Annual air quality monitoring report for the Wellington region, 2006

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1. Introduction

Greater Wellington Regional Council (Greater Wellington) monitors ambient air quality at five 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 2006 calendar year. The calendar year was chosen as the reporting period so that the monitoring results for an entire winter period can be examined. The calendar year is also consistent with the Ministry for the Environment's reporting framework for air quality[1]. 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.

[1] www.mfe.govt.nz/state/reporting/air/nes

2. Ambient air quality monitoring programme

2.1 Objectives

The objectives of Greater Wellington's ambient air 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 to national guidelines[2] and standards[3].

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.

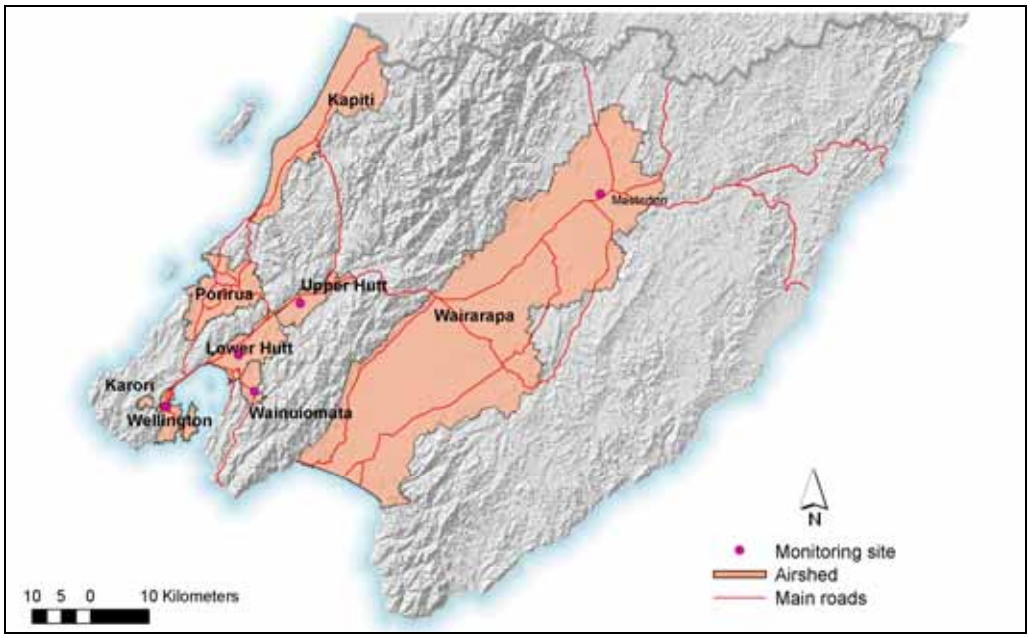

Figure 2.1: Location of current monitoring stations within airsheds

Each airshed has a distinct microclimate, meteorological conditions and air quality pressures. Air quality in one airshed, therefore, cannot be inferred from another.

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

[2] Ambient air quality guidelines 2002 update. Air quality report no. 32. Ministry for the Environment, May 2002.

[3] Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004.

Karori and Porirua Basin airshed stations were both commissioned in 2007 and data from these stations will be reported in 2008.

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 2006, Greater Wellington operated five permanent monitoring sites employing continuous monitoring instruments (Table 2.1).

Table 2.1: Permanent monitoring sites operated in 2006

Site	Station	Airshed	Location	Pollutants monitored	Site established
Wellington central	Corner V	Wellington City	Corner Victoria & Vivian Streets	PM_{10}, CO, NOx	2004
Lower Hutt	Birch Lane	Lower Hutt Valley	Phil Evans Reserve	PM_{10}, CO, NOx	2001
Wainuiomata	Wainuiomata Bowling Club	Wainuiomata	Moohan Street	PM_{10}	2006
Upper Hutt	Savage Park	Upper Hutt Valley	Savage Crescent	PM_{10}, CO, NOx	2005
Masterton	Wairarapa College	Wairarapa Valley	Cornwell Street	PM_{10}, CO, NOx	2002

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.

2.4 Air pollutants monitored

The pollutants currently monitored in the Wellington region are particulate matter (PM_{10}), carbon monoxide (CO) and nitrogen oxides (NOx). 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_2) and ozone (O_3), 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_{10})

Particulate matter is a mixture of solid particles and liquid droplets that are dispersed in air. PM_{10} is that portion of particulate matter with an equivalent aerodynamic cross-section less than 10 micrometers. 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_{10} in the Wellington region include:

- Domestic solid fuel heating (e.g., wood burners)
- Motor vehicles, particularly from diesel
- 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_{10}. 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_{10} 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_{10} exposure. National standards and guidelines for PM_{10} 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_2) 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 (NOx). Most of the NOx 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_{10} is monitored by Rupprech & Patashnick TEOM series 1400AB Ambient Particulate Monitors or ThermoElectron Corp FH62 C14 Beta Attenuation Monitors. Both of these instruments are designated as United States Federal Reference Methods and so comply with the monitoring method specified by the national standard for PM_{10}.

Carbon monoxide is monitored using CO Gas Filter Correlation Infrared Analysers in accordance with AS3580.7.1:1992.

Nitrogen dioxide is monitored using NOx Chemiluminscence Analysers in accordance with AS3580.5.1:1993.

All pollutants are monitored continuously with instruments that are connected by digital interface to dataloggers. All logged data are stored as 10 or 5 minute averages at New Zealand Standard Time (NZST).

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_{10} and NO_2 values are rounded up to the nearest whole number and CO concentrations are reported to one decimal place.

