E N V I R O N M E N T   P R O T E C T I O N   A U T H O R I T Y

Ambient Air Quality in Port Pirie South Australia
Monitoring Campaign 2002–2005

EPA South Australia

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ABBREVIATIONS

Air NEPM	National Environment (Ambient Air Quality) Protection Measure
EPA	South Australian Environment Protection Authority
HVS	high volume sampling (or sampler)
NEPM	National Environment Protection Measure
$PM_{2.5}$	particulate matter with an equivalent aerodynamic diameter of 2.5 μm or less
PM_{10}	particulate matter with an equivalent aerodynamic diameter of 10 μm or less
ppb	parts per billion (by volume)
ppm	parts per million (by volume)
TEOM	tapered element oscillating microbalance
TSP	total suspended particles
$\mu g/m^3$	micrograms per cubic metre
μm	micrometre

GLOSSARY

Average (arithmetic mean): the sum of all the values in a set of data, divided by the number of values in the set.

Australian Central Standard Time: Greenwich Mean Time plus 9½ hours

Exceedence: an occasion when a standard set under the National Environment (Ambient Air Quality) Protection Measure has been exceeded

Maximum: the largest value in a set of data

Median: the middle value in a set of data that has been placed in order from smallest to largest, or for a set with an even number of values the average of the middle two values

Percentile: a statistical parameter that represents the distribution characteristics of a set of data; the percentile is a value on a scale of 100 that indicates the percentage of the data points that are equal or lesser in value, for example 90% of the data points are equal to, or less than, the 90th percentile

Tapered element oscillating microbalance (TEOM): an appliance for determining airborne particulate matter

SUMMARY

In the years 2002 to 2005, the South Australian Environment Protection Authority conducted an ambient air quality monitoring campaign in the city of Port Pirie to complement the lead monitoring program that has been operating there for many years. The substances monitored during this campaign were sulfur dioxide, oxides of nitrogen, ozone and particulate matter, as PM_{10}. The monitoring results were compared to the standards and goals set by the National Environment Protection (Ambient Air Quality) Measure or Air NEPM (National Environment Protection Council 1998) and to the acceptance limits specified for monitoring campaigns in Technical Paper No. 4 *Screening Procedures*, prepared by the Peer Review Committee of the National Environment Protection Council (2001a).

Monitoring for sulfur dioxide showed that, while there is not a constant problem with elevated levels of sulfur dioxide, high levels of sulfur dioxide frequently occur for short periods. On average, there were 26 days per year on which the one-hour standard of 0.20 parts per million was exceeded. Most of these events occurred when the wind was blowing from the direction of the Zinifex smelter to the north-north-west of the Oliver Street monitoring site. There was no distinct annual or weekly cycle to these occasions but they all occurred between the hours of 0900 and 1900.

The monitoring campaign has demonstrated that it is necessary to continue monitoring sulfur dioxide in the ambient air of Port Pirie. The monitoring equipment installed for this campaign will continue in operation at the Oliver Street monitoring site.

During the monitoring campaign, the daily average concentration of particulate matter (PM_{10}) exceeded the standard set by the Air NEPM on an average of five days a year. In the 2004 calendar year, the daily average exceeded the Air NEPM standard on four days. The Air NEPM goal is that there should not be more than five days per year on which the standard is exceeded, so the site complies with the Air NEPM requirement.

There were, on average, 40 days per year on which the daily average concentration of particulate matter, as PM_{10}, exceeded the acceptance limit set for campaign monitoring sites. The screening procedures specify that monitoring should continue for particulate matter, as PM_{10}, in Port Pirie. The tapered element oscillating microbalance (TEOM) monitoring unit installed for this campaign will remain in operation at the Oliver Street monitoring site.

Some of the monitoring data for ozone appeared to be inconsistent with the characteristics expected for ozone pollution and this has been attributed to interference by another pollutant. An analysis of edited data indicates that the ozone levels complied with the standards and goals of the Air NEPM and that the maximum one-hour and four-hour ozone concentrations were at all times below the acceptance limits specified for campaign monitoring sites. However, further work is required to characterise this unidentified pollutant and to provide reliable data on the levels of ozone in the ambient air of Port Pirie.

Monitoring for nitrogen dioxide demonstrated that the annual average and the one-hour average nitrogen dioxide concentrations complied with the standards and goals of the Air NEPM and that the maximum one-hour average nitrogen dioxide concentrations were at all times below the acceptance limit specified for campaign monitoring sites. However, the screening procedures recommend that nitrogen oxides should be monitored with ozone so these substances should be monitored if further monitoring for ozone is undertaken in Port Pirie.

INTRODUCTION

The city of Port Pirie is situated on the estuary of the Pirie River on the eastern shore of Spencer Gulf in South Australia, adjacent to the Southern Flinders Ranges. With a population of 16,000, Port Pirie is South Australia's fourth largest urban area. The city is located in the vicinity of latitude 33° 10' south and 138° 02' east, and is 230 km north of Adelaide.

The metal smelter operated by Zinifex Limited in Port Pirie is the largest industrial facility, and the largest employer, in Port Pirie. It was established in 1889 to process lead concentrate from the Broken Hill mines in New South Wales. It is the largest primary lead smelter in the world, with a production capacity of 245,000 tonnes per year. The smelter also produces silver, zinc, copper and gold. Sulfur dioxide removed from the process exhaust gases is used for the manufacture of sulfuric acid. The plant's 205-metre 'tall stack' dominates the Port Pirie skyline.

Lead emissions from the smelter are the highest priority environmental issue in Port Pirie and have been the subject of monitoring and studies for the past 35 years. The latest South Australian Department of Health report on the lead pollution problem in Port Pirie, *The Port Pirie Lead Implementation Program: Future Focus and Directions* (2005) indicates that blood lead levels in young children are no longer decreasing.

Zinifex Limited has committed $56 million to reduce lead emissions from the smelter. The objective of this program is to ensure that by 2010 at least 95% of the city's young children have blood lead levels below the national goal of 10 micrograms (μg) per decilitre.

Currently in Port Pirie, the South Australian Environment Protection Authority (EPA) operates four monitoring sites for lead and particulate matter. At the Oliver Street site (chosen for this monitoring campaign), particulate matter, as PM_{10} and total suspended particles (TSP), along with lead determinations on the collected samples, have been monitored since 1998, using high volume sampling (HVS). The site was previously used between May 1984 and August 1988 to monitor lead and particulate matter, as PM_{10} and TSP. The other EPA monitoring sites in Port Pirie are located at the Port Pirie West Primary School, The Terrace (since 1995); Frank Green Park, Senate Road (since 1999); and in Ellen Street, near the boundary of the lead smelter (operating from 1995 to 1998 and resuming in 2001).

Port Pirie has mean daily maximum temperatures ranging from 16°C in July to 32°C in January and February. Average annual rainfall is 345 mm. The prevailing wind is a combination of local and continental sea breeze that blows from the south up the Spencer Gulf, which is bounded by the Middleback Range to the west and the Southern Flinders Ranges to the east. The next most frequent wind direction is north-westerly, which prevails in the winter months. Winds from the west or the east are less frequent. Wind roses summarising the wind data obtained at the monitoring site in the 2004 calendar year are provided in Appendix 1.

The EPA monitoring site at Oliver Street (Figure 1) was chosen for this monitoring campaign because it is considered to be representative of the residential areas of Port Pirie. It is located approximately 3 km south-south-east of the Zinifex smelter. Key dates of the campaign are given in Table 1.

Table 1 Key dates for atmospheric monitoring at Oliver Street, Port Pirie, 2002–2005

Substance monitored	Campaign start	Campaign end	Monitoring period (days)
Sulfur dioxide	26 June 2002	31 July 2005	1132
Nitrogen dioxide	28 May 2002	31 July 2005	1161
Ozone	10 May 2002	31 July 2005	1179
Particulate matter, as PM_{10}, by TEOM	28 June 2003	31 July 2005	765

The substances monitored at the Oliver Street site during the monitoring program were sulfur dioxide, nitrogen oxides, ozone and particulate matter, as PM_{10}. Appendix 2 contains the technical details of the site and the atmospheric monitoring equipment used for the monitoring campaign. Meteorological conditions were monitored at the site throughout the campaign by recording temperature, barometric pressure, total solar radiation, wind speed, wind direction and sigma theta (a parameter that indicates the variability of wind direction during the averaging period).

In June 2001, the EPA published the *Ambient Air Quality Monitoring Plan for South Australia* to ensure that ambient air quality monitoring in South Australia would be consistent with other states. This plan includes information on the requirements for monitoring in populous regions, the placement of air monitoring sites, instrumentation, data collection, management and reporting. A review of the monitoring plan, *South Australian Ambient Air Quality Monitoring Program—A Review,* was published in May 2005.

The primary objective of this document is to report the results of an air monitoring campaign in Port Pirie to fulfil the commitment made in the Ambient Air Quality Monitoring Plan for South Australia. The atmospheric lead monitoring data collected at the Oliver Street site from 1998 to 2005, as part of the long-term EPA lead monitoring program in Port Pirie, is included to provide a full record of atmospheric monitoring data for the site.

For the purposes of this report, the monitoring campaign concluded on 31 July 2005; however, the EPA continues to monitor for sulfur dioxide and particulate matter at this site.

