Ministry for the Environment

GEMS Air Monitoring Program
Annual Report 2000

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GEMS AIR MONITORING PROGRAMME
Annual Report

A report for the
Ministry for the Environment

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DISCLAIMER

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 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 2000. Monitoring and reporting is undertaken by Watercare Services Ltd, and data is reported to MfE and WHO as part of the GEMS program.

2 CONTAMINANTS MONITORED

2.1 Particulate Matter

Particulate matter refers to numerous substances that existing 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 form 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. Its main effect 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. However, all these fractions are currently measured within the PM_{10} category.

2.1.3 Smoke

Smoke is produced by incomplete combustion, and includes carbon compounds and organic compounds. Depending on the source of the smoke, and the combustion conditions, it will include both deposited and suspended particulate. Smoke has potential adverse aesthetic and health effects.

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), which is of concern due to its potential to cause health effects, and the monoxide form 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 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, 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 effects with other pollutants such as SO_2 and particulate.

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), and existing and proposed guidelines are included in this report. The criteria for inclusion in the guidelines was the effect of a contaminant on human health. MfE guidelines for the contaminants monitored are given in Table 1.

The current MfE AAQG for PM_{10} is 120 $\mu g/m^3$, 24 hour average. The Auckland and Canterbury Regional Council, as part of their regional air quality management programs, have adopted a PM_{10} concentration of 50 $\mu g/m^3$, 24 hour average, as an air quality target. This has also been adopted in the proposed MfE guidelines.

Some contaminants currently being monitored do not have guideline values in the Ministry for the Environment's AAQG. In these cases the criteria are those applied previously by the Department of Health. These have been superseded by the MfE's Ambient Air Quality Guidelines, but are useful for analysing the results of the monitoring data. The Department of Health guideline for total suspended particulate (7 day average) is 60 $\mu g/m^3$ and for smoke (24 hour average) is 60 $\mu g/m^3$.

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
Smoke			60 $\mu g/m^3$ (DoH)	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

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 RM Act 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, Auckland, Site 4:19

This site is representative of industrial activity and is west of the Southern Motorway. The monitor is located at the rear of the Penrose Occupational Health Clinic, approximately 15 meters east of Great South Rd.

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 will be from the new location. Details of the new location will be included in the next report.

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 will be relocated in 2001. 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}	Smoke	SO_2	CO	NO	NO_2	Lead
Mt Eden, Auckland site 4:65	✓					✓	✓	✓
Penrose, Auckland site 4:19	✓		✓	✓				✓
Penrose, Auckland site 4:23						✓	✓	
St Albans, Christchurch site :16:67	✓	✓		✓	✓	✓	✓	✓

5 METHODS

5.1 Quality Assurance

Watercare Services Ltd has ISO9002 accreditation for its operation. In addition, Watercare Services Ltd is undertaking systems and methods reviews to achieve compliance with IANZ.

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 at St Albans continuously using a Beta Attenuation analyser and TEOM (Tapered Element Oscillating Microbalance). The analyser is covered by Australian Standard AS 3580.9.6 and US EPA 'equivalent' method. The Beta Attenuation analyser is operated for the MfE and the TEOM for Environment Canterbury.

Smoke is monitored by collection on a filter. The darkness of particles collected on a filter is measured using light reflectance. This gives an indication of relative 'soiling potential' and was originally used for monitoring smoke from domestic fires. The method used is Air Quality Test Method T100 and this is based on a British Standard (BS1747, pt 2).

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

The current monitoring method at Penrose, Auckland, uses bubbler collection followed by chemical analysis. The method is Air Quality Test Method T100 (based on BS1747, pt 3). At St Albans, sulphur dioxide is monitored continuously using a UV fluorescence analyser according to Air Quality Test Method T202 (ref AS 3580.4.1-1990).

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).

6 RESULTS AND DISCUSSION

6.1 Site Performance and QA

Overall, site performance in 2000 was very good. Eleven of the fourteen analysis (by site and contaminant) had over 90% valid data. The overall site performance is recorded in Table 4.

Table 4: Percentage Valid Data

Contaminant	Site	Percentage Valid Data (ann. avg.)	Reasons
TSP	Mt Eden	94.2 %	No result – pump malfunction
TSP	Penrose	94.2 %	No result – pump malfunction
TSP	St Albans	98.0 %	Missing data. Sample time 25% of normal.
PM_{10}	St Albans	76.3 %	Beta Gauge malfunction
Smoke	Penrose	95.3%	Equipment removed for maintenance (4 days) Power failure (13 days)
SO_2	Penrose	95.6 %	Power failure
SO_2	St Albans	92.5 %	Wiring to analogue input failed
CO	St Albans	96.6 %	Malfunction of analyser
NO_x	Mt Eden	96.9 %	Power failure
NO_x	Penrose	88.6 %	Equipment was relocated to new housing and calibration was not performed so data had to be invalidated
NO_x	St Albans	72.1 %	Malfunction of analyser
Lead	Mt Eden	100 %	N/A
Lead	Penrose	100 %	N/A
Lead	St Albans	100 %	N/A

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 current MfE AAQG, and therefore excluded TSP and smoke. The existing guidelines were used to calculate the site performance relative to the EPI categories. For lead, the lower recommended guideline of 0.5 $\mu g/m^3$ was used to calculate the EPI. It is noted that for PM_{10}, lead and NO_2, the proposed guidelines are lower than existing, which will worsen the relative performance of all sites for those contaminants. Results for each site are shown in Figure 1, Figure 2 and Figure 3.

