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GEMS Air Monitoring Program
Annual Report 2001

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GEMS AIR MONITORING PROGRAMME
Annual Report

A report for the
Ministry for the Environment

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1 INTRODUCTION

The World Health Organisation (WHO) reports on global environmental standards and current environmental quality. Environmental quality is reported under the Global Environmental Monitoring System (GEMS). The data collected is sent to the WHO GEMS program, and in return, the New Zealand Ministry of Health (MoH) receives information from the WHO. The New Zealand Ministry for the Environment (MfE) has a Memorandum of Understanding with the MoH for administration of the GEMS program and supply of data to WHO.

The MfE's Air Quality Management Program aims to support and assist in the maintenance of air quality in parts of New Zealand that enjoy clean air, and improve air quality in places where it has deteriorated. As part of this program, the MfE is supporting the operation of ambient air quality monitoring sites in Auckland and Christchurch.

The GEMS ambient air quality sites are the longest running sites in New Zealand, and as such are very important in discerning trends in pollution, beyond the variation caused by annual climate variations. The Auckland sites are located at Penrose and Mt Eden and the Christchurch site is in St Albans. Monitoring has been performed at the Penrose Clinic since 1964 and at Gavin Street since 1989. At Mt Eden, the monitoring was started in 1982 and at St Albans monitoring has been performed since 1989. The site details and locations are given in Section 4.

This report presents the results for ambient air quality monitoring in Auckland and Christchurch in the year 2001. Monitoring and reporting is undertaken by Watercare Services Ltd, and data is reported to MfE and WHO as part of the GEMS program.

Quarterly reports in 2001 for this project reported nitrogen oxides from Penrose site 4:19 (ACI site). This was an error, as monitoring of nitrogen oxides at the ACI site is undertaken on behalf of the Auckland Regional Council. The GEMS nitrogen oxide data is collected at Penrose site 4:23 (Gavin Street). The nitrogen oxide data contained in this annual report is from the Gavin Street site.

2 Contaminants Monitored

2.1 Particulate Matter

Particulate matter refers to numerous substances that exist in the atmosphere. It is a somewhat complex category, encompassing a wide range of chemically and physically diverse substances. Particulate matter includes all solid and aerosol matter that exists in ambient conditions.

Particulate matter has been divided into several categories, based upon the potential health or environmental effect. The main categories are described briefly below.

2.1.1 Total Suspended Particulate (TSP)

TSP consists of all particles which range in size from 20 μm diameter downwards. Particles larger than 20 μm are too large to remain airborne for extended periods, and thus are categorised as deposited particulate.

TSP is sufficiently small to be inhaled, however, the larger particles (10 – 20 μm) are readily filtered out in the nasal cavity. Particles 10 μm and less can be drawn into the respiratory system. TSP has an effect on both aesthetic and health quality of the ambient air.

2.1.2 Inhalable Particulate (PM_{10})

As described above, particles with a diameter of 10 μm or less can be inhaled into the respiratory system. The main effect of inhalable particulate is on human health.

Current research is recognising the division into finer fractions, including PM_5 and $PM_{2.5}$, which may penetrate beyond the bronchial tubes and deep into the aveoli. These fractions are commonly referred to as fine particulate. The MfE Proposed Ambient Air Quality Guidelines (AAQG) (2000) suggests a guideline value for $PM_{2.5}$ of 25 $\mu g/m^3$, 24 hour average. However, current monitoring does not differentiate into PM_{10} and $PM_{2.5}$, and all inhalable fractions are measured within the PM_{10} category.

2.2 Lead

Motor vehicle emissions are the major source of lead. Historically, lead was included in petrol as a catalyst for combustion, but has been removed from fuel supplies since 1996. Consequently, atmospheric concentrations of lead have dropped markedly. Lead is present in the atmosphere in its elemental form.

Lead can cause harm to many human tissues and organs, and especially the nervous system, the kidneys and the cardiovascular system. Young children may be particularly vulnerable to exposures at moderately low levels in the environment.

2.3 Sulphur Dioxide

Sulphur 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 building and other materials. It can have significant effects on the human respiratory system as well.

2.4 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 motor vehicle exhaust emissions, and as such elevated levels are mainly found in areas of significant traffic congestion, particularly at busy intersections on inner-city streets. Carbon monoxide acts on humans by displacing oxygen from 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.

2.5 Nitrogen Oxides

Nitrogen oxides incorporates several species that exist in the atmosphere, which are collectively referred to as NO_x. The two main oxides are nitrogen dioxide (NO_2), and the monoxide form nitric oxide (NO). 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, 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 this can then be oxidised to nitrogen dioxide in ambient air. As with carbon monoxide, motor vehicles are the major source of the NO_x in most parts of the country. Power stations and other large combustion units may be produce localised sources.

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 effects with other pollutants such as SO_2 and particulate.

2.6 Volatile Organic Compounds

Hazardous air contaminants are comprised of a wide range of potentially airborne chemicals with toxic or carcinogenic properties. Contaminants may be present in gaseous, aerosol or particulate forms. There are thousands of chemicals which could be regarded as a hazardous air contaminant. To rationalise air quality guidelines, the MfE has compiled a list of priority contaminants, based on a review of international literature. This list of priority hazardous air contaminants is included in the MfE review of AAQG (MfE 2000). The priority list identifies the volatile organic compounds (VOC) benzene, toluene, 1,3-butadiene, and xylene, and provides ambient air quality guidelines for these contaminants.

3 Ambient Air Quality Guidelines

3.1 New Zealand Ambient Air Quality Guidelines

The MfE published ambient air quality guidelines (AAQG) in 1994. These guidelines are currently under review (discussion document released Dec 2000). Existing and proposed guidelines are included in Table 1, but compliance is measured against the proposed guidelines.

MfE guidelines for the contaminants monitored are given in Table 1. The criteria for inclusion in the guidelines was the effect of a contaminant on human health.

TSP is currently being monitored using a modified method. TSP does not have a guideline value in the MfE AAQG. In this cases the criteria is that applied previously by the Department of Health, which is 60 $\mu g/m^3$ (7 day average). This guideline has been superseded by the MfE's AAQG, but is useful for analysing the results of the current and historic monitoring data.

Table 1: Ambient Air Quality Guidelines and Regional Targets

Contaminant	MfE AAQG 1994	Proposed MfE AAQG 2000	Other AAQG	Averaging Period
Total Suspended Particulate			60 $\mu g/m^3$ (DoH)	7 day average
Inhalable particulate (PM_{10})	40 $\mu g/m^3$	Withdrawn		Annual average
	120 $\mu g/m^3$	50 $\mu g/m^3$	50 $\mu g/m^3$ (ARC & E.Can)	24 hour average
Sulphur dioxide	50 $\mu g/m^3$	Withdrawn		Annual mean
	125 $\mu g/m^3$	120 $\mu g/m^3$		24 hour average
	350 $\mu g/m^3$	350 $\mu g/m^3$		1 hour average
	500 $\mu g/m^3$	Withdrawn		10 minute average
Carbon monoxide	10 mg/m^3	10 mg/m^3		8 hour average
	30 mg/m^3	30 mg/m^3		1 hour average
Nitrogen dioxide	100 $\mu g/m^3$	100 $\mu g/m^3$		24 hour average
	300 $\mu g/m^3$	200 $\mu g/m^3$		1 hour average
Lead	0.5 – 1.0 $\mu g/m^3$	0.2 $\mu g/m^3$		3 month average
Benzene Year 2000 Year 2010		 10 $\mu g/m^3$ 3.6 $\mu g/m^3$		 Annual Annual
Toluene		190 $\mu g/m^3$		Annual
Xylene		950 $\mu g/m^3$		Annual
1,3-Butadiene		2.4 $\mu g/m^3$		Annual

3.2 New Zealand Environmental Performance Indicators

The MfE has acknowledged that recent and on-going research has resulted in the need for revisions of AAQG. MfE is addressing this in part with the review of the AAQG, but also it has promulgated some Environmental Performance Indicators (EPI) for air quality.

The MfE notes that AAQG should not be seen as a limit to pollute up to, but rather should be considered as minimum requirements for air quality. The Resource Management Act (1991) requires the quality of the environment to be maintained or enhanced. In order to provide guidance on when enhancement should be required, the MfE has provided EPI, as set out in Table 2. These indicators can act as both indicators of poor air quality, and goals which policy can work towards achieving.

Table 2: Environmental Performance Indicators for Air

Category	Maximum Measured Value	Comment
Action	Exceeds guideline	Completely unacceptable by national and international standards
Alert	Between 66 % and 100 % of the guideline	Warning level, which can lead to guidelines being exceeded in trends are not curbed
Acceptable	Between 33 % and 66 % of the guideline	A broad category, where maximum values might be of concern in some sensitive locations, but are generally at a level which does not warrant dramatic action
Good	Between 10 % and 33 % of the guideline	Peak measurements in this range are unlikely to affect air quality
Excellent	Less than 10% of the guideline	Of little concern. If maximum values are less than a tenth of the guideline, average values are likely to be much less
Not Assessed		Insufficient monitoring data to assess this category

4 Monitoring Sites

4.1 Site Description

Site location maps are included in Appendix A.

4.1.1 Penrose (ACI), Auckland, Site 4:19

The Penrose site was partially relocated in January 2001 into the neighbouring property, with further relocation into new housing in November 2001. The new site is immediately adjacent to the original site. The move was undertaken to provide improved security, as the wet SO_2 monitoring equipment had been stolen from the original site. Furthermore, it provides improved monitoring conditions, because tall buildings had been constructed near the original site, whereas the new site is located in close proximity to high voltage electricity lines and therefore is unlikely to be built out. Finally, the new site provides a location with long term potential.

This site is representative of industrial activity and is west of the Southern Motorway. The site is located within the ACI Glass car park, approximately 8 metres east of Great South Rd. This is immediately adjacent to the Penrose Occupational Health Clinic, where monitors were previously located.

4.1.2 Penrose, Auckland, Site 4:23

This is also an industrial site, and monitors NO_x from industry and traffic. The monitor is located at the electricity substation in Gavin St, approximately 50 metres east of the motorway.

4.1.3 Mt Eden, Auckland, Site 4:65

This site is representative of a residential location. The monitors and samplers are located at the rear of the Mt Eden Science Centre site, on the corner of Mt Eden Road and Kelly Street.

The Mt Eden site has been relocated in February 2001 to another location within the overall site. The move was necessitated by the sale of part of the Science Centre. Data for 2000 was collected at the original location, but data for 2001 is from the new location.

4.1.4 St Albans, Christchurch, Site 16:67

This site is representative of a residential location within an older area of Christchurch. The monitor is located on Madras Street, 30 m to the east of a busy arterial route.

This site measures some meteorological variables, namely temperature, humidity, wind speed and wind direction.

This site was scheduled for relocation in 2001, but due to difficulties in finding a suitable replacement site, it will now be relocated in 2002. Relocation will be undertaken to avoid duplication with Regional Council monitoring, and to increase the monitoring network in Christchurch. The new site will also be located to reflect a residential area.

4.2 Contaminants Monitored at Individual Sites

The full suite of contaminants is not monitored at each site. The contaminants monitored, by site, are listed in Table 3 below.

Table 3: Monitoring Sites and Contaminants Monitored

Site	TSP	PM_{10}	SO_2	CO	NO	NO_2	VOC	Lead
Mt Eden, Auckland site 4:65	✓				✓	✓	✓	✓
Penrose (ACI), Auckland: site 4:19	✓		✓					✓
Penrose, Auckland site 4:23					✓	✓	✓	
St Albans, Christchurch site :16:67	✓	✓	✓	✓	✓	✓	✓	✓

5 Methods

5.1 Quality Assurance

Watercare Services Ltd holds IANZ accreditation for the operation of its laboratory. The Watercare Services Ltd Air Quality Department are taking steps to include its air quality methods in the IANZ accreditation.

All sites were operated by the ESR Air Quality Unit until 31 August 2000, when the ESR Air Quality Unit was sold to Watercare Services Ltd. Watercare Services Ltd have operated the sites since 01 September 2000. Operation includes maintenance of the site, calibration of monitoring equipment, and provision of quality assured data.

Quality Assurance procedures are undertaken in accordance with MfE guidelines. Data is corrected for instrument and method calibrations, missing data is annotated, and summary statistics of data are recorded as part of data processing and QA.

5.2 Analytical Methods

5.2.1 Particulate Matter

TSP is collected by drawing air through a filter giving a measure of the total quantity of particles suspended in the air. The method used is a scaled down version of the standard high-volume sampler (Department of Health sampler) and is Air Quality Test Method T101.

PM_{10} is monitored continuously at St Albans using a Beta Attenuation analyser.

5.2.2 Lead

Lead is measured by chemical analysis of the samples collected in the monitoring of suspended particulate according to Air Quality Test Method T102.

5.2.3 Sulphur Dioxide

Sulphur dioxide is monitored continuously at Penrose and St Albans using a UV fluorescence analyser according to Air Quality Test Method T202 (ref AS 3580.4.1-1990).