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[4] 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_{10}	50 µg/m^3	24-hour mean	One 24-hour period
Carbon monoxide	10 mg/m^3	8-hour mean (moving)	One 8-hour period
Nitrogen dioxide	200 µg/m^3	1-hour mean	9 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_{10}. 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_{10}	20 µg/m^3	Annual (24-hour)
Carbon monoxide	30 mg/m^3	1-hour
Nitrogen dioxide	100 µg/m^3	24-hour

3.3 Air quality categories

A useful method 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).

[4] 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)[5] 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.

3.4 Air quality management for particulate matter (PM_{10})

3.4.1 National standard achievement

The national standard mandates regional councils to demonstrate that they will meet the standard for PM_{10} 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. We must be assured that, given an unfavourable winter, the emissions in the airshed will be low enough so that the national standard is not breached in the years following 2013.

3.4.2 Airshed emission inventories

In June 2006 Greater Wellington commissioned two emission inventories to benchmark emission levels in Wainuiomata and Upper Hutt. The emission inventories involved a phone survey to determine domestic home heating

[5] Greater Wellington's Long-term Council Community Plan for the region for 2006-16.

methods, a VKT (vehicle kilometre travelled) model and a review of existing resource consents that authorise the discharge to air of particulate matter.

Figure 3.1 shows the results of the emissions inventory for Wainuiomata. On a typical winter day, around 385 kg of PM_{10} is discharged to air. The main source is solid fuel burning from domestic home heating, which contributes around 91% of the total PM_{10}. Other sources include outdoor burning (4%), transport (3%) and industry (2%).

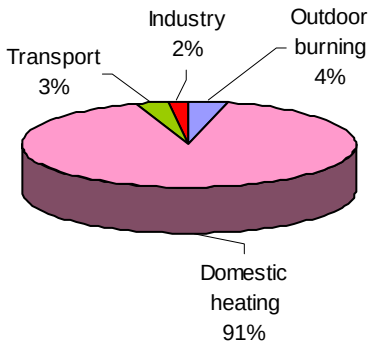

Figure 3.1: Wainuiomata PM_{10} emissions on a typical winter day (June 2006)

In Upper Hutt, just over one tonne of PM_{10} is discharged to air on a typical winter day (Figure 3.2). Domestic home heating is the main source, contributing 87% of the daily winter time PM_{10}. Other sources include outdoor burning and transport which contribute 9% and 4% respectively. The industrial contribution to PM_{10} emissions in Upper Hutt from consented activities in 2006 is negligible and less than 1% of the total PM_{10}.

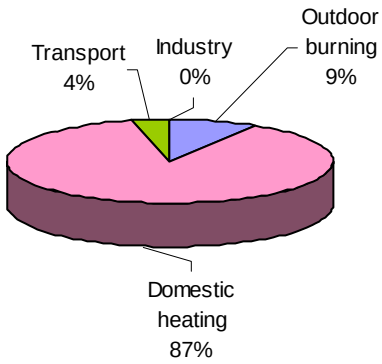

Figure 3.2: Upper Hutt PM_{10} emissions on a typical winter day (June 2006)

During the summer months motor vehicles and outdoor burning are the dominant contributors to PM_{10} emissions in Wainuiomata and Upper Hutt. However, the total emissions from both these sources are relatively low (115 kg/day in Upper Hutt and 32 kg/day in Wainuiomata) when compared to the contribution from domestic heating in winter.

3.4.3 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 ($PM_{2.5}$) and coarse particulate matter ($PM_{10-2.5}$). Various analytical techniques are used to 'fingerprint' sources of particulate matter such as, motor vehicles, industry, domestic fires, and sea salt or soils.

The results of this work are being used to determine the relative contributions of different sources of particulate to ambient concentrations of particulate matter. This information will help to formulate emission reduction policies that will be the most effective for improving air quality. For example, the Masterton study shows that reducing emissions from domestic wood burners is the key to avoiding wintertime pollution episodes (Figure 3.3).

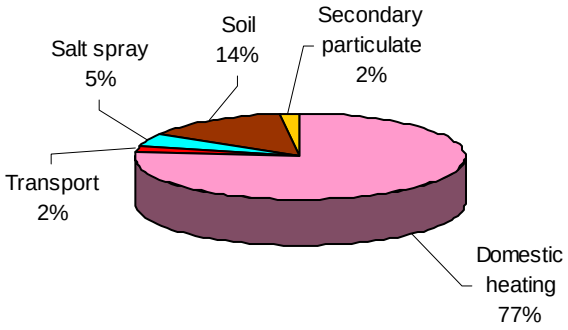

Figure 3.3: Source contributions to elevated PM_{10} measured on 12 July 2004 in Masterton

4. Particulate matter (PM_{10})

4.1 Compliance with the national standard

Ambient PM_{10} concentrations recorded at the various air quality monitoring sites within the Wellington region have been assessed against the national standard of 50 $\mu g/m^3$ (24-hour average) (Table 4.1).

Table 4.1: Descriptive statistics PM_{10} $\mu g/m^3$ (24-hour average) for 2006

Site	Max	99.9th %ile	99.5th %ile	75th %ile	Median	25th %ile	Data completeness[6]
Wellington central	37	36	30	17	14	12	99.5%
Lower Hutt	34	33	29	17	14	11	98.9%
Wainuiomata	29	29	27	15	11	8	50.1%
Upper Hutt	38	37	33	14	11	8	98.4%
Masterton	54	53	52	17	13	10	98.9%

The dataset for Wainuiomata is incomplete as continuous monitoring only started on 30 June 2006, part way through the reporting period.