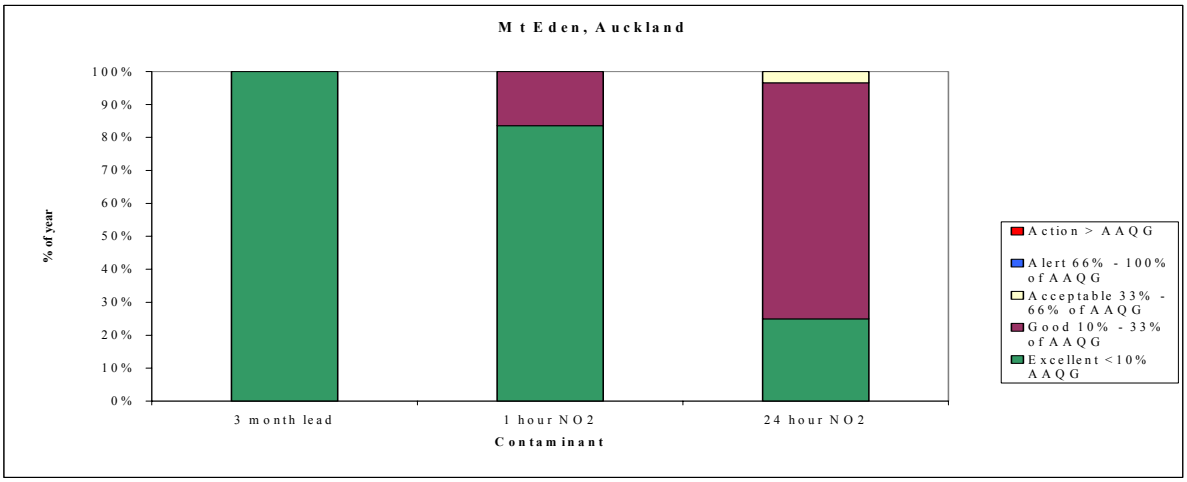

Figure 1: Comparison of monitored contaminants at Mt Eden to EPI

Figure 2: Comparison of monitored contaminants at Penrose to EPI

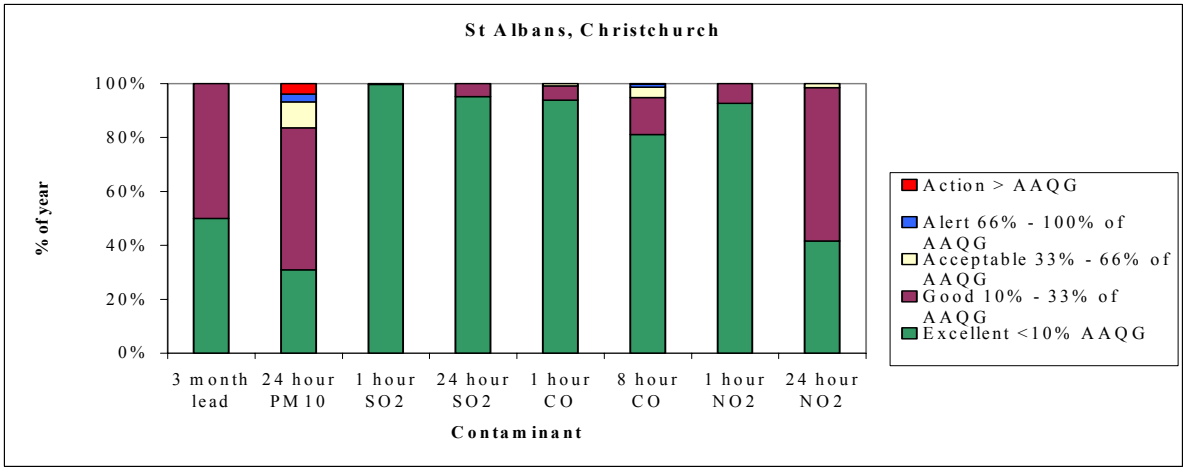

Figure 3: Comparison of monitored contaminants at St Albans to EPI

6.3 Particulate Matter

6.3.1 Total Suspended Particulate (TSP)

TSP is recorded as 7 day averages, and the results for 2000 from the three sites are shown in Figure 4. Summary statistics are presented in Table 5.

Table 5: Statistics for Particulate Monitoring in 2000

Statistics for Particulate Monitoring						
	PM_{10} - 24 hour average data*				TSP - 7 day average data	
Site	99.5 percentile ($\mu g/m^3$)	No. of Exceeedence (>120 $\mu g/m^3$)	Valid data (%)	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	29
Penrose	-	-	-	-	0	50
St Albans	143	5	86	231	2	75

*Measured by Beta Gauge

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 2000, the guideline was not exceeded at Mt Eden or Penrose on any occasion. There were two exceedances at the St Albans site, one in May and one in August.

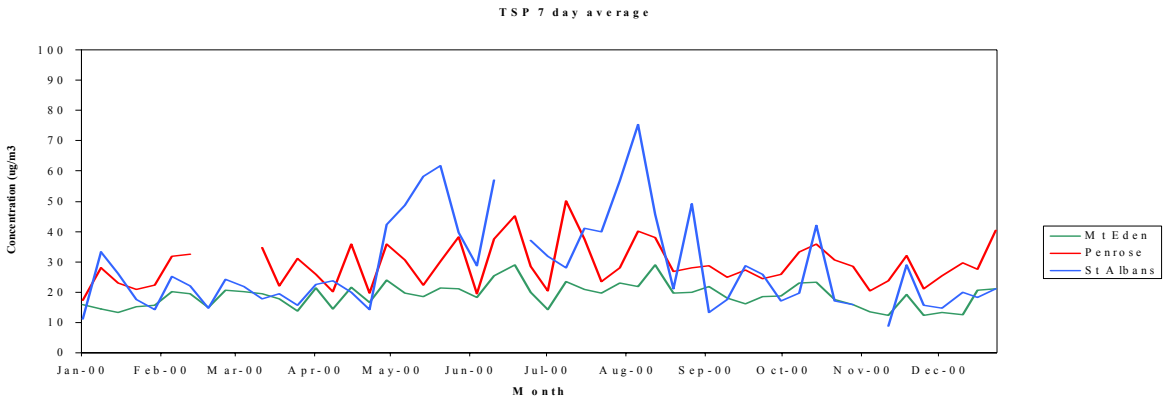

Figure 4: TSP 7 day average 2000 (all sites)

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 2000 shows a variable but low TSP concentration, ranging from 12 – 29 $\mu g/m^3$, 7 day average. There appears to be a slight 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 is declining. The DOH guideline has only been exceeded on one occasion since monitoring began.

At Penrose, there were no exceedances in the 2000 monitoring year. Concentrations appear to be higher in the winter. Monitoring commenced at Penrose in 1964, and results are shown in Figure 6. 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 2000 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 two occasions. Monitoring commenced at this site in 1989, and the guideline is exceeded on several occasions every winter (Figure 7). The 2000 winter had fewer exceedances than other years, and concentrations appeared generally lower than previous years. July 2000 experienced very mild temperatures, and this may have affected both the maximum values and the number of exceedances. Results are similar to 1996, and are insufficient to conclude a decrease in average winter TSP concentrations is occurring.

