Ministry for the Environment
Manatū Mō Te Taiao

GEMS/AMIS Air Quality Monitoring Programme

Annual Report 2007

Prepared for the Ministry for the Environment
by Watercare Services Limited

New Zealand Government

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1 Summary

This report contains the 2007 annual ambient air quality dataset, measured from two sites in Auckland and one site in Christchurch. These sites form New Zealand's contribution to the Global Environmental Monitoring System (GEMS).

The GEMS monitoring sites were established to measure key air pollutants associated with adverse effects on people's health and well-being. The GEMS sites include some of the longest running air quality monitoring sites in New Zealand. For example, various air quality monitoring has been undertaken at the Gavin Street, Penrose site in Auckland since 1964. These sites were established to determine the effects of policies for air quality management and are important for recording trends in pollution levels in New Zealand. The GEMS sites have provided long-term continuity in monitoring data for Auckland and Christchurch, and provide an important snapshot of air quality for two of New Zealand's largest cities.

The two Auckland monitoring sites include a site exposed to residential and vehicle emissions (Kowhai Intermediate School, Kingsland) and a site representative of vehicle and industrial emissions (Gavin Street, Penrose). The Greers Road, Burnside site in Christchurch is located within a residential area and represents emissions from domestic properties.

Air pollutants arise from a number of different sources. Particulate matter (PM_{10}) arises from stationary and mobile combustion sources, principally domestic heating, industrial processes and vehicle emissions (as well as natural processes such as soil erosion and sea salt). Sulfur dioxide is produced from the burning of fossil fuels, particularly coal and oil. Carbon monoxide is a product of incomplete combustion of carbon containing fuels, especially from motor vehicles. Volatile organic compounds (VOCs) are organic chemicals, such as hydrocarbons, that are closely tied to vehicle emissions and many industrial processes. Historically, lead was a petrol additive but since the significant reduction of lead in petrol from 1996, levels have declined in New Zealand.

Five ambient air quality standards for carbon monoxide, nitrogen dioxide, ozone, PM_{10} and sulfur dioxide were promulgated in October 2004. These standards are the minimum requirements that outdoor air quality must meet to guarantee a set level of protection for human health and the environment. The ambient standards are based on existing ambient air quality guidelines. Guideline levels for pollutants (and averaging periods) not covered by the standards still applies.

All air pollutants monitored at all the sites were below the NES (National Environmental Standards) 2004 as well as the Ambient Air Quality Guidelines (AAQG) 2002 for all averaging periods considered with the exception of Greers Road, Burnside. At this site, there were 11 exceedances of the 24-hour standard for PM_{10}, mainly during the colder months from May to August 2007. These exceedances were most likely caused by home heating emissions. The ambient air quality standard allows for one exceedance of the PM_{10} 24-hour threshold per year before the standard is breached.

2 Introduction

This report presents the 2007 ambient air quality data set for Auckland and Christchurch, New Zealand. The monitoring is conducted by Watercare Services Ltd, on behalf of the Ministry for the Environment.

The Ministry for the Envirionment has a Memorandum of Understanding with the New Zealand Ministry of Health (MoH) to collect and supply air quality monitoring data to the World Health Organization (WHO) from three sites – two in Auckland and one in Christchurch.

This data has historically formed New Zealand's contribution to the WHO's Global Environmental Monitoring System / Air Pollution Programme (GEMS/AIR) which began in 1973.[1]

In 1996 the WHO developed the Air Management Information System (AMIS) – the successor to GEMS/AIR. The objective of AMIS is to transfer information on air pollutant concentrations and air quality management between countries and to support and assist in the maintenance of air quality in parts of New Zealand that enjoy clean air, and to improve air quality in places where it has deteriorated.

As a result, monitoring from the AMIS programme is used by the Ministry for the Environment to support and enhance ambient air quality monitoring and management in Auckland and Christchurch. The GEMS / AMIS ambient air quality sites are the longest running sites in New Zealand, and as such are very important in identifying local long-term trends of air pollution.

The Auckland sites are located in the industrial area of Penrose to the south-east of the city centre and in Mt Eden and Kingsland, both of which are older residential areas just south of the city centre. Air quality monitoring has been performed in Penrose since 1964 and at Mt Eden between 1982 and 2004. In October 2004, the Mt Eden site was decommissioned pending redevelopment of the site and replaced by the Kingsland site at Kowhai Intermediate. In September 2007, the Kowhai, Kingsland site was decommissioned due to the construction of a swimming pool complex on school grounds. At present an alternative site is under investigation.

Between 1989 and 2002 monitoring was undertaken in Christchurch at a site located in the older residential area of St Albans which is just north of the city centre. Due to impending redevelopment of this site the monitoring station was relocated in November 2002 to a site in Burnside / Bishopdale which is a newer residential area to the north-west of the city centre.

Environment Canterbury provided sampling services for gravimetric and passive monitoring methods at Christchurch sites (Coles Place, St Albans and Greers Road Burnside).

This report includes graphical and statistical presentations of the data as well as any data collection issues that may have arisen during the monitoring period.

All data in this report has been completely validated. Quality assurance checks have been carried out to ensure that invalid and calibration data is not reported.

1 Schwela DH. 1999. Public Health and the air management information system (AMIS). *Epidemiology*, 10(5): 647–655.

3 Air Pollutants Monitored

3.1 Particulate matter

Particulate matter can be a significant air pollutant that is associated with a variety of health and environmental effects. Particulate matter refers to numerous substances that exist in the atmosphere. It is a somewhat complex pollutant, encompassing a wide range of chemically and physically diverse substances. Particulate matter includes all solids and aerosols that exist in ambient conditions.

Sources of particulates vary widely from location to location reflecting the wide range of emission sources that contribute to particulate concentrations in New Zealand. Typical sources can include:

- fine particulates emitted as a result of fuel combustion such as those associated with road vehicles, power generation, industrial processes, and domestic heating appliances. Particulates formed by chemical reactions in the atmosphere are comprised largely of sulphates and nitrates
- coarse particulates that arise from a wide range of sources, including re-suspended dusts from road, vehicles, construction works, mineral extraction processes, wind-blown dusts and soils, sea salt and biological particles such as pollen.

A variety of measurements can be used to determine the different health and environmental effects of particulate matter. As part of the GEMS / AMIS programme two particle size fractions are monitored:

- fine particulates (PM_{10})
- total suspended particulates (TSP).

3.1.1 Fine particulates (PM_{10})

Particles with an aerodynamic diameter of 10 µm or less can be inhaled into the respiratory system. The main effect is on human health. The coarser fractions of airborne particles (2.5 µm to 10 µm) are deposited in the trachea bronchial region, where asthma attacks are triggered.

3.1.2 Total suspended particulate (TSP)

TSP consists of all particles which range in size up to 50 µm in diameter. TSP is sufficiently small enough to be inhaled; however, the larger particles (10–50 µm) are readily filtered out in the nasal cavity. Particles 10 µm and smaller can be drawn into the respiratory system. TSP has an effect on both the aesthetic and health quality of the ambient air.

3.2 Lead

Lead is a toxic metal emitted into the air both from motor vehicles that use leaded fuel and some industry. Since lead was removed from fuel in 1996, concentrations of lead in air has dropped markedly. In October 2000, monitoring of lead was reduced from monthly samples to samples taken over a three-month period during the winter period (June–August) only as lead concentrations are historically higher during the cooler months.

3.3 Sulfur dioxide

Sulfur dioxide is an acidic gas with a pungent odour, which is mainly produced by the burning of fossil fuels. The gas is quite corrosive and can cause damage to buildings and other materials.

It can also have significant effects on the human respiratory system. Inhalation of high ambient concentrations of sulfur dioxide can cause stimulation of the nerves in the air passages, resulting in a reflex cough, irritation and chest tightness.

In addition, sulfur dioxide can also cause narrowing of the air passages, particularly in people suffering from asthma and chronic lung disease. These people frequently have narrowed airways, and any further restriction will have a disproportionately large effect, compared to people with uncompromised respiratory systems.

3.4 Carbon monoxide

This colourless, odourless, toxic gas is formed as a product of incomplete combustion in the burning of fossil fuels. The main sources in most parts of New Zealand are vehicle exhaust emissions, and as such elevated concentrations are mainly found in areas of significant traffic congestion, particularly at busy intersections on inner-city streets.

Carbon monoxide acts on humans by inhibiting oxygen uptake in the blood. Prolonged exposure at moderate levels can lead to symptoms such as headaches and dizziness, while at high levels it can lead to loss of consciousness and even death. At the lower levels typically encountered in urban areas, carbon monoxide measurements can serve as a useful indicator for objectionable levels of vehicle exhaust fumes.

3.5 Nitrogen oxides

Nitrogen oxides incorporate several species that exist in the atmosphere, which are collectively referred to as NO_x. The two main oxides are nitrogen dioxide (NO_2), which is of concern due to its potential to cause health effects, and nitric oxide (NO), which is less toxic but may oxidise to NO_2 in the atmosphere.

Nitrogen oxides are formed in most combustion processes by oxidation of the nitrogen present in the atmosphere. Nitric oxide is the predominant primary product but, as indicated, this can then be oxidised to nitrogen dioxide in ambient air. Emissions from motor vehicles are the major source of the NO_x in most parts of the country, although power stations and other large combustion units may be significant localised sources as well.

The main health effects of the oxides of nitrogen are due to NO_2, which is a respiratory irritant. Nitric oxide is believed to be quite harmless at the levels normally encountered in urban air.

NO_x is also an important air pollutant because of its role in photochemical smog. NO_2 is a reddish brown gas, and has synergistic health effects with other pollutants such as SO_2 and particulate.

3.6 Volatile organic compounds

Volatile organic compounds are chemicals that easily evaporate at room temperature. The term 'organic' indicates that the compounds contain carbon. A wide range of carbon-based molecules, such as aldehydes, ketones and hydrocarbons are VOCs.

To rationalise air quality guidelines, the Ministry for the Environment has compiled a list of priority contaminants, based on a review of international literature. The priority list includes the volatile organic compounds (VOC) benzene and 1,3-butadiene and provides ambient air quality guidelines for these contaminants[2]

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[2] Ministry for the Environment. 2002. *Ambient Air Quality Guidelines*. Wellington: Ministry for the Environment.

4 Ambient Air Quality Guidelines and Standards

In October 2004, the Ministry for the Environment introduced the National Environmental Standards (NES) for air quality. The NES includes five standards for ambient (outdoor) air quality. These and other New Zealand guidelines are described in table 1 below.

The criteria applied to TSP, 60 µg/m^3 (seven-day average), was previously applied by the Ministry of Health. This has been superseded by the Ministry for the Environment Ambient Air Quality Guidelines but is useful for analysing the results of the monitoring data.

Table 1: National environmental standards, guidelines and regional targets[3]

Air pollutant	National environmental standards 2004	Ministry for the Environment Ambient Air Quality Guidelines 2002 and other	Averaging period	National environmental standards permissible excess
Carbon monoxide	10 mg/m^3		8-hour average	One 8-hour period in a 12-month period
		30 mg/m^3	1-hour average	
Nitrogen dioxide		100 µg/m^3	24-hour average	
	200 µg/m^3		1-hour average	9 hours in a 12-month period
Sulfur dioxide		120 µg/m^3	24-hour average	
	350 µg/m^3		1-hour average	9 hours in a 12-month period
	570 µg/m^3		1-hour average	Not to be exceeded at any time
Benzene				
– Year 2002		10 µg/m^3	Annual average	
– Year 2010		3.6 µg/m^3	Annual average	
1,3-Butadiene		2.4 µg/m^3	Annual average	
Fine particulate (PM_{10})		20 µg/m^3	Annual average	
	50 µg/m^3		24-hour average	One 24-hour period in a 12-month period
Total suspended particulate (TSP)		60 µg/m^3 (Ministry of Health)[2]	7-day average	
Lead		0.2 µg/m^3	3-month average	

[3] See http://www.mfe.govt.nz/laws/standards/air-quality-standards.html

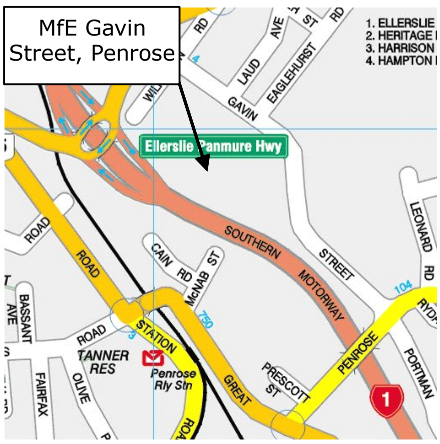
5 Monitoring Sites

5.1 Site descriptions

A brief description of all the monitoring sites in the GEMS / AMIS air quality monitoring programme is given below. This includes the two Auckland sites at Gavin Street in Penrose and Kowhai Intermediate School in Kingsland and two sites in Christchurch at Greers Road, in Burnside and Coles Place, in St Albans. (Note at Coles Place, only TSP, lead and VOCs are monitored by the Ministry for the Environment).

5.1.1 MfE Gavin Street, Penrose, Auckland – site AKL009

Site name	MfE Gavin Street, Penrose	**Site ID**	AKL009	
Address	Transpower, Gavin Street, Penrose, Auckland	**Site class**	Industrial – dense / traffic – peak	
Description This site is located within the grounds of the Transpower NZ Ltd electrical sub-station on Gavin Street, Penrose. It is representative of road, vehicle and industrial emissions in the Penrose area which lies to the southeast of Auckland City and is also approximately 120 metres northeast of the Southern Motorway. There are residential properties immediately to the northeast of the site. During 2003 parallel monitoring was undertaken between this site and the neighbouring ACI site on Great South Road, in Penrose with a view to consolidating all monitoring at the Gavin Street site early in 2004.				
Pollutants monitored	**CO** N	**NO_2** Y	**SO_2** Y	**VOCs** Y
	PM_{10} Y	**TSP** Y	**Lead** Y	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**Relative humidity** Y	
	Temperature (6 m) Y	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map	**Photograph**
	

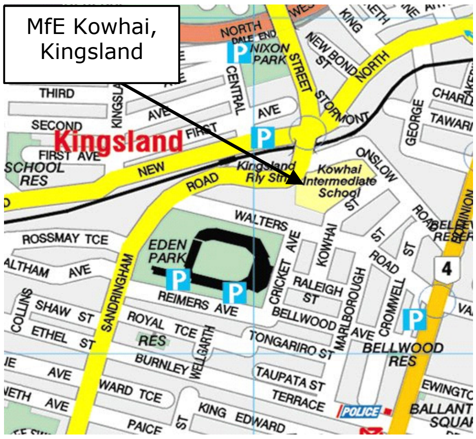
5.1.2 MfE Kowhai, Auckland – site AKL073

Site name	MfE Kowhai, Kingsland	Site ID	AKL073
Address	Kowhai Intermediate School, Sandringham Road, Kingsland, Auckland	Site class	Residential – peak

Description

This site is located within the grounds of Kowhai Intermediate School. It is surrounded by residential properties on three sides as well as the school buildings which lie about 100 metres to the north east. The busy New North Road is approximately 170 metres to the north of the site whilst Sandringham Road to the north west aligns north-east to south-west past the site. Eden Park Stadium is within 300 metres to the south-west of the site. It is representative of emissions arising from road, vehicles as well as domestic properties in the older inner-city area of Kingsland which lies to the south of Auckland City. This site was commissioned in 2004, designed to replace, the neighbouring Kelly Street site in Mt Eden which was to be redeveloped. The Kowhai site is about 1300 metres to the west of Kelly Street. During 2004, a period of parallel monitoring between the two sites was undertaken before all monitoring was re-located to the Kowhai site in October 2004. In September 2007, Kowhai was decommissioned due to the construction of a swimming pool complex inside the school grounds. A replacement site has not yet been finalised.

Pollutants monitored	**CO** N	**NO_2** Y	**SO_2** N	**VOCs** Y
	PM_{10} Y	**TSP** Y	**Lead** Y	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**Relative humidity** Y	
	Temperature (6 m) Y	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map	Photograph
	

5.1.3 MfE Greers Road, Burnside, Christchurch – site CAN002

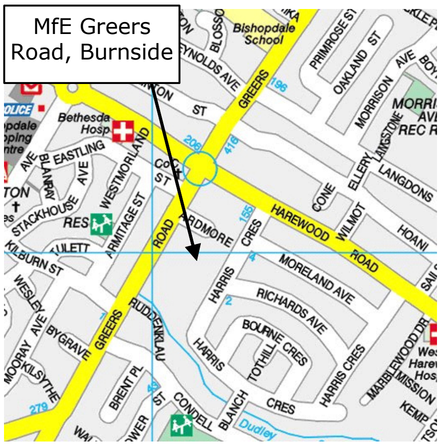
Site name	MfE Greers Road, Burnside	**Site ID**	CAN002
Address	Transpower, Greers Road, Burnside, Christchurch	**Site class**	Residential – neighbourhood

Description

This site is located in a paddock to the rear of the Transpower NZ Ltd electrical sub-station on Greers Road, and is surrounded by residential properties on four sides. Greers Road is approximately 100 m to the north west of the site. It is representative of emissions arising from domestic properties in the newer sub-urban areas of Burnside and Bishopdale which lie to the north-west of Christchurch city centre. The site was commissioned in November 2002 and replaces the former GEMS / AMIS site which was located off Madras Street, St Albans.

Pollutants monitored	**CO** Y	**NO_2** Y	**SO_2** Y	**VOCs** Y
	PM_{10} Y	**TSP** N	**Lead** N	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**Relative humidity** Y	
	Temperature (6 m) N	**Temperature (10 m)** Y	**Temperature (1.5 m)** Y	

Location map



Photograph

5.1.4 MfE Coles Place, St Albans, Christchurch – site CAN003

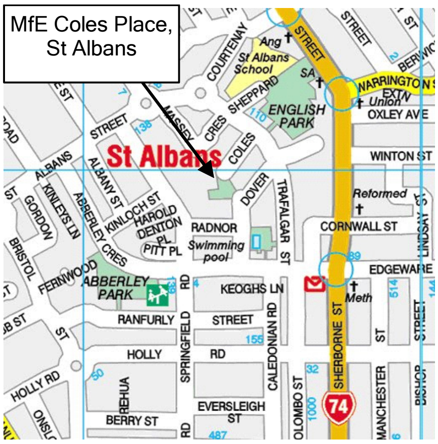
Site name	MfE Coles Place, St Albans	**Site ID**	CAN003
Address	Coles Place, St Albans, Christchurch	**Site class**	Residential – neighbourhood

Description

This site is operated by Environment Canterbury and is located on an area of public open space at the end of Coles Place. It is surrounded by residential properties on four sides. It is representative of emissions arising from domestic properties in the older sub-urban area of St Albans which lies to the north of Christchurch city centre.

Pollutants monitored	**CO** N	**NO_2** N	**SO_2** N	**VOCs** Y
	PM_{10} N	**TSP** Y	**Lead** Y	
Meteorological parameters monitored	**Wind speed** N	**Wind direction** N	**Relative humidity** N	
	Temperature (6 m) N	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map



Photograph

5.2 Air pollutants monitored at GEMS / AMIS sites

An overview of the air pollutants monitored at each site during 2007, as part of the GEMS / AMIS programme, is given in table 2 below.

Table 2: Air pollutants monitored at GEMS / AMIS sites 2007

Site	CO	NO_2	SO_2	VOC	PM_{10}	TSP	Lead*
Kowhai Intermediate, Kingsland AKL073		✓		✓	✓	✓	✓
Transpower, Gavin Street, Penrose, Auckland AKL009		✓	✓	✓	✓	✓	✓
Greers Road, Burnside, Christchurch CAN002	✓	✓	✓	✓	✓		
Coles Place, St Albans, Christchurch CAN003				✓		✓	✓

Note:

* Lead is measured on the TSP filters in the months of June, July and August only.

6 Methods

6.1 Quality assurance

All monitoring services are undertaken by Watercare Services Ltd in accordance with the Ministry for Environment's *Good Practice Guide for Air Quality Monitoring and Data Management* and wherever applicable the appropriate Australian / New Zealand and US EPA monitoring methods.

Watercare Laboratory Services is accredited by IANZ (International Accreditation New Zealand) for the following methods:

- AS 3580.7.1 – 1992 'Method 7.1: Determination of carbon monoxide – direct-reading instrumental method'.
- AS 3580.5.1 – 1993 'Method 5.1: Determination of oxides of nitrogen – chemiluminescence method'.
- AS 3580.4.1 – 1990 'Method 4.1: Determination of sulfur dioxide – direct reading instrumental method'.
- AS/NZS 3580.9.3 – 2003 'Method 9.3: Determination of Ambient Particulates (Gravimetric Method) – TSP High Volume Sampling'
- AS/NZS 3580.9.6 – 2003 'Method 9.6: Determination of Ambient Particulates (Gravimetric Method) – PM10 High Volume Sampling'
- US EPA Equivalent Method EQPM-1102-150 'Thermo Anderson Series FH62-C14 Continuous PM10 Monitor Automated Equivalent Method'.