During the reporting period the threshold concentration for PM_{10} was exceeded three times at the Masterton monitoring station (Wairarapa airshed) on the following days:

- 8 June 2006 (52 $\mu g/m^3$)
- 2 July 2006 (52 $\mu g/m^3$)
- 29 July 2006 (54 $\mu g/m^3$)

On these days, low temperatures and low wind speeds combined to restrict the dispersion of PM_{10} in the Masterton urban area and PM_{10} concentrations remained elevated from late evening until 2 am the following morning.

The national standard was breached twice in 2006 in the Wairarapa airshed as the national standard allows one 24-hour period to exceed the standard in a 12-month period. The national standard was met at all other monitoring stations during the reporting period.

4.2 Assessment against the national guideline

Ambient PM_{10} 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 $\mu g/m^3$ (annual average based on daily data). Annual means for 2006 are within the national guideline (Table 4.2).

[6] Percentage of valid averaging periods in 2006 (maximum of 25% missing record allowed per averaging period).

Table 4.2: PM_{10} annual average concentrations for 2006

Monitoring site	Annual mean (µg/m^3) based on 24-hour averages
Wellington central	15
Lower Hutt	15
Upper Hutt	12
Masterton	15

4.3 Assessment against air quality categories

Ambient PM_{10} daily averages are reported by percentage of days per year in each air quality category (Figure 4.1). A breakdown of the actual number of days in 2006 by air quality category is given in Appendix 2 (Table A2.1). There were two days each in Wellington central and Upper Hutt and one day in Lower Hutt where the 'alert' level was reached. In Masterton there were 12 days where the 'alert' level was reached and three days where the 'action' level (equivalent to exceeding the national standard) was reached.

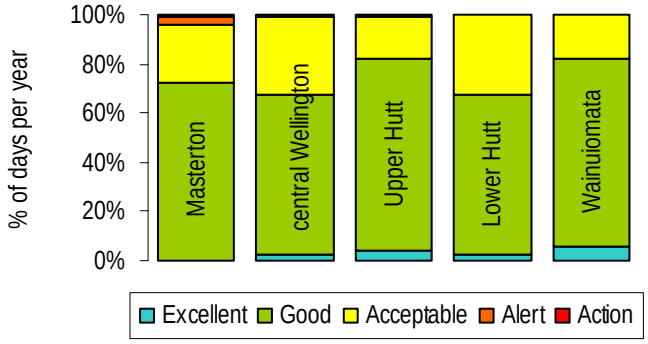

Figure 4.1: PM_{10} (24-hour average) by air quality category for 2006

4.4 Seasonal and hourly variation

Particulate matter concentrations in air change throughout the day depending on meteorological conditions, traffic volumes and congestion, and patterns of wood burner use.

At the Masterton and Upper Hutt monitoring stations, hourly average concentrations of PM_{10} during the winter months[7] are typically elevated from about 6 pm onwards, peaking around midnight and then declining by around 3 am. Concentrations then increase again between 8 am and 10 am the following day. The average winter hourly fluctuation in PM_{10} concentrations over the course of a day follows the general pattern of domestic solid fuel burner use (Figure 4.2).

[7] May, June, July and August 2006.

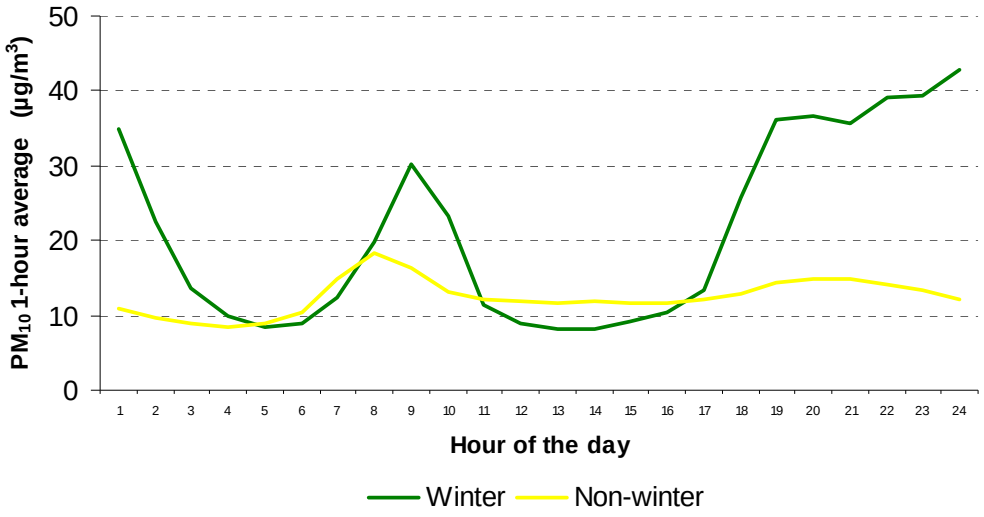

Figure 4.2: Annual 1-hour PM_{10} concentrations (2006) for Masterton

At the Lower Hutt and Wellington central sites there is little difference between winter and non-winter hourly averages. At Wellington central, PM_{10} concentrations tend to rise at 7 am and gradually increase throughout the day with another peak at around 5 pm to 6 pm, coinciding with rush hour traffic flows (Figure 4.3).