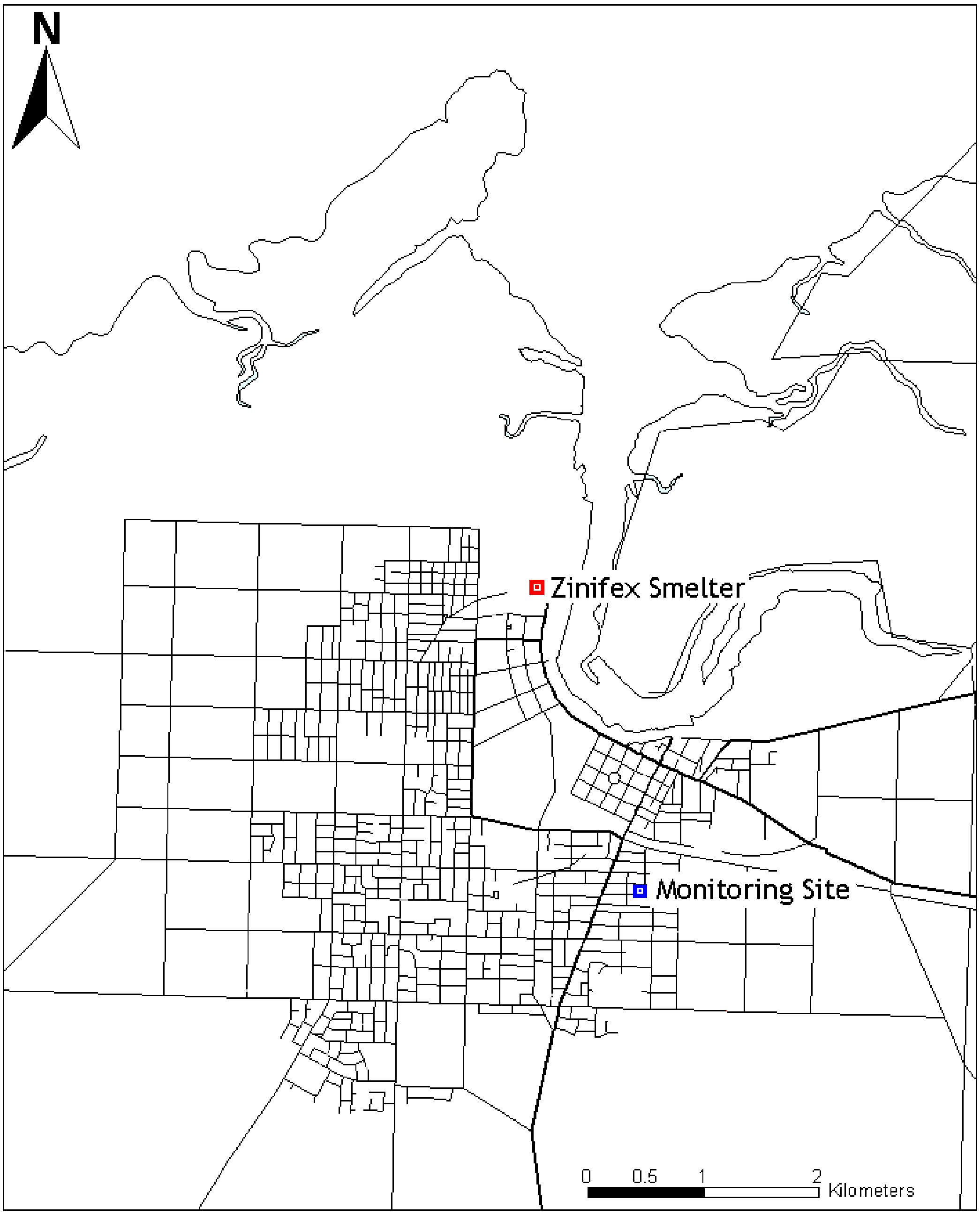

Figure 1 Port Pirie, showing the location of the Oliver Street monitoring site

AIR QUALITY STANDARDS, GOALS AND SCREENING PROCEDURES

South Australia has enacted the National Environment Protection (Ambient Air Quality) Measure or Air NEPM (NEPC 1998) as the required standard for six common pollutants: carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, lead and particulate matter as PM_{10}. The Air NEPM sets standards and goals at levels that protect human health and wellbeing, aesthetic enjoyment and local amenity.

The standards are set as concentrations in parts per million (ppm) or, for particulate matter, as micrograms per cubic metre ($\mu g/m^3$) against which air quality can be assessed. The goals in the Air NEPM specify a maximum permissible number of days per year when the standards can be exceeded and a timeframe of 10 years (1998–2008) within which these goals must be met.

The monitoring program in Port Pirie was implemented to determine if there was a need for continued monitoring for sulphur dioxide, ozone and nitrogen oxides in the city. Therefore, the data from the program was also compared to the acceptance limits specified in Technical Paper No. 4, *Screening Procedures*, published by the Peer Review Committee of the National Environment Protection Council (2001a). These acceptance limits are transparent criteria that can be used to demonstrate that pollutant levels can reasonably be expected to be consistently lower than the Air NEPM standards. If acceptance limits are met, continuing air quality monitoring need not take place in the area under consideration.

The screening procedures aim to maintain a conservative approach and state that the maximum predicted or measured concentration (except for particulate matter as PM_{10}) should be used for comparison with the acceptance limit, even though the Air NEPM goal may permit a maximum number of days per year when the standard can be exceeded. For pollutants with standards for more than one averaging period, the acceptance limit to be used is that of the standard which is most difficult to meet in any given region; in most cases this is the shortest averaging period.

For particulate matter, as PM_{10}, screening is not easy in centres subject to smoke from wood fires or prescribed burning. High concentrations of smoke from wood fires occur locally under near calm conditions. Large prescribed burn plumes impact small and large centres alike over hundreds of kilometres. The acceptance limits are intended to apply to the fifth highest daily reading, where the higher readings can be shown to be due to bushfires or controlled burning.

To demonstrate annual compliance, the Peer Review Committee (2001b) requires 75% of annual data and at least 75% of each calendar quarter data to be available to cover possible seasonal effects in pollutant behaviour. Years with less than 75% data availability can still demonstrate non-compliance if the number of days when the standard is exceeded is greater than the goal specified by the Air NEPM.

Sulfur dioxide, nitrogen dioxide and ozone were monitored for full calendar years in 2003 and 2004, and the quarterly data recovery rates met the 75% requirement. In 2002 and 2005, the monitoring did not cover a full calendar year, so did not meet the requirements for compliance reporting.

Particulate matter, as PM_{10}, was monitored for the full calendar year in 2004 and the quarterly data recovery rates met the 75% requirement specified by the Peer Review Committee (2001b). In 2003 and 2005, monitoring did not cover a full calendar year so did not meet the requirements for compliance reporting.

SULFUR DIOXIDE

Sulfur dioxide is a gas generated by the processing of sulfide ores or by the combustion of fuels that contain sulfur. Ambient levels of sulfur dioxide have been associated with increases in daily mortality, hospital admissions and emergency room attendances for respiratory and cardiovascular disease, and respiratory symptoms and decreases in lung function. Ambient sulfur dioxide levels have a high correlation with other pollutants, especially particles; so it is difficult to confidently attribute observed effects to sulfur dioxide alone (NEPC 2000).

The levels of sulfur dioxide in ambient air were monitored from 26 June 2002 to 31 July 2005. During this time, the annual average and daily average sulfur dioxide concentrations complied with the standards and goals of the Air NEPM (Table 2). However, there were on average 26 days per year on which the one-hour standard of 0.20 ppm specified by the Air NEPM for sulfur dioxide was exceeded.

While the yearly average sulfur dioxide concentrations did not exceed the acceptance limit specified for campaign monitoring sites (Table 3), both the daily average and the one-hour average sulfur dioxide concentrations exceeded the acceptance limits for campaign monitoring sites. There were, on average, two days per year on which the one-day average exceeded the acceptance limit, and 55 days per year on which the daily maximum one-hour average exceeded the acceptance limit.

Table 2 Air NEPM standards and goals for sulfur dioxide

Pollutant	Averaging period	Maximum concentration	Goal within 10 years: maximum allowable exceedences
Sulfur dioxide	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None

Table 3 Acceptance limits for sulfur dioxide

Pollutant	Acceptance limit: percentage of Air NEPM standard	Averaging period	Acceptance limit
Sulfur dioxide	60% for two or more years of data	1 hour	0.120 ppm
		1 day	0.048 ppm
		1 year	0.012 ppm

Annual average

In the calendar years 2003 and 2004, the annual average sulfur dioxide concentration was lower than the standard set by the Air NEPM (Table 4).

In 2002 and 2005, when the monitoring did not cover a full calendar year, the average sulfur dioxide concentrations recorded for these periods were lower than the standard set by the Air NEPM.

During the campaign, the yearly average sulfur dioxide concentrations did not exceed the acceptance limit specified for campaign monitoring sites.

Table 4 Sulfur dioxide, annual average concentrations, compliance with standard and acceptance limit

Year	Data recovery, % hours	Annual average, (ppm)	Did site meet NEPM standard and goal?	Did site meet acceptance limit?
2002*	51	0.010	See *	Yes
2003	96	0.008	Yes	Yes
2004	97	0.008	Yes	Yes
2005†	54	0.008	See †	Yes

* Incomplete data for 2002: monitoring campaign started 26 June 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

One-day average

In the calendar year 2003, the Air NEPM standard of 0.08 ppm for the one-day average sulfur dioxide concentration was exceeded on one day. The goal set by the Air NEPM permits one day per year on which the standard may be exceeded and so was met. In the calendar year 2004, there were no days that exceeded the Air NEPM standard (Table 5).

In 2002 and 2005, when monitoring did not cover a full calendar year, the one-day average sulfur dioxide concentrations recorded during these periods were lower than the Air NEPM standard.

During the monitoring campaign, there were, on average, two days per year on which the one-day average exceeded the acceptance limit.

Table 5 Sulfur dioxide, one-day average concentrations and compliance

Year	Number of days NEPM standard exceeded	Did site meet NEPM standard and goal?	Number of days acceptance limit exceeded	Did site meet acceptance limit?
2002*	0	Incomplete	1	No
2003	1	Yes	3	No
2004	0	Yes	1	No
2005†	0	Incomplete	2	No

* Incomplete data for 2002: monitoring campaign began 26 June 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

Further statistics on sulfur dioxide one-day average concentrations from the Oliver Street site are given in Table 6 and Figure 2.

