Report to
Ministry for the Environment

GEMS Air Monitoring Programme (1999 Annual Report)(Amended)

March 2000

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S/5224/04

GEMS AIR MONITORING PROGRAMME
Annual Report (Amended)

A report for the
Ministry for the Environment

March 2000

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Contents

Table of Figures and Tables

GEMS AIR MONITORING PROGRAMME

This report presents the 1999 data for air pollution monitoring in Auckland and Christchurch. The work is carried out by staff of the ESR and data from these sites are reported to the World Health Organisation as part of its Global Environmental Monitoring Systems (GEMS) programme.

Pollutants Monitored

The following pollutants are currently included in this programme:

Particulate Matter: the term particulate matter refers to any airborne material in the form of particles, and encompasses those pollutants that we might commonly refer to as dust, smoke, aerosols or haze. The primary effects of particulate matter are aesthetic ones, such as the development of a hazy appearance in the air, or the soiling of clean surfaces. Airborne particles can also have an effect on people, mainly through inhalation. Long term exposures to high levels of inhalable particles can have significant effects on the performance of the lungs.

Airborne particulate matter can be measured in a number of different ways that are intended to reflect some of the different effects noted above. The methods currently included in this programme are as follows:

> Total suspended particulate (TSP) - the particulate is collected by drawing air through a filter gives 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 ESR Air Quality Test Method T101.
>
> Smoke - 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 ESR Air Quality Test Method T100 and this is based on a British Standard (BS1747, pt 2).
>
> Total Inhalable particulate (PM_{10}) - this is monitored at Packe Street continuously using a Beta Attenuation analyser and TEOM (Tapered Element Oscillating Microbalance). Prior to mid-1994 this was monitored using a Beta Attenuation Monitor that was not covered by any Australian Standard or US EPA equivalent method. The current analysers are covered by Australian Standard AS 3580.9.6 and US EPA 'equivalent' method. The Beta Attenuation analyser has been in operation since 23 May 1996. The Beta Attenuation analyser is operated for the Ministry and the TEOM for Canterbury Regional Council

Sulfur dioxide: this is an acidic gas with a pungent odour, which is mainly produced by the burning of 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. The current monitoring method at Penrose, Auckland, uses bubbler collection followed by chemical analysis is ESR Air Quality Test

Method T100 (based on BS1747, pt 3). Sulfur dioxide is monitored continuously at Packe Street using a fluorescence analyser according to ESR Air Quality Test Method T202 (ref AS3580.4.1-1990).

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.

Carbon monoxide is monitored continuously using a non-dispersive infra-red analyser according to ESR Air Quality Test Method T200 (ref AS2695-1984).

Oxides of nitrogen (NO_x): this term is used to describe a mixture of two gases, nitric oxide (NO) and nitrogen dioxide (NO_2). These are formed in most combustion processes by oxidation of the nitrogen present in combustion air. Nitric oxide is the 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_x is monitored continuously using a chemiluminescence analyser according to ESR Air Quality Test Method T201 (ref AS3580.5.1-1993).

Lead: the only major source of lead in air in New Zealand was, until recently, leaded petrol, with the lead being emitted as finely divided particulate matter in vehicle exhausts. 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. The amount of lead in air has dropped quite markedly since the reduction of lead in petrol in 1986/87 and again in 1996 with the introduction of unleaded 96 octane petrol. Lead is measured by chemical analysis of the samples collected in the monitoring of suspended particulate according to ESR Air Quality Test Method T102.

Air Quality Guidelines

Results from this work can be compared with various air quality guidelines or standards. The most relevant guidelines are those published by the Ministry for the Environment in 1994, as part of its responsibilities under the Resource Management Act. These criteria were set on the basis of human health effects, and are listed in the attached Table 1. The Ministry for the Environment's Air Quality Guidelines are currently under review.

Because of differences in methodology, the criteria are not relevant for some of the measurements currently being taken, and in these cases the criteria are those applied previously by the Department of Health. These have been superseded by the Ministry for the Environment, 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) 60 $\mu g/m^3$.

Table 1: Ministry for the Environment Air Quality Guidelines

Pollutant	Concentration	Time Period
inhalable particulate (PM_{10})	40 $\mu g/m^3$ 120$\mu g/m^3$	annual average 24 hr average
sulfur dioxide	50 $\mu g/m^3$ 125 $\mu g/m^3$ 350 $\mu g/m^3$	annual mean 24 hr average 1 hr average
carbon monoxide	10 mg/m^3 30 mg/m^3	8 hr average 1 hr average
nitrogen dioxide	100 $\mu g/m^3$ 300 $\mu g/m^3$	24 hr average 1 hr average
lead	0.5 - 1.0 $\mu g/m^3$	3-month average

Monitoring Sites

The sites used are as follows:

Site 4:19, Penrose, Auckland (Industrial site) (smoke, sulfur dioxide, total suspended particulate and lead) - the monitor is located at the rear of the Penrose Occupational Health Clinic in Great South Rd.

Site 4:23, Penrose, Auckland (Industrial site) (oxides of nitrogen) - the monitor is located at the electricity substation in Gavin St, approximately 50 metres east of the motorway.

Site 4:65, Kelly St, Mt Eden, Auckland (Residential site) (oxides of nitrogen, total suspended particulate and lead) - the monitor and samplers are located at the rear of the Mt Eden Science Centre site.

Site 16:67, Packe Street, Christchurch (Residential site) (carbon monoxide, sulfur dioxide, oxides of nitrogen, PM_{10}, total suspended particulate and lead) - the monitor is 30 m to the east of a busy arterial route.

Results

The monitoring results are presented as specified in the project specifications.

Suspended particulate matter - results are recorded as 7-day averages. The results for Mt Eden, Penrose and Packe St, for 1999, are shown in Figure 1, Figure 2 and Figure 3, respectively. The data for the last 5 years are shown in Figure 4, Figure 5 and Figure 6.

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 7, Figure 8 and Figure 9.

Smoke - results are recorded as 24 hour averages and the results for 1999 are shown in Figure 10 for Penrose, Auckland.

Inhalable particulate (PM_{10}) - output from the continuous monitors is recorded as 1 hour averages. This is measured at Packe Street, Christchurch. The 24-hour average for the Beta-Gauge analyser have been calculated, and the results for 1999 are shown in Figure 11, data for the last 5 years in Figure 12. The annual average data, for the earliest available data to 1999, is illustrated in Figure 13. The Canterbury Regional Council uses a different averaging period (9am to 9am) and apply a guideline of 50 $\mu g/m^3$ (24 hour average), therefore their statistics and reported exceedences are different to those reported here.

Carbon monoxide - output from the continuous monitors are recorded as 10 minute averages. Carbon monoxide is measured at Packe Street, Christchurch site. The 1 hour (fixed) have been calculated from this 10 minute data. The 8 hour moving averages have been calculated from the 1 hour averages. The 1 hour average data for 1996, 1997, 1998 and 1999 and shown in Figure 14, Figure 15, Figure 16 and Figure 17, respectively. The 8 hour moving average data 1996, 1997, 1998 and 1999 and shown in Figure 18, Figure 19, Figure 20 and Figure 21, respectively.

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

The 1 hour average data for Mt Eden, Auckland, for 1995 to 1999 is shown in Figure 22, Figure 23, Figure 24, Figure 25 and Figure 26.
The 1 hour average data for Penrose, Auckland, for 1995 to 1999 is shown in Figure 27, Figure 28, Figure 29, Figure 30 and Figure 31.
The 1 hour average data for Packe St, Christchurch, for 1996 to 1999 is shown in Figure 32, Figure 33, Figure 34 and Figure 35.

The 24 hour average data for 1999 are illustrated in Figure 36 (Mt Eden), Figure 37 (Penrose) and Figure 38 (Packe St). The 24 hour average data for 1995 to 1999 are illustrated in Figure 39 (Mt Eden), Figure 40 (Penrose) and Figure 41 (Packe St).

The nitric oxide 1 hour data for 1999 (together with the nitrogen dioxide data) are illustrated in Figure 42 (Mt Eden), Figure 43 (Penrose) and Figure 44 (Packe St). The nitric oxide 24 hour data

for 1999 (together with the nitrogen dioxide data) are illustrated in Figure 45 (Mt Eden), Figure 46 (Penrose) and Figure 47 (Packe St).

Sulfur dioxide - results are recorded as 24 hour averages at Penrose and output from the continuous monitor at Packe Street is recorded as 10 minute averages. The 24 hour results for Penrose, Auckland, for 1999 is shown in Figure 48 and the annual average data, for the earliest available data to 1999, is illustrated in Figure 51. The data for Packe St as 1 hour averages for 1999 is shown in Figure 49, as 24 hour average for 1999, Figure 50, and the annual average data, for the earliest available data to 1999, is illustrated in Figure 52.

Table 2: Statistics for 1999 Particulate Monitoring

Statistics for Particulate Monitoring						
	PM_{10} - 24 hour average data				TSP - 7 day average data	
Site	**99.5 percentile (µg/m³)**	**No. of Exceeedence (>120 µg/m³)**	**Valid data (%)**	**Maximum 24 hour average (µg/m³)**	**No. of Exceeedence (>60 µg/m³)**	**Maximum 7 day average (µg/m³)**
Mt Eden	-	-	-	-	0	33
Penrose	-	-	-	-	1	70
Packe St	188	12	77	262	10	95

Table 3: Statistics for 1999 Lead Monitoring

Statistics for Lead Monitoring			
Site	**No. of Exceeedences (>1 µg/m³)**	**Valid data (%)**	**Maximum monthly average (µg/m³)**
Mt Eden	0	100	0.07
Penrose	0	100	0.03
Packe St	0	100	0.12

Table 4: Statistics for 1999 Smoke Monitoring

Statistics for Smoke Monitoring				
	24 hour average data			
Site	99.5 percentile ($\mu g/m^3$)	No. of Exceeedence (>120 $\mu g/m^3$)	Valid data (%)	Maximum 24 hour average ($\mu g/m^3$)
Penrose	15	0	100	18

Table 5: Statistics for 1999 Carbon monoxide Monitoring

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)
Packe St	18.8	0	98	26	16.7	69*	98	21

*: These occurred on 12 days (8/5/99, 13/5/99, 23/5/99, 7/6/99, 10/6/99, 22/6/99, 29/6/99, 30/6/99, 1/7/99, 9/7/99, 10/7/99 and 15/7/99).

Table 6: Statistics for 1999 Nitrogen dioxide Monitoring

Statistics for Nitrogen dioxide Monitoring								
	1 hour average data				24 hour average data			
Site	99.9 percentile ($\mu g/m^3$)	No. of Exceeedence (>300 $\mu g/m^3$)	Valid data (%)	Maximum 1 hour average ($\mu g/m^3$)	99.5 percentile ($\mu g/m^3$)	No. of Exceeedence (>100 $\mu g/m^3$)	Valid data (%)	Maximum 24 hour average ($\mu g/m^3$)
Mt Eden	62	0	99	71	40	0	100	45
Penrose	79	0	91	117	52	0	93	59
Packe St	66	0	91	112	35	0	94	42

Table 7: Statistics for 1999 Sulfur dioxide Monitoring

Statistics for Sulfur 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	-	-	-	-	30	0	99	32
Packe St	64	0	97	90	25	0	99	37

Discussion

Overall, no significant anomalies can be seen in the data trends for the 1999 year. On a site by site basis, the following observations can be made;

Mt Eden, Auckland
The TSP levels recorded are similar to those of recent years. Nitrogen dioxide shows higher levels recorded from April to October, which tends to be similar to previous years.

Penrose, Auckland
The peak period for TSP occurred from May to July, and the levels are similar to those of recent years. The higher nitrogen dioxide levels occurred from March to October. In this case, while the levels tend to be similar to those of recent years, the overall pattern is different. This may possibly due to a shift in prevailing wind direction for the area, given that the main source (the Auckland motorway) is in one defined direction.

Packe Street, Christchurch*

Suspended particulate matter
Total Suspended Particulate levels peaked from May to September, and the overall pattern is similar to 1998. The PM_{10} winter peak occurred from June to September, with these records being slightly higher than 1998, but less than 1997.

Carbon monoxide
Carbon monoxide levels peaked during May through to the end of July. The overall pattern is different to that of previous years.

Sulfur dioxide

The winter peak for sulfur dioxide occurred from May though to September, and overall these levels were somewhat higher than those of recent years.

**It should be noted that due to the activities of the business at this site, significant heavy vehicle operations occurred in close proximity to the monitoring housing during the winter months.*

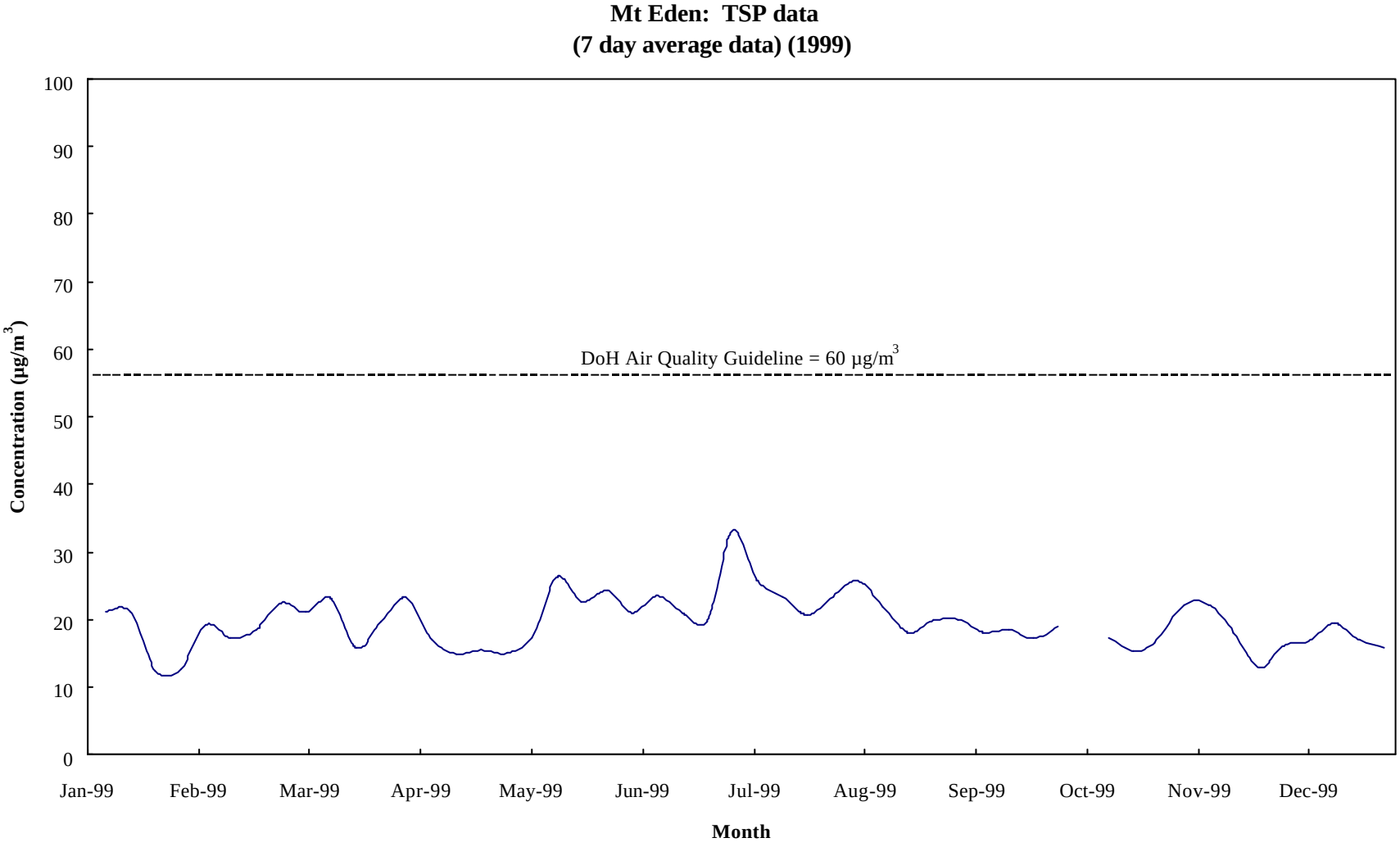


Figure 1: Mt Eden, Auckland - Suspended Particulate (TSP) Data (1999)

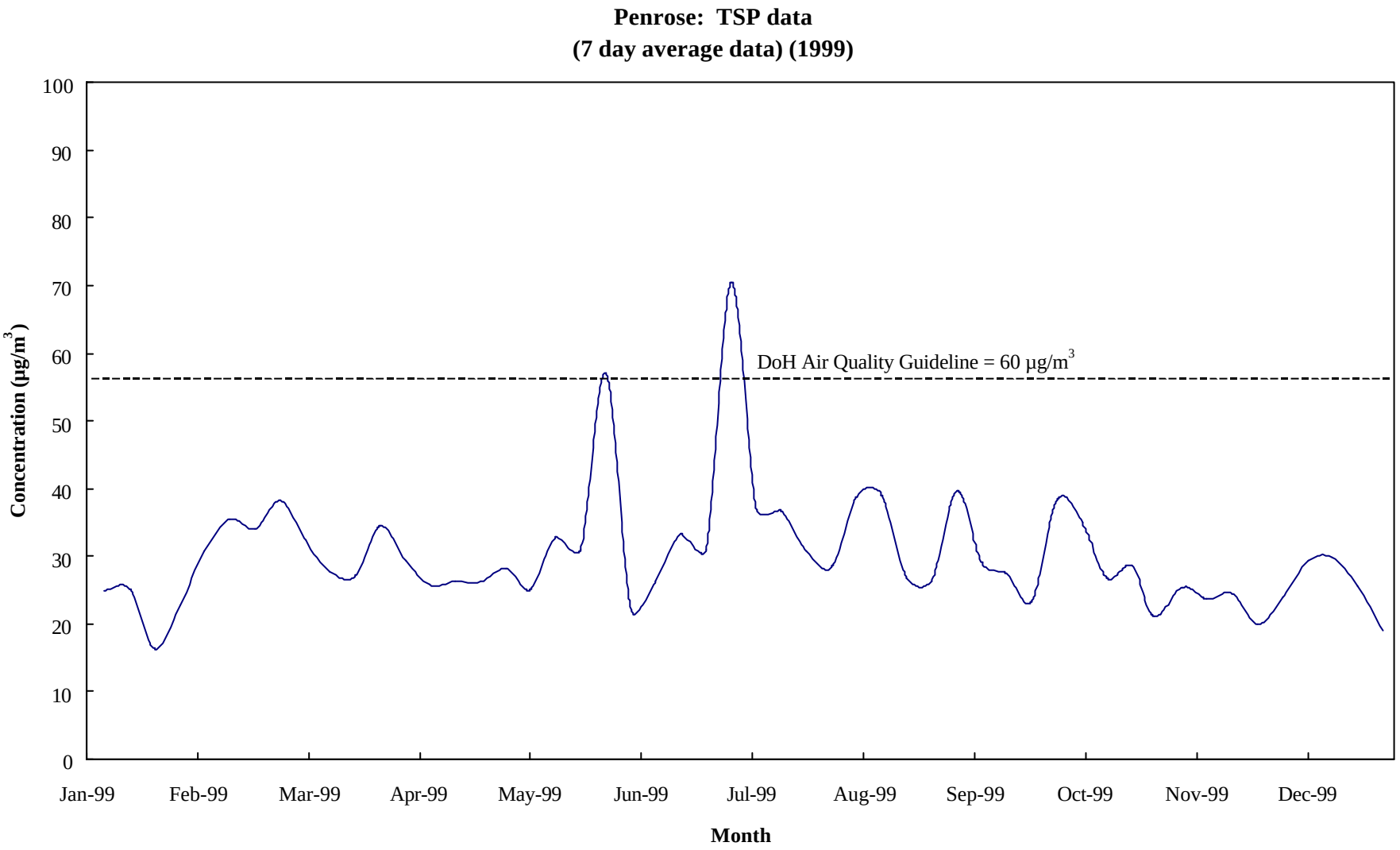


Figure 2: Penrose, Auckland - Suspended Particulate (TSP) Data (1999)

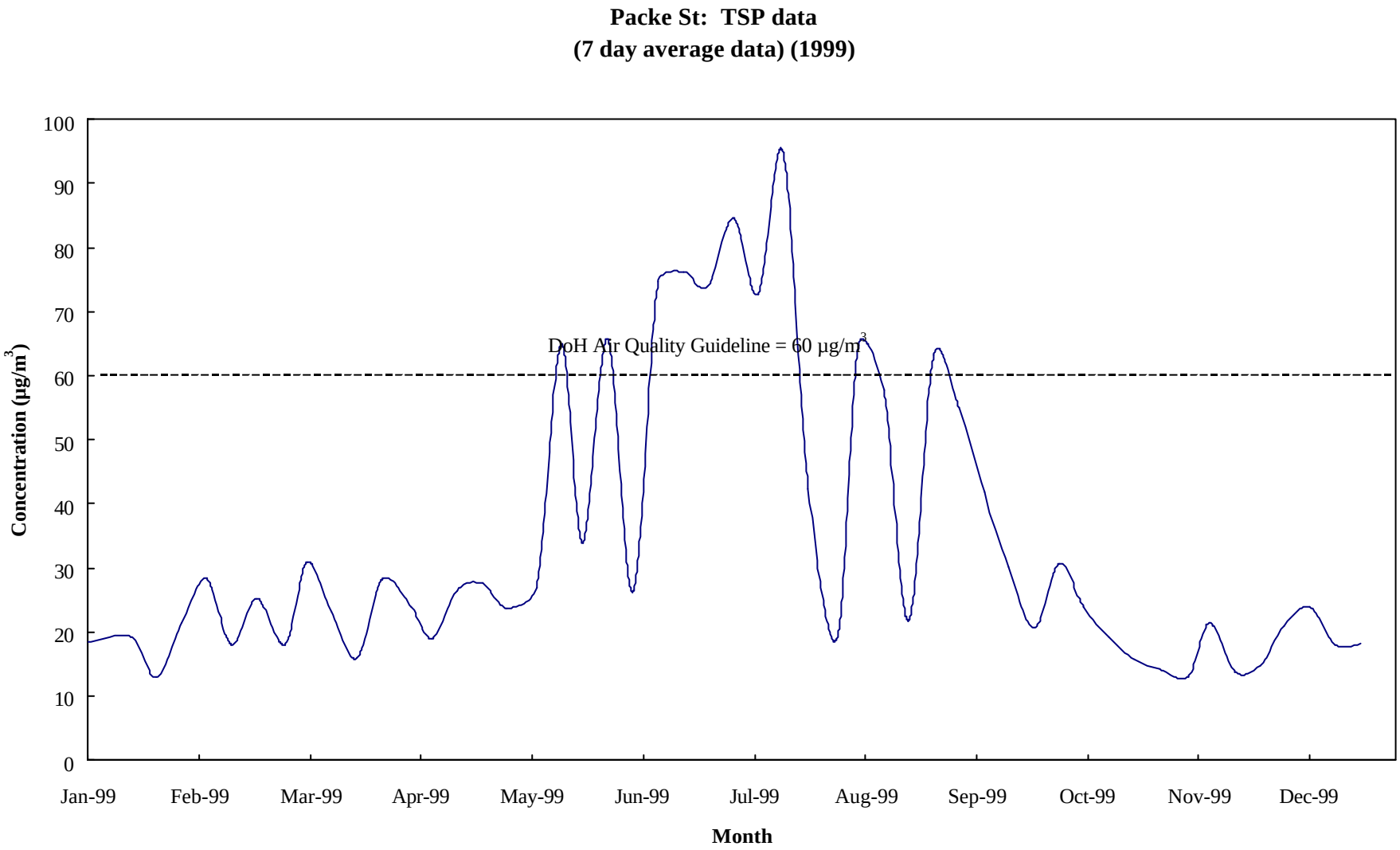


Figure 3: Packe St, Christchurch Suspended Particulate (TSP) Data (1999)

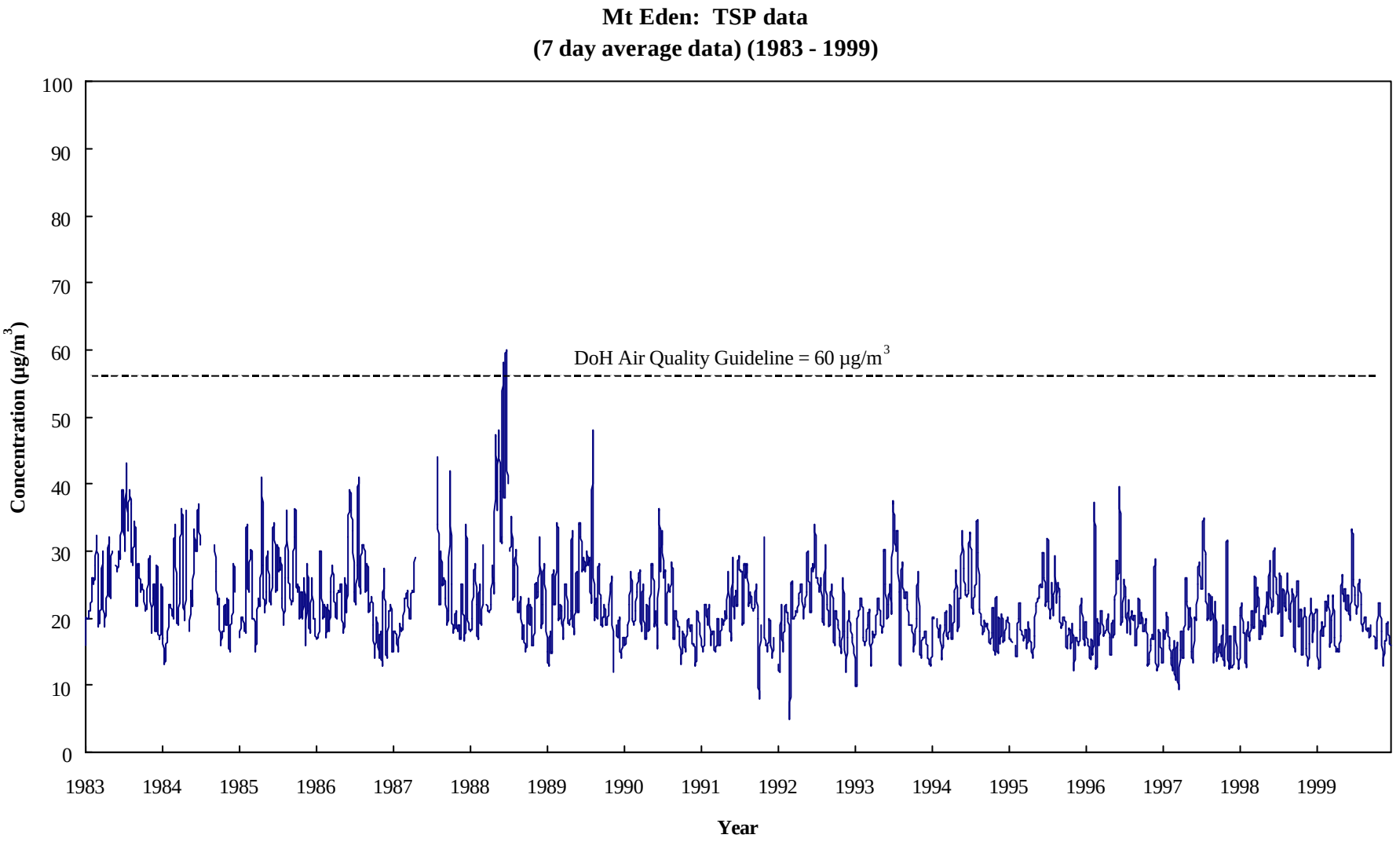


Figure 4: Mt Eden, Auckland - Suspended Particulate (TSP) Data (1983 – 1999)