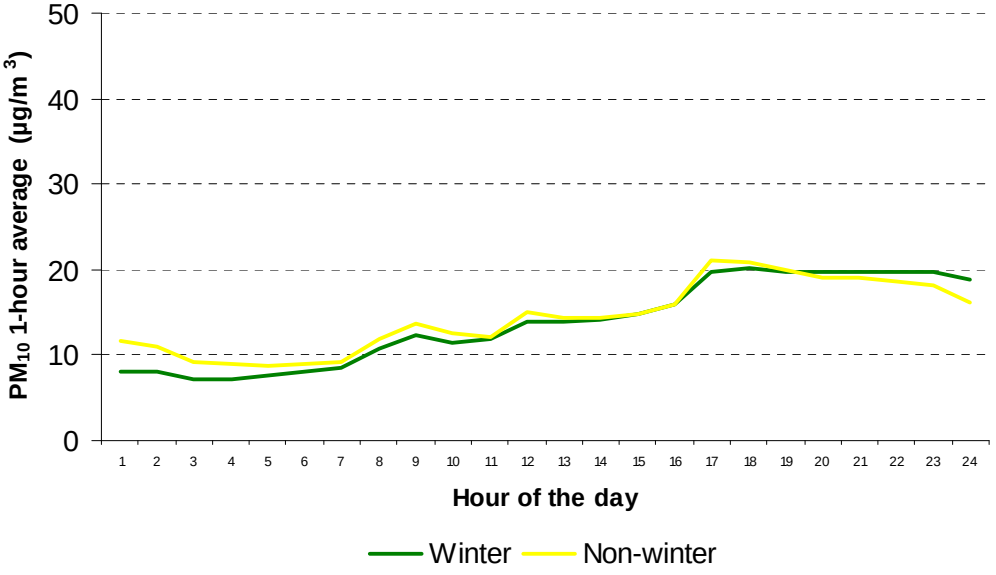

Figure 4.3: Annual 1-hour average PM_{10} concentrations (2006) for Wellington central

Overall winter and non-winter levels of PM_{10} are similar in Lower Hutt. The small winter evening peak in PM_{10} concentrations at Lower Hutt tails off before midnight, reflecting the lesser contribution of domestic wood burners to local air quality (Figure 4.4).

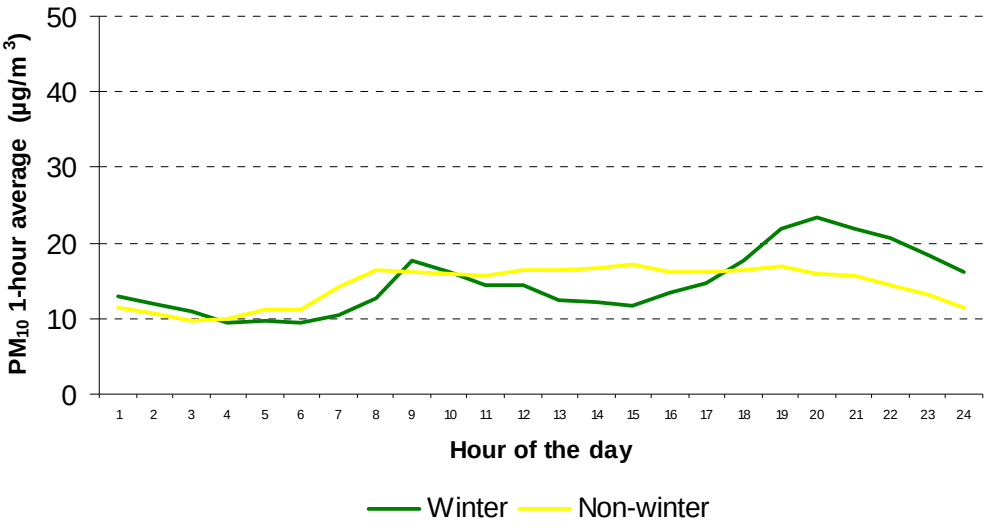

Figure 4.4: Annual 1-hour average PM_{10} concentrations (2006) for Lower Hutt

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 mg/m^3 (8-hour moving average calculated on the hour) (Table 5.1).

Table 5.1: Descriptive statistics CO mg/m^3 (8-hour moving average) for 2006

Site	Max	99.9th %ile	99.5th %ile	75th %ile	Mean (annual)	Median	25th %ile
Wellington central	3.7	3.2	2.7	1.0	0.6	0.5	0.2
Lower Hutt	2.2	2.0	1.7	0.3	0.2	0.1	0.03
Upper Hutt	2.6	2.4	1.9	0.2	0.1	0.03	NA
Masterton	4.3	3.6	2.7	0.3	0.3	0.1	0.01

The national standard for carbon monoxide was not exceeded at any time during the reporting period.

5.2 Assessment against the national guideline

All hourly average concentrations were well within the national guideline of 30 mg/m^3 (1-hour average).

5.3 Assessment against air quality categories

The concentrations of carbon monoxide in air are reported by percentage of hours per year in each air quality category (Figure 5.1).

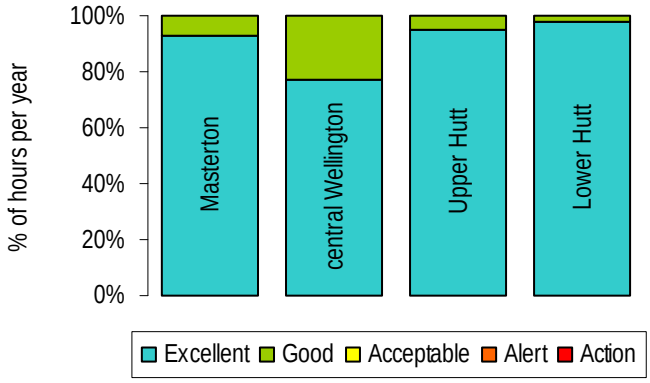

Figure 5.1: CO (8-hour moving average) by air quality category for 2006

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 A2.3).