Table 6 Sulfur dioxide, one-day average concentrations, statistics

Year	Annual data recovery (% days)	Annual average (ppm)	Annual maximum (ppm)	Percentiles 99th (ppm)	95th (ppm)	90th (ppm)
2002*	52	0.010	0.050	0.045	0.035	0.029
2003	97	0.008	0.095	0.043	0.024	0.018
2004	100	0.008	0.051	0.039	0.028	0.022
2005†	55	0.008	0.058	0.038	0.026	0.019

* Incomplete data for 2002: monitoring campaign began 26 June 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

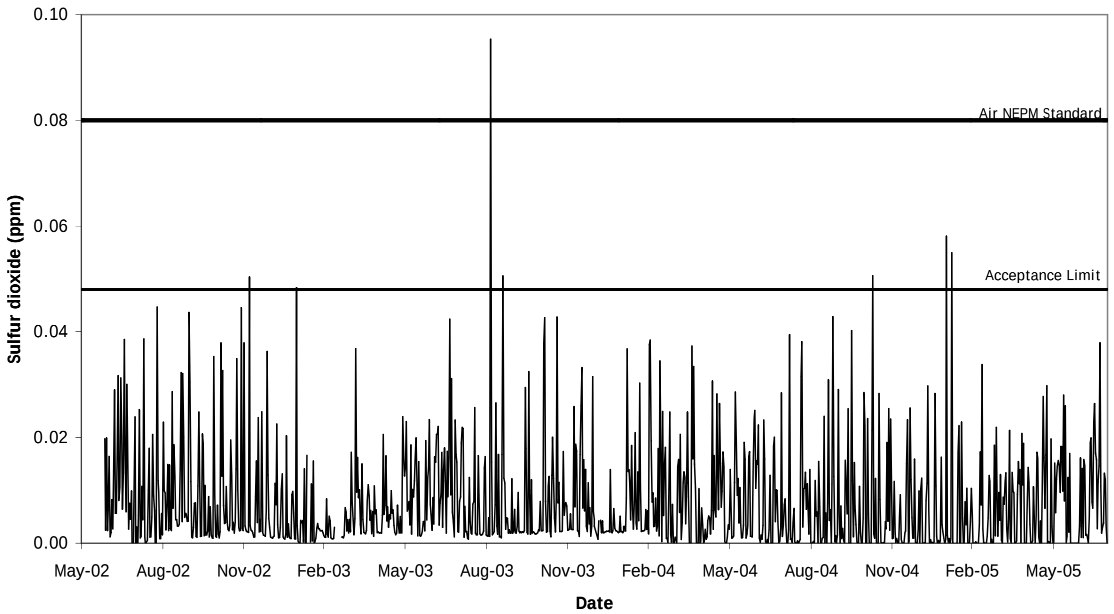

Figure 2 Sulfur dioxide, one-day average concentrations versus standard and acceptance limit

One-hour average

During the period of the monitoring campaign, the Air NEPM one-hour standard for sulfur dioxide was exceeded on many days. On average, the daily maximum one-hour average exceeded the Air NEPM standard on 26 days per year. The Air NEPM goal allows the standard to be exceeded on only one day per year (Table 7).

In the calendar years 2003 and 2004, the daily maximum one-hour average exceeded the Air NEPM standard on 21 days and 31 days respectively, so the site did not meet the Air NEPM goal for the one-hour average.

In 2002 and 2005, when monitoring did not cover a full calendar year, the Air NEPM standard was exceeded on 16 and 13 days respectively. This is more than the Air NEPM goal of not more than one day per year, so the site did not meet the Air NEPM goal for the one-hour average in 2002 and 2005.

During the period of monitoring, the daily maximum one-hour average exceeded the acceptance limit set for campaign monitoring sites, on average, 55 days per year.

Table 7 Sulfur dioxide, one-hour averages, compliance with standard and acceptance limit

Year	Number of days NEPM standard exceeded	Did site meet NEPM standard and goal?	Number of days acceptance limit exceeded	Did site meet acceptance limit?
2002*	16	No‡	32	No
2003	21	No	46	No
2004	31	No	58	No
2005†	13	No‡	36	No

* Incomplete data for 2002: monitoring campaign began 26 June 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

‡ Although the monitoring period did not cover a complete year, the number of days on which the standard was exceeded is greater than the Air NEPM goal

Further statistics on sulfur dioxide one-hour averages are given in Table 8 and Figure 3.

Table 8 Sulfur dioxide, one-hour average concentrations, statistics

Year	Annual data recovery (% hours)	Annual average (ppm)	Annual maximum (ppm)	Percentiles‡ 99th (ppm)	95th (ppm)	90th (ppm)
2002*	51	0.010	0.656	0.146	0.048	0.021
2003	96	0.008	0.487	0.113	0.035	0.014
2004	97	0.008	0.440	0.129	0.039	0.017
2005†	54	0.008	0.721	0.128	0.044	0.020

* Incomplete data for 2002 year: monitoring began 26 June 2002

† Incomplete data for 2005 year: monitoring campaign ended 31 July 2005

‡ Percentiles have been calculated from all one-hour averages, not from the peak daily one-hour averages

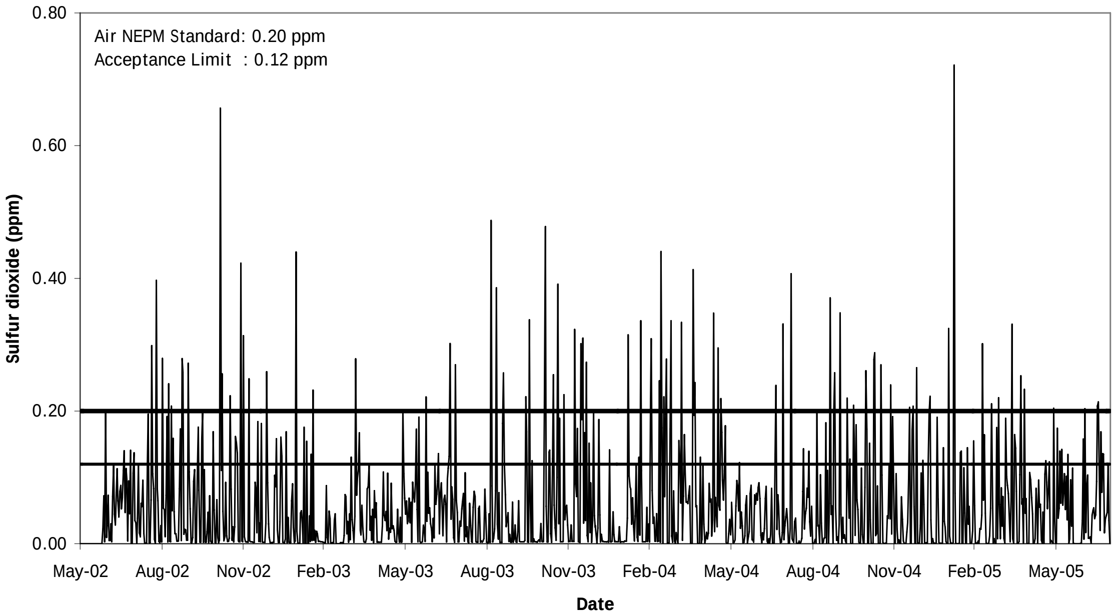

Figure 3 Sulfur dioxide, daily maximum one-hour average concentrations versus standard and acceptance limit

NITROGEN DIOXIDE

Nitrogen dioxide is a gas generated by combustion processes. Exposure to nitrogen dioxide has been associated with increases in daily mortality, hospital admissions and emergency room attendances for cardiovascular and respiratory disease, and respiratory illness and symptoms, and decreases in lung function. The elderly, asthmatics, children and people with existing disease are particularly susceptible to the effects of nitrogen dioxide (NEPC 2000).

Levels of nitrogen dioxide in the ambient air were monitored from 28 May 2002 to 31 July 2005. During this time, the annual average and the one-hour average nitrogen dioxide concentrations complied with the standards and goals of the Air NEPM (Table 9) and met the acceptance limits specified for campaign monitoring sites (Table 10).

Table 9 Air NEPM standards and goals for nitrogen dioxide

Pollutant	Averaging period	Maximum concentration	Goal within 10 years: maximum allowable exceedences
Nitrogen dioxide	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None

Table 10 Acceptance limits for nitrogen dioxide

Pollutant	Acceptance limit: percentage of Air NEPM standard	Averaging period	Acceptance limit
Nitrogen dioxide	60% for two or more years of data	1 hour	0.072 ppm
		1 year	0.018 ppm

Annual average

In the calendar years 2003 and 2004, the annual average nitrogen dioxide concentration was below the standard set by the Air NEPM (Table 11).

In 2002 and 2005, when monitoring did not cover a full calendar year, the annual average nitrogen dioxide concentration was lower than the standard set by the Air NEPM.

During the period of monitoring, the annual average nitrogen dioxide concentration did not exceed the acceptance limits specified for campaign monitoring sites.

Table 11 Nitrogen dioxide, annual averages, compliance with standard and acceptance limit

Year	Data recovery (% hours)	Annual average (ppm)	Did site meet NEPM standard?	Did site meet acceptance limit?
2002*	58	0.003	Incomplete	Yes
2003	93	0.003	Yes	Yes
2004	97	0.003	Yes	Yes
2005†	59	0.003	Incomplete	Yes

* Incomplete data for 2002: monitoring campaign began 28 May 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

One-hour average

In the calendar years 2003 and 2004, the one-hour average nitrogen dioxide concentrations were within the standard set by the Air NEPM (Table 12).

In 2002 and 2005, when the monitoring did not cover a complete calendar year, the one-hour average nitrogen dioxide concentrations recorded during for these monitoring periods were lower than the standard set by the Air NEPM.

During the period of monitoring, the one-hour average nitrogen dioxide concentration never exceeded the acceptance limits specified for campaign monitoring sites.