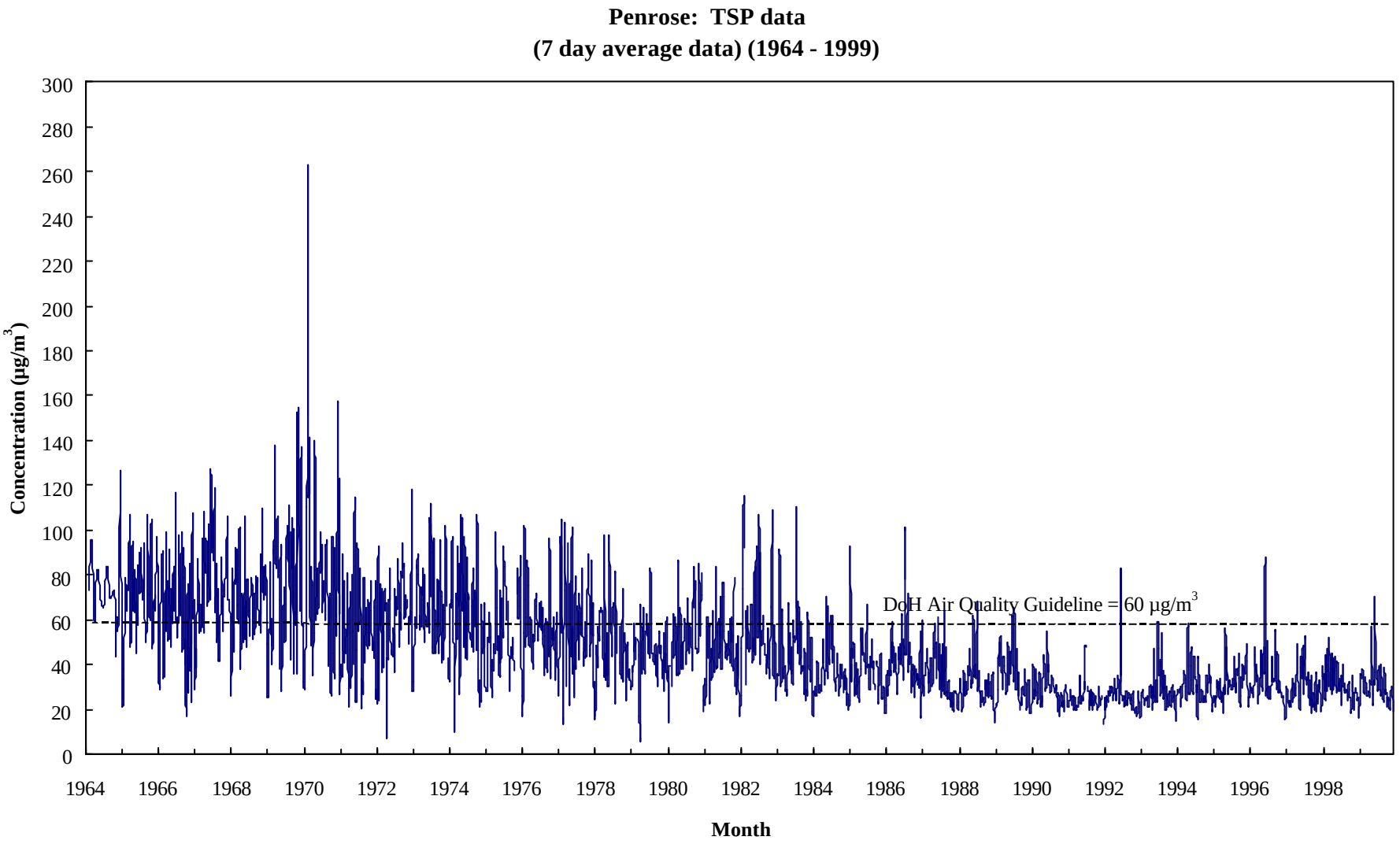


Figure 5: Penrose, Auckland - Suspended Particulate (TSP) Data (1964 – 1999)

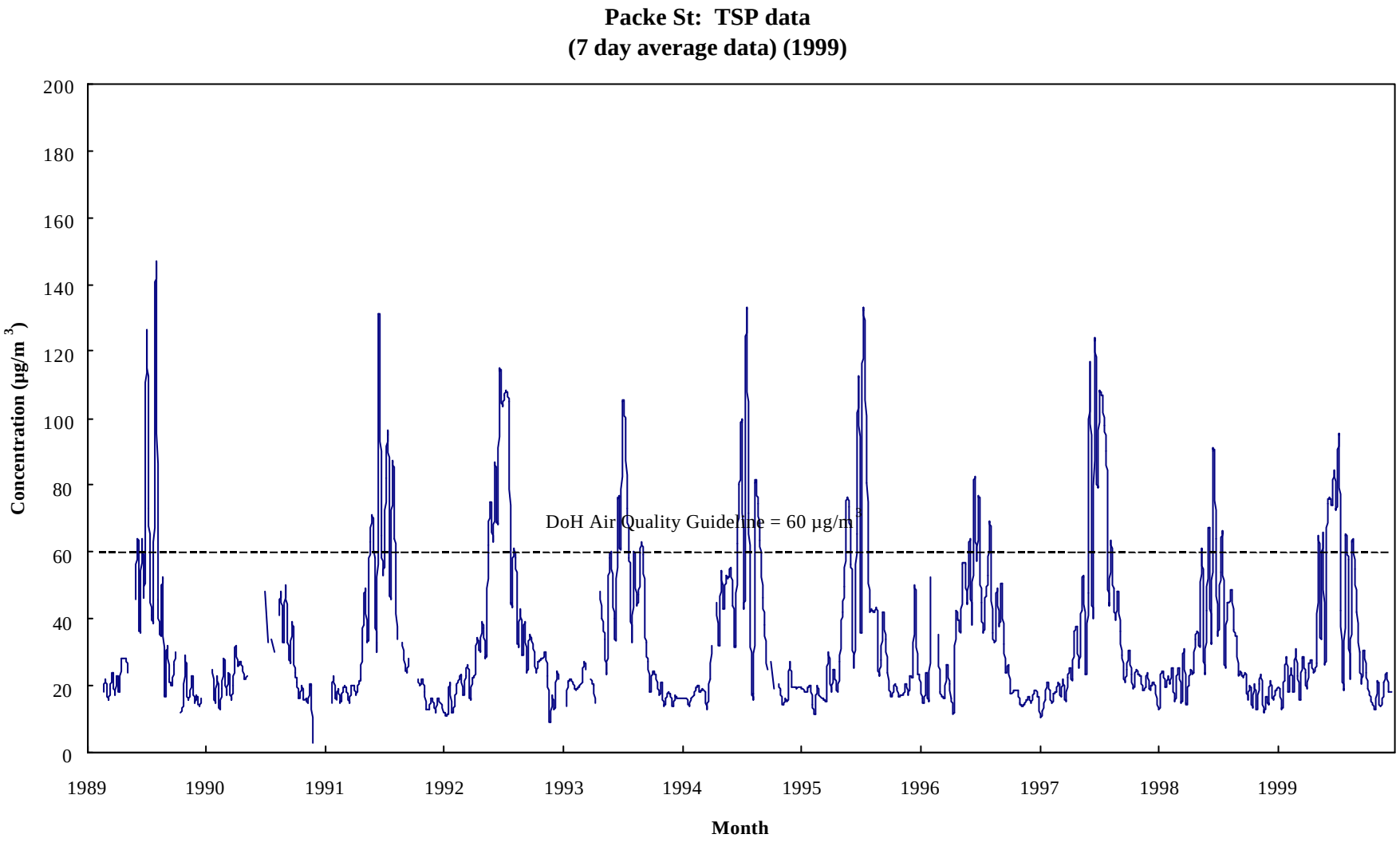


Figure 6: Packe St, Christchurch - Suspended Particulate (TSP) Data (1989 – 1999)

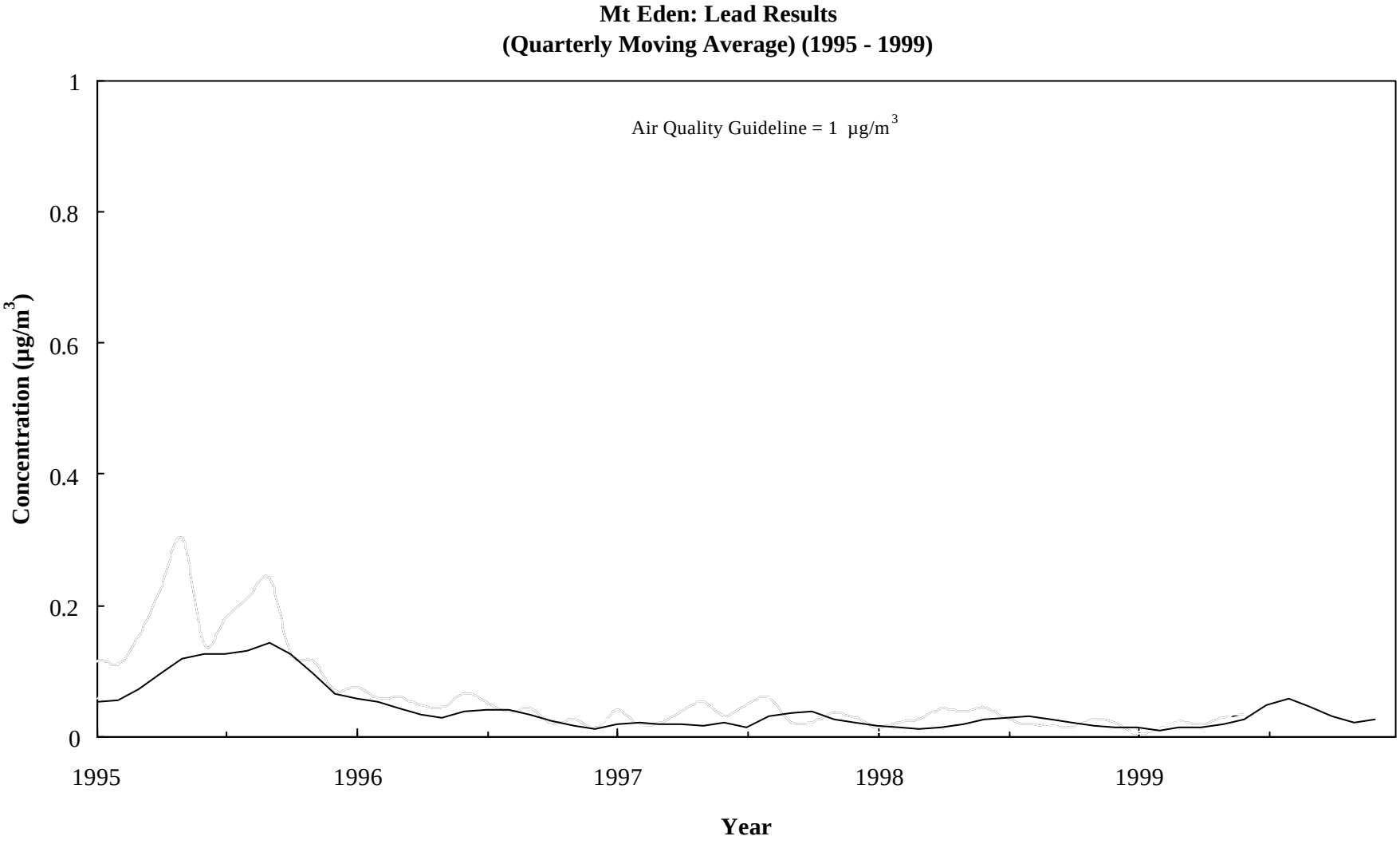


Figure 7: Mt Eden, Auckland - Lead in Air Data (1995 – 1999)

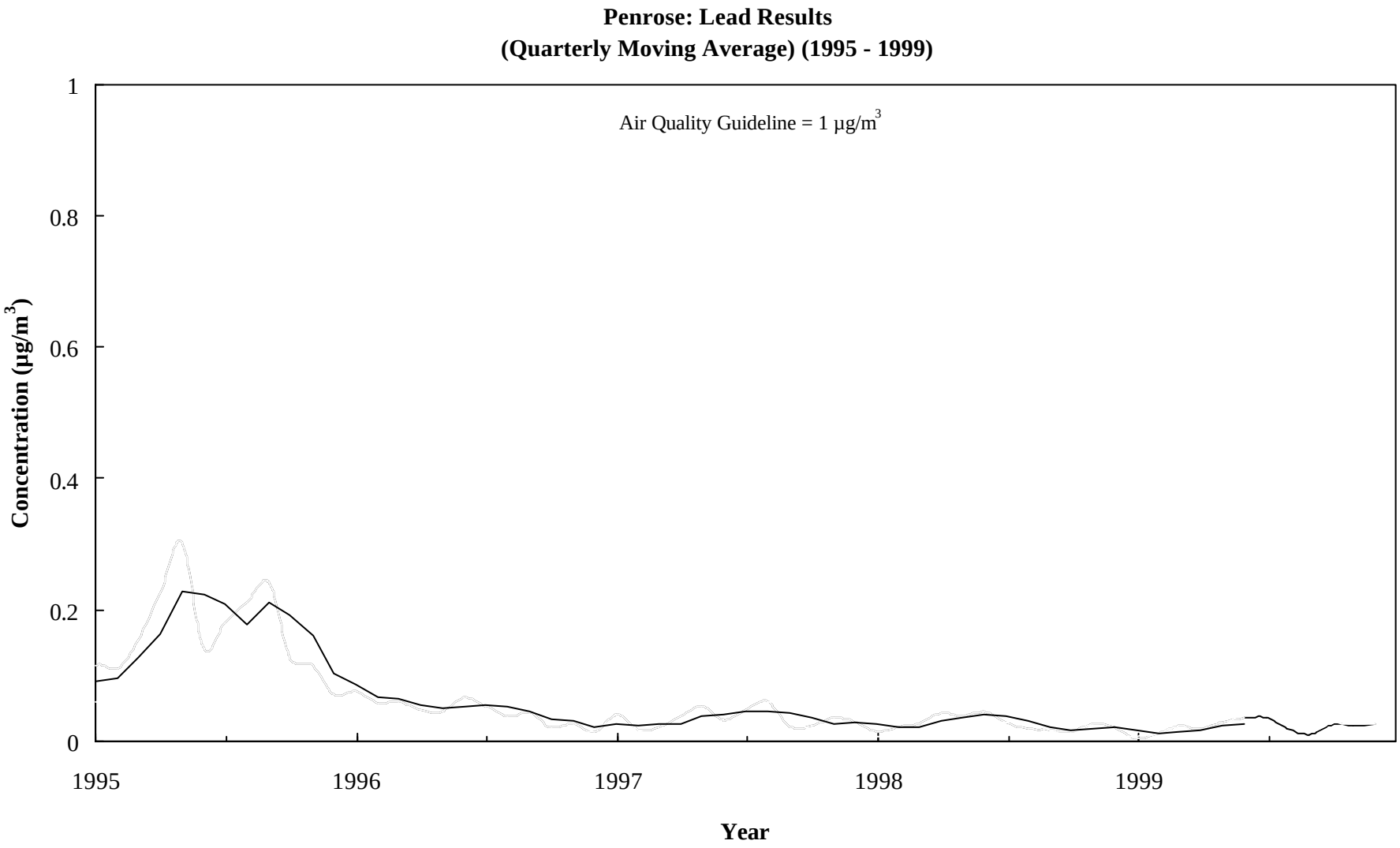


Figure 8: Penrose, Auckland - Lead in Air Data (1995 – 1999)

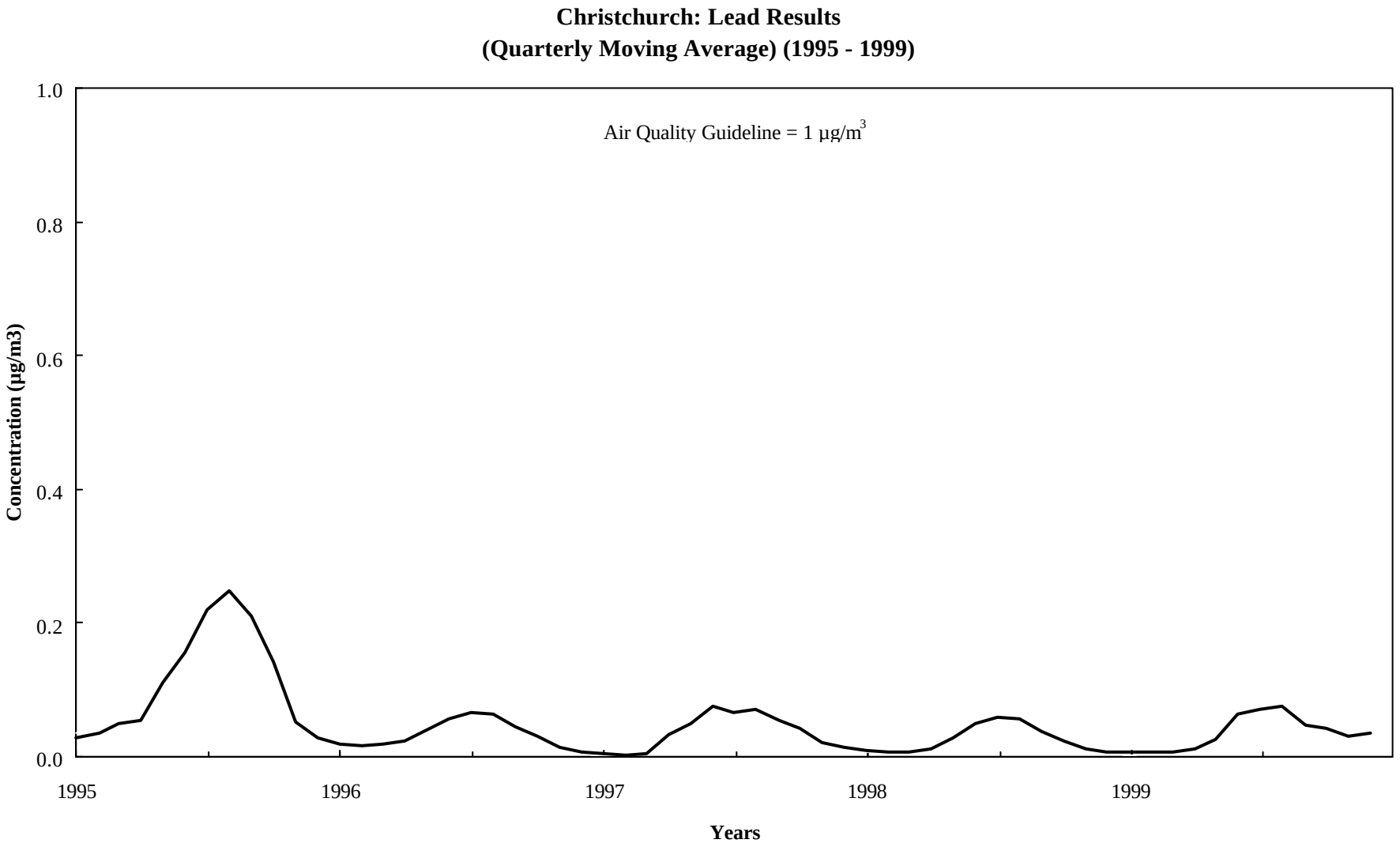


Figure 9: Packe St, Christchurch - Lead in Air Data (1995 – 1999)

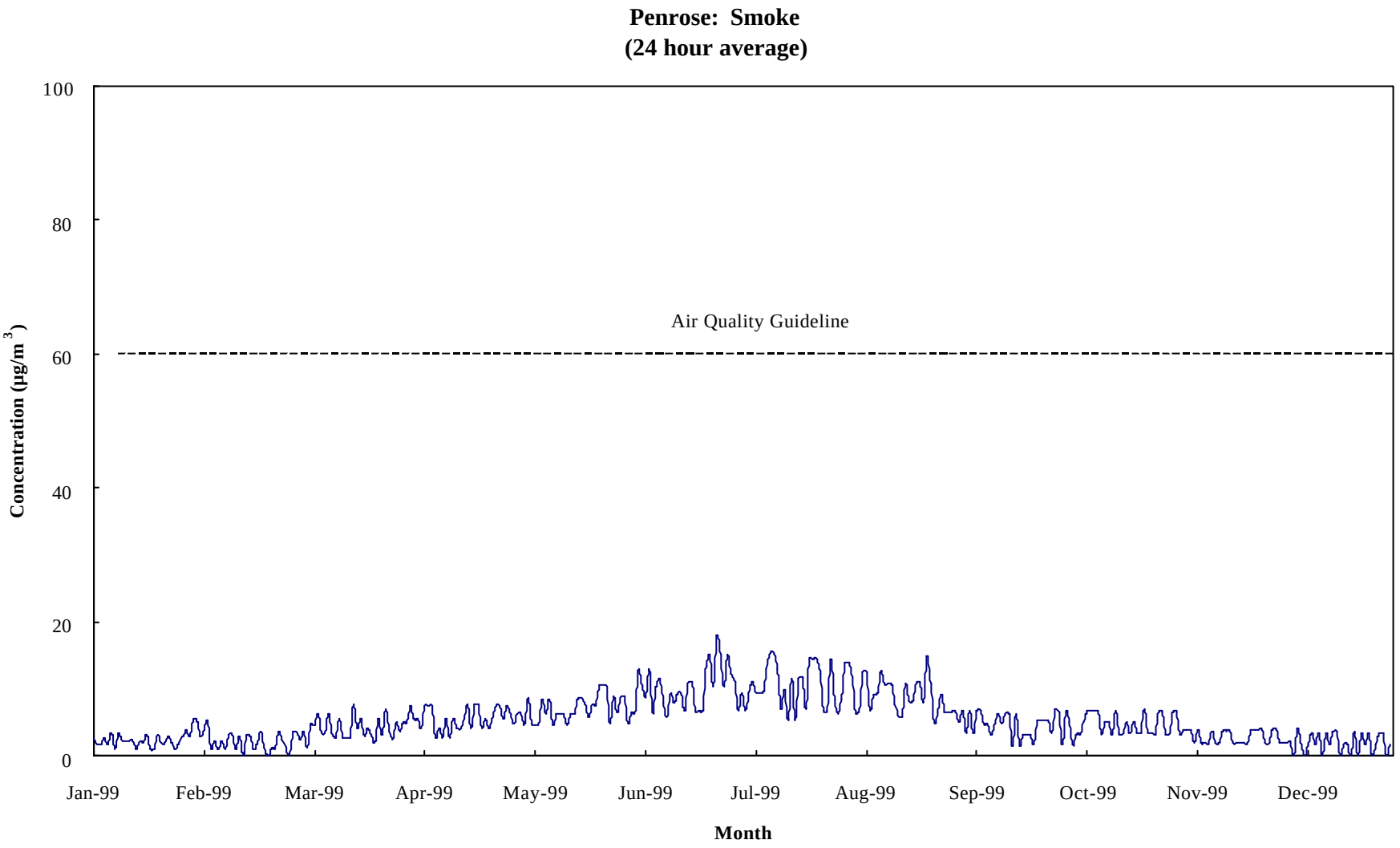


Figure 10: Penrose, Auckland - Smoke Data (1999)

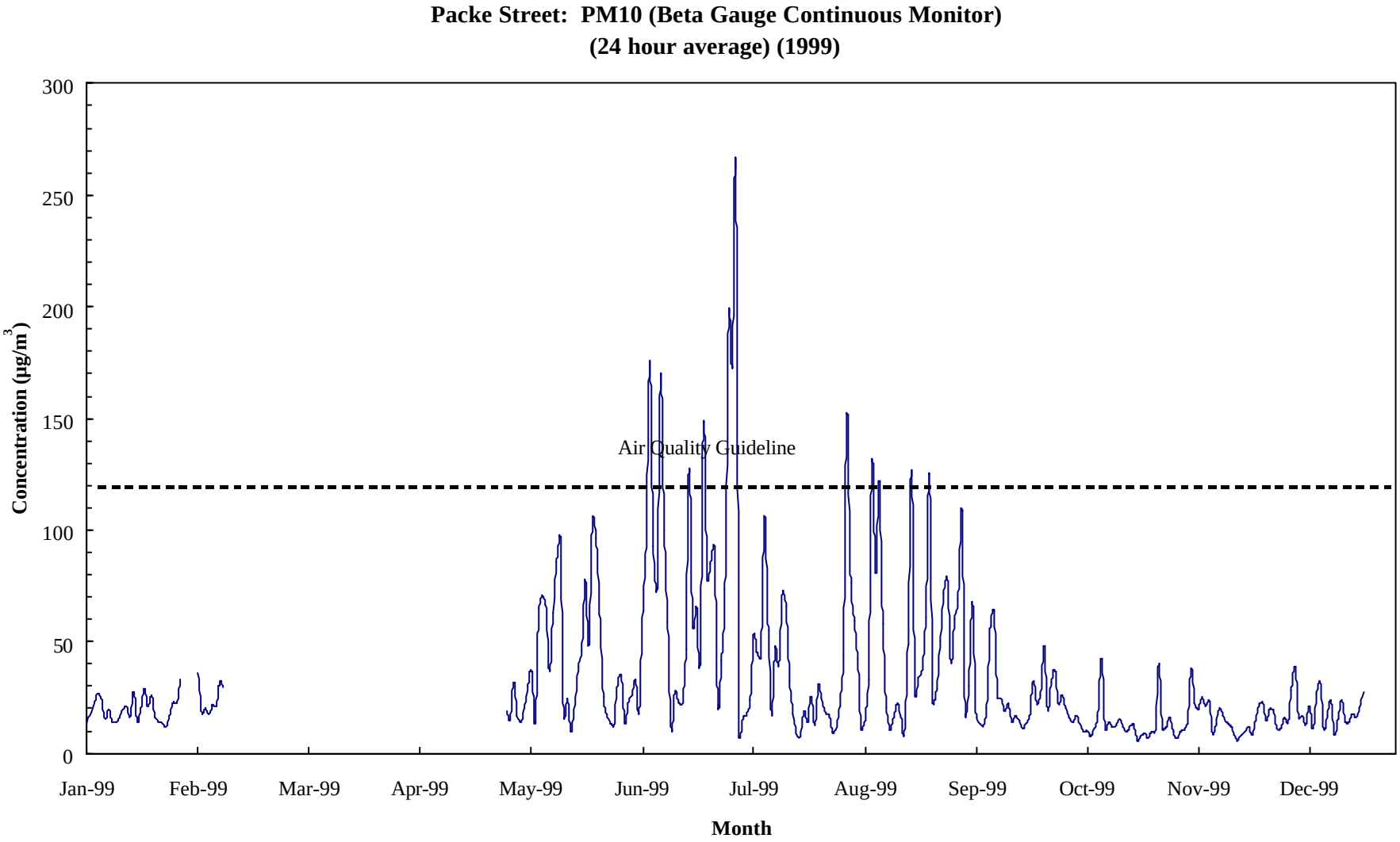


Figure 11: Packe Street, Christchurch - PM_{10} Data (1999)