5.4 Seasonal and hourly variation

Carbon monoxide concentrations vary throughout the day depending on meteorological conditions, traffic intensity and congestion, and wood burner use.

Hourly average concentrations recorded at the Masterton and Upper Hutt monitoring stations follow the same pattern as that of PM_{10} concentrations. Carbon monoxide concentrations rise between 8 am and 10 am and peak again around midnight, and decline during the early hours of the morning (Figure 5.2). This daily fluctuation in carbon monoxide concentration matches winter domestic solid fuel burner use. Overall, carbon monoxide concentrations in air are higher in winter than at other times of the year due to the influence of wood burner smoke coupled with more frequent periods of colder and calmer weather conditions, that are less favourable for dispersion of pollutants.

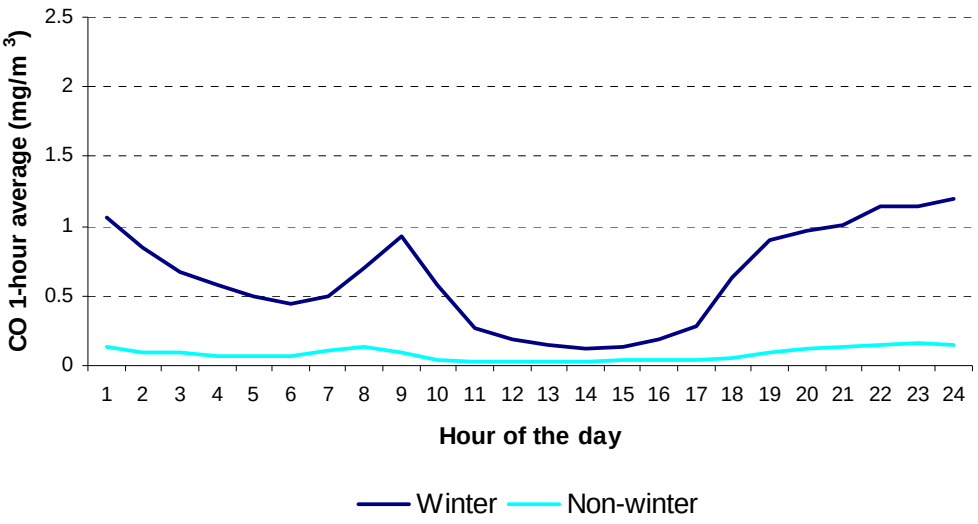

Figure 5.2: Annual 1-hour average CO concentrations (2006) for Masterton

The Wellington central site, which is more influenced by transport emissions, shows daily peaks at around 8 am and 5 pm correlated with rush hour traffic. Concentrations during the middle of the day are also higher than those recorded at the other monitoring sites due to sustained traffic flows throughout the day (Figure 5.3). The winter peaks are also higher than non-winter peaks due to meteorological conditions being less favourable for dispersion of pollutants.

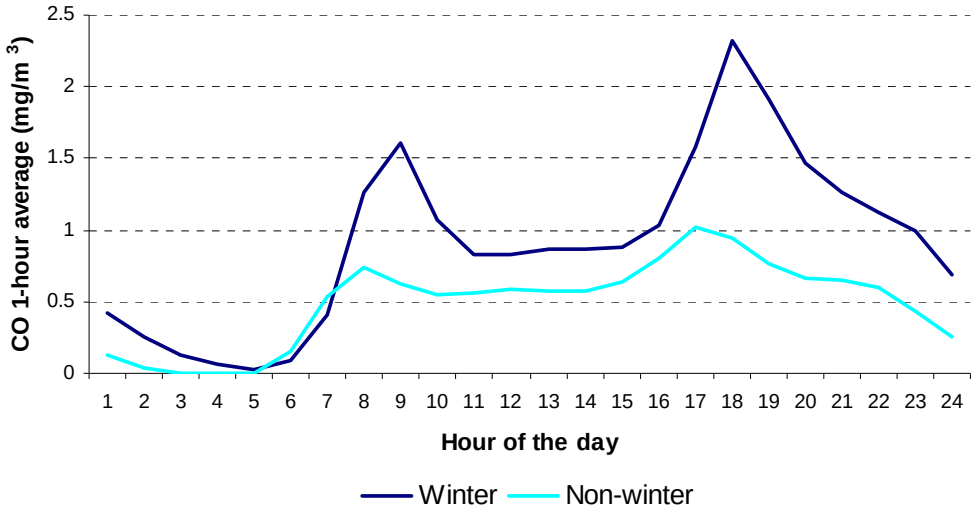

Figure 5.3: Annual 1-hour average CO concentrations (2006) for Wellington central

6. Nitrogen dioxide

6.1 Compliance with the national standard

Ambient concentrations of nitrogen dioxide have been assessed against the national standard of 200 μg/m^3 (1-hour average calculated on the hour) (Table 6.1).

Table 6.1: Descriptive statistics NO_2 μg/m^3 (1-hour average) for 2006

Site	Max	99.9th %ile	99.5\th %ile	75th %ile	Mean (annual)	Median	25th %ile	Data completeness[8]
Wellington central	99	97	91	48	33	30	17	98.3%
Lower Hutt	62	56	48	15	11	8	4	98%
Upper Hutt	49	46	43	14	10	7	3	85.9%
Masterton	58	53	47	11	8	5	2	81.6%

The national standard was not exceeded at anytime during the reporting period.