As part of the GEMS / AMIS programme, Watercare Laboratory Services provides the following monitoring services:

- Instrument operation, calibration and maintenance. This includes the use of automatic daily calibration systems for all continuous ambient gas monitors ensuring that the requirements of the relevant Australian Standards for weekly calibration of continuous analysers are met.
- Site maintenance as well as, when necessary, commissioning new sites and decommissioning old sites.
- Data logging, polling, checking, re-scaling, validation, ratification and reporting. This encompasses the entire data quality assurance process ensuring that the final dataset reported is fit for the purpose of the GEMS / AMIS programme.

6.2 Analytical methods

6.2.1 Carbon monoxide

Measurements are made in accordance with AS 3580.7.1. – 1992 'Determination of Carbon Monoxide – Direct Reading Instrumental Method'. The performance of the instrument is checked using an automatic calibration system ensuring compliance with the method which requires instrumentation to be calibrated on a weekly basis.

The instruments themselves are infrared absorption gas analysers which continuously measure carbon monoxide. This allows data to be analysed and reported over a variety of average periods, including 10-minute, 24-hour and one year.

6.2.2 Nitrogen oxides

Measurements are made in accordance with AS 3580.5.1. – 1993 'Determination of Oxides of Nitrogen – Chemiluminescence Method'. The performance of the instrument is checked using an automatic calibration system ensuring compliance with the method which requires instrumentation to be calibrated on a weekly basis.

The instruments themselves are chemiluminescence gas analysers which continuously measure nitrogen oxides. This allows data to be analysed and reported over a variety of average periods, including 10-minute, 24-hour and one year.

6.2.3 Sulfur dioxide

Measurements are made in accordance with AS 3580.4.1. – 1990 'Determination of Sulfur Dioxide – Direct Reading Instrumental Method'. The performance of the instrument is checked using an automatic calibration system ensuring compliance with the method which requires instrumentation to be calibrated on a weekly basis.

The instruments themselves are UV fluorescence gas analysers which continuously measure sulfur dioxide. This allows data to be analysed and reported over a variety of average periods, including 10-minute, 24-hour and one year.

6.2.4 Volatile organic compounds

VOCs are measured each quarter (January–March, April–June, July–September and October–December) in accordance with the manufacturer's instructions (3M Technical Data Bulletin 1028).

VOC samples are taken using passive (3M) sampling badges, which are exposed for a three-month period. The VOCs diffuse on to the badges, which are coated with activated carbon. Following exposure the samples are forwarded to AsureQuality who extract the VOCs using carbon disulphide and analyse them using GC-MS. AsureQuality are accredited for VOCs by GC-MS using NIOSH Method 1500.

Note: Investigations have determined that samples of 1,3-butadiene are unstable when held above -4.41°C (BP) with significant reverse desorption occurring. Due to the potential for error over a three-month exposure period, 1,3-butadiene has not been analysed and reported. Alternative methods of measuring 1,3-butadiene are OSHA Method 56 and NIOSH Method 1024 both of these involve the use of solid sorbent coconut charcoal tubes.

6.2.5 Particulate matter (PM_{10})

Measurements are made in accordance with the US EPA Equivalent Method for measuring PM_{10} EQPM-1102-150 ‘Thermo Andersen Series FH62-C14 Continuous PM_{10} Ambient Particulate Monitor’. This method was designated as an Equivalent Method by the US EPA in accordance with 40 CFR Part 53 on 11December 2002.

The Thermo Andersen FH62-C14 is fitted with a size-selective PM_{10} head and measures the mass as it accumulates during sampling. As a result the instrument is able to record and output real-time measurements of PM_{10} data which allows measurements to be reported over a variety of average periods, including 10-minute, 24-hour and one year. The inlet temperature of all units operated by the Ministry for the Environment is 40°C.

6.2.6 Total suspended particulate matter (TSP)

Measurements of TSP are made in accordance with Watercare’s Air Quality Group Test Method T101 and the TSP analysis is performed in accordance with Watercare Laboratory Services Method GE08 (for TSP filters). It is a gravimetric method of measuring particulates and is modelled upon the High Volume sampler method. These techniques have been used to provide TSP data at existing GEMS / AMIS sites since 1964.

The equipment used to measure TSP is quite basic and involves ambient air being pulled through a glass fibre filter by a pump with a gas meter being used to measure the air volume drawn through the filter. The filter is weighed before and after sampling. The TSP concentration is determined from the weight of particulates collected and the air volume sampled.

6.2.7 Lead

Lead is sampled during the winter months, June–August, using same samples acquired to measure TSP. Analysis of lead is performed by Watercare Laboratory Services according to APHA Method 3030 and US EPA Method 200.8. This involves analysing each individual TSP filter exposed during the winter period using mixed acid digestion. This sample is then analysed for lead using ICP-MS. The concentration of lead is then determined from the amount of lead detected and the total volume of air sampled during that sample period. Concentrations are averaged for the three-month monitoring period.

7 Results and Discussion

7.1 Site performance and quality assurance

Overall site performance and explanations shown in table 3 below, based on 10-minute averages for continuously monitored data. Per cent of valid data (V) is defined as the per cent valid data following quality assurance adjustments. Per cent of captured data (C) is the per cent of total instrument availability.

All sampling was performed at all sites as planned during 2007, except at Kowhai, where the site was decommissioned in September. This was unavoidable due to redevelopment of the site and a new site is currently being investigated. Annual valid data rates were below 95 per cent at Greers Road, Burnside as the sample lines were found inside the PVC housing.

Continuously monitored pollutant's instrument performance during 2007 was generally very good, and with the exception of Kowhai, all sites had annual data capture rates greater than 95 per cent.

Table 3: Percentage valid and capture data 2007

Analyte	Site	Percentage valid data (V) and Percentage data capture (C)																									
		January		February		March		April		May		June		July		August		September		October		November		December		Annual	
		V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C
CO	Burnside	1.9[a]	99.8	98.3	99.8	98.2	99.7	97.7	99.5	97.8	99.9	97.6	100	86.9[d]	99.7	98.1	100	97.2	99.7	98.3	99.9	98.2	99.9	84.6[i]	99.9	87.7	99.8
NO_2	Penrose	97.9	100	96.6	98.4	98.3	100	89.4[c]	99.8	98.3	100	95.2	96.9	89.4[f]	91.6[f]	97.7	99.9	98.1	100	98.3	99.9	97.7	99.4	98.1	100	96.3	99.0
NO_2	Burnside	1.3[a]	99.8	98.1	99.8	97.9	99.7	97.7	99.5	98.3	99.9	98.4	100	95.2	99.7	98.4	100	97.2	99.7	98.0	99.9	98.3	99.9	98.1	99.9	89.6	99.8
NO_2	Kowhai	97.8	100	98.2	100	98.2	100	97.4	100	88.0[d]	100	97.7	100	98.5	100	95.2	100	14.5[g]	15.0[g]	0.0[g]	0.0[g]	0.0[g]	0.0[g]	0.0[g]	0.0[g]	65.3	67.8
SO_2	Penrose	97.4	100	95.5	98.4	97.0	100	96.4	99.8	97.4	100	94.1[f]	96.9	88.6[f]	91.6[f]	97.4	99.9	97.4	100	92.5	99.9	96.8	99.4	97.0	100	95.6	99.0
SO_2	Burnside	1.7[a]	99.8	97.5	99.8	97.4	99.7	97.1	99.5	97.6	99.9	97.8	100	97.2	99.7	97.3	100	91.3[h]	99.7	97.7	99.9	97.5	99.9	97.5	99.9	88.8	99.8
PM_{10}	Burnside	91.9	99.8	98.8	99.8	98.1	99.7	98.1	99.5	98.8	99.9	98.3	100	97.4	99.7	97.8	99.9	98.5	99.7	98.2	99.9	98.6	99.9	97.3	99.9	97.6	99.8
PM_{10}	Kowhai	98.7	100	99.1	100	98.9	100	99.0	100	99.0	100	98.8	100	99.8	100	99.7	100	14.7[g]	15.0[g]	0.0[g]	0.0[g]	0.0[g]	0.0[g]	0.0[g]	0.0[g]	67.2	67.8
PM_{10}	Penrose	98.8	100	97.2	98.4	98.8	100	98.7	99.8	99.1	100	95.9	96.9	89.5[f]	91.6[f]	98.8	99.9	98.6	100	98.4	99.9	97.6	99.4	98.4	100	97.5	98.8
VOC	Penrose	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VOC	Burnside	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VOC	St Albans	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
TSP	St Albans	60[b]	60[b]	75[b]	75[b]	100	100	100	100	100	100	100	100	100	100	100	100	100	100	60[b]	100	100	100	75[b]	75[b]	88.5	92.3
TSP	Penrose	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
TSP	Kowhai	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	25[g]	25[g]	0[g]	0[g]	0[g]	0[g]	0[g]	0[g]	69.2	69.2
Lead	St Albans	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	100	100	100	100	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	100
Lead	Penrose	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	100	100	100	100	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	100
Lead	Kowhai	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	75[e]	75[e]	100	100	100	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	92.3	92.3

Notes:

a Sample lines inside PVC housing
b Sampling error
c Analyser pump fault
d Analyser exchange failed
e Sample missing
f Power cut
g Site decommissioned
h Analyser swap and warm-up
i Analyser fault

7.2 Carbon monoxide (CO) 2007

CO was monitored at Greers Road, Burnside. One-hour and 8-hour averages have been calculated from 10-minute averages recorded by the instruments.

Summary statistics for CO and their dates are described below.

Site	Maximum 1-hour average (mg/m^3)	99.9 percentile 1-hour average (mg/m^3)	Maximum 8-hour average (mg/m^3)	99.9 percentile 8-hour average (mg/m^3)
Greers Road, Burnside	9.2 (6 August 23:00)	6.3	5.5 (7 August 02:00)	4.7

Carbon monoxide results are shown in figures 7 to 11.

At Greers Road, Burnside during the 12 month period there were no exceedances of the ambient air quality 1-hour guideline (30 mg/m^3) or 8-hour National Environmental Standard (10 mg/m^3).

7.3 Nitrogen oxides (NO_2 and NO) 2007

Oxides of nitrogen were monitored at Gavin Street, Penrose, Kowhai Intermediate, Kingsland and Greers Road, Burnside. One hour and 24-hour averages have been calculated from 10-minute averages recorded by the instruments.

Summary statistics for NO_2 and their dates for each site are described below.

Site	Maximum 1-hour average ($\mu g/m^3$)	99.9 percentile 1-hour average ($\mu g/m^3$)	Maximum 24-hour average ($\mu g/m^3$)	99.5 percentile 24-hour average ($\mu g/m^3$)
Gavin Street, Penrose	88.4 (29 May 09:00)	73.0	55.8 (27 June)	50.0
Kowhai Intermediate School, Kingsland	81.4 (3 July 09:00)	68.7	43.7 (4 July)	42.7
Greers Road, Burnside	66.6 (19 July 20:00)	56.6	38.1 (28 July)	34.6

Nitrogen dioxide results are shown in figures 12 to 21 (Kowhai), 22 to 31 (Gavin Street), and 32 to 41 (Burnside).

There were no exceedances of the NO_2 ambient air quality 1-hour standard (200 $\mu g/m^3$) or the 24-hour guideline (100 $\mu g/m^3$) during 2007 at any site in Auckland or Christchurch.

7.4 Sulfur dioxide (SO_2) 2007

Sulfur dioxide was monitored at Gavin Street, Penrose and Greers Road, Burnside. One-hour and 24-hour averages have been calculated from 10-minute averages recorded by the instruments.

Summary statistics for SO_2 and their dates for each site are described below.

Site	Maximum 1-hour average (µg/m^3)	99.9 percentile 1-hour average (µg/m^3)	Maximum 24-hour average (µg/m^3)	99.5 percentile 24-hour average (µg/m^3)
Gavin Street, Penrose	43.2 (17 June 12:00)	25.0	11.9 (19 June)	10.1
Greers Road, Burnside	52.2 (1 March 08:00)	31.4	13.8 (27 July)	11.0

Results for Gavin Street, Penrose are shown in figures 42 to 46 and Greers Road, Burnside is shown in figures 47 to 51. There were no exceedances of the SO_2 ambient air quality 1-hour standard (350 µg/m^3) or the 24-hour guideline (120 µg/m^3) during 2007 at any site.

7.5 Volatile organic compounds (VOC) January–December 2007

Monitoring of VOCs was conducted at four sites, Kowhai Intermediate School, Kingsland, Gavin Street, Penrose, Greers Road, Burnside, and Coles Place, Christchurch. VOC monitoring utilises passive sampling badges, exposed over a three-month period. A set of results for each 2007 quarter are shown in tables 4 to 7. See monitoring method in section 4.

The benzene guideline is 10 µg/m^3 as an annual average, with an average value of 3.6 µg/m^3 to be achieved by 2010. The 2007 six-month and 12-month averages are described below. The benzene annual averages from all the sites are less than the AAQG 2002 guideline and are graphed in figure 1.

Site	Six-month average (January–June 2007) benzene (µg/m^3)	Six-month average (July–December 2007) benzene (µg/m^3)	2007 annual average benzene (µg/m^3)
Coles Place, St Albans	1.9	1.3	1.6
Greers Road, Burnside	1.8	1.3	1.5
Gavin Street, Penrose	1.3	0.8	1.1
Kowhai Intermediate, Kingsland	1.3	1.2	1.3

Table 4: VOC results (January–March 2007)

January–February–March 2007 Analyte	Limit of detection (μg/m^3)	Results (μg/m^3)			
		Coles Place	Burnside	Gavin Street	Kowhai
Target VOCs					
ethanol	ND				
isopropyl alcohol	ND				
acetone	ND				
pentane	ND				
dichloromethane	ND				
butan-2-one	ND				
hexane	0.5	0.5	0.7	0.6	0.7
ethyl acetate	ND				
trichloromethane	ND				
1,1,1-trichloroethane	ND				
n-butanol	ND				
benzene	**0.2**	**0.7**	**0.7**	**0.6**	**0.6**
2-methylhexane	0.5		0.6		
2,3-dimethylpentane	ND				
3-methylhexane	0.5		0.5		
heptane	ND				
trichloroethene	ND				
propyl acetate	ND				
methylcyclohexane	ND				
4-methylpentan-2-one	ND				
toluene	0.2	4.0	3.3	5.2	4.6
octane	ND				
tetrachloroethene	ND				
butyl acetate	ND				
ethylbenzene	0.3	0.6	0.5	0.7	0.6
m+p-xylene	0.3	2.1	1.7	2.4	1.9
styrene	ND				
o-xylene	0.3	0.7	0.6	0.8	0.6
nonane	ND				
alpha pinene	ND				
propylbenzene	ND				
1,3,5-trimethylbenzene	ND				
beta pinene	ND				
decane	ND				
1,2,4-trimethylbenzene	0.6	0.8	0.7	0.9	0.8
limonene	ND				
undecane	0.7			0.8	
dodecane	ND				
tetradecane	ND				

ND = Not detected.

Table 5: VOC results (April–June 2007)

April–May–June 2007 Analyte	Limit of detection (µg/m³)	Results (µg/m³)			
		Coles Place	Burnside	Gavin Street	Kowhai
Target VOCs					
ethanol	ND				
isopropyl alcohol	ND				
acetone	ND				
pentane	2.9			3.5	3.0
dichloromethane	ND				
butan-2-one	ND				
hexane	0.6	1.3	1.6	1.8	1.7
ethyl acetate	0.6			0.8	0.6
trichloromethane	ND				
1,1,1-trichloroethane	ND				
n-butanol	ND				
benzene	**0.3**	**3.1**	**3.0**	**2.0**	**2.1**
2-methylhexane	0.7	1.2	2.0	0.7	0.6
2,3-dimethylpentane	0.7		1.8		
3-methylhexane	0.7	1.6	2.9	0.8	0.7
heptane	0.7	1.4	2.2	0.8	0.6
trichloroethene	0.6				1.1
propyl acetate	ND				
methylcyclohexane	0.7	3.6	9.9		
4-methylpentan-2-one	ND				
toluene	0.3	12.5	9.8	12.3	12.5
octane	ND				
tetrachloroethene	ND				
butyl acetate	0.6			0.7	
ethylbenzene	0.4	1.9	1.5	2.0	1.9
m+p-xylene	0.4	5.6	4.3	5.8	5.2
styrene	ND				
o-xylene	0.4	2.6	1.9	2.3	2.0
nonane	ND				
alpha pinene	0.9			0.7	
propylbenzene	ND				
1,3,5-trimethylbenzene	0.7			0.8	0.7
beta pinene	0.9		1.1	0.8	
decane	0.8			0.7	
1,2,4-trimethylbenzene	0.8	2.3	1.7	2.4	2.3
limonene	ND				
undecane	0.9			0.8	
dodecane	ND				
tetradecane	ND				

ND = Not detected.

Table 6: VOC results (July–September 2007)

July–August–September 2007 Analyte	Limit of detection (µg/m^3)	Results (µg/m^3)			
		Coles Place	Burnside	Gavin Street	Kowhai
Target VOCs					
ethanol	ND				
isopropyl alcohol	ND				
acetone	ND				
pentane	2.3			3.0	2.7
dichloromethane	ND				
butan-2-one	ND				
hexane	0.5	1.2	1.6	1.1	1.3
ethyl acetate	0.5		0.5	0.8	0.5
trichloromethane	ND				
1,1,1-trichloroethane	ND				
n-butanol	ND				
benzene	**0.2**	**2.2**	**2.2**	**1.1**	**1.5**
2-methylhexane	0.5	1.5	1.3		
2,3-dimethylpentane	0.5	1.1	0.9		
3-methylhexane	0.5	2.2	1.8		
heptane	0.5	1.8	1.6		
trichloroethene	0.5				1.3
propyl acetate	ND				
methylcyclohexane	0.5	2.2	1.7		
4-methylpentan-2-one	ND				
toluene	0.3	8.4	6.9	6.5	7.5
octane	ND				
tetrachloroethene	ND				
butyl acetate	0.5			0.5	
ethylbenzene	0.3	1.3	1.1	1.0	1.2
m+p-xylene	0.3	4.5	3.6	3.9	4.2
styrene	ND				
o-xylene	0.3	1.7	1.4	1.3	1.4
nonane	ND				
alpha pinene	ND				
propylbenzene	ND				
1,3,5-trimethylbenzene	ND				
beta pinene	ND				
decane	ND				
1,2,4-trimethylbenzene	0.6	1.6	1.2	1.3	1.4
limonene	ND				
undecane	0.7			0.7	
dodecane	ND				
tetradecane	ND				

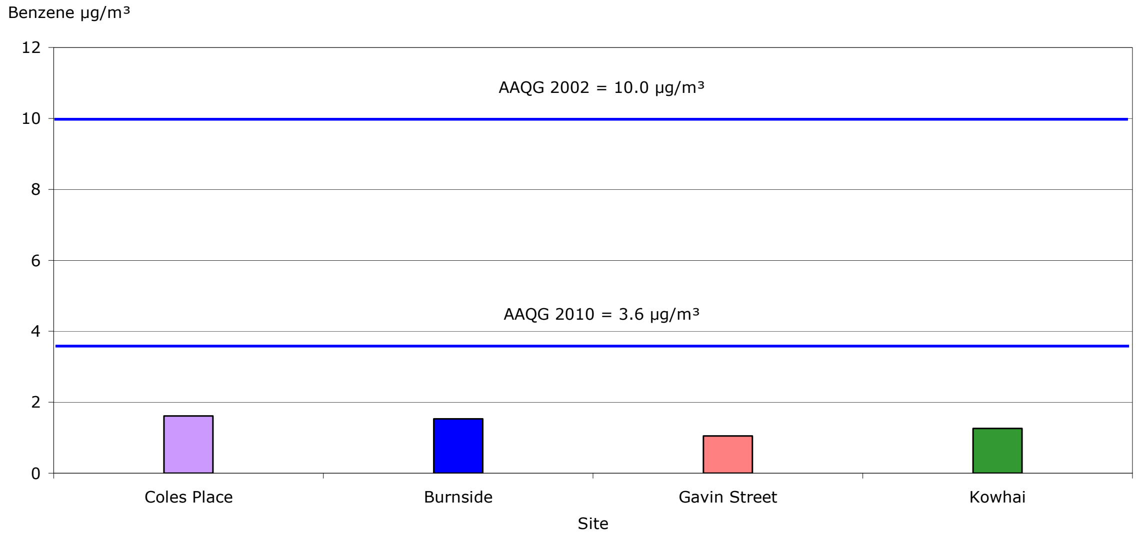
ND = Not detected.

