



# Annual air quality monitoring report for the Wellington region, 2007

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GW/EMI-G-08/158

October 2008



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## **1. Introduction**

Greater Wellington Regional Council (Greater Wellington) monitors ambient air quality at seven permanent monitoring stations in the Wellington region. Ambient air is outdoor air where people live, work and play (i.e., does not include air indoors or inside tunnels and vehicles). Air quality depends not only on the amount and types of pollutants discharged to air from human activities, but also on whether meteorological conditions are favourable for dispersion of those pollutants.

This report summarises ambient air quality monitoring data for the Wellington region measured during the 2007 calendar year. Monitoring results for the year are compared against national standards and guidelines for air quality that are designed to protect human health and the environment.

## 2. Ambient air quality monitoring programme

### 2.1 Objectives

The objectives of Greater Wellington's ambient air quality monitoring programme are to:

- Provide scientifically robust information about air quality in the Wellington region on which to base sound resource management and policy decisions; and
- Use standard monitoring methods that allow monitoring data to be compared against national guidelines<sup>1</sup> and standards<sup>2</sup>.

### 2.2 Regional airsheds

The Wellington region is divided into eight airsheds, constrained by valleys between steep hills or mountains (Figure 2.1). These airsheds are Wellington City, Karori, Porirua Basin (including Tawa valley and Pauatahanui Inlet), Lower Hutt Valley, Wainuiomata, Upper Hutt Valley, Wairarapa Valley and Kapiti Coast. Each airshed has a distinct microclimate, meteorological conditions and air quality pressures.

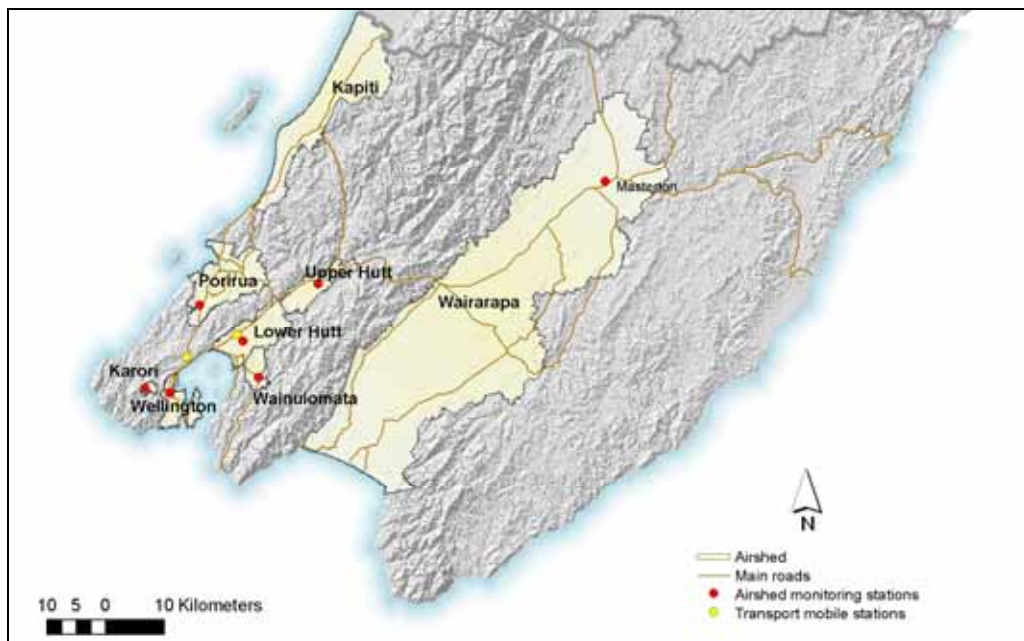


Figure 2.1: Location of current monitoring stations within airsheds

Monitoring stations have now been installed in seven of the eight airsheds, with the Kapiti Coast airshed station due to be installed by 30 June 2009. The Karori (Figure 2.2) and Porirua Basin airshed stations were both commissioned in mid-2007 and data from these stations are included in this report.

<sup>1</sup> Ambient air quality guidelines 2002 update. Air quality report no. 32. Ministry for the Environment, May 2002.

<sup>2</sup> Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004.



Figure 2.2: Monitoring station beside Terawhiti Bowling Club, Karori Park, Wellington

### 2.3 Monitoring sites

Permanent monitoring stations are required to assess trends in air quality and to determine compliance with national standards and guidelines. Air quality information is also used for resource management purposes, such as assessing the impact of resource consent proposals. At least three years of continuous data are needed before any trends become evident and useful comparisons can be made between sites. In 2007, Greater Wellington operated seven permanent monitoring sites employing continuous monitoring instruments (Table 2.1).

Meteorological instruments for recording parameters such as wind speed, wind direction and temperature are co-located at each monitoring site to assist with the interpretation of air quality data. Wind roses showing relative wind speeds by wind direction during the monitoring period at each monitoring site are presented in Appendix 1.

Table 2.1: Permanent monitoring sites operated in 2007

| Site               | Station                  | Airshed           | Location                         | Pollutants monitored                   | Site established |
|--------------------|--------------------------|-------------------|----------------------------------|--|------------------|
| Wellington central | Corner V                 | Wellington City   | Corner Victoria & Vivian Streets | PM <sub>10</sub> , CO, NO <sub>x</sub> | 2004             |
| Lower Hutt         | Birch Lane               | Lower Hutt Valley | Phil Evans Reserve               | PM <sub>10</sub> , CO, NO <sub>x</sub> | 2001             |
| Wainuiomata        | Wainuiomata Bowling Club | Wainuiomata       | Moohan Street                    | PM <sub>10</sub>                       | 2006             |
| Upper Hutt         | Savage Park              | Upper Hutt Valley | Savage Crescent                  | PM <sub>10</sub> , CO, NO <sub>x</sub> | 2005             |
| Masterton          | Wairarapa College        | Wairarapa Valley  | Cornwell Street                  | PM <sub>10</sub> , CO, NO <sub>x</sub> | 2002             |
| Tawa               | Duncan Park              | Porirua           | Linden Street                    | PM <sub>10</sub> , CO, NO <sub>x</sub> | 2007             |
| Karori             | Terawhiti Bowling Club   | Karori            | Karori Park                      | PM <sub>10</sub> , CO, NO <sub>x</sub> | 2007             |

## 2.4 Air pollutants monitored

The pollutants currently monitored in the Wellington region are particulate matter (PM<sub>10</sub>), carbon monoxide (CO) and nitrogen oxides (NO<sub>x</sub>) which include nitrogen dioxide (NO<sub>2</sub>) and nitric oxide (NO). These are the contaminants emitted in the greatest amounts throughout the region and all have known adverse human health effects when concentrations in air are elevated. The two other pollutants regulated by the national standards, sulphur dioxide (SO<sub>2</sub>) and ozone (O<sub>3</sub>), are not presently monitored in the region. Meteorological conditions in the region are not usually conducive to the formation of ozone and there are no major point source emissions of sulphur dioxide.

### 2.4.1 Particulate matter (PM<sub>10</sub>)

Particulate matter is a mixture of solid particles and liquid droplets that are dispersed in air. PM<sub>10</sub> is that portion of particulate matter with an equivalent aerodynamic cross-section less than 10 micrometres. This size fraction is small enough to be inhaled into the respiratory system.

Particulate matter arises from human activities and from natural sources. Sources of PM<sub>10</sub> in the Wellington region include:

- Domestic solid fuel heating (e.g., wood burners)
- Motor vehicles, particularly from diesel-fuelled vehicles
- Industrial combustion processes
- Quarrying activities
- Natural sources such as sea salt and wind-blown soil particles



Epidemiological studies show adverse health effects from both short-term and long-term exposure to PM<sub>10</sub>. However, a threshold below which there are no observed adverse effects has not been reliably established to date.

The adverse health effects associated with exposure to PM<sub>10</sub> range from increases in the number of restricted activity days to increases in hospital admissions and premature deaths for people with existing lung and heart disease.

The short-term daily average limit set by the national standard and the long term annual average national guideline value are both designed to minimise (not eliminate) adverse health effects associated with PM<sub>10</sub> exposure. National standards and guidelines for PM<sub>10</sub> are presented in section 3 of this report.

#### 2.4.2 Carbon monoxide

Carbon monoxide (CO) is a colourless and odourless gas produced by the incomplete combustion of carbon-containing fuels such as petrol and diesel used by motor vehicles or wood and coal used by domestic appliances or industrial boilers. Motor vehicles are the main source of carbon monoxide in urban areas.

When inhaled, carbon monoxide reduces the oxygen carrying capacity of the blood and, depending on its concentration, causes a range of adverse health effects. The national standards and guidelines (described in section 3 of this report) are set at a level to protect susceptible groups, such as those with existing heart disease, children and developing foetuses.

#### 2.4.3 Nitrogen dioxide

Nitrogen dioxide (NO<sub>2</sub>) arises from combustion processes, with vehicle emissions being the main source in urban areas. Vehicle exhausts contain a mixture of nitrogen dioxide and nitric oxide (NO), collectively known as oxides of nitrogen (NO<sub>x</sub>). Most of the NO<sub>x</sub> discharged from vehicle exhausts is in the form of nitric oxide which is subsequently converted to nitrogen dioxide by oxidation.

