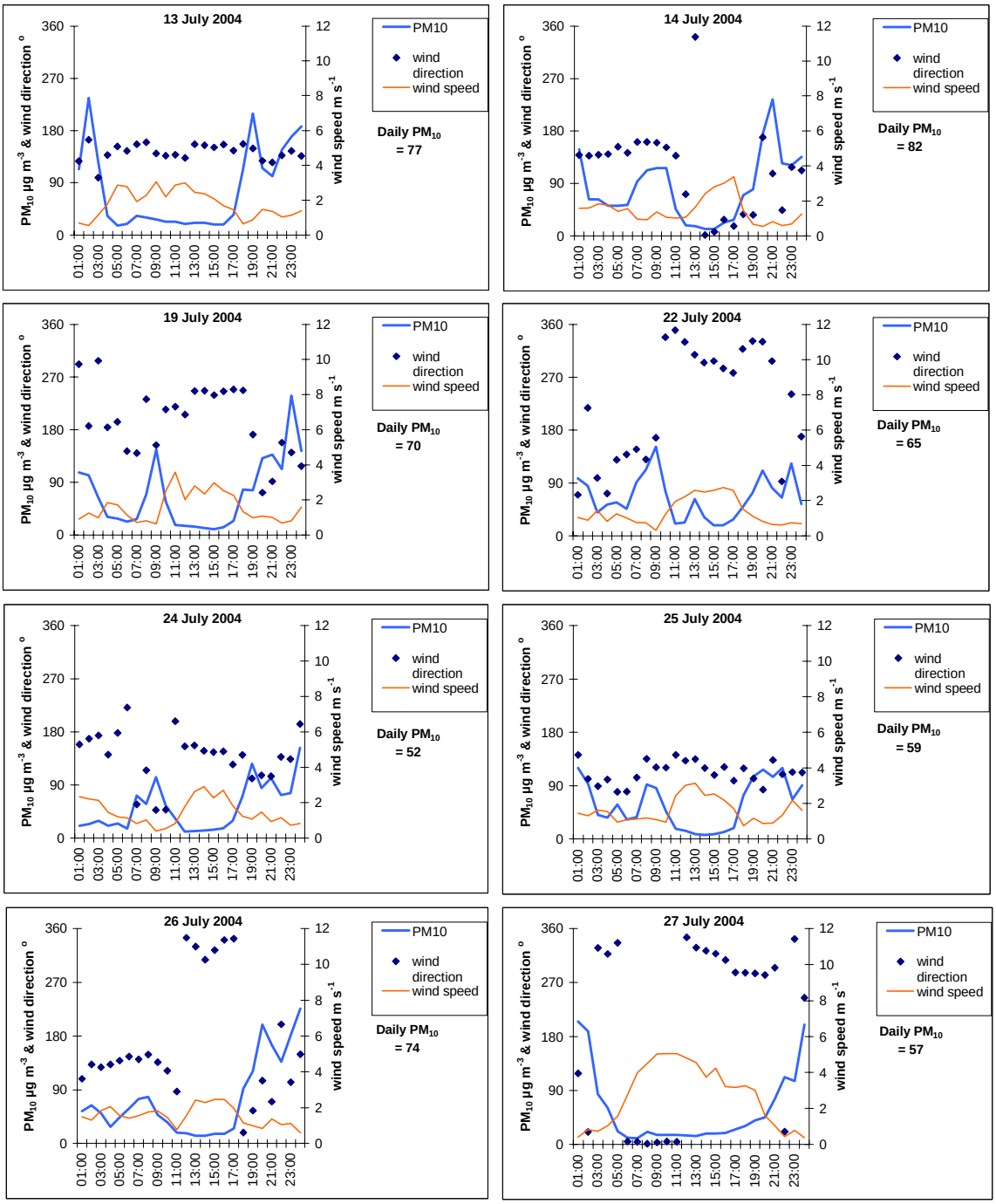

Figure 3-8: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded from 12 to 27 July 2004