The method of sulphur dioxide monitoring at Penrose changed in January 2001 from a wet chemistry method (bubbler collection followed by chemical analysis) to a continuous instrumental method. This may cause some differences between historic and 2001 data, and comparisons should be treated with caution.

5.2.4 Carbon Monoxide

Carbon monoxide is monitored continuously using a non-dispersive infra-red analyser according to Air Quality Test Method T200 (ref AS 2695-1984).

5.2.5 Nitrogen Oxides

NO_x is monitored continuously using a chemiluminescence analyser according to Air Quality Test Method T201 (ref AS 3580.5.1-1993).

5.2.6 Volatile Organic Compounds

VOC are monitored using passive sampling badges (3M badges), exposed for a 3 month period. VOC are adsorbed onto an activated carbon filter, and desorbed and analysed using gas chromotagraphy/mass spectrometry (GC/MS), according to Air Quality Test Method T114 (ref NIOSH Method 1500 & 1501). Duplicate badges were exposed at each site to verify individual results.

Determination of 1,3-butadiene over a three month exposure period is not reliable. Investigations have determined that samples are unstable when held above -4°C (OSHA Method 54, NIOSH Method 1024), with significant desorption occurring. Technical information supplied with 3M badges reports a 10% loss of 1,3-butadiene over 3 weeks' storage at room temperature. Due to the potential for error over a three month exposure period, 1,3-butadiene has not been analysed and reported.

6 Results and Discussion

6.1 Site Performance and QA

Overall, site performance in 2001 was very good. Eleven of the sixteen analysis (by site and contaminant) had over 90% valid data. The overall site performance is recorded in Table 4.

At St Albans, the Beta gauge failed in February/March 2001, and due to a lack of manufacturer support was not repaired until October 2001. Therefore this site has very poor valid data for PM_{10}. Since October, the site has been exposed to excessive dust from nearby construction works. Particulate matter data for St Albans for February to December 2001 was obtained from Environment Canterbury's air monitoring site at Coles Place. Environment Canterbury use a TEOM to determine particulate, and a correction factor was applied.

Table 4: Percentage Valid Data

Contaminant	Site	Percentage Valid Data (ann. avg.)	Reasons for low valid data (<90%)
TSP	Mt Eden	85	Power off during site relocation (Jan, Feb)
TSP	Penrose	85	Power off (Jan), sampler did not run (Mar), pump failed (Nov)
TSP	St Albans	97	Missing filter (Jan)
PM_{10}	St Albans	37	Beta gauge failed (Mar to Oct)
SO_2	Penrose	75	Instrument stolen (Jan), instrument failed (Mar), power supply fault (Jul), power off for relocation to new shed (Nov)
SO_2	St Albans	87	Instrument failure (Nov), power failure (Dec)
CO	St Albans	98	
NO_x	Mt Eden	95	
NO_x	Penrose	95	
NO_x	St Albans	96	
Lead	Mt Eden	92	
Lead	Penrose	100	
Lead	St Albans	100	
VOC	Mt Eden	100	
VOC	Penrose	100	
VOC	St Albans	100	

6.2 Site Assessment and EPI Categories

The performance of different sites was determined by calculating the Environmental Performance Indicators (EPI) for the whole year, according to MfE (1997). The EPI's were determined for contaminants listed in the proposed MfE AAQG, and therefore excluded TSP. The EPI for $PM_{2.5}$ cannot be calculated because $PM_{2.5}$ is not currently being monitored.

The proposed ambient air quality guidelines (MfE 2000) were used to calculate the site performance relative to the EPI categories. For lead, the lower recommended guideline of 0.5 μ

g/m^3 was used to calculate the EPI. Results are presented in Figure 1 (Mt Eden), Figure 2 (Penrose) and Figure 3 (St Albans).

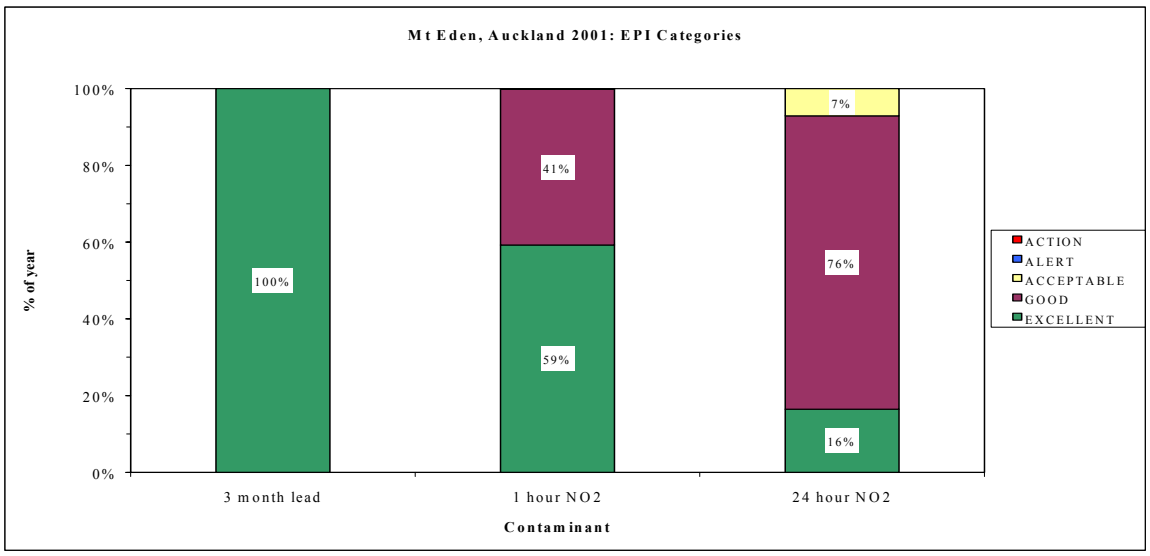

Figure 1: Comparison of monitored contaminants at Mt Eden to EPI

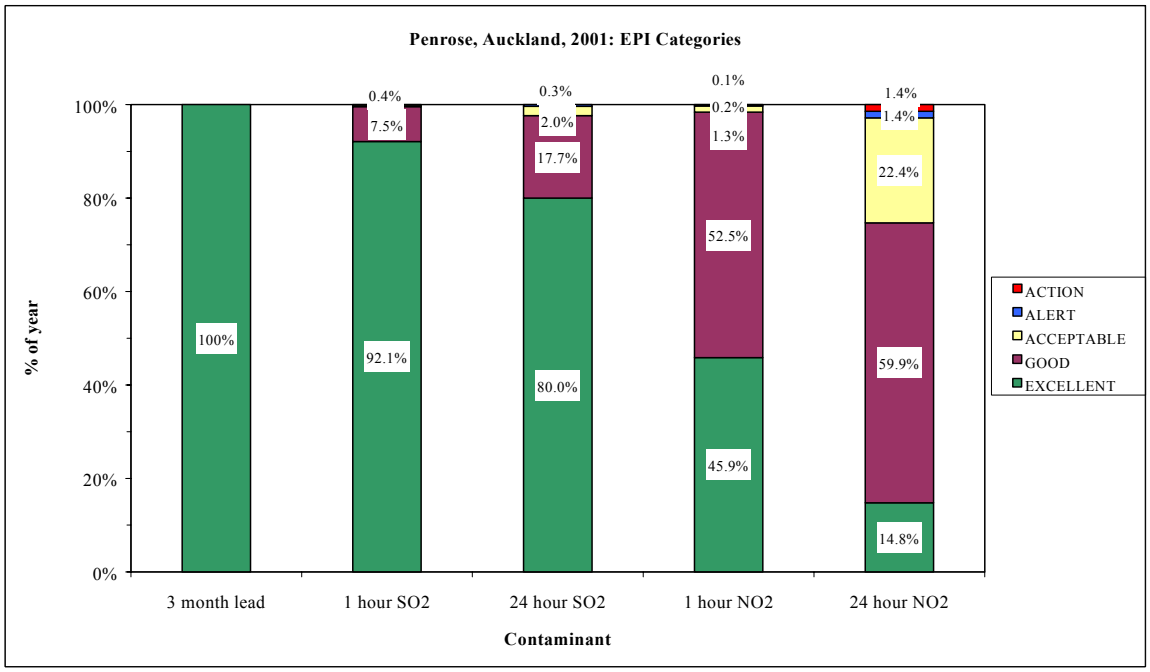

Figure 2: Comparison of monitored contaminants at Penrose to EPI

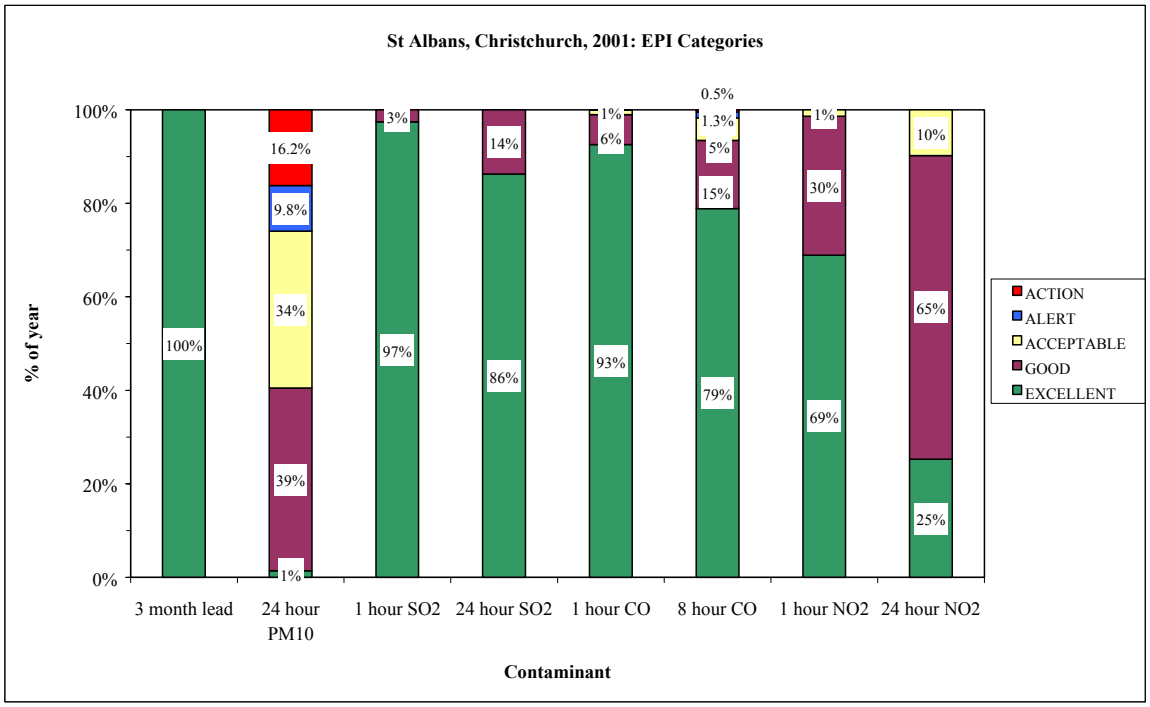

Figure 3: Comparison of monitored contaminants at St Albans to EPI

6.3 Particulate Matter

6.3.1 Total Suspended Particulate (TSP)

TSP is recorded as 7 day averages, and the results for 2001 from the three sites are shown in Figure 4. Summary statistics are presented in Table 5.

Table 5: Statistics for Particulate Monitoring in 2001

Statistics for Particulate Monitoring						
	PM_{10} - 24 hour average data*[1]				TSP - 7 day average data	
Site	99.5 percentile ($\mu g/m^3$)	No. of Exceeedence (>50 $\mu g/m^3$)	Valid data*[2] (%)	Maximum 24 hour average ($\mu g/m^3$)	No. of Exceeedence (>60 $\mu g/m^3$)	Maximum 7 day average ($\mu g/m^3$)
Mt Eden	-	-	-	-	0	35
Penrose	-	-	-	-	0	49
St Albans	136.3	58	7%		4	95

*1 Measured by Beta Gauge or Ecan TEOM, with adjustment factor applied to TEOM data
*2 Percentage valid data of Beta gauge or TEOM

MfE AAQG do not include a guideline for TSP. The guideline used for TSP is the DoH guideline of 60 $\mu g/m^3$. In the year 2001, the guideline was not exceeded at Mt Eden or Penrose on any occasion. There were four exceedances at the St Albans site, occurring between June and August.