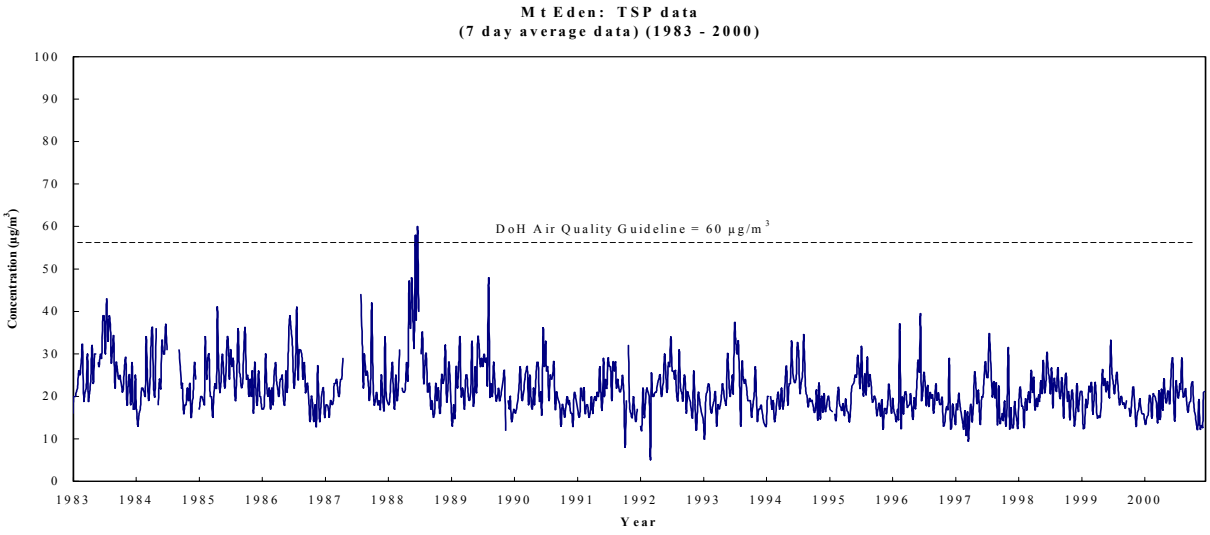

Figure 5: TSP, 7 day average 1983 – 2000 at Mt Eden

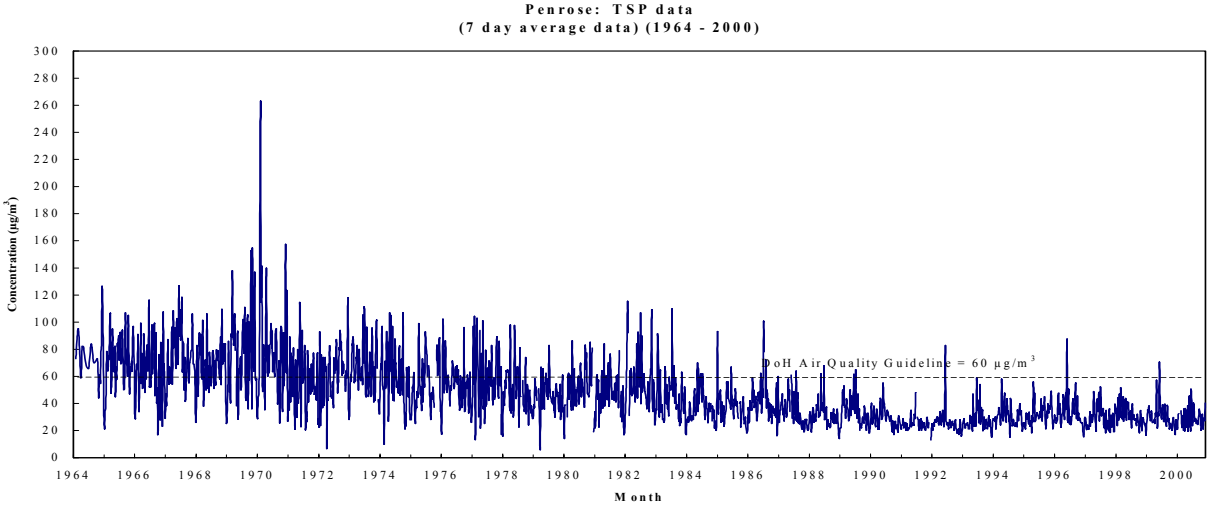

Figure 6: TSP 7 day average 1964 – 2000 at Penrose

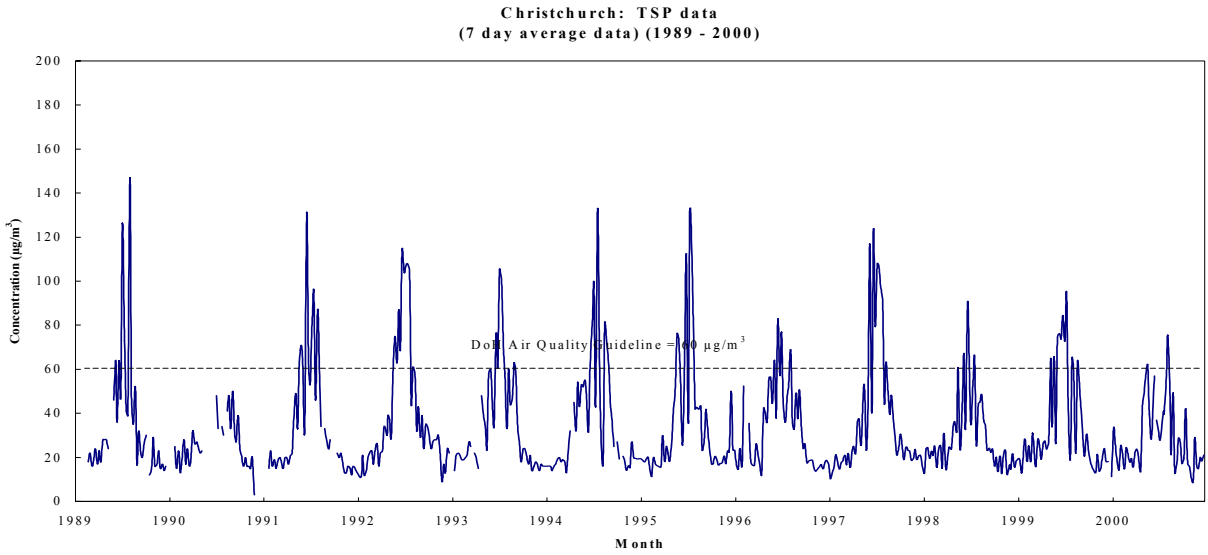

Figure 7: TSP 7 day average 1989 – 2000 at St Albans

6.3.2 Inhalable Particulate (PM_{10})

Only one site, St Albans, Christchurch, monitors ambient PM_{10}. Output from the continuous monitors is recorded as 1-hour averages. The 24-hour average for the Beta-Gauge analyser have been calculated, and the results for 2000 are shown in Figure 8, data for the last 5 years in Figure 9. The annual average data, for the earliest available data to 2000, is illustrated in Figure 10. Summary statistics for PM_{10} are given in Table 5.

Environment Canterbury uses a different averaging period (9am to 9am) and apply a guideline of 50 µg/m^3 (24 hour average), therefore their statistics and reported exceedances are different to those reported here. An ambient concentration of 50 µg/m^3 PM_{10} is proposed in the new MfE guideline, and therefore is included in the figures below.

Ambient PM_{10} concentrations exceeded the MfE's current guideline of 120 µg/m^3 on 5 occasions between June and September 2000. The MfE's proposed guideline of 50 µg/m^3, which is also Environment Canterbury's ambient air quality target, was exceeded on 42 occasions. Exceedances occurred between May and October.

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 lower than 1999, but similar to 1996 & 1997.

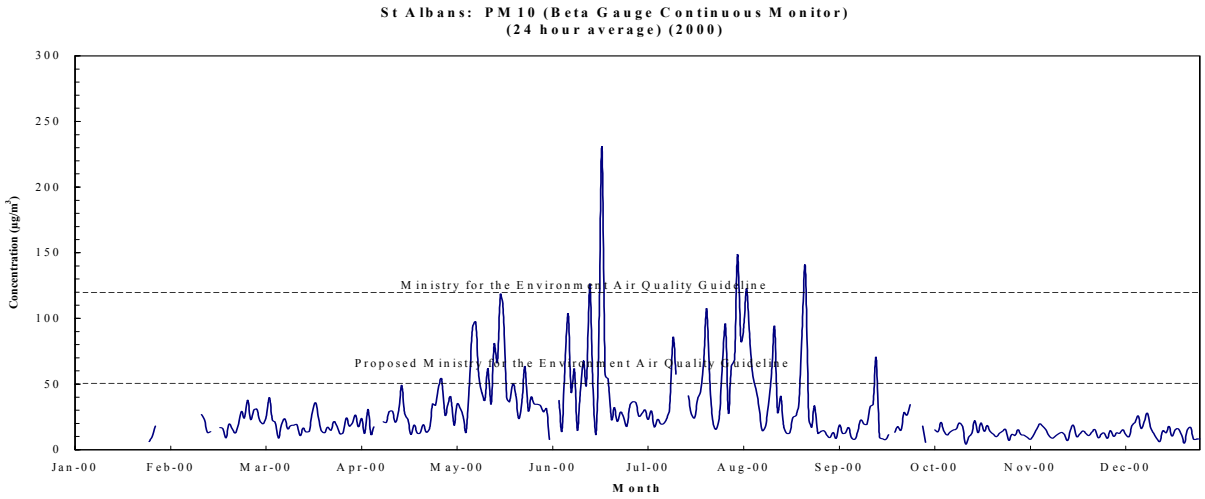

Figure 8: PM_{10} 24 hour average 2000 (St Albans only)

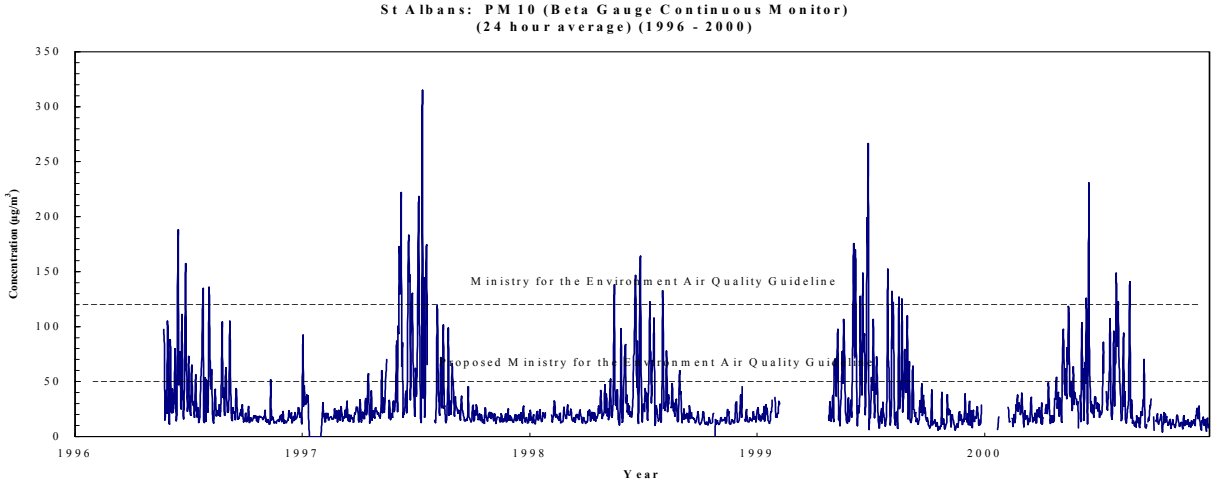

Figure 9: PM_{10} 24 hour average 1996 – 2000 (St Albans only)