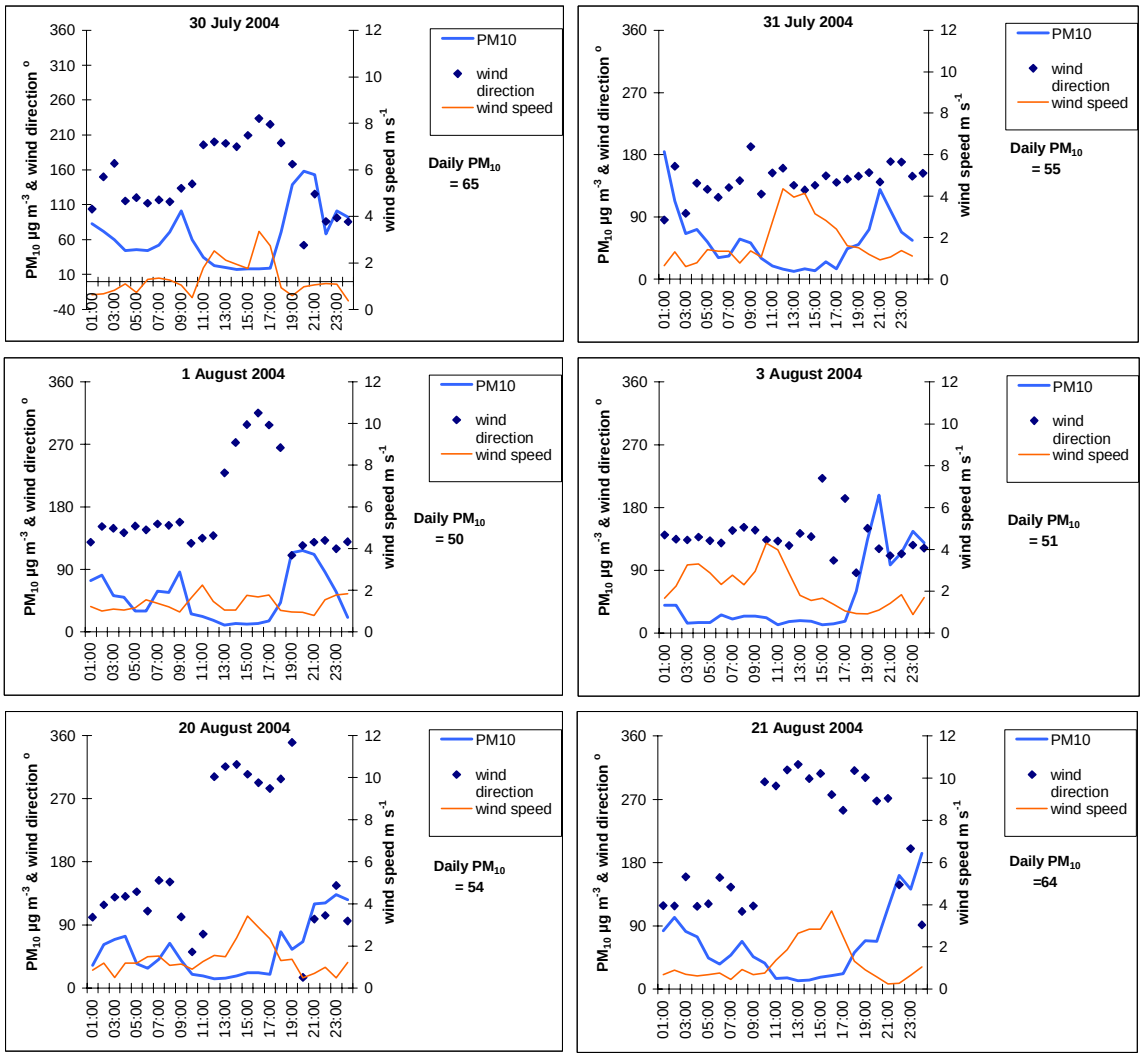

Figure 3-9: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded from 27 July to 21 August 2004

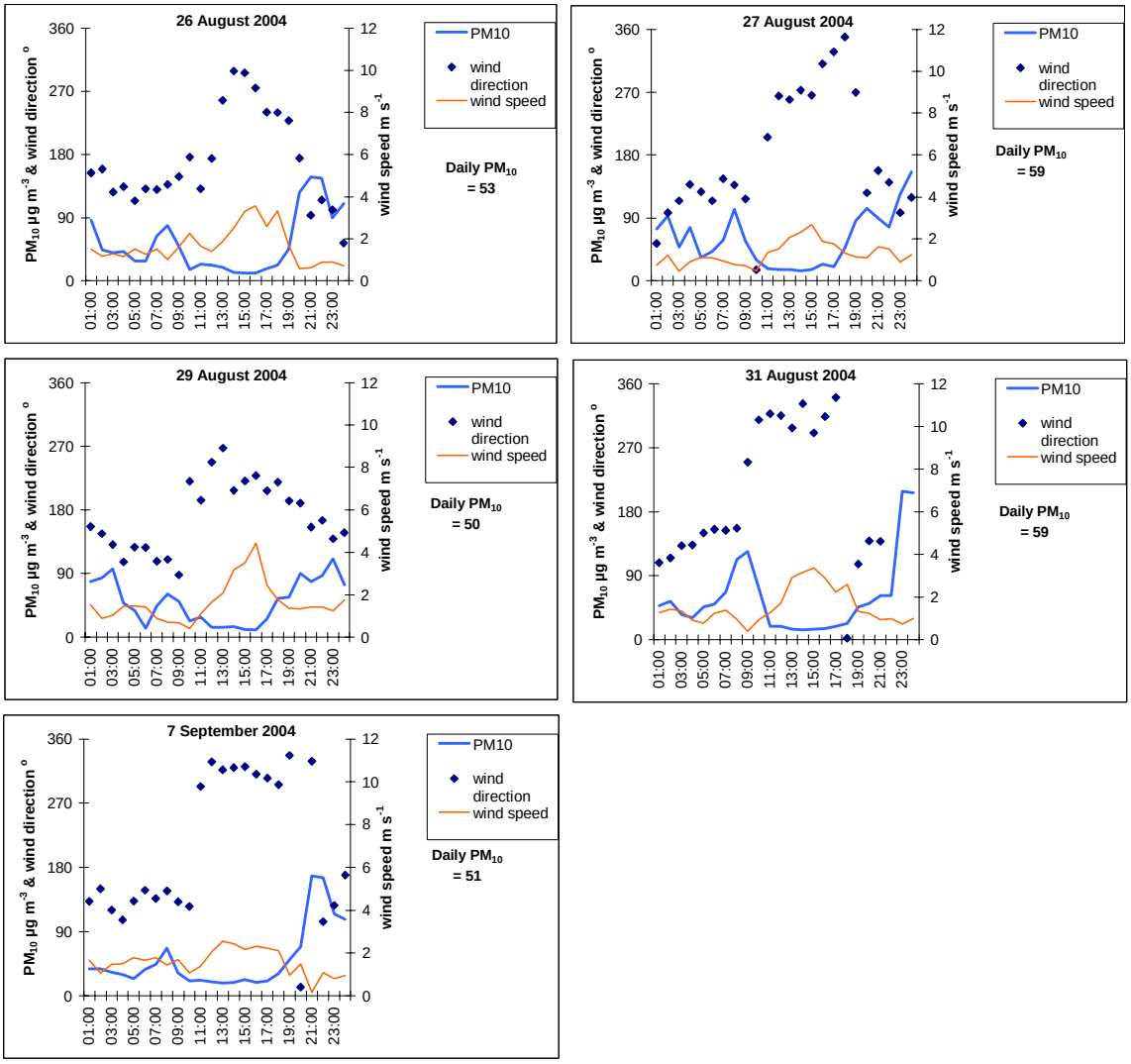

Figure 3-10: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded from 22 August to 7 September 2004

3.2 Meteorology

Meteorological data including wind speed and direction were collected at the air quality monitoring site in Tokoroa during 2004. Figure 3.11 compares hourly average wind speed and wind direction data for the months May to August for 2004.

All four months show periods of stable weather patterns lasting for periods greater than a week on occasions. For example, the wind direction was consistently from the south-east direction for the period from 15 to 28 May. Similarly, the wind was from the northwest from the 6 to 16 August.