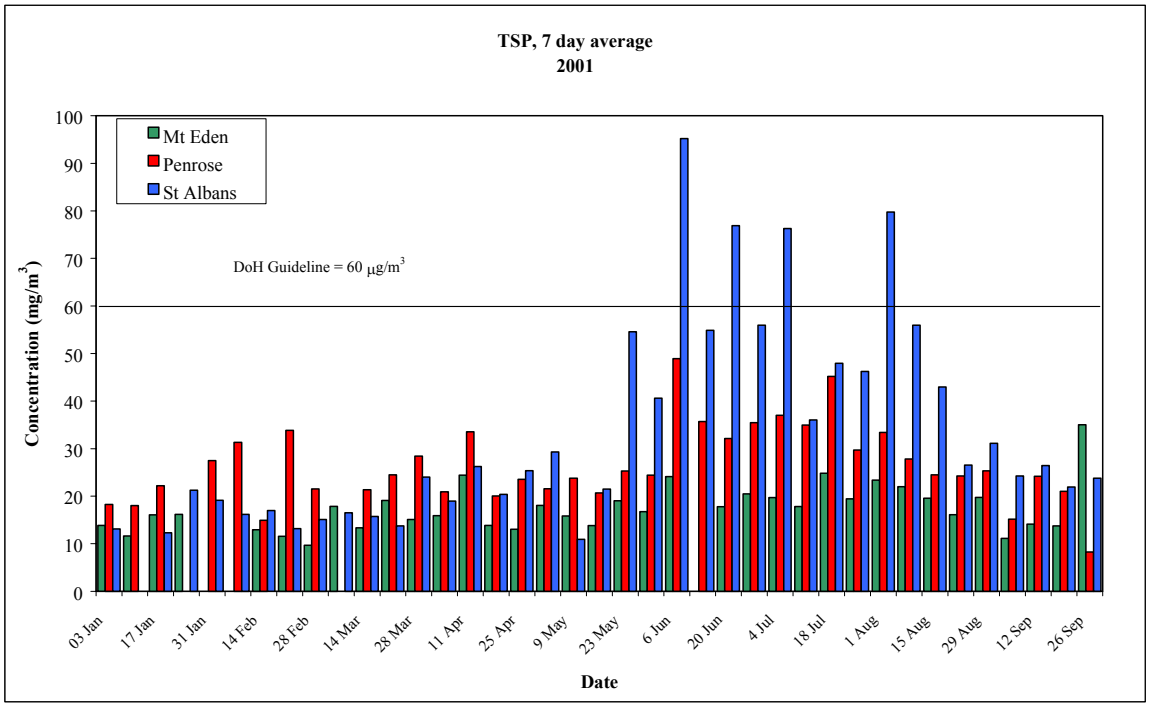

Figure 4: TSP 7 day average 2001 (all sites)

Monitoring of TSP commenced at Mt Eden in 1983, and results since records began are shown in Figure 5. The TSP monitoring at Mt Eden in 2001 shows a variable but low TSP concentration, ranging from 10 – 35 μg/m^3, 7 day average. There is a seasonal trend, with concentrations being higher during the winter months. Historic monitoring since 1983 shows typically higher concentrations in winter, and that since monitoring commenced, the maximum annual peak and annual average is declining. The DOH guideline has only been exceeded on one occasion since monitoring began.

At Penrose, there were no exceedances in the 2001 monitoring year. Concentrations ranged from 8 – 49 μg/m^3, and appear to be higher in the winter. Monitoring commenced at Penrose in 1964, and results are shown in Figure 6. Historic data shows a clear seasonal trend, with elevated concentrations occurring in winter. A significant decrease in ambient TSP occurred in the mid to late 1980's, and since that time both the average TSP and the peaks have typically been below guidelines, with the guideline only being occasionally exceeded i.e. once in each of 1992, 1996 and 1999.

TSP monitoring in 2001 at St Albans shows the typical distinct seasonal pattern for this site, with ambient TSP concentrations being elevated through the winter months, and the guideline being exceeded on four occasions. Monitoring commenced at this site in 1989, and the guideline is exceeded on several occasions every winter (Figure 7). Concentrations appeared to be higher than in 2000, but similar to the previous 5 years. Results suggest average winter TSP concentrations are similar from year to year

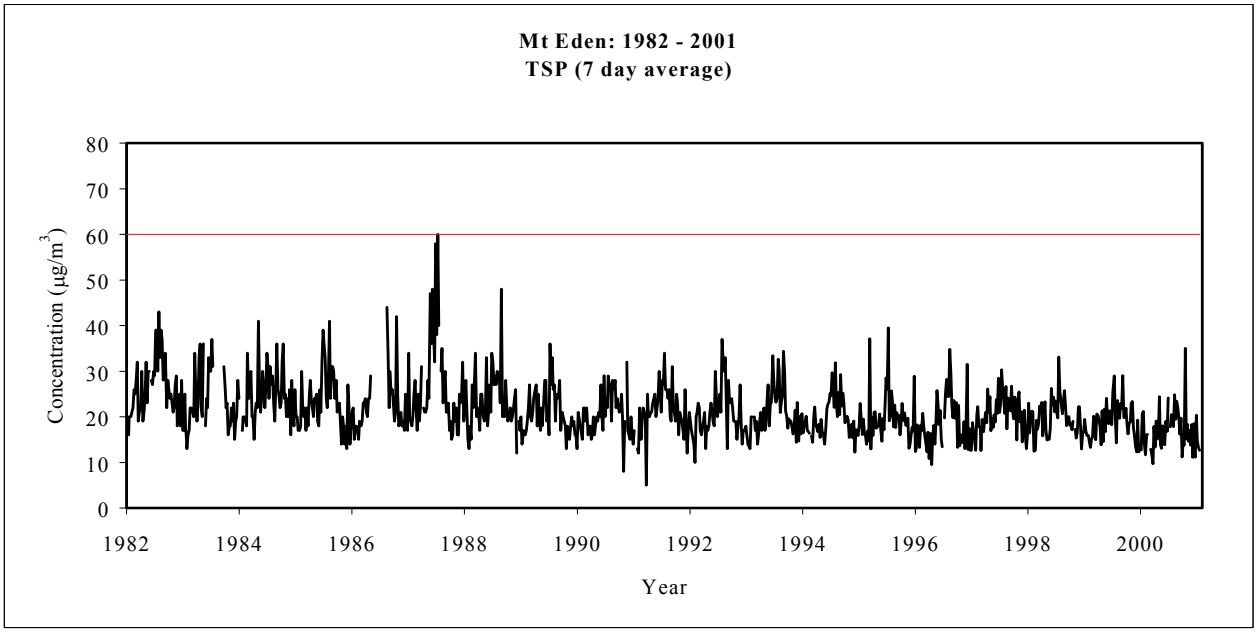

Figure 5: TSP, 7 day average 1983 – 2001 at Mt Eden

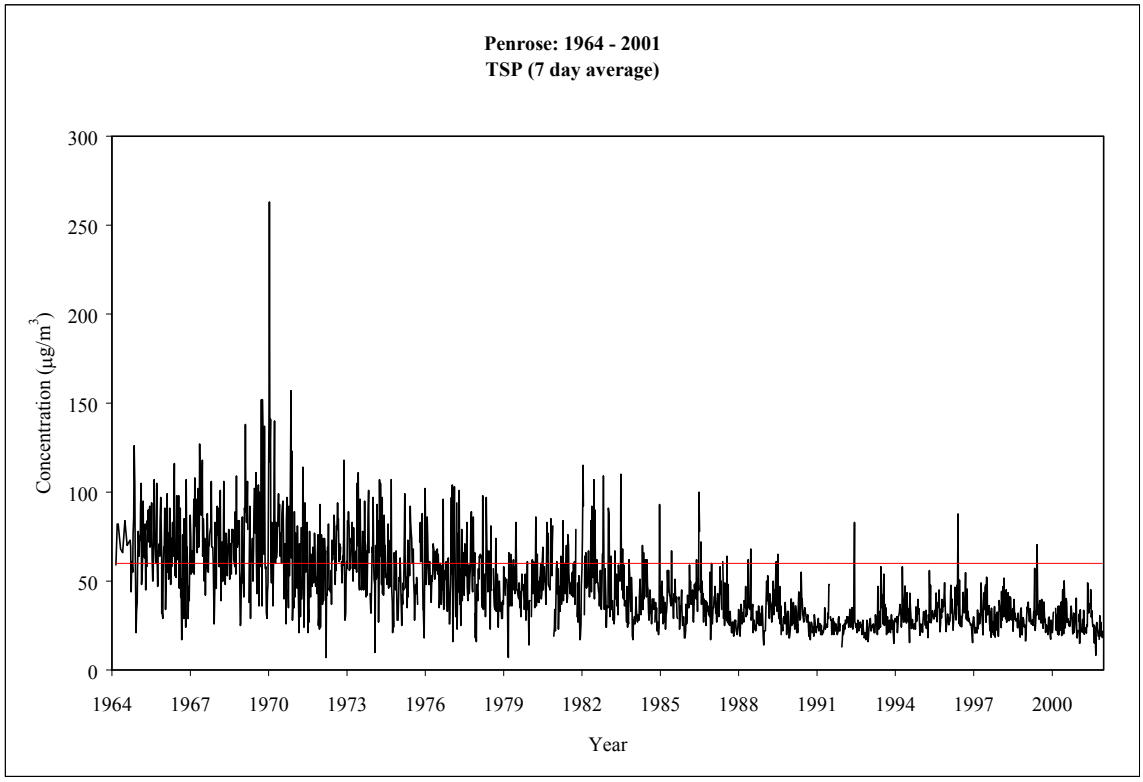

Figure 6: TSP 7 day average 1964 – 2001 at Penrose

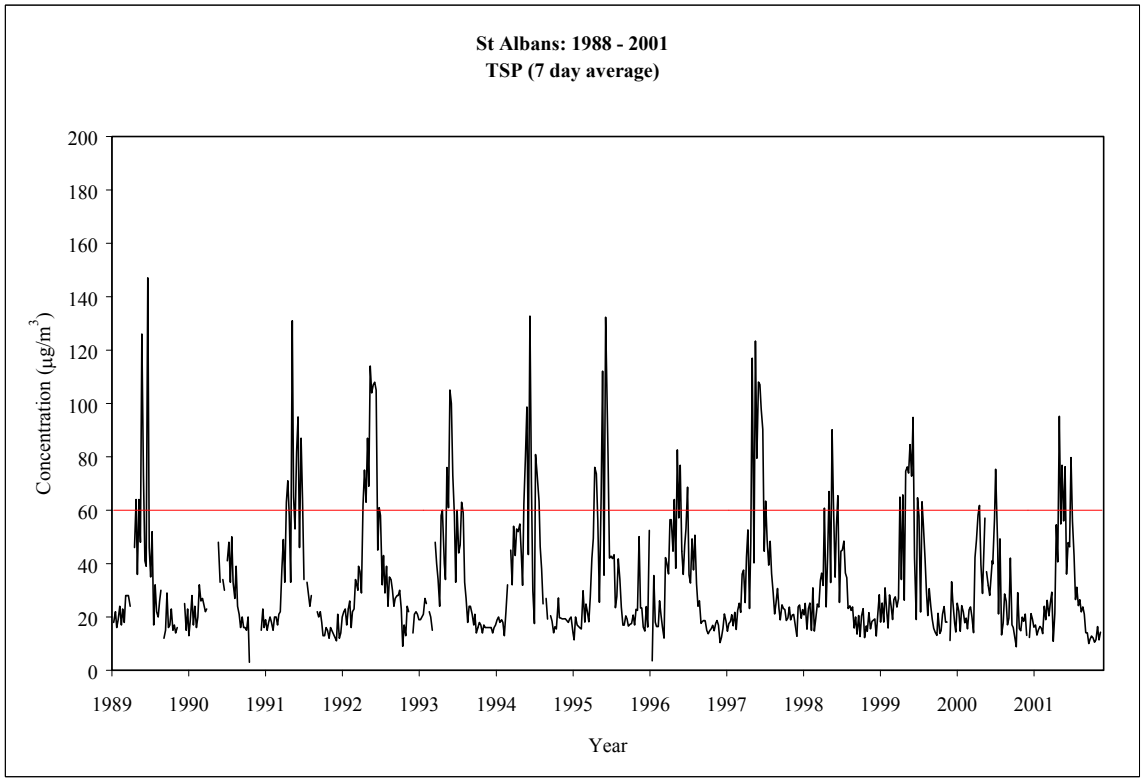

Figure 7: TSP 7 day average 1989 – 2001 at St Albans

6.3.2 Inhalable Particulate (PM_{10})

Only one site, St Albans, Christchurch, monitors ambient PM_{10}. The Beta gauge malfunctioned in February 2001. The instrument manufacturer has ceased operation, and due to difficulty sourcing equipment and information the Beta gauge was not repaired until October 2001. Since repair, on occasions the Beta gauge results have been very high. It has not been identified whether this is an equipment fault, or are real results due to excessive dust at the site from site redevelopment. In order to minimise the risk of incorrect reporting, alternative data has been used for the Feb to Dec 2001 period.

Environment Canterbury provided PM_{10} data from its TEOM monitor at St Albans for the period Feb 2001 to Dec 2001, when the MfE Beta Gauge was out of operation. The following points are noted:

- Environment Canterbury calculates its 24 hour fixed average from 9am to 9 am. This is at variance with MfE reporting, which calculates the 24 hour fixed average from midnight to midnight. Therefore, Environment Canterbury provided 10 minute data, which was used to calculate the 24 hour average for the midnight to midnight period.