Table 7: VOC results (October–December 2007)

October–November–December 2007 Analyte	Limit of detection (µg/m^3)	Results (µg/m^3)			
		Coles Place	Burnside	Gavin Street	Kowhai
Target VOCs					
ethanol	ND				
isopropyl alcohol	ND				
acetone	ND				
pentane	ND				
dichloromethane	ND				
butan-2-one	ND				
hexane	0.4	0.5	1.0	0.7	0.9
ethyl acetate	ND				
trichloromethane	ND				
1,1,1-trichloroethane	ND				
n-butanol	ND				
benzene	0.2	0.4	0.4	0.5	0.9
2-methylhexane	ND				
2,3-dimethylpentane	ND				
3-methylhexane	ND				
heptane	0.5		0.5		
trichloroethene	ND				
propyl acetate	ND				
methylcyclohexane	ND				
4-methylpentan-2-one	ND				
toluene	0.2	2.3	2.1	3.3	4.8
octane	ND				
tetrachloroethene	ND				
butyl acetate	ND				
ethylbenzene	0.3	0.4	0.3	0.5	0.7
m+p-xylene	0.3	1.4	1.2	2.0	2.7
styrene	ND				
o-xylene	0.3	0.5	0.4	0.6	0.8
nonane	ND				
alpha pinene	ND				
propylbenzene	ND				
1,3,5-trimethylbenzene	ND				
beta pinene	ND				
decane	ND				
1,2,4-trimethylbenzene	0.6			0.7	0.9
limonene	ND				
undecane	ND				
dodecane	ND				
tetradecane	0.6	0.7			

ND = Not detected.

Figure 1: MfE benzene annual average 2007



7.6 Particulate matter (PM_{10}) 2007

PM_{10} is monitored at Greers Road, Burnside, Gavin Street, Penrose and Kowhai Intermediate, Kingsland sites, using Thermo FH62-C14 Beta Gauges. Twenty-four hour averages have been calculated from 10-minute averages recorded by the instruments. All PM_{10} concentrations are reported at standard temperature and pressure (0°C and 101.3 kPa).

The maximums for PM_{10} and their dates for each site are described below.

Site	Maximum 24-hour average (µg/m^3)	99.5 percentile 24-hour average (µg/m^3)
Gavin Street, Penrose	46.2 (28 May)	41.1
Kowhai Intermediate, Kingsland	33.6 (29 May)	32.5
Greers Road, Burnside	110.3 (6 August)	68.9

There were no exceedances of the ambient air quality standard (50 µg/m^3) in Auckland during the 12-month period.

At Greers Road, Burnside, there were 11 exceedances of the 24-hour standard. Each exceedance and the date are listed in table 8 below. PM_{10} for 2007 for each site are shown in figures 52 to 54 (Kowhai), 55 to 57 (Gavin Street), and 58 to 60 (Burnside). As there were exceedances at the Christchurch site, more data analysis was carried out in section 7.9. All exceedances occurred over the winter period, a time when wood burning is widely used to heat homes. Cold winter conditions strongly influence air pollution in the region especially in calm conditions. All 10 exceedances occurred in cooler months between June and August 2007.

Table 8: Greers Road, Burnside PM_{10} exceedances of the daily NES 2007

Date	Burnside PM_{10} (µg/m^3)
04/6/2007	60
13/6/2007	69
18/6/2007	63
19/6/2007	56
08/7/2007	69
09/7/2007	51
23/7/2007	78
27/7/2007	61
28/7/2007	67
06/8/2007	110

Note: National Environmental Standard for PM_{10} = 50 µg/m^3.

7.7 Total suspended particulates (TSP) 2007

TSP is measured as a seven-day average at, Gavin Street, Penrose, Kowhai Intermediate, Kingsland and Coles Place, St Albans. Maximum results and their dates (seven-day ending period) for each site are described below.

Site	Maximum seven-day average (µg/m^3)
Gavin Street, Penrose	33 (28 February)
Kowhai Intermediate, Kingsland	22 (30 May)
Coles Place, St Albans	32 (26 July)

There were no exceedances of the Ministry of Health (MoH) guideline of 60 µg/m^3 at any site. The TSP concentrations in Auckland are shown in figures 2 and 3 while Christchurch TSP concentrations are shown in figures 4 and 5.

Figure 2: Auckland TSP seven-day average 2007

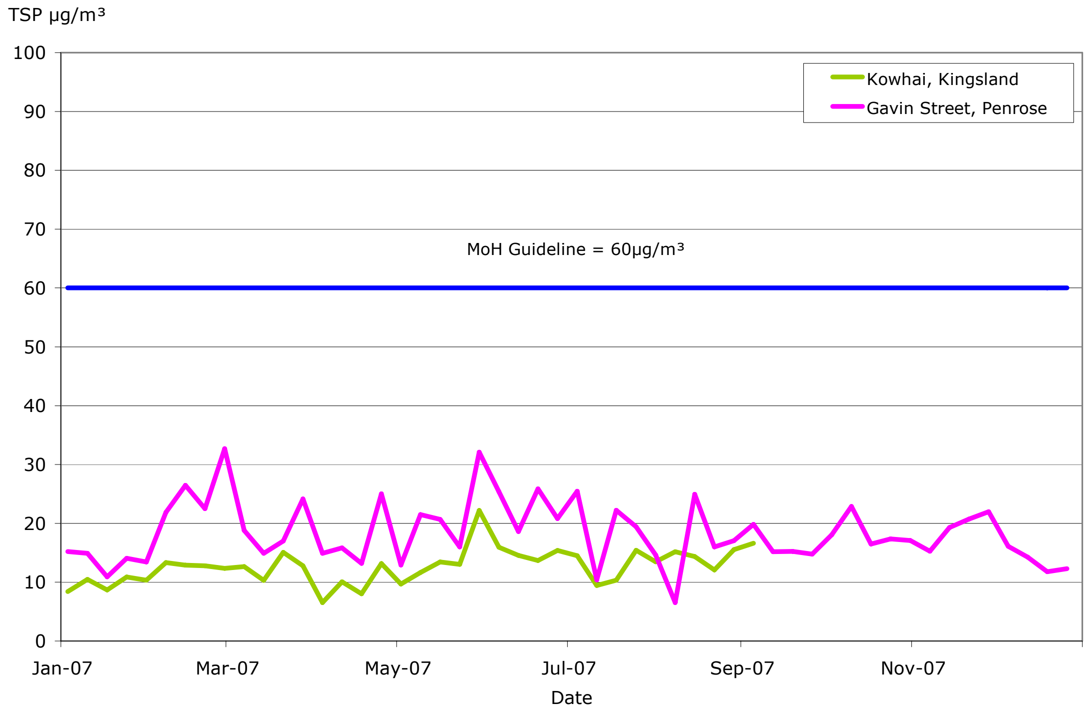


Figure 3: Auckland TSP seven-day average 1994–2007

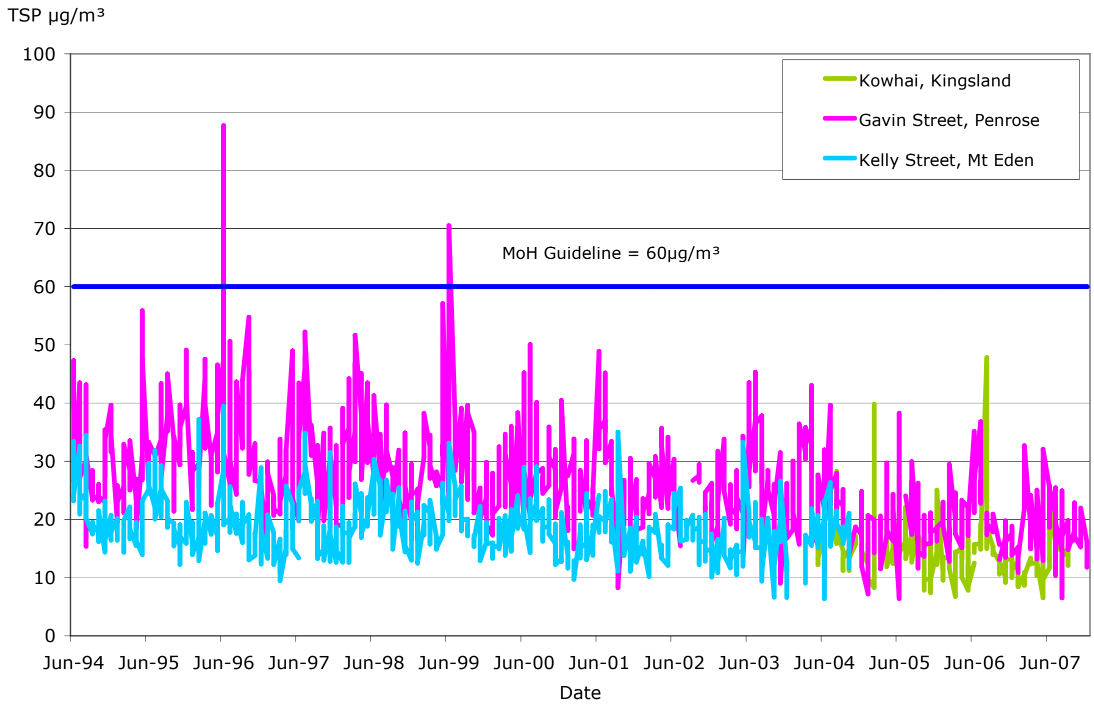


Figure 4: Christchurch TSP seven-day average 2007

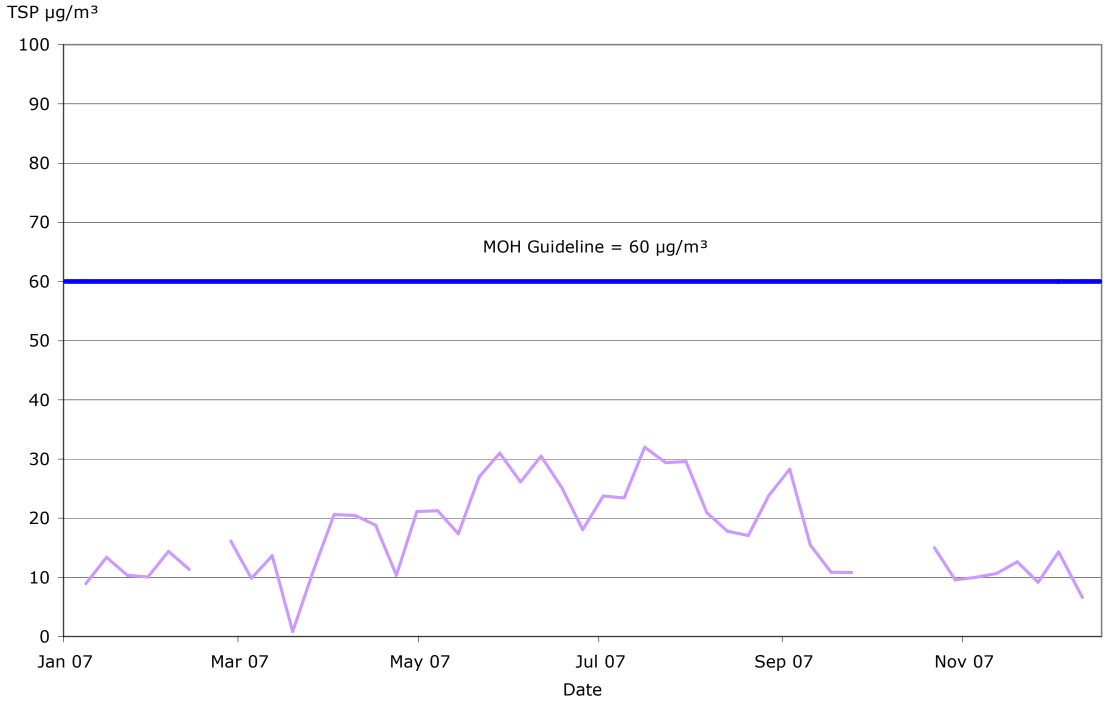
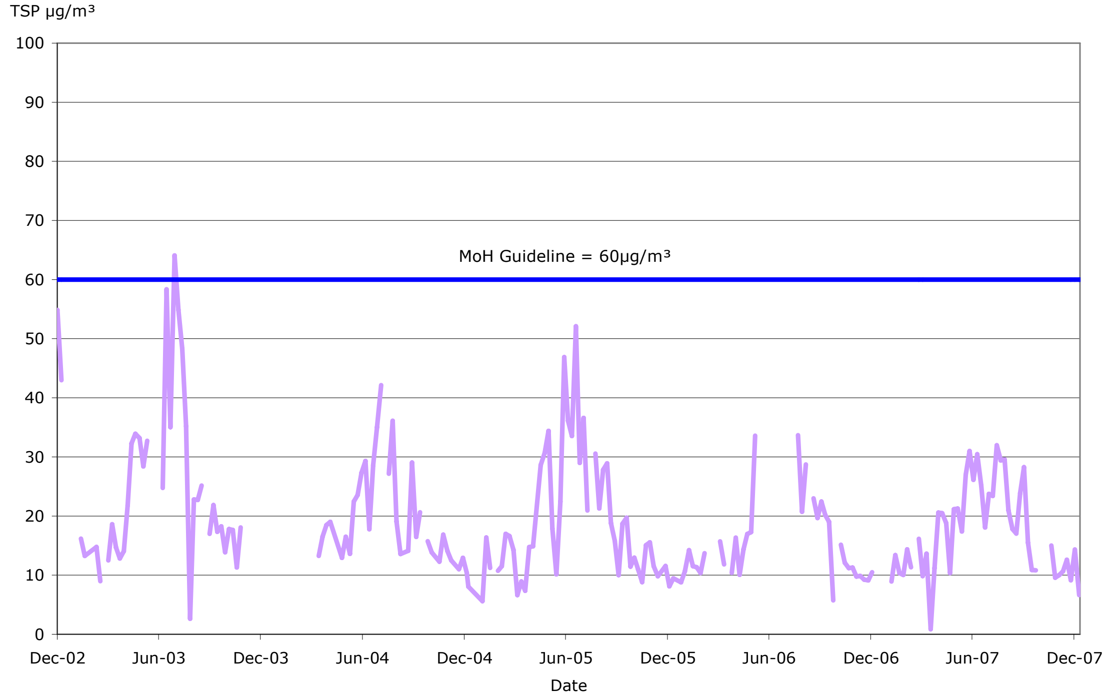


Figure 5: Christchurch TSP seven-day average 2002–2007



7.8 Lead (Pb) June–August 2007

Lead is measured from seven-day averaged TSP samples to derive a three-month average. The results are described in the table below. Figure 6 provides moving three-month averaged lead data between January 1996 and September 2000 when lead monitoring was performed on a monthly basis. From this point lead continued to be monitored over a three-month period (June to August) annually.

Site	June 2007 average (µg/m^3)	July 2007 average (µg/m^3)	August 2007 average (µg/m^3)	Winter 2007 average (µg/m^3)
Kowhai Intermediate, Kingsland	0.020	0.010	0.006	0.012
Gavin Street, Penrose	0.020	0.010	0.006	0.012
Coles Place, St Albans	0.032	0.028	0.016	0.025

No site exceeded the three-month average guideline for lead (0.2 µg/m^3).

Figure 6: MfE lead three-month average results 1996–2007

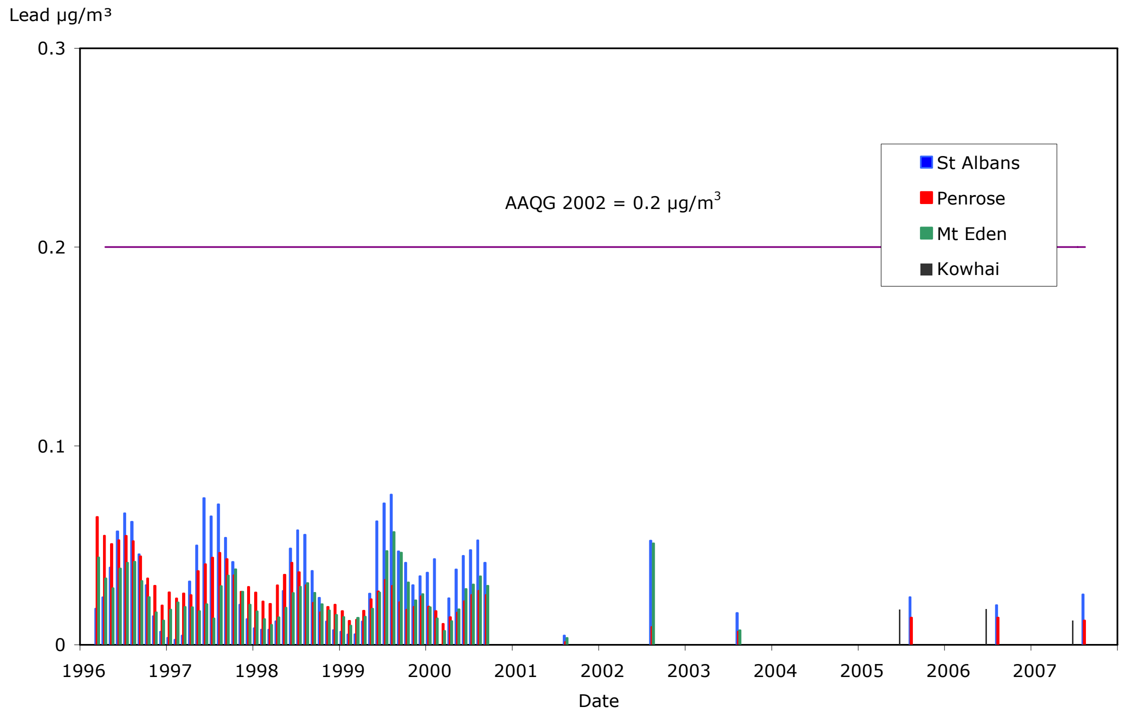
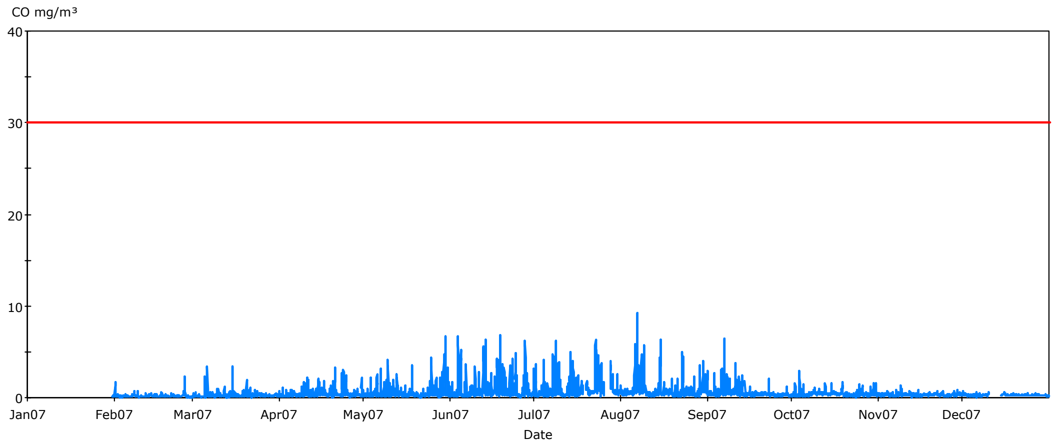
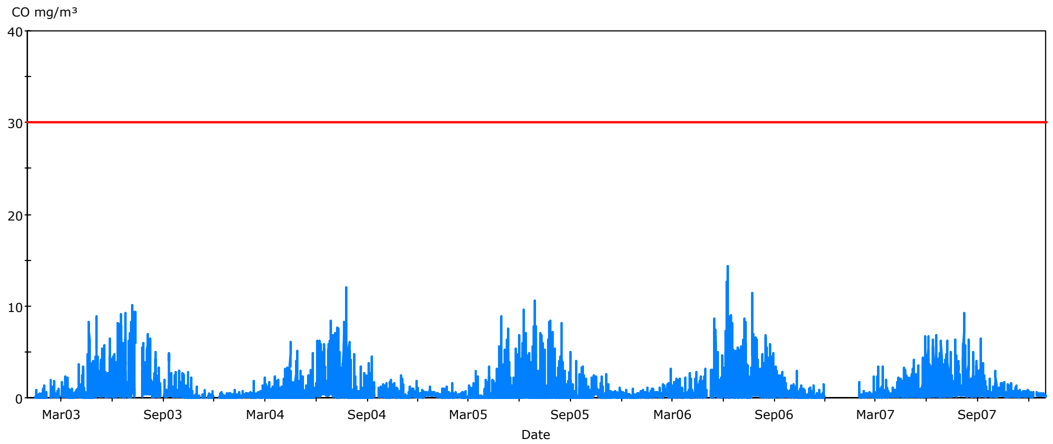


Figure 7: MfE Burnside CO 1-hour fixed average January–December 2007



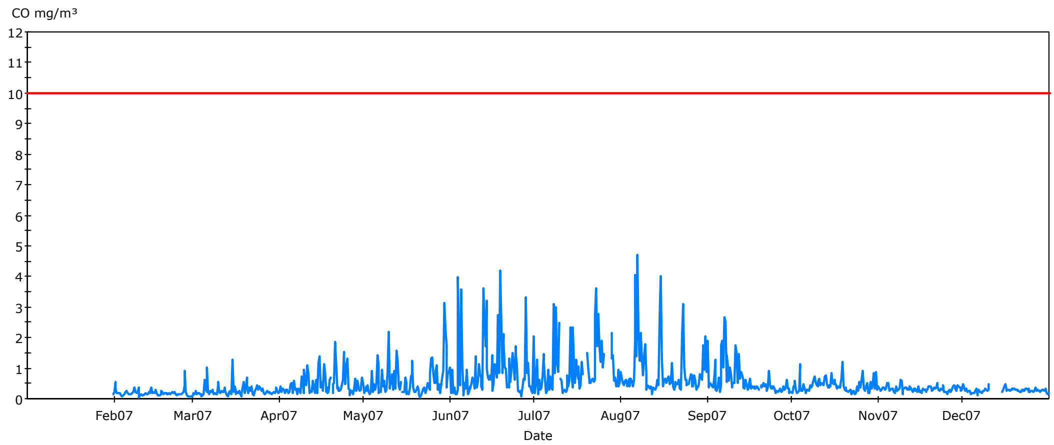
Ambient air quality guideline for CO – 30 mg/m^3