Nitrogen dioxide forms a brown and acidic gas in the atmosphere and can be seen as a haze over some cities during periods of calm weather and heavy traffic congestion. As well as contributing to poor visibility, nitrogen dioxide has adverse health effects such as lung inflammation and eye, nose and throat irritation.

The national standard and national guideline concentration thresholds (described in section 3 of this report) are designed to protect children, asthmatics and adults with chronic respiratory and cardiac conditions.

## 2.5 Monitoring instruments and methods

PM<sub>10</sub> is monitored by Rupprech & Patashnick TEOM series 1400AB Ambient Particulate Monitors at Masterton, Tawa and Lower Hutt; and by ThermoElectron Corp FH62 C14 beta attenuation monitors at the remainder of the stations. Both of these instruments are designated as automated methods equivalent to the United States Code of Federal Regulations (Title 40 – Protection of the Environment, Volume 2, Part 50, Appendix J: Reference Method for the Determination of Particulate Matter as PM<sub>10</sub> in the Atmosphere) and therefore comply with the monitoring method specified by the national standard.

Carbon monoxide is monitored using CO Gas Filter Correlation Infrared Analysers in accordance with AS3580.7.1:1992 using API 300 series analysers at all stations apart from Tawa where an Ecotech ML 9830 instrument is used.

Nitrogen dioxide is monitored using NO<sub>x</sub> Chemiluminescence Analysers in accordance with AS3580.5.1:1993 using API 200 series analysers at all stations apart from Tawa where an Ecotech ML 9841B instrument is used.

All pollutants are monitored continuously with instruments that are connected by digital interface to dataloggers. All logged data are stored as five or 10 minute averages at New Zealand Standard Time (NZST).



Senior monitoring officer, Darren Li, carries out maintenance on a nitrogen dioxide analyser at the Wellington central monitoring station



Monitoring officer, Karl Watson, calibrates a carbon monoxide analyser inside the Wellington central monitoring station

## **2.6 Data quality and disclaimer**

Greater Wellington's Environmental Monitoring and Investigations Department collects, checks and archives air quality data in accordance with a Quality Management System certified by Telarc Limited as meeting the requirements of AS/NZ ISO 9001:2000. Data may be amended or revised, where necessary and without notice, at any time.

## **2.7 Data reporting**

Summary statistics used in this report are adopted from the Ministry for the Environment's (2000) good practice guide. PM<sub>10</sub> and NO<sub>2</sub> values are rounded up to the nearest whole number and CO concentrations are reported to one decimal place. The reported percentiles for each contaminant are interpolated from the data and therefore do not represent actual values.

### 3. Air quality guidelines and standards

#### 3.1 National environmental standards for air quality

The national environmental standards for air quality (national standards) specify minimum requirements for outdoor air quality that provide a consistent level of protection for human health and the environment. Table 3.1 shows the concentration limits that apply to the three pollutants<sup>3</sup> currently monitored by Greater Wellington.

Table 3.1: National environmental standards for air quality

| Contaminant      | Threshold concentration | Averaging period        | Permissible excess per 12 month period |
|------------------|-------------------------|-------------------------|--|
| PM <sub>10</sub> | 50 µg/m <sup>3</sup>    | 24-hour mean            | One 24-hour period                     |
| Carbon monoxide  | 10 mg/m <sup>3</sup>    | 8-hour mean<br>(moving) | One 8-hour period                      |
| Nitrogen dioxide | 200 µg/m <sup>3</sup>   | 1-hour mean             | Nine hours                             |

#### 3.2 National ambient air quality guidelines

National ambient air quality guidelines (national guidelines) were established by the Ministry for the Environment (MfE) in 1994 and revised in 2002. A number of these guideline values now have been adopted as national standards. However, the guidelines that are not superseded by national standards remain valid and provide a 1-hour short-term exposure value for carbon monoxide, a daily limit for nitrogen dioxide and an annual average value for PM<sub>10</sub>. Table 3.2 shows the national guideline values for the concentrations in air of the three pollutants currently monitored by Greater Wellington.

Table 3.2: National ambient air quality guidelines, from MfE (2002)

| Contaminant      | Guideline value       | Averaging time   |
|------------------|-----------------------|------------------|
| PM <sub>10</sub> | 20 µg/m <sup>3</sup>  | Annual (24-hour) |
| Carbon monoxide  | 30 mg/m <sup>3</sup>  | 1-hour           |
| Nitrogen dioxide | 100 µg/m <sup>3</sup> | 24-hour          |

#### 3.3 Air quality categories

A useful way to illustrate the significance of ambient air quality monitoring results is to show the percentage of time that monitoring results fall into different categories (Table 3.3). This method is described by MfE (1997).

<sup>3</sup> As mentioned in Section 2.4, ozone and sulphur dioxide are also regulated by the national standards but are not monitored in the Wellington region as concentrations of these contaminants are unlikely to be of concern.

**Table 3.3: Air quality categories**

| Category   | Measured values                                | Comment   |
|------------|--|---|
| Action     | Exceed guideline/standard                      | Completely unacceptable by national and international standards.  |
| Alert      | Between 66% and 100% of the guideline/standard | A warning level which can lead to guidelines being exceeded if trends are not curbed.   |
| Acceptable | Between 33% and 66% of the guideline/standard  | A broad category, where maximum values might be of concern in some sensitive locations, but are generally at a level that does not warrant dramatic action. |
| Good       | Between 10% and 33% of the guideline/standard  | Peak measurements in this range are unlikely to affect air quality.   |
| Excellent  | Less than 10% of the guideline/standard        | Of little concern.  |

The main intention of the air quality categories is to present the results of ambient monitoring in a manner that assists in setting goals for air quality management. Greater Wellington's ten-year plan (2006-2016)<sup>4</sup> has set a long-term target of no recorded instances when air pollution reaches the 'alert' level of the national ambient air quality guideline (66% or higher than the limit set by the relevant national ambient air quality standard) by 30 June 2016.

<sup>4</sup> Greater Wellington's Long-term Council Community Plan for the region for 2006-16.

## 4. Particulate matter (PM<sub>10</sub>)

### 4.1 Compliance with the national standard

Ambient PM<sub>10</sub> concentrations recorded at the various air quality monitoring sites within the Wellington region have been assessed against the national standard of 50 µg/m<sup>3</sup> (24-hour average) (Table 4.1).

Table 4.1: Descriptive statistics PM<sub>10</sub> µg/m<sup>3</sup> (24-hour average), 2007

| Site               | Max. | 2 <sup>nd</sup> highest | 99.9 <sup>th</sup> %ile | 99.5 <sup>th</sup> %ile | 75 <sup>th</sup> %ile | Median | 25 <sup>th</sup> %ile | Data completeness <sup>5</sup> |
|--------------------|------|-------------------------|-------------------------|-------------------------|-----------------------|--------|-----------------------|--------------------------------|
| Wellington central | 27   | 27                      | 27                      | 24                      | 16                    | 13     | 11                    | 99.4%                          |
| Lower Hutt         | 32   | 30                      | 31                      | 27                      | 16                    | 13     | 11                    | 97.5%                          |
| Wainuiomata        | 51   | 38                      | 46                      | 37                      | 15                    | 12     | 8                     | 97.2%                          |
| Upper Hutt         | 45   | 45                      | 41                      | 31                      | 14                    | 11     | 8                     | 98.9%                          |
| Masterton          | 43   | 42                      | 43                      | 41                      | 17                    | 14     | 10                    | 98.6%                          |
| Tawa               | 54   | 40                      | 51                      | 39                      | 22                    | 18     | 14                    | 64.9%                          |
| Karori             | 29   | 27                      | 28                      | 27                      | 15                    | 12     | 9                     | 45.4%                          |

The datasets for Tawa and Karori are incomplete as monitoring only started in at these sites in May and June 2007, respectively. The monitoring results for these two stations may not, therefore, be truly representative.

During the reporting period the threshold concentration for PM<sub>10</sub> was exceeded on 28 June 2007 at Wainuiomata (51 µg/m<sup>3</sup>) and at Tawa (54 µg/m<sup>3</sup>) monitoring stations. Levels at the Upper Hutt monitoring station were also elevated on this day, reaching 45 µg/m<sup>3</sup>.

There were no breaches of the national standard in 2007 in any of the Greater Wellington airsheds as the standard allows one 24-hour period per 12-month period to exceed the 51 µg/m<sup>3</sup> threshold concentration.

### 4.2 Assessment against the national guideline

Ambient PM<sub>10</sub> concentrations recorded at the various air quality monitoring sites (with more than 75% annual data capture) have been assessed against the national guideline of 20 µg/m<sup>3</sup> (annual average based on daily data). Annual means for 2007 are below the national guideline (Table 4.2).