Table 12 Nitrogen dioxide, one-hour averages, compliance with standard and acceptance limit

Year	Number of days NEPM standard exceeded	Did site meet NEPM standard and goal?	Number of days acceptance limit exceeded	Did site meet acceptance limit?
2002*	0	Incomplete	0	Yes
2003	0	Yes	0	Yes
2004	0	Yes	0	Yes
2005†	0	Incomplete	0	Yes

* Incomplete data for 2002: monitoring campaign began 28 May 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

Further statistics on one-hour average nitrogen dioxide concentrations are given in Table 13 and Figure 4.

Table 13 Nitrogen dioxide, one-hour averages, statistics

Year	Annual data recovery (% hours)	Annual average (ppm)	Annual maximum (ppm)	Percentiles‡ 99th (ppm)	95th (ppm)	90th (ppm)
2002*	58	0.003	0.019	0.014	0.009	0.007
2003	93	0.003	0.016	0.011	0.008	0.006
2004	97	0.003	0.047	0.011	0.008	0.006
2005†	59	0.003	0.023	0.016	0.009	0.007

* Incomplete data for 2002: monitoring campaign began 28 May 2002

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

‡ Percentiles have been calculated from all one-hour averages, not from peak daily one-hour averages

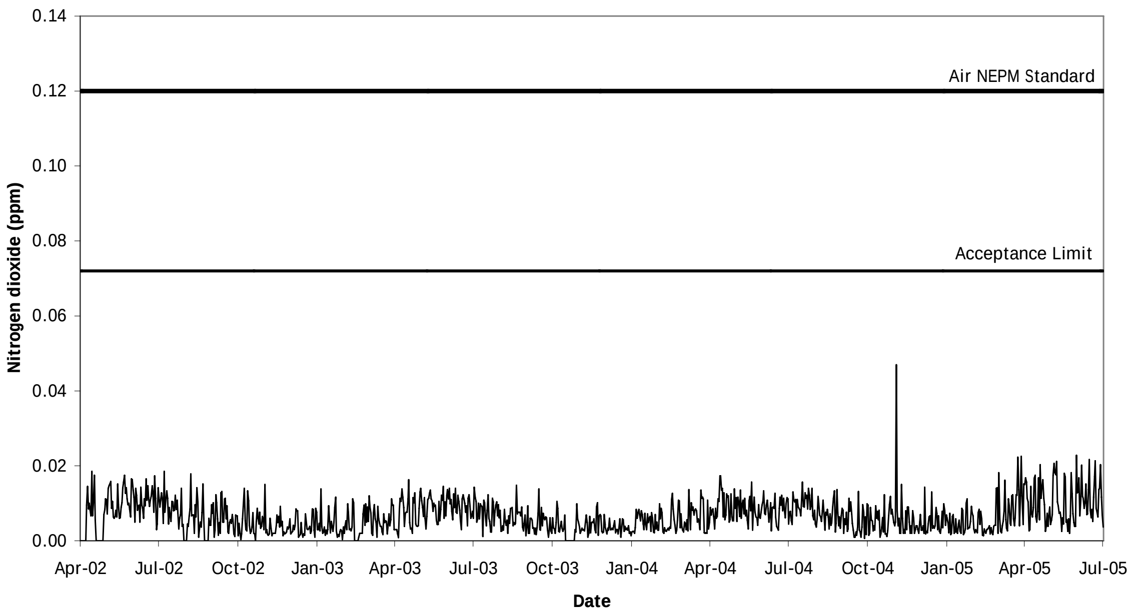

Figure 4 Nitrogen dioxide, daily maximum one-hour averages versus standard and acceptance limit

OZONE (PHOTOCHEMICAL OXIDANTS)

Ozone is an oxidising gas, created in the atmosphere by the interaction of nitrogen oxides and volatile organic compounds in sunlight. Exposure to ozone has been associated with increases in daily mortality, increases in hospital admissions and emergency room visits (respiratory and cardiovascular disease), decreases in lung function, increases in symptoms of respiratory illness such as cough, phlegm and wheeze, and increases in bronchodilator usage. These effects are observed in sensitive subpopulations although effects on lung function have been observed in the healthy normal population (NEPC 2000).

Levels of ozone in ambient air were monitored from 10 May 2002 to 31 July 2005. Some monitoring data appeared to be inconsistent with the characteristics expected for ozone. This inconsistency has been attributed to interference by another pollutant that absorbs the 254 nanometre ultraviolet light used to measure ozone concentrations. The following statistics are based on a data set from which this inconsistent data has been edited out. Further work is required to characterise this unidentified pollutant and to produce reliable data on the levels of ozone in the ambient air of Port Pirie.

During the monitoring period, the edited data indicated that one-hour average and four-hour average ozone concentrations complied with the standards and goals of the Air NEPM (Table 14) and met the acceptance limits specified for campaign monitoring sites (Table 15).

Table 14 Air NEPM standards and goals for photochemical oxidants (as ozone)

Pollutant	Averaging period	Maximum concentration	Goal within 10 years: maximum allowable exceedences
Photochemical oxidants (as ozone)	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year

Table 15 Acceptance limits for photochemical oxidants (as ozone)

Pollutant	Acceptance limit: percentage of Air NEPM standard	Averaging period	Acceptance limit
Photochemical oxidants	70% for two to four years of data	1 hour	0.070 ppm
(as ozone)		4 hours	0.056 ppm

One-hour average

In the calendar years 2003 and 2004, the one-hour average ozone concentrations were within the standard set by the Air NEPM (Table 16).

In 2002 and 2005, when the monitoring did not cover a complete calendar year, one-hour average ozone concentrations recorded for these periods of monitoring were lower than the Air NEPM standard.

In the monitoring period, the one-hour average ozone concentrations were within the acceptance limits specified for campaign monitoring sites.

Table 16 Ozone, one-hour averages, compliance with standard and acceptance limit

Year	Number of days NEPM standard exceeded*	Did site meet NEPM standard and goal?*	Number of days acceptance limit exceeded*	Did site meet acceptance limit?*
2002†	0	Incomplete	0	Yes
2003	0	Yes	0	Yes
2004	0	Yes	0	Yes
2005‡	0	Incomplete	0	Yes

* Analysis based on ozone monitoring data that has been edited to remove inconsistent data apparently caused by an interfering substance

† Incomplete data for 2002: monitoring campaign began 10 May 2002

‡ Incomplete data for 2005: monitoring campaign ended 31 July 2005

Further statistical information on one-hour average ozone concentrations from the Oliver Street site is presented in Table 17 and Figure 5.

Table 17 Ozone, one-hour averages, statistics

Year	Data recovery (% hours)	Annual average* (ppm)	Annual maximum* (ppm)	Percentiles§ 99th (ppm)	95th (ppm)	90th (ppm)
2002†	61	0.021	0.065	0.039	0.032	0.030
2003	96	0.020	0.049	0.039	0.032	0.030
2004	96	0.020	0.048	0.038	0.033	0.030
2005‡	57	0.017	0.042	0.034	0.030	0.028

* Analysis based on ozone monitoring data that has been edited to remove inconsistent data apparently caused by an interfering substance.

† Incomplete data for 2002: monitoring campaign began 10 May 2002

‡ Incomplete data for 2005: monitoring campaign ended 31 July 2005

§ Percentiles calculated from all one-hour averages, not from peak daily one-hour averages

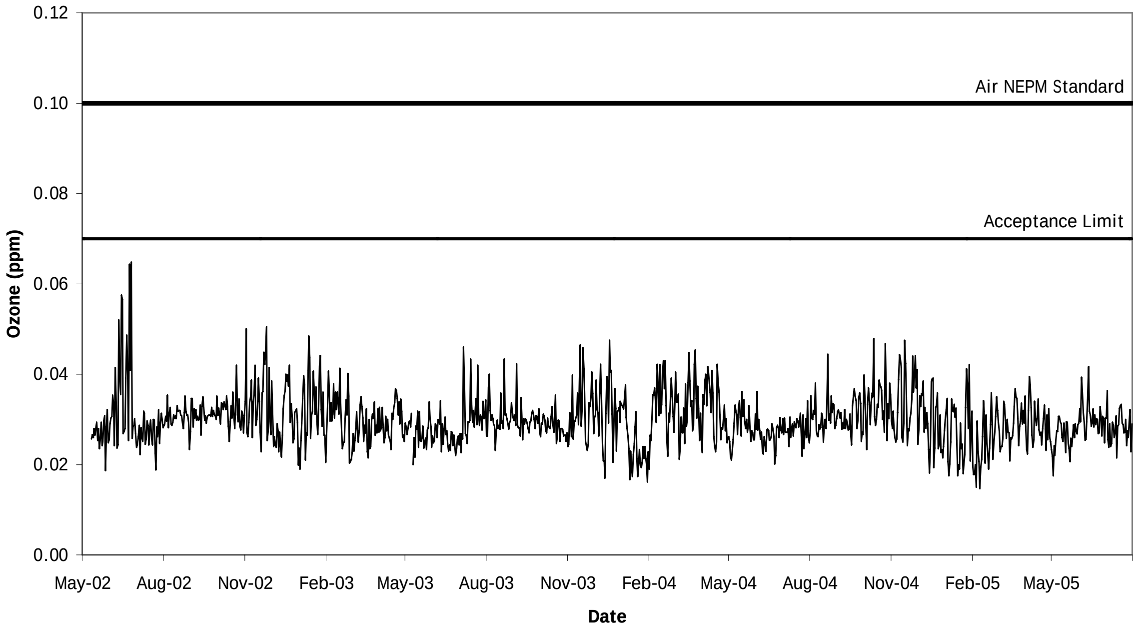

Figure 5 Ozone, daily maximum one-hour averages versus standard and acceptance limit

Four-hour average

In 2003 and 2004, when monitoring covered a complete calendar year and the quarterly data recovery rate exceeded the required 75% minimum, the four-hour average ozone concentrations complied with the Air NEPM standard. In 2002 and 2005, the monitoring did not cover a complete calendar year so the quarterly data recovery rate did not meet the 75% minimum requirement. However, the four-hour average ozone concentrations recorded during these periods of monitoring were lower than the Air NEPM standard of 0.08 ppm (Table 18).