- The TEOM sampler is known to provide lower PM_{10} concentrations than other methods, due to the use of a heated air inlet. The data was adjusted to represent Beta Gauge results using the following equation, which was derived by Environment Canterbury from co-located equipment:

$$\text{Beta gauge} = 1.4 \times \text{TEOM} + 0.06$$

- Environment Canterbury uses a different averaging period (9am to 9am). Due to the difference in averaging times, and the use of a conversion factor from TEOM to Beta gauge results, the Environment Canterbury statistics and reported exceedances may differ from those reported here.

Adjusted TEOM results are included in the results shown below. The results for 2001 are given in Figure 8, data for the last 5 years in Figure 9. The annual average data, for the earliest available data to 2001, is illustrated in Figure 10. Summary statistics for PM_{10}, calculated from Beta gauge and adjusted TEOM data, are given in Table 5.

Ambient PM_{10} concentrations exceeded the MfE's proposed guideline of 50 $\mu g/m^3$ on 58 occasions in 2001. Exceedances occurred between May and September.

The PM_{10} concentrations showed the seasonal trend typical of this site. There was no apparent annual trend, compared with previous years. The annual average was similar to previous years.

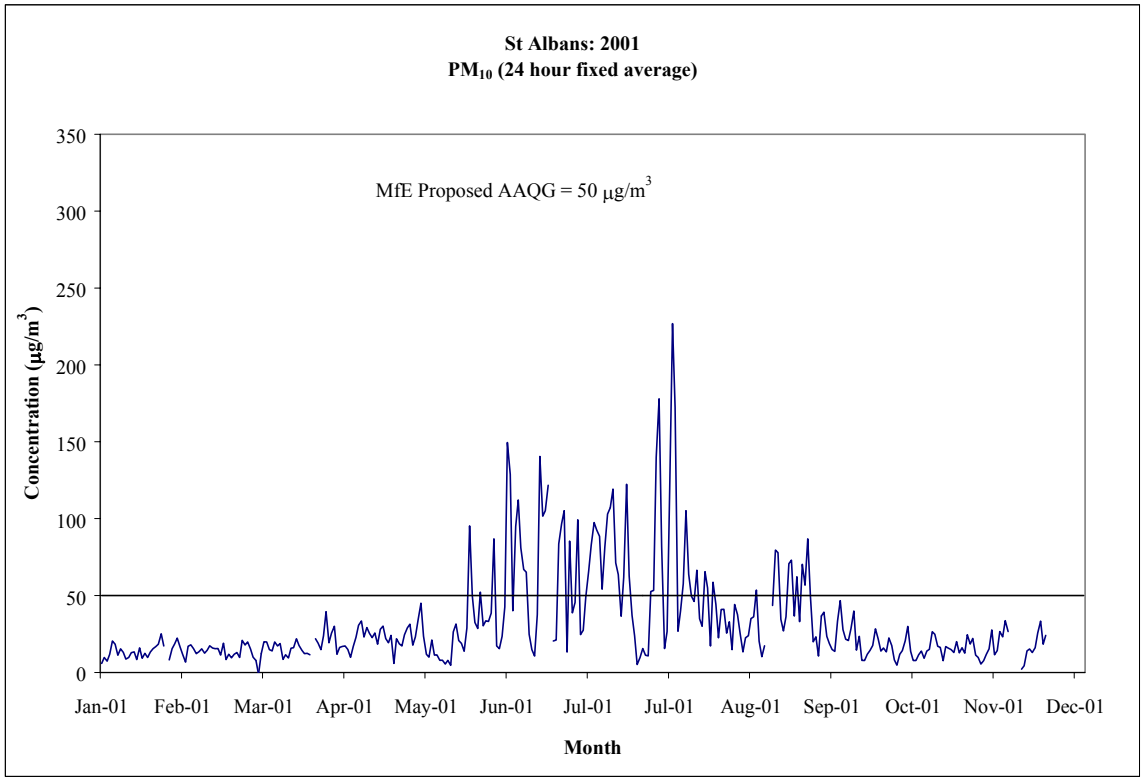

Figure 8: PM_{10} 24 hour average 2001 (St Albans only)

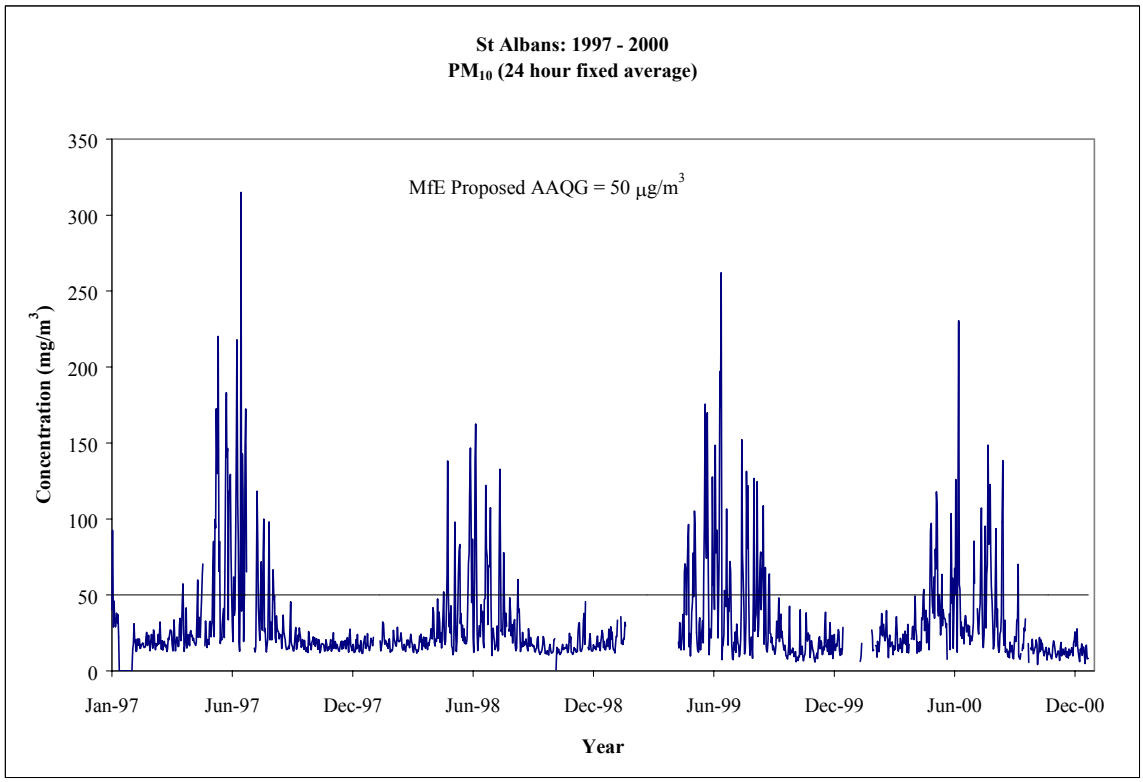

Figure 9: PM_{10} 24 hour average 1997 – 2000 (St Albans only)

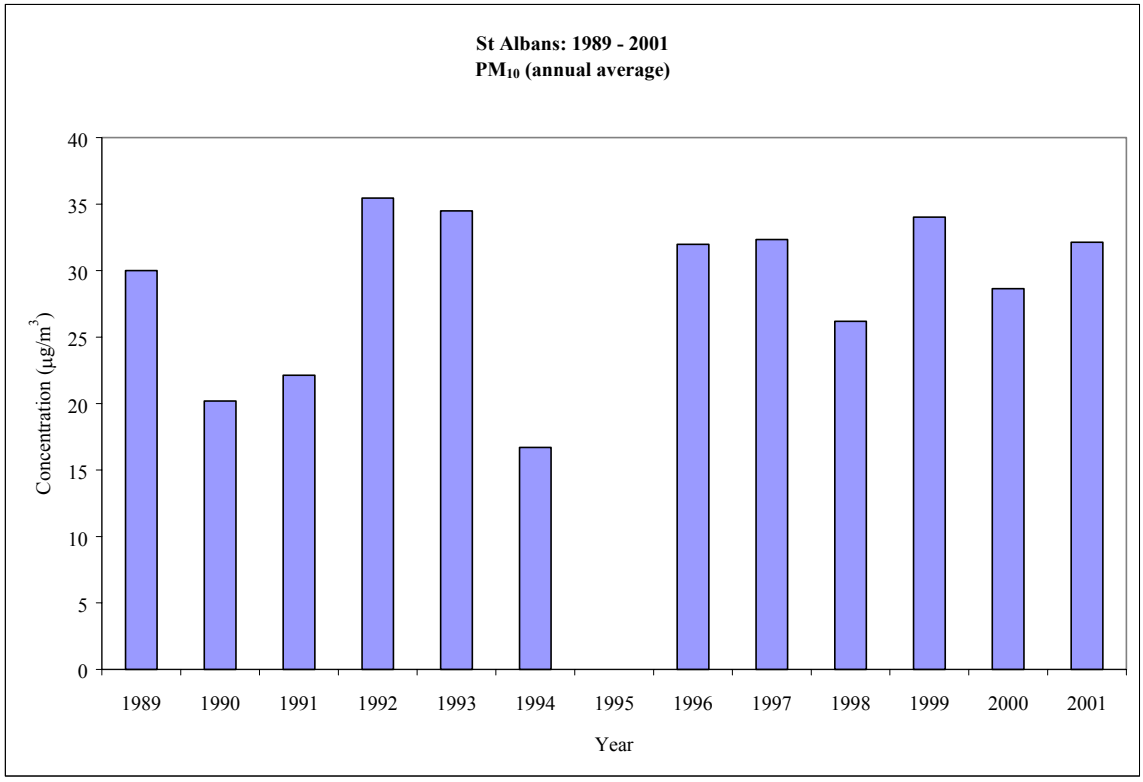

Figure 10: PM_{10} annual average 1989 – 2001 (St Albans only)

6.4 Lead

Lead results are recorded as 1-month averages and presented as 3-month moving averages. The results for the last 5 years are shown in Figure 11. Summary statistics for lead monitoring are given in Table 6. The proposed AAQG is 0.2 g/m^3, 3 month average.

Ambient concentrations of lead have fallen steadily since the removal of lead from petrol in 1996. Contract requirements have changed and lead analysis is now only undertaken on winter samples as a 3-monthly average. The statistics in Table 6 are based on June to August 2001 data only.

Results for 2001 are significantly lower than for earlier years. This has coincided with a change to a different laboratory. Watercare Services is currently undertaking re-analysis of 2000 and 2001 filters to determine the accuracy of recent analysis.

The existing AAQG of 0.5 $\mu g/m^3$ 3 month average, and the proposed AAQG of 0.2 $\mu g/m^3$ 3 month average, was not breached at any site on any occasion. Monthly and 3-monthly concentrations were very similar at all sites, 0.01 – 0.05 $\mu g/m^3$.

Table 6: Statistics for Lead Monitoring in 2001

Statistics for Lead Monitoring			
Site	**Maximum monthly average ($\mu g/m^3$)**	**No. of Exceeedences (>0.2 $\mu g/m^3$)**	**Valid data (%)**
Mt Eden	>LOD	0	92%
Penrose	0.001	0	100%
St Albans	0.007	0	100%

Note: Lead analysis is now only undertaken on winter samples as a 3-monthly average. The above statistics are based on June to August 2001 data only.

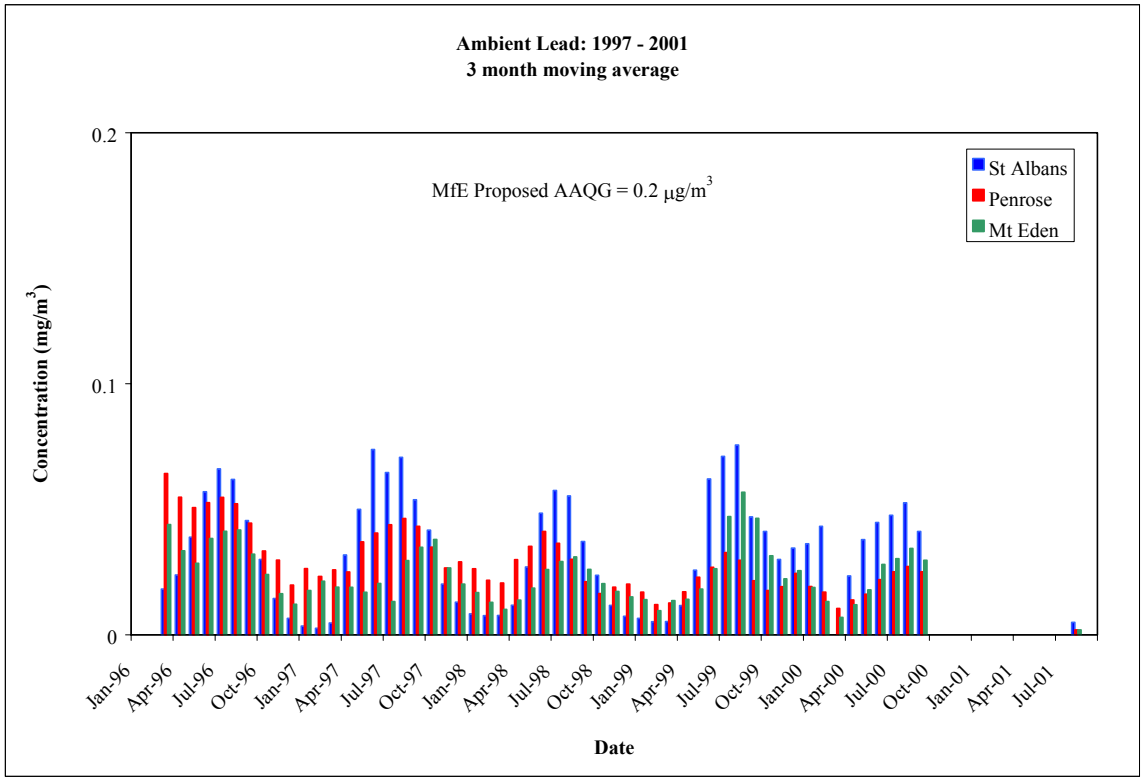

Figure 11: Lead 3-month moving average 1997 – 2001 (all sites)

6.5 Sulphur Dioxide

Current MfE AAQG has values for 10 minute, 1 hour, 24 hour and annual SO_2 averages. The proposed AAQG recommend removal of the 10 minute and annual averaging period. These values are being removed because the 10 minute period does not appear to be related to measurable health effects, and the annual concentrations affect ecosystem health and are better managed under ecosystem management strategies. The proposed 1 hour AAQG remains unchanged at 350 $\mu g/m^3$, and the 24 hour average has been rounded down from 125 $\mu g/m^3$ to 120 $\mu g/m^3$.