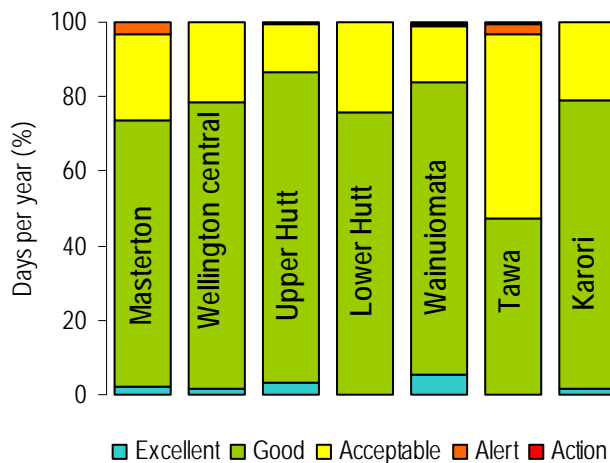
<sup>5</sup> Percentage of valid averaging periods in 2007 (maximum of 25% missing record allowed per averaging period).

Table 4.2: PM<sub>10</sub> annual average concentrations, 2007

| Monitoring site    | Annual mean (µg/m <sup>3</sup> ) based on 24-hour averages |
|--------------------|--|
| Wellington central | 14   |
| Lower Hutt         | 14   |
| Upper Hutt         | 12   |
| Masterton          | 14   |
| Wainuiomata        | 12   |

### 4.3 Assessment against air quality categories

Ambient PM<sub>10</sub> daily averages are reported as the percentage of days per year in each air quality category (Figure 4.1). A breakdown of the actual number of days in 2007 by air quality category is given in Appendix 2 (Table A2.1). There were two days in Upper Hutt, three days in Lower Hutt, seven days in Tawa and 11 days in Masterton where the 'alert' level was reached. There was one day in both Wainuiomata and Tawa when the 'action' level (equivalent to exceeding the national standard) was reached.

Figure 4.1: PM<sub>10</sub> (24-hour average) by air quality category, 2007

### 4.4 Gravimetric monitoring at Wainuiomata

Since September 2000, PM<sub>10</sub> has been monitored gravimetrically by high volume sampler at Wainuiomata Bowling Club. The monitoring frequency was one day in six until October 2001 when monitoring frequency was increased to one day in three until September 2007 when monitoring ceased. This monitoring method measured concentrations from midday to midday and is not directly comparable to the national standard which stipulates measurement from midnight to midnight. However, the high volume sampling programme provided valuable information to characterise air quality in Wainuiomata and indicated that exceedances of the national standard were likely. Results for 2007 are shown in Figure 4.2.

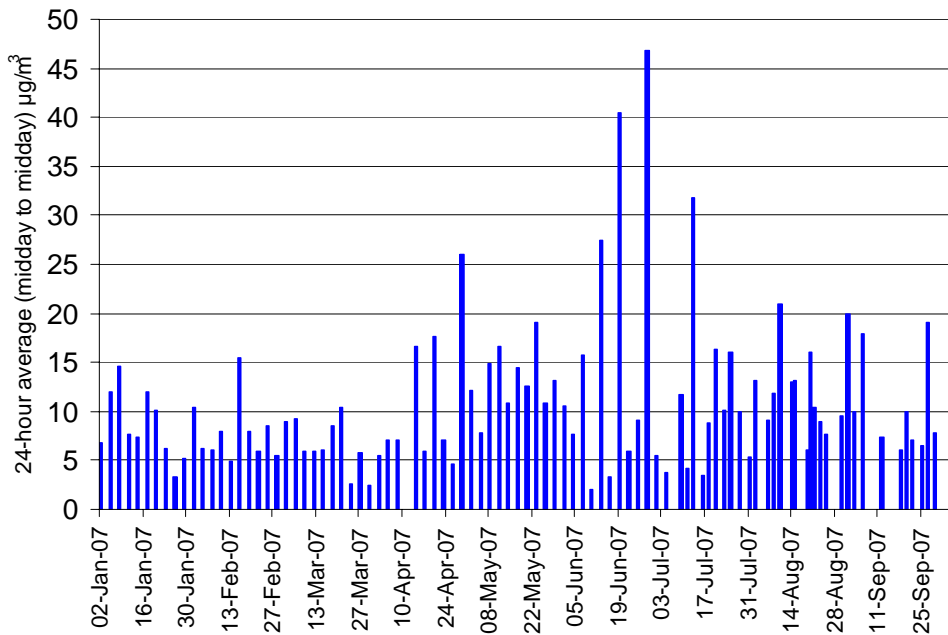


Figure 4.2: Gravimetric PM<sub>10</sub> (24-hour averages) at Wainuiomata, 2007

Continuous monitoring of PM<sub>10</sub> to assess compliance with the national standard using a beta attenuation monitor (FH62 C14) started in June 2006. A comparison of the continuous and gravimetric monitoring methods using the same averaging period shows good agreement between the methods. Studies elsewhere in the country have shown that beta attenuation monitors can underestimate the ‘true’ concentration of particulate during the winter months because sampled air is heated by the instrument before the particulate mass is determined (Bluett et al. 2007). This heating process causes some of the volatile particulate mass to be destroyed before it is measured.

PM<sub>10</sub> concentrations recorded by the two methods are shown in Figure 4.3. During the period that the two instruments were co-located, the maximum 24-hour value measured by high-volume sampler on 28 June 2007 was 47 µg/m<sup>3</sup>; corresponding to an average of 49 µg/m<sup>3</sup> (midday to midday) on the beta

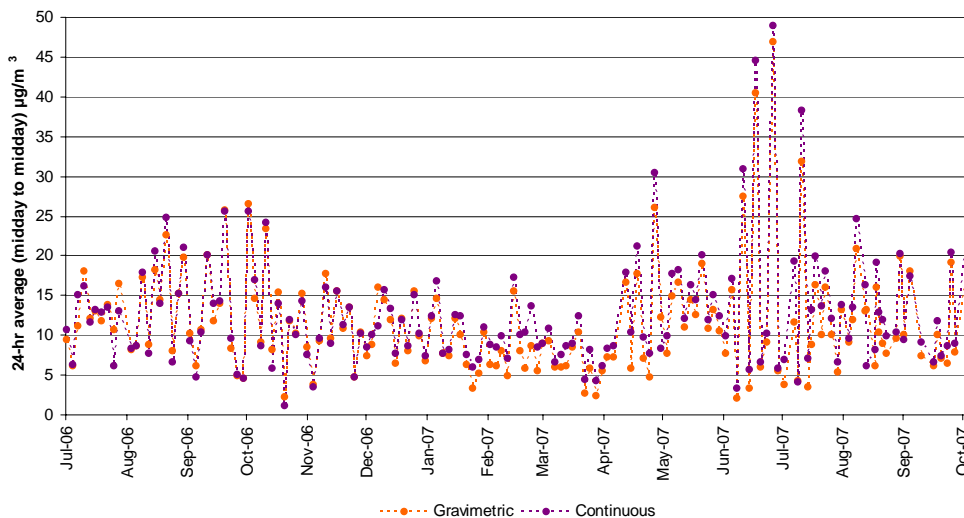


Figure 4.3: Gravimetric and continuous PM<sub>10</sub> (24-hour averages) at Wainuiomata, 2007



attenuation monitor. When the concentration recorded by the beta attenuation monitor on this date is averaged from midnight to midnight, the resulting value of  $51\mu\text{g}/\text{m}^3$  exceeds the national standard.

#### 4.5 PM<sub>10</sub> exceedance profile

Particulate matter concentrations in air change throughout the day depending on meteorological conditions, traffic volumes and congestion, and patterns of wood burner use. Figure 4.4 shows changes in hourly concentrations of PM<sub>10</sub> over a 24-hour period when the national standard was exceeded at Wainuiomata on 28 June 2007 due to domestic heating emissions. Hourly PM<sub>10</sub> concentrations exhibited a morning peak around 9 am followed by another higher peak at midnight. On this day hourly average temperatures were below 0°C until 11 am and hourly average wind speeds were less than 1 m/s throughout the 24-hour period (Figure 4.5). These meteorological conditions are conducive to poor dispersion of the PM<sub>10</sub> emitted by home fires and other sources.