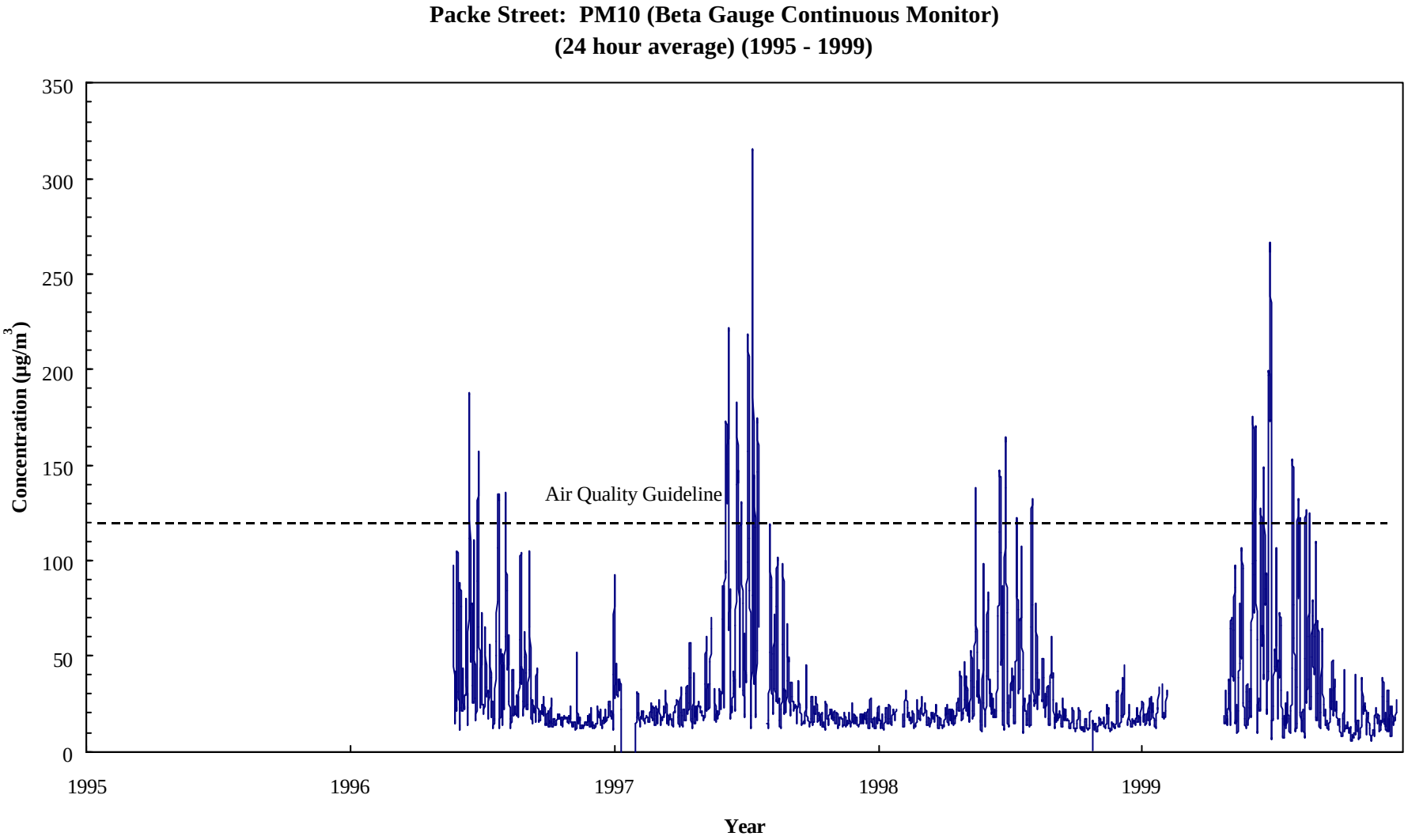


Figure 12: Packe Street, Christchurch - PM_{10} Data (1995 – 1999)

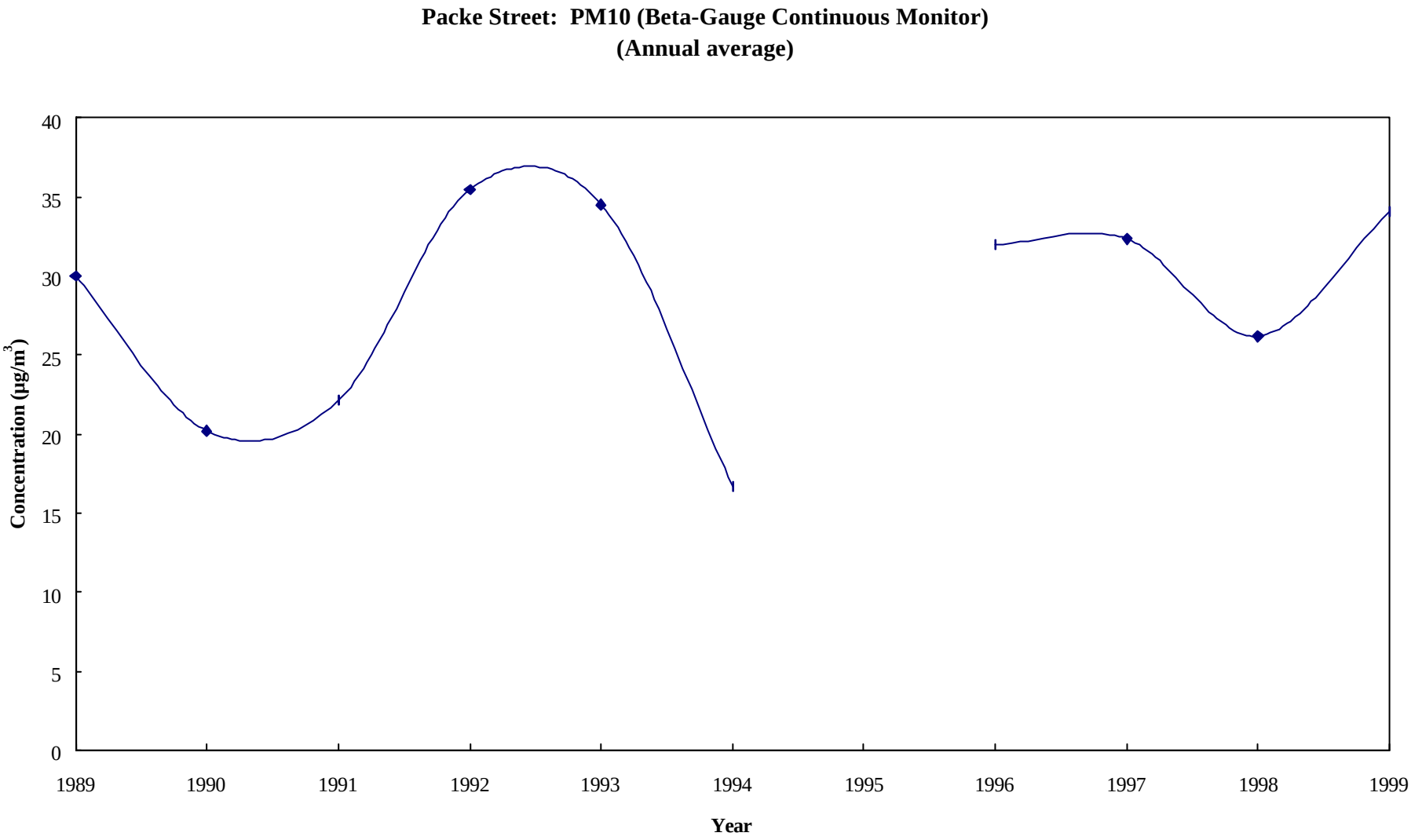


Figure 13: Packe Street, Christchurch - PM_{10} Annual Average Data (1989 – 1999)

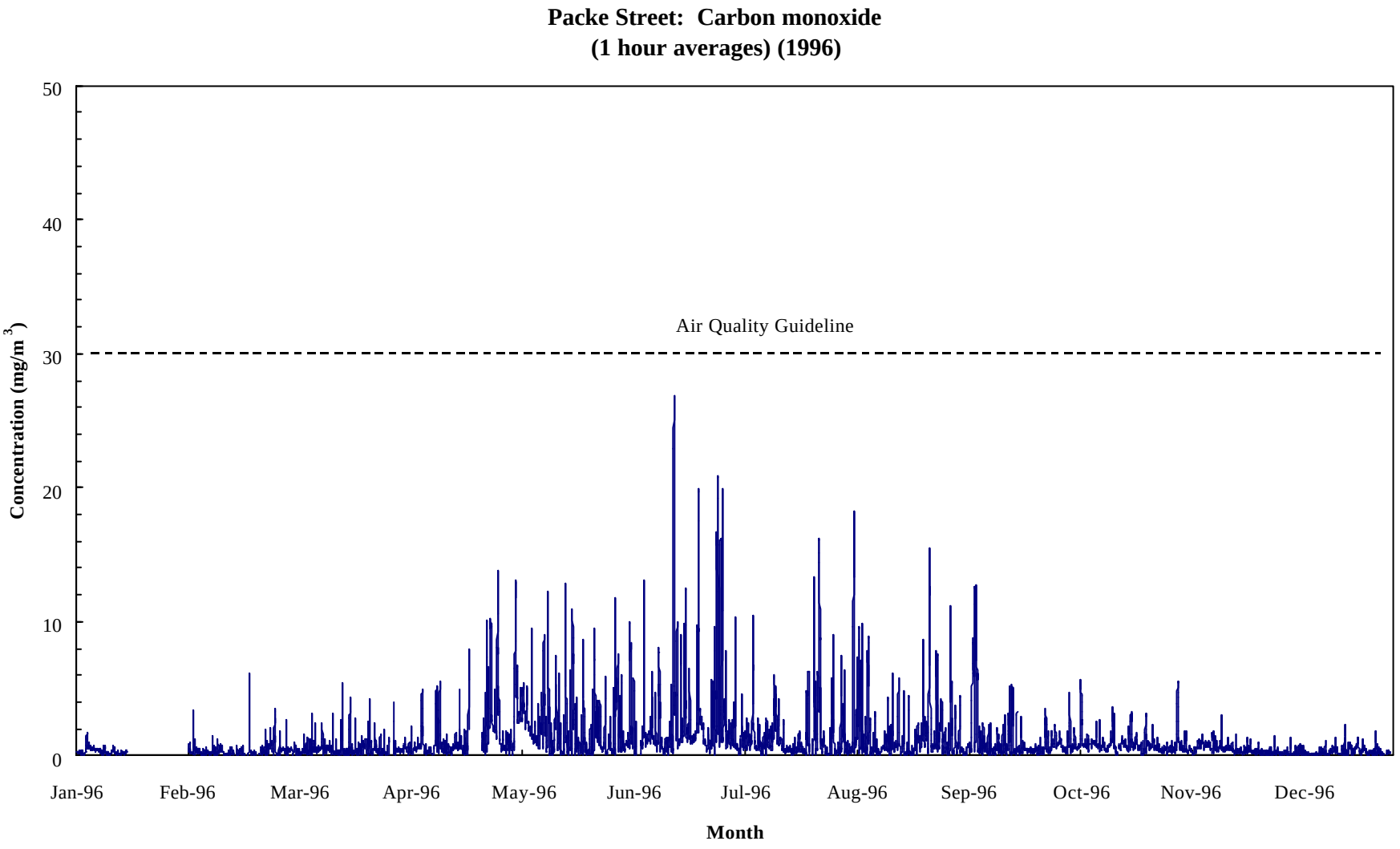


Figure 14: Packe Street, Christchurch - Carbon monoxide 1 hour Data (1996)

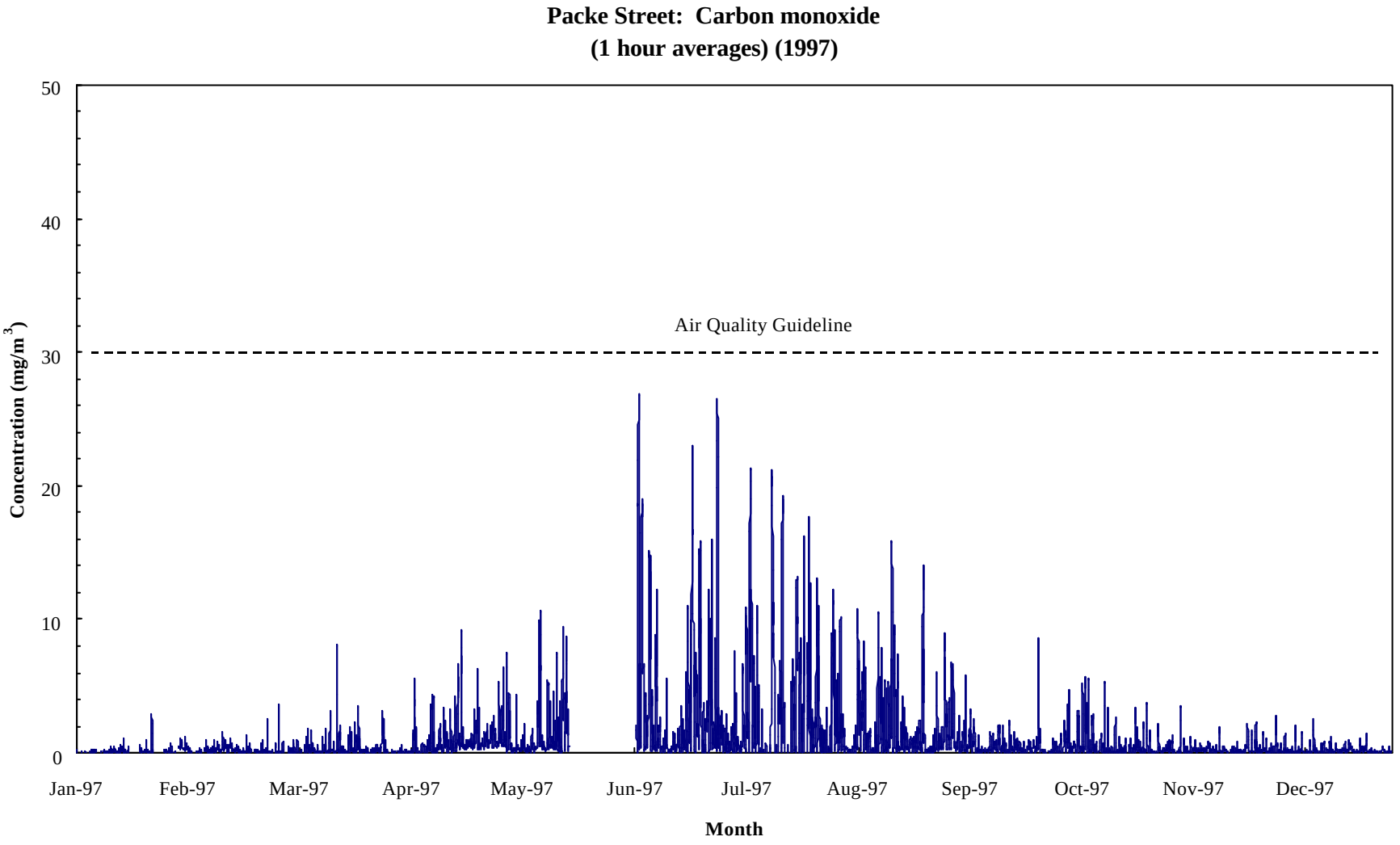


Figure 15: Packe Street, Christchurch - Carbon monoxide 1 hour Data (1997)

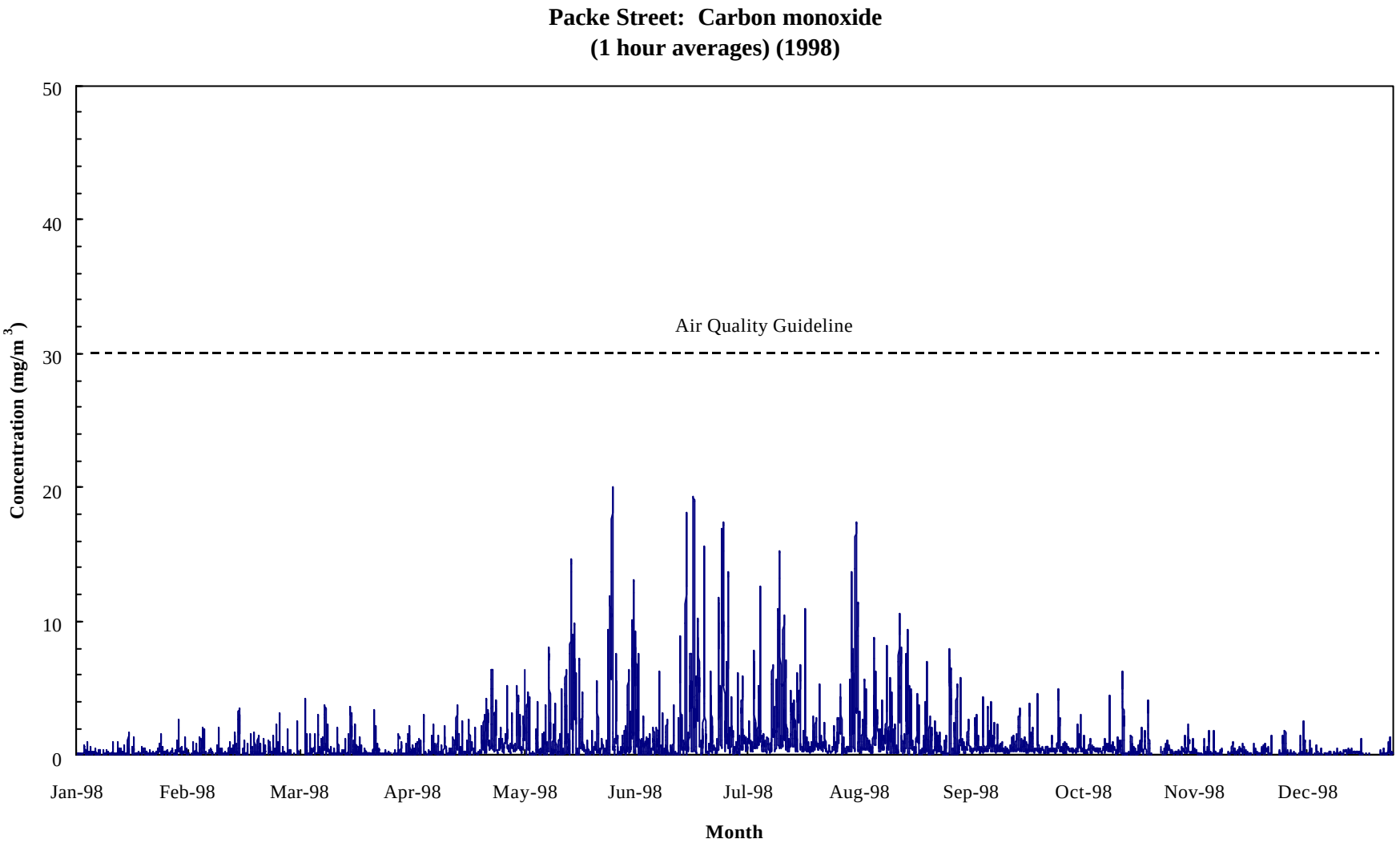


Figure 16: Packe Street, Christchurch - Carbon monoxide 1 hour Data (1998)

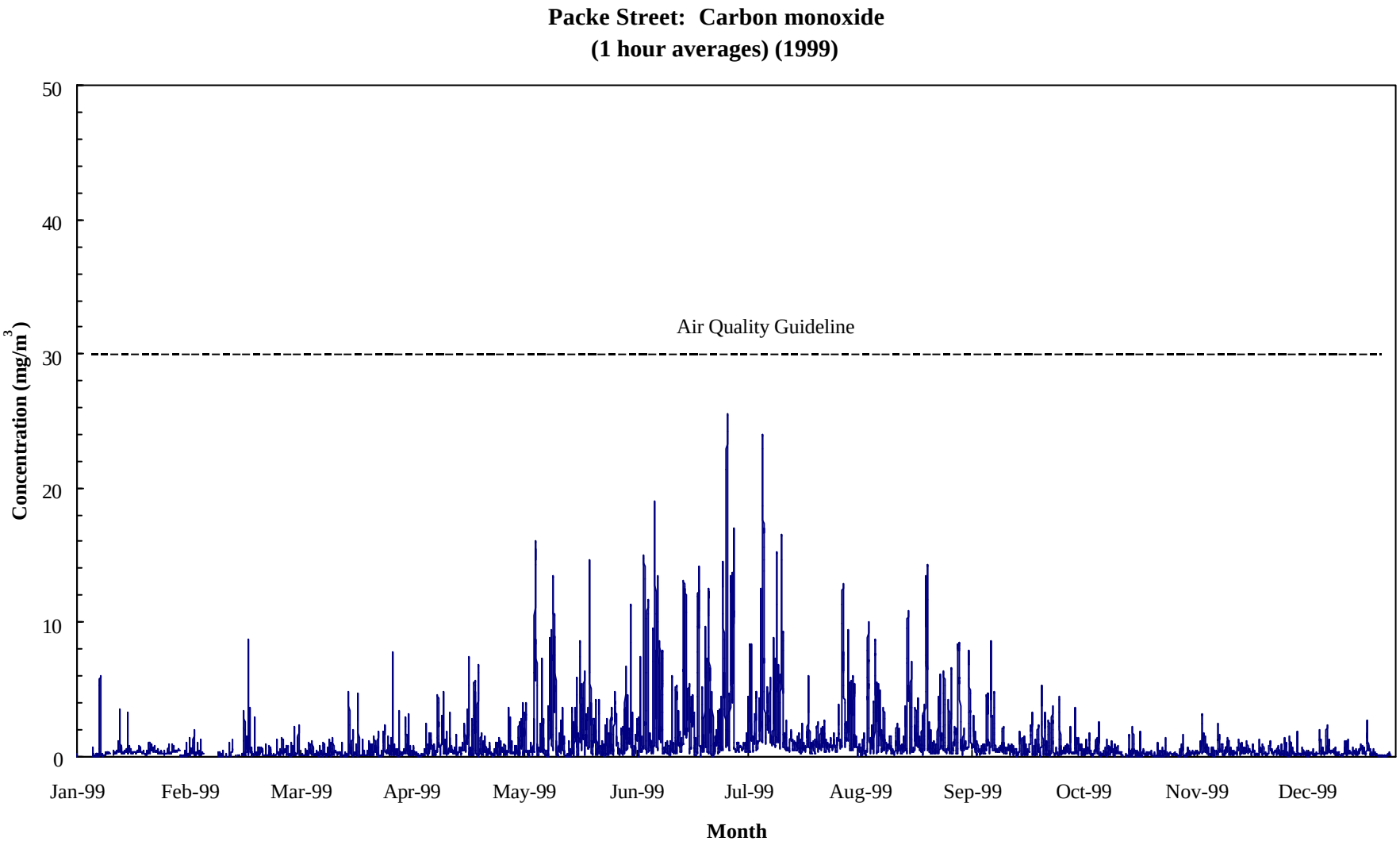


Figure 17: Packe Street, Christchurch - Carbon monoxide 1 hour Data (1999)

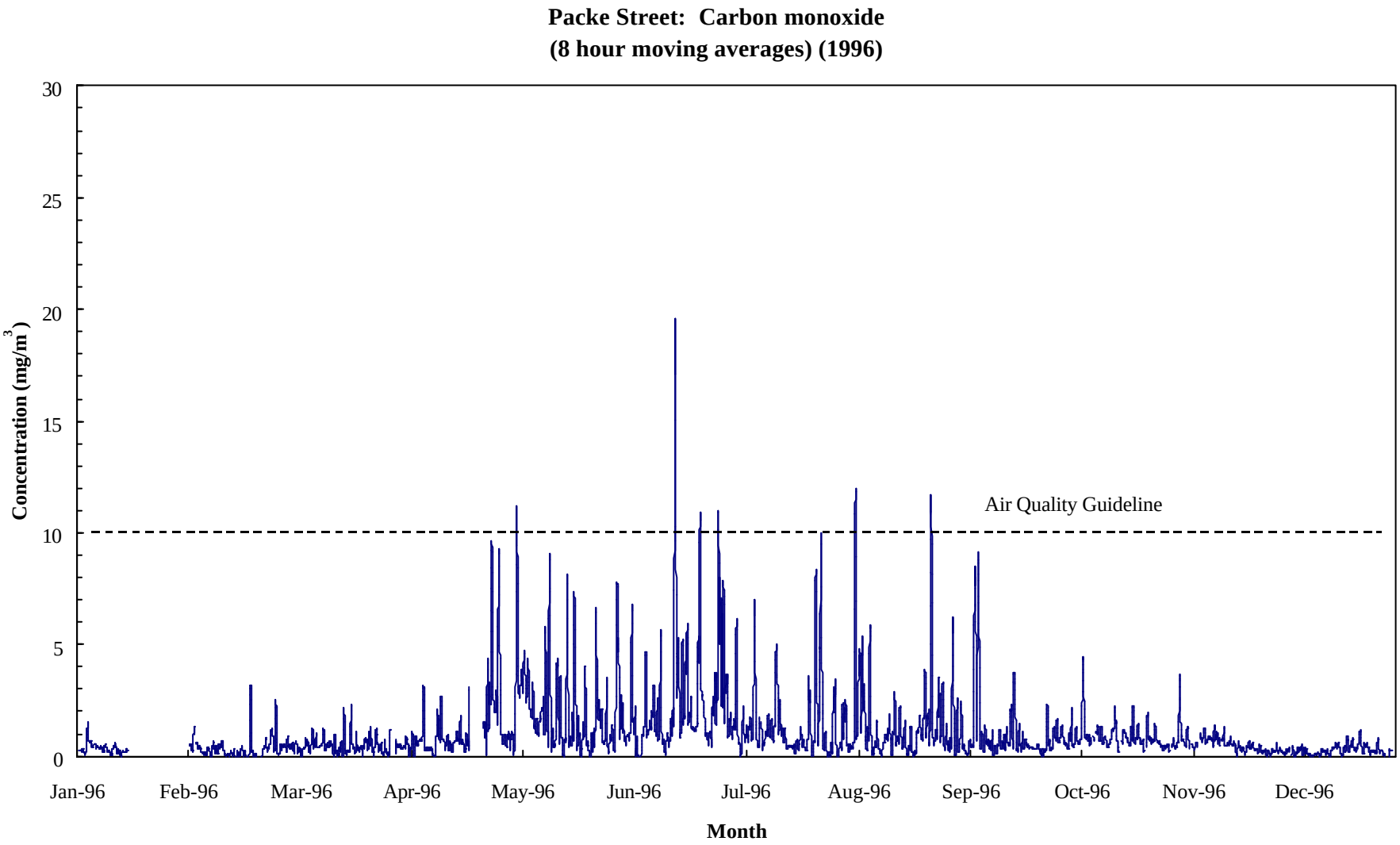


Figure 18: Packe Street, Christchurch - Carbon monoxide 8 hour Data (1996)