Summary results for SO_2 monitoring in 2001 are presented in Figure 12 (St Albans and Penrose 1 hour monthly maximum and average) and Figure 13 (St Albans and Penrose 24 hour monthly maximum and average). Full results for the year 2001 are presented in Appendix B. Monitoring at Penrose changed in January 2001 from wet chemistry to continuous instrumental monitoring. Therefore, results of historic 24 hour data at Penrose are not directly comparable to 2001 data.

Summary statistics are presented in Table 8.

Table 7: Statistics for Sulphur Dioxide Monitoring in 2001

Statistics for Sulphur Dioxide Monitoring								
	1 hour average data				24 hour average data			
Site	Maximum 1 hour average ($\mu g/m^3$)	99.9 percentile ($\mu g/m^3$)	No. of Exceeedence (>350 $\mu g/m^3$)	Valid data (%)	Maximum 24 hour average ($\mu g/m^3$)	99.5 percentile ($\mu g/m^3$)	No. of Exceeedence (>120 $\mu g/m^3$)	Valid data (%)
Penrose	164.7	94.0	0	79.3%	69.8	68.2	0	82.4
St Albans	63.8	40.3	0	91.4%	20.4	19.6	0	94.0

Guidelines were not exceeded at either St Albans or Penrose on any occasion. The maximum 1 hour and 24 hour concentrations were within the acceptable air quality range, according to EPI.

At St Albans, concentrations were high in January, and also in the May – July period. Concentrations were generally lower throughout the rest of the year. The maximum monthly 1 hour averages ranged from 13 – 63 $\mu g/m^3$, and the 24 hour averages ranged from 8 – 20 $\mu g/m^3$.

Penrose had slightly higher SO_2 concentrations than St Albans throughout the year, especially in the June – July period. However, concentrations are still low relative to guidelines. The maximum monthly 1 hour averages ranged from 17 – 71 $\mu g/m^3$, and the 24 hour averages ranged from 6 – 69 $\mu g/m^3$. At both sites, there is some evidence of a seasonal trend, with concentrations being low in summer and higher in winter.

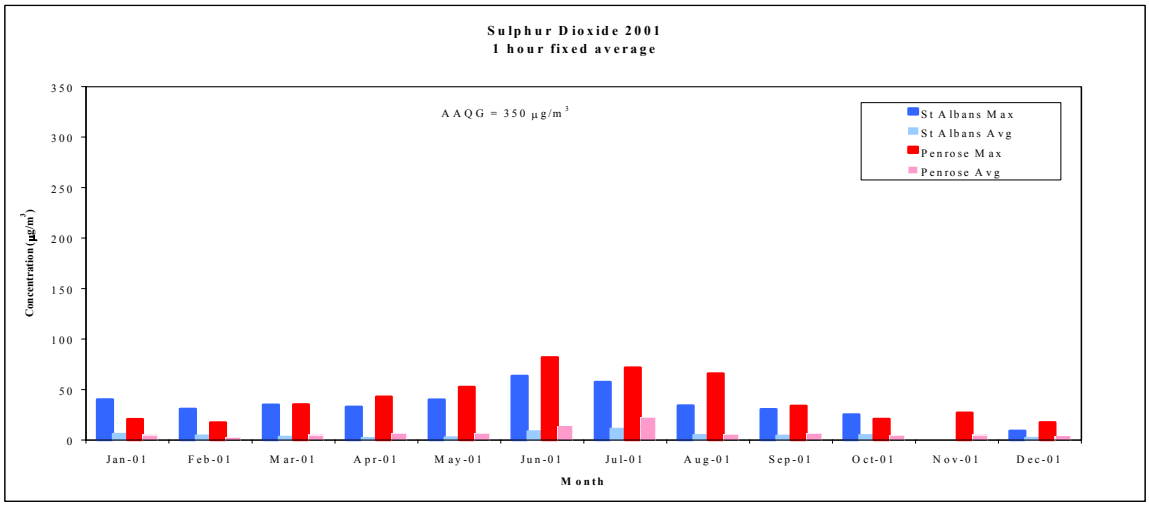

Figure 12: SO_2 monthly average and maximums (1 hour avg) 2001

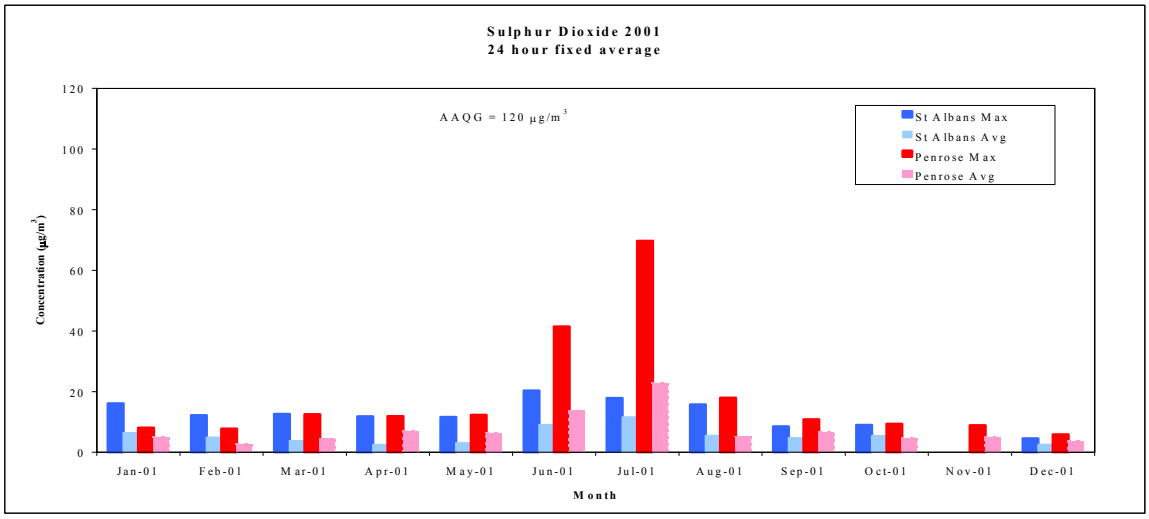

Figure 13: SO_2 monthly average and maximums (24 hour avg) 2001

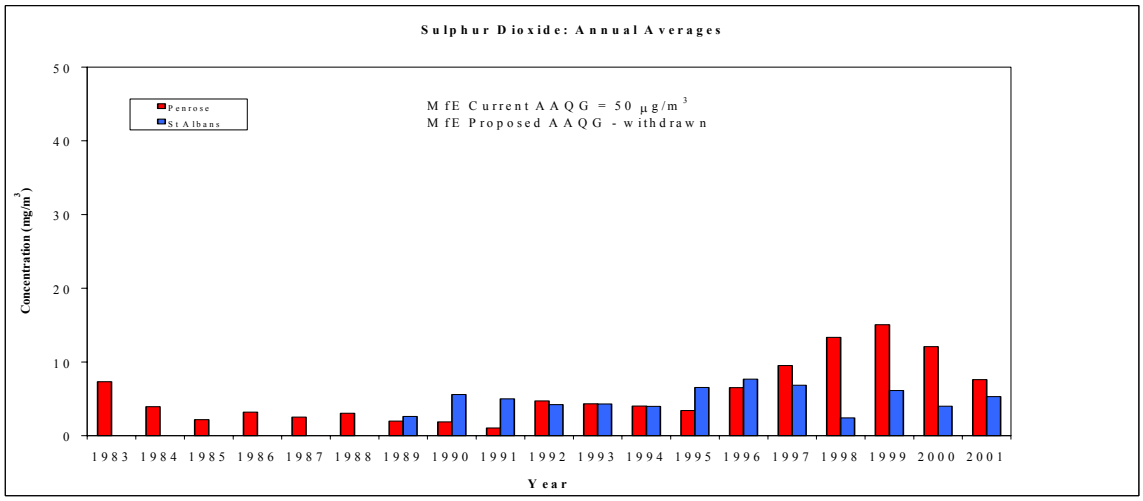

Figure 14: SO_2 Annual Average 1975 - 2001

6.6 Carbon Monoxide

CO is monitored at the St Albans site only. Carbon monoxide output from the continuous monitors are recorded as 10-minute averages. The 1-hour (fixed) averages have been calculated from this 10-minute data. The 8-hour moving averages have been calculated from the 1-hour averages. Summary statistics are presented in Table 8. Full results for the period 1997 to 2001 are presented in Appendix C.

The maximum and average monthly 1 hour averages for 2001 are given in Figure 15a, and maximum and average monthly 8 hour averages are given in Figure 15b. The MfE AAQG for CO, 1 hour average, was not exceeded at any time in the year 2001. The maximum value of 20 mg/m^3 put air quality in the alert category in June, according to EPI, but when averaged on an annual basis air quality was acceptable.

There were 14 exceedances of the 8 hour AAQG of 10 mg/m^3 in 2001 (Figure 15a). The maximum concentration for the year was 16 mg/m^3. In 2001, the number of breaches and frequency were relatively high compared to other years. The pattern was similar to 1997 and 1999. There were fewer breaches of the guideline in 1998 and 2000.

Ambient CO concentrations showed a seasonal trend, being higher from May to August. This trend is also apparent in earlier years (Figures 16a and 16b).

Table 8: Statistics for Carbon Monoxide Monitoring in 2001

Statistics for Carbon monoxide Monitoring								
	1 hour average data				8 hour average data			
Site	Maximum 1 hour average (mg/m^3)	99.9 percentile (mg/m^3)	No. of Exceeedence (>30 mg/m^3)	Valid data (%)	Maximum 8 hour average (mg/m^3)	99.9 percentile (mg/m^3)	No. of Exceeedence (>10 mg/m^3)	Valid data (%)
St Albans	20.4	16.2	0	97	16.0	13.7	14	98

The number of exceedances are calculated and reported in accordance with the MfE Good Practice Guide for Air Quality Monitoring and Data Management (2000).