In the monitoring period, the four-hour average ozone concentrations were within the acceptance limits specified for campaign monitoring sites.

Table 18 Ozone, four-hour averages, compliance with standard and acceptance limit

Year	Number of days NEPM standard exceeded[1]	Did site meet NEPM standard and goal?*	Number of days acceptance limit exceeded*	Did site meet acceptance limit?*
2002†	0	Incomplete	0	Yes
2003	0	Yes	0	Yes
2004	0	Yes	0	Yes
2005‡	0	Incomplete	0	Yes

* Analysis based on ozone monitoring data that has been edited to remove inconsistent data apparently caused by an interfering substance

† Incomplete data for 2002: monitoring campaign began 10 May 2002

‡ Incomplete data for 2005: monitoring campaign ended 31 July 2005

Further ozone statistics are provided in Table 19 and Figure 6.

Table 19 Ozone, four-hour averages, statistics

Year	Data recovery (% hours)	Annual average* (ppm)	Annual maximum* (ppm)	Percentiles§ 99th (ppm)	95th (ppm)	90th (ppm)
2002†	62	0.021	0.049	0.037	0.031	0.030
2003	98	0.020	0.045	0.037	0.032	0.029
2004	98	0.020	0.045	0.036	0.032	0.029
2005‡	57	0.017	0.040	0.033	0.029	0.027

* Analysis based on ozone monitoring data that has been edited to remove inconsistent data apparently caused by an interfering substance

† Incomplete data for 2002: monitoring campaign began 10 May 2002

‡ Incomplete data for 2005: monitoring campaign ended 31 July 2005

§ Percentiles have been calculated from all four-hour averages, not from peak daily four-hour averages

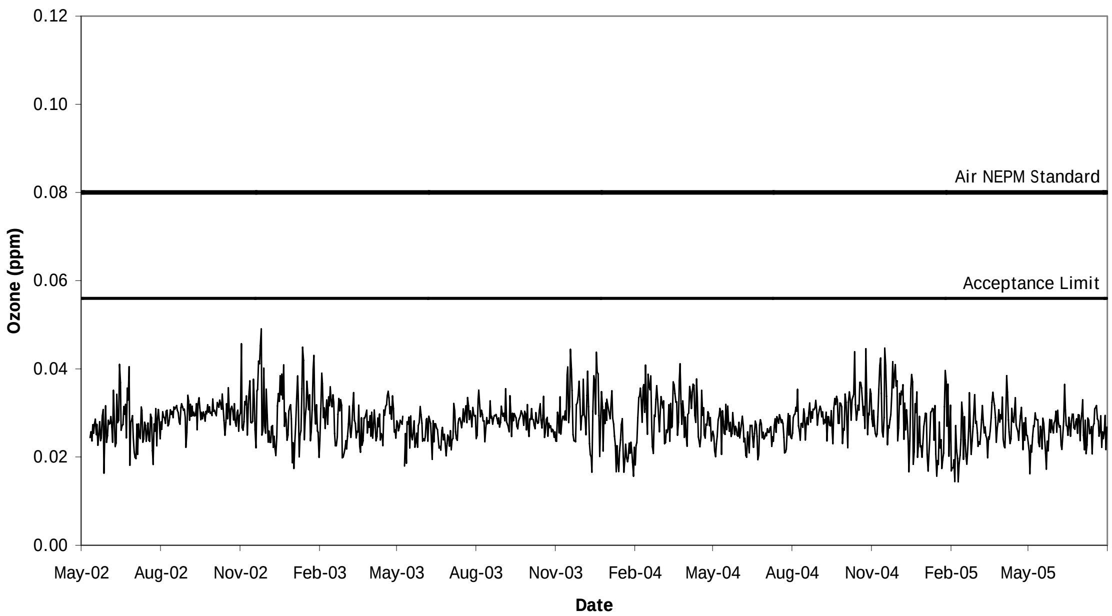

Figure 6 Ozone, daily maximum four-hour averages versus standard and acceptance limit

PARTICULATE MATTER

Particulate matter in ambient air is measured as total suspended particles (TSP), as particles with an equivalent aerodynamic diameter smaller than 10 μm (PM_{10}) and as particles with an equivalent aerodynamic diameter smaller than 2.5 μm ($PM_{2.5}$).

Unlike the other common air pollutants, which are specific substances, particles are a broad class of chemically and physically diverse substances. They are emitted from a wide range of sources including natural dusts and pollens. The biological effects of particles are determined by the physical and chemical nature of the particles, the physics of deposition and distribution in the respiratory tract, and the physiological response to the presence of the particle. The health effects of particles include increases in daily mortality, hospital admissions and emergency room attendances and exacerbation of respiratory symptoms and asthma. There is no conclusive evidence on the role of particle size in the response, but it is thought that different sizes may be important for different health outcomes, for example $PM_{2.5}$ for mortality and PM_{10} for asthma (NEPC 2000).

Particulate matter, as PM_{10}, by TEOM

Levels of particulate matter, as PM_{10}, were monitored from 28 June 2003 to 31 July 2005, using the TEOM apparatus, a unit that continuously monitors particulate matter levels.

One-day average concentrations of PM_{10} in the monitoring period were compared with the Air NEPM standard and goal (Table 20) and acceptance limits (Table 21).

Table 20 Air NEPM standards and goals for particulate matter, as PM10

Pollutant	Averaging period	Maximum concentration	Goal within 10 years: maximum allowable exceedences
Particulate matter, as PM_{10}	1 day	50 μg/m^3	5 days a year

Table 21 Acceptance limits for particulate matter, as PM_{10}

Pollutant	Acceptance limit: percentage of Air NEPM standard	Averaging period	Acceptance limit
Particulate matter, as PM_{10}	60% for two or more years of data	1 day	30 μg/m^3

In the 2004 calendar year, daily average particulate matter concentration exceeded the standard set for PM_{10} by the Air NEPM on four days (Table 22). The site complied with the Air NEPM goal, which allows not more than five days a year on which the standard is exceeded.

During the whole monitoring period of 765 days, the daily average particulate matter concentration exceeded the Air NEPM standard on 11 days. This is, on average, five days per year, which falls within the Air NEPM goal.

During the 765 days of monitoring, the acceptance limit for daily average concentration of PM_{10} was exceeded on 82 days, or on average 39 days per year.

Table 22 Particulate matter, as PM_{10}, one-day averages, compliance with standard and acceptance limit

Year	Number of valid days	Number of days NEPM standard exceeded	Did site meet NEPM standard and goal?	Number of days acceptance limit exceeded	Did site meet acceptance limit?
2003*	183	3	Incomplete	21	No
2004	356	4	Yes	29	No
2005†	204	4	Incomplete	32	No

* Incomplete data for 2003: monitoring campaign began 28 June 2003

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

Further statistics are given in Table 23 and Figure 7.

Table 23 Particulate matter, as PM_{10}, one-day averages by TEOM

Year	Average (µg/m³)	Maximum (µg/m³)	2nd highest (µg/m³)	6th highest (µg/m³)	90th percentile (µg/m³)	Median value (µg/m³)
2003*	17.3	60.5	54.5	42.6	30.8	14.1
2004	18.3	135.8	65.9	46.4	28.5	15.7
2005†	21.9	464.3	81.4	45.5	34.2	17.0

* Incomplete data for 2003: monitoring campaign began 28 June 2003

† Incomplete data for 2005: monitoring campaign ended 31 July 2005

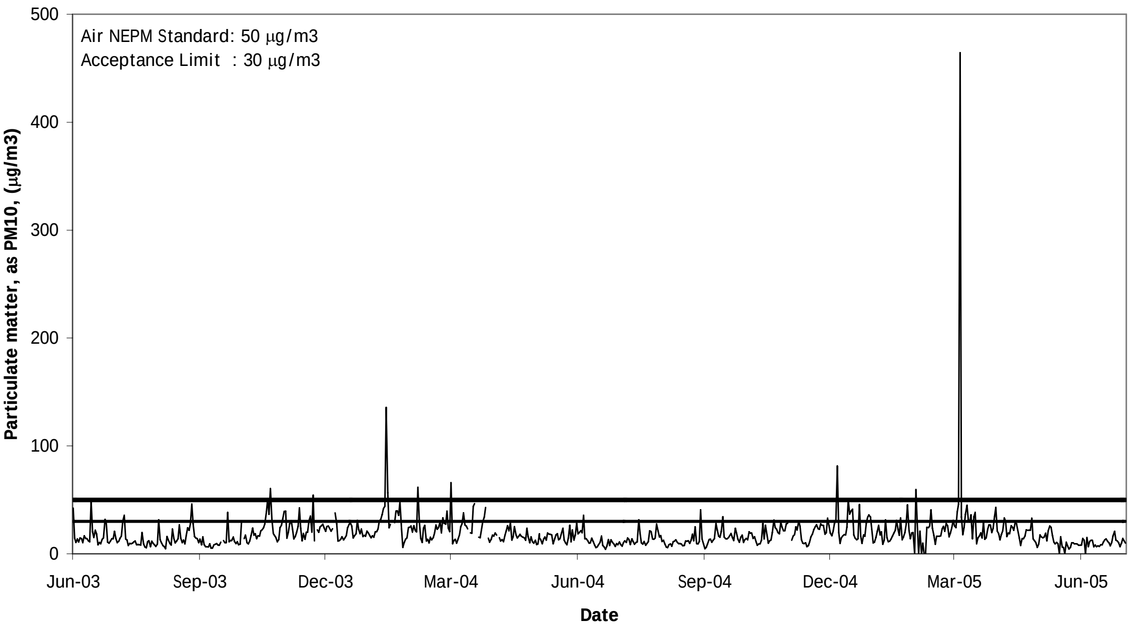

Figure 7 Particulate matter, as PM_{10}, daily average versus standard and acceptance limit

Particulate matter, as PM_{10}, by high volume sampling

Particulate matter, as PM_{10}, has been monitored at the Oliver Street site by HVS since September 1998, with an earlier period of monitoring from May 1984 to August 1988. Results for the years 2002 to 2005 are given in Table 24.