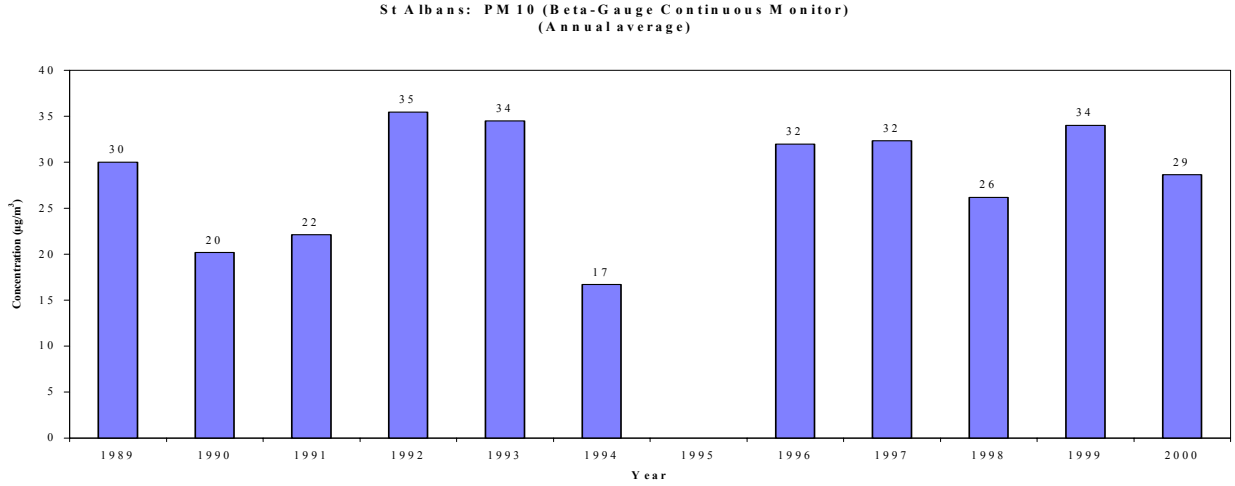

Figure 10: PM_{10} annual average 1989 – 2000 (St Albans only)

6.3.3 Smoke

Only one site, Penrose in Auckland, undertakes smoke monitoring. Results are recorded as a 24 hour average. Summary statistics for 2000 are given in Table 6. Results for 2000 are shown in Figure 11.

There were no exceedances of the Department of Health guideline of 60 µg/m^3 in the 2000 year. The maximum recorded value was 19 µg/m^3. The seasonal trend was similar to previous year, with concentrations increasing from less than 10 µg/m^3 in January – March, to 10 – 20 µg/m^3 between March and September, decreasing again to below 10 µg/m^3 from September to December.

Table 6: Statistics for Smoke Monitoring in 2000

Statistics for Smoke Monitoring				
	24 hour average data			
Site	**99.5 percentile (µg/m^3)**	**No. of Exceeedence (>120 µg/m^3)**	**Valid data (%)**	**Maximum 24 hour average (µg/m^3)**
Penrose	19	0	95	19

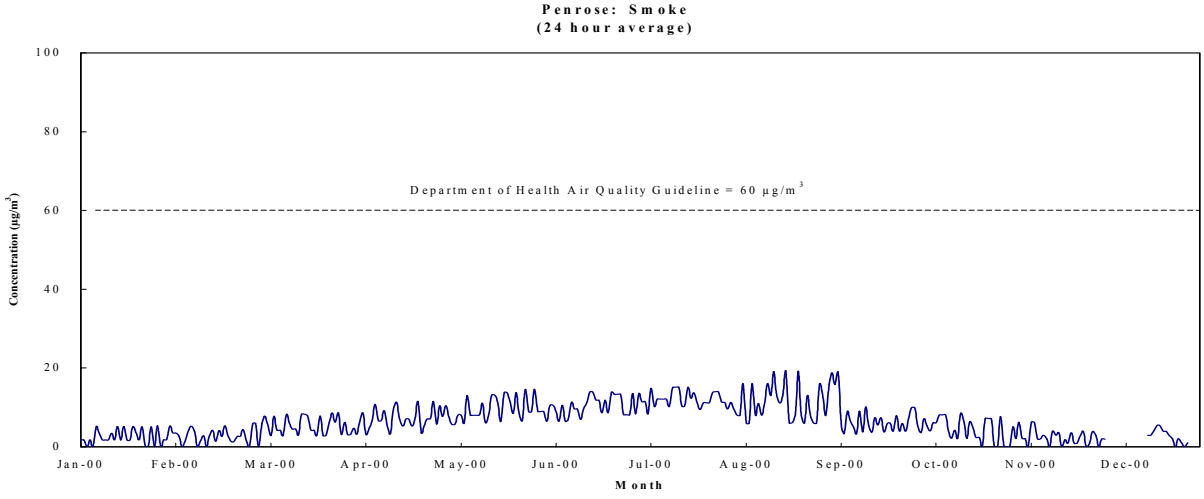

Figure 11: Smoke 24 hour average 2000 (Penrose only)

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 12. Summary statistics for lead monitoring are given in Table 7. Results are graphed against the MfE 0.5 – 1.0 µg/m^3, 3 month average. The proposed AAQG is 0.2 g/m^3, 3 month average.

The existing AAQG of 0.5 µg/m^3 3 month average, and the proposed AAQG of 0.2 µg/m^3 3 month average, was not breached at any site on any occasion. Monthly and 3-montlhy concentrations were very similar at all sites, 0.01 –0.07 µg/m^3. No annual trend is apparent since 1996, with concentrations being uniformly low.

Table 7: Statistics for Lead Monitoring in 2000

6.4.1.1.1 Statistics for Lead Monitoring

Site	No. of Exceeedences (>1 µg/m^3)	Valid data (%)	Maximum monthly average (µg/m^3)
Mt Eden	0	100	0.04
Penrose	0	100	0.03
St Albans	0	100	0.07

Note: Contract requirements have changed and lead analysis is now only required on winter samples as a 3-monthly average. The above statistics are based on January to September 2000 data only.

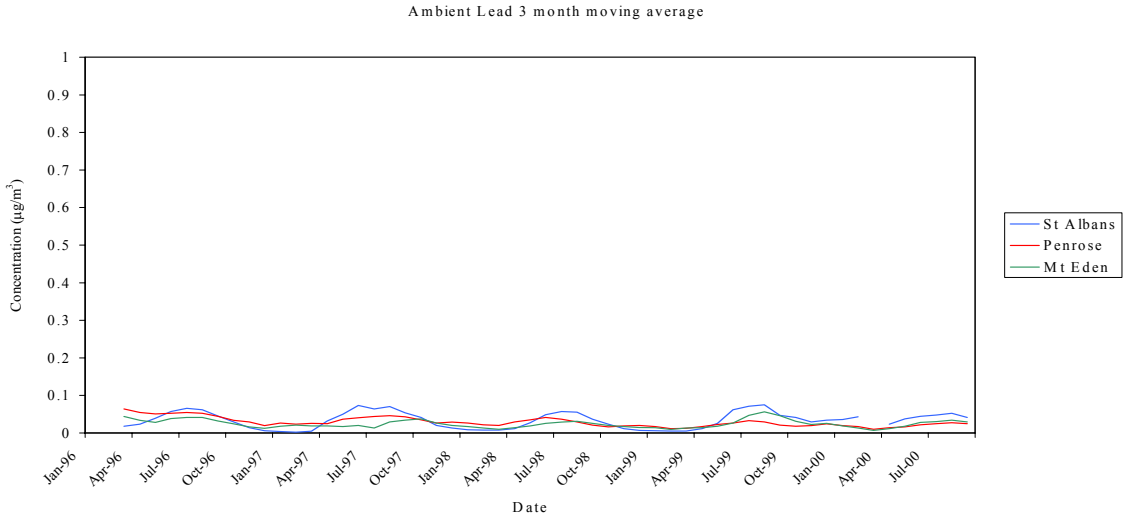

Figure 12: Lead 3-month moving average 1996 – 2000 (all sites)

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, on the basis that 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 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 $\mu g/m^3$.