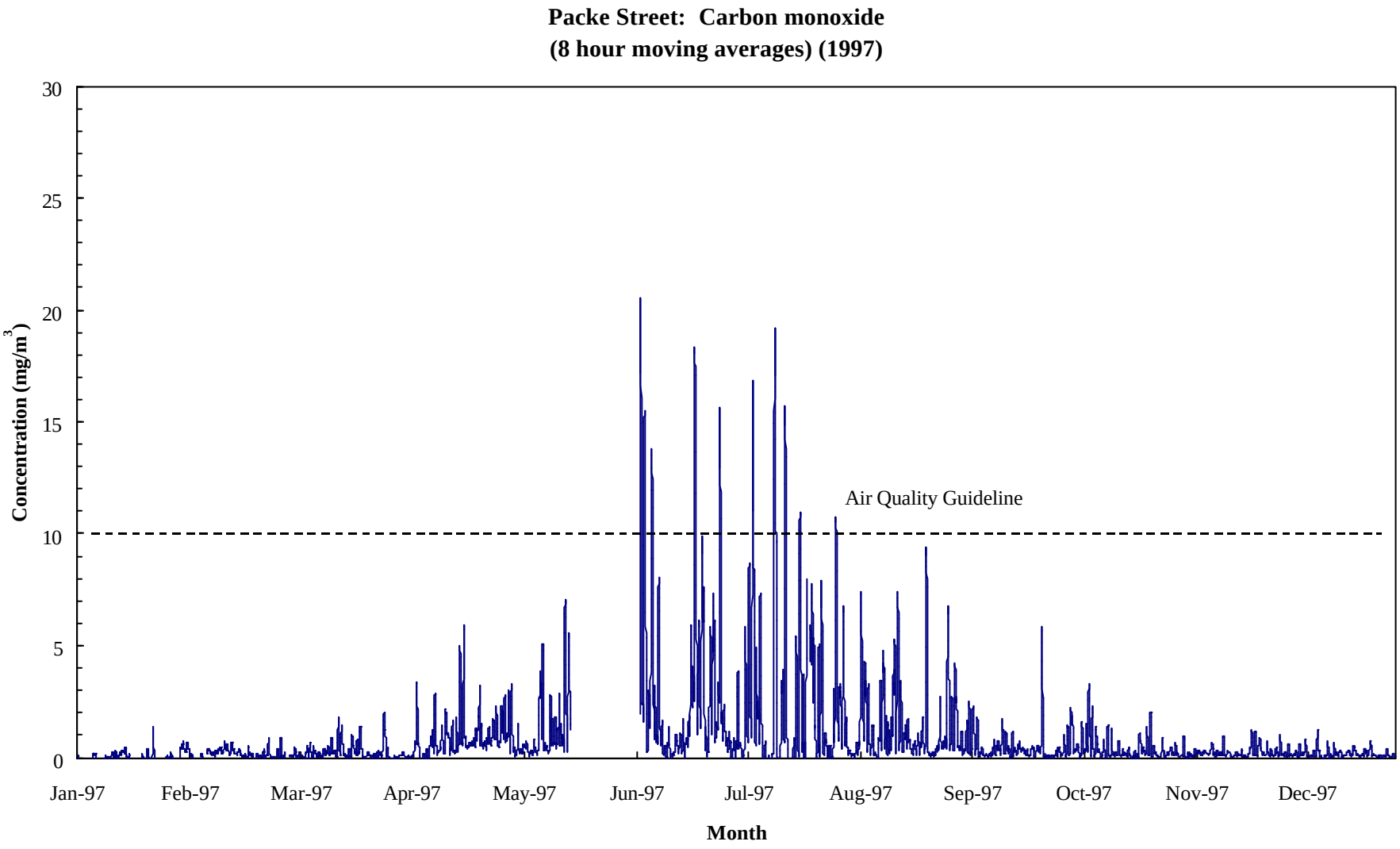


Figure 19: Packe Street, Christchurch - Carbon monoxide 8 hour Data (1997)

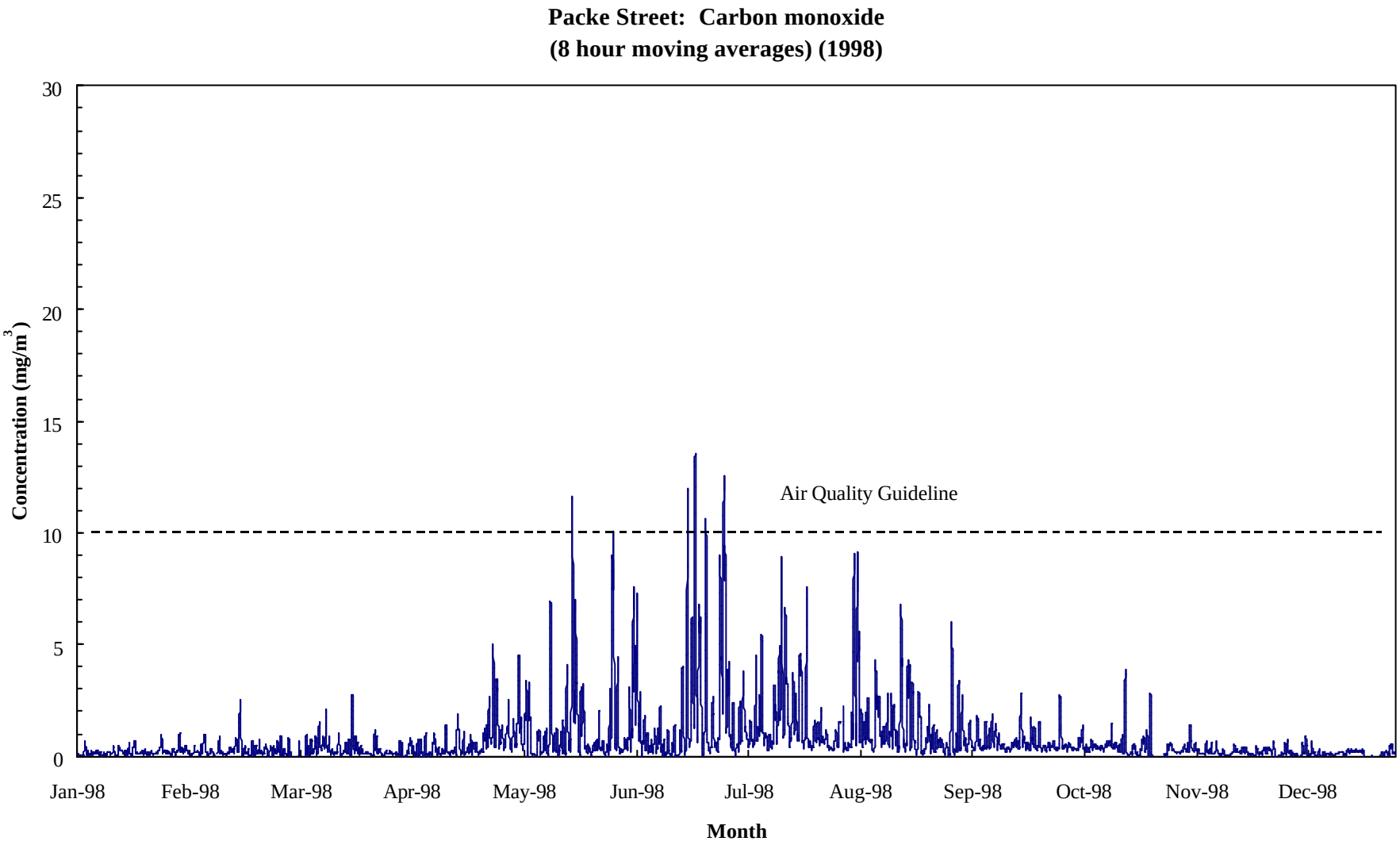
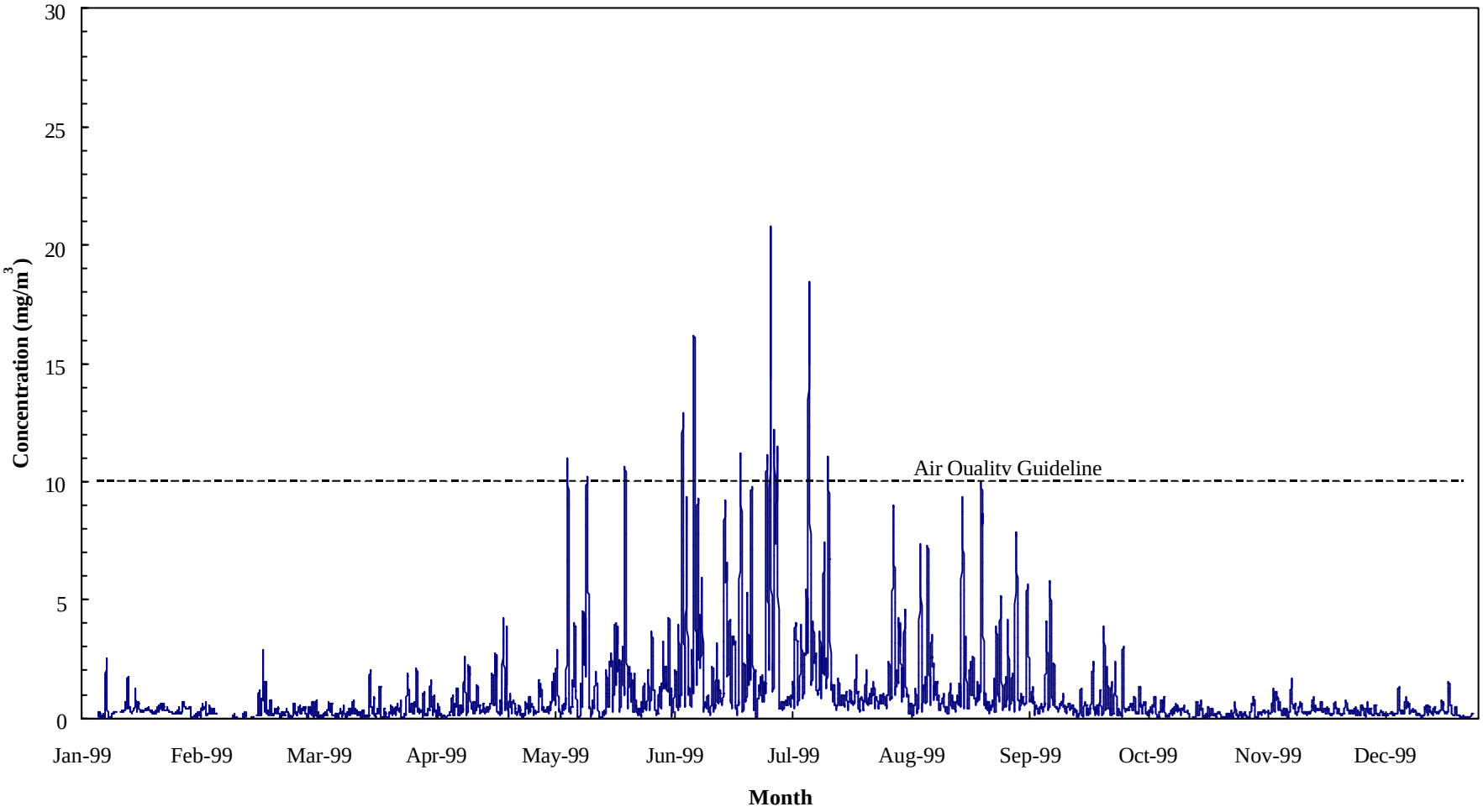


Figure 20: Packe Street, Christchurch - Carbon monoxide 8 hour Data (1998)

Packe Street: Carbon monoxide
(8 hour moving averages) (1999)



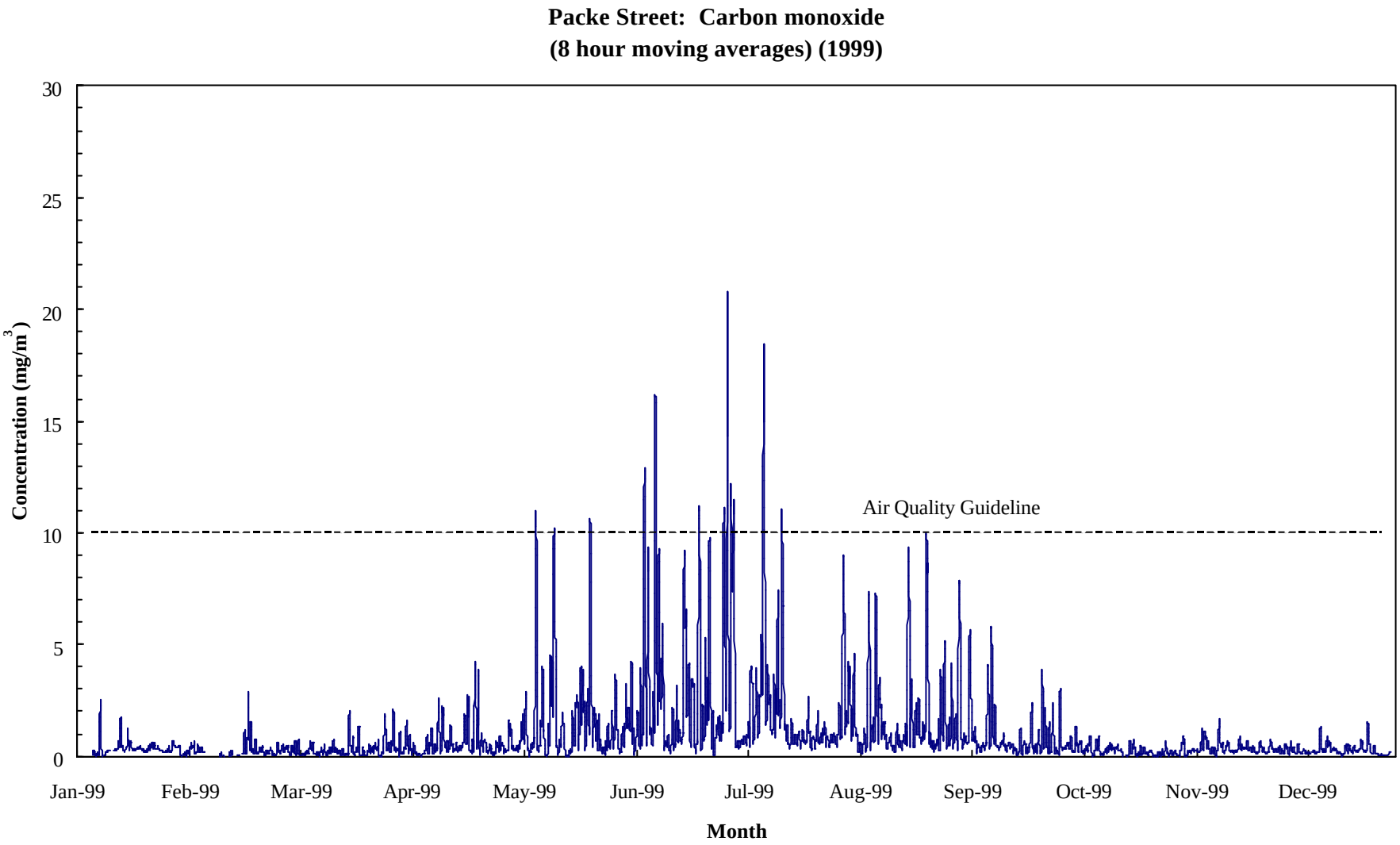


Figure 21: Packe Street, Christchurch - Carbon monoxide 8 hour Data (1999)

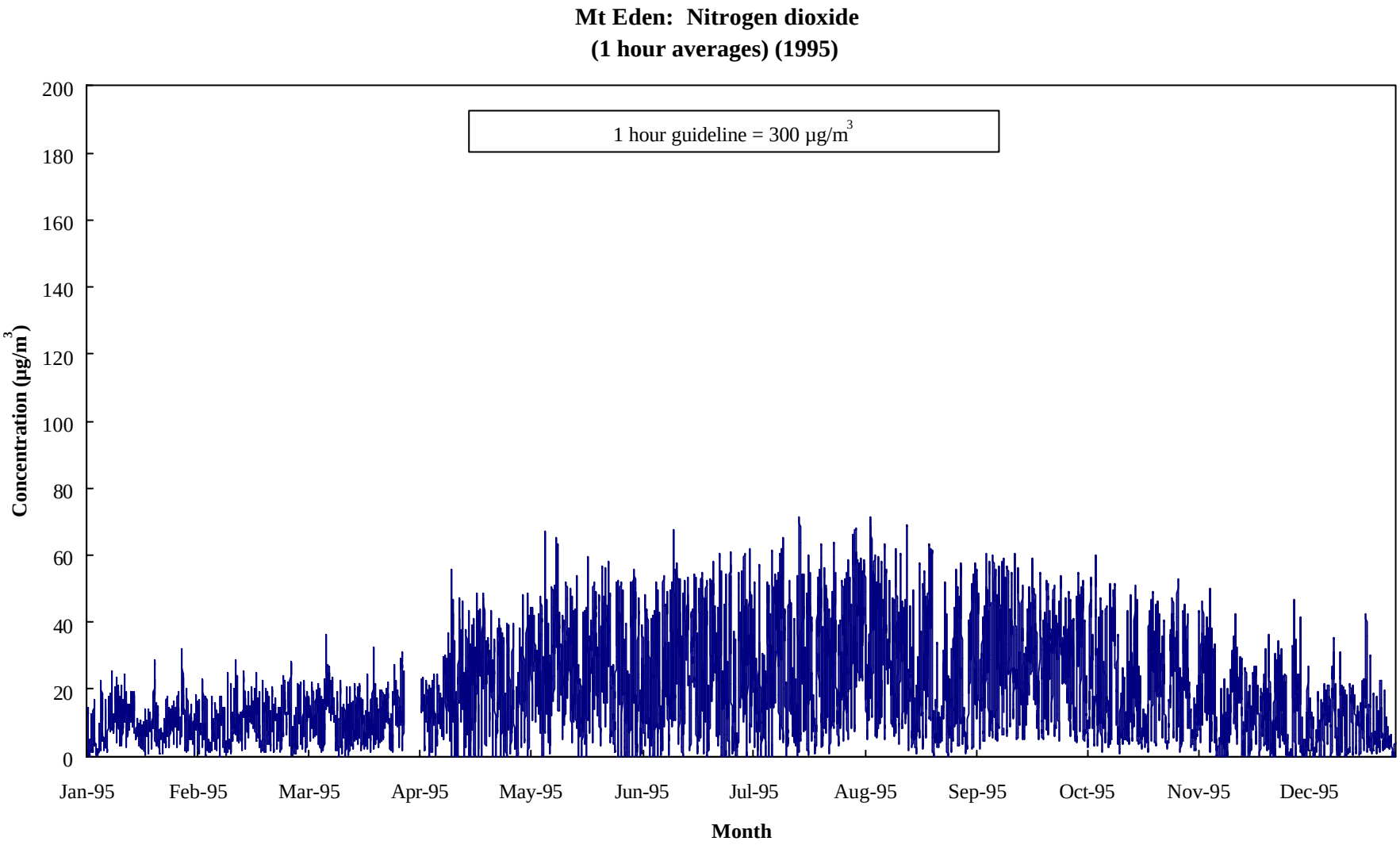


Figure 22: Mt Eden, Auckland - Nitrogen dioxide 1 hour Data (1995)

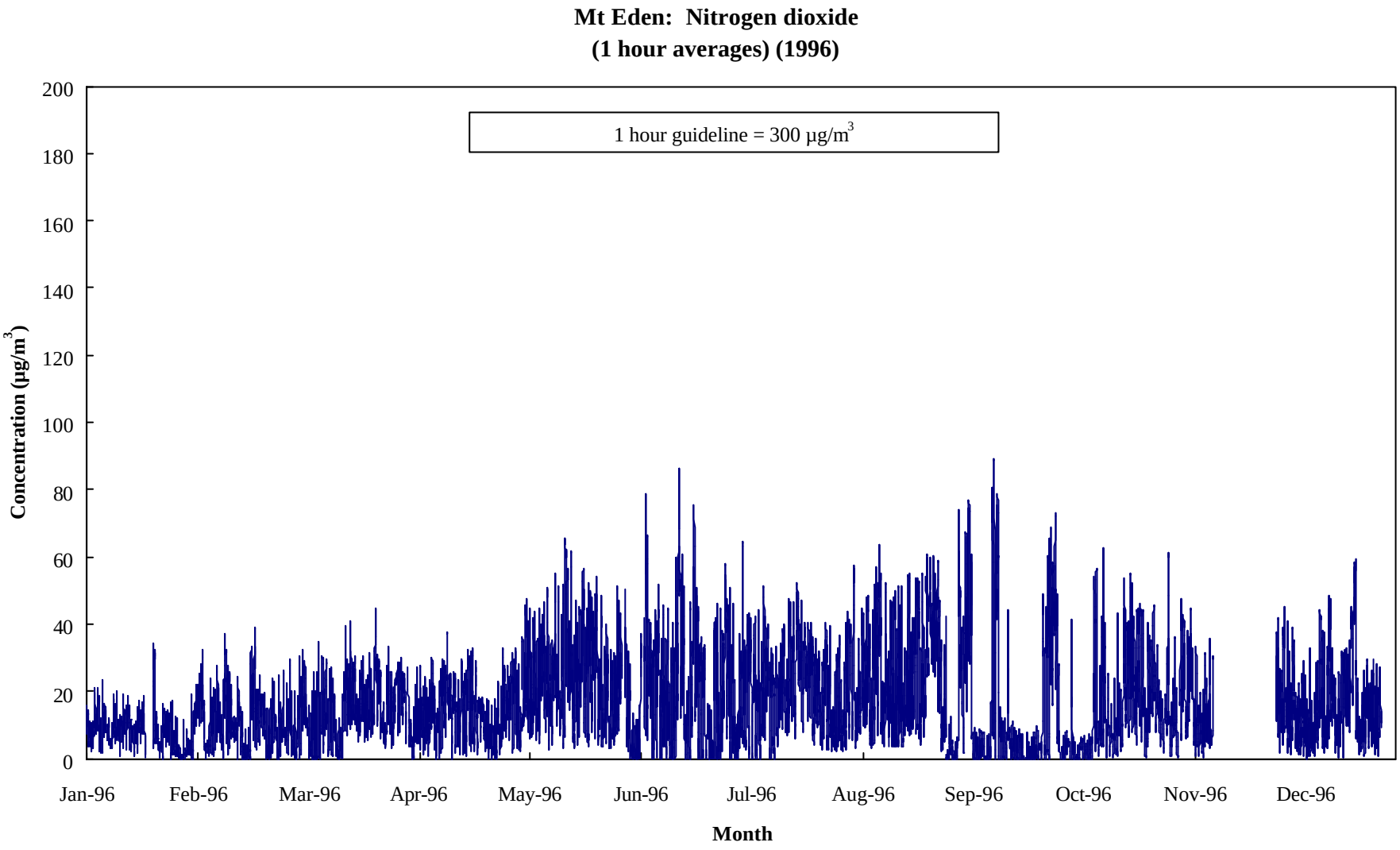


Figure 23: Mt Eden, Auckland - Nitrogen dioxide 1 hour Data (1996)

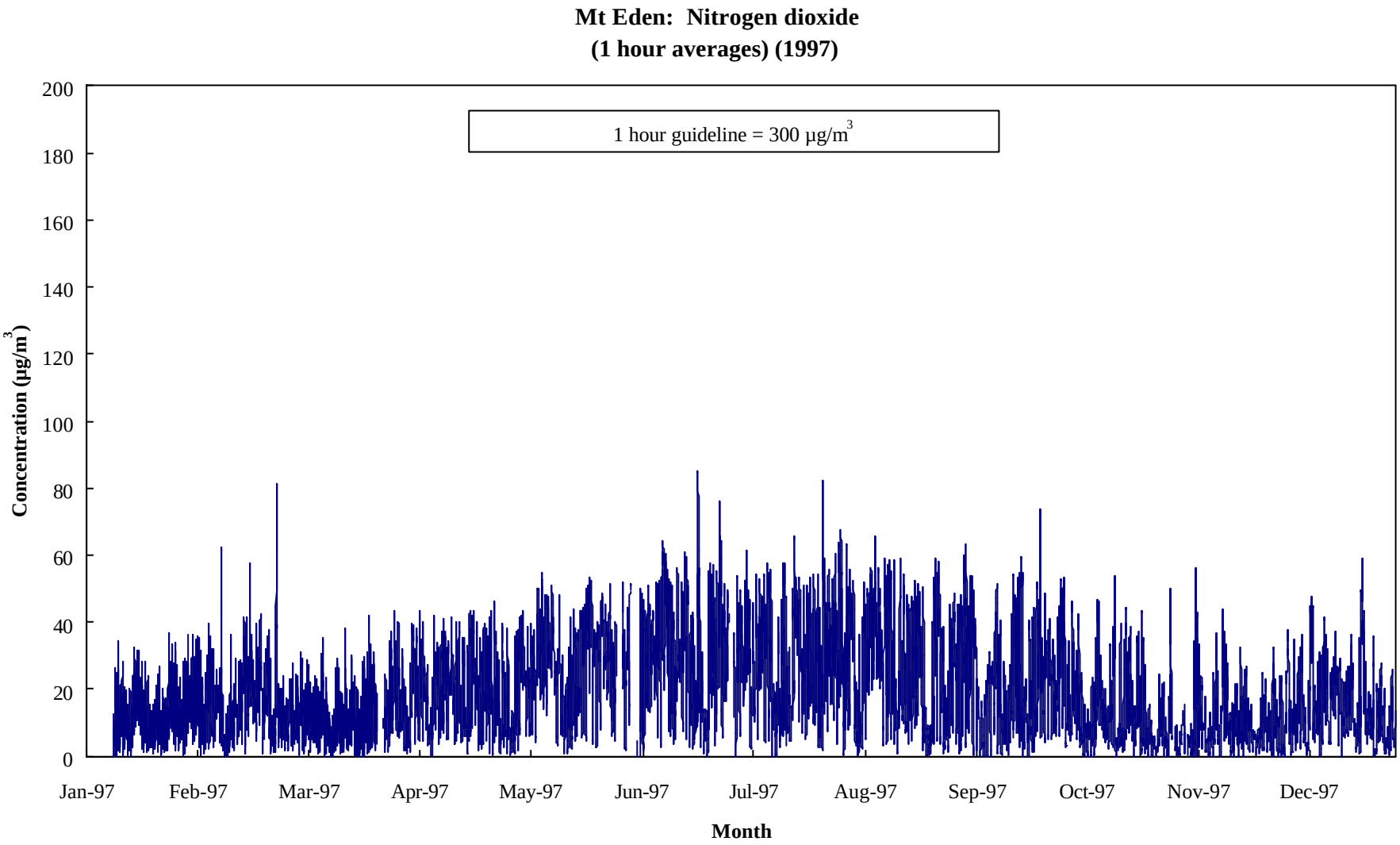


Figure 24: Mt Eden, Auckland - Nitrogen dioxide 1 hour Data (1997)