6.2 Assessment against national guideline

Ambient concentrations of nitrogen dioxide recorded at all monitoring stations were within the national guideline of 100 μg/m^3 (24-hour average) during the reporting period.

6.3 Assessment against air quality categories

The concentration of nitrogen dioxide in air is reported as a percentage of the number of hours per year in each air quality category (Figure 6.1). 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 A2.5).

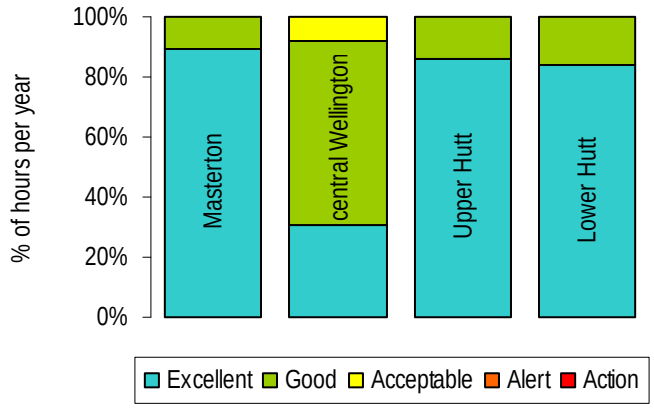

Figure 6.1: NO_2 (1-hour average) by air quality category for 2006

[8] Percentage of valid averaging periods in 2006 (maximum of 25% missing record allowed per averaging period).

6.4 Seasonal and hourly variation

Nitrogen dioxide concentrations vary throughout the day depending on meteorological conditions and traffic flows and congestion. For example, nitrogen dioxide concentrations at the Wellington central site (Figure 6.2), (which is more influenced by transport emissions) follow the same general pattern as carbon monoxide levels. Daily peaks at around 8 am and again at 5 pm coincide with rush hour traffic. Concentrations during the middle of the day are also relatively higher than those measured at the other airshed stations due to higher levels of traffic at that location throughout the day. The winter peaks are also higher than non-winter peaks due to meteorological conditions being less favourable for dispersion for pollutants.

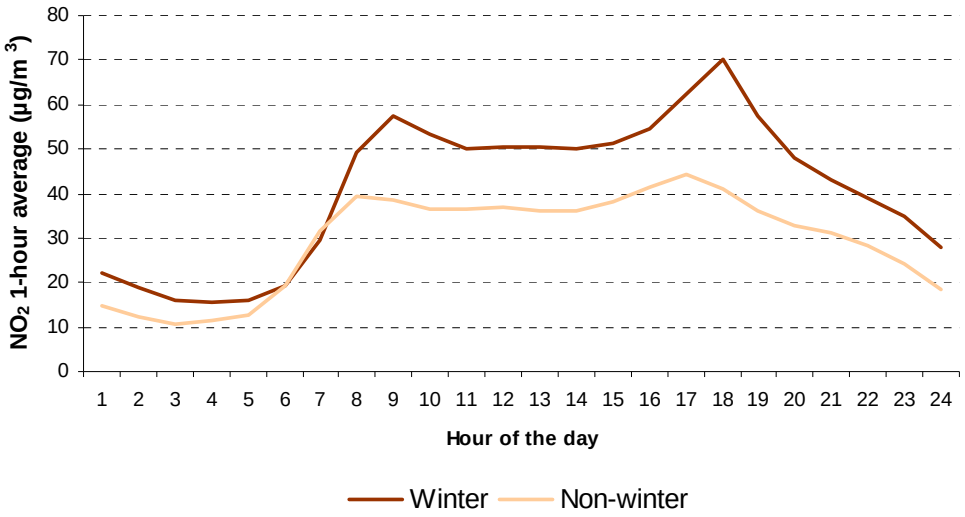

Figure 6.2: Annual 1-hour average NO_2 concentrations (2006) for Wellington central

Nitrogen dioxide concentrations recorded at the Lower Hutt, Upper Hutt and Masterton monitoring stations also show the same daily peaks due to increased traffic flows at commuting times. However, nitrogen dioxide concentrations during the middle of the day are low (Figure 6.3). At all sites, the concentration of nitrogen dioxide drops off following the evening traffic rush hour when vehicle numbers diminish overnight.

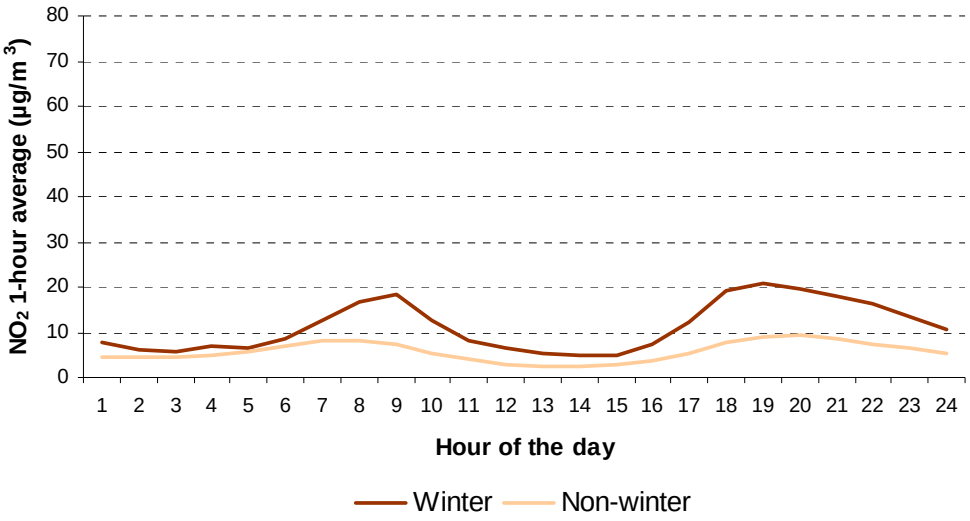

Figure 6.3: Annual 1-hour average NO_2 concentrations (2006) for Masterton

7. Summary of airshed air quality

7.1 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 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.