Sulphur dioxide results are recorded as 24-hour averages at Penrose and output from the continuous monitor at St Albans is recorded as 10-minute averages. The analytical method used at Penrose has a minimum averaging period of 24 hours, and therefore only 24 hour and annual results are available for this site. However, a continuous monitor has been installed at Penrose in 2001, and in future 1 hour averages can be reported for this site.

The results for SO_2 monitoring in 2000 are presented in Figure 13 (St Albans 1 hour), Figure 14 (St Albans and Penrose 24 hour) and Figure 15 (St Albans and Penrose, annual average since records began). Summary statistics are presented in Table 8.

Table 8: Statistics for Sulphur Dioxide Monitoring in 2000

Statistics for Sulphur Dioxide Monitoring								
	1 hour average data				24 hour average data			
Site	99.9 percentile ($\mu g/m^3$)	No. of Exceeedence (>350 $\mu g/m^3$)	Valid data (%)	Maximum 1 hour average ($\mu g/m^3$)	99.5 percentile ($\mu g/m^3$)	No. of Exceeedence (>125 $\mu g/m^3$)	Valid data (%)	Maximum 24 hour average ($\mu g/m^3$)
Penrose	-	-	-	-	28	0	95	30
St Albans	41	0	94	56	22	0	96	28

Guidelines were not exceeded at either St Albans or Penrose on any occasion. The maximum 24 hour concentrations were 28 and 30 $\mu g/m^3$, respectively. This represents good air quality, according to EPI.

At St Albans, concentrations were higher in the May – June period (10 – 20 $\mu g/m^3$, 24 hour average), and were generally less than 10 $\mu g/m^3$ throughout the rest of the year. As the May-June period does not cover the whole winter season, this is cannot be considered as a seasonal effect, especially when considering SO_2 concentrations in July were much lower (5 – 8 $\mu g/m^3$, 24 hour average). However, as noted earlier, July temperatures were very mild, which may have caused a reduction in SO_2 in this month.

Penrose had generally higher concentrations than St Albans throughout the year, exceeding 10 $\mu g/m^3$ for most of the year and approaching 30 $\mu g/m^3$ on several occasions, but concentrations are still low relative to guidelines. At Penrose, there is some evidence of a seasonal trend, with concentrations being low in summer (October – March) and higher in winter.

Annual averages at St Albans are also lower than Penrose, being consistently less than 8 µ g/m^3. Penrose exhibited increased annual concentrations in 1997, 1998 and 1999, peaking at 16 µg/m^3 in 1999. In 2000, concentrations at Penrose fell to 10 µg/m^3, and at St Albans to 4 µg/m^3, and it will be interesting to observe if this continues. It is noted that despite the increase at Penrose between 1997 and 1999, annual concentrations are still less than 33% of the AAQG, and air quality is good.

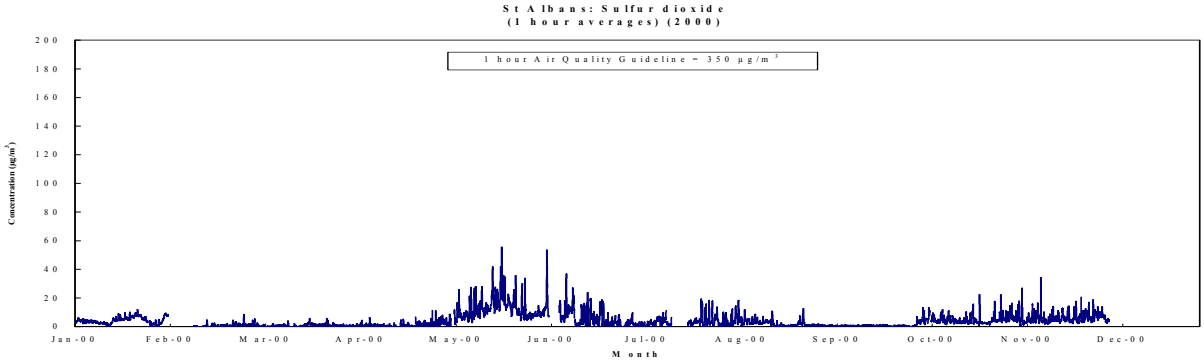

Figure 13: SO_2 1 hour average 2000 at St Albans

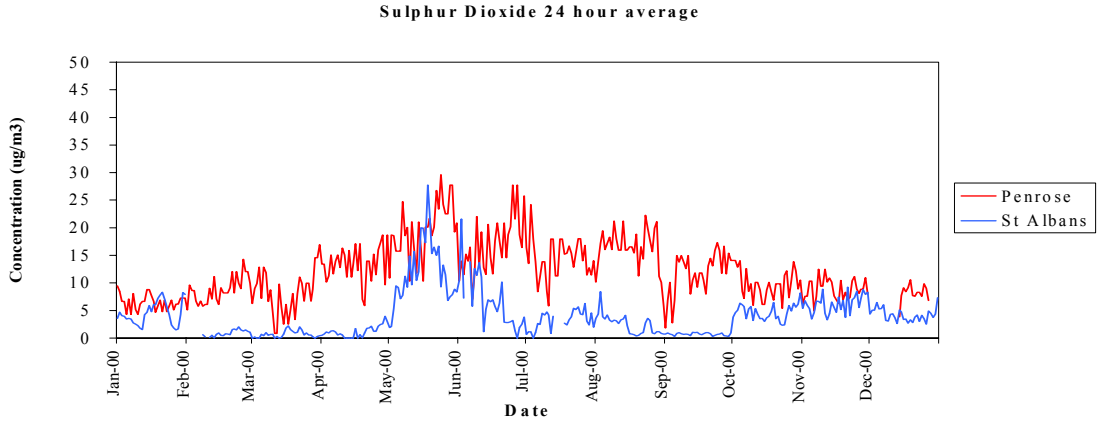

Figure 14: SO_2 24 hour average 2000 (all sites)

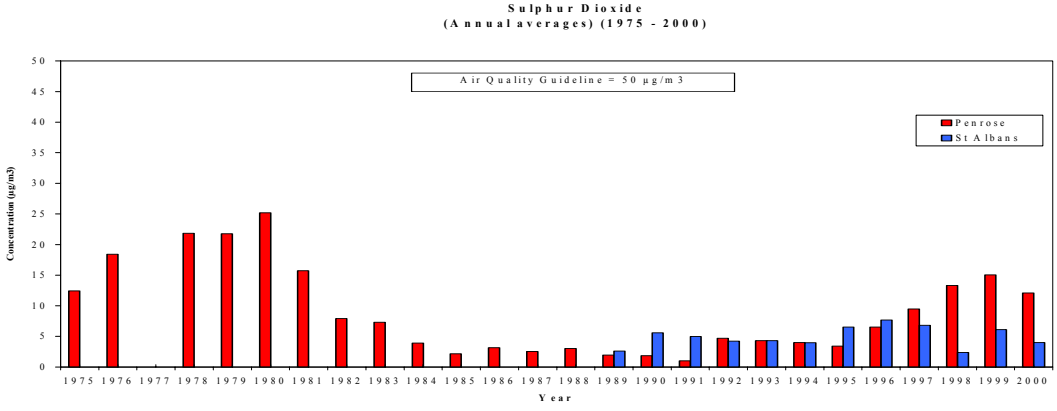

Figure 15: SO_2 annual average, since record commencement (all sites)

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 9. The 1 hour averages for 2000 are given in Figure 16, and the 1 hour concentrations for the period 1996 – 2000 are presented in Appendix E.

The MfE AAQG for CO, 1 hour average, was not exceeded at any time in the year 2000. The maximum value of 20 mg/m^3 puts air quality in the alert category, according to EPI.

Ambient CO concentrations showed a seasonal trend, increasing between late April and late October. This trend is also apparent in earlier years.

The 8 hour AAQG of 10 mg/m^3 was breached for 16 hours in 2000, with the maximum concentration being 16 mg/m^3. This result is similar to other years. In 2000, the number of breaches and frequency were similar to 1996 and 1998, and lower than 1997 and 1999. No trend between years is evident.