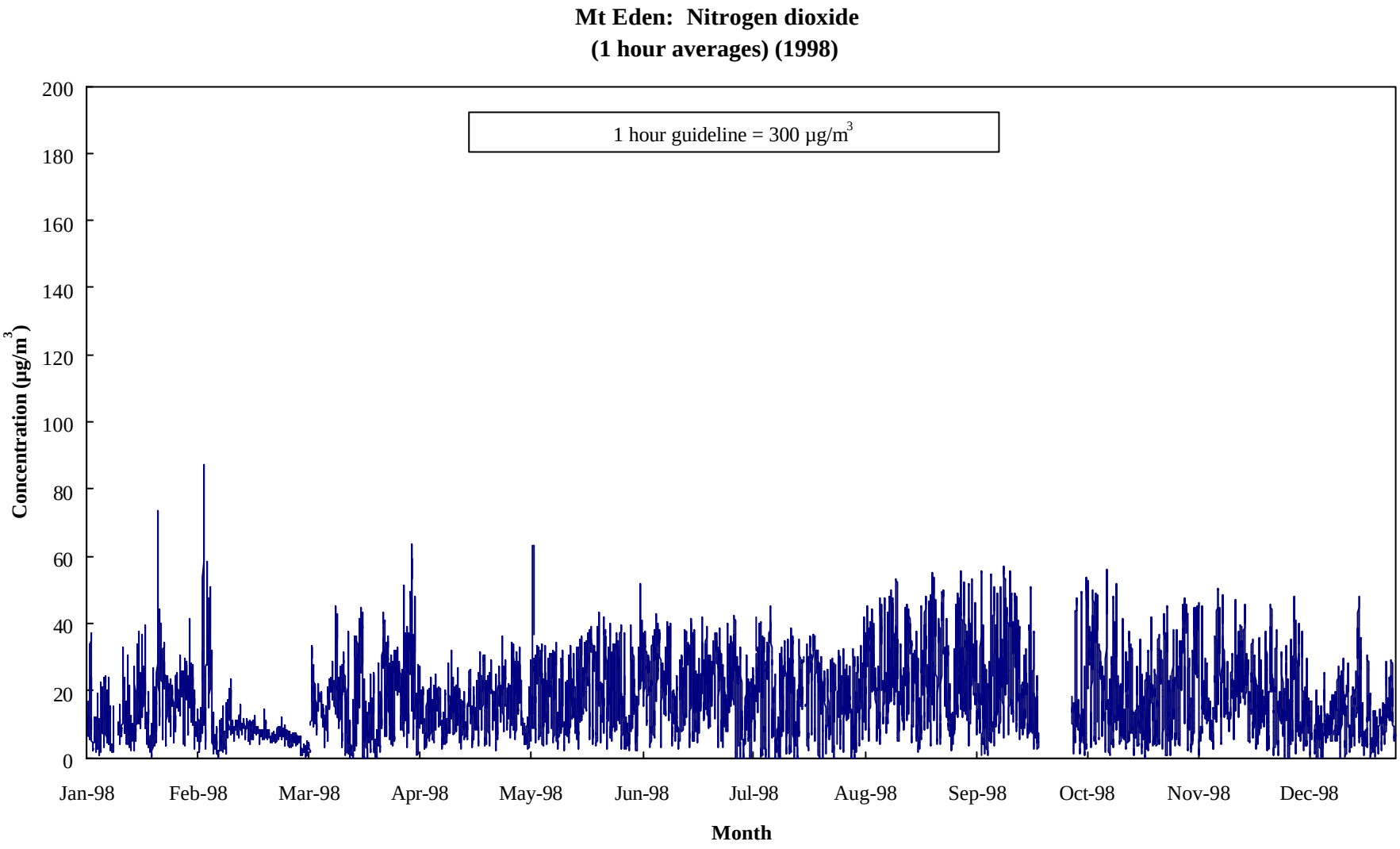


Figure 25: Mt Eden, Auckland - Nitrogen dioxide 1 hour Data (1998)

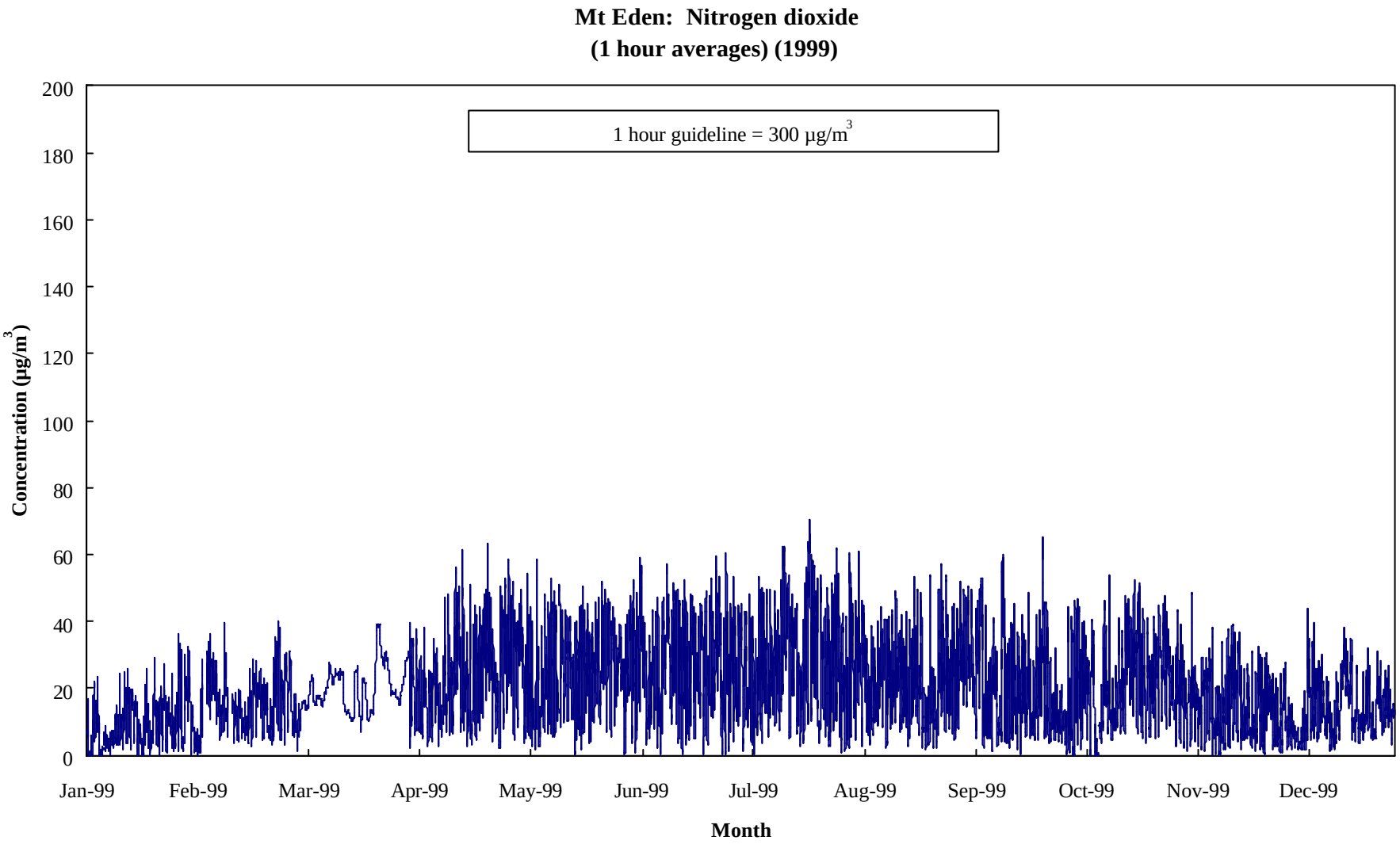


Figure 26: Mt Eden, Auckland - Nitrogen dioxide 1 hour Data (1999)

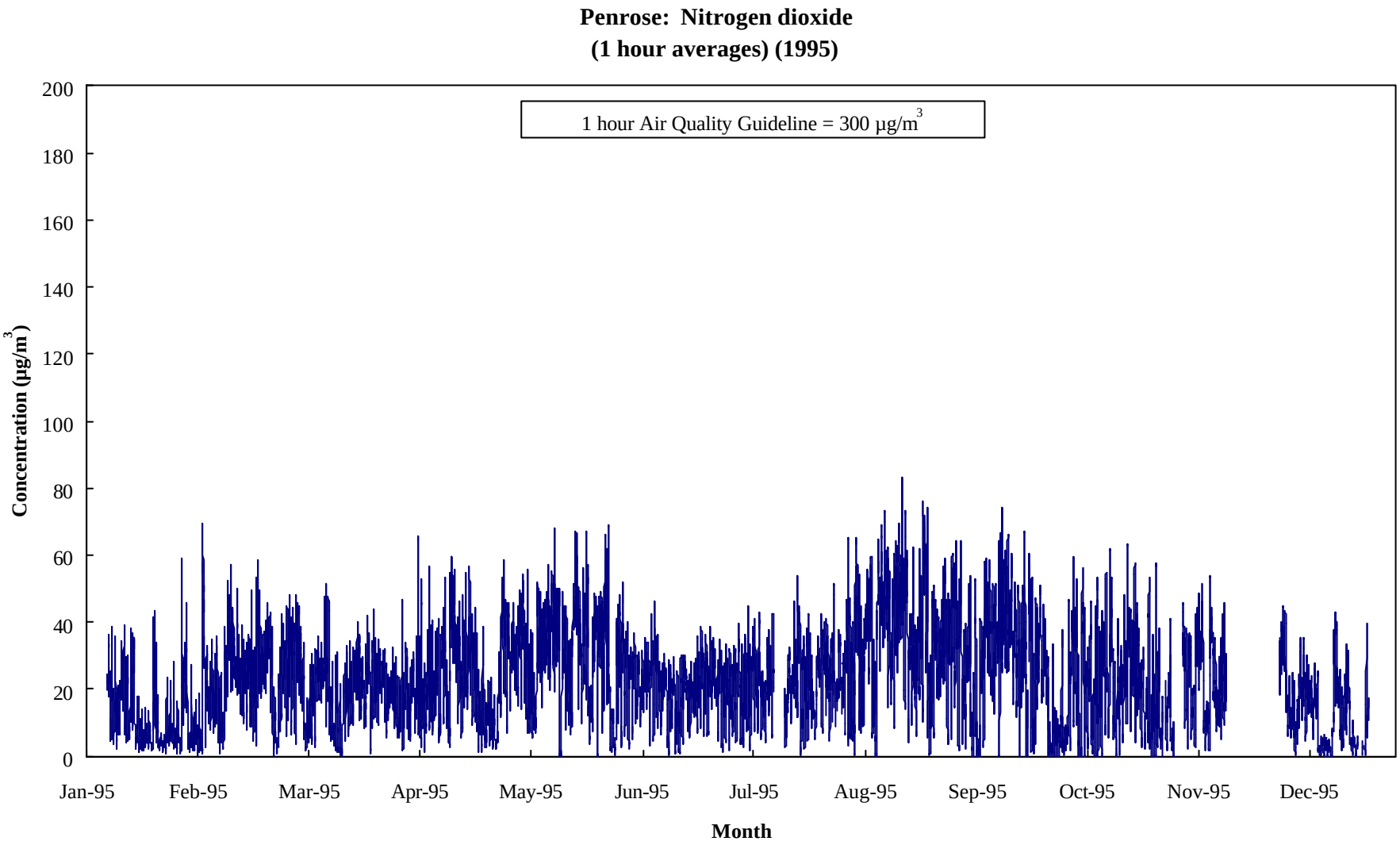


Figure 27: Penrose, Auckland - Nitrogen dioxide 1 hour Data (1995)

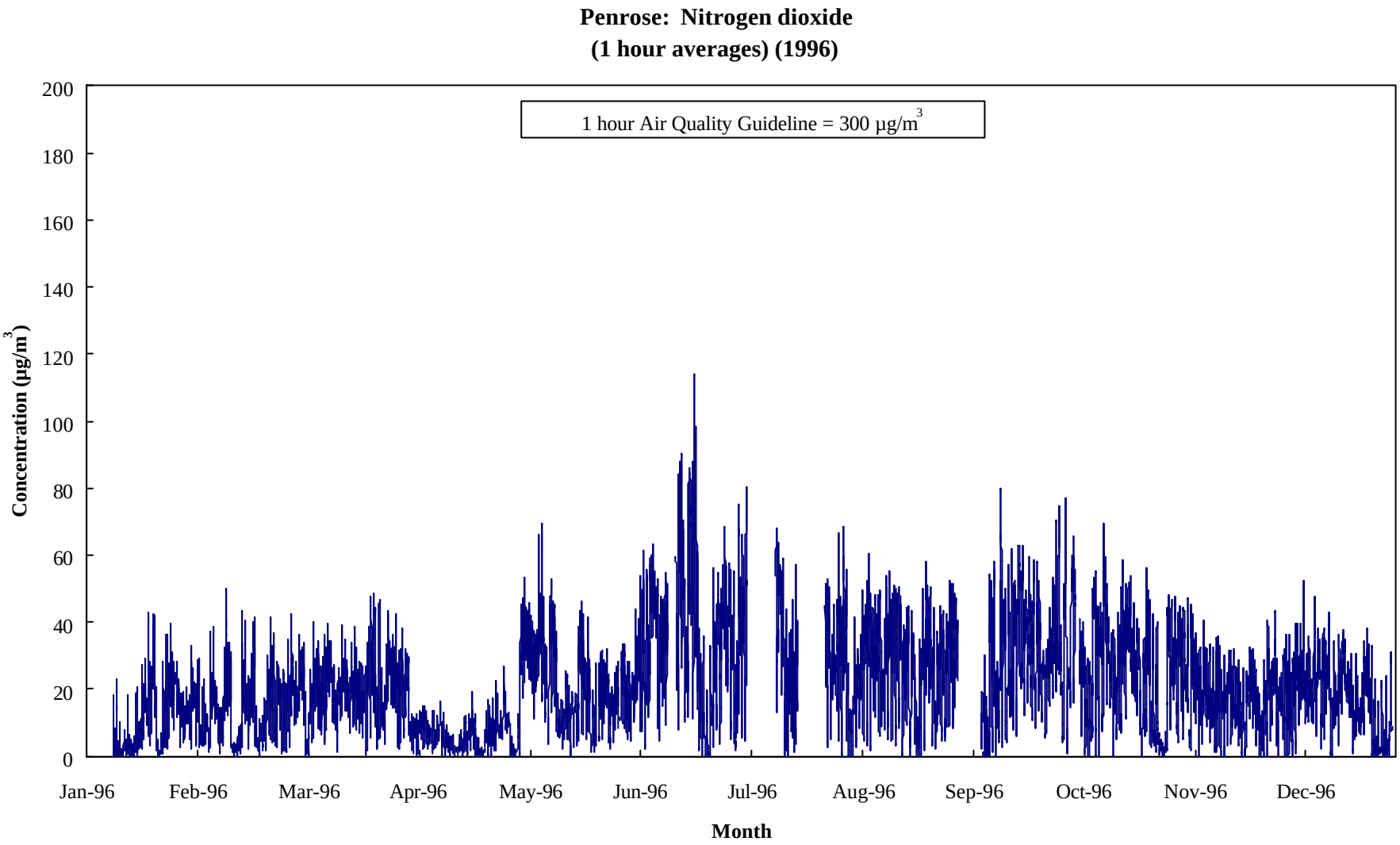


Figure 28: Penrose, Auckland - Nitrogen dioxide 1 hour Data (1996)

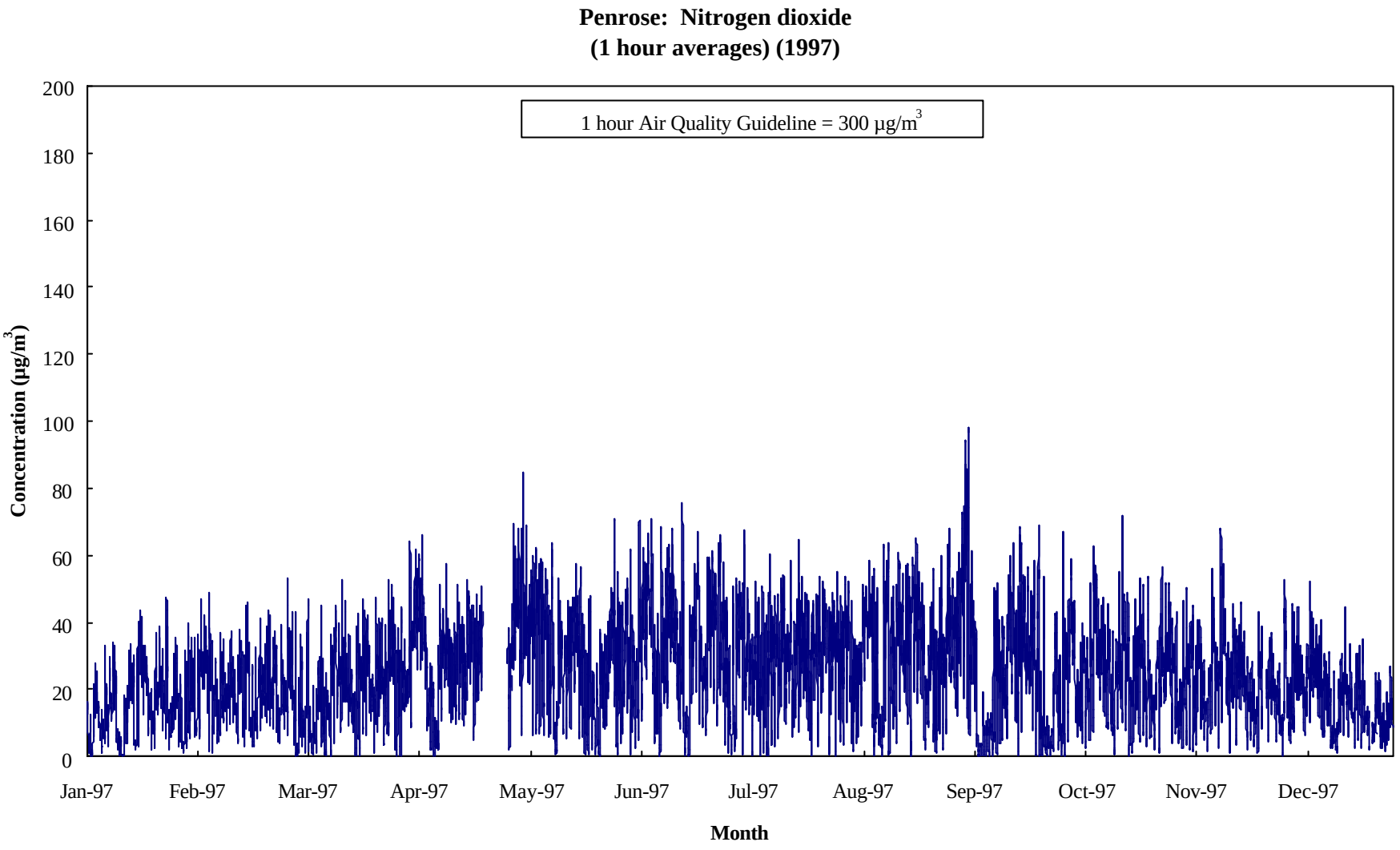


Figure 29: Penrose, Auckland - Nitrogen dioxide 1 hour Data (1997)

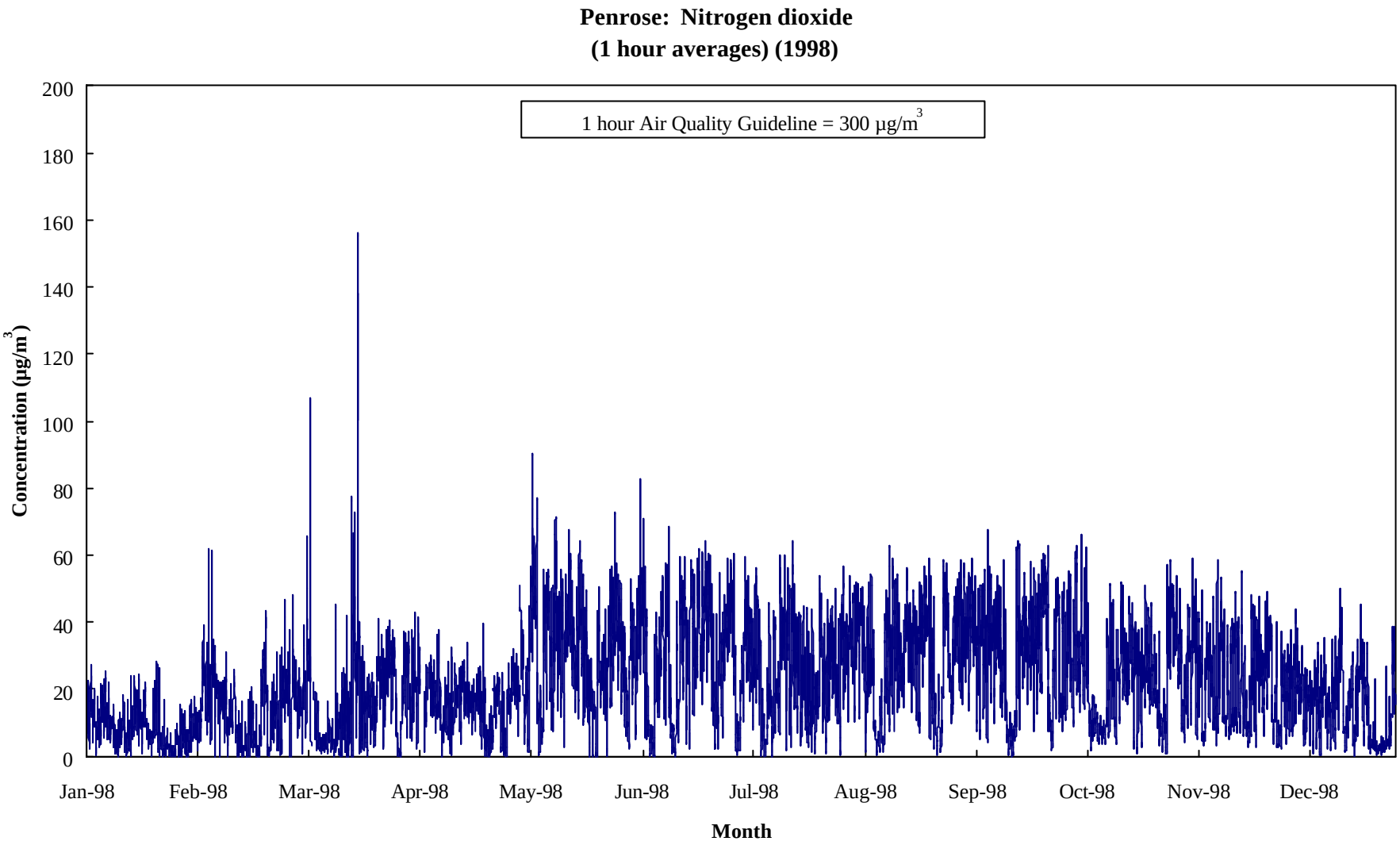


Figure 30: Penrose, Auckland - Nitrogen dioxide 1 hour Data (1998)

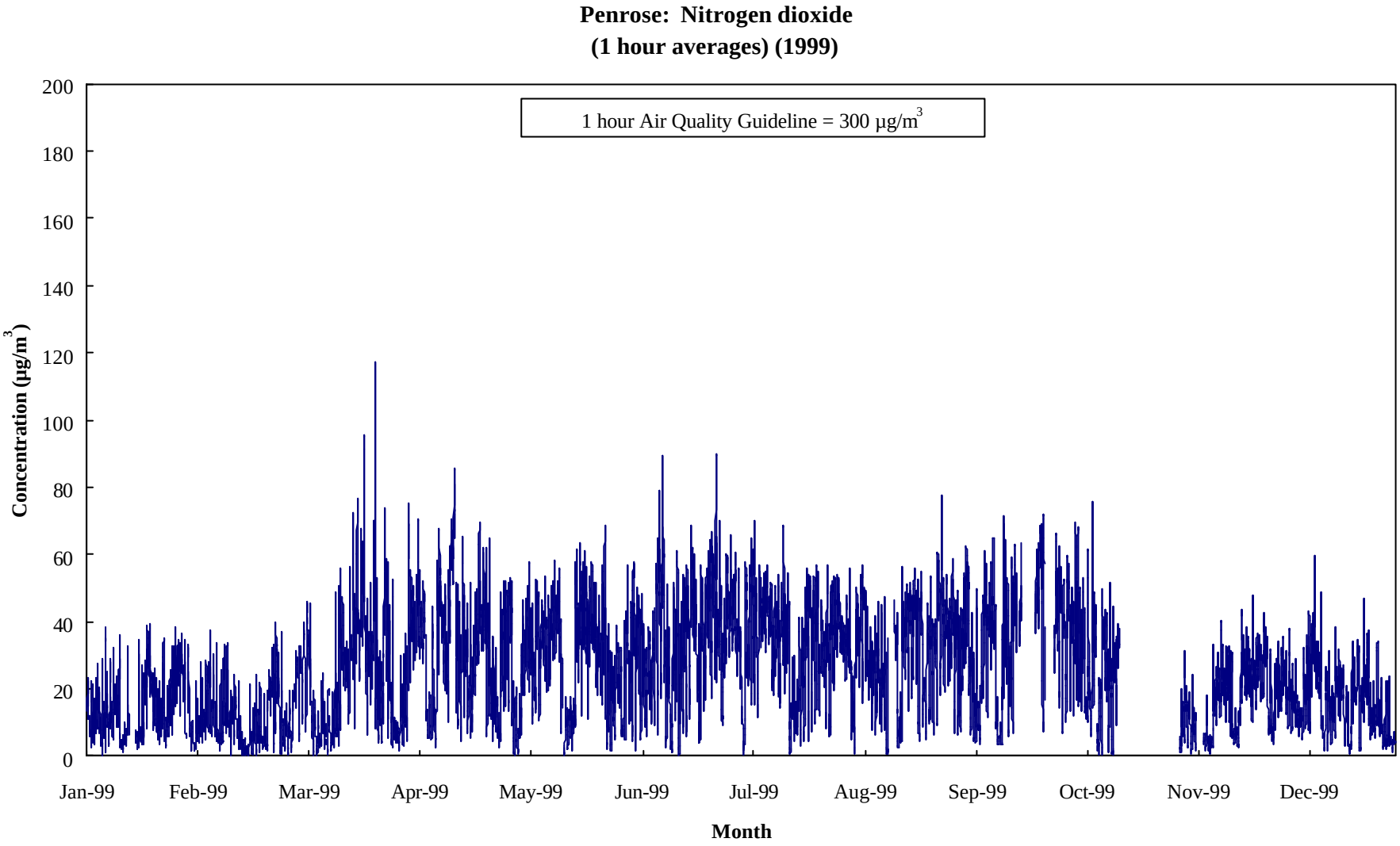


Figure 31: Penrose, Auckland - Nitrogen dioxide 1 hour Data (1999)