HVS is undertaken for a 24-hour period every sixth day, so the data recovery rate is at most one-sixth of the year (16.6%) and therefore cannot not meet the 75% requirement of the Air NEPM.

Table 24 Particulate matter, as PM_{10}, one-day samples by HVS

Year	Number of valid days	No. days NEPM Standard exceeded	Average (μg/m³)	Maximum (μg/m³)	2nd highest (μg/m³)	6th highest (μg/m³)	90th percentile (μg/m³)	Median value (μg/m³)
2002	59	1	21.9	57.0	45.7	31.3	31.3	21.2
2003	53	0	21.5	49.5	45.7	36.4	36.0	20.8
2004	50	2	25.3	78.7	71.6	39.7	39.8	23.3
2005*	30	0	21.3	44.8	33.0	29.6	30.4	21.5

* Incomplete data for 2005: data reported to 27 June 2005

Total suspended particles by high volume sampling

At the Oliver Street site, TSP has been monitored by HVS since September 1998 (see Table 25 for 2002–2005 results), with an earlier period of monitoring from May 1984 to August 1988. The Air NEPM does not specify a standard for TSP because the PM_{10} particulate matter is considered to have a more significant relationship to health effects.

High volume sampling is undertaken for a 24-hour period every sixth day.

Table 25 Particulate matter, as TSP, one-day samples by high volume sampling

Year	Number of valid days	Average (μg/m³)	Maximum (μg/m³)	2nd highest (μg/m³)	6th highest (μg/m³)	90th percentile (μg/m³)	Median Value (μg/m³)
2002	61	45.1	120.8	111.3	104.5	65.5	41.5
2003	59	43.8	113.8	107.1	73.2	70.8	39.1
2004	60	45.7	167.3	159.0	84.6	76.0	37.4
2005*	30	46.0	100.2	83.6	62.8	65.4	45.1

* Incomplete data for 2005: data reported to 27 June 2005

AIRBORNE LEAD

Lead is absorbed into the body after being inhaled or ingested. It can result in a wide range of biological effects depending on the level and duration of exposure. Its toxicity can largely be explained by its interference with different enzyme systems, which it affects in a number of ways so lead exposure may result in a very wide range of adverse health effects. Effects at the subcellular level, as well as effects on the overall functioning of the body, have been noted and range from inhibition of enzymes to the production of marked morphological changes and death. Foetuses, babies and children (especially those below the age of four) are considered to be more susceptible to the adverse effects of lead exposure than adults. Children up to the age of 4–6 are also considered to be at increased risk of exposure due to a range of behavioural characteristics such as the greater amount of time they spend outdoors, hand to mouth behaviours (such as thumb sucking) and possibly pica, the compulsive habitual consumption of non-food items (NEPC 2000).

Lead concentrations are determined on 24-hour samples of TSP collected by HVS one day in six, using a nitric acid extraction method as specified by Australian Standard 2800 (Standards Australia 1985). The Air NEPM standard and goal are given in Table 26.

Airborne lead concentrations have been measured at the Oliver Street monitoring site from September 1998 to the current day, with a pause between September 2000 and July 2001. The site was previously used for lead measurements between May 1984 and August 1988.

Table 26 Air NEPM standard and goal for lead

Pollutant	Averaging period	Maximum concentration	Goal within 10 years: maximum allowable exceedences
Lead	1 year	0.5 μg/m^3	None

Annual average

In the calendar years 1999, 2003, 2004 and 2005, the annual average lead concentrations exceeded the Air NEPM standard; in 2000, the average concentration was equal to the standard; in 1998, 2001 and 2002, average concentrations were below the standard.

Table 27 gives statistics for the annual average and daily sample lead concentrations for the 1998 to 2005 period. Figure 8 compares the annual average lead concentration to the Air NEPM standard.

Table 27 Lead, annual averages 1998–2005, compliance with standard

Year	No of valid samples	Annual average (μg/m³)	Maximum daily value (μg/m³)	2nd highest daily value (μg/m³)	90th percentile (μg/m³)	Median daily value (μg/m³)
1998*	19	0.35	2.76	1.12	0.86	0.11
1999	57	0.94	8.38	5.81	3.57	0.25
2000†	43	0.50	3.10	2.56	1.30	0.18
2001†	28	0.43	1.63	1.47	0.99	0.26
2002	61	0.47	2.65	2.42	1.14	0.25
2003	59	0.59	4.97	4.71	1.54	0.16
2004	60	0.59	3.69	3.38	1.58	0.26
2005	60	0.60	5.51	4.80	1.38	0.21

* Incomplete data for 1998: sampling began 8 September1998

† Incomplete data for 2000 and 2001: sampling ended 15 September 2000 and resumed 6 July 2001

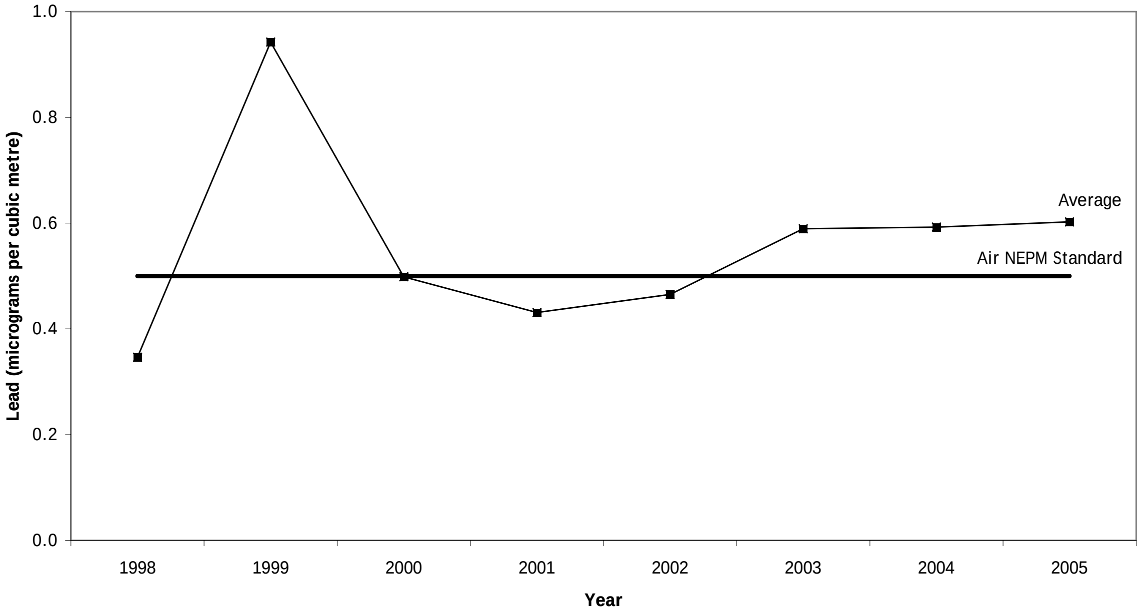

Figure 8 Lead, annual average concentrations versus standard, 1998–2005

DISCUSSION

Sulfur dioxide in Port Pirie

Monitoring for sulfur dioxide at the Oliver Street site has demonstrated that, while the annual and daily average sulfur dioxide levels comply with the Air NEPM standards, the one-hour standard has been exceeded on a considerable number of occasions. During 1132 days of monitoring, the one-hour standard was exceeded on 81 days, an average of 26 days each year.

Figure 9 shows one-hour average sulfur dioxide concentrations plotted by month for the average, 95th and 99th percentile, and maximum. The mean monthly average of 0.008 ppm is well below the standard and the acceptance limit. The 95th percentile never exceeds the acceptance limit and has a monthly mean of 0.038 ppm. The 99th percentile is generally below the Air NEPM standard but its monthly mean, 0.126 ppm, is slightly above the acceptance limit of 0.12 ppm. However, the monthly maximum is generally well above the Air NEPM standard, with a mean value of 0.312 ppm. This figure demonstrates that the high sulfur dioxide levels in Port Pirie are caused by occasional emissions of short duration, which can cause one-hour average concentrations considerably in excess of the Air NEPM standard of 0.20 ppm.