7.2 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_{10} 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. There were no recorded exceedances of any of the national standards or guidelines in 2006.

7.3 Wainuiomata

Since September 2000, PM_{10} has been monitored by high volume sampler at Wainuiomata Bowling Club every sixth day and from October 2001 every third day. Using this monitoring method, fine particulate concentrations were found to occasionally exceed the threshold concentration specified by the national standard in winter. However, this monitoring method does not comply with the national standard and therefore is not used for compliance reporting purposes. Continuous monitoring of particulate matter using a beta attenuation monitor started on 30 June 2006.

PM_{10} concentrations typically peaked during cold calm weather conditions when dispersion of air pollutants was poor. An emissions inventory carried out in June 2006 indicates that wood burning for domestic heating is the main source of wintertime PM_{10} emissions in Wainuiomata. A particulate analysis study is planned to confirm the relative contribution of domestic fires and of natural sources to ambient air concentrations of PM_{10}.

7.4 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_{10}, carbon monoxide and nitrogen dioxide concentrations were found to be higher in winter than in summer. As with other airsheds, PM_{10} concentrations typically peaked during cold calm weather conditions when dispersion of air pollutants is poor. The results of an emissions inventory show that domestic fires are the main source of particulate pollution in Upper Hutt. The national standard has not been exceeded at the permanent station to date.

7.5 Wairarapa

A permanent monitoring station was established at Wairarapa College in Masterton during October 2002. The highest pollution levels were recorded during winter and the national standard for PM_{10} was exceeded three times during the 2006 winter. Therefore, the airshed breached the national standard in 2006.

Research has shown that domestic solid fuel fires are the primary contributor to wintertime PM_{10} pollution episodes which occur under cold and calm weather conditions.

8. Synthesis

Ambient air quality monitoring results show that the highest concentrations of pollutants occurred during winter. Ambient concentrations of PM_{10} 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.

Air quality is generally good during the summer months at suburban locations.

The monitoring network is being expanded in 2007 to include urban valley areas in Karori and Porirua (Tawa).

9. References

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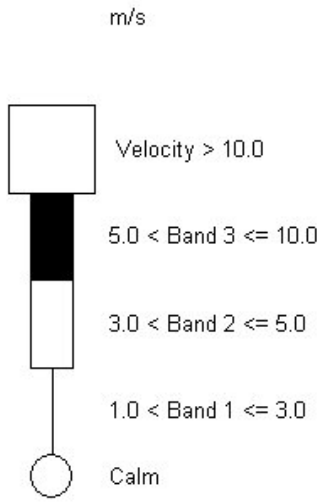
10. Acknowledgements

The work of Brent King, Darren Li and Suresh Syed 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.

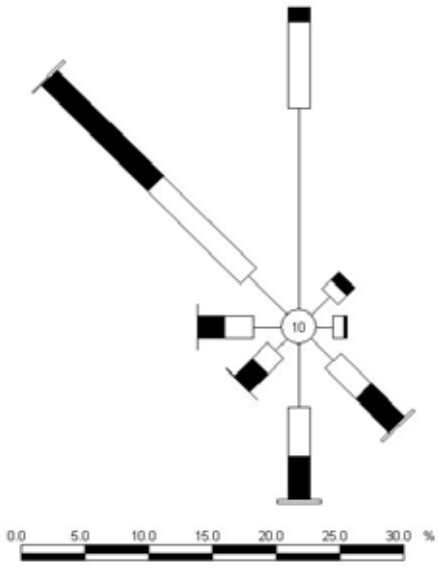
Appendix 1: Wind roses at monitoring sites

Wind speed and direction were recorded at all permanent air quality monitoring stations during the 2006 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.

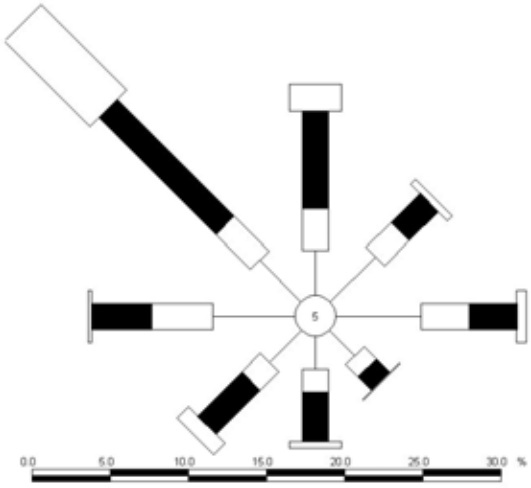
Key to wind speed bands



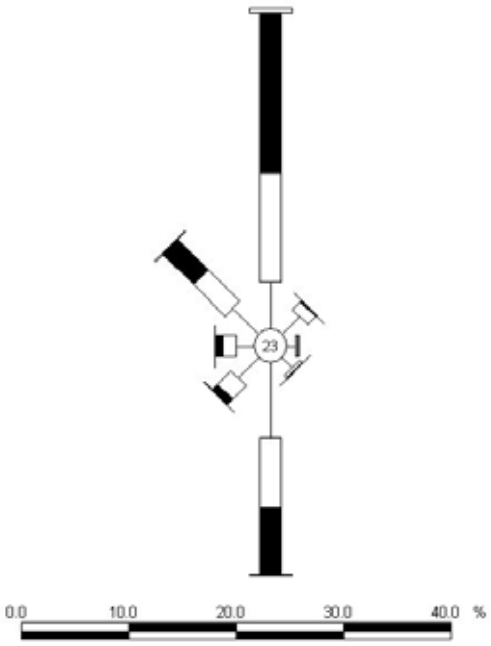
Lower Hutt from 1/1/06 to 1/1/07 at 10 m above ground level