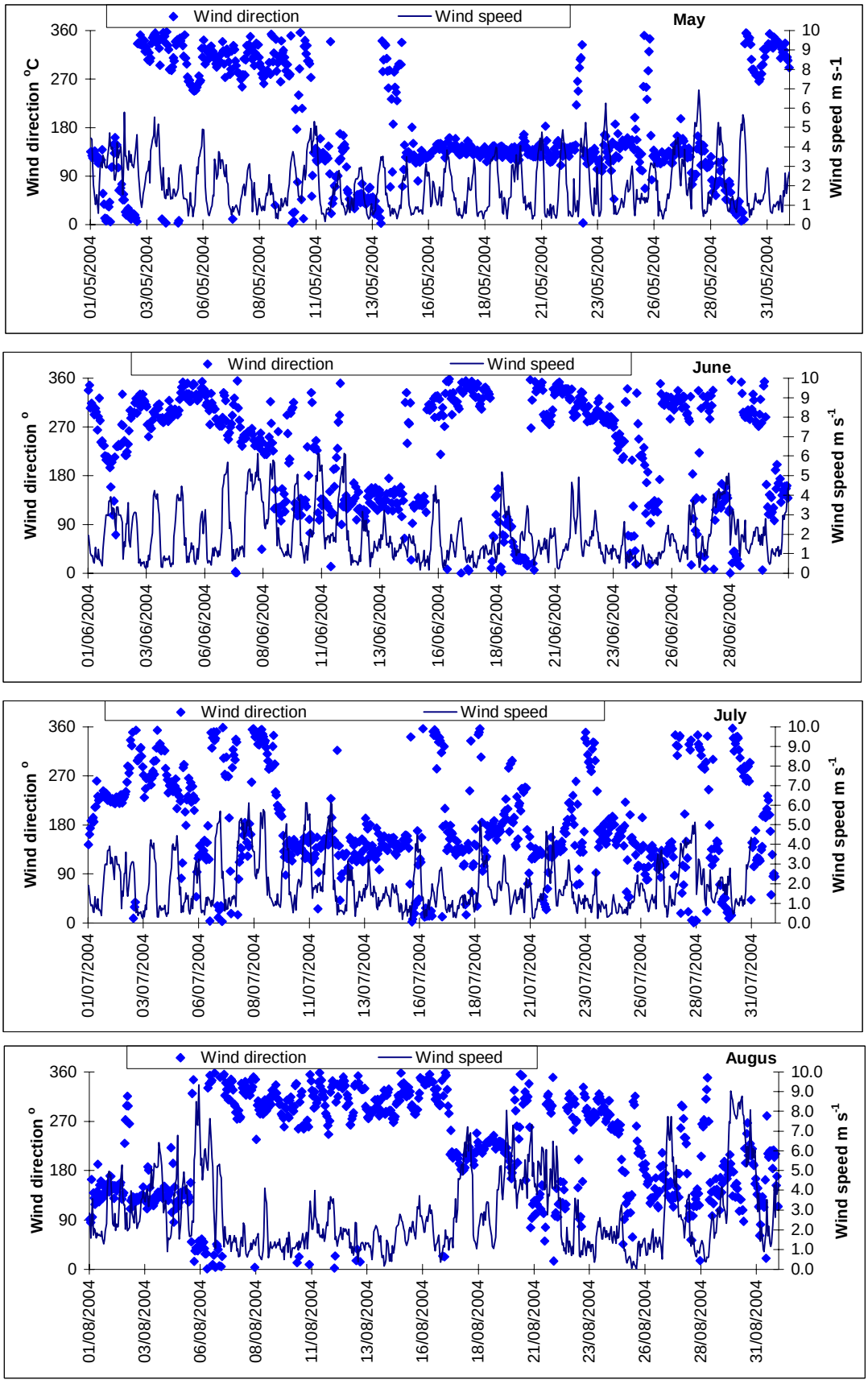

Figure 3-11: Hourly average wind direction and wind speed data for Tokoroa from May to August 2004

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

3.3 Comparison of meteorology and PM_{10} to 2003

A comparison of meteorological conditions during 2004 to 2003 was made with the aim of illustrating differences that may have resulted in the observed differences in PM_{10} concentrations. Figures 3.12 and 3.13 compare hourly average PM_{10}, wind speed and temperature data for the months January to December for 2003 and 2004.

Surprisingly there was no significant difference between 2003 and 2004 in wind speed, which is one of the key variables impacting on air quality. Differences in PM_{10} concentrations from January to June suggest higher baseline PM_{10} concentrations as well as larger variations during peak pollution times. Results for July to September show the baseline is similar but the peaks are higher during 2004. The latter observation may be the result of a more stable atmosphere and stronger temperature inversions during the evening and early morning periods. This effect cannot be evaluated with the meteorological data collected at this site.

Possible explanations for the higher baseline observed from December 2003 to June 2004 include:

- A new emissions source or variation to an existing source that occurred just for these months.
- Meteorological conditions.
- Instrumentation issues.

It is unlikely that the higher baseline concentrations measured from December 2003 to June 2004 occur as a result of meteorological conditions as the difference in concentrations occurs under a range of meteorological conditions. Moreover, it would be unusual for any emission source to have such a constant impact on PM_{10} concentrations across varying meteorological conditions.

Hourly average data were examined for minimum values each month for 2003 and 2004 to determine whether an offset in the instrumentation or data logging was a possibility. The lowest concentration measured from January to June 2004 was 7 µg m^{-3}, compared with 3 µg m^{-3} for 2003 indicating a difference of 4 µg m^{-3}. An equivalent minimum value for both years would have indicated that instrumentation offset was not an explanation, whereas in this case it is a possibility. Instrument records around November 2003 and June/July 2004 should be checked to determine any changes in instrument or logger settings that may have resulted in variations in recorded concentrations. It should be noted, however, that a difference of 4 µg m^{-3} is minimal relative to the increases observed in maximum PM_{10} concentrations.

The reason for variations in PM_{10} concentrations from 2003 to 2004 remains uncertain. While there appears to be some differences in baseline concentrations during the first half of the year, the difference in concentrations is greatest during the evening, night time and morning periods when meteorological conditions are most conducive to elevated pollution.