Figure 8: MfE Burnside CO 1-hour fixed average 2003–2007



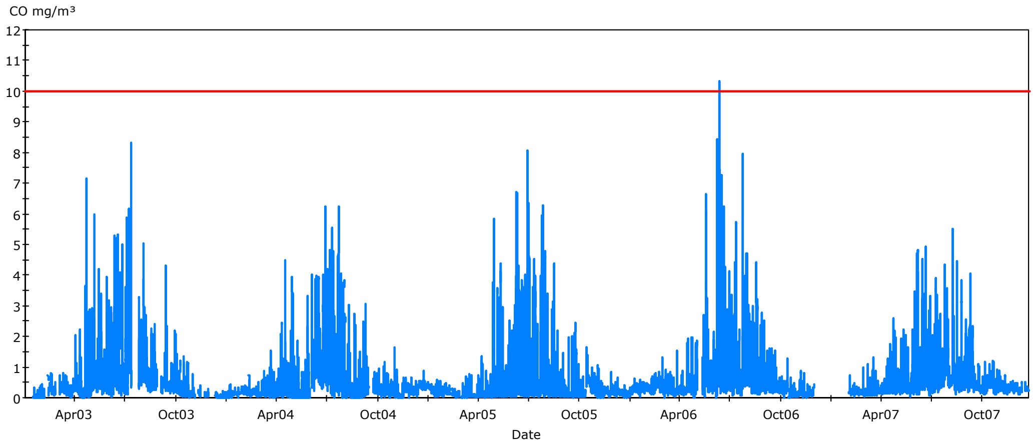
Ambient air quality guideline for CO – 30 mg/m^3

Figure 9: MfE Burnside CO 8-hour rolling average January–December 2007



National environmental standard for CO – 10 mg/m^3

Figure 10: MfE Burnside CO 8-hour rolling average 2003–2007



National environmental standard for CO – 10 mg/m^3

Figure 11: MfE Burnside CO annual average 2003–2007

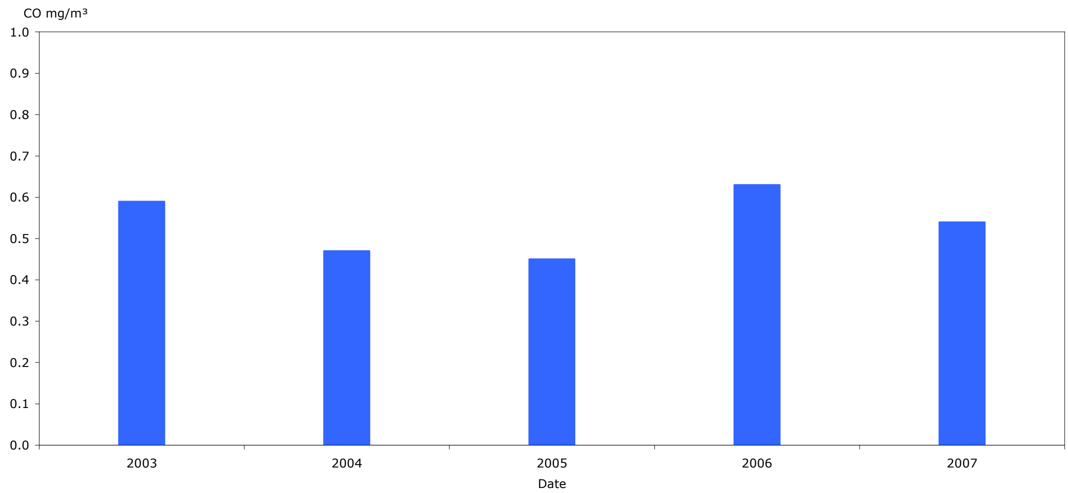
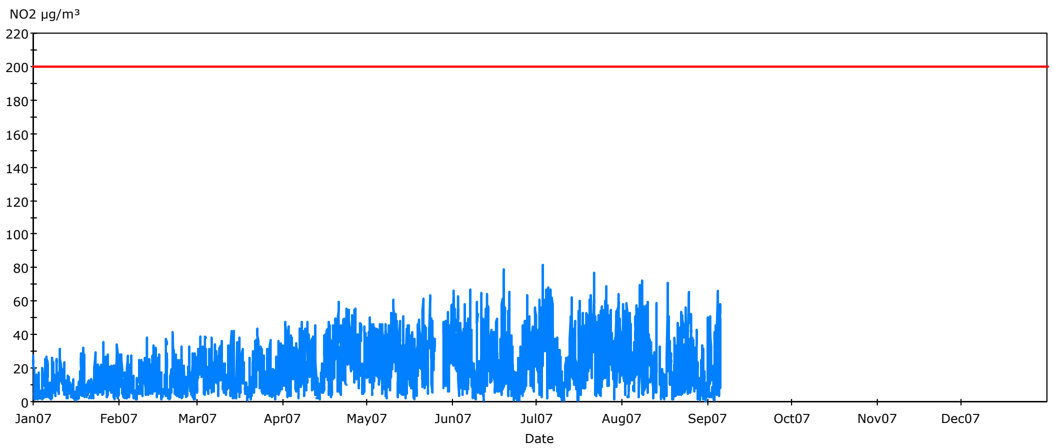
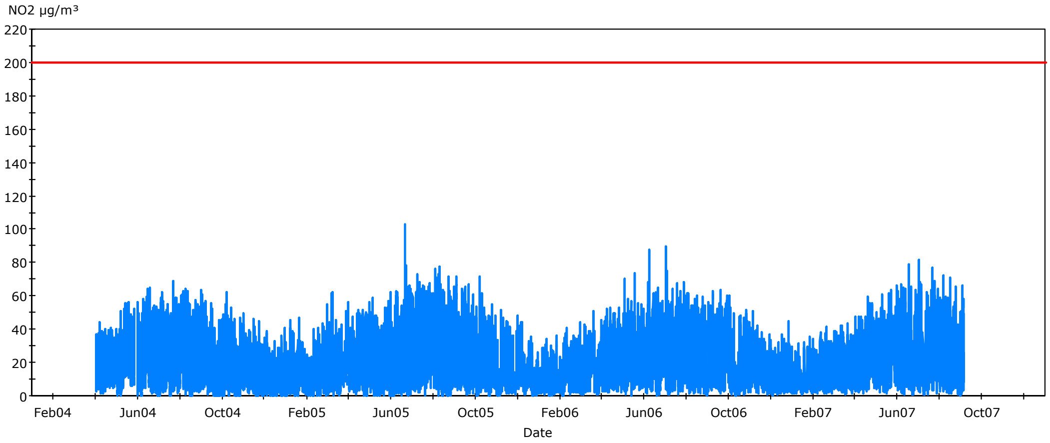


Figure 12: MfE Kowhai NO_2 1-hour fixed average January–December 2007



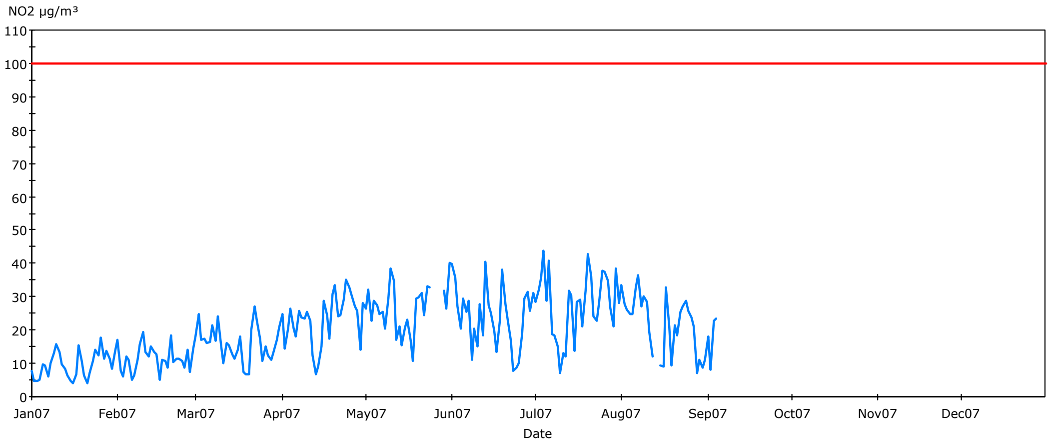
National environmental standard for NO_2 – 200 μg/m^3

Figure 13: MfE Kowhai NO_2 1-hour fixed average 2004–2007



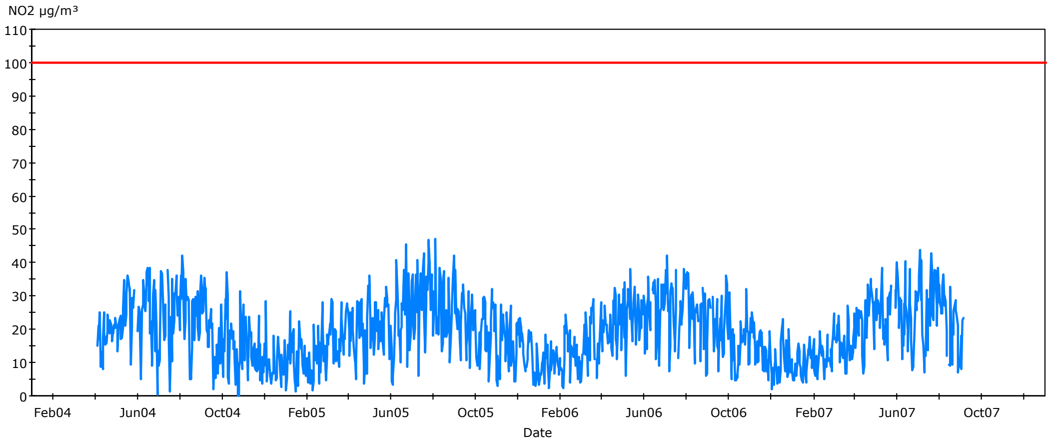
National environmental standard for NO_2 – 200 µg/m^3

Figure 14: MfE Kowhai NO_2 24-hour fixed average January–December 2007



Ambient air quality guideline for NO_2 – 100 µg/m^3

Figure 15: MfE Kowhai NO_2 24-hour fixed average 2004–2007



Ambient air quality guideline for NO2 – 100 µg/m^3

Figure 16: MfE Kowhai NO_2 annual average 2004–2007

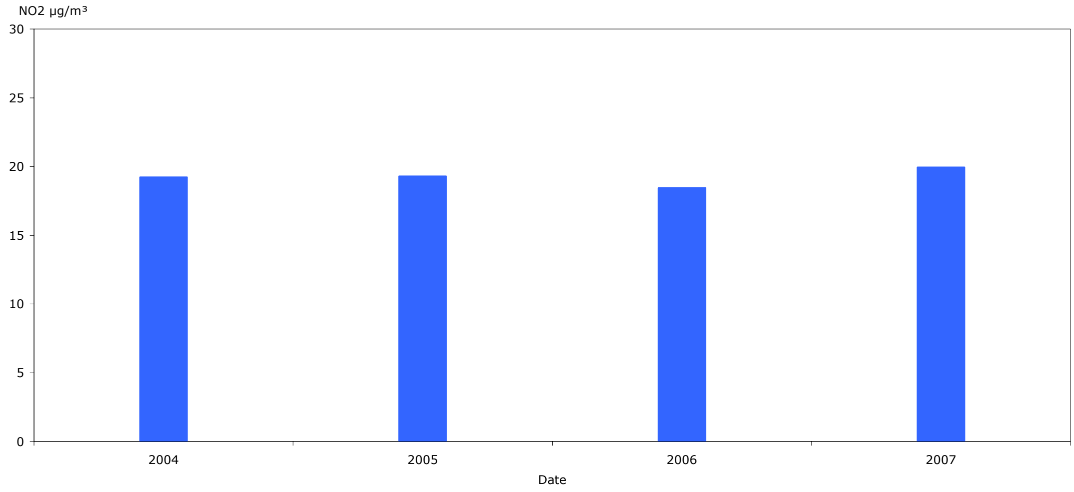


Figure 17: MfE Kowhai NO_2 and NO 1-hour fixed average January–December 2007

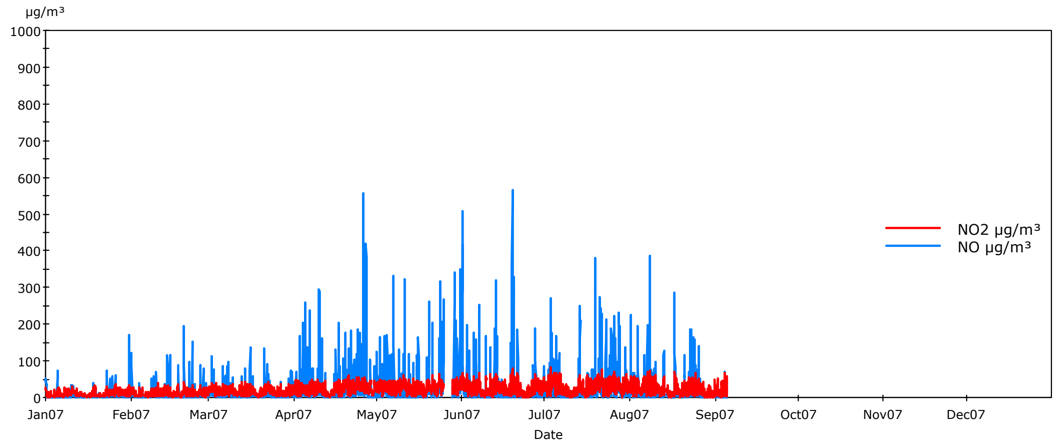


Figure 18: MfE Kowhai NO_2 and NO 24-hour fixed average January–December 2007

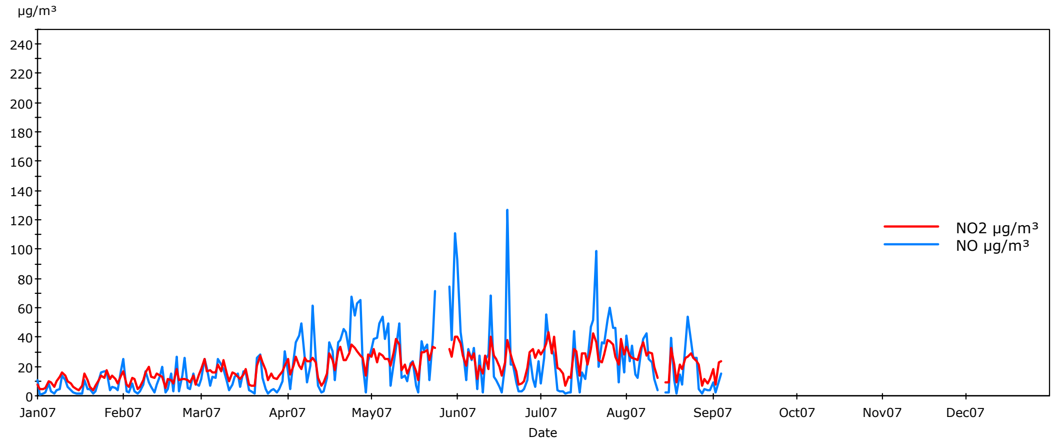


Figure 19: MfE Kowhai NO 1-hour fixed average 2004–2007

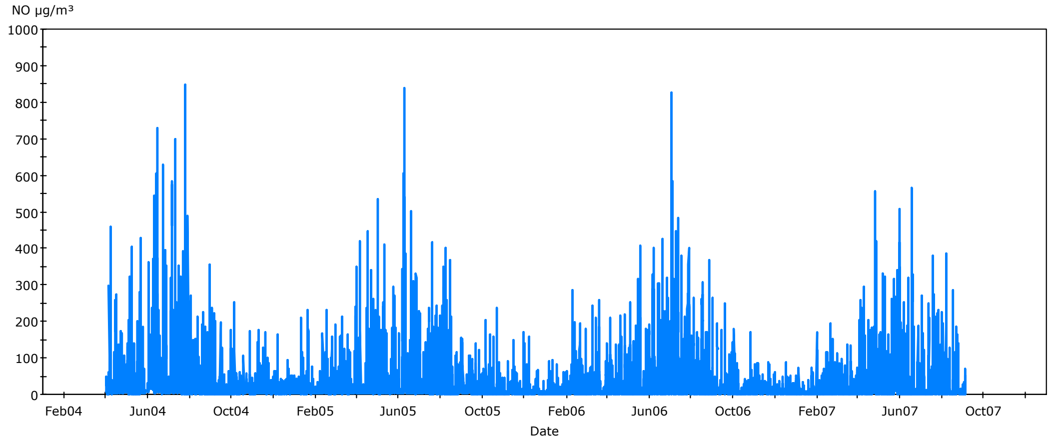


Figure 20: MfE Kowhai NO 24-hour fixed average 2004–2007

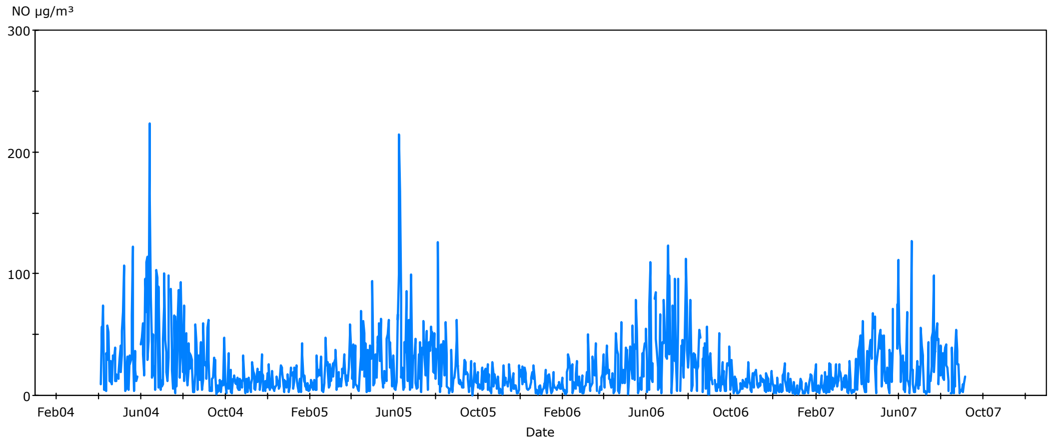


Figure 21: MfE Kowhai NO annual average 2004–2007

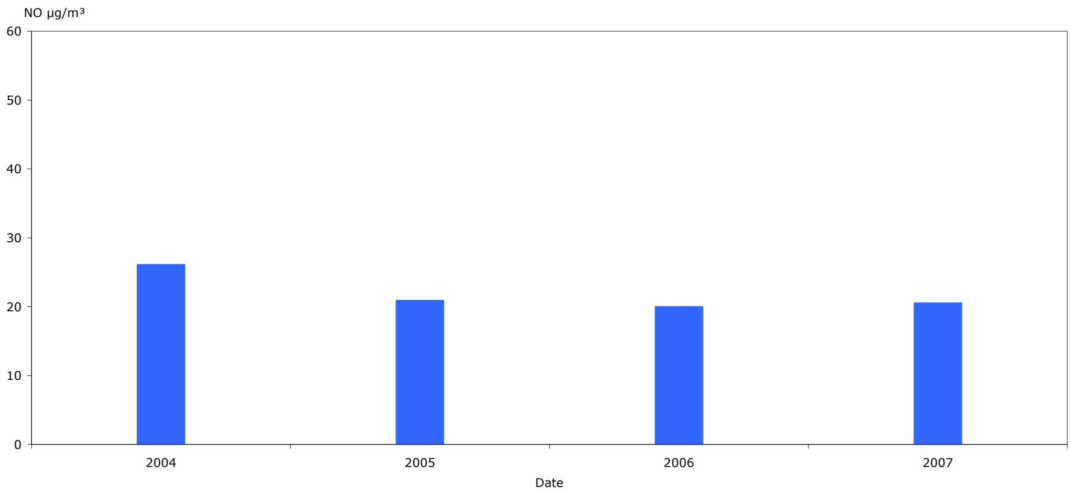
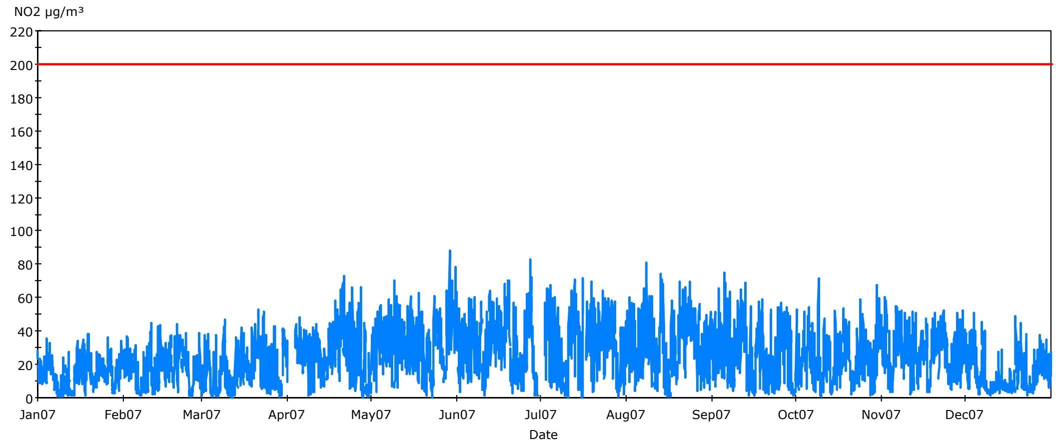
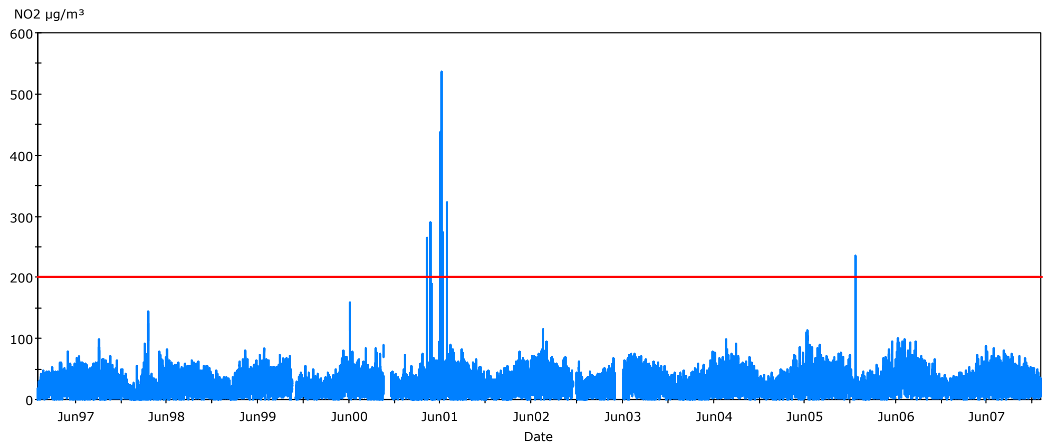