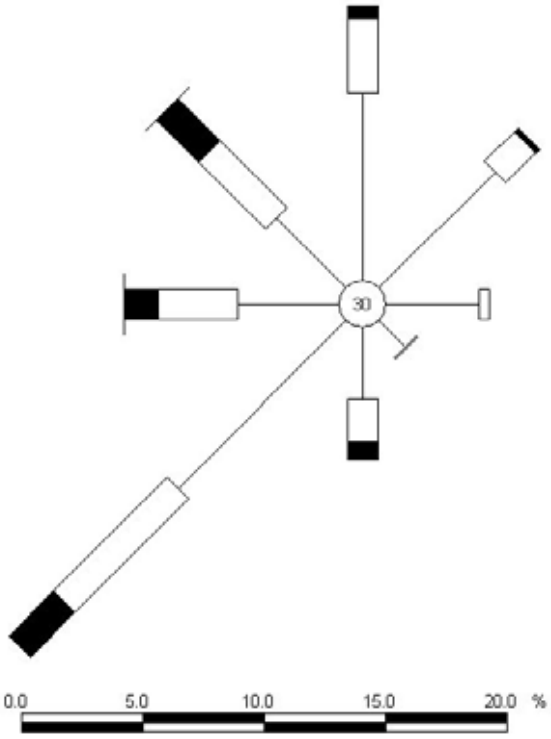
Upper Hutt from 1/1/06 to 1/1/07 at 10 m above ground level



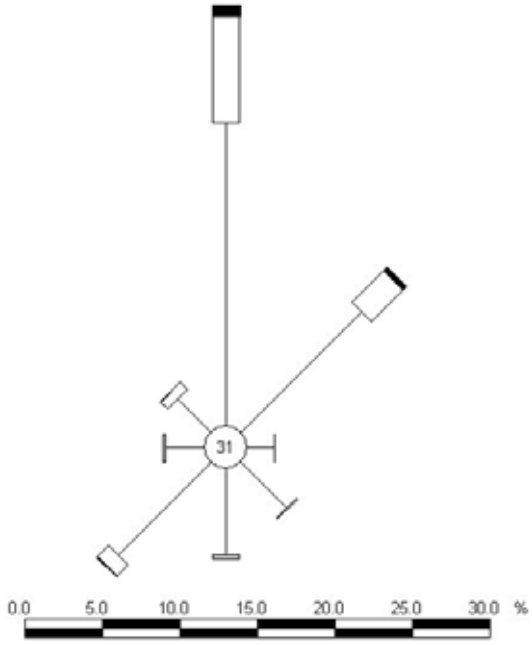
Wainuiomata from 1/1/06 to 1/1/07 at 10 m above ground level



Wairarapa from 1/1/06 to 1/1/07 at 10 m above ground level



Wellington central from 1/1/06 to 1/1/07 at 6 m above ground level



Appendix 2: Air quality categories

Table A2.1: PM_{10} - number of days in 2006 by air quality category

Monitoring sites	Total days sampled	Excellent	Good	Acceptable	Alert	Action
Wellington central	363	10	235	116	2	0
Lower Hutt	361	8	235	117	1	0
Wainuiomata	183	11	140	32	0	0
Upper Hutt	359	16	280	61	2	0
Masterton	361	0	260	86	12	3

Table A2.2: PM_{10} – concentrations by air quality category

PM_{10} limit	Excellent	Good	Acceptable	Alert	Action
50 µg/m^3 (24-hour average)	< 5	5 to 16.5	16.5 to 33	33 to 50	> 50

Table A2.3: CO - number of hours (8-hour moving) in 2006 by air quality category

Monitoring sites	Total no. hours sampled	Excellent	Good	Acceptable	Alert	Action
Wellington central	8600	6609	1985	6	0	0
Lower Hutt	6933	6782	151	0	0	0
Upper Hutt	8493	8072	421	0	0	0
Masterton	8570	7941	614	15	0	0

Table A2.4: CO – concentrations by air quality category

CO limit	Excellent	Good	Acceptable	Alert	Action
10 mg/m^3 (8-hour moving average)	< 1	1 to 3.3	3.3 to 6.6	6.6 to 10	> 10

Table A2.5: NO_2 - number of hours in 2006 by air quality category

Monitoring sites	Total no. hours sampled	Excellent	Good	Acceptable	Alert	Action
Wellington central	8613	2614	5294	705	0	0
Lower Hutt	8583	7194	1389	0	0	0
Upper Hutt	7524	6465	1059	0	0	0
Masterton	7144	6383	761	0	0	0

Table A2.6: NO_2 – concentrations by air quality category

NO_2 limit	Excellent	Good	Acceptable	Alert	Action
200 µg/m^3 (1-hour average)	< 20	20 to 66	66 to 132	133 to 200	> 200