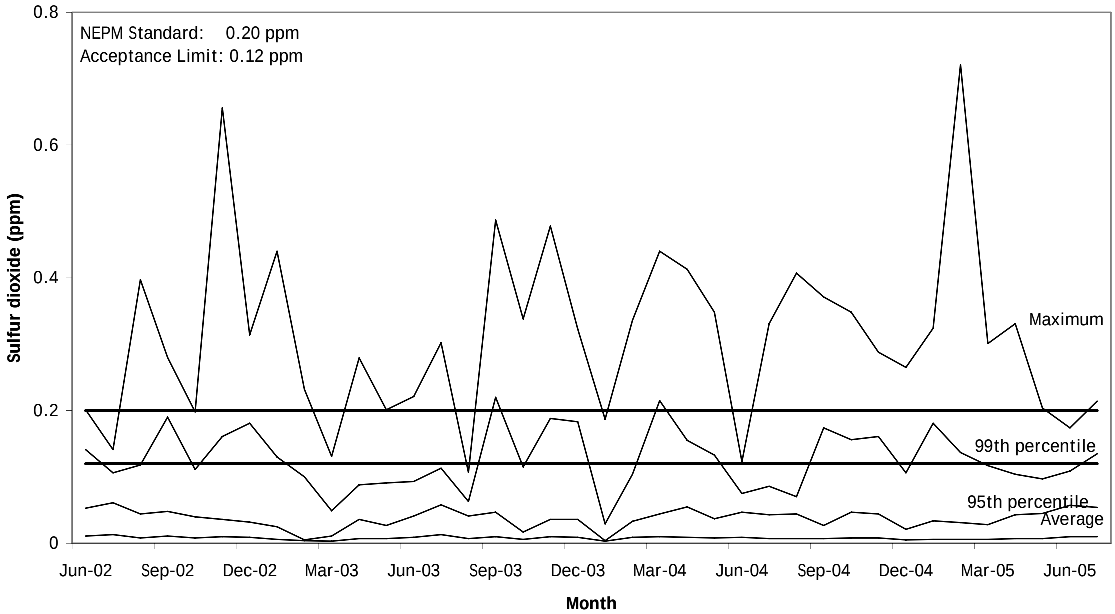

Figure 9 Sulfur dioxide, one-hour averages by month

The example of these short-duration sulfur dioxide emissions in Figure 10 shows the 10-minute average sulfur dioxide concentrations for 31 January 2005, a day on which four of the one-hour averages exceeded the one-hour Air NEPM standard. It is however unusual for the one-hour standard to be exceeded this many times on a single day.

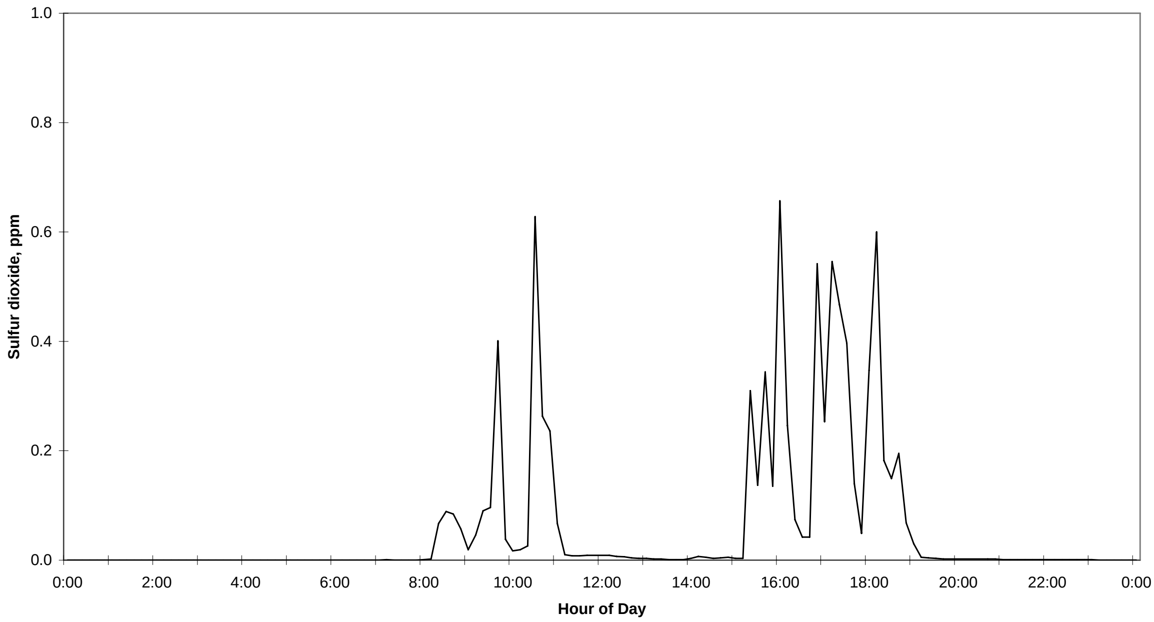

Figure 10 Sulfur dioxide concentrations, 10-minute averages, 31 January 2005

Figure 11 shows the number of days per month on which the one-hour standard for sulfur dioxide was exceeded. There appeared to be no distinct annual cycle and further analysis did not suggest a weekly cycle.

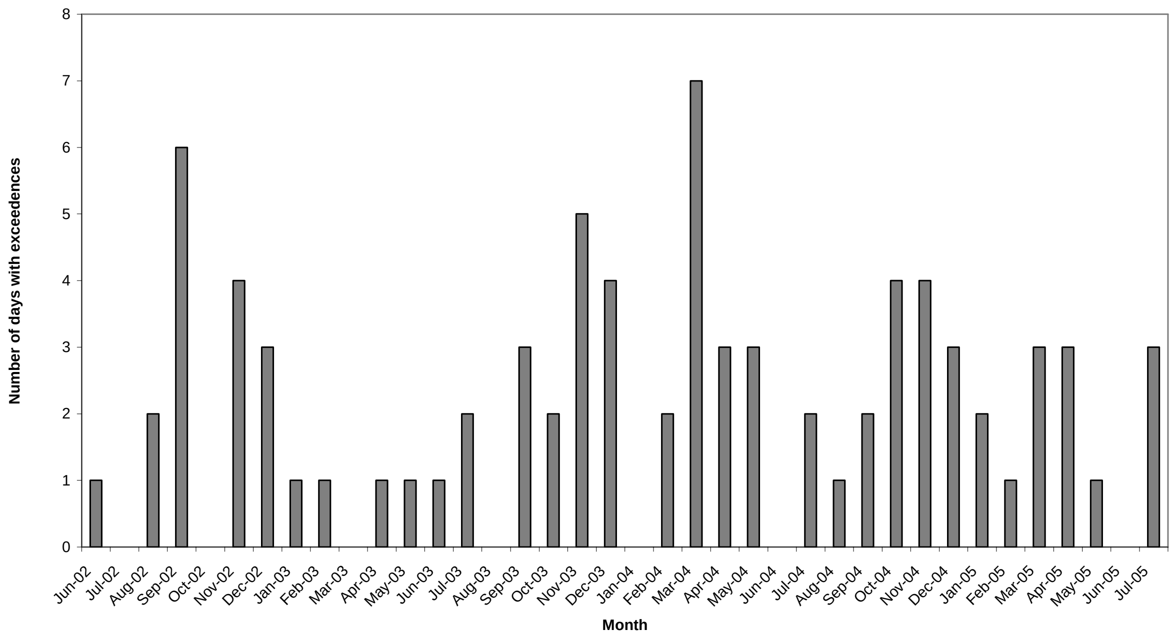

Figure 11 Number of days per month on which the one-hour standard for sulfur dioxide was exceeded

Analysis of the monitoring data showed that, at the Oliver Street monitoring site, the occasions when the one-hour average sulfur dioxide concentration exceeded the Air NEPM of 0.20 ppm were all recorded between the hours of 0900 and 1900. They probably occurred during these daylight hours because of the highly unstable convective atmospheric conditions that occur during the day; at night, atmospheric conditions are normally more stable.

The Oliver Street monitoring site is located south-south-east of the smelter. When the occasions on which the Air NEPM one-hour standard was exceeded were compared to wind direction at the site, it was found that 58% of these events had occurred when the wind was from the north-west to north and 82% when the wind was from the west to north-east.

There appeared to be no relationship between sulfur dioxide concentrations and levels of particulate matter, as PM_{10}, recorded at the Oliver Street monitoring site.

Sulfur dioxide in Whyalla

The EPA has also been monitoring atmospheric sulfur dioxide concentrations in the city of Whyalla, about 47 km west-north-west of Port Pirie, across the Spencer Gulf.

Sulfur dioxide concentrations monitored in Whyalla are considerably lower than those in Port Pirie, but days of recorded elevated levels of sulfur dioxide in Whyalla tend to coincide with days of high levels of sulfur dioxide in Port Pirie. These sulfur dioxide events in Whyalla occur during periods of light winds (usually less than 5 metres per second) from the south-east, so it is probable that the sulfur dioxide has been blown across the Spencer Gulf from Port Pirie.

Figure 12 compares the sulfur dioxide concentration in Port Pirie and Whyalla on 16 October 2004, a day on which a high level of sulfur dioxide was recorded in Whyalla. From mid-morning on this day, the wind blew steadily from the east-south-east (113° on average) at an average speed of 2.6 metres per second. At this speed, it would take five hours to cover the 47 km from Port Pirie.

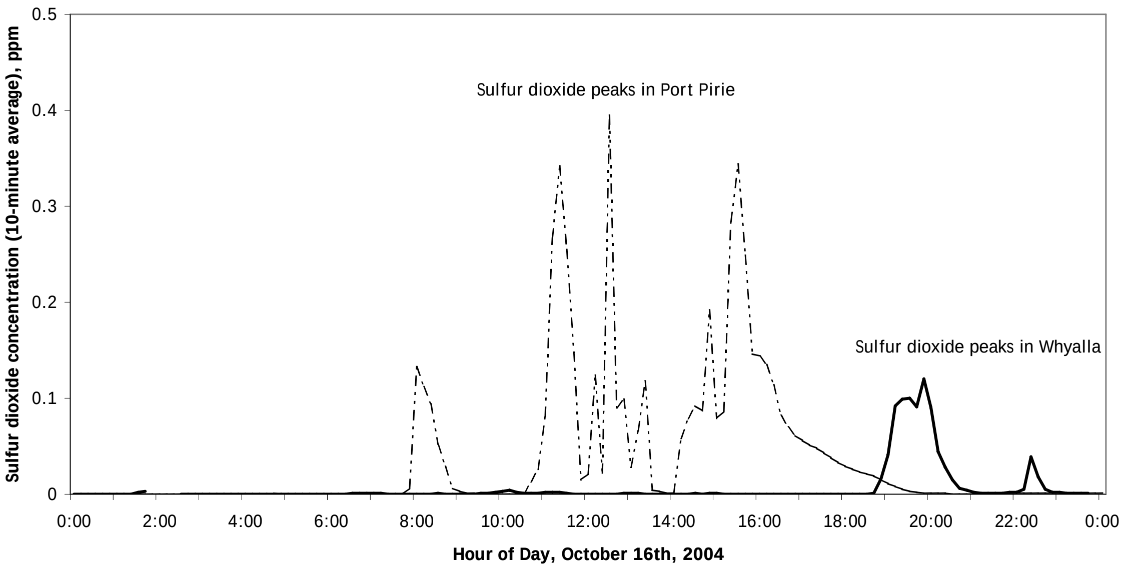

Figure 12 Comparison of sulfur dioxide in Port Pirie and Whyalla, 16 October 2004

Correlating particulate matter data from TEOM and HVS methods

Particulate matter, as PM_{10}

Since HVS and TEOM are measuring the same parameter, there should be a linear correlation between the two methods. Analysis by least squares regression of the PM_{10} data obtained from HVS against the 24-hour average PM_{10} obtained by the TEOM method gives the relationship as:

> *HVS* = 1.0332**TEOM* + 3.08, where
>
> *HVS* is the 24-hour sample value obtained by HVS
>
> *TEOM* is the 24-hour average value obtained by the TEOM method for the same day

The correlation coefficient (R^2) is 0.80, showing that there is a strong correlation between the two methods.