Figure 22: MfE Gavin Street NO_2 1-hour fixed average January–December 2007



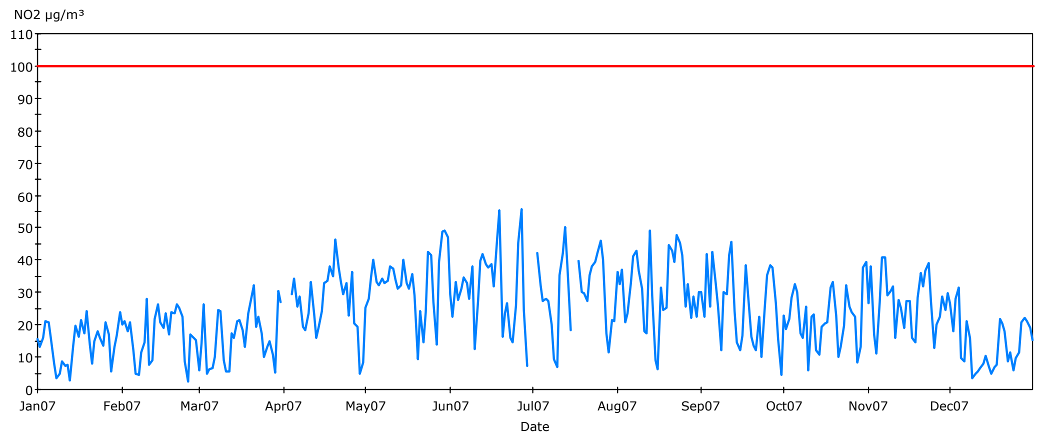
National environmental standard for NO_2 – 200 µg/m^3

Figure 23: MfE Gavin Street NO_2 1-hour fixed average 1997–2007



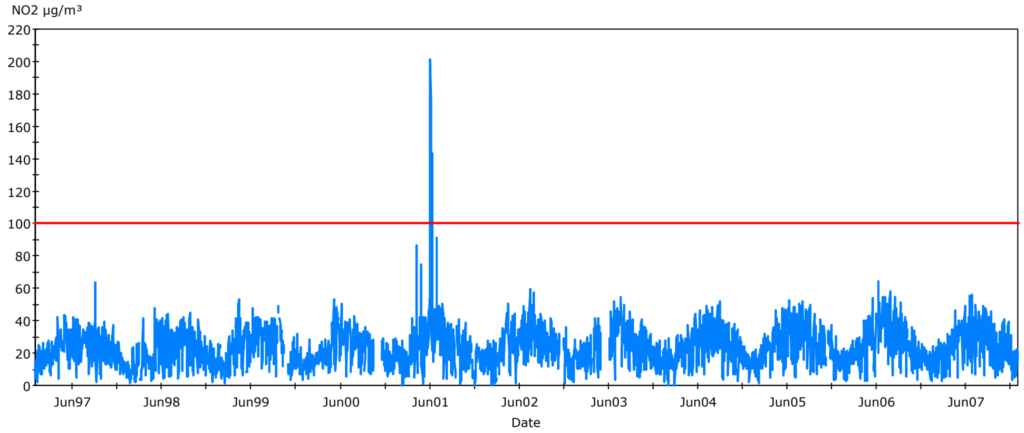
National environmental standard for NO_2 – 200 µg/m^3

Figure 24: MfE Gavin Street NO_2 24-hour fixed average January–December 2007



Ambient air quality guideline for NO_2 – 100 µg/m^3

Figure 25: MfE Gavin Street NO_2 24-hour fixed average 1 January 1997–2007



Ambient air quality guideline for NO_2 – 100 µg/m^3

Figure 26: MfE Gavin Street NO_2 annual average 1997–2007

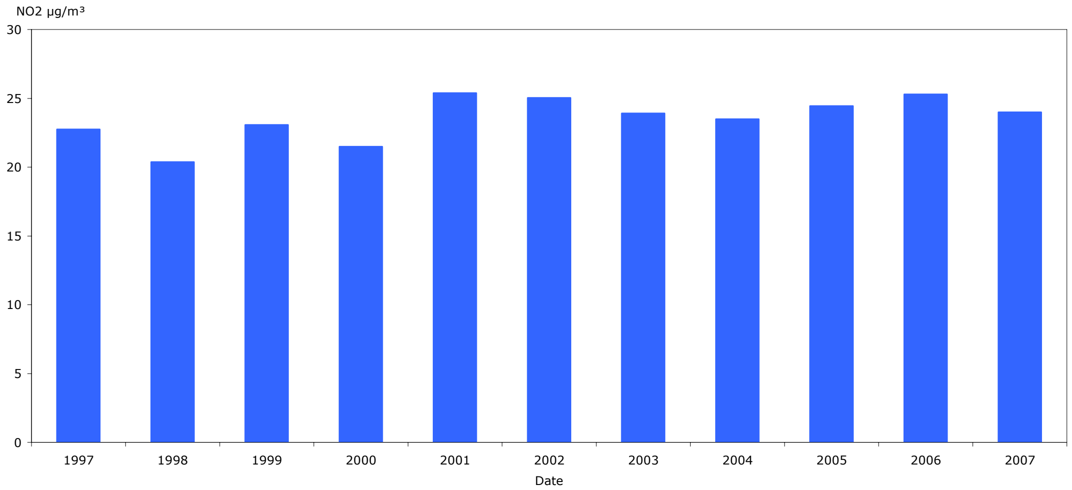


Figure 27: MfE Gavin Street NO_2 and NO 1-hour fixed average January–December 2007

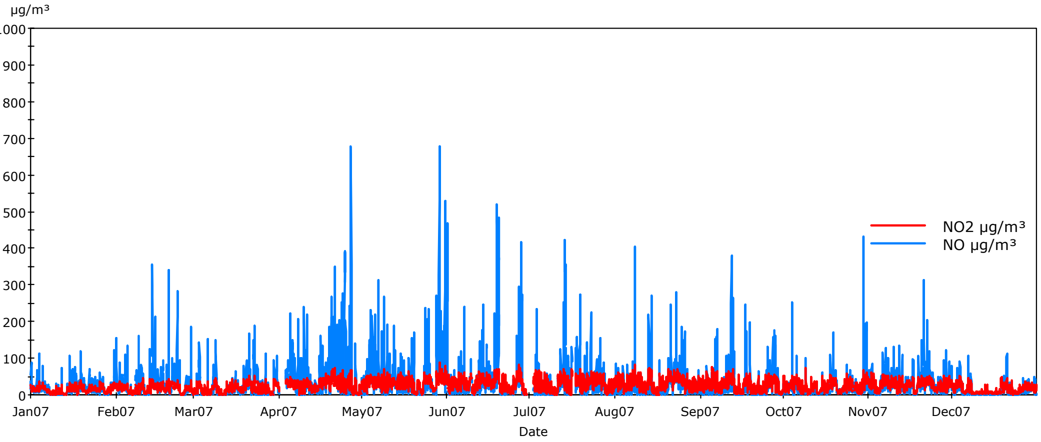


Figure 28: MfE Gavin Street NO_2 and NO 24-hour fixed average January–December 2007

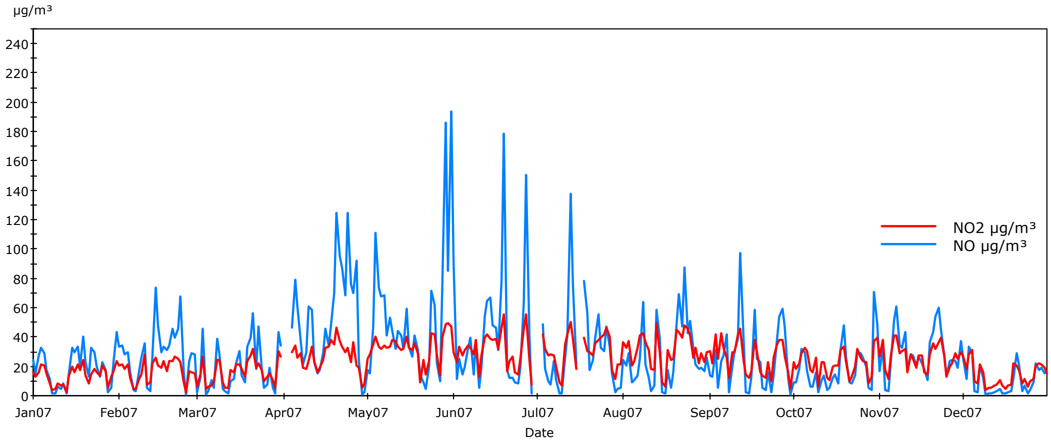


Figure 29: MfE Gavin Street NO 1-hour fixed average 1997–2007

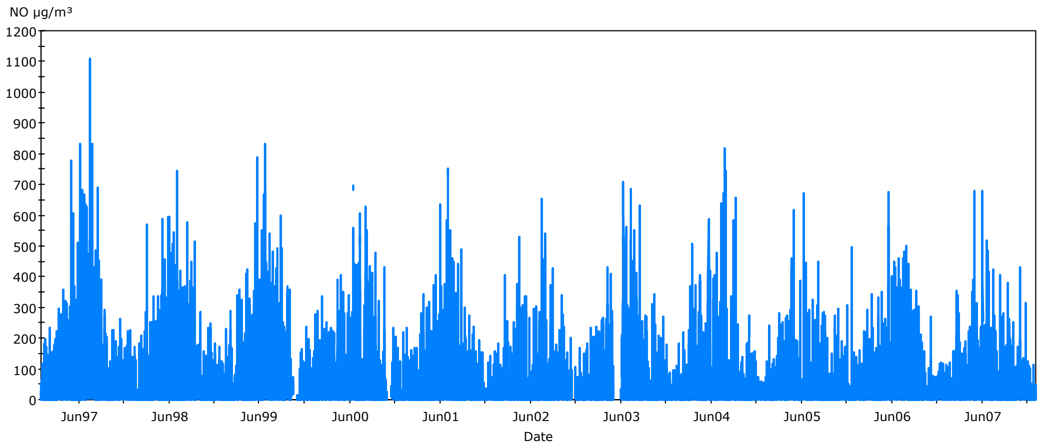


Figure 30: MfE Gavin Street NO 24-hour fixed average 1997–2007

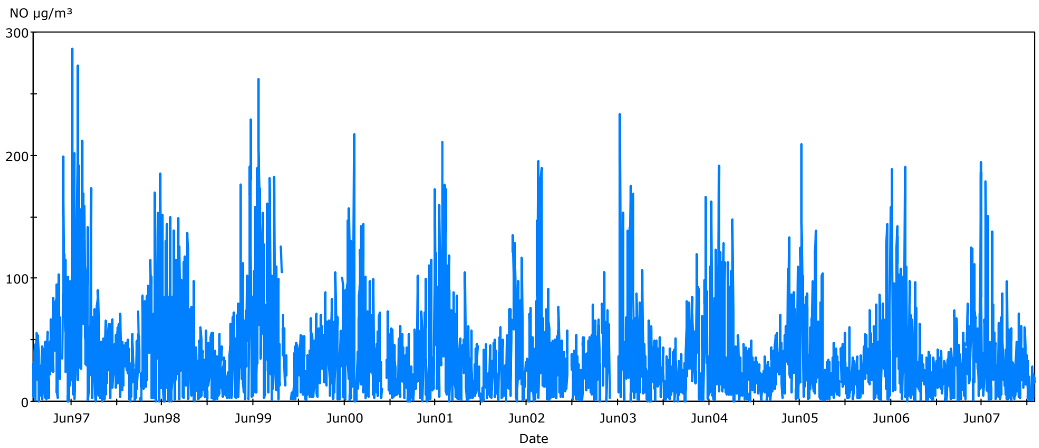


Figure 31: MfE Gavin Street NO annual average 1997–2007

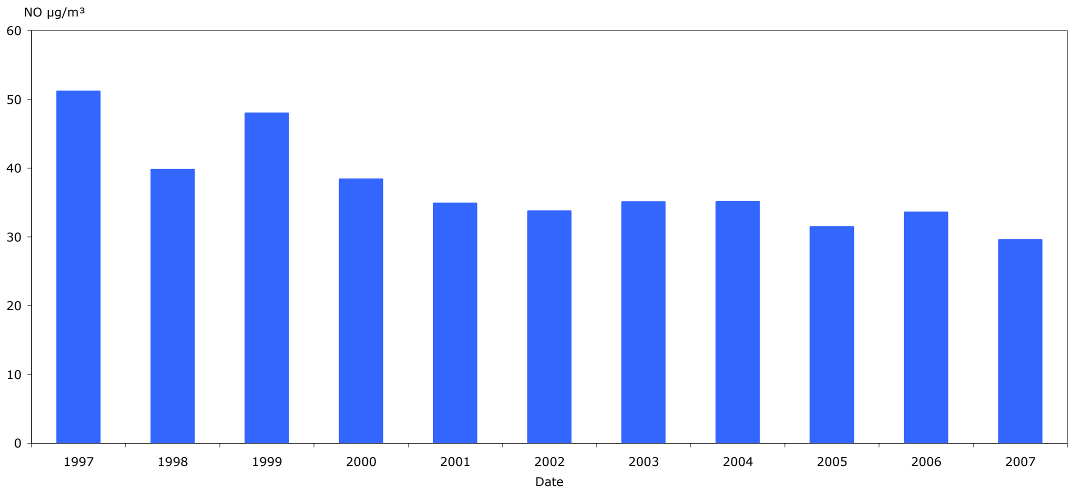
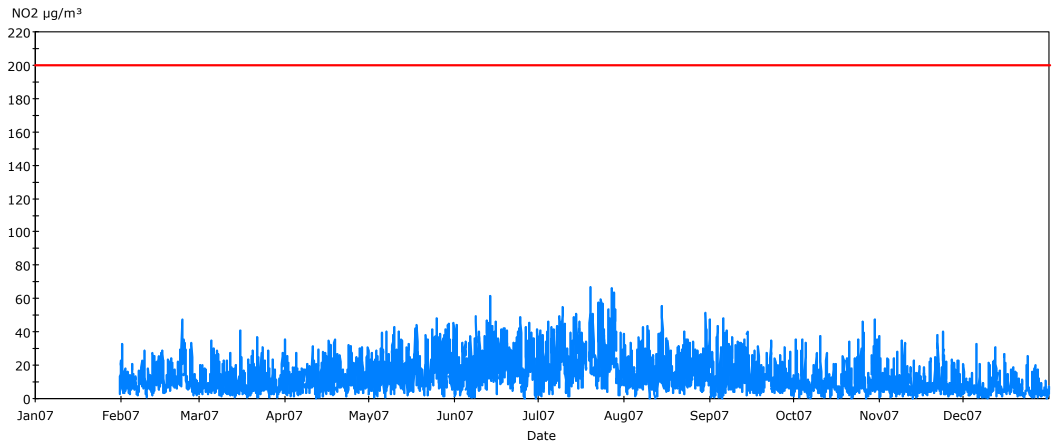
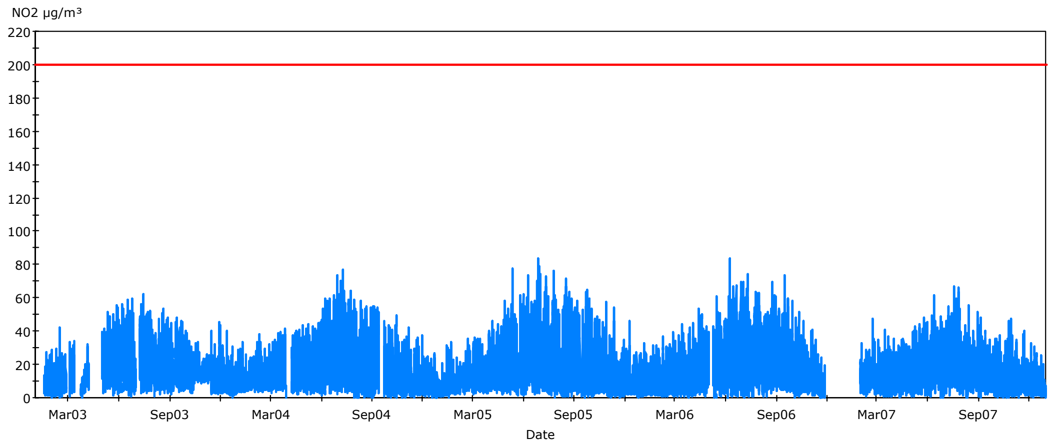


Figure 32: MfE Burnside NO_2 1-hour fixed average January–December 2007



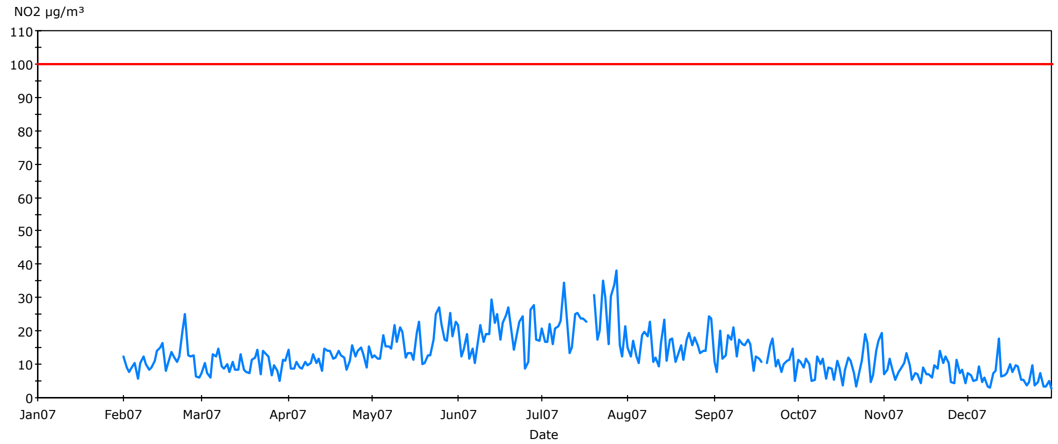
National environmental standard for NO_2 – 200 µg/m^3

Figure 33: MfE Burnside NO_2 1-hour fixed average 2003–2007



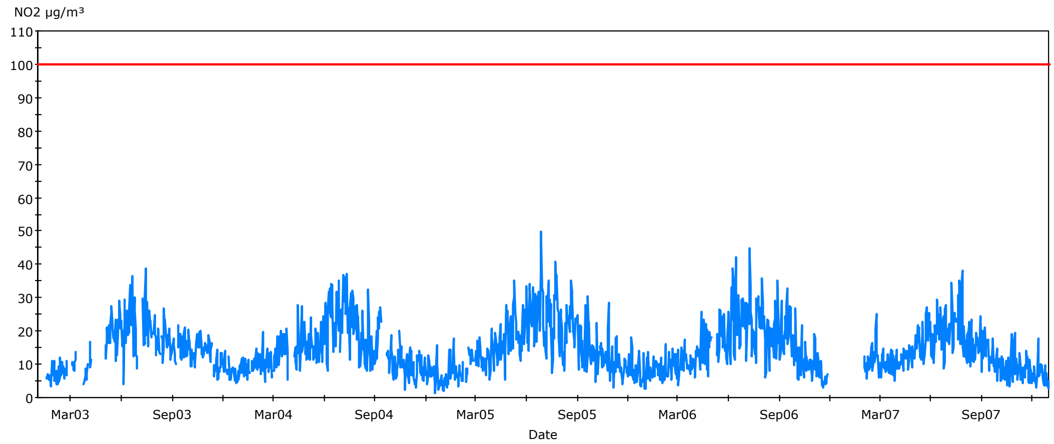
National environmental standard for NO_2 – 200 µg/m^3