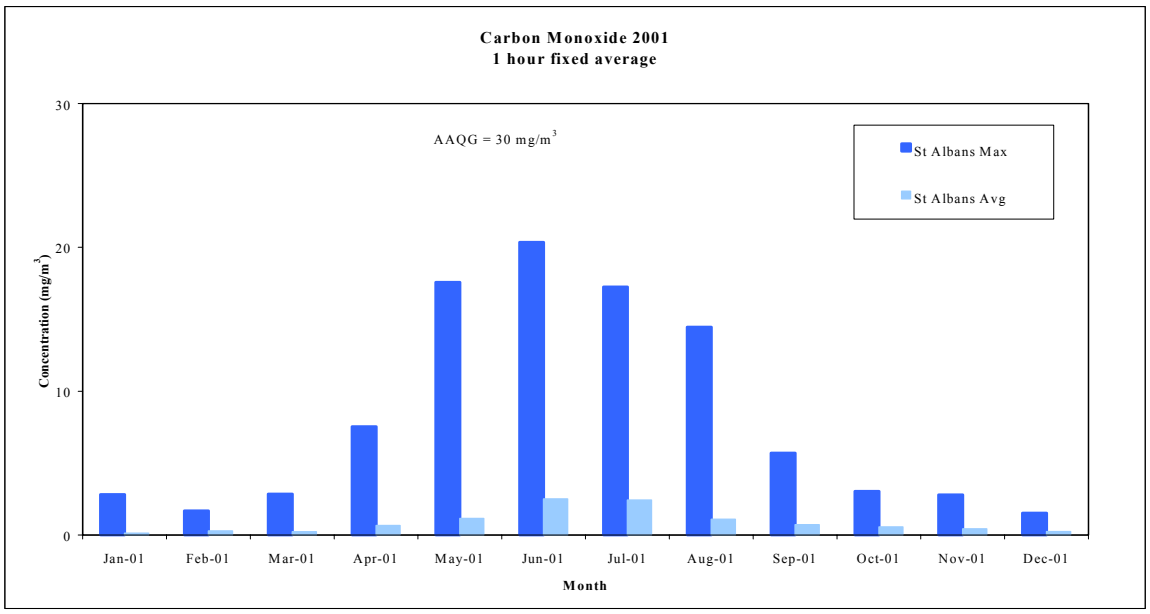

Figure 15a: CO monthly average and maximums (1 hour avg) 2001

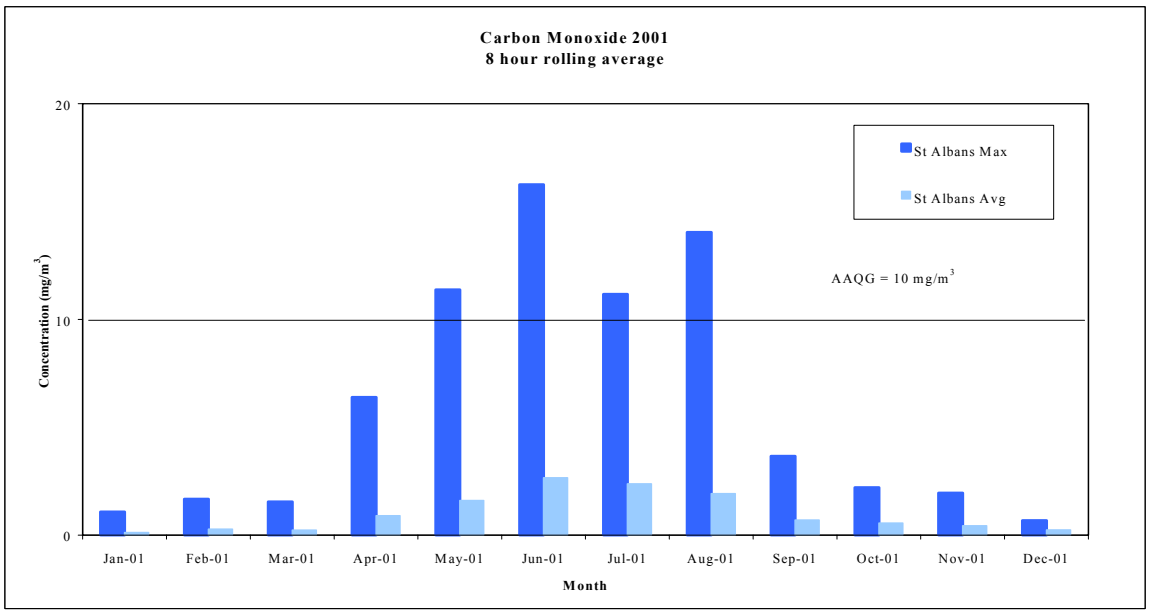

Figure 15b: CO monthly average and maximums (8 hour avg) 2001

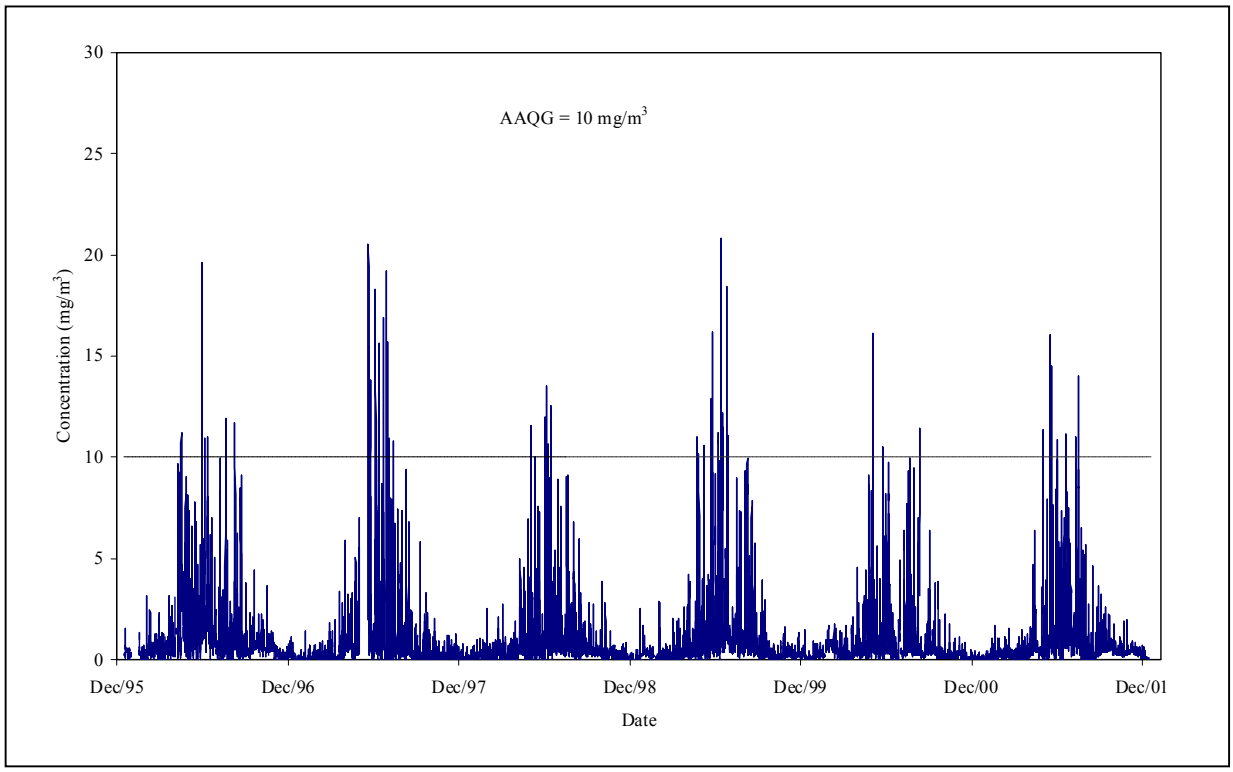

Figure 16a: CO 8-hour averages for St Albans from 1995 - 2001.

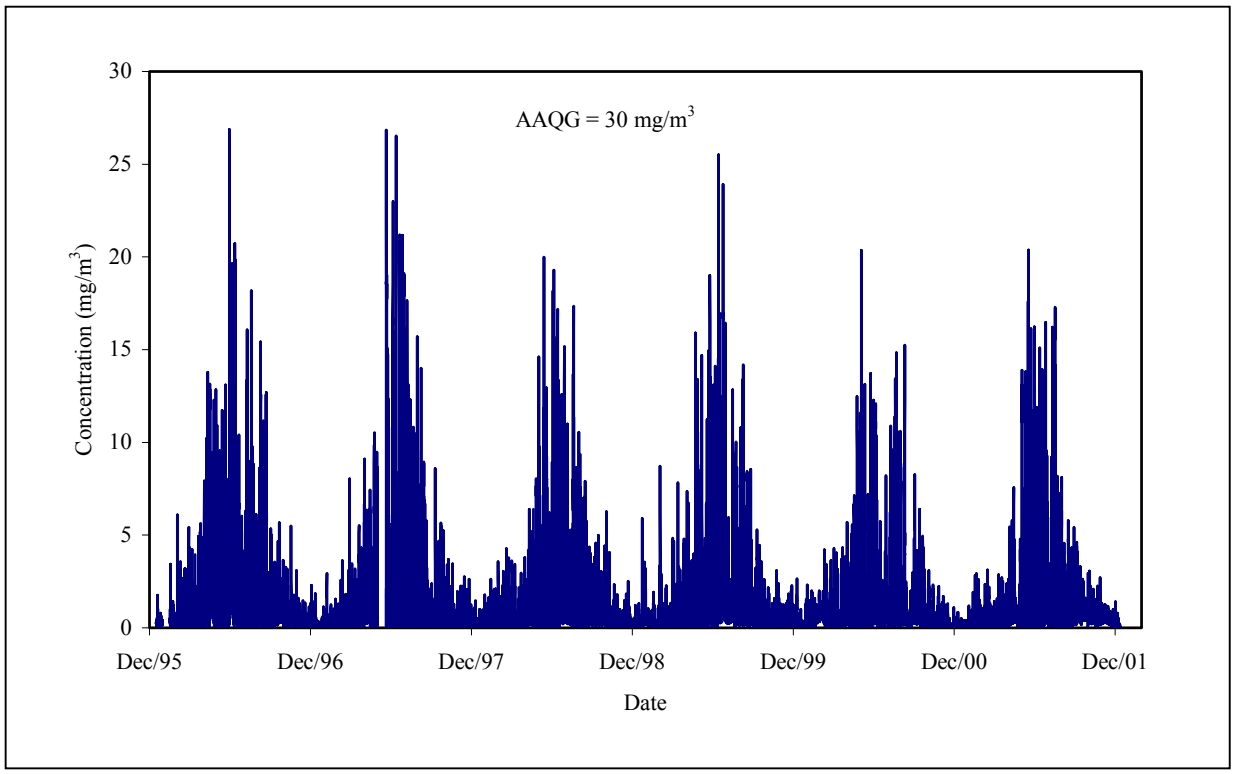

Figure 16b: CO 1 hour averages for St Albans from 1995 - 2001

6.7 Nitrogen Oxides

6.7.1 Nitrogen Dioxide

Oxides of nitrogen are monitored at three sites. Output from the continuous monitors are recorded as 10-minute averages. The 1-hour and 24-hour averages for nitrogen dioxide and nitric oxide have been calculated from the 10 minute data.

Quarterly reports for this project reported nitrogen oxides from Penrose site 4:19 (ACI site). This was an error, as monitoring at the ACI site is undertaken on behalf of the Auckland Regional Council. The GEMS data is collected at Penrose site 4:23 (Gavin Street). The nitrogen oxide data contained in this annual report is from the Gavin Street site.

Summary statistics for NO_2 for all sites, 1 hour and 24 hour averaging period, are given in Table 9. The maximum monthly NO_2 concentrations, 1 hour average, are presented in Figure 17. The maximum monthly NO_2 concentrations, 24 hour average, are presented in Figure 18. All nitrogen dioxide concentrations, 1 hour average and 24 hour average, since 1997, are presented in Appendix F.

Table 9: Statistics for Nitrogen Dioxide Monitoring in 2001

Statistics for Nitrogen Dioxide Monitoring								
	1 hour average data				24 hour average data			
Site	Maximum 1 hour average ($\mu g/m^3$)	99.9 percentile ($\mu g/m^3$)	No. of Exceeedence (>200 $\mu g/m^3$)	Valid data (%)	Maximum 24 hour average ($\mu g/m^3$)	99.9 percentile ($\mu g/m^3$)	No. of Exceeedence (>100 $\mu g/m^3$)	Valid data (%)
Mt Eden	73.7	67.1	0	79.9	44.4	44.0	0	96.2
Penrose	574.8	372.4	43	88.1	215.2	206.2	5	96.2
St Albans	105.5	91.6	0	95.6	51.2	51.1	0	97.3

The maximum value at Mt Eden was 74 $\mu g/m^3$, 1 hour average. This is 37% of the proposed AAQG (200 $\mu g/m^3$). Air quality with respect to NO_2 in Mt Eden on occasions is only acceptable, but most of the time is good to excellent, according to Ministry for the Environment's EPI's (Figure 1).

There is a slight seasonal pattern of NO_2 for Mt Eden. January and February appear to have lower NO_2 concentrations, with higher concentrations in the winter months. This pattern is similar to other years.

Maximum values for 1997 and 1998 were in the order of 80 – 100 $\mu g/m^3$. In 1999, 2000 and 2001, maximum values have dropped to 70 – 80 $\mu g/m^3$. Whilst this is a reduction, it is considered to be too early to conclude a real downward trend is occurring. Given the small magnitude of the change and the relatively short time frame, the observed variability could be caused by variations in weather patterns.

The maximum value at Penrose in 2001 was 574 $\mu g/m^3$, 1 hour fixed average. Based on 1 hour fixed averages, there were five exceedances of the 1 hour air quality guideline in April (occurring on 3 days), 42 exceedances in June (occurring on 6 days), and one exceedance in July. The 24 hour guideline was also exceeded in June on five occasions. The seasonal pattern shows higher concentrations in winter.

The maximum value St Albans was 105 μg/m^3, 1 hour average. Concentrations were generally higher in winter (60 – 105 μg/m^3, May to October) and lower through the summer (less than 40 μg/m^3). Overall concentrations for 2001 are slightly higher that 1998 - 2000, and are similar to 1997. A slight seasonal trend is evident in 2001 and in previous years, with concentrations being lower in December – February.