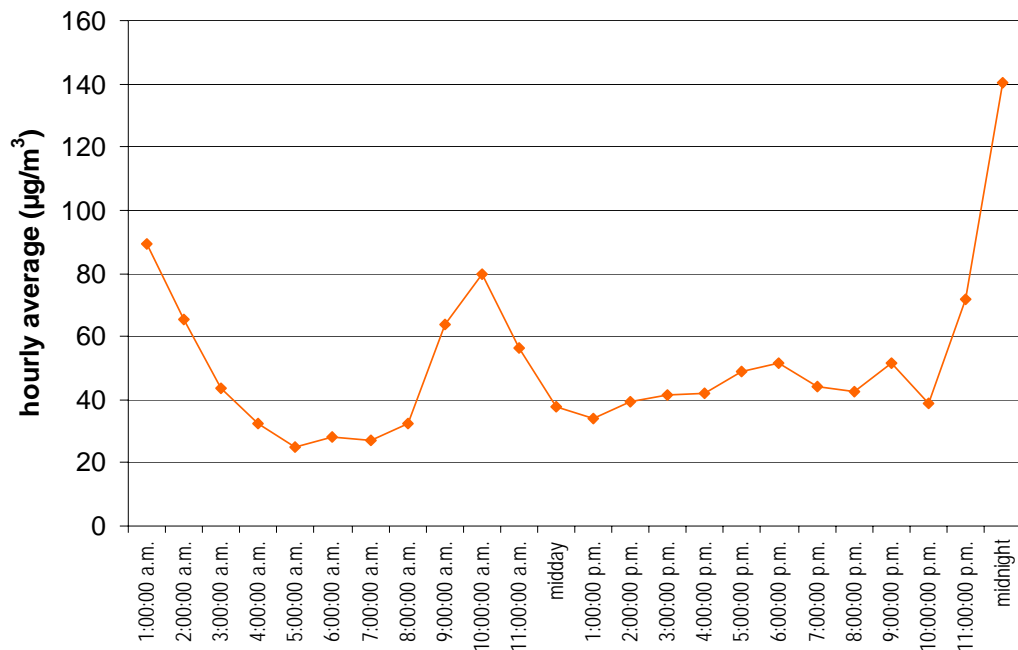


Figure 4.4: PM<sub>10</sub> hourly averages on 28 June 2007, Wainuiomata

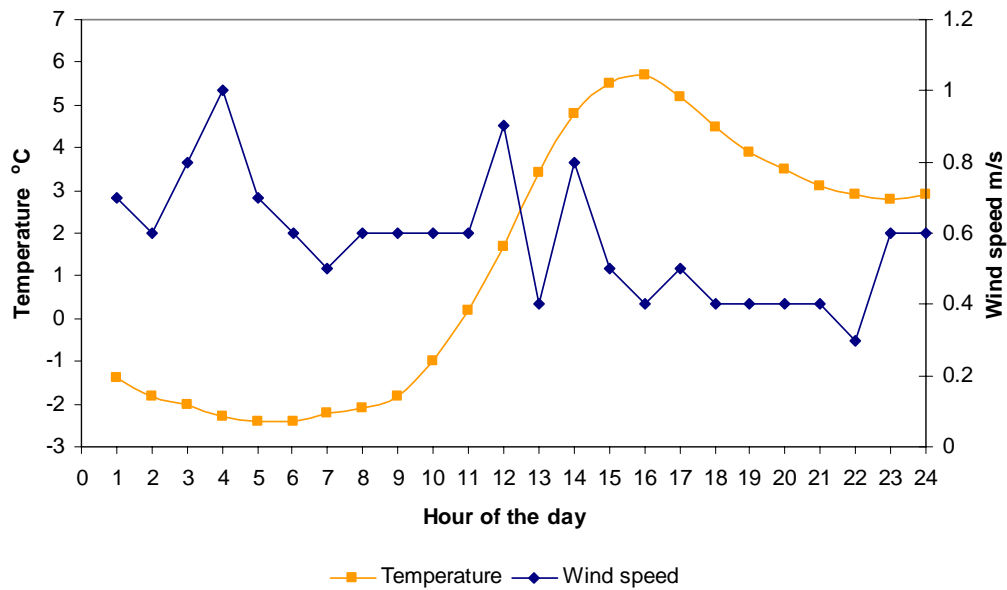


Figure 4.5: Temperature and wind speed hourly averages on 28 June 2007, Wainuiomata

## 4.6 Air quality management for particulate matter (PM<sub>10</sub>)

### 4.6.1 National standard achievement

The national standard mandates regional councils to demonstrate that they will meet the standard for PM<sub>10</sub> in their nominated airsheds by 2013 or face restrictions on the granting of resource consents to discharge particulate matter in non-complying airsheds. Past monitoring shows that Wairarapa valley, Upper Hutt valley and Wainuiomata valley are at-risk airsheds, and under a 'business-as-usual' approach may not achieve the standard by 2013. In these airsheds, Greater Wellington may need to develop emission reduction strategies and control the granting of new resource consents to ensure an incremental year-on-year improvement in air quality until the standard is met by 2013. This predicted annual improvement in air quality is referred to as the 'straight line path' by the national standard.

Air quality depends on both the level of emissions in an airshed and the prevailing meteorological conditions. Greater Wellington must be assured that, given an unfavourable winter, the emissions in an airshed will be low enough so that the national standard is not breached in the years following 2013.

### 4.6.2 Masterton emission inventory

In June 2008 Greater Wellington commissioned an emission inventory to benchmark emission levels in Masterton. The emission inventory involved a telephone survey to determine domestic home heating methods, a VKT (vehicle kilometre travelled) estimate and a review of existing resource consents that authorise the discharge to air of particulate matter. This inventory provides valuable information on the proportions on households using different heating methods and fuels and on the ages and types of solid-fuel appliances, and their frequency of use.

On a typical winter day, around 831 kg of PM<sub>10</sub> is discharged to air from human activities with solid fuel burning from domestic home heating being the principal source as shown in Figure 4.6. In contrast, on a typical summer day, only 68 kg of PM<sub>10</sub> is discharged to air, with outdoor burning being the major source (Figure 4.7).

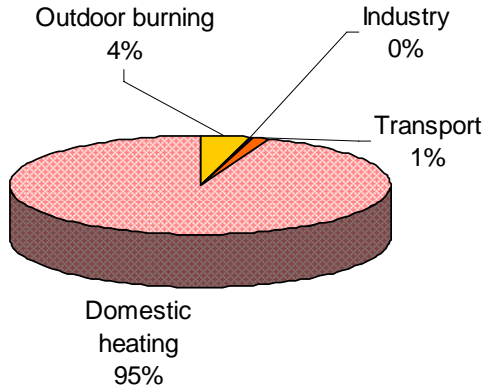


Figure 4.6: Relative inventory source contributions to daily winter PM<sub>10</sub> emissions in Masterton (July 2008)

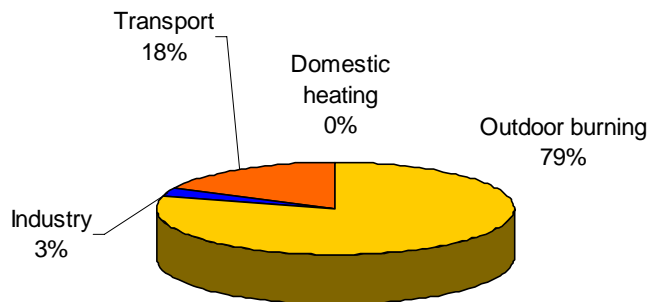


Figure 4.7: Relative inventory source contributions to daily summer PM<sub>10</sub> emissions for Masterton (February 2008)

#### 4.6.3 Analysis of particulate sources

Greater Wellington, in collaboration with GNS Science, has been carrying out particulate source apportionment studies at a number of monitoring sites. The studies involve collecting samples of fine particulate matter (PM<sub>2.5</sub>) and coarse particulate matter (PM<sub>10-2.5</sub>). Various analytical techniques are used to 'fingerprint' particulate matter to determine its source, for example, motor vehicles, industry, domestic fires (Figure 4.8), and sea salt or soils.

The results of this work are being used to determine the relative contributions of particulate matter originating from different sources to actual ambient concentrations of particulate matter. This information will help to formulate emission reduction policies that will be the most effective for improving air quality. The Masterton emissions inventory does not include the contribution of particulate matter from natural sources, such as sea salt and wind-blown soil dust. When natural sources are accounted for, the contribution of domestic heating to PM<sub>10</sub> concentrations measured in air on a high pollution night is lower (Figure 4.9) than indicated by the emissions inventory.



Figure 4.8: A single smoky chimney may cause nuisance smoke – the cumulative impact of many households using solid fuel burners is a major cause of winter pollution in some areas of the region

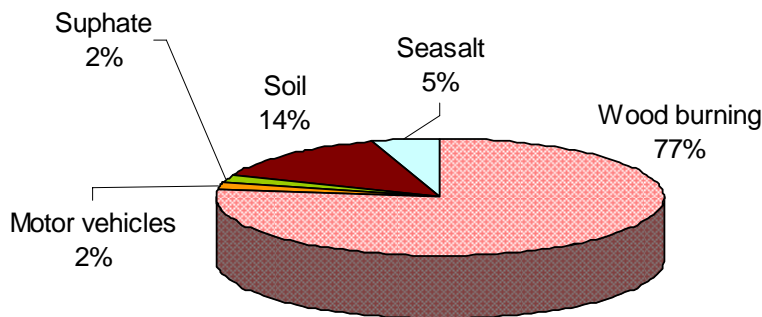


Figure 4.9: Relative source contributions to ambient PM<sub>10</sub> concentrations (24-hour average), 12 July 2004, Masterton

Analysis of particulate matter samples collected from Seaview, Lower Hutt between July 2005 and July 2007 show that air quality is highly influenced by sea salt and soil particles throughout the year. Other sources of particulate matter were local industry (producing zinc and sulphur-containing particulate), road dust, motor vehicles, and, in winter, domestic fires in the Hutt Valley.