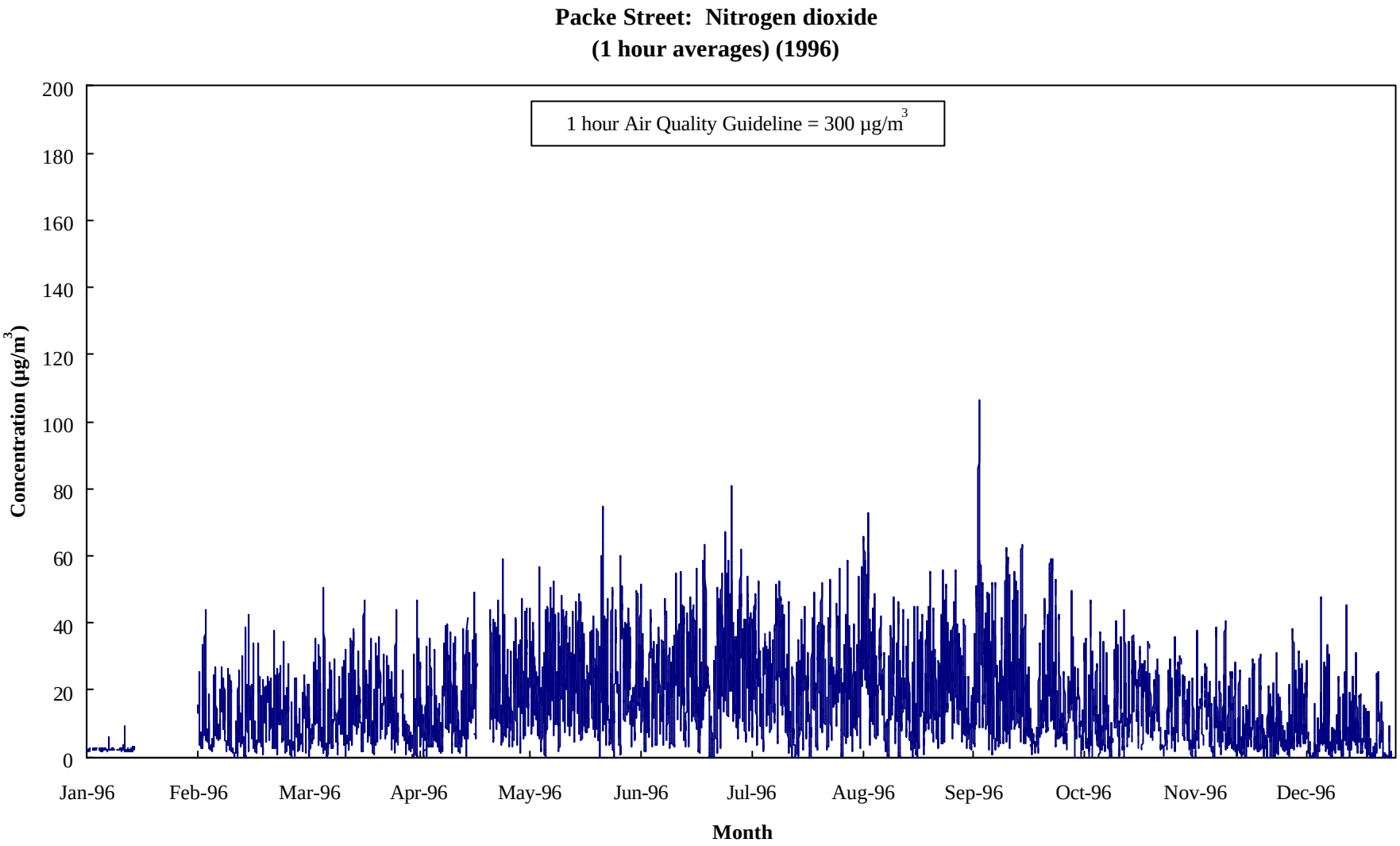


Figure 32: Packe Street, Christchurch - Nitrogen dioxide 1 hour Data (1996)

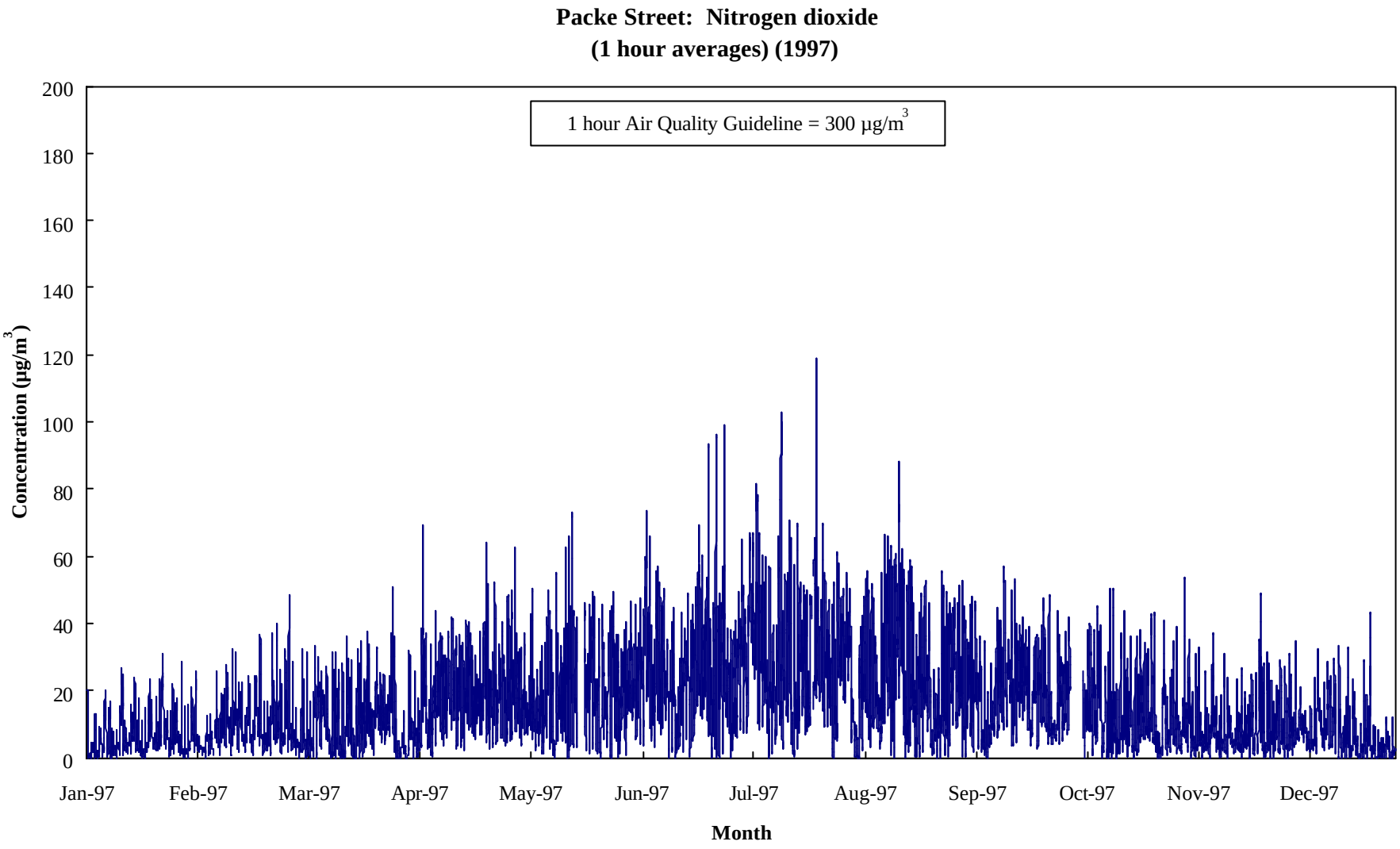


Figure 33: Packe Street, Christchurch - Nitrogen dioxide 1 hour Data (1997)

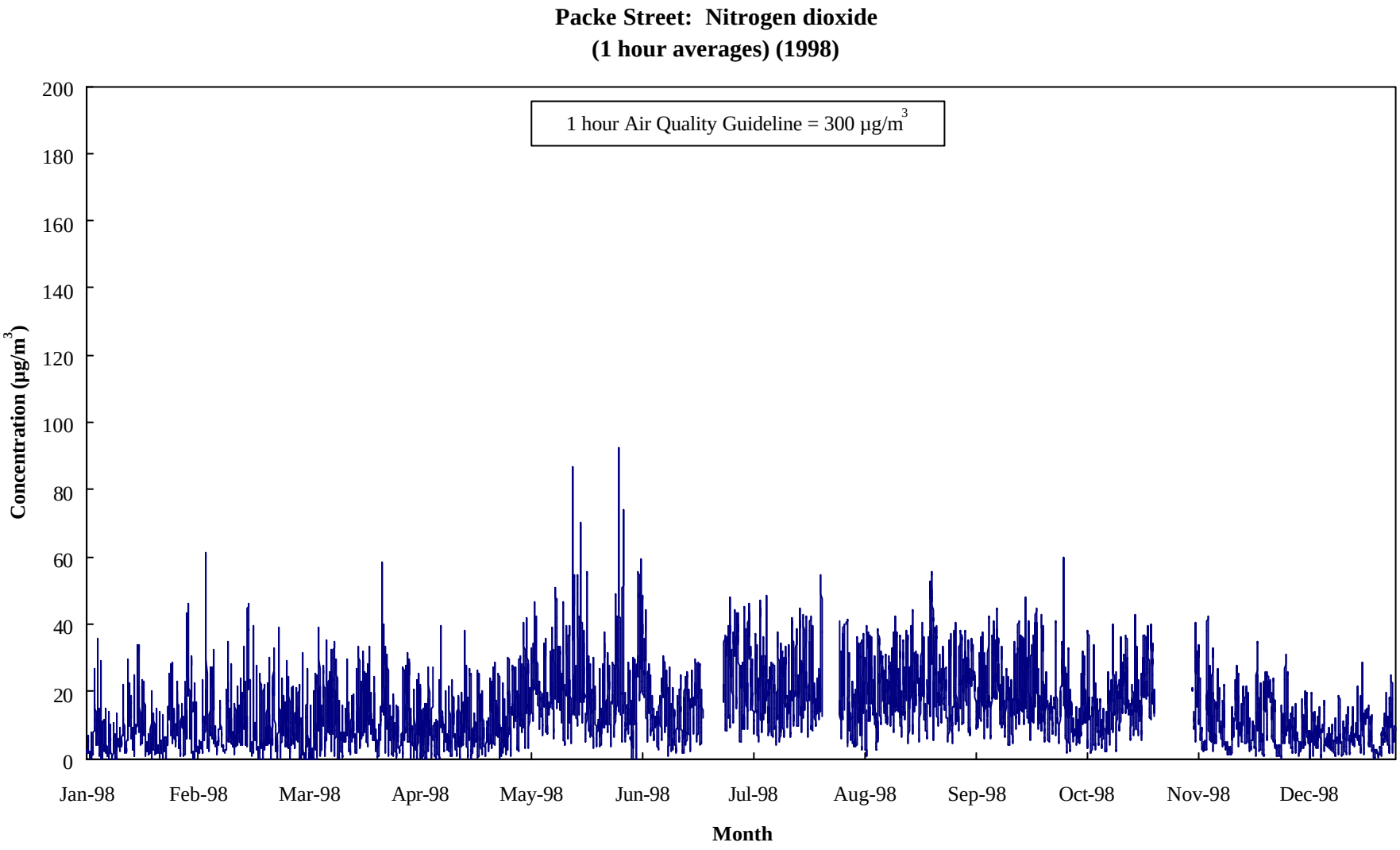


Figure 34: Packe Street, Christchurch - Nitrogen dioxide 1 hour Data (1998)

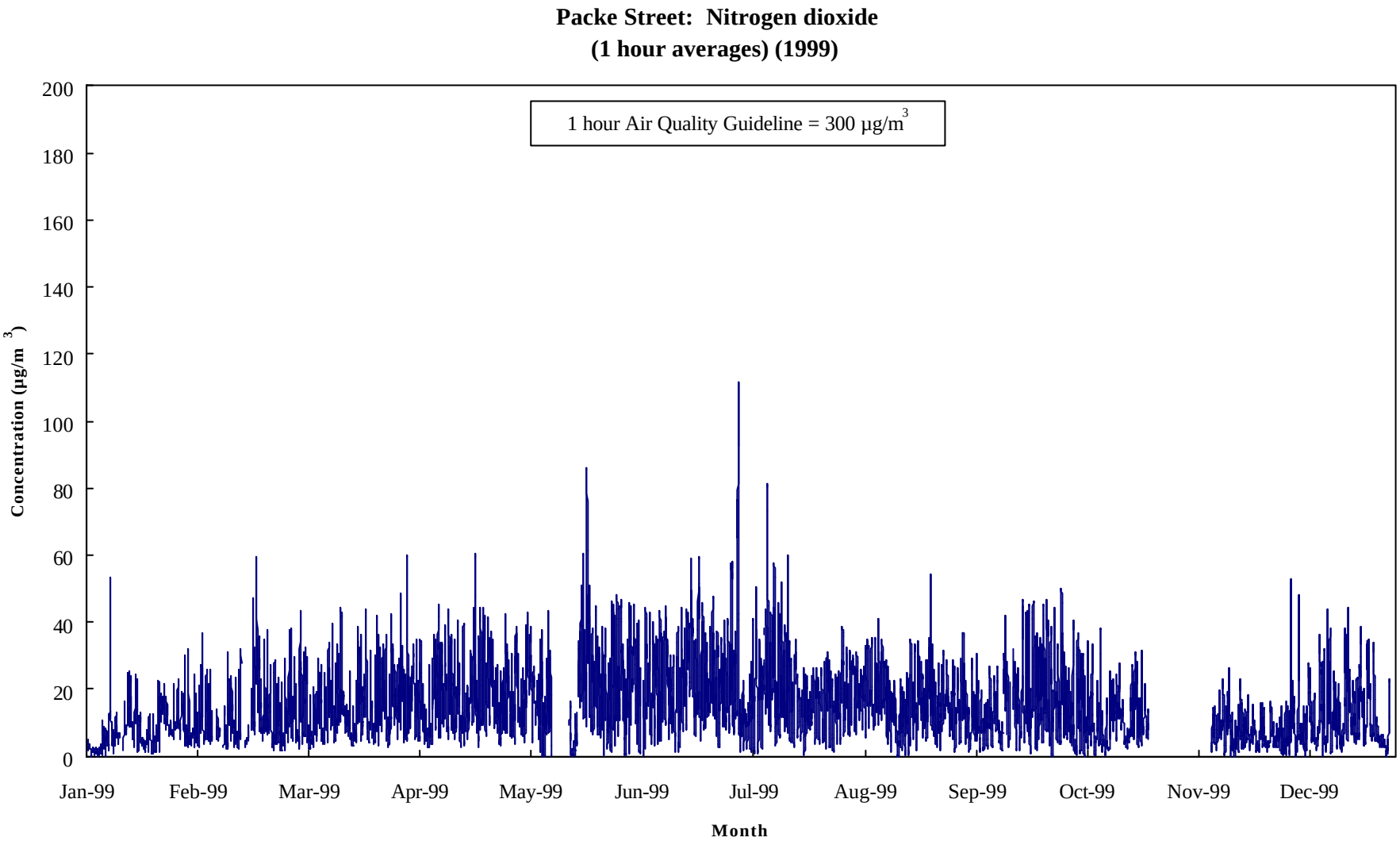


Figure 35: Packe Street, Christchurch - Nitrogen dioxide 1 hour Data (1999)

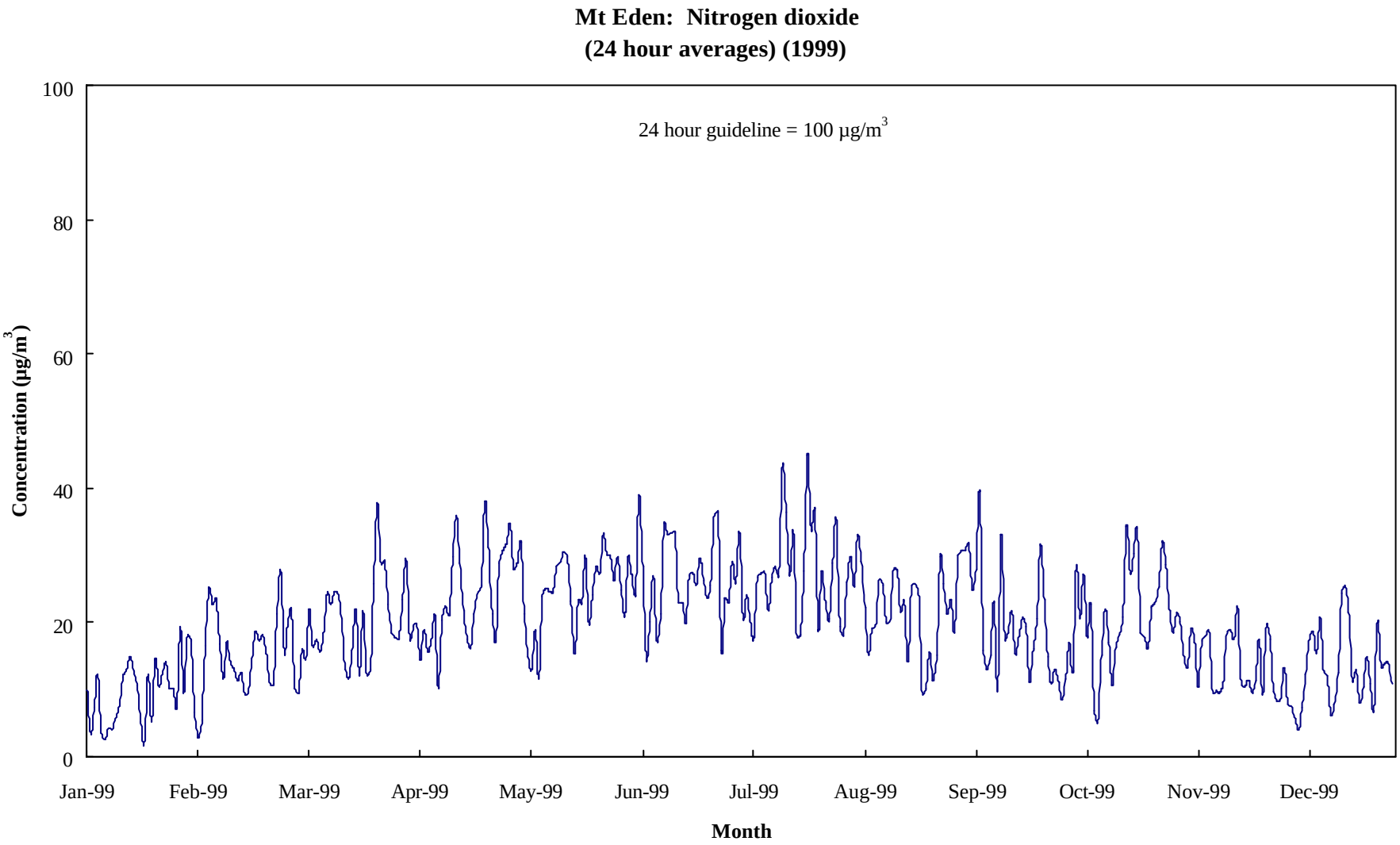


Figure 36: Mt Eden, Auckland - Nitrogen dioxide 24 hour Data (1999)

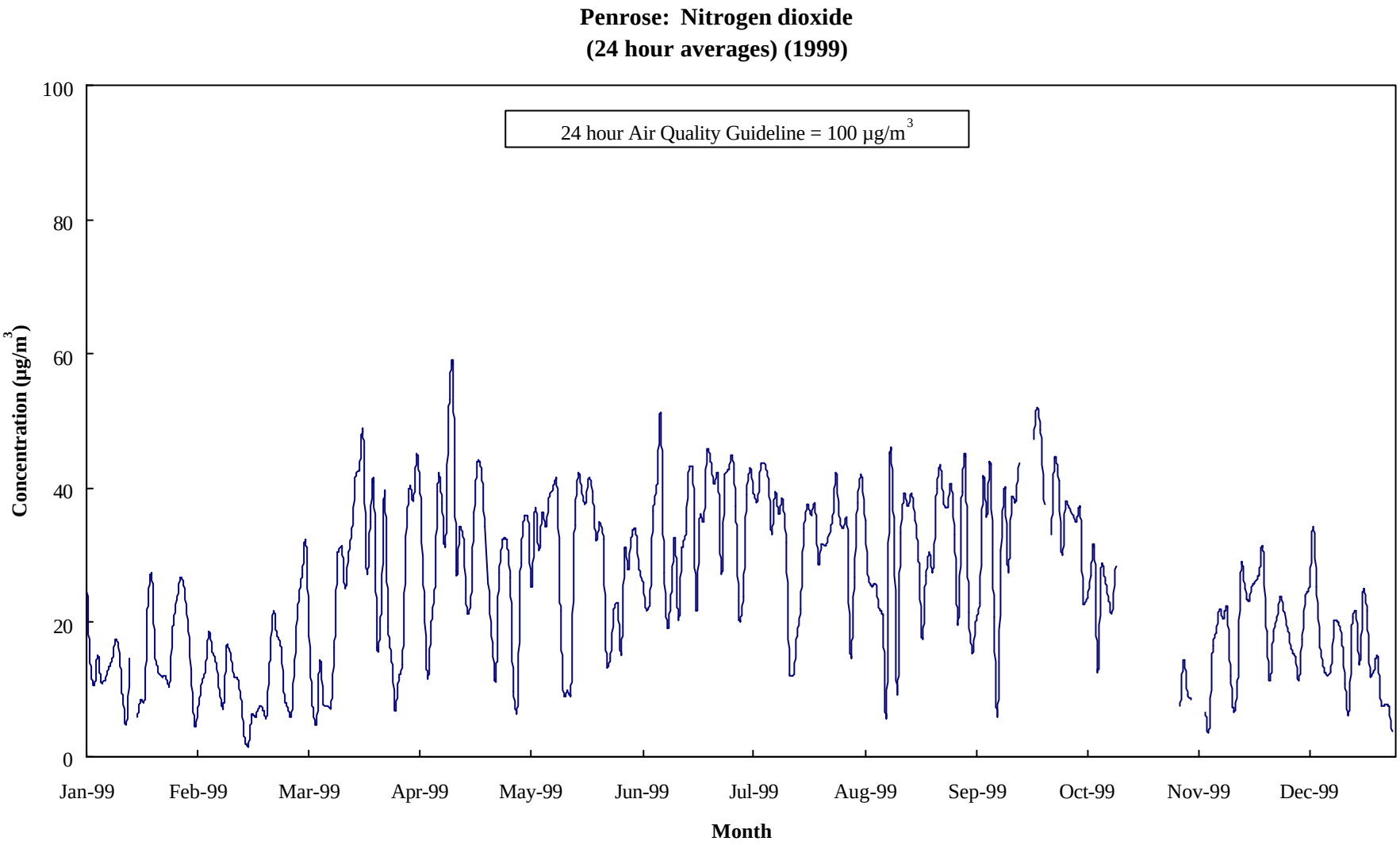


Figure 37: Penrose, Auckland - Nitrogen dioxide 24 hour Data (1999)

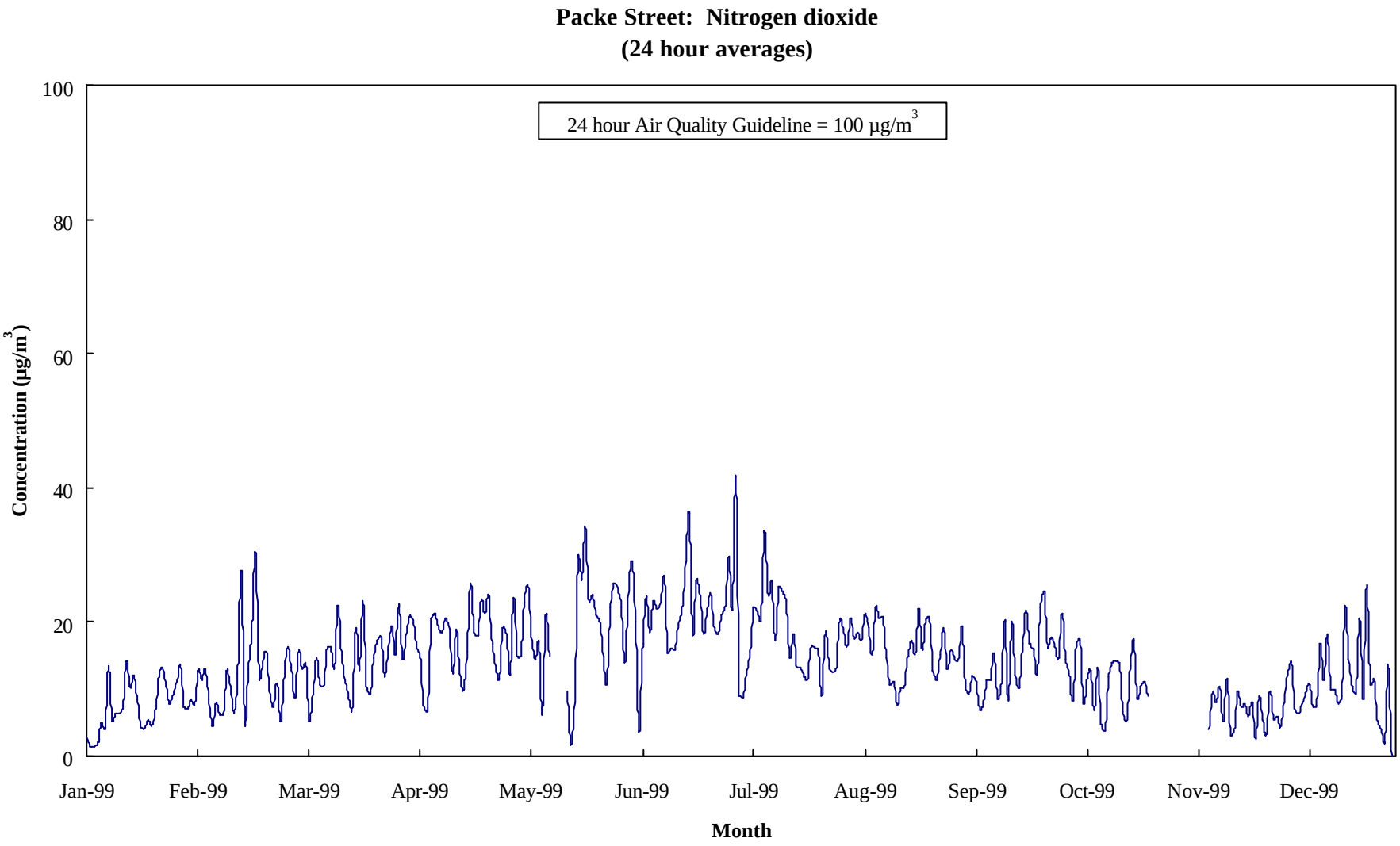


Figure 38: Packe Street, Christchurch - Nitrogen dioxide 24 hour Data (1999)