Figure 34: MfE Burnside NO_2 24-hour fixed average January–December 2007



Ambient air quality guideline for NO_2 – 100 µg/m^3

Figure 35: MfE Burnside NO_2 24-hour fixed average 2003–2007



Ambient air quality guideline for NO_2 – 100 µg/m^3

Figure 36: MfE Burnside NO_2 annual average 2003–2007

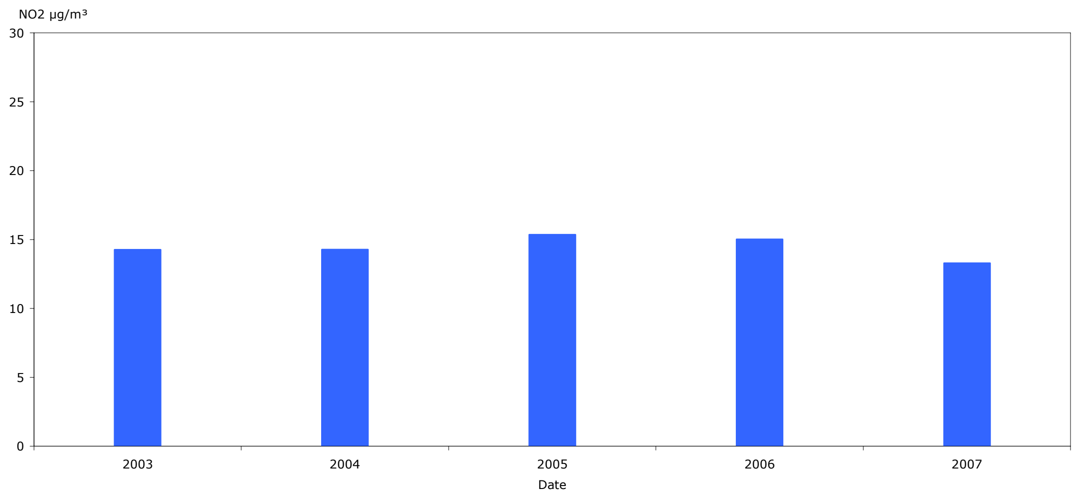


Figure 37: MfE Burnside NO2 and NO 1-hour fixed average January–December 2007

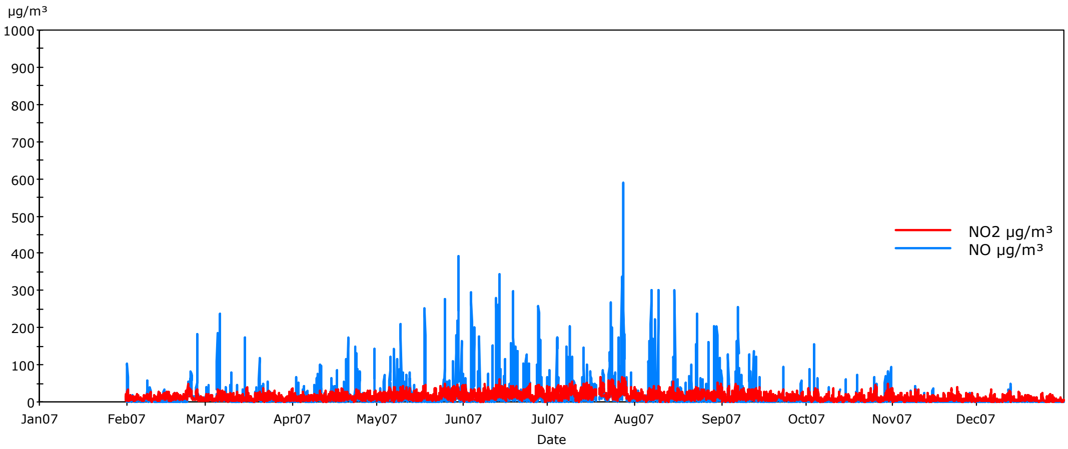


Figure 38: MfE Burnside NO_2 and NO 24-hour fixed average January–December 2007

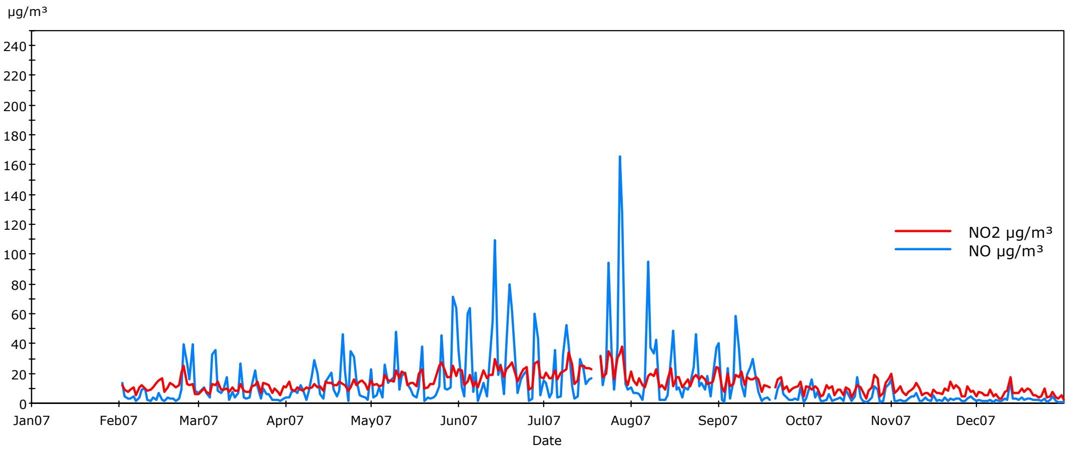


Figure 39: MfE Burnside NO 1-hour fixed average 2003–2007

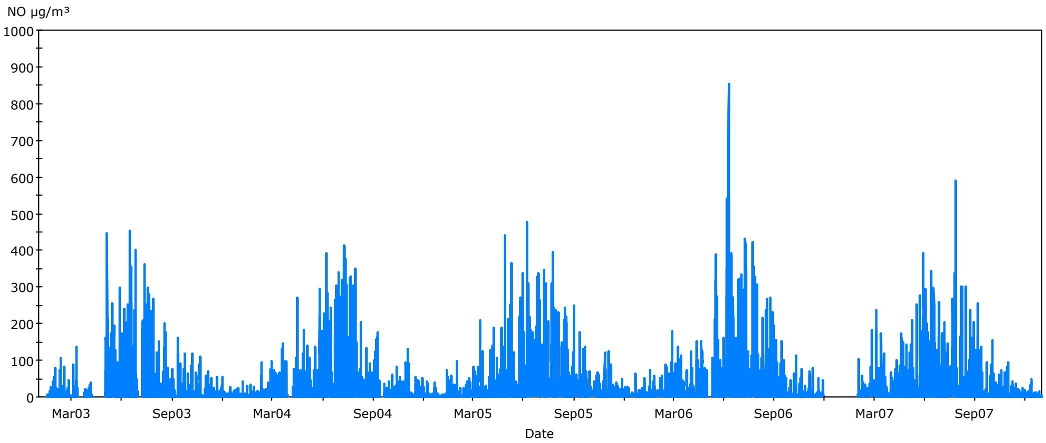


Figure 40: MfE Burnside NO 24-hour fixed average 2003–2007

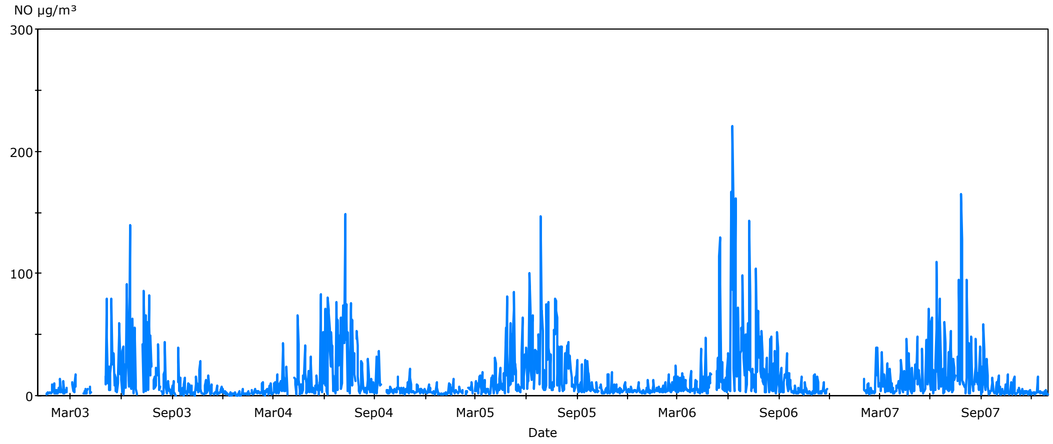


Figure 41: MfE Burnside NO annual average 2003–2007

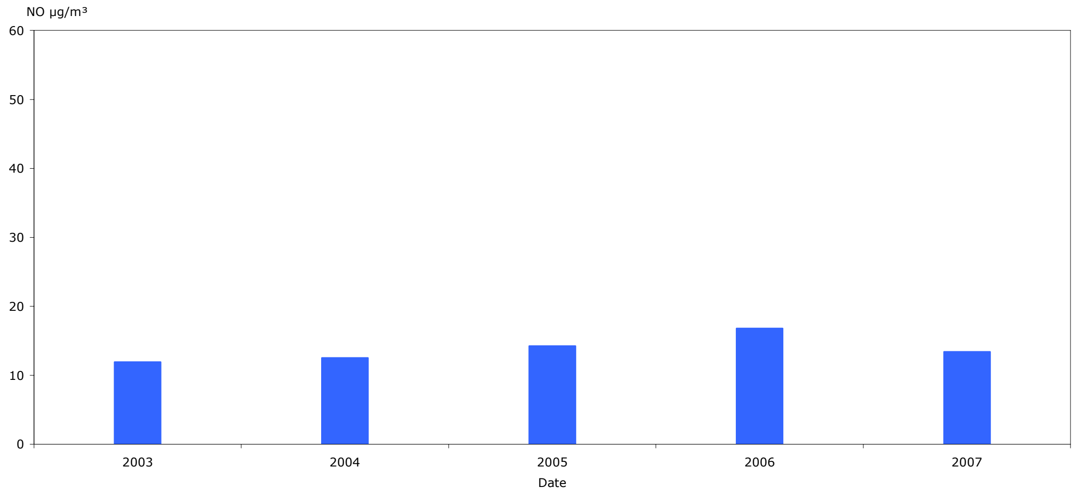
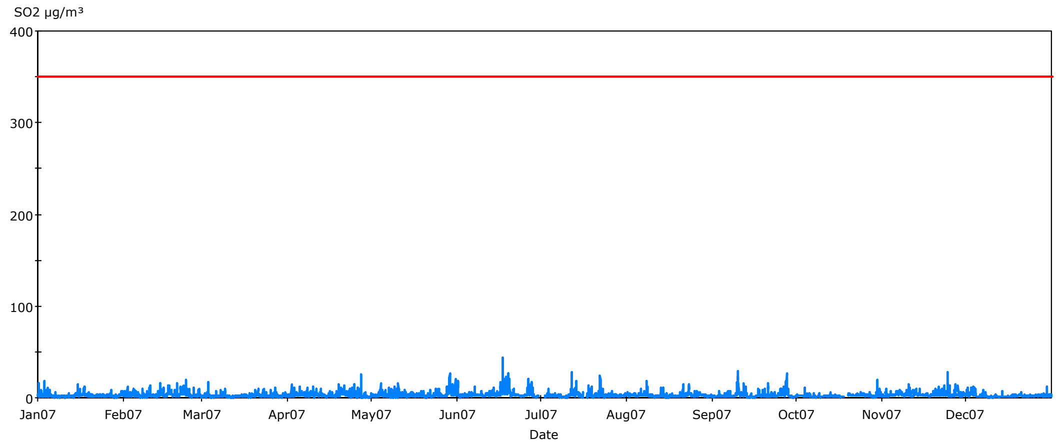
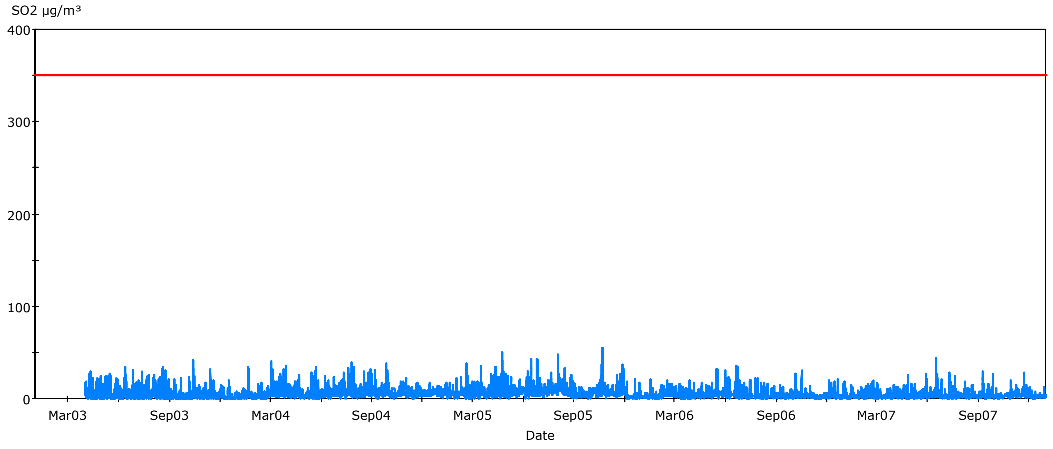


Figure 42: MfE Gavin Street SO_2 1-hour fixed average January–December 2007



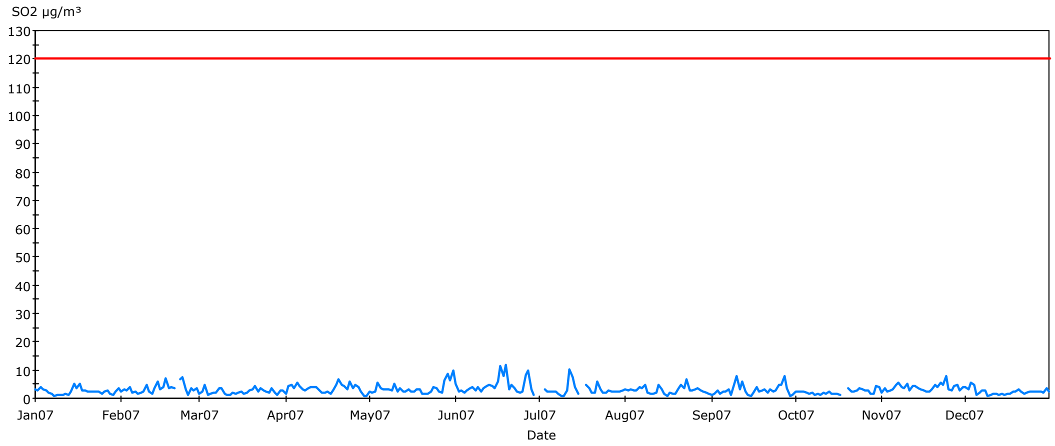
National environmental standard for SO_2 – 350 µg/m^3

Figure 43: MfE Gavin Street SO_2 1-hour fixed average 2003–2007



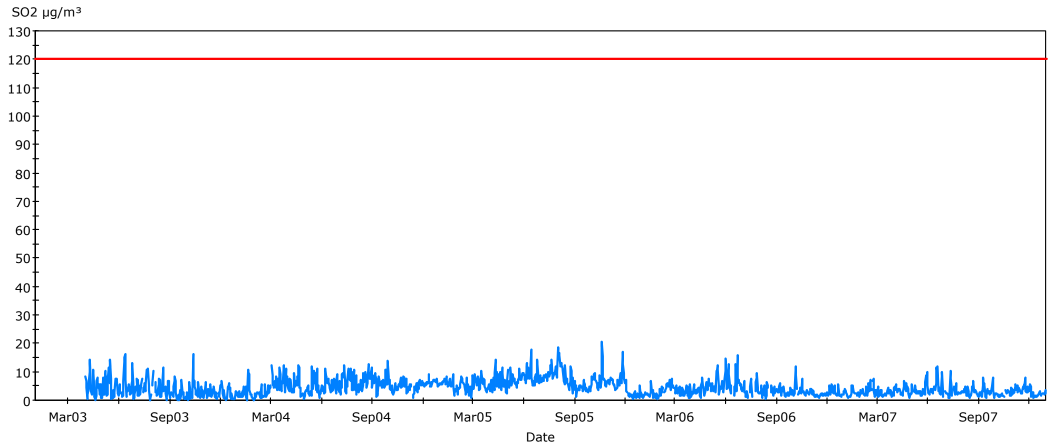
National environmental standard for SO_2 – 350 µg/m^3

Figure 44: MfE Gavin Street SO_2 24-hour fixed average January–December 2007



Ambient air quality guideline for SO_2 – 120 µg/m^3

Figure 45: MfE Gavin Street SO_2 24-hour fixed average 2003–2007



Ambient air quality guideline for SO_2 – 120 µg/m^3

Figure 46: MfE Gavin Street SO_2 annual average 2003–2007

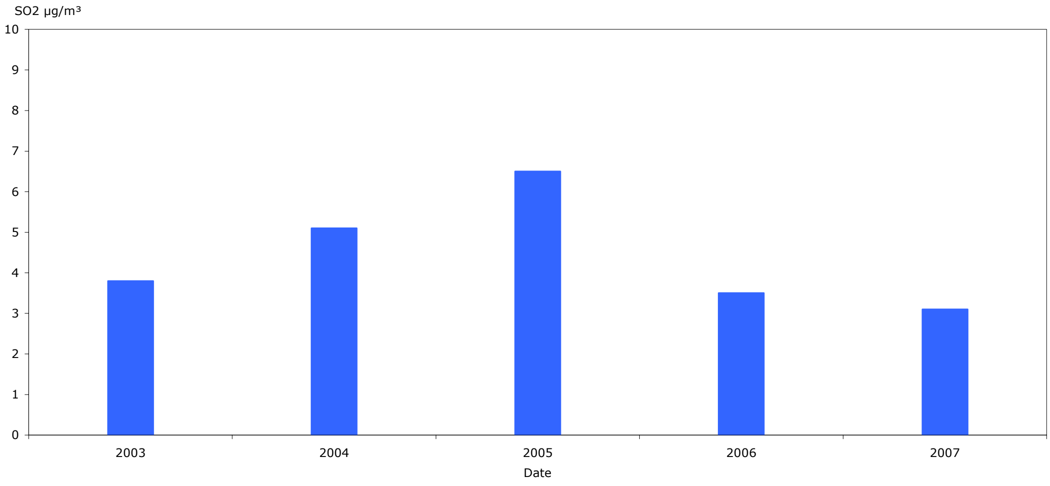
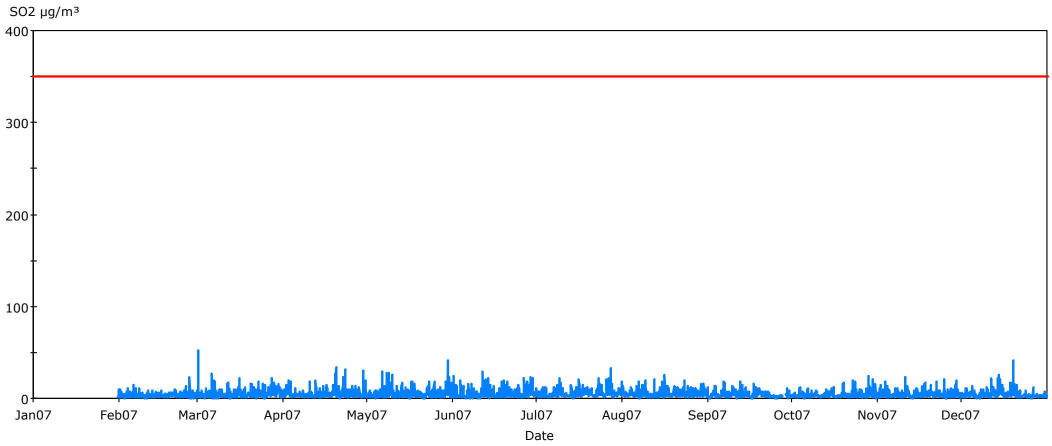
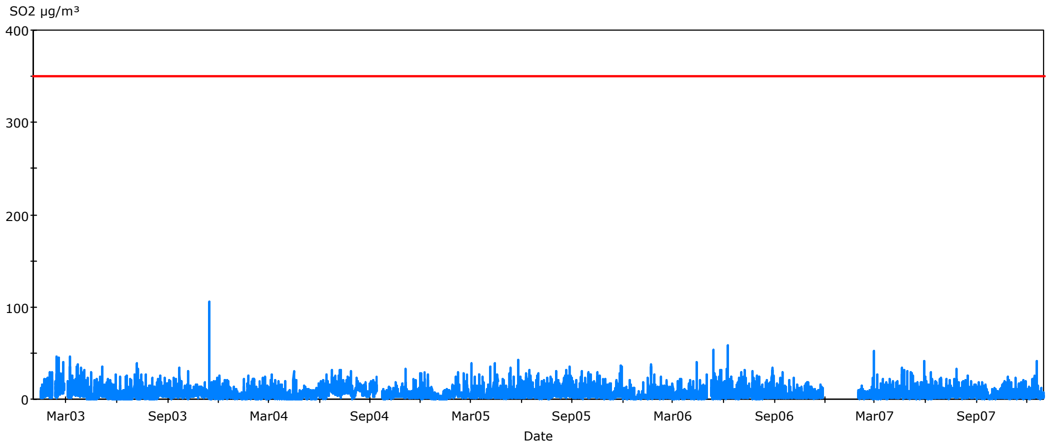