Monitoring results over a 24 hour averaging period at all sites are more suggestive of a seasonal trend, with concentrations being lower over the summer (Figure 18). These results also show Penrose has the highest NO_2 concentrations. Averages over the last 5 years confirms that the summer concentrations are lower, but does not suggest any annual trend of concentrations increasing or decreasing over time.

Prior to 2001, NO_2 air quality guidelines were not exceeded at any site. This includes consideration of proposed guidelines, which reduce the 1 hour guideline from 300 μg/m^3 to 200 μg/m^3. In 2001, there were several exceedances at Penrose. At this stage there is insufficient information to suggest whether the exceedances are a trend, or are a function of meteorology in the winter of 2001.

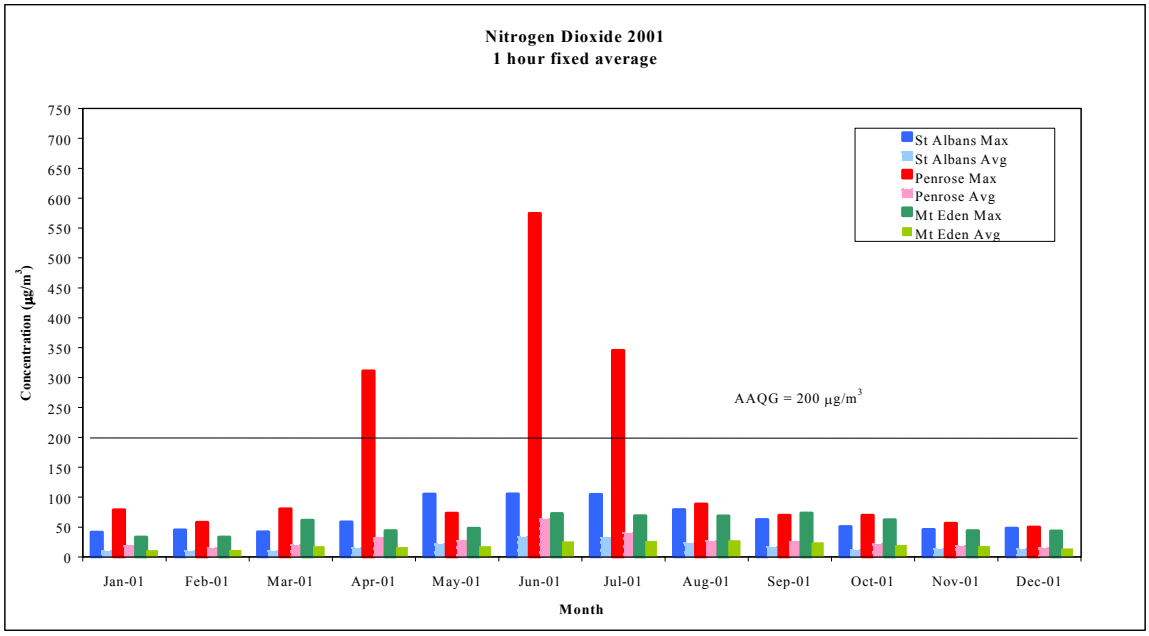

Figure 16: NO_2 monthly average and maximums (1 hour avg) 2001

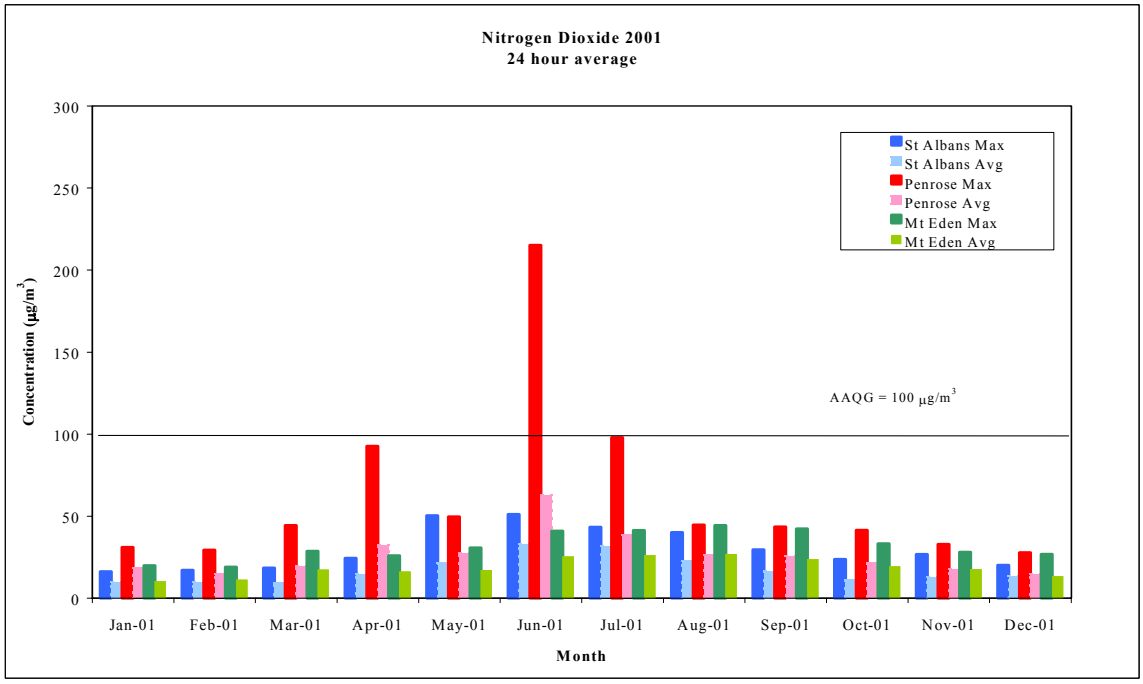

Figure 17: NO_2 monthly average and maximums (24 hour avg) 2001

6.7.2 Nitrogen Monoxide and Nitrogen Dioxide

The concentration of NO and NO_2 has been presented graphically for each site. One hour averages are presented in Figure 19 (Mt Eden), Figure 19 (Penrose) and Figure 20 (St Albans), and 24 hour averages are presented in Figure 22 (Mt Eden), Figure 23 (Penrose) and Figure 24 (St Albans).

Much of the NO and NO_2 in the atmosphere is produced from combustion processes. This can include internal combustion engines (vehicle engines), external combustion (stationary boilers and fuel burners) and home heating. Predominantly, NO is discharged (85 – 90% total NOx in discharge is NO), and is oxidised to NO_2 in the atmosphere. Therefore, the relative percentages of each species can provide an indication of the proximity of a monitoring station to the NOx source.

Total NOx and NO at all sites shows a consistent seasonal pattern, with there being significantly higher concentrations during the winter. This could be caused by a combination of increased space heating causing higher NOx emissions, and winter meteorology reducing dispersion.

At Mt Eden, most NOx is present as NO_2. This suggests that the point of emission is some distance from the monitoring site. In this predominantly residential area, the major source of ambient NOx is expected to be traffic emissions.

At Penrose, there is significantly more NO relative to NOx. Potential sources at this location are industrial boilers, and traffic emissions. It is suggested that if traffic were the major source, a concurrent increase in VOC could be expected. However, VOC concentrations at this site were not high relative to other sites (see Section 6.8). Therefore, it is likely that industrial emissions are the main source of NOx. High winter NO_2 concentrations indicate the effect of meteorology on ambient NOx concentrations.

At St Albans, there is significantly more NO relative to NO_2 in the winter months. St Albans is located in a residential area, but relatively close to major roads. The high winter NO concentrations may be affected by both winter meteorology, and by increased emissions from solid fuel domestic heating.