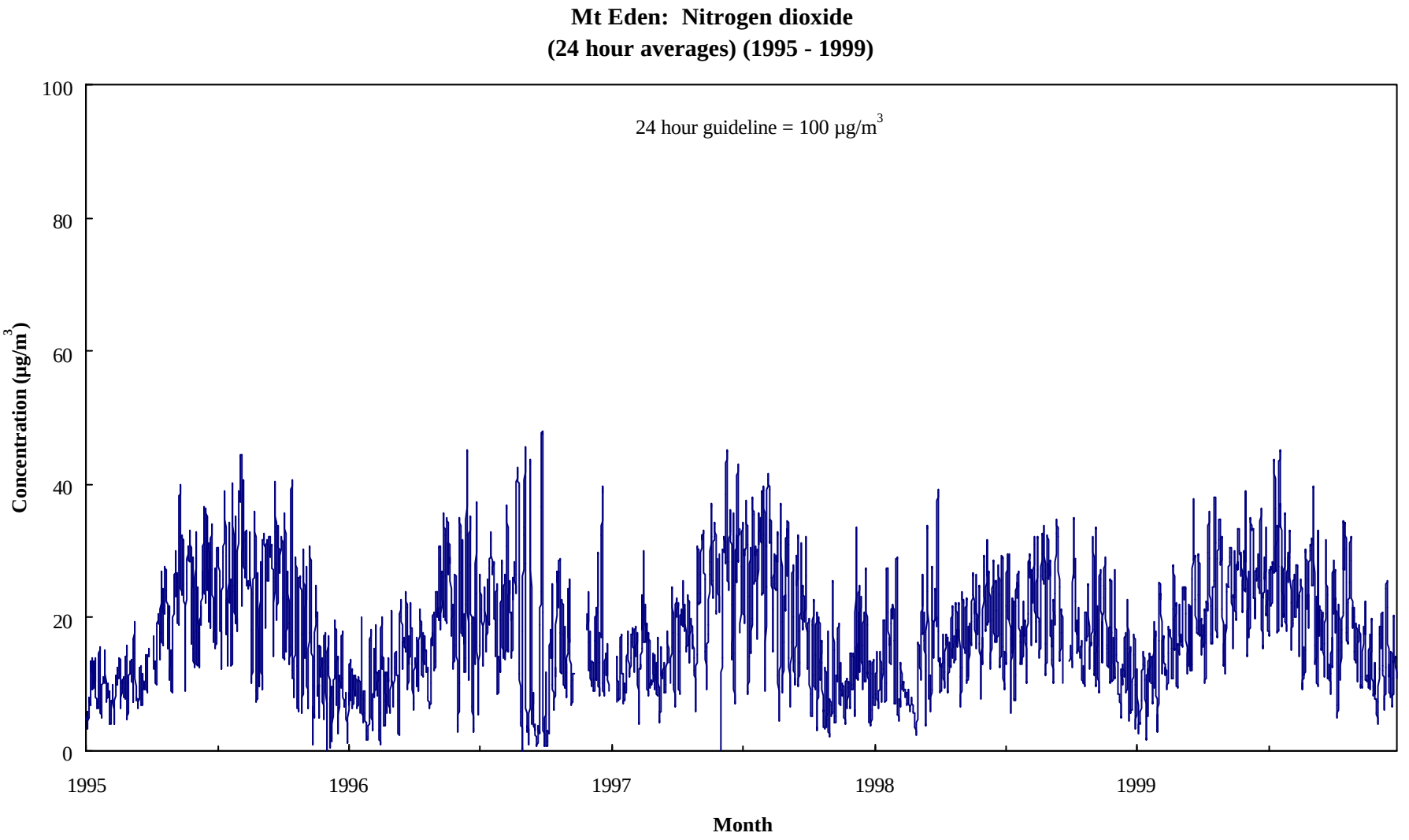


Figure 39: Mt Eden, Auckland - Nitrogen dioxide 24 hour Data (1995 - 1999)

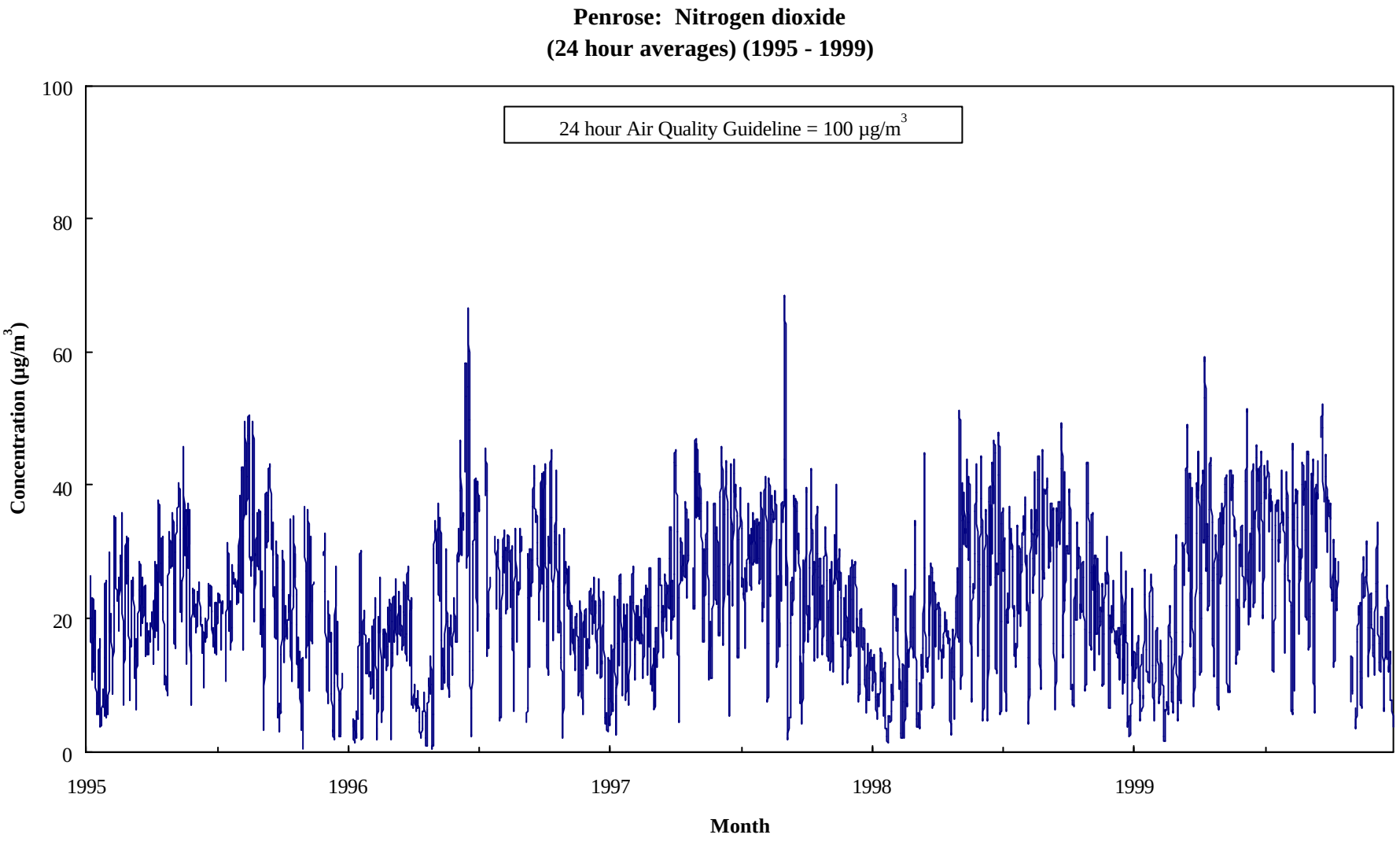


Figure 40: Penrose, Auckland - Nitrogen dioxide 24 hour Data (1995 - 1999)

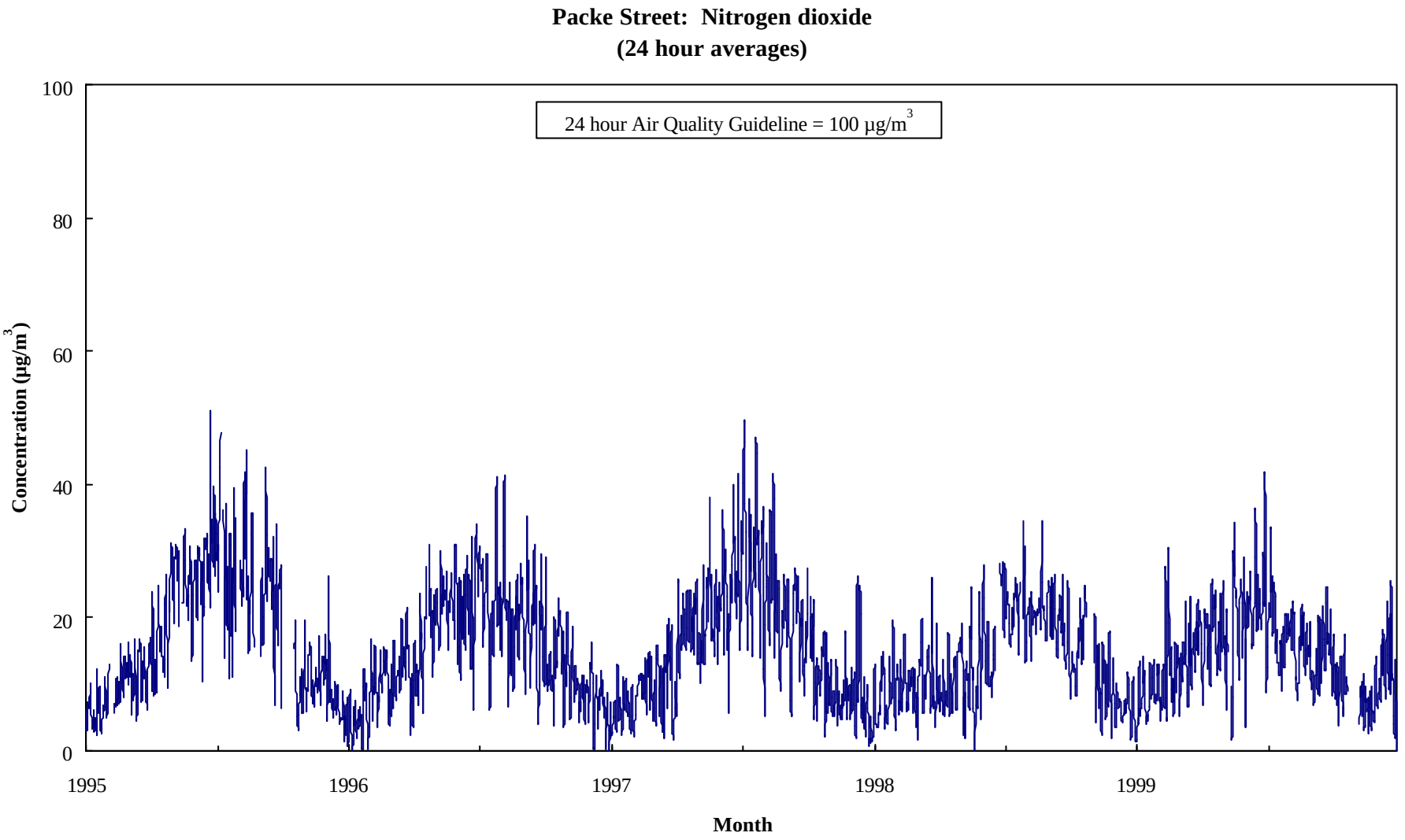


Figure 41: Packe Street, Christchurch - Nitrogen dioxide 24 hour Data (1995 - 1999)

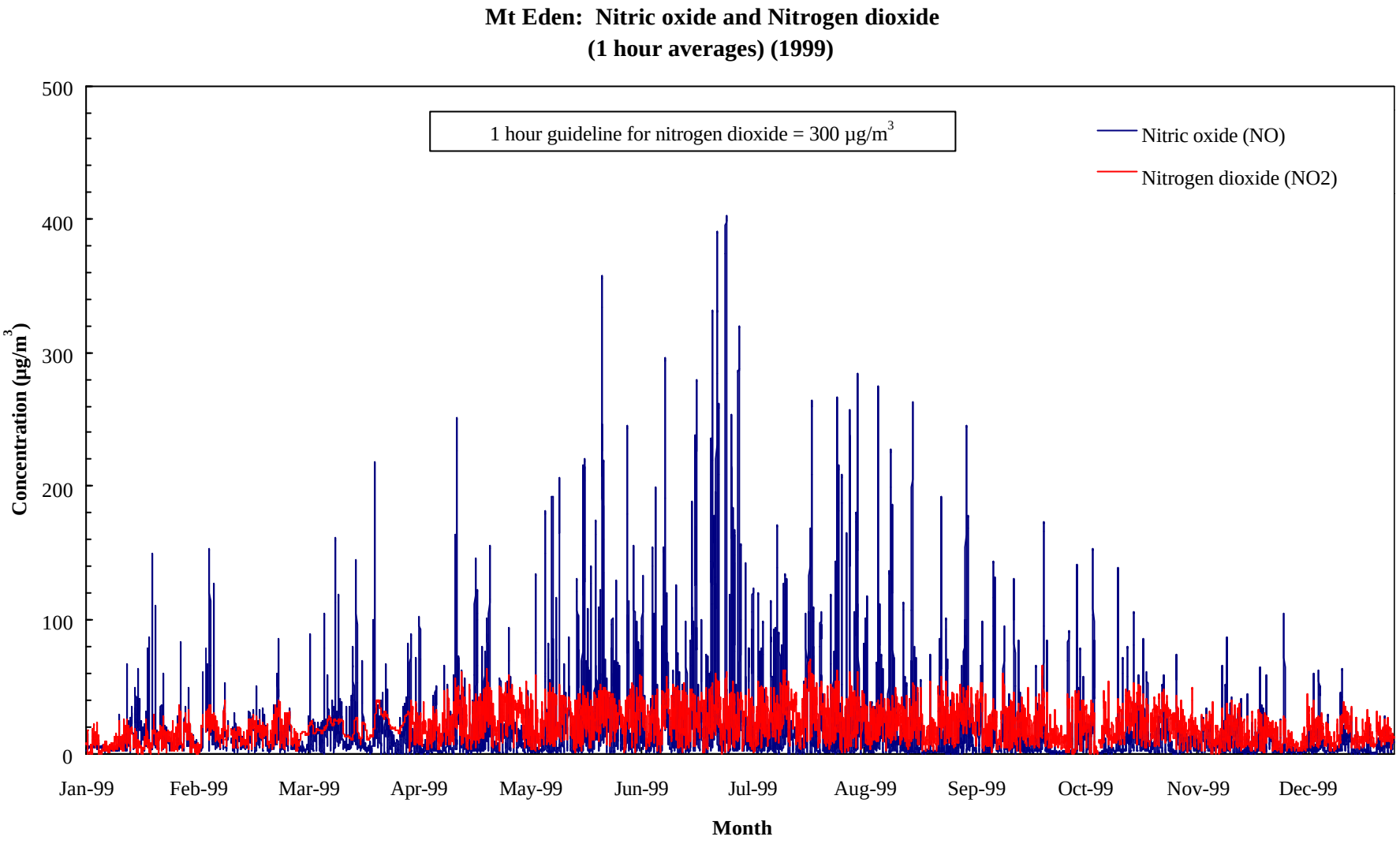


Figure 42: Mt Eden, Auckland - Nitric oxide and Nitrogen dioxide 1 hour Data (1999)

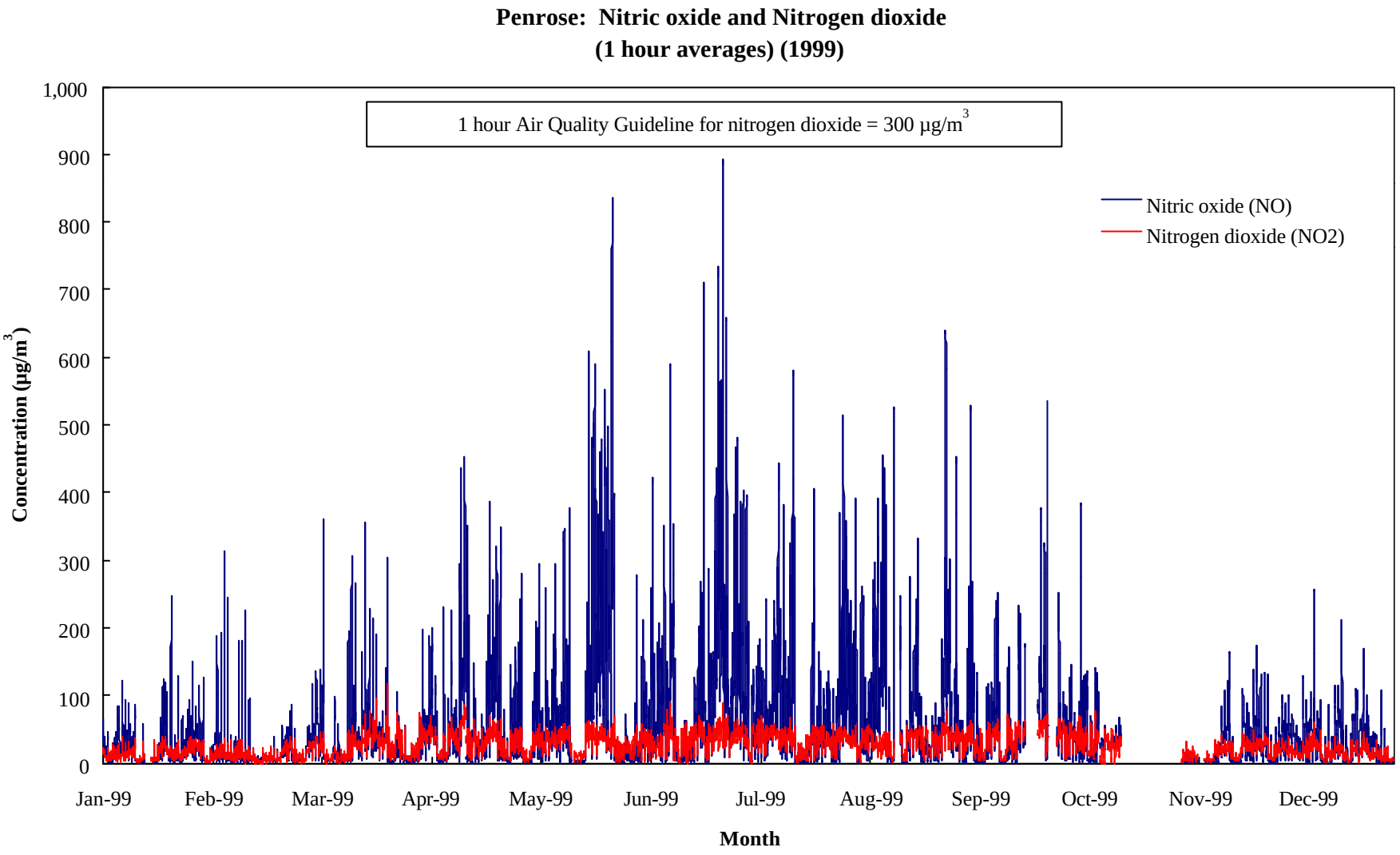


Figure 43: Penrose, Auckland - Nitric oxide and Nitrogen dioxide 1 hour Data (1999)

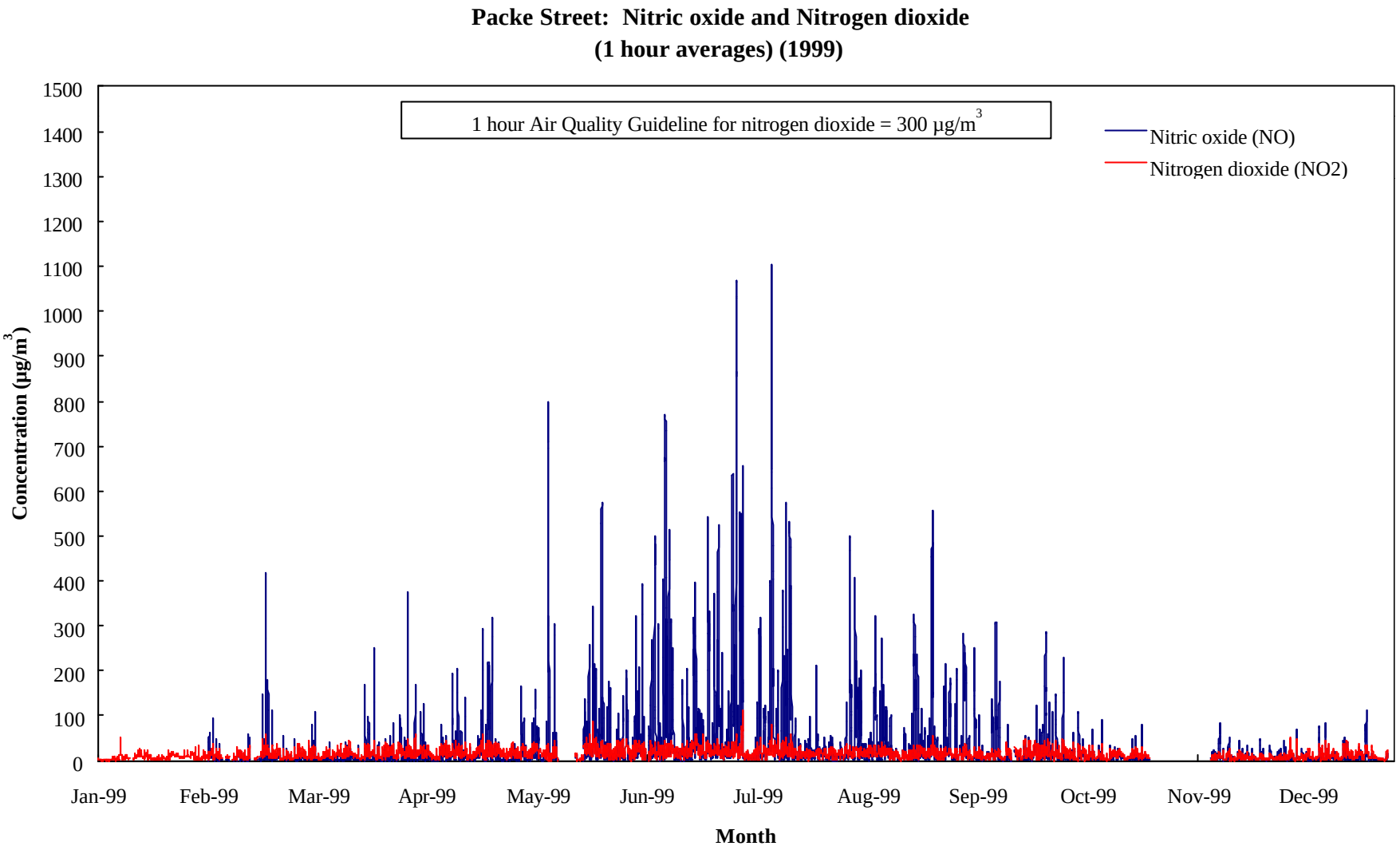


Figure 44: Packe Street, Christchurch - Nitric oxide and Nitrogen dioxide 1 hour Data (1999)

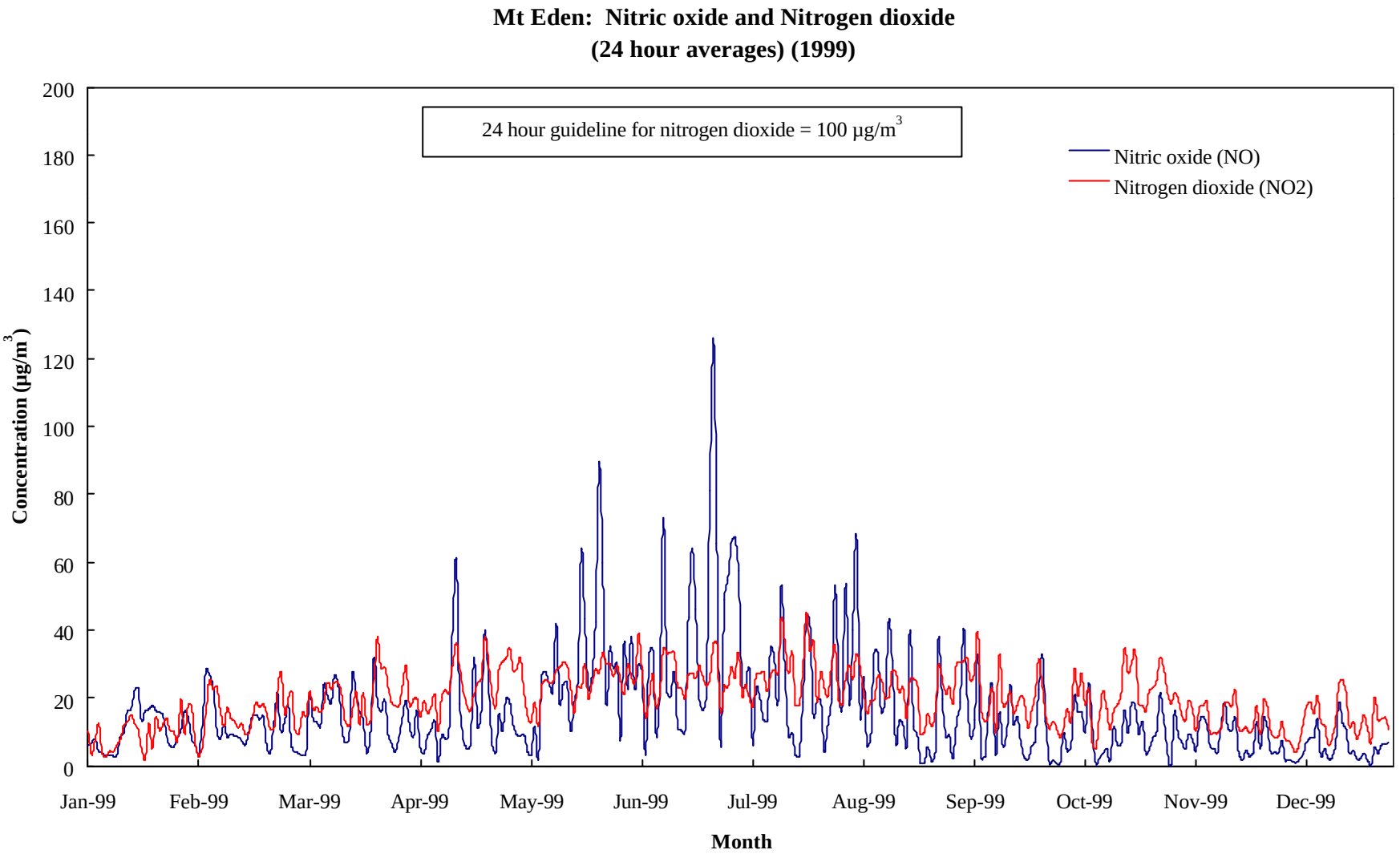


Figure 45: Mt Eden, Auckland - Nitric oxide and Nitrogen dioxide 24 hour Data (1999)