## 5. Carbon monoxide

### 5.1 Compliance with the national standard

Ambient concentrations of carbon monoxide measured at the various sites have been assessed against the national standard of  $10 \text{ mg/m}^3$  (8-hour moving average calculated on the hour) (Table 5.1). The national standard for carbon monoxide was not exceeded at any time during the reporting period.

Average levels of carbon monoxide in air are low and reflect the national trend for lower vehicle emissions due to improvements in emissions control technology brought about by modernisation of the vehicle fleet.

Table 5.1: Descriptive statistics carbon monoxide  $\text{mg/m}^3$  (8-hour moving average), 2007

| Site               | Max. | 99.9 <sup>th</sup> %ile | 99.5 <sup>th</sup> %ile | 75 <sup>th</sup> %ile | Mean (annual) | Median | 25 <sup>th</sup> %ile | Data capture |
|--------------------|------|-------------------------|-------------------------|-----------------------|---------------|--------|-----------------------|--------------|
| Wellington central | 3.6  | 3.3                     | 2.8                     | 0.7                   | 0.5           | 0.3    | 0.1                   | 96.0%        |
| Lower Hutt         | 2.6  | 2.3                     | 1.8                     | 0.4                   | 0.3           | 0.2    | 0.1                   | 85.0%        |
| Upper Hutt         | 2.7  | 2.2                     | 1.7                     | 0.2                   | 0.2           | 0.1    | 0.0                   | 98.3%        |
| Masterton          | 2.5  | 2.3                     | 1.9                     | 0.2                   | 0.2           | 0.0    | 0.0                   | 97.3%        |
| Tawa               | 4.0  | 2.7                     | 2.1                     | 0.1                   | 0.1           | 0.0    | 0.0                   | 85.7%        |
| Karori             | 3.7  | 3.4                     | 1.0                     | 0.1                   | 0.1           | 0.0    | 0.0                   | 43.0%        |

### 5.2 Assessment against the national guideline

All hourly average concentrations were well within the national guideline of  $30 \text{ mg/m}^3$  (1-hour average). Hourly concentrations of carbon monoxide measured at Wellington central show distinct peaks at the time of rush-hour traffic (Figure 5.1). Concentrations measured at the other sites exhibit a lower peak later in the evening due to the influence of domestic fires in winter.

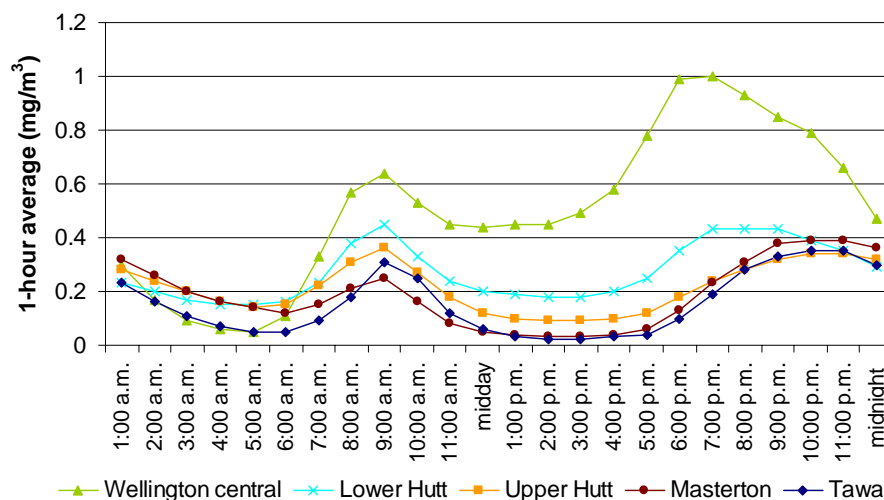


Figure 5.1: Ensemble of 1-hour average carbon monoxide ( $\text{mg/m}^3$ ), 2007

### 5.3 Assessment against air quality categories

The concentrations of carbon monoxide in air are reported as the percentage of hours per year in each air quality category (Figure 5.2). Across all monitoring sites concentrations of carbon monoxide were mostly at least ‘good’ or better. A breakdown of the actual number of moving 8-hour periods in each air quality category is included in Appendix 2 (Table A2.2).

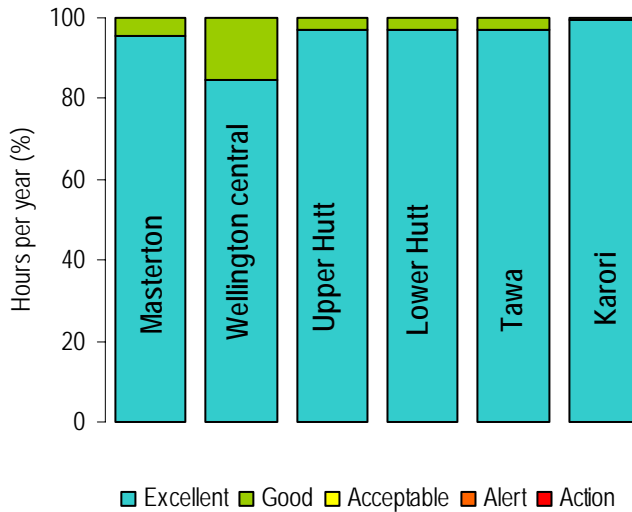


Figure 5.2: Carbon monoxide (8-hour moving average) by air quality category, 2007

## 6. Nitrogen dioxide

### 6.1 Compliance with the national standard

Ambient concentrations of nitrogen dioxide have been assessed against the national standard of  $200 \mu\text{g}/\text{m}^3$  (1-hour average calculated on the hour) (Table 6.1). The national standard was not exceeded at any time during the reporting period. Data for some of the 2007 winter are missing from the Wellington central site and this may affect the air quality assessment, as the highest concentrations typically occur during the winter months.

Table 6.1: Descriptive statistics nitrogen dioxide  $\mu\text{g}/\text{m}^3$  (1-hour average) for 2007

| Site               | Max | 99.9 <sup>th</sup> %ile | 99.5 <sup>th</sup> %ile | 75 <sup>th</sup> %ile | Mean (annual) | Median | 25 <sup>th</sup> %ile | Data completeness <sup>6</sup> |
|--------------------|-----|-------------------------|-------------------------|-----------------------|---------------|--------|-----------------------|--------------------------------|
| Wellington central | 103 | 87                      | 77                      | 42                    | 32            | 30     | 21                    | 79.4%                          |
| Lower Hutt         | 69  | 60                      | 50                      | 15                    | 11            | 8      | 4                     | 97.9%                          |
| Upper Hutt         | 50  | 44                      | 40                      | 12                    | 9             | 6      | 3                     | 96.8%                          |
| Masterton          | 58  | 51                      | 45                      | 9                     | 7             | 4      | 2                     | 97.2%                          |
| Tawa               | 52  | 47                      | 43                      | 21                    | 14            | 12     | 7                     | 82.9%                          |
| Karori             | 50  | 37                      | 30                      | 3                     | 3             | 1      | 1                     | 54.8%                          |

Nitrogen dioxide concentrations recorded at the Lower Hutt, Upper Hutt, Tawa and Masterton monitoring sites show daily peaks coinciding with commuter traffic times. As expected, the Wellington central site experiences the highest nitrogen dioxide concentrations due to larger traffic volumes (Figure 6.1).

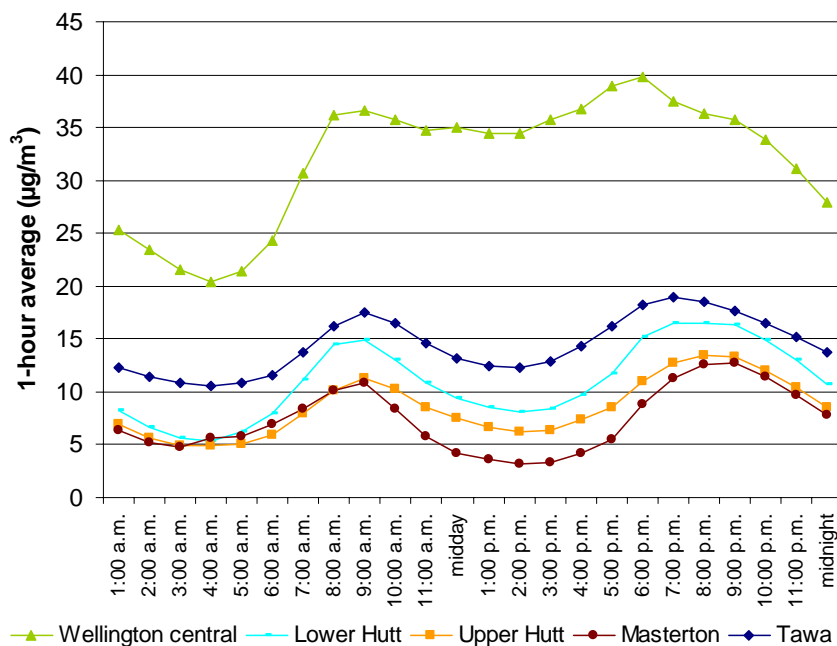


Figure 6.1: Ensemble of 1-hour average nitrogen dioxide ( $\mu\text{g}/\text{m}^3$ ), 2007

<sup>6</sup> Percentage of valid averaging periods in 2006 (maximum of 25% missing record allowed per averaging period).