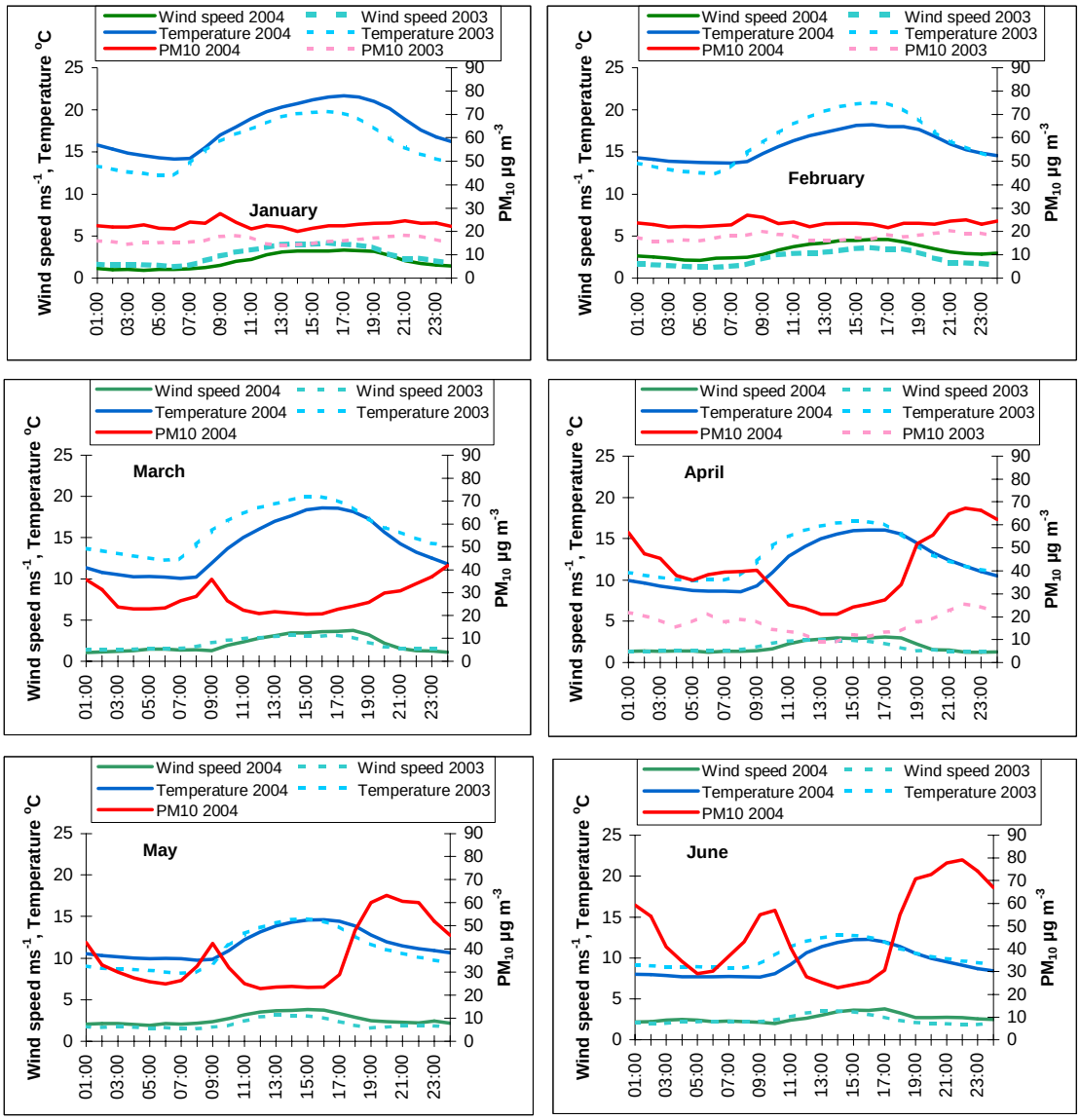

Figure 3-12: Hourly average PM10, wind speed and temperature values for 2003 and 2004 for each month from January to June

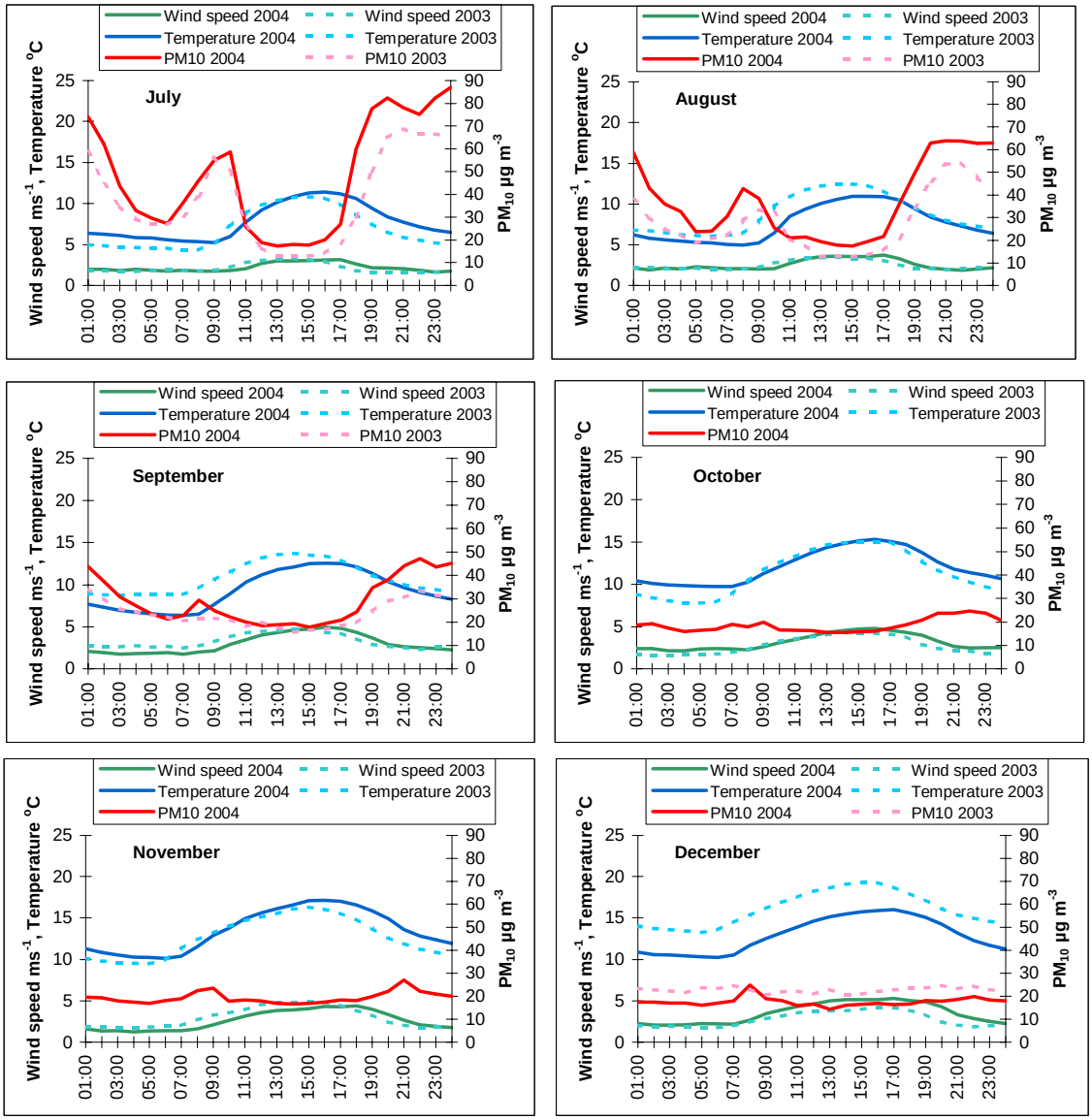

Figure 3-13: Hourly average PM10, wind speed and temperature values for 2003 and 2004 for each month from July to December

4 Air quality monitoring in Taupo

The air quality monitoring site in Taupo for 2004 was at the Gillies Street Reserve. 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).

The monitoring method for measuring PM_{10} concentrations in Taupo was gravimetric low volume sampling using a Partisol PM_{10} sampler. The sampling regime during 2004 was approximately one-day-in-three, with a midnight to midnight filter exposure period. The sampling was carried out by the Institute of Geological & Nuclear Sciences (GNS) on behalf of Environment Waikato.