Table 9: Statistics for Carbon Monoxide Monitoring in 2000

Statistics for Carbon monoxide Monitoring								
	1 hour average data				8 hour average data			
Site	99.9 percentile (mg/m^3)	No. of Exceeedence (Hours) (>30 mg/m^3)	Valid data (%)	Maximum 1 hour average (mg/m^3)	99.9 percentile (mg/m^3)	No. of Exceeedence (Hours) (>10 mg/m^3)	Valid data (%)	Maximum 8 hour average (mg/m^3)
St Albans	14	0	96	20	11	16*	95	16

* THESE OCCURRED ON 6 DAYS (18/5/00, 19/5/00, 9/6/00, 20/6/00, 6/8/00 AND 25/8/00).

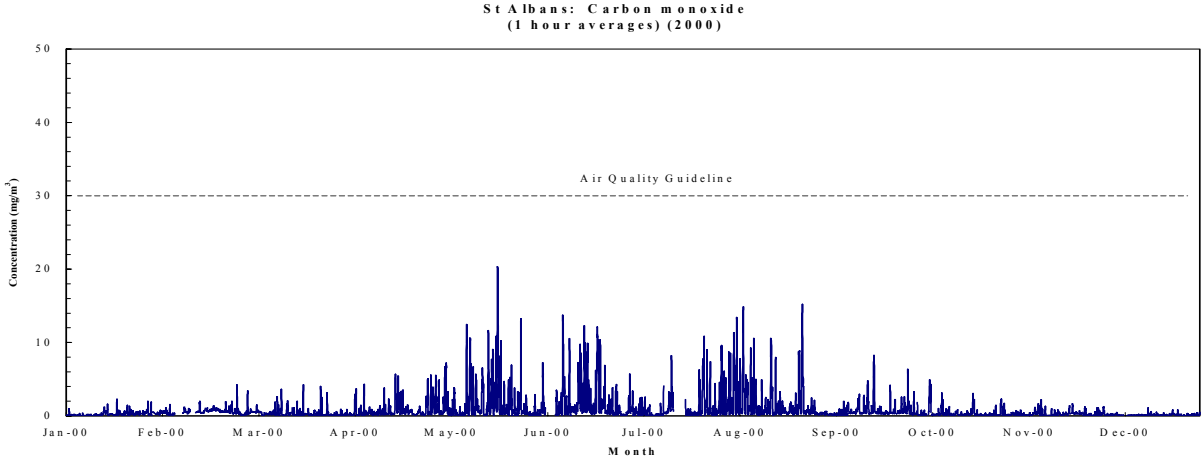

Figure 16: CO 1 hour average 2000 (St Albans)

Summary statistics for 8 hour averaging periods are presented in Table 9. The 8 hour averages for 2000 are given in Figure 17, and the 8 hour concentrations for the period 1996 – 2000 are presented in Appendix E.

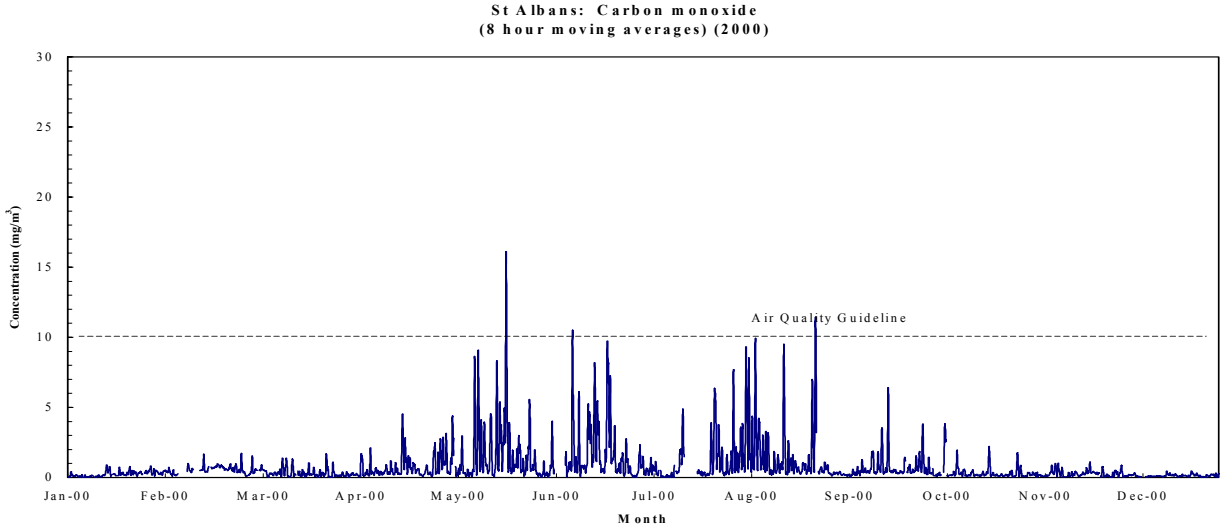

Figure 17: CO 8 hour average 2000 (St Albans)

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 this data.

Summary statistics for NO_2 for all sites, 1 hour and 24 hour averaging period, are given in Table 10. The maximum monthly NO_2 concentrations, 1 hour average, are presented in Figure 18. All nitrogen dioxide concentrations, 1 hour average, since 1996 are presented by site in Appendix F.

In 2000, there was one extremely high NO_2 concentration of 170 $\mu g/m^3$ (1 hour average) at Penrose, and one event of 110 $\mu g/m^3$ at St Albans. These results are unusual, and coul represent statistical outliers. Therefore, both maximum and 99.5 %ile values have been presented. All results are shown in the relevant graphs in Appendix F.

Table 10: Statistics for Nitrogen Oxide Monitoring in 2000

Statistics for Nitrogen Dioxide Monitoring								
	1 hour average data				24 hour average data			
Site	99.9 percentile ($\mu g/m^3$)	No. of Exceedence (>300 $\mu g/m^3$)	Valid data (%)	Maximum 1 hour average ($\mu g/m^3$)	99.5 percentile ($\mu g/m^3$)	No. of Exceedence (>100 $\mu g/m^3$)	Valid data (%)	Maximum 24 hour average ($\mu g/m^3$)
Mt Eden	60	0	97	77	40	0	99	42
Penrose	86	0	89	170	53	0	90	57
St Albans	62	0	81	108	33	0	82	38

The 99.9 %ile for Mt Eden is 60 $\mu g/m^3$, 1 hour average. This is 20% of the current AAQG (300 $\mu g/m^3$) and 30% of the proposed AAQG (200 $\mu g/m^3$). Air quality in Mt Eden is therefore within the range of good to excellent for NO_2, according to Ministry for the Environment's EPI's.

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 1996, 1997 and 1998 were in the order of 80 – 100 $\mu g/m^3$. In 1999 and 2000, these 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 magnitude of the change and the relatively short time frame, the observed variability could be caused by variations in weather patterns.

The 99.9 %ile for Penrose is 86 $\mu g/m^3$, 1 hour average. The seasonal pattern shows higher concentrations in winter. Concentrations were generally less than 40 $\mu g/m^3$ from January to April, then increased to 50 – 60 $\mu g/m^3$ in May – October, before decreasing again in December. Historically, NO_2 concentrations are lower in the first 2 – 3 months of the year.

The 99 %ile for St Albans is 62 $\mu g/m^3$, 1 hour average. Concentrations were generally less than 60 $\mu g/m^3$. Overall concentrations for 2000 are similar to 1998 and 1999, and are slightly lower than 1996 and 1997. A slight seasonal trend is evident in 2000 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. 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.