Figure 13 shows the relationship of the data obtained by the two methods. The dotted lines represent the ± 5 µg/m³ precision of the HVS method. Australian Standard 3580.9.6: 2003 for determination of particulate matter, as PM_{10}, by HVS states that the precision of high volume samplers will be 5 µg/m³ for concentrations below 80 µg/m³ and 7% for concentrations above 80 µg/m³.

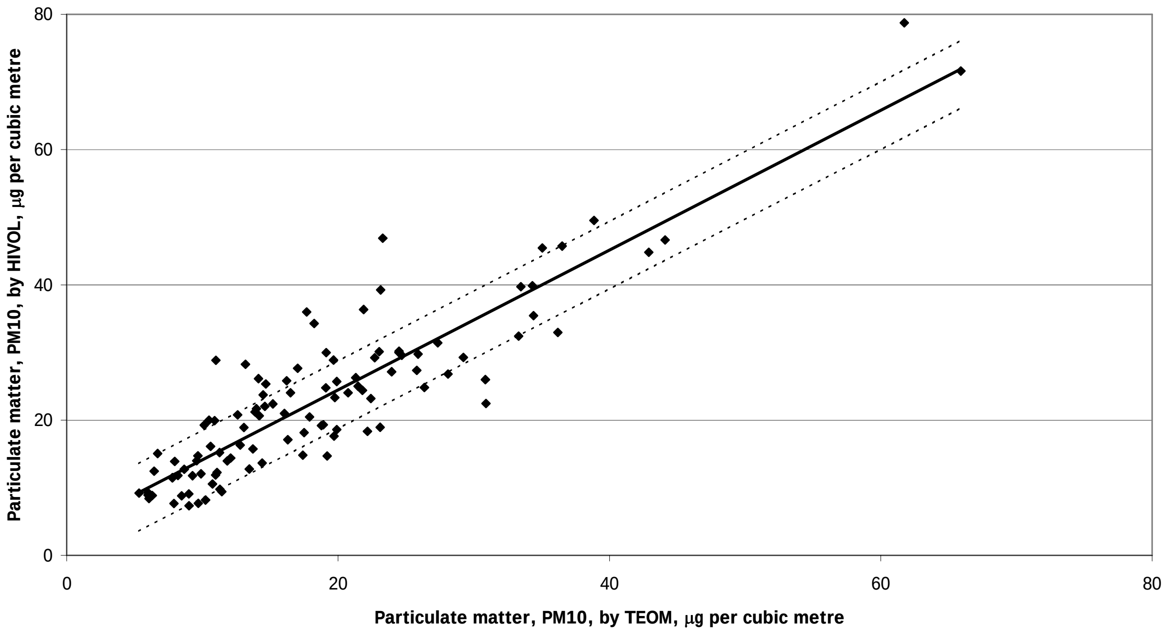

Figure 13 Correlation between PM_{10} data by TEOM and HVS

Particulate matter, as total suspended particles

Particulate matter as TSP and as PM_{10} are different but closely related parameters as the PM_{10} material is a fraction of TSP. It is reasonable to expect some degree of correlation between the two parameters. Analysis by least squares regression of the TSP data obtained from HVS against the 24-hour average obtained for PM_{10} by the TEOM method gives the relationship as:

> *HVS* = 2.432**TEOM* + 0.080, where
>
> *HVS* is the 24-hour sample value obtained by HVS
>
> *TEOM* is the 24-hour average value obtained by the TEOM method for the same day

The correlation coefficient (R^2) is 0.85, showing that there is a strong correlation between the two methods. Figure 14 shows the relationship of the data obtained by the two methods.

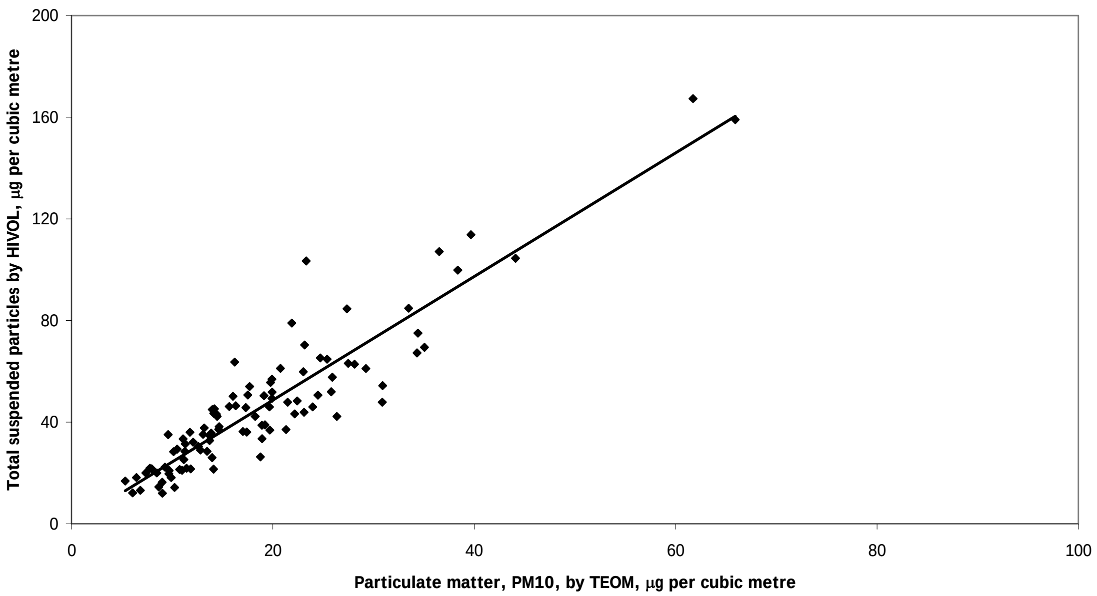

Figure 14 Correlation between PM_{10} data by TEOM and TSP data by HVS

CONCLUSIONS

Sulfur dioxide

During the monitoring campaign, annual average and daily average sulfur dioxide concentrations in the ambient air of Port Pirie complied with the standards and goals of the Air NEPM. However, there were many days each year, on average 26, on which the one-hour standard of 0.20 ppm specified by the Air NEPM for sulfur dioxide was exceeded. On average, on 55 days per year, the one-hour acceptance limit of 0.12 ppm for campaign monitoring sites was exceeded.

Although annual and daily averages meet Air NEPM requirements, the one-hour averages demonstrate frequent high levels of sulfur dioxide for short periods, mostly when the wind is blowing from the direction of the Zinifex smelter to the north-north-west of the Oliver Street monitoring site. There appears to be no distinct annual or weekly cycle to these occasions. At the Oliver Street monitoring site, the events all occur between the hours of 09:00 and 19:00, and this may be related to the daytime unstable convective conditions.

The EPA will continue to monitor sulfur dioxide in the ambient air of Port Pirie.

Nitrogen dioxide

During the monitoring campaign, annual average and one-hour average nitrogen dioxide concentrations complied with Air NEPM standards and goals, and met the acceptance limits specified for campaign monitoring sites.

The screening procedures note that ozone distributions cannot be interpreted without data on nitrogen oxides and recommend that nitrogen oxides should be monitored wherever ozone is monitored.

Ozone

Some ozone monitoring data collected during the campaign appeared to be inconsistent with the characteristics expected for ozone pollution. This inconsistency has been attributed to interference by another pollutant that absorbs the 254 nanometre ultraviolet light used to measure ozone concentrations.

When this inconsistent data was edited out, the one-hour average and four-hour average ozone concentrations appeared to comply with the standards and goals of the Air NEPM and met the acceptance limits specified for campaign monitoring sites.

Further work is required to characterise this unidentified pollutant and to provide reliable data on ozone levels in the ambient air of Port Pirie.

Particulate matter, as PM_{10}

During the monitoring campaign, daily average particulate matter (PM_{10}) concentrations exceeded the Air NEPM standard on an average of five days per year, which does not exceed the Air NEPM goal of not more than five days a year. There were, on average, 40 days per year, on which the daily average concentration of particulate matter, as PM_{10}, exceeded the acceptance limit set for campaign monitoring sites.

The screening procedures specify that it is desirable to continue monitoring for particulate matter, as PM_{10}, in Port Pirie. The monitoring campaign has also demonstrated that the continuous monitoring capability of the TEOM unit is a valuable complement to the HVS program that has been operating in Port Pirie for many years. Accordingly, the TEOM monitoring unit installed for this campaign will remain in operation at the Oliver Street monitoring site.

Lead

The annual average lead concentration has been lower than the Air NEPM standard in only three of the eight years of monitoring. Lead emissions from the Zinifex smelter are the highest priority environmental issue in Port Pirie and the EPA will continue to monitor lead levels at its four monitoring sites.

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