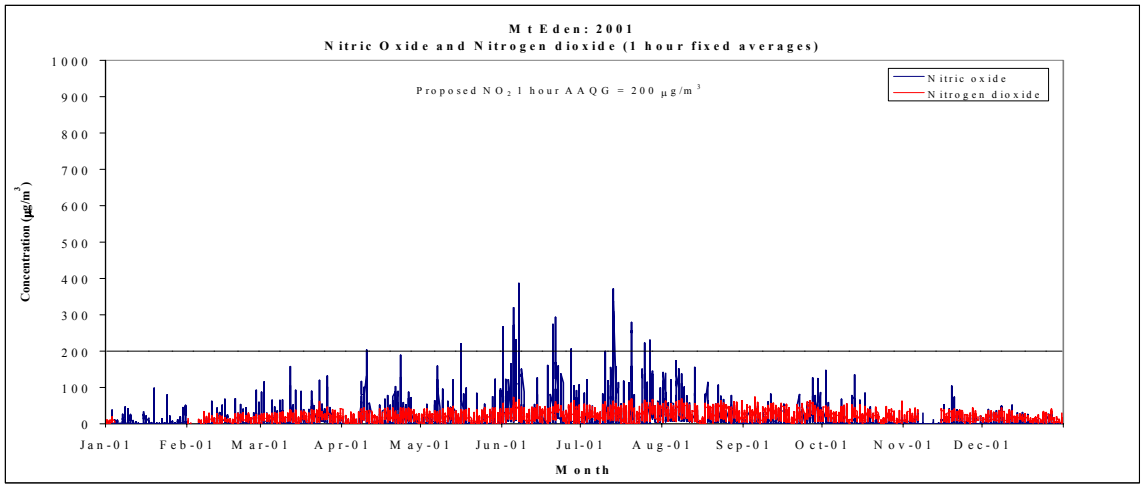

Figure 18: NO / NO_2 1 hour average 2001 at Mt Eden

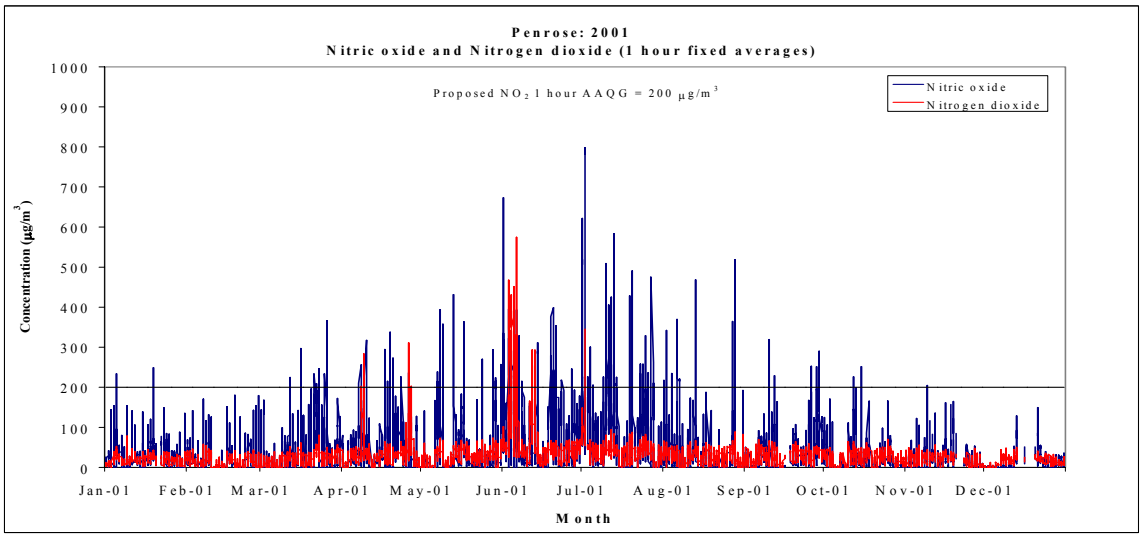

Figure 19: NO / NO_2 1 hour average 2001 at Penrose

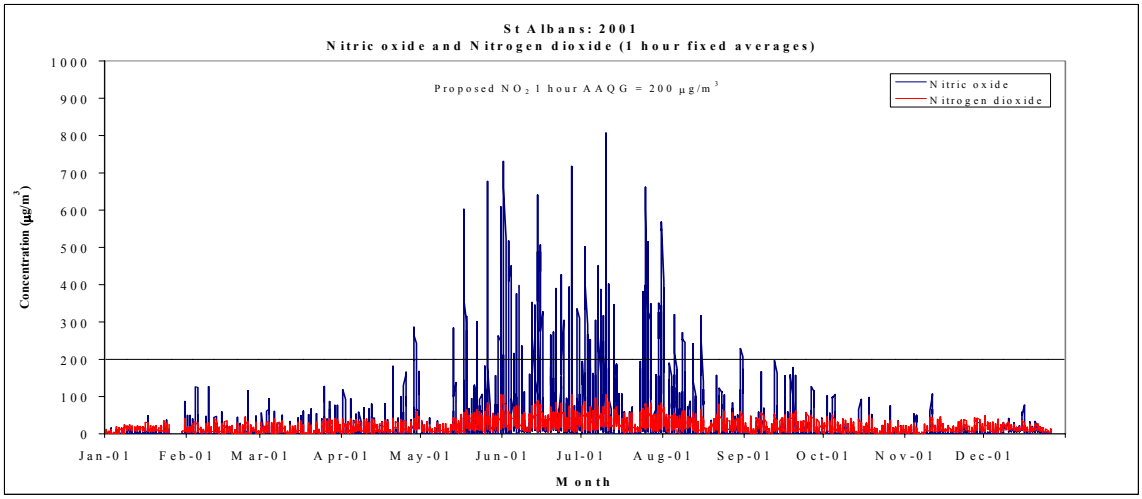

Figure 20: NO / NO_2 1 hour average 2001 at St Albans

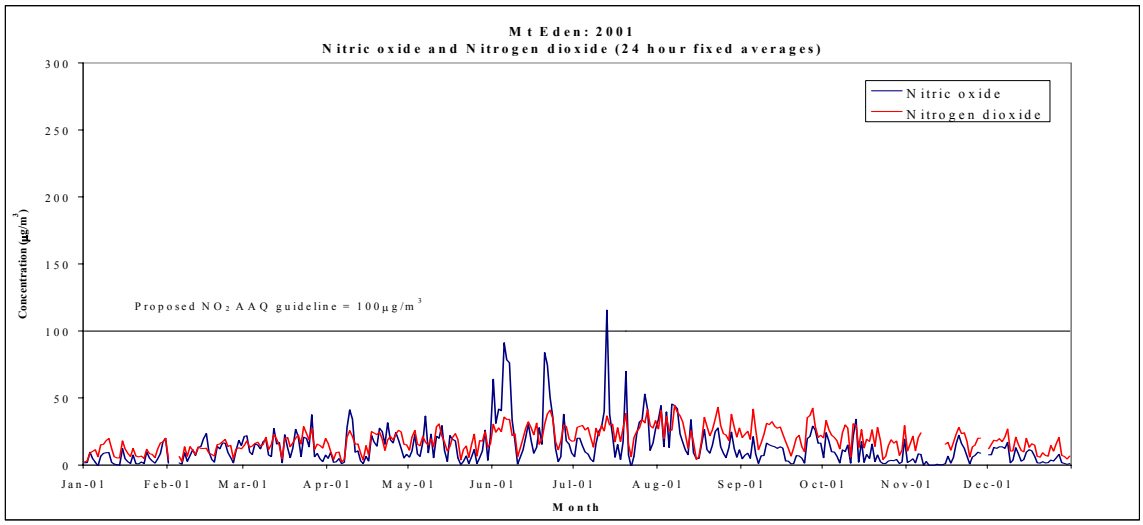

Figure 21: NO / NO_2 24 hour average 2001 at Mt Eden

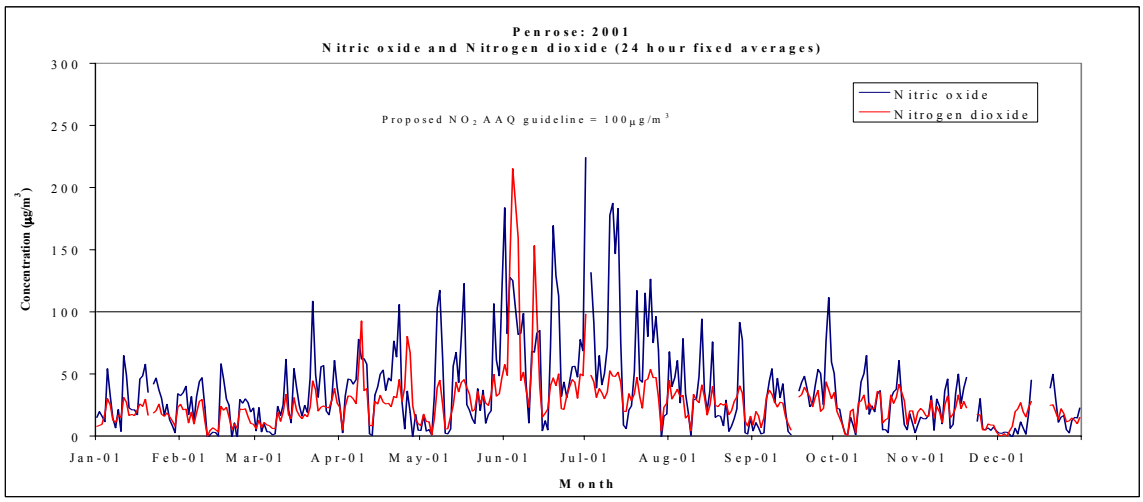

Figure 22: NO / NO_2 24 hour average 2001 at Penrose

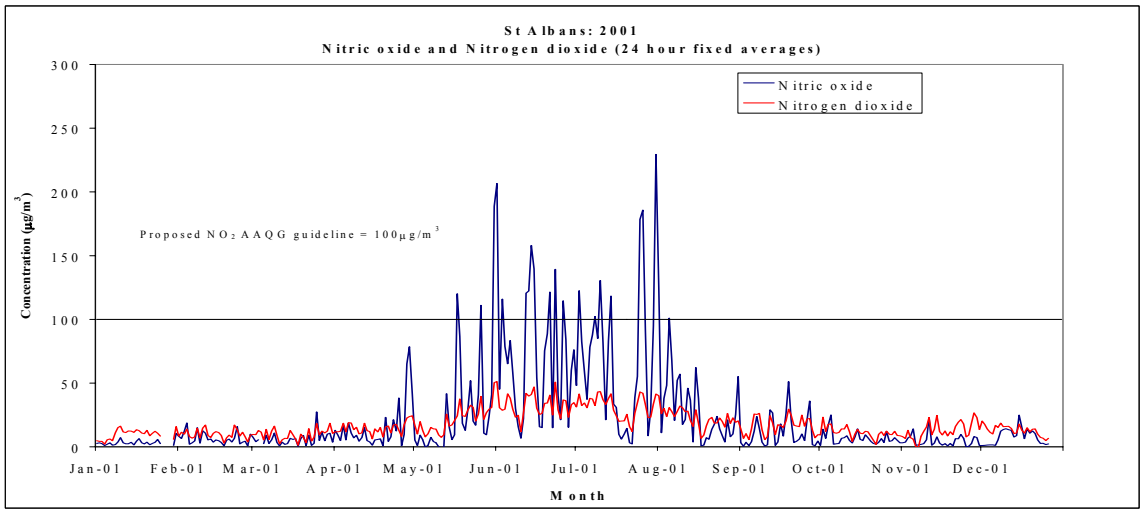

Figure 23: NO / NO_2 24 hour average 2001 at St Albans

6.8 Volatile Organic Compounds

Monitoring of VOC commenced on 01 April 2001. Passive badges were exposed for 3 month periods. The badges were analysed for a range of VOC, but only compounds which were detected in at least one sample were reported.

Benzene, toluene and xylene are contaminants which were included in the Proposed AAQG. The results of monitoring of these three contaminants are given in Figure 26 (benzene), Figure 27 (toluene) and Figure 28 (xylene). Full reports for each quarter are included in Appendix E, and laboratory analytical reports are in Appendix F.

Monitoring to date has shown that the highest concentration of benzene, toluene and xylene are at St Albans. Benzene concentrations at St Albans were within the guideline of 10 $\mu g/m^3$ (annual average) proposed for the year 2000, but above the guideline of 3.6 $\mu g/m^3$ proposed for 2010. Benzene concentrations at both Penrose and Mt Eden were within both of the above guideline values.

The proposed ambient air quality guideline for toluene is 190 $\mu g/m^3$ (annual average), and for xylene is 950 $\mu g/m^3$ (annual average). All results at all sites are significantly less than the proposed guidelines. The highest values were at St Albans, and were 16 $\mu g/m^3$ toluene and 10 $\mu g/m^3$ xylene.

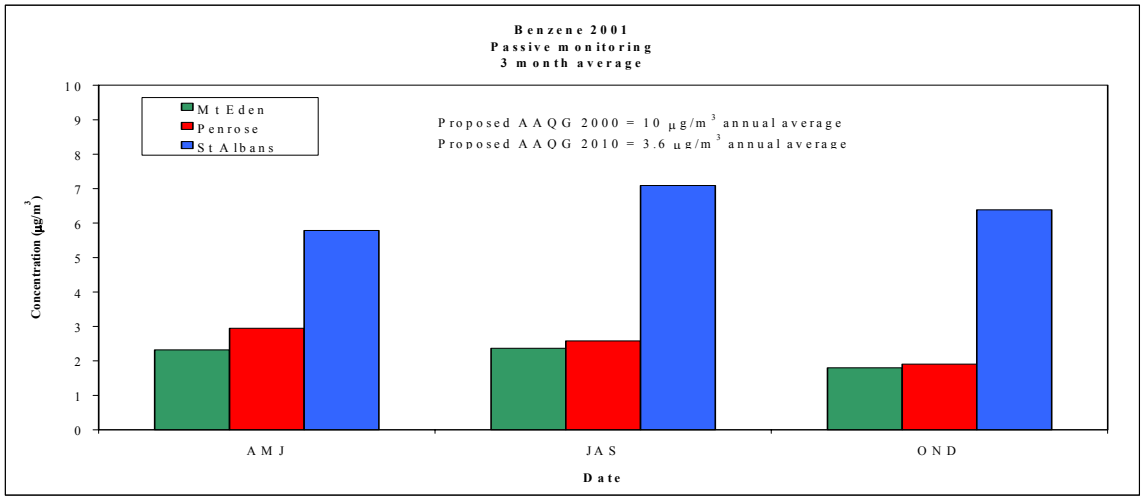

Figure 24 Benzene 3 month average 2001

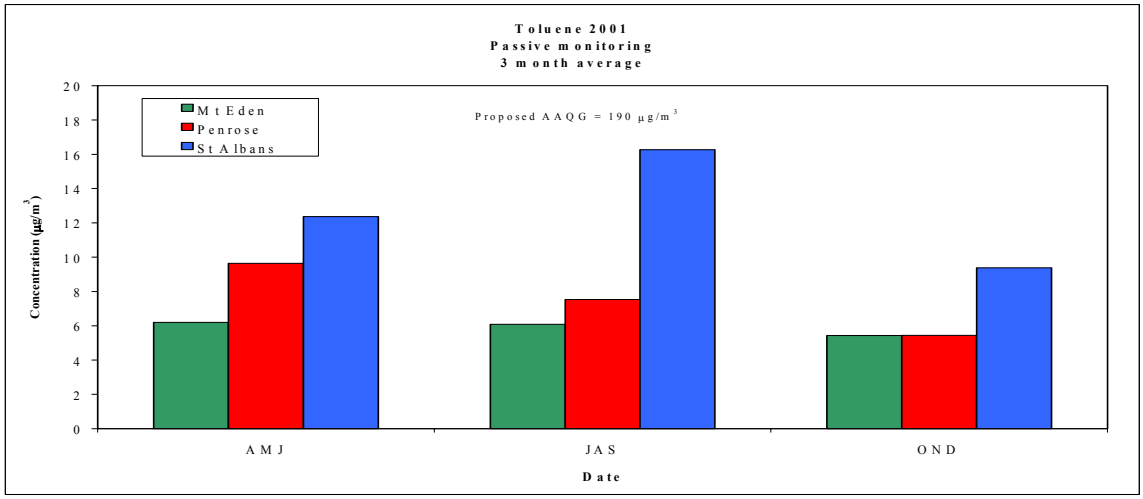

Figure 25 Toluene 3 month average 2001

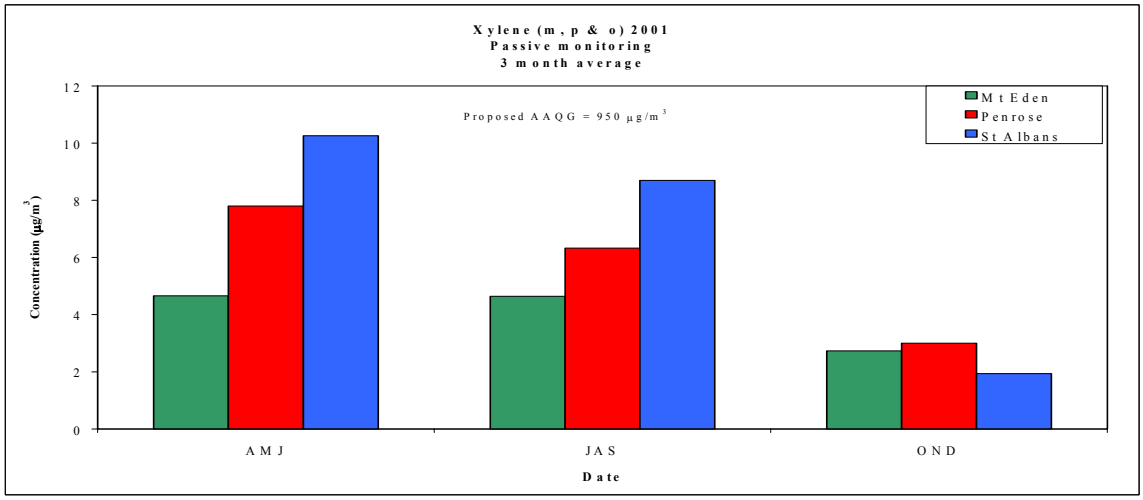

Figure 26 Xylene 3 month average 2001

8 References

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