A total of 105 samples was collected during 2004.

4.1 Concentrations of PM_{10}

Two exceedences of the 50 µg m^{-3} guideline for PM_{10} were measured during 2004. Extrapolating these data statistically for days when monitoring wasn't conducted suggests that around 6 breaches may have occurred during 2004. This is less than the

12 estimated for 2003 and the same as the number estimated for 2002. Concentrations of PM_{10} in Taupo would have been in excess of the NES for PM_{10} in each of these years.

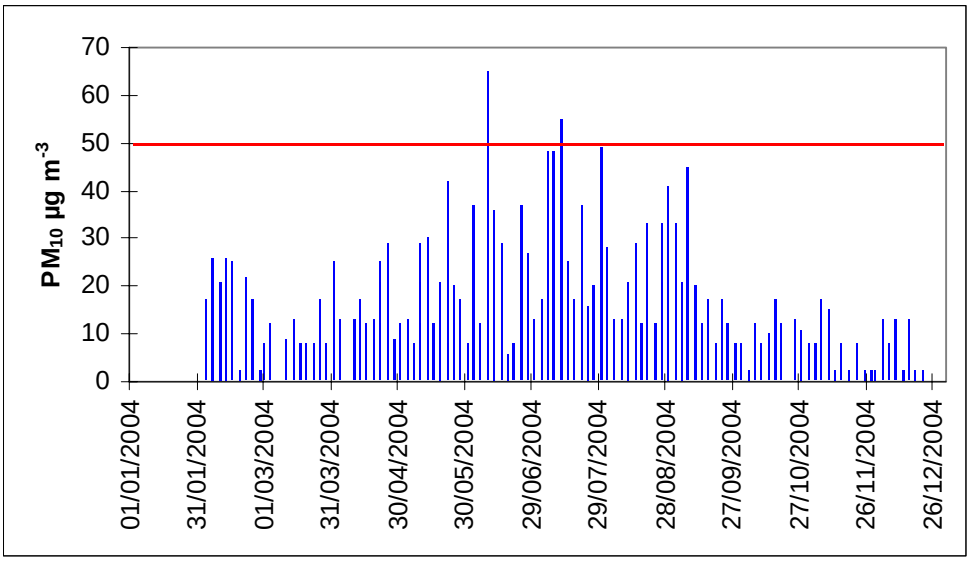

Figure 4-1: 24-hour average concentrations of PM10 in Taupo during 2004

The maximum measured PM_{10} concentration at Taupo during 2004 was 65 µg m^{-3}. This is similar to maximum values measured from 2002 to 2003 (62 µg m^{-3}, 57 µg m^{-3} and 53 µg m^{-3}). One day in three sampling suggests that the annual average PM_{10} concentration for Taupo for 2004 was around 17 µg m^{-3}. This compares to an annual average guideline for PM_{10} of 20 µg m^{-3} (MfE, 2002).

Seasonal variations in PM_{10} concentrations relative to the MfE air quality indicator categories are shown in Figure 4.2. This indicates that the guideline exceedences occurred during the months June and July, with 50% of the measurements in July being greater than 33 µg m^{-3}.

An emission inventory study carried out in Taupo for 2004 indicates that the main source of PM_{10} emissions is solid fuel burning for domestic home heating (Wilton, 2004).

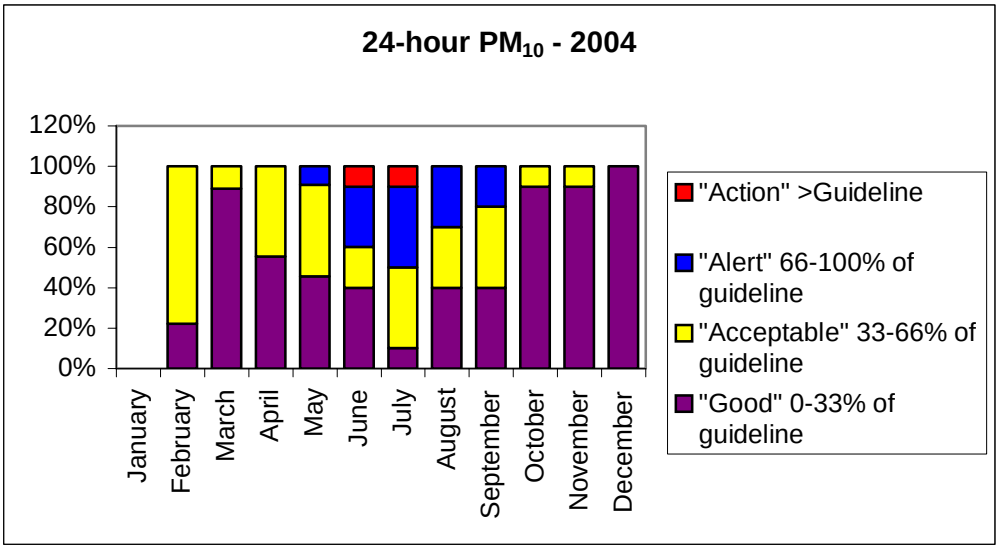

Figure 4-2: Comparison of PM10 concentrations measured in Taupo to MfE air quality indicator categories

A comparison of PM_{10} data for Taupo from 2001 to 2004 is shown in Table 4.1 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 2004

	PM_{10} 2001	PM_{10} 2002	PM_{10} 2003	PM_{10} 2004
"Good" 0-33% of guideline	43%	59%	52%	55%
"Acceptable" 33-66% of guideline	36%	33%	32%	30%
"Alert" 66-100% of guideline	18%	7%	12%	10%
"Action" >Guideline	2%	1%	4%	2%
Percentage of valid data	12%	21%	29%	29%
Annual average (µg m-3)	20	16	18	17
Guideline exceedences (extrapolated)	7	6	12	6
99.7 %ile concentration (µg m-3)	54	49	61	62
Annual maximum (µg m-3)	57	54	62	65