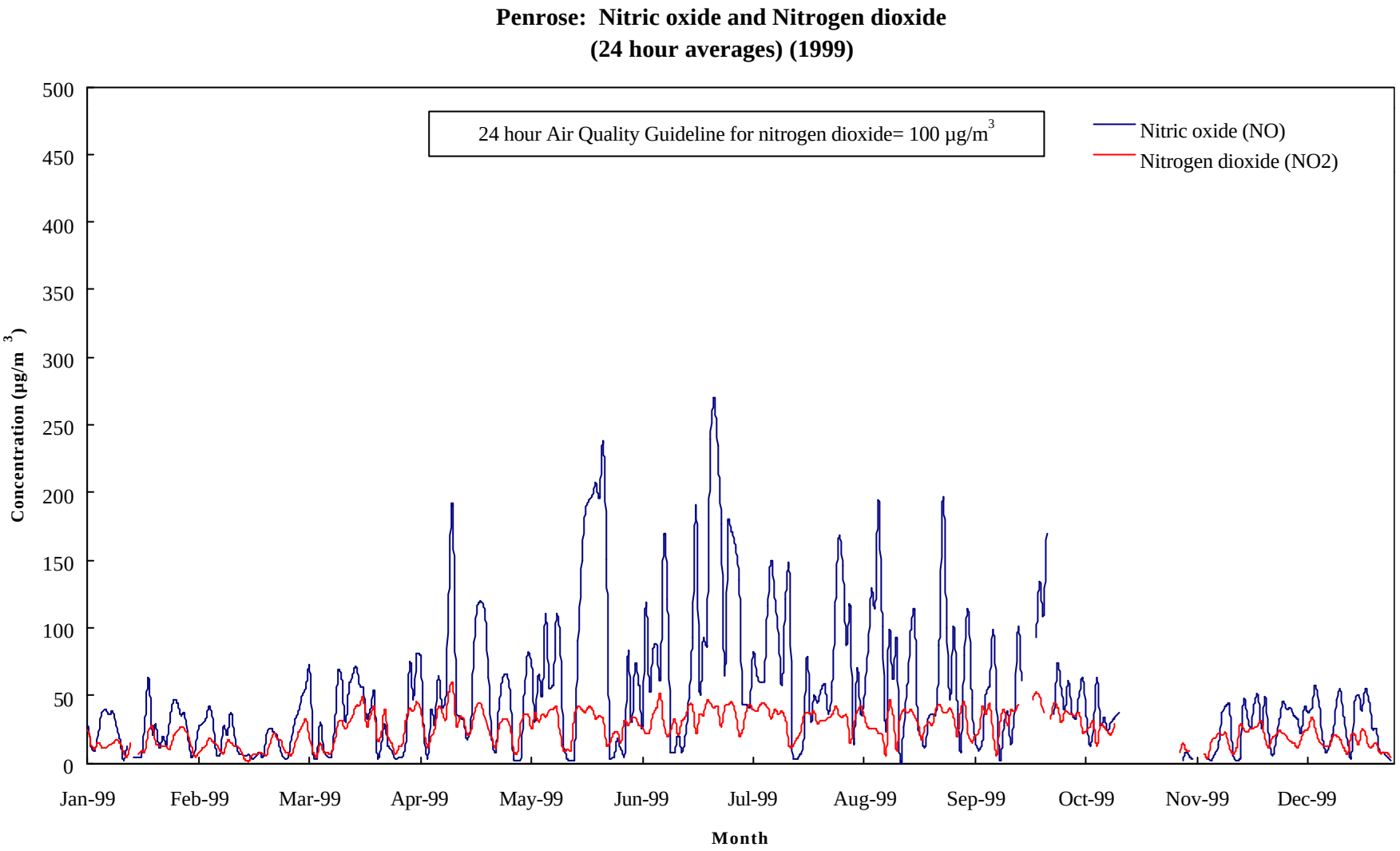


Figure 46: Penrose, Auckland - Nitric oxide and Nitrogen dioxide 24 hour Data (1999)

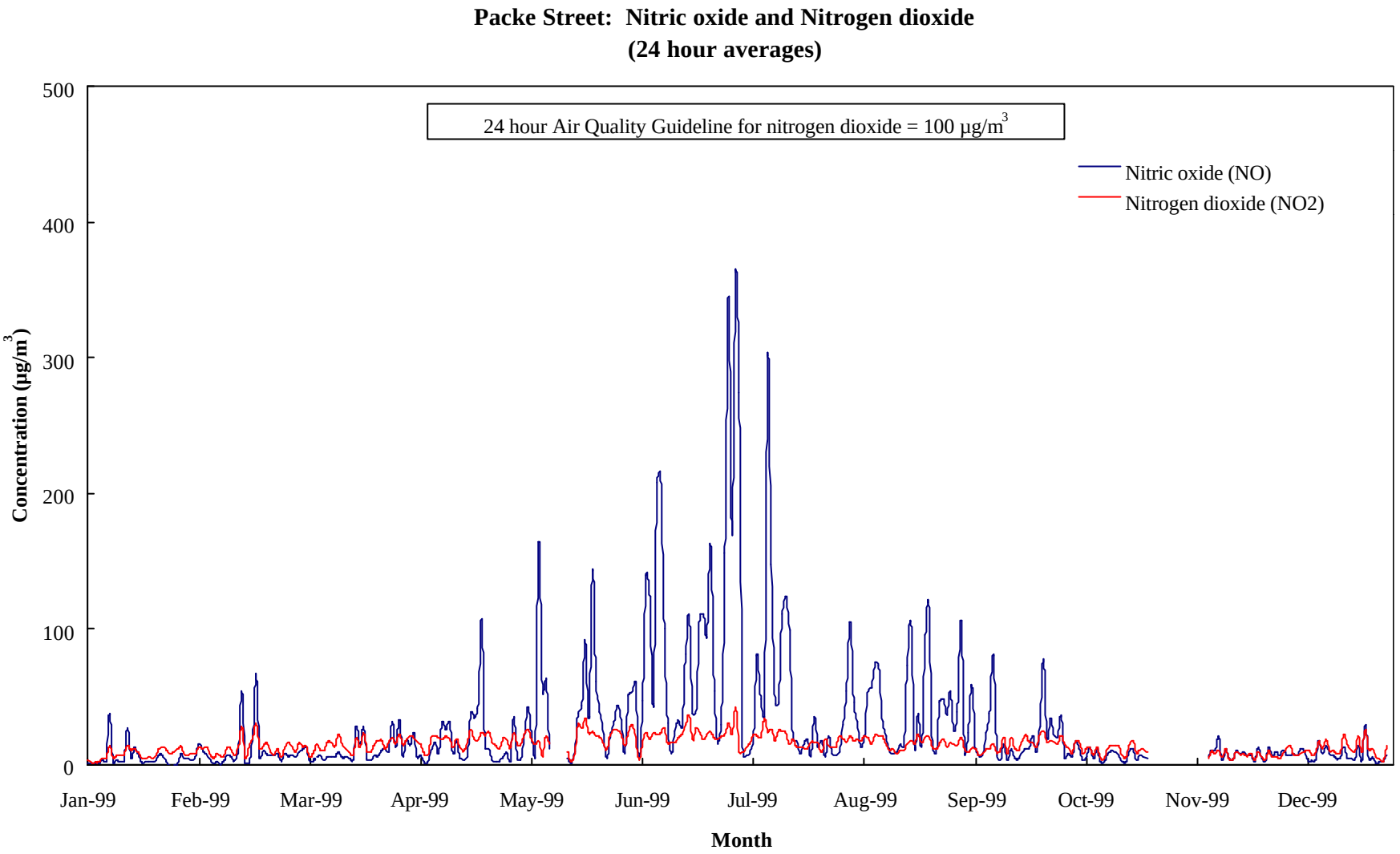


Figure 47: Packe Street, Christchurch - Nitric oxide and Nitrogen dioxide 24 hour Data (1999)

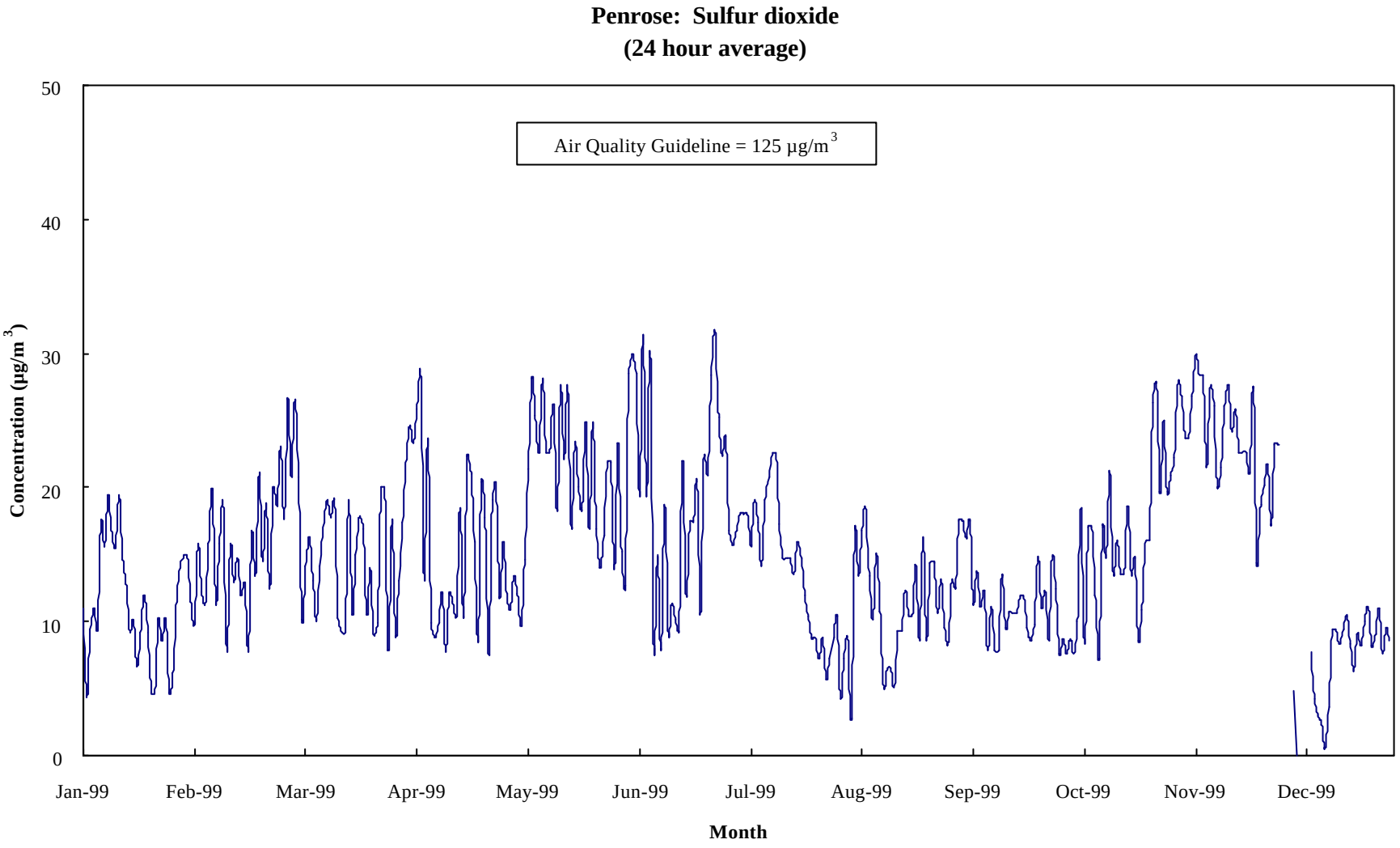


Figure 48: Penrose, Auckland Sulfur dioxide Data (1999)

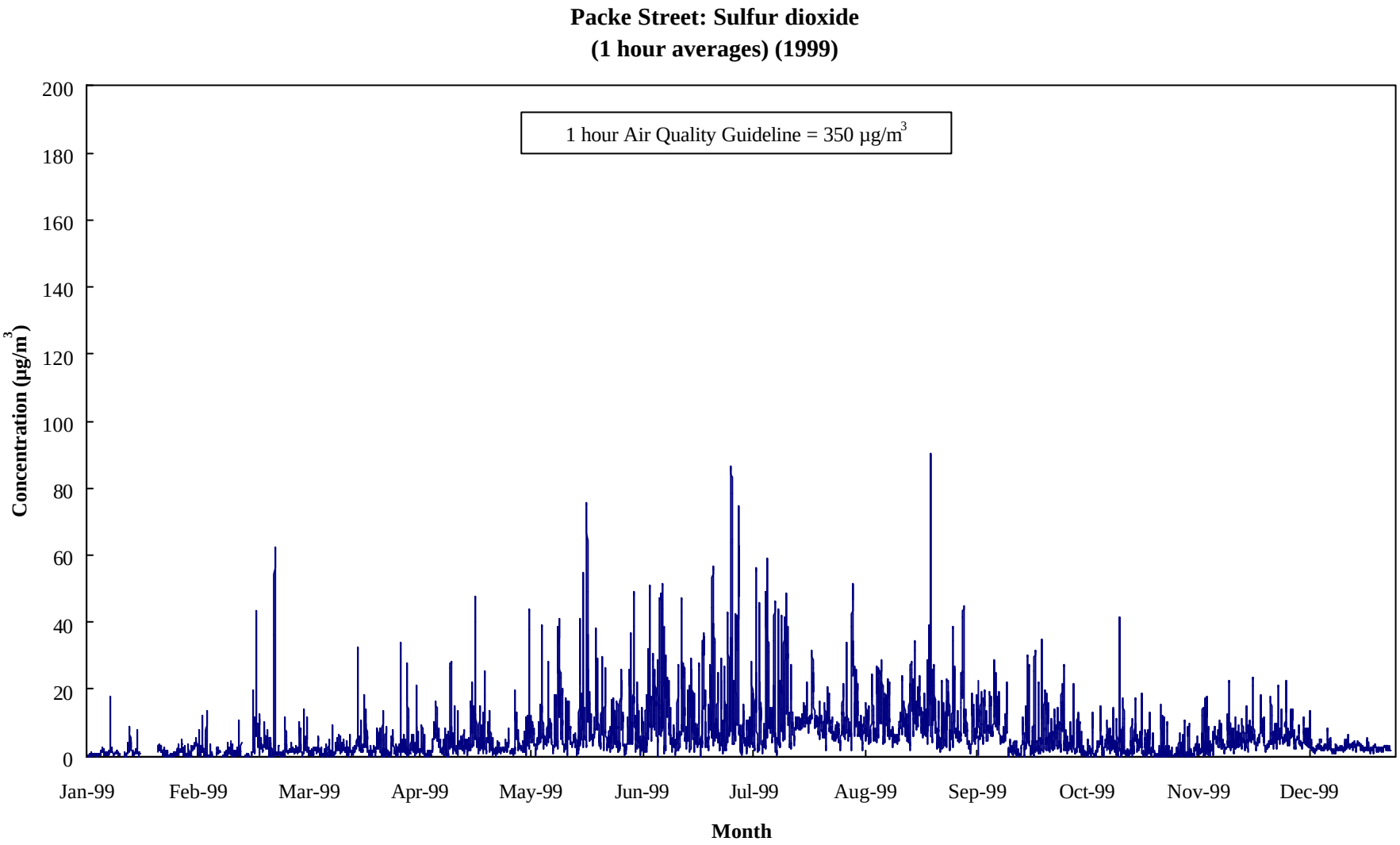


Figure 49: Packe Street, Christchurch - Sulfur dioxide 1 hour Data (1999)

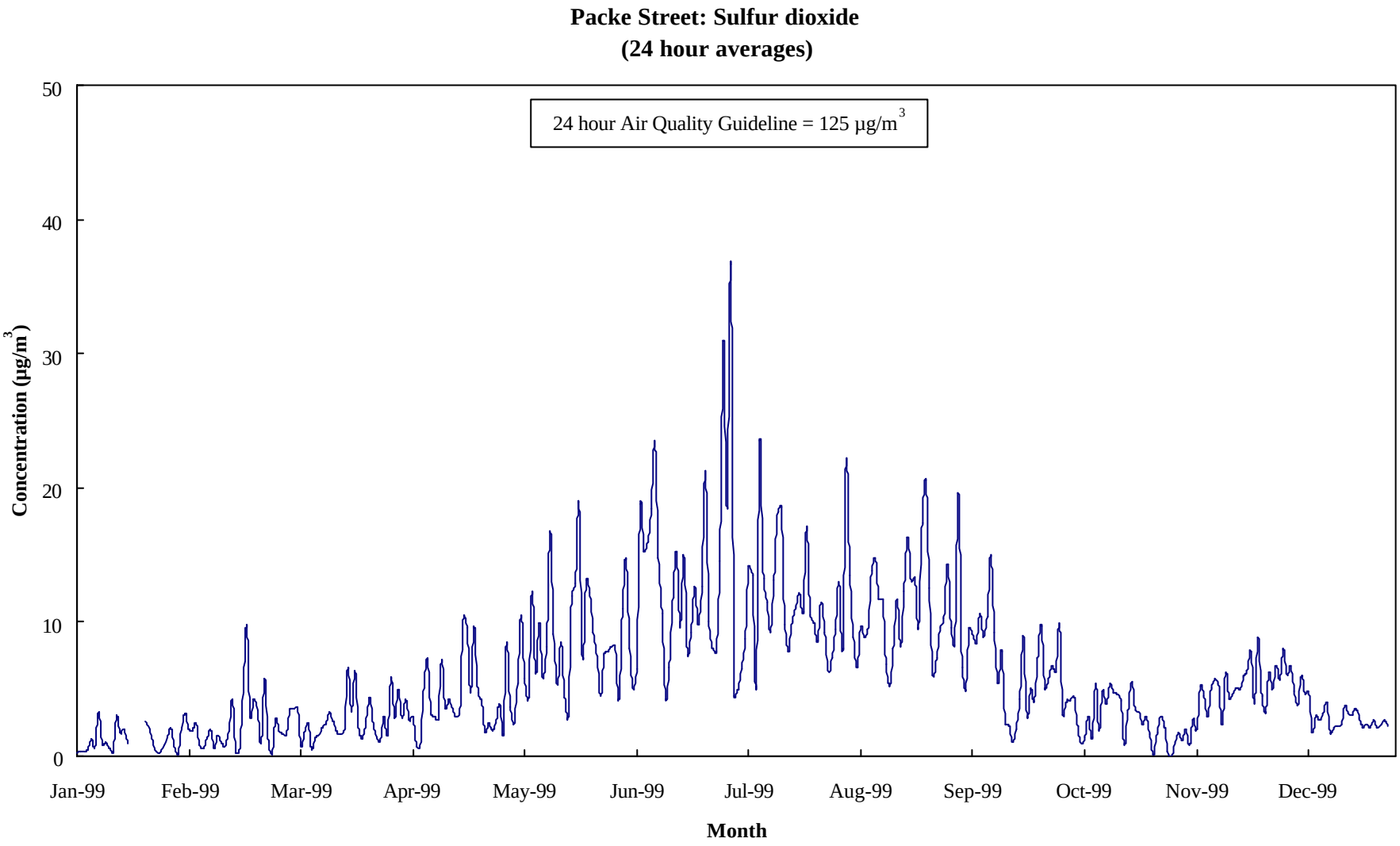


Figure 50: Packe Street, Christchurch - Sulfur dioxide 24 hour Data (1999)

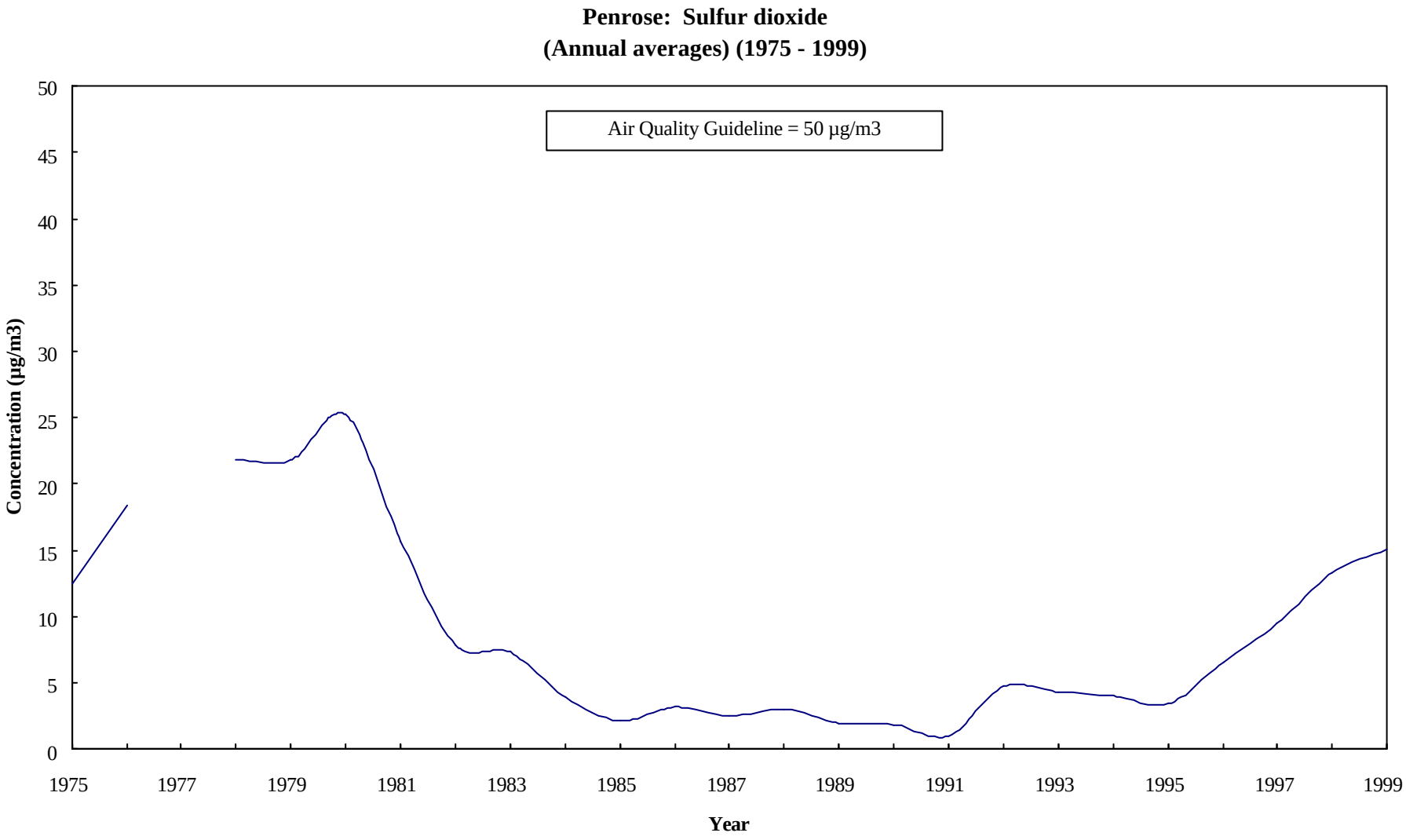


Figure 51: Penrose, Auckland Sulfur dioxide Annual Average Data (1975 - 1999)

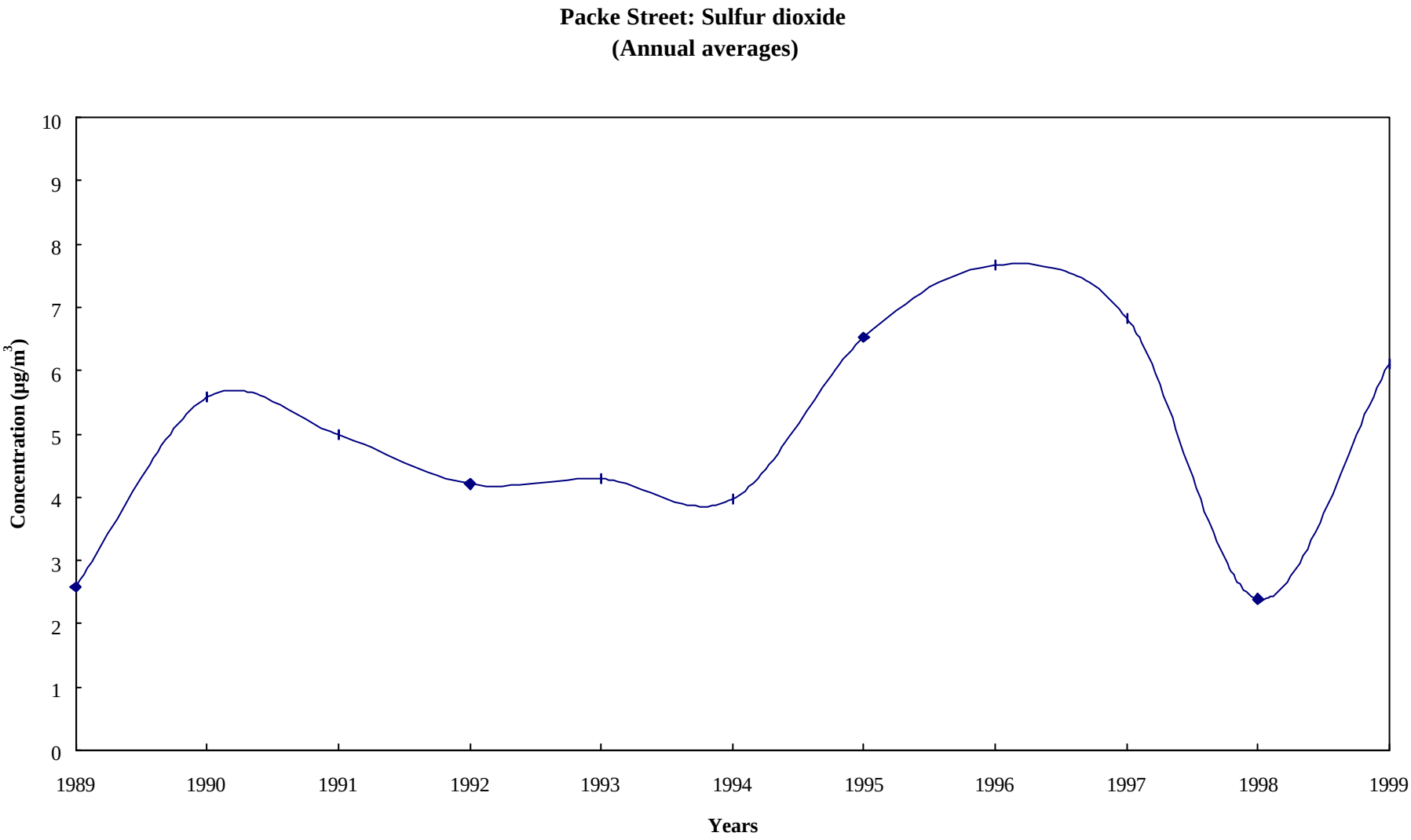


Figure 52: Packe Street, Christchurch - Sulfur dioxide Annual Average Data (1989 - 1999)

APPENDIX 1 REPORT DISTRIBUTION

Copies have been made and distributed to:

File at ESR Mt Eden Science Centre
Michael Taylor at the Ministry of Health
Auckland Regional Council
Canterbury Regional Council

Data from these sites have been or will be sent to:

Auckland Regional Council
Canterbury Regional Council
World Health Organisation (at the end of year)

Further copies of this report may be obtained at a cost from:

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Mt Eden Science Centre
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Mt Eden
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