## 6.2 Assessment against national guideline

Ambient concentrations of nitrogen dioxide recorded at all monitoring stations were within the national guideline of  $100 \mu\text{g}/\text{m}^3$  (24-hour average) during the reporting period.

## 6.3 Assessment against air quality categories

The concentrations of nitrogen dioxide in air are reported as a percentage of the number of hours per year in each air quality category (Figure 6.2). Across all monitoring sites concentrations of nitrogen dioxide were at least ‘acceptable’ or better. A breakdown of the number of hours in each category is given in Appendix 2 (Table A2.3).

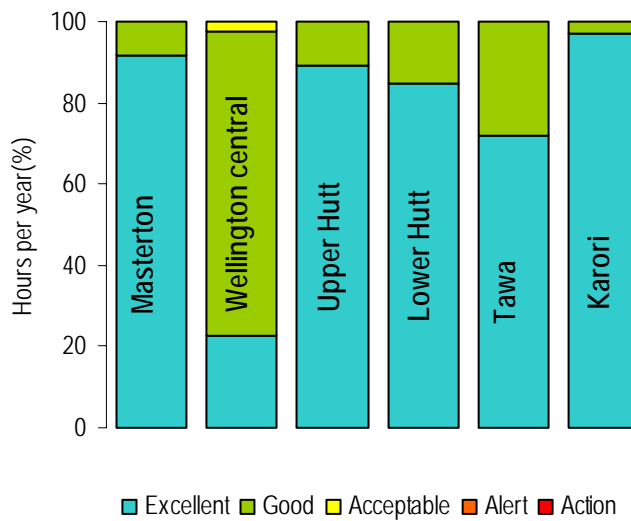


Figure 6.2: Nitrogen dioxide (1-hour average) by air quality category, 2007



## 7. Roadside air quality monitoring

In collaboration with Greater Wellington's Transport Strategy Development Department and in addition to the permanent monitoring station in central Wellington, two mobile air quality stations were set up to monitor air quality near busy roads so that the impact of traffic emissions on local air quality could be assessed. During 2007 air quality monitoring was undertaken at the Melling bridge intersection (SH 2, Lower Hutt) and at Ngauranga Gorge (Centennial Highway, Wellington) (Figure 7.1).



Photo courtesy of GNS Science

Figure 7.1: Traffic approaching the Ngauranga Gorge monitoring station on Centennial Drive, Wellington

The results of air quality monitoring undertaken in 2007 are presented in Figures 7.2 and 7.3. The results have been assessed against the national standard and the categories described in Table 4.1. Apart from one exceedance of the national standard for  $PM_{10}$  at Ngauranga Gorge, air quality at both sites was acceptable or better. The single elevated  $PM_{10}$  24-hour average concentration recorded at Ngauranga is thought to be due to a local industrial source and not traffic-related.

In collaboration with GNS Science, a pilot study was carried out at the Ngauranga site to analyse the sources of particulate collected at hourly intervals over two 48 hour periods in March 2007. During these time periods the contributing  $PM_{10}$  sources were identified as vehicle combustion, sea salt, soil and sulphate. Vehicle combustion was the dominant source of  $PM_{10}$ . However, during light southerly winds, the contribution of sea salt to ambient  $PM_{10}$  measurements was significant.

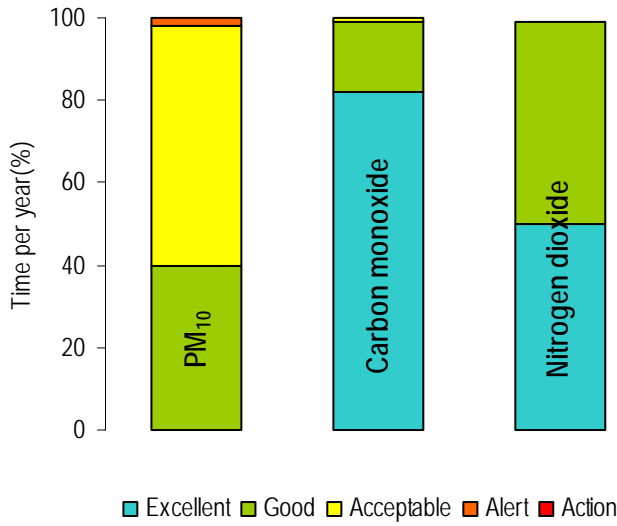


Figure 7.2: Monitoring results by air quality category at Ngauranga Gorge, 2007

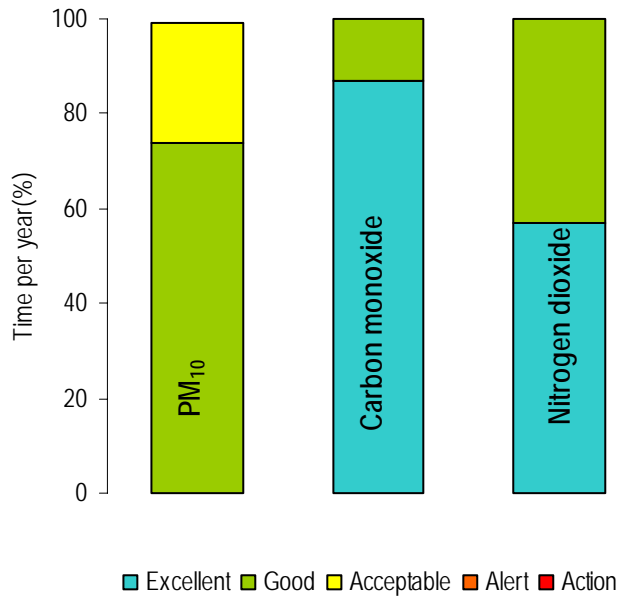


Figure 7.3: Monitoring results by air quality category at Melling intersection, 2007

## **8. Summary of airshed air quality and site history**

### **8.1 Wellington City**

The monitoring station at the corner of Vivian and Victoria Streets was established in February 2004. Monitoring at this location is aimed at tracking the influence of motor vehicle emissions on local air quality and the site is classed as a 'peak' monitoring site. All other Greater Wellington airshed sites are orientated towards measuring residential air quality.

Air quality monitoring at the central city site shows that although maximum nitrogen dioxide concentrations and average carbon monoxide concentrations were higher than other sites, they have not exceeded national standards or guidelines to date. Several years of monitoring is required to provide a fully informed picture of air quality at this location.

### **8.2 Lower Hutt**

A permanent air quality monitoring station has been operating at Birch Lane, (Phil Evans Reserve) in Lower Hutt, since February 2001.

As in previous years, the results indicate that nitrogen dioxide and carbon monoxide concentrations were higher during the winter than summer. The maximum winter time PM<sub>10</sub> concentrations were likely to be due to the combined effects of motor vehicle emissions and combustion emissions from residential and commercial heating, combined with cold and calm weather conditions. No exceedances of any of the national standards or guidelines have been recorded at this station.

### **8.3 Wainuiomata**

A permanent monitoring site was established in June 2006 to monitor PM<sub>10</sub> at the Wainuiomata Bowling Club, Moohan Road, Wainuiomata. Monitoring by high volume sampler was undertaken from 2001 to 2007. PM<sub>10</sub> concentrations typically peaked during cold calm weather conditions when dispersion of air pollutants was poor and domestic wood burners are being used. During the monitoring period, there was one exceedance of the national standard on 28 June 2007, when a concentration of 51 µg/m<sup>3</sup> was recorded.

### **8.4 Upper Hutt**

A permanent monitoring station has been located at Savage Park in Upper Hutt since September 2005. This replaced the temporary station which had been located at the Trentham Fire Station since June 2000.

PM<sub>10</sub>, carbon monoxide and nitrogen dioxide concentrations were found to be higher in winter than in summer. PM<sub>10</sub> concentrations typically peaked during cold calm weather conditions when dispersion of air pollutants was poor and domestic wood burners are being used. The national standard has not been exceeded at the permanent station to date.

## **8.5 Tawa**

A permanent monitoring station was established at Duncan Park, Linden Avenue, Tawa in early 2007. PM<sub>10</sub> has been monitored at the site since May 2007, with one exceedance of 54 µg/m<sup>3</sup> recorded on 28 June 2007. Nitrogen dioxide and carbon dioxide have been measured at the site since February 2007 and are well within the national standards and guidelines.

## **8.6 Karori**

A monitoring station was installed next to the Terawhiti Bowling Club at Karori Park, Wellington in June 2007. To date measured concentrations of PM<sub>10</sub>, carbon monoxide and nitrogen dioxide have been low. As with other airsheds, levels of pollutants are higher in winter when weather conditions are less favourable for dispersion.