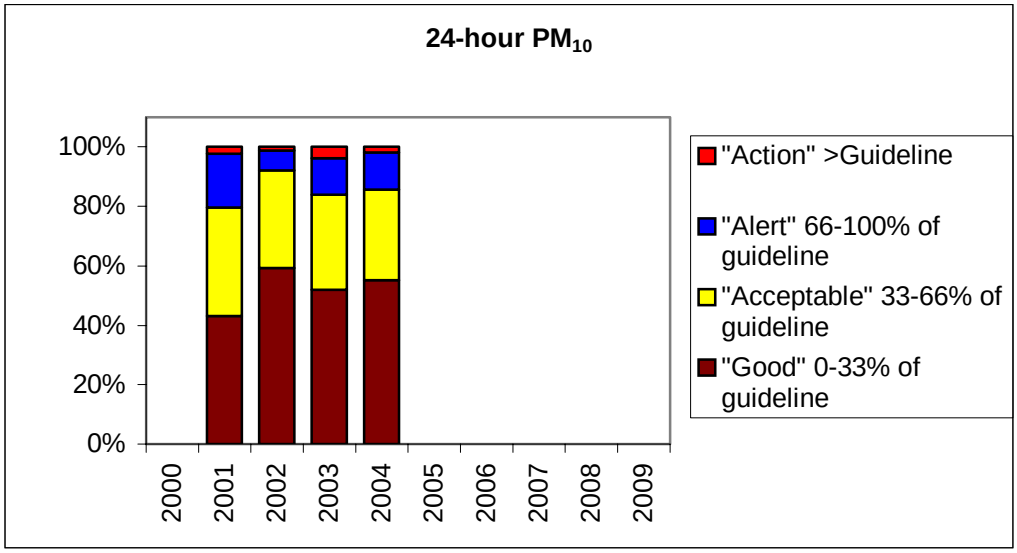

Figure 4-3: Comparison of PM10 concentrations measured in Taupo from 2001 to 2004 to MfE air quality indicator categories

5 Air quality monitoring in Te Kuiti

Air quality monitoring in Te Kuiti during 2004 was carried out at the Te Kuiti City Council Offices off Queen Street. This is the same site as used in 2003 and for 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). The site was operated and maintained by NIWA for Environment Waikato.

5.1 Concentrations of PM_{10}

Figure 5.1 shows the 24-hour average PM_{10} concentrations measured at the Te Kuiti monitoring site during 2004. This shows that PM_{10} concentrations in excess of 50 µg m^{-3} occurred on five days. The maximum measured PM_{10} concentration was 61 µg m^{-3} (24-hour average).

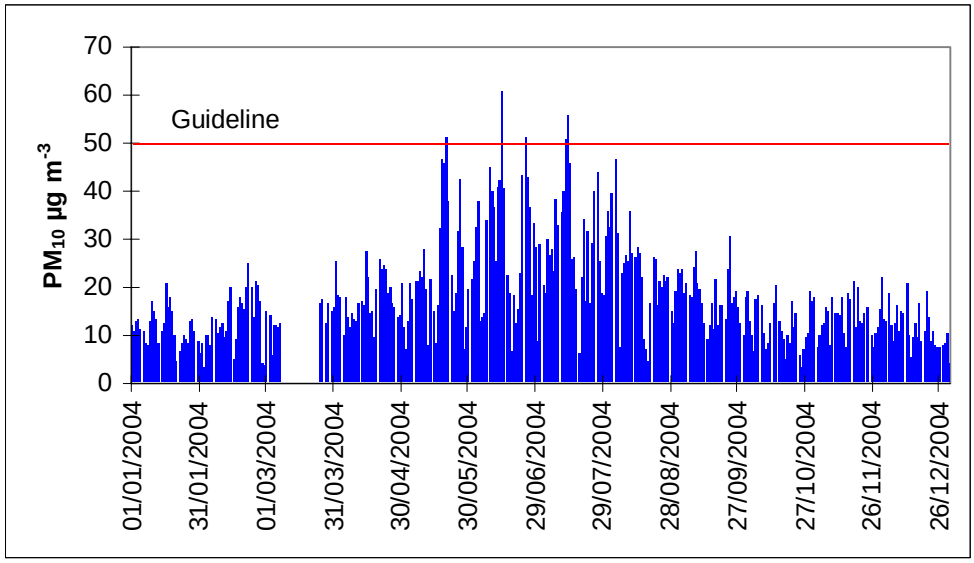

Figure 5-1: 24-hour average concentrations of PM10 in Te Kuiti during 2004

The annual average PM_{10} concentration for Te Kuiti for 2004 was 18 µg m^{-3}. This is less than the MfE annual average guideline (MfE, 2002) of 20 µg m^{-3}.

Seasonal variations in PM_{10} concentrations in Te Kuiti relative to the MfE air quality indicator categories are shown in Figure 5.2. As with other locations within the region, the poorest air quality occurs during the months May to August.

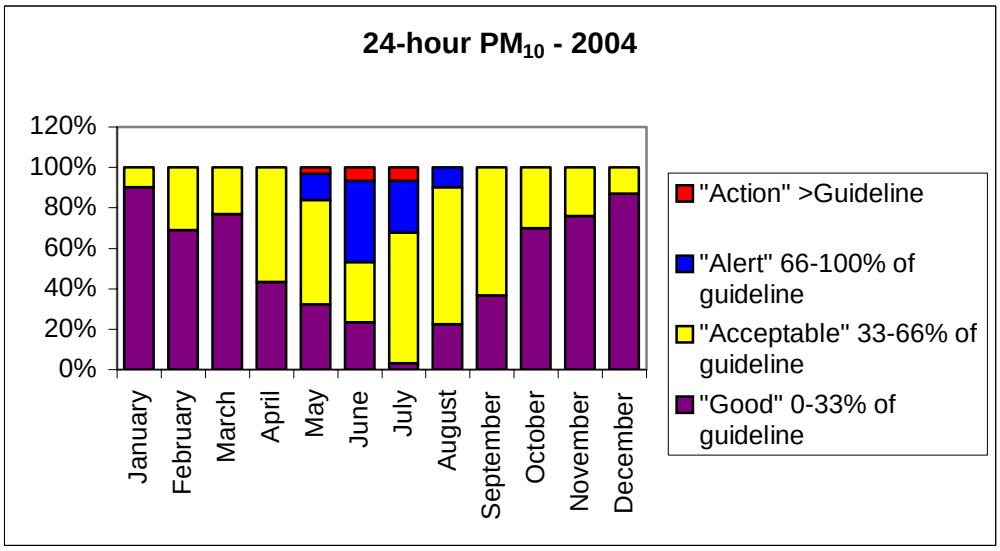

Figure 5-2: Comparison of PM10 concentrations measured in Te Kuiti to MfE air quality indicator categories

Figure 5.3 shows daily variations in PM_{10} concentrations, wind speed and wind direction on days when 24-hour average PM_{10} concentrations exceeded 50 µg m^{-3} during 2004. This shows PM_{10} exceedences occurring for very low wind speeds and a range of wind directions. Negative air temperatures were measured on 12 and 13 July in the early morning hours.