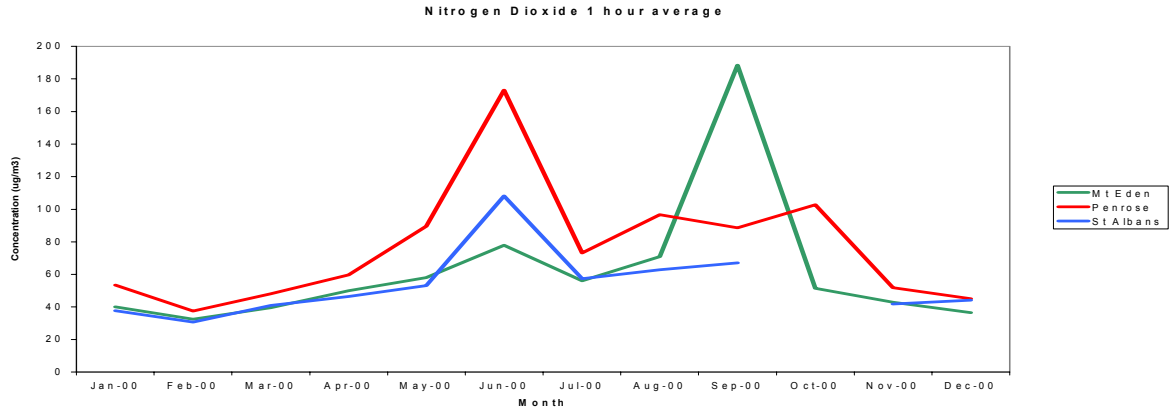

Figure 18: NO_2 maximum monthly 1 hour average 2000 (all sites)

The results for NO_2, 24 hour average, are summarised in Figure 19 (NO_2 24 hour average, all results) and Figure 20 (NO_2 24 hour average, maximum monthly values). Full results for all sites are presented in Appendix F.

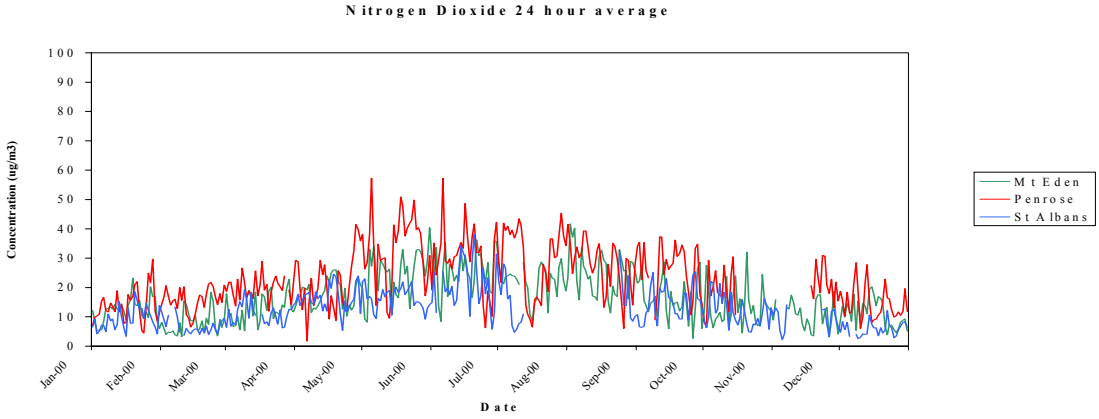

Figure 19: NO_2 monthly 24 hour average 2000 (all sites)

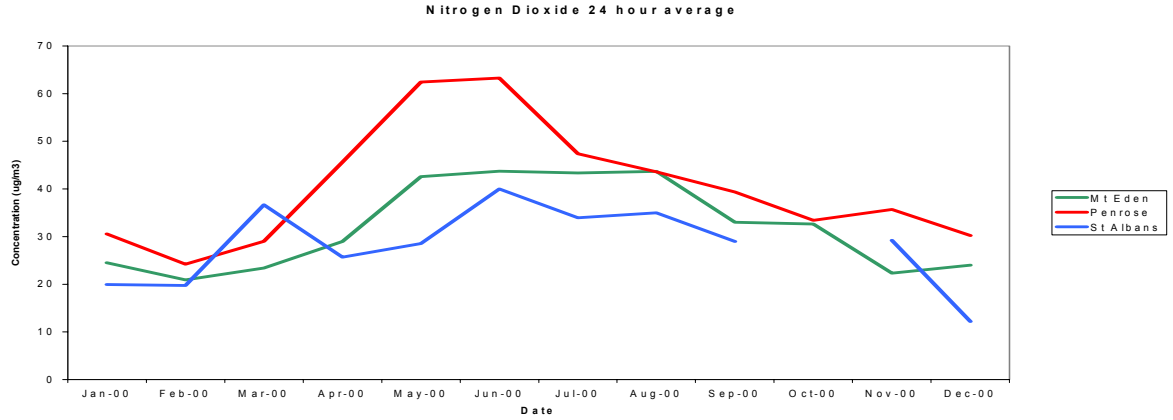

Figure 20: NO_2 maximum monthly 24 hour average 2000 (all sites)

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 21 (Mt Eden), Figure 22 (Penrose) and Figure 23 (St Albans), and 24 hour averages are presented in Figure 24 (Mt Eden), Figure 25 (Penrose) and Figure 26 (St Albans).

At Mt Eden, NO_2 formed a significant percentage of total NO_x over most of the year. This contrasts to Penrose, where NO_2 was a smaller fraction (>25%) of total NO_x throughout the year, and to St Albans, where NO_2 was a small percentage of NO_x from May to August, but a large percentage at other times of the year.

It is possible that the Penrose site, being close to a major road, is dominated by traffic emissions, which have a higher percentage of NO than NO_2. Other sites are further from major roads, and the NO from vehicle engines would have had an opportunity to undergo oxidation in the atmosphere to NO_2.