## **8.7 Wairarapa**

A permanent monitoring station was established at Wairarapa College in Masterton during October 2002. The urban Masterton area typically records the highest PM<sub>10</sub> concentrations in the region. Although there were 11 days on which the 'alert' level for PM<sub>10</sub> was reached there were no exceedances of the national standard during 2007.

Source apportionment research has shown that domestic solid fuel fires are the primary contributor to wintertime PM<sub>10</sub> pollution episodes which occur under cold and calm weather conditions.

## **8.8 Synthesis**

Air quality is generally good during the summer months at suburban locations with the highest concentrations of pollutants occurring during winter. Ambient concentrations of PM<sub>10</sub> can become elevated at times in valleys or basins with a high incidence of solid fuel heating appliances. On cloudless nights, when temperatures and wind speeds drop, a temperature inversion can form, restricting the dispersion of pollutants. The extent and severity of pollution episodes is primarily dependent on winter meteorological conditions.

Two new airshed monitoring stations at Tawa and at Karori were established in 2007. The monitoring network is being expanded in 2008/09 to include the Kapiti Coast airshed.

## 9. References

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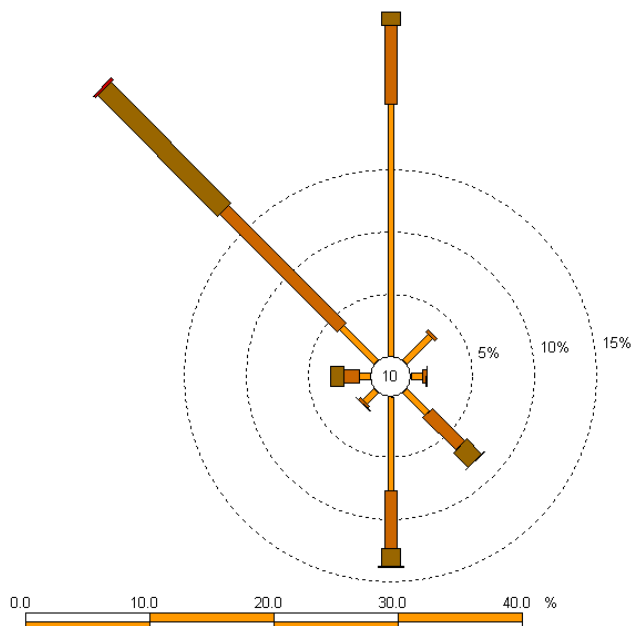
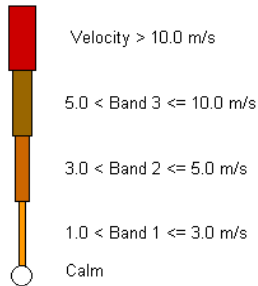
## **Acknowledgements**

The work of Darren Li and Brent King in operating and maintaining monitoring equipment and stations is gratefully acknowledged. Thanks also to Jon Marks and his team for installing and maintaining the meteorological and communications equipment.

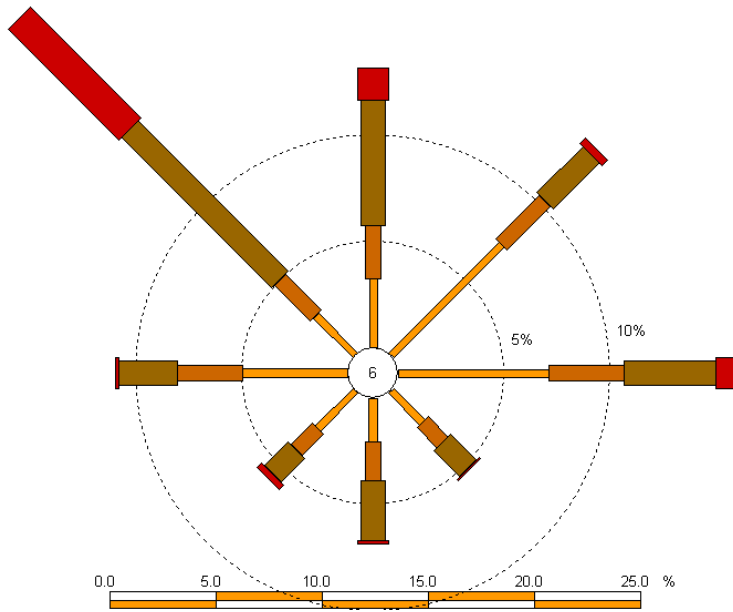
## Appendix 1: Wind roses at monitoring sites

Wind speed and direction were recorded at all permanent air quality monitoring stations during the 2007 calendar year. The wind roses below show the percentage frequency of wind speeds (metres per second) recorded in five wind speed bands by eight main wind direction ranges. The number in the centre of the rose is the percentage frequency of calms (wind speeds less than 1 m/s). The wind direction comes from the direction that the bar is pointing.