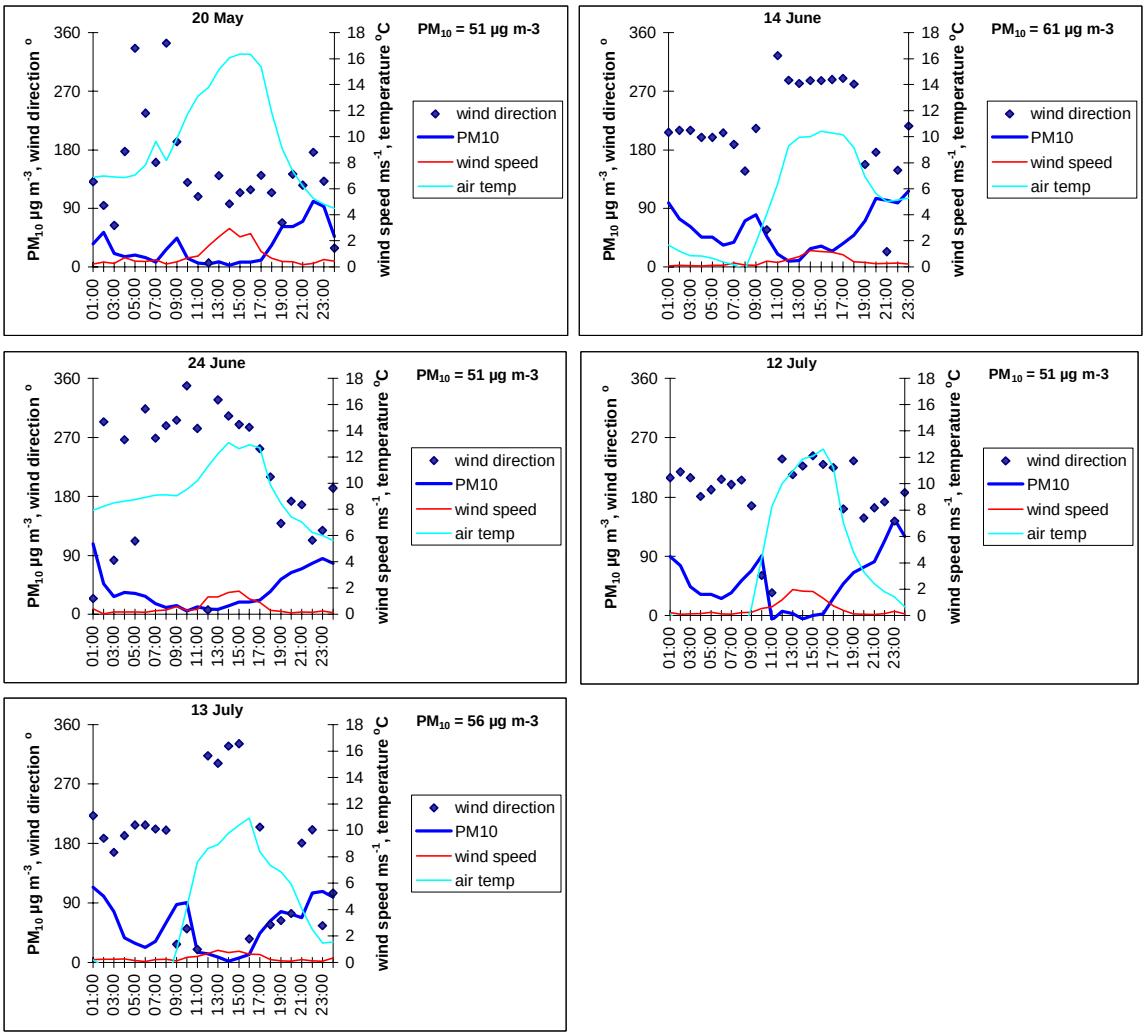

Figure 5-3: Daily variations in PM10, wind direction and wind speed on days the guideline was exceeded at Te Kuiti during 2004

Figure 5.4 compares PM_{10} concentrations measured during 2004 and 2003. Previous monitoring of PM_{10} in Te Kuiti during 1998 is not shown because of differences in the monitoring method. However, summary statistics from 1998 as well as 2003 and 2004 are shown in Table 5.1. Note that the 1998 values are likely to under-represent PM_{10} concentrations relative to 2003 and 2004 because of the differences in the monitoring methods.

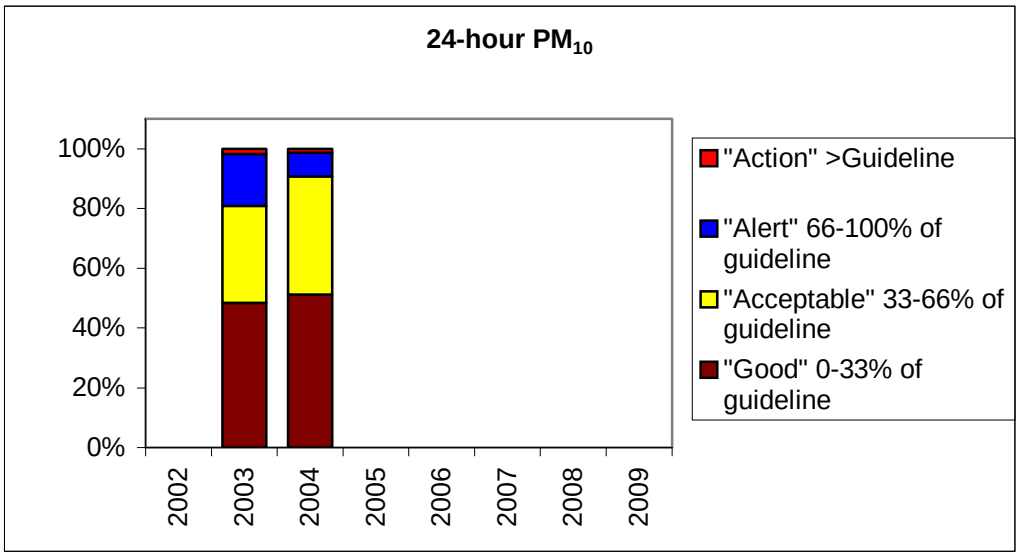

Figure 5-4: Comparison of PM10 concentrations in Te Kuiti to MfE air quality indicator categories for 2003 and 2004

Table 5-1: Summary statistics for PM10 data for Te Kuiti for 1998, 2003 and 2004

	PM_{10} 1998	PM_{10} 2003	PM_{10} 2004
"Good" 0-33% of guideline	61%	48%	51%
"Acceptable" 33-66% of guideline	35%	32%	40%
"Alert" 66-100% of guideline	4%	17%	8%
“Action” >Guideline	0%	2%	1%
Percentage of valid data	53%	63%	95%
Annual average (µg m-3)	16	18	18
Guideline exceedences (extrapolated)	0	5	5
99.5 %ile concentration (µg m-3)	42	56	56
Annual maximum (µg m-3)	42	59	61

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

5.2 Meteorology

Figure 5.5 shows wind speed and wind direction for the months May to August 2004 at the Te Kuiti air quality monitoring site. In comparison to other areas, e.g., Hamilton and Tokoroa, wind speeds were low on a large proportion of days during winter 2004, particularly the months May to July. The low wind speeds would suggest that the area is particularly susceptible to elevated air pollution. The relatively few number of exceedences may be related to infrequent or weak temperature inversions.