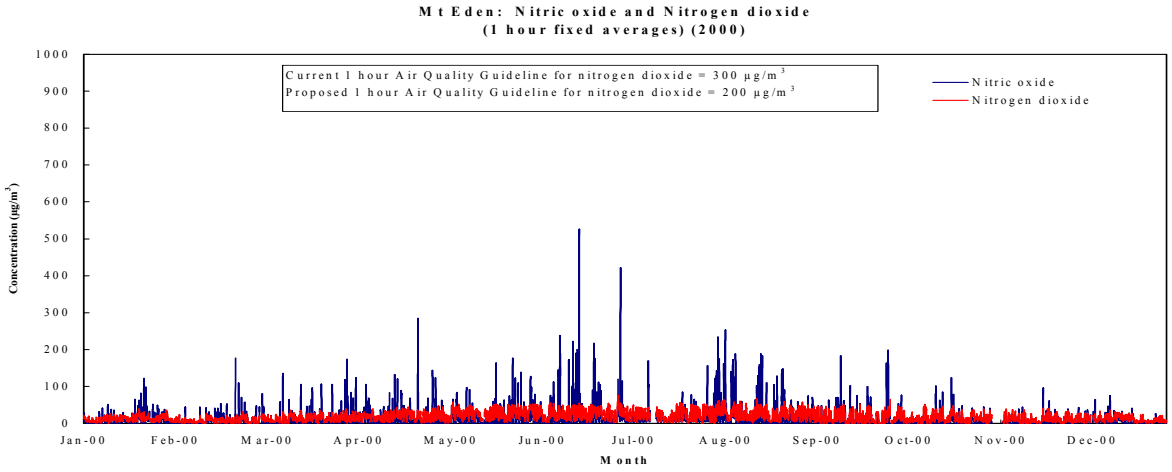

Figure 21: NO / NO_2 1 hour average 2000 at Mt Eden

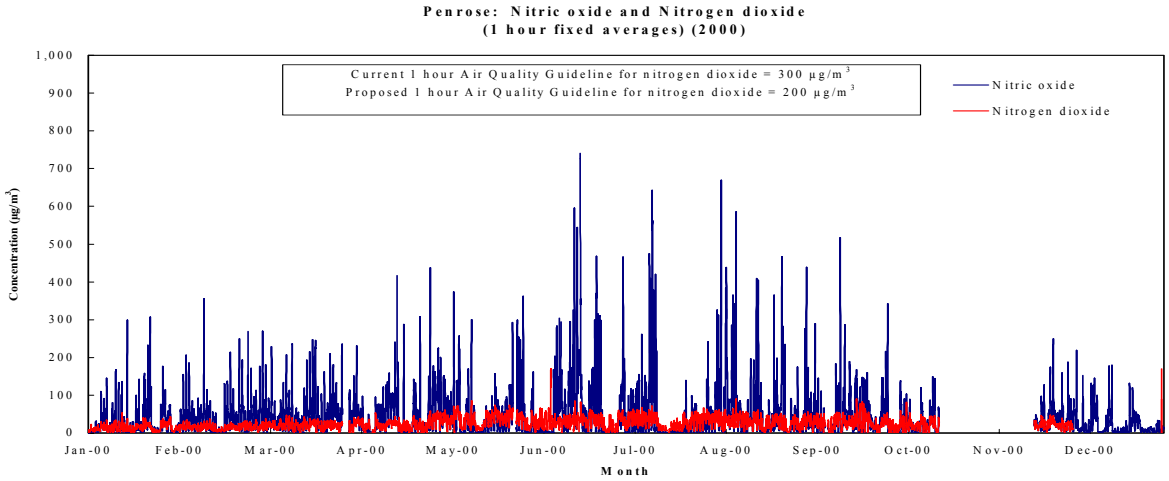

Figure 22: NO / NO_2 1 hour average 2000 at Penrose

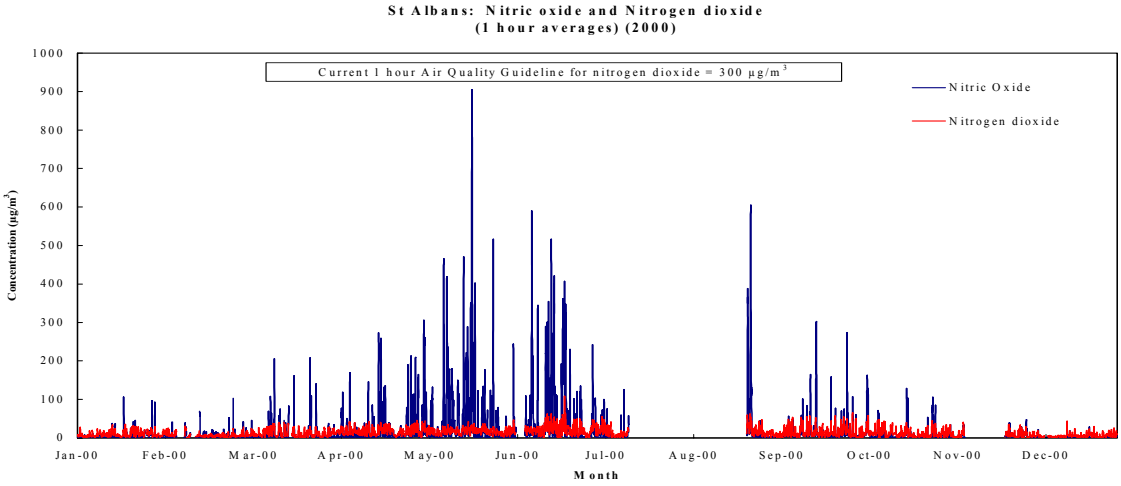

Figure 23: NO / NO_2 1 hour average 2000 at St Albans

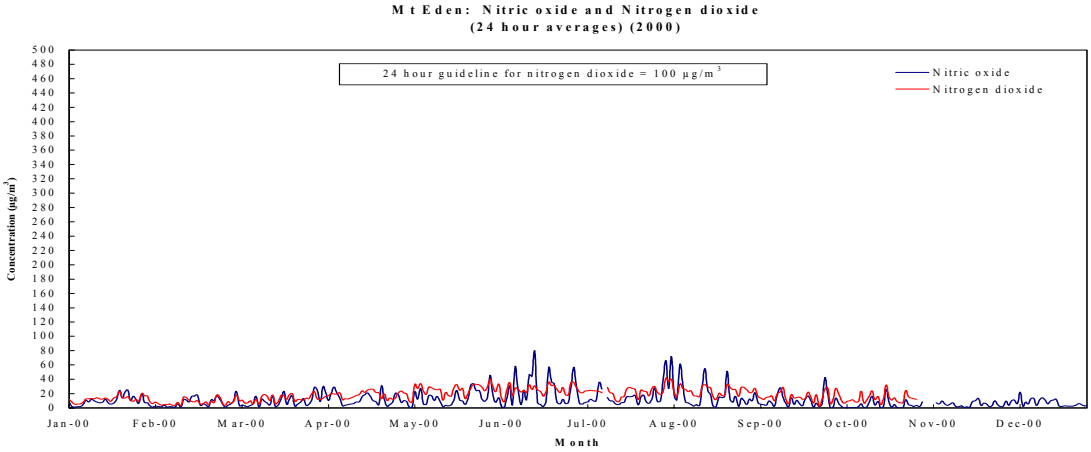

Figure 24: NO / NO_2 24 hour average 2000 at Mt Eden

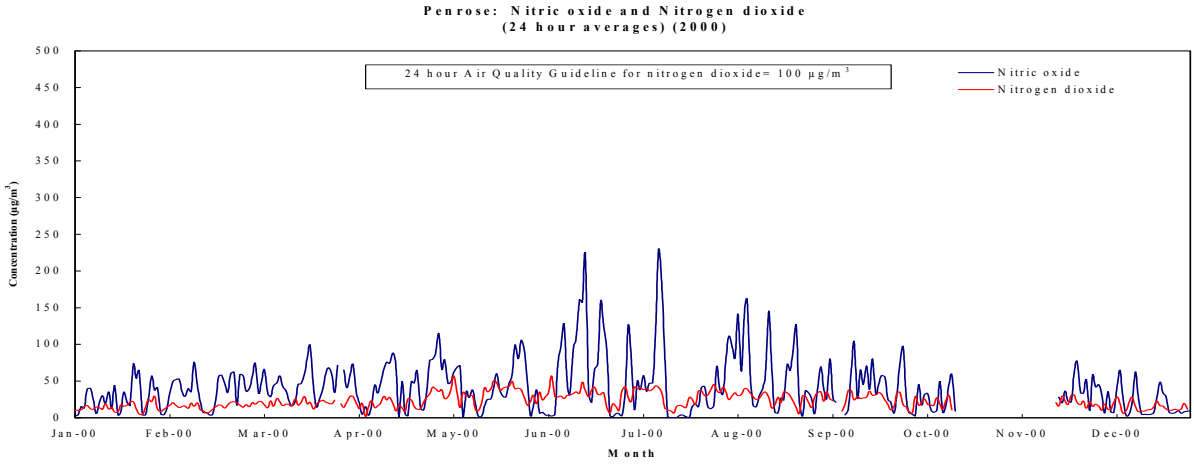

Figure 25: NO / NO_2 24 hour average 2000 at Penrose

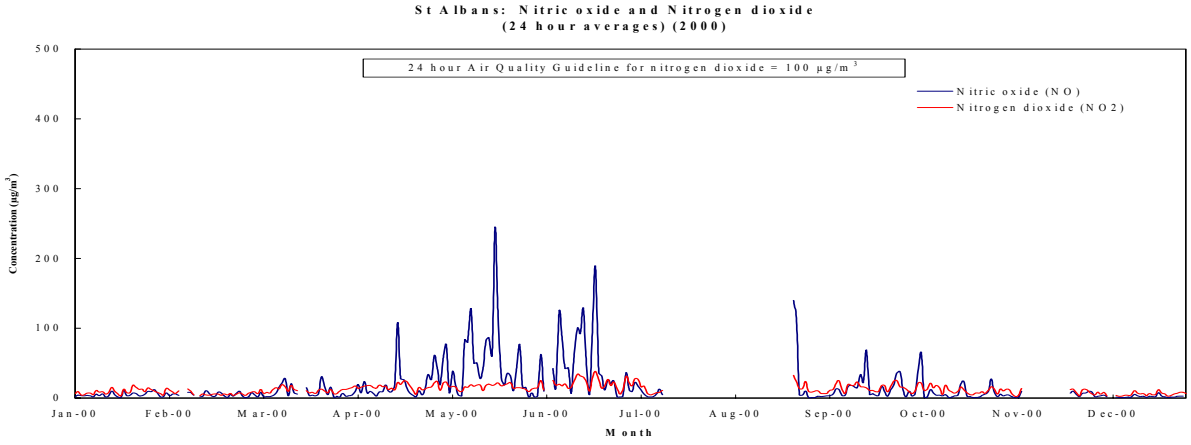

Figure 26: NO / NO_2 24 hour average 2000 at St Albans

8 REFERENCES

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New Zealand Ministry for the Environment (1997). Environmental Performance Indicators: Proposals for air, fresh water and land. MfE, Wellington, New Zealand.

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