Figure 47: MfE Burnside SO_2 1-hour fixed average January–December 2007



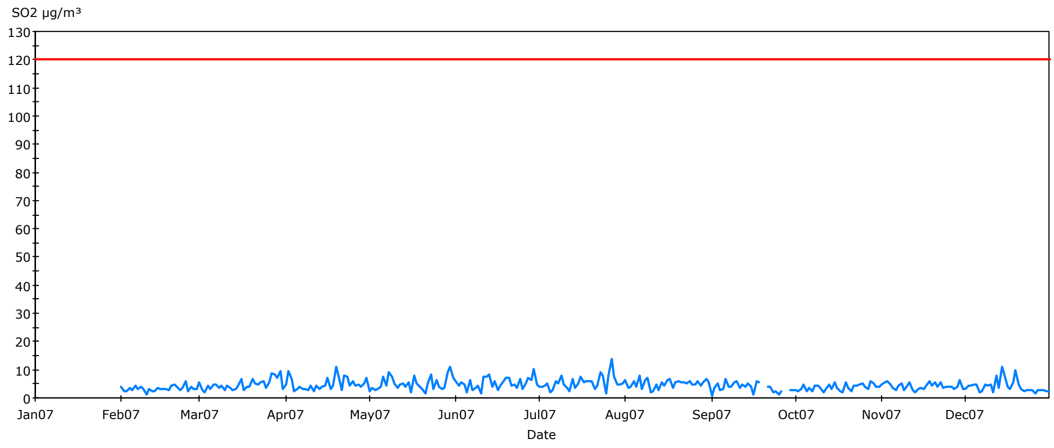
National environmental standard for SO_2 – 350 µg/m^3

Figure 48: MfE Burnside SO_2 1-hour fixed average 2003–2007



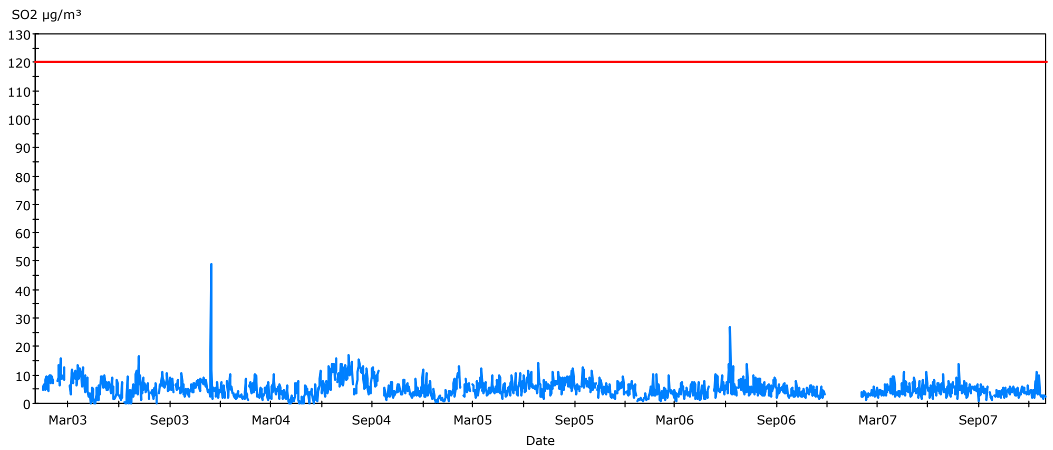
National environmental standard for SO_2 – 350 µg/m^3

Figure 49: MfE Burnside SO_2 24-hour fixed average January–December 2007



Ambient air quality guideline for SO_2 – 120 µg/m^3

Figure 50: MfE Burnside SO_2 24-hour fixed average 2003–2007



Ambient air quality guideline for SO_2 – 120 µg/m^3

Figure 51: MfE Burnside SO_2 annual average 2003–2007

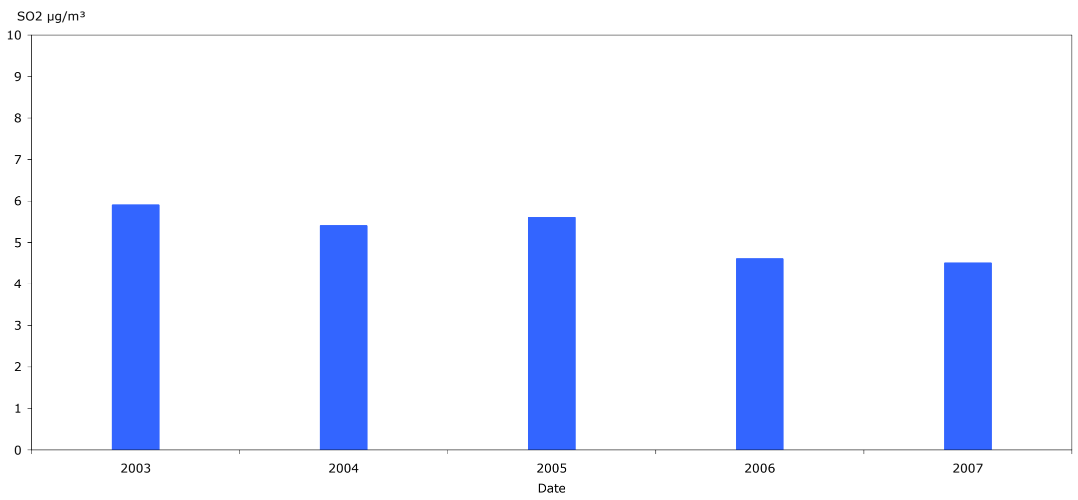
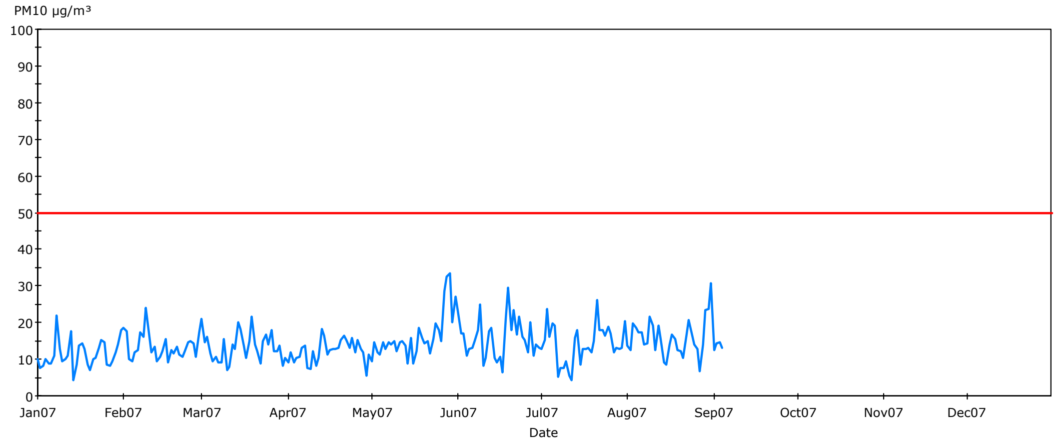
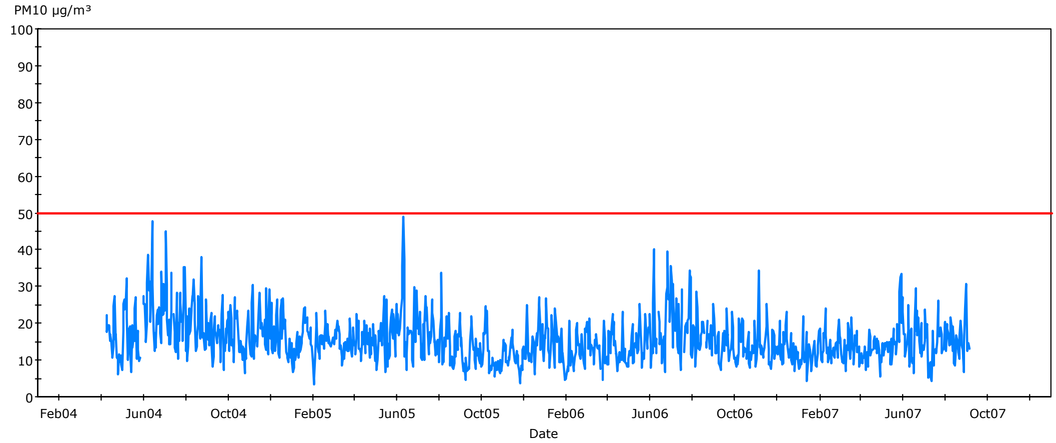


Figure 52: MfE Kowhai PM_{10} 24-hour fixed average January–December 2007



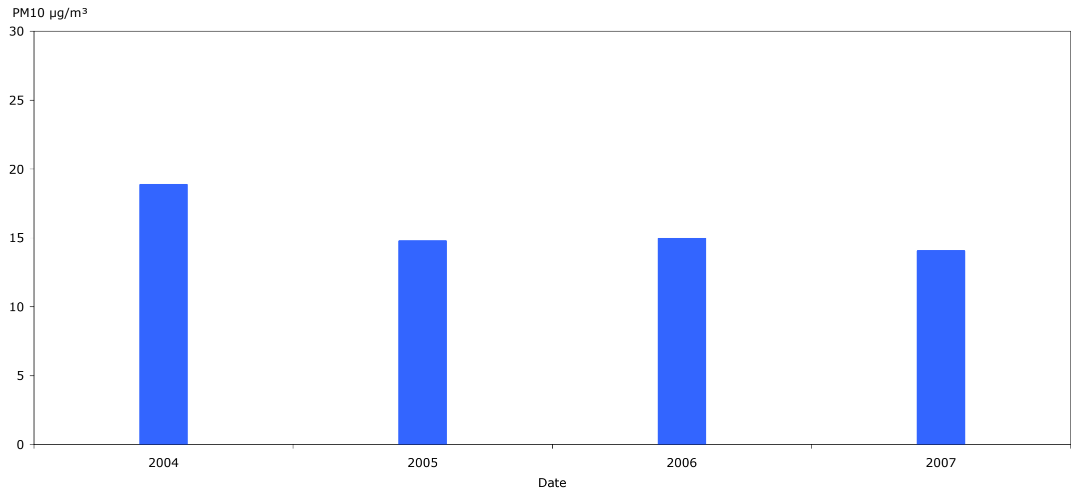
National environmental standard for PM_{10} – 50 µg/m^3

Figure 53: MfE Kowhai PM_{10} 24-hour fixed average 2004–2007



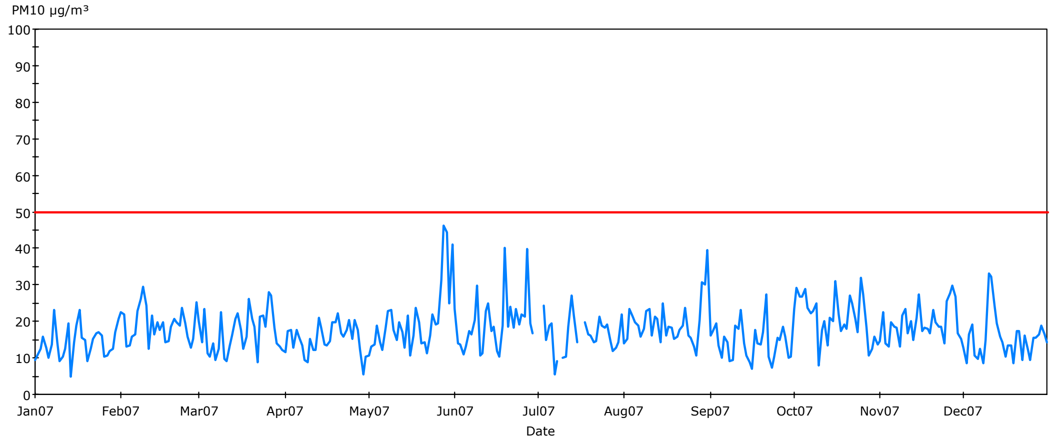
National environmental standard for PM_{10} – 50 µg/m^3

Figure 54: MfE Kowhai PM_{10} annual average 2004–2007



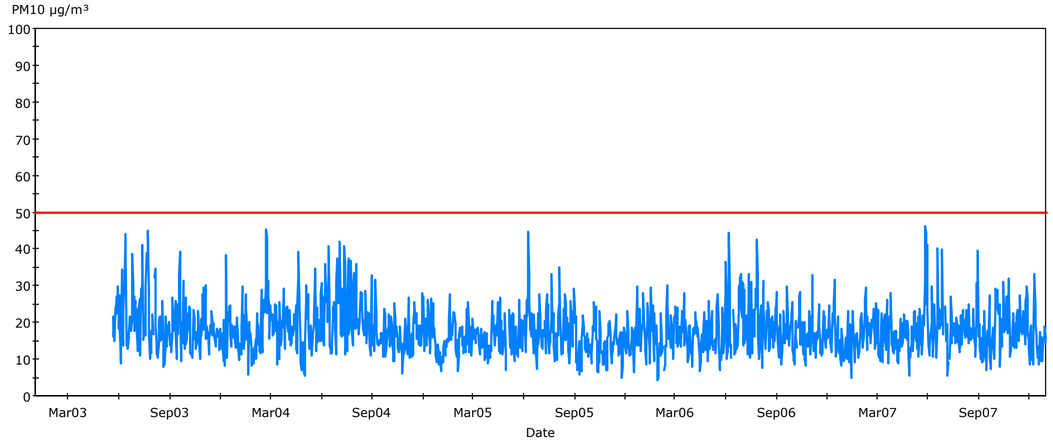
Ambient air quality guideline for PM_{10} – 20 µg/m^3

Figure 55: MfE Gavin Street PM_{10} 24-hour fixed average January–December 2007



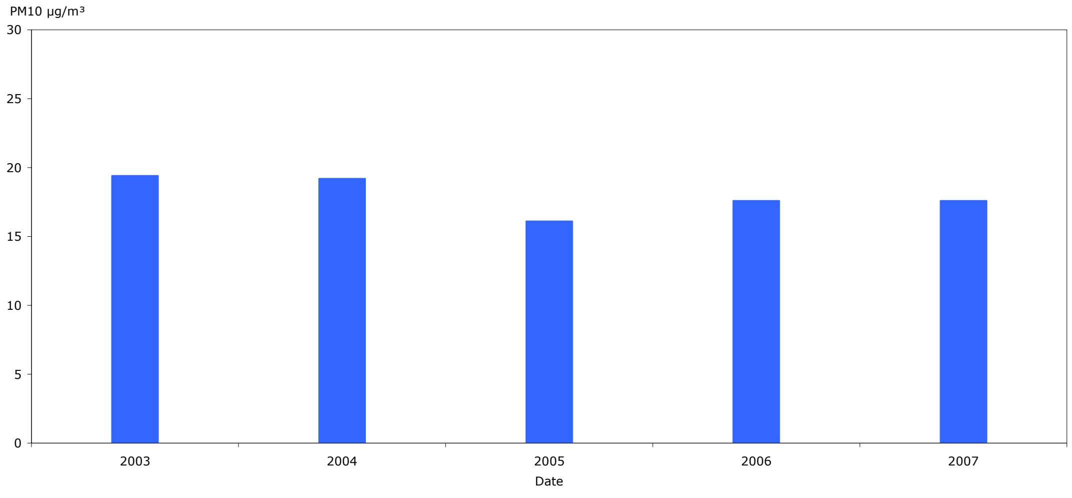
National environmental standard for PM_{10} – 50 µg/m^3

Figure 56: MfE Gavin Street PM_{10} 24-hour fixed average 2003–2007



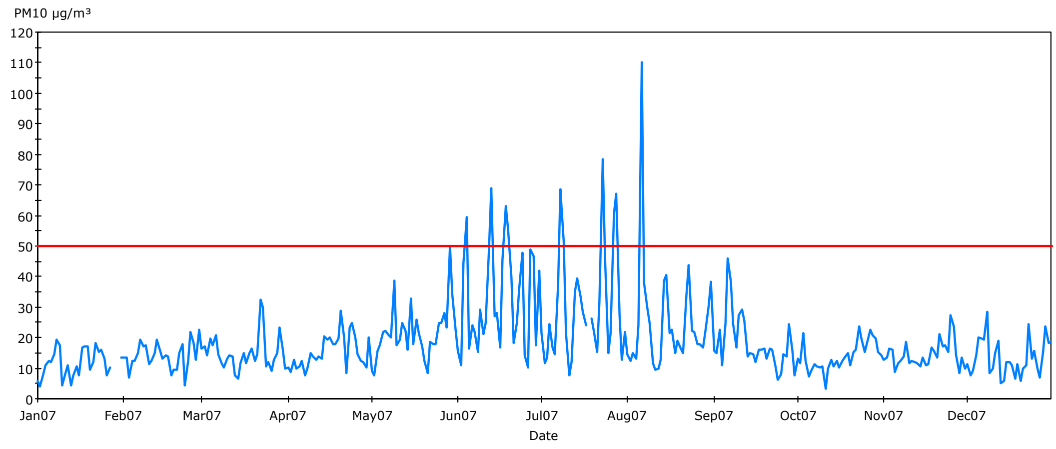
National environmental standard for PM_{10} – 50 µg/m^3

Figure 57: MfE Gavin Street PM_{10} annual average 2003–2007



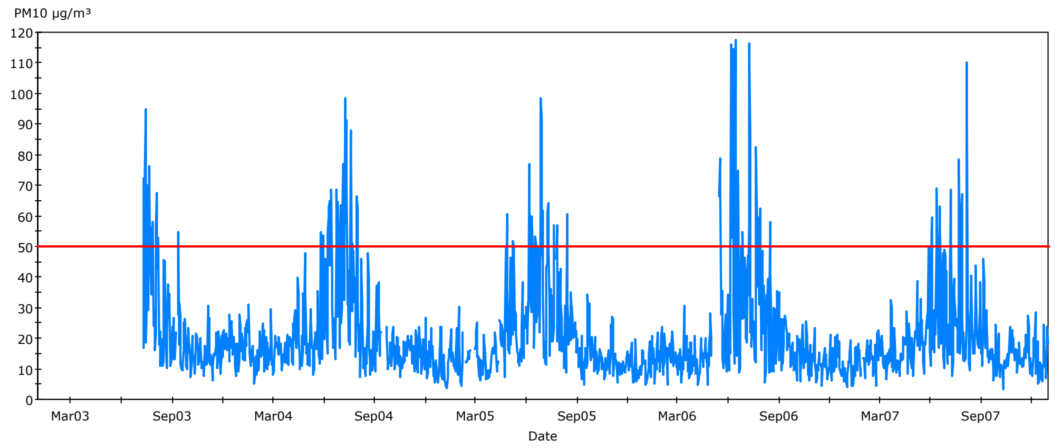
Ambient air quality guideline for PM_{10} – 20 µg/m^3

Figure 58: MfE Burnside PM_{10} 24-hour fixed average January–December 2007



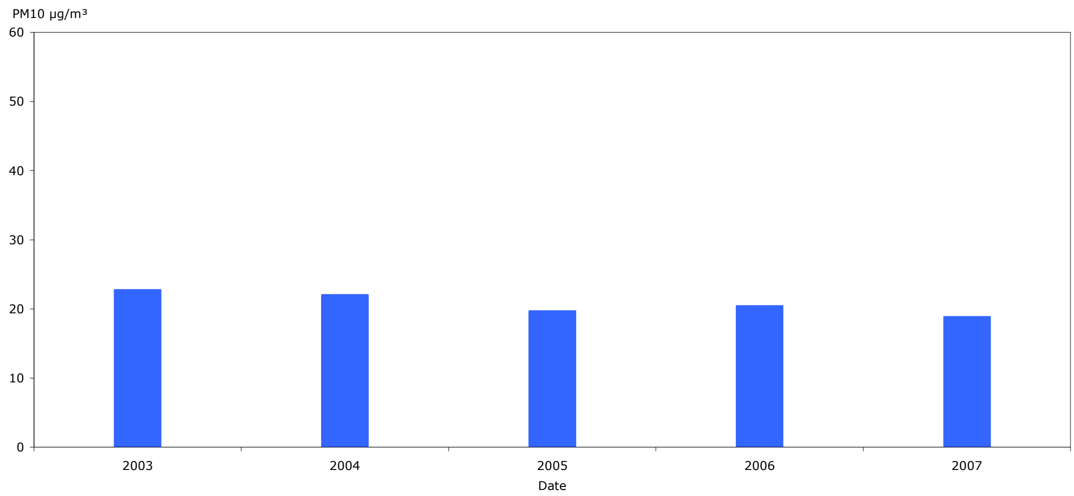
National environmental standard for PM_{10} – 50 µg/m^3

Figure 59: MfE Burnside PM_{10} 24-hour fixed average 2003–2007



National environmental standard for PM_{10} – 50 µg/m^3

Figure 60: MfE Burnside PM_{10} annual average 2003–2007



Ambient air quality guideline for PM_{10} – 20 µg/m^3

7.9 Analysis of exceedances

7.9.1 Exceedances at Greers Road, Burnside

The only exceedances recorded during 2007 were at Greers Road, Burnside, and for PM_{10} daily averages. All parameters at the other two Auckland sites were below the national environmental standards (NES) for air quality.