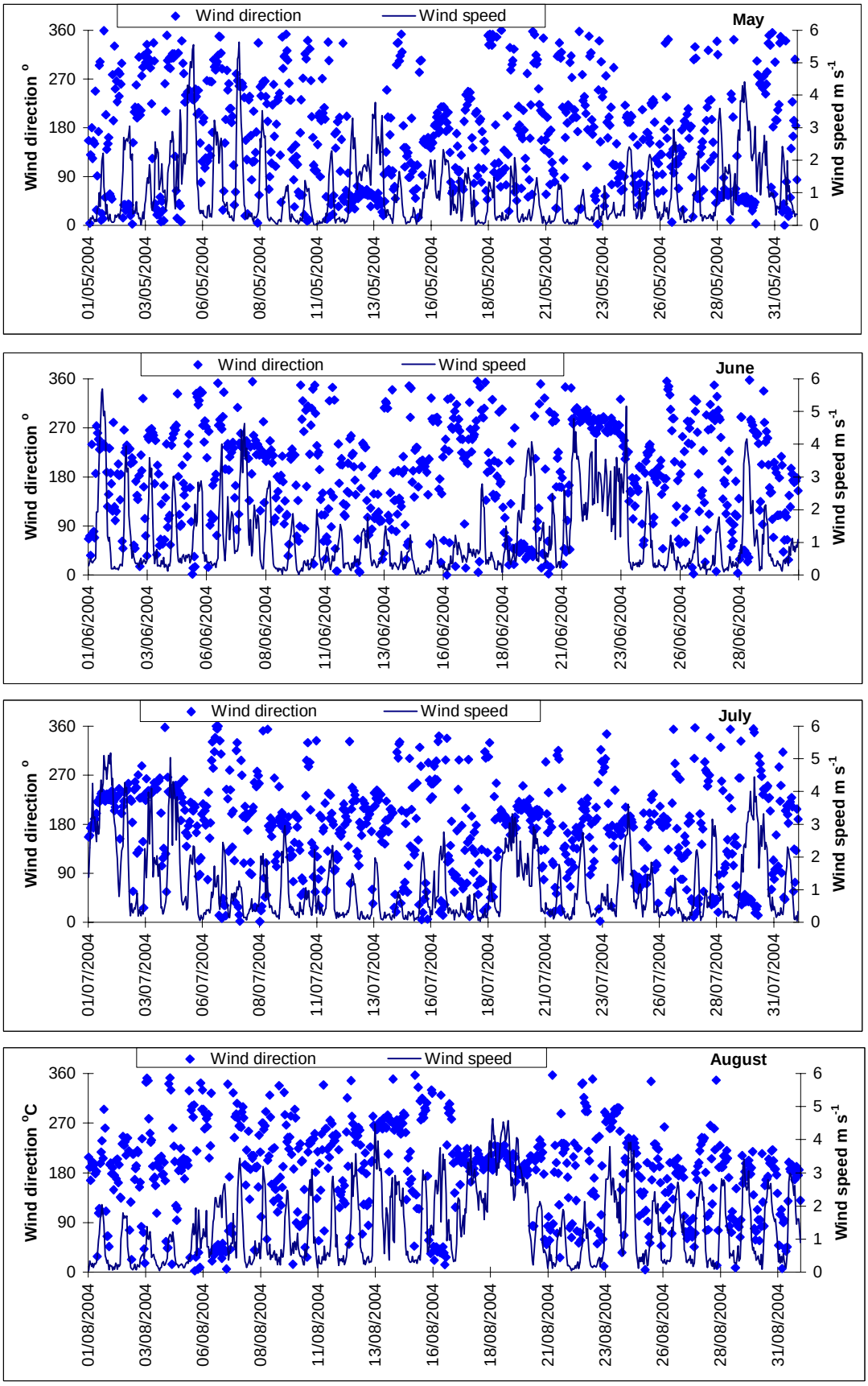

Figure 5-5: Hourly average wind direction and wind speed data for Te Kuiti from May to August 2004

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

6 Summary

Ambient air quality monitoring in the Waikato during 2004 was carried out at monitoring sites in Hamilton, Tokoroa and Taupo and Te Kuiti. Monitoring was limited to concentrations of PM_{10}, the main contaminant of concern in the Waikato at all sites except Hamilton, which also included CO and ozone. Results of ozone monitoring are reported elsewhere.

Of all the sites, the poorest air quality was measured in Tokoroa. Results for Tokoroa for 2004 were also worse than for previous years monitoring in this location, with 41 measured breaches of the 50 µg m^{-3} guideline and 40 breaches of the NES (which allows one breach of 50 µg m^{-3} per year). The maximum measured PM_{10} concentration during 2004 was 97 µg m^{-3} (24-hour average) compared with a previous maximum of 75 µg m^{-3}. The annual average PM_{10} concentration at Tokoroa was 31 µg m^{-3}, which is also higher than previous averages of around 24 µg m^{-3} and is in excess of the MfE guideline of 20 µg m^{-3}.

In Taupo, PM_{10} concentrations were similar to other years with two measured breaches and a maximum of 65 µg m^{-3}. Because the sampling regime is limited to monitoring one-day-in-three, the number of actual breaches is likely to be higher. Statistically extrapolating this value would suggest around six breaches for 2004.

PM_{10} concentrations in Te Kuiti were similar to 2003 with a maximum PM_{10} concentration of 61 µg m^{-3} and five measured breaches of the 50 µg m^{-3} guideline.

In Hamilton, one guideline breach was measured. The concentration reached 55 µg m^{-3}, which compares with a guideline of 50 µg m^{-3}. The annual average PM_{10} concentration was 17 µg m^{-3} compared to an annual PM_{10} guideline of 20 µg m^{-3}. Additional monitoring of PM_{10} using a gravimetric high-volume sampler during 2004 found no significant differences between the TEOM and high-volume sampler at PM_{10} concentrations greater than 33 µg m^{-3} and higher TEOM values on average below this concentration. Based on these results, no adjustments to the TEOM data for gravimetric equivalency were considered appropriate. Additional high-volume sampling during 2005 is recommended.

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 and the NES. The majority of CO concentrations were less than 33% of the guideline, falling within the “excellent” or “good” air quality categories. 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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