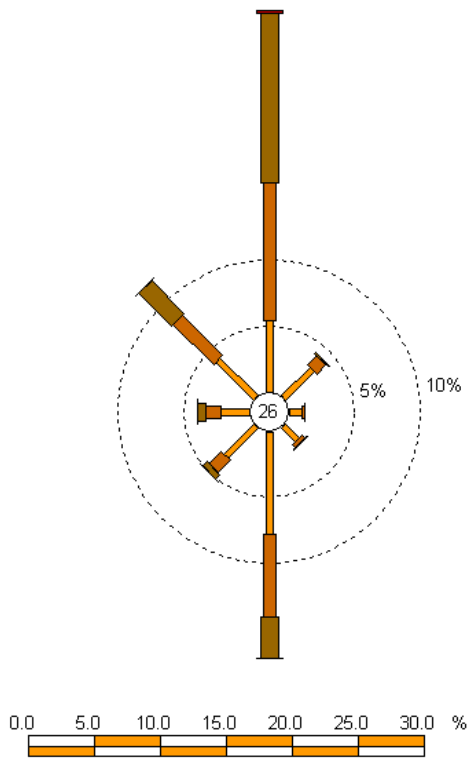
### Key to wind speed bands



Lower Hutt from 1 January 2007 to 31 December 2007 at 10 m above ground level

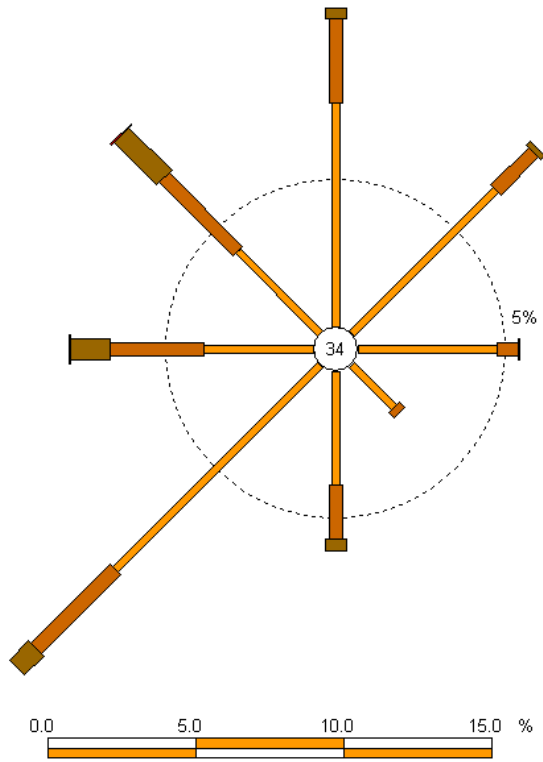


Upper Hutt from 1 January 2007 to 31 December 2007 at 10 m above ground level

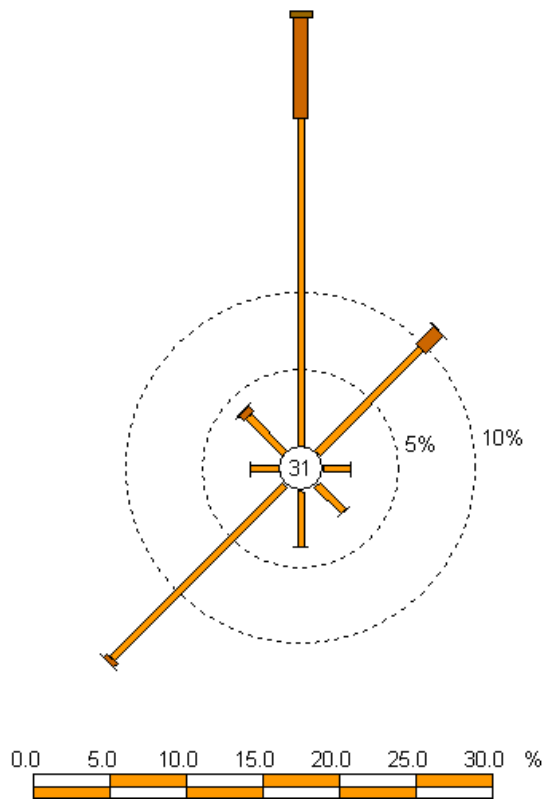


Wainuiomata from 1 January 2007 to 31 December 2007 at 10 m above ground level

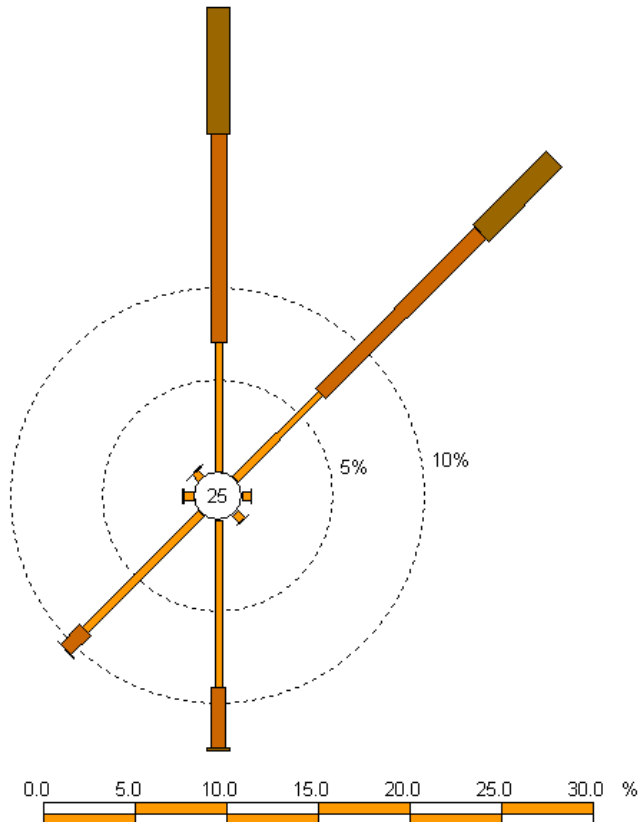




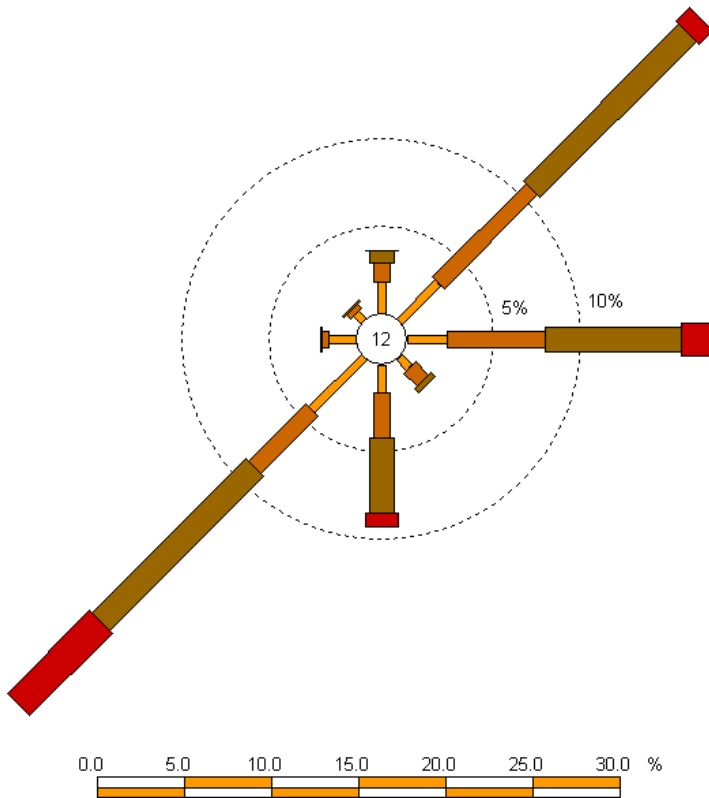
Wairarapa from 1 January 2007 to 31 December 2007 at 10 m above ground level



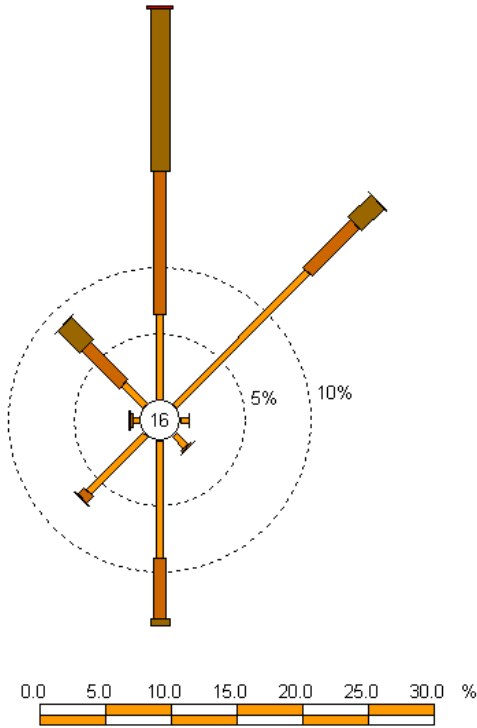
Wellington central from 1 January 2007 to 31 December 2007 at 4 m above ground level



Tawa from 9 February 2007 to 31 December 2007 at 6 m above ground level



Karori from 9 February 2007 to 31 December 2007 at 6 m above ground level



Shandon Golf Course from 1 January 2007 to 31 January 2008 at 10 m above ground level

## Appendix 2: Air quality categories

Table A2.1: PM<sub>10</sub> - number of days (24-hour average) in 2007 by air quality category

| Monitoring sites   | Total days sampled | Excellent<br>< 5 µg/m <sup>3</sup> | Good<br>5 to 16.5<br>µg/m <sup>3</sup> | Acceptable<br>16.5 to 33<br>µg/m <sup>3</sup> | Alert<br>33 to 50<br>µg/m <sup>3</sup> | Action<br>> 50 µg/m <sup>3</sup> |
|--------------------|--------------------|------------------------------------|--|---|--|----------------------------------|
| Wellington central | 363                | 5                                  | 279                                    | 79  | 0                                      | 0                                |
| Lower Hutt         | 356                | 0                                  | 270                                    | 86  | 0                                      | 0                                |
| Wainuiomata        | 355                | 19                                 | 278                                    | 54  | 3                                      | 1                                |
| Upper Hutt         | 361                | 12                                 | 301                                    | 46  | 2                                      | 0                                |
| Masterton          | 360                | 7                                  | 259                                    | 83  | 11                                     | 0                                |
| Tawa               | 237                | 0                                  | 112                                    | 117   | 7                                      | 1                                |
| Karori             | 166                | 3                                  | 128                                    | 35  | 0                                      | 0                                |

Table A2.2: CO - number of hours (8-hour moving average) in 2007 by air quality category

| Monitoring sites   | Total no. hours sampled | Excellent<br>< 1 mg/m <sup>3</sup> | Good<br>1 to 3.3<br>mg/m <sup>3</sup> | Acceptable<br>3.3 to 6.6<br>mg/m <sup>3</sup> | Alert<br>6.6 to 10<br>mg/m <sup>3</sup> | Action<br>> 10<br>mg/m <sup>3</sup> |
|--------------------|-------------------------|------------------------------------|---------------------------------------|---|---|-------------------------------------|
| Wellington central | 8410                    | 7108                               | 1296                                  | 6   | 0                                       | 0                                   |
| Lower Hutt         | 7489                    | 7267                               | 222                                   | 0   | 0                                       | 0                                   |
| Upper Hutt         | 8608                    | 8335                               | 273                                   | 0   | 0                                       | 0                                   |
| Masterton          | 8521                    | 8144                               | 377                                   | 0   | 0                                       | 0                                   |
| Tawa               | 7509                    | 7268                               | 239                                   | 2   | 0                                       | 0                                   |
| Karori             | 3770                    | 3754                               | 11                                    | 5   | 0                                       | 0                                   |

Table A2.3: NO<sub>2</sub> - number of hours (1-hour average) in 2007 by air quality category

| Monitoring sites   | Total no. hours sampled | Excellent<br>< 20<br>µg/m <sup>3</sup> | Good<br>20 to 66<br>µg/m <sup>3</sup> | Acceptable<br>66 to 133<br>µg/m <sup>3</sup> | Alert<br>133 to 200<br>µg/m <sup>3</sup> | Action<br>> 200 µg/m <sup>3</sup> |
|--------------------|-------------------------|--|---------------------------------------|--|--|-----------------------------------|
| Wellington central | 6956                    | 1580                                   | 5221                                  | 155  | 0  | 0                                 |
| Lower Hutt         | 8577                    | 7250                                   | 1325                                  | 2  | 0  | 0                                 |
| Upper Hutt         | 8477                    | 7560                                   | 917                                   | 0  | 0  | 0                                 |
| Masterton          | 8519                    | 7823                                   | 696                                   | 0  | 0  | 0                                 |
| Tawa               | 7265                    | 5242                                   | 2023                                  | 0  | 0  | 0                                 |
| Karori             | 4801                    | 4665                                   | 136                                   | 0  | 0  | 0                                 |