Time of year

The PM_{10} daily average NES of 50 $\mu g/m^3$ was exceeded on 11 days during 2007, during the cooler months from late May to early August. On three occasions the exceedances occurred on consecutive days (18–19 June, 8–9 July and 27–28 July).

Time of week

It is interesting to note that five of the 11 exceedances occurred on a Monday, with all other week days having one exceedance each (except Thursday). This is probably coincidental, as there is no apparent reason (other than response to weather) why wood burning should be higher on Mondays.

Time of day

The typical diurnal trend in PM_{10} during winter is shown in figure 61. Here PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 $\mu g/m^3$ are plotted against time of day. From figure 61, the biggest contributions to PM_{10} were between the hours of 18:00 and 05:00. This would suggest contributions from wood burning for home heating.

Temperature

Figures 62, 63 and 64 plot PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 $\mu g/m^3$ against hourly average temperature measured at 1.5 m, hourly average temperature measured at 10 m, and the difference between the hourly averages of the two temperature heights. From figure 62, the biggest contributions to PM_{10} were when temperature measured at 1.5 m was below 10°C. From figure 63, the biggest contributions to PM_{10} were when temperature measured at 10 m was below 12°C. From figure 64, the biggest contributions to PM_{10} were when temperature difference between 10 m and 1.5 m was greater than zero, ie, when temperature inversion conditions prevailed. This is consistent with the trapping of pollutants and subsequent higher concentrations expected during temperature inversion conditions.

Wind direction

Figure 65 plots PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 $\mu g/m^3$ against hourly average wind directions. From figure 65, no wind direction seems to contribute significantly higher concentrations than others. This is consistent with an area wide diffuse (as opposed to point/line) source of pollution. There were very few data points in the sector 120 degrees to 180 degrees as wind frequency from this sector is usually low.

Wind speed

Figure 66 plots PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 µg/m^3 against hourly average wind speeds. From figure 66, the biggest contributions to PM_{10} were when wind speed was below 1.5 m/s, ie, low wind speed conditions. This is consistent with reduced dispersion under low wind speed conditions.

NO

Figure 67 plots PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 µg/m^3 against hourly average NO. From figure 67, a positive linear relationship seems to exist between PM_{10} and NO concentrations. This is expected as PM_{10} and NO is co-generated during wood burning.

CO

Figure 68 plots PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 µg/m^3 against hourly average CO. From figure 68, a positive linear relationship seems to exist between PM_{10} and CO concentrations. This is expected as PM_{10} and CO is co-generated during wood burning.

SO_2

Figure 69 plots PM_{10} hourly averages for those days where the daily PM_{10} average exceeded 50 µg/m^3 against hourly average SO_2. From figure 69, no relationship seems to exist between PM_{10} and SO_2 concentrations. This is expected as wood burning does not generate SO_2.

Conclusions

From the univariate comparisons of meteorological parameters and other pollutants as discussed above, it can be concluded that the PM_{10} exceedances were most likely due to wood burning for home heating during the colder months, especially in the evenings, exacerbated by temperature inversions trapping the pollutants and low wind speed conditions preventing effective dispersion of pollutants.

Figure 61: MfE Burnside PM_{10} vs time of day

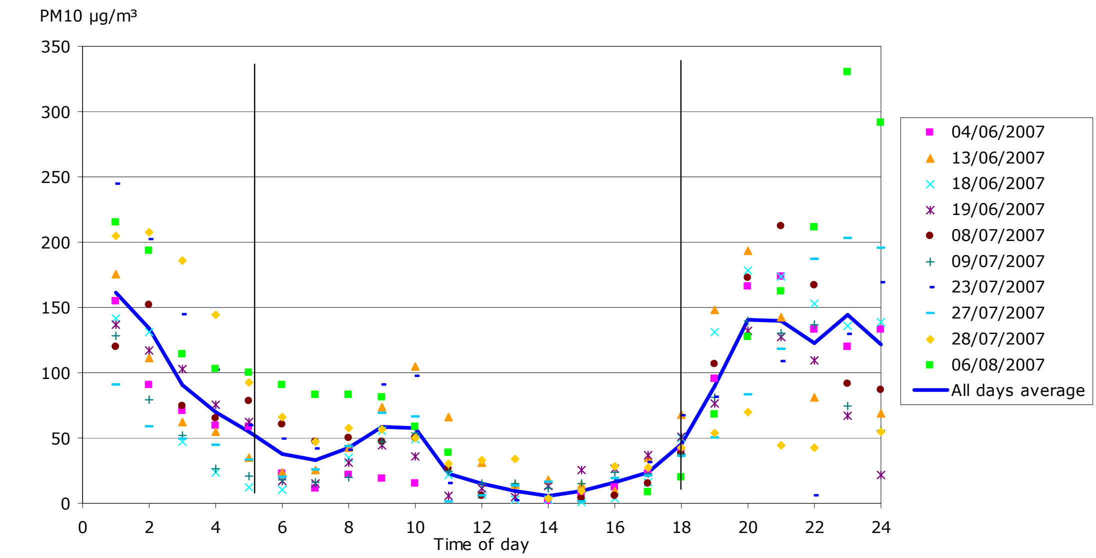


Figure 62: MfE Burnside PM_{10} vs 1.5 m temperature

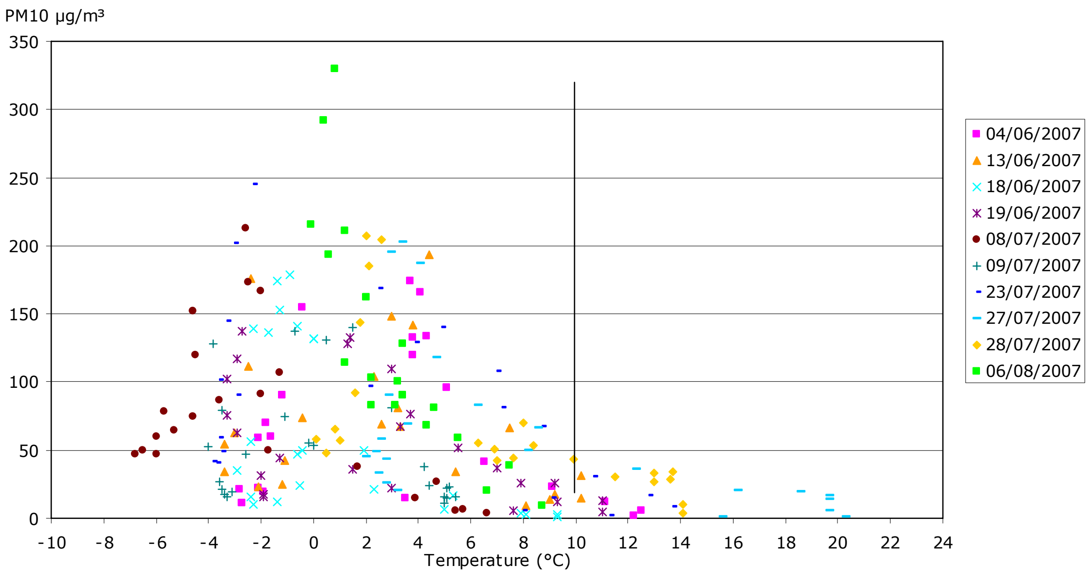


Figure 63: MfE Burnside PM_{10} vs 10 m temperature

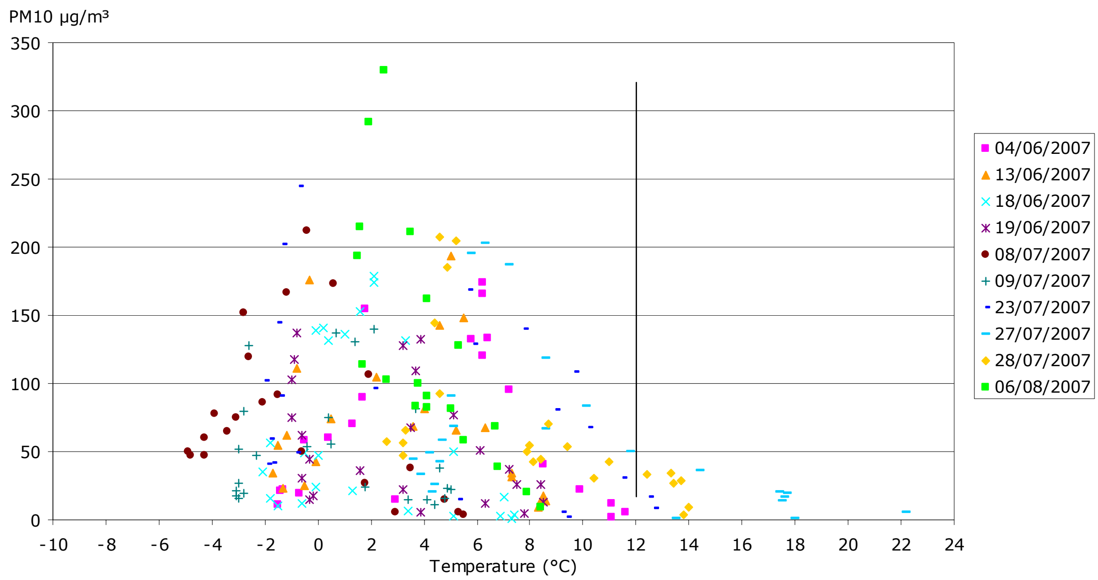


Figure 64: MfE Burnside PM_{10} vs temperature diff 10 m–1.5 m

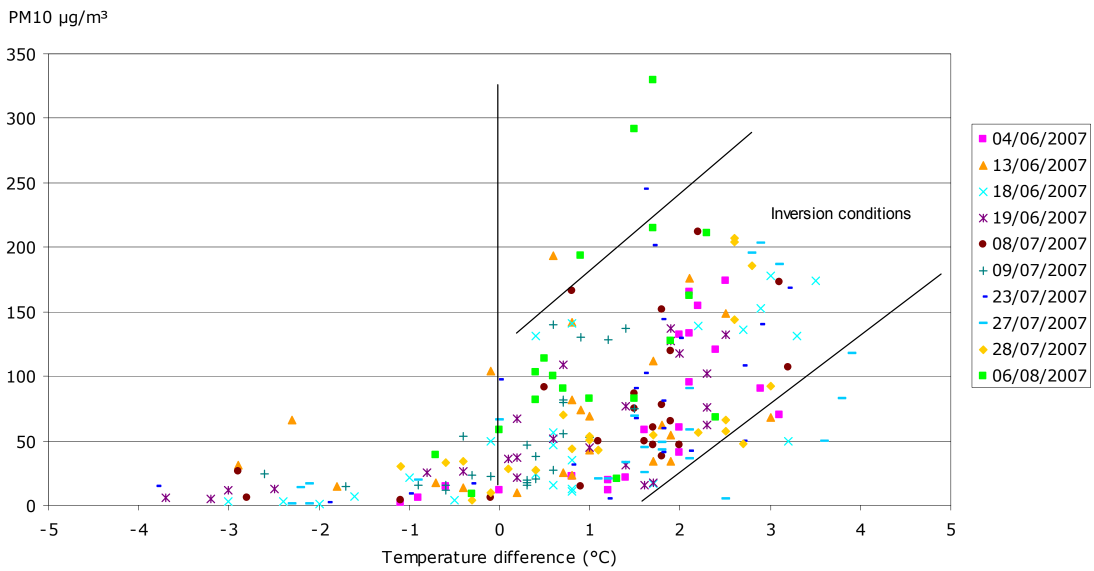


Figure 65: MfE Burnside PM_{10} vs wind direction

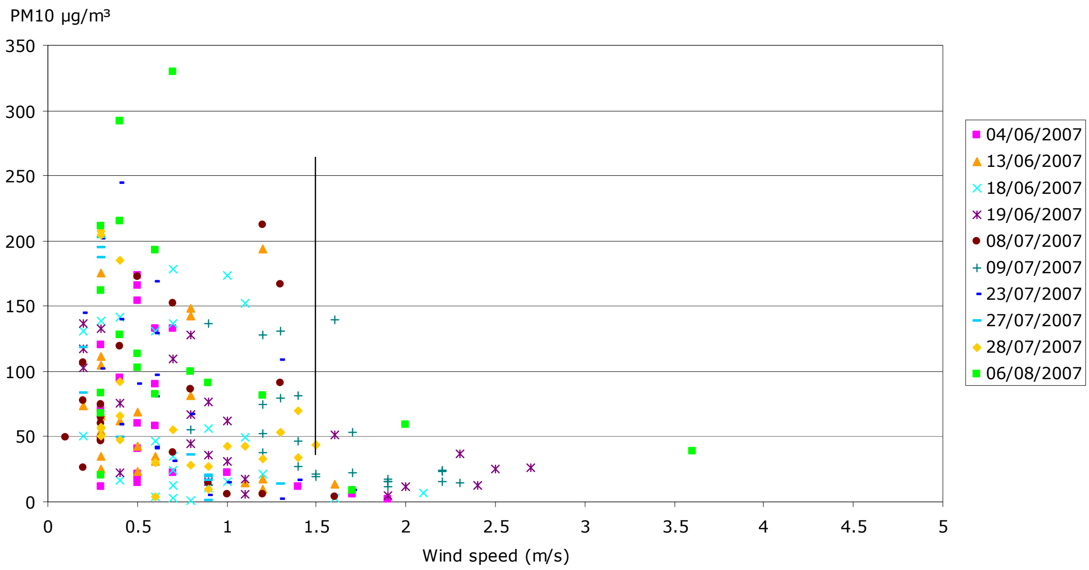


Figure 66: MfE Burnside PM_{10} vs wind speed

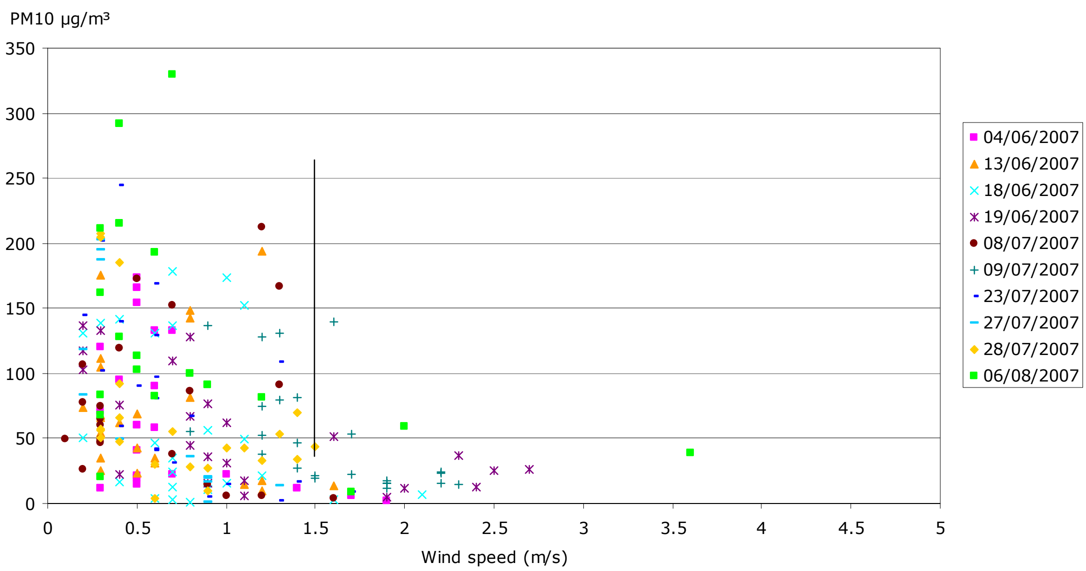


Figure 67: MfE Burnside PM_{10} vs NO

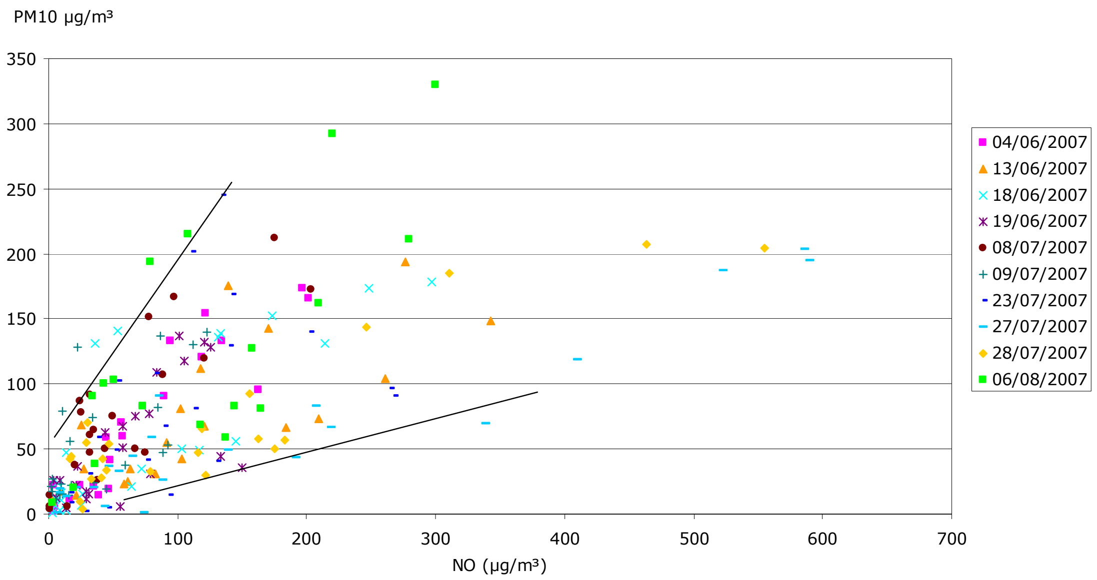


Figure 68: MfE Burnside PM_{10} vs CO

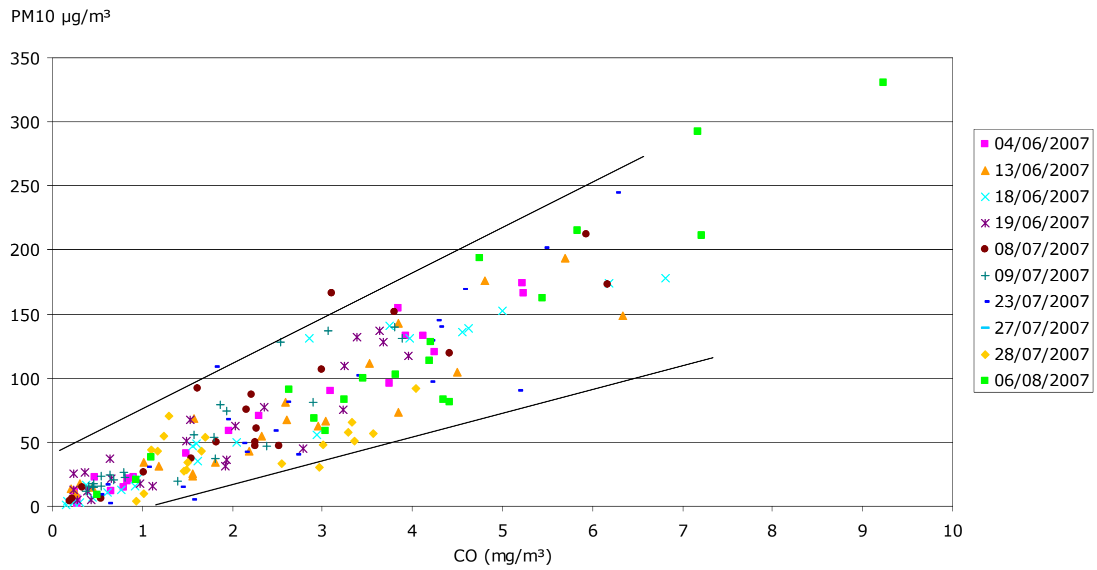


Figure 69: MfE Burnside PM_{10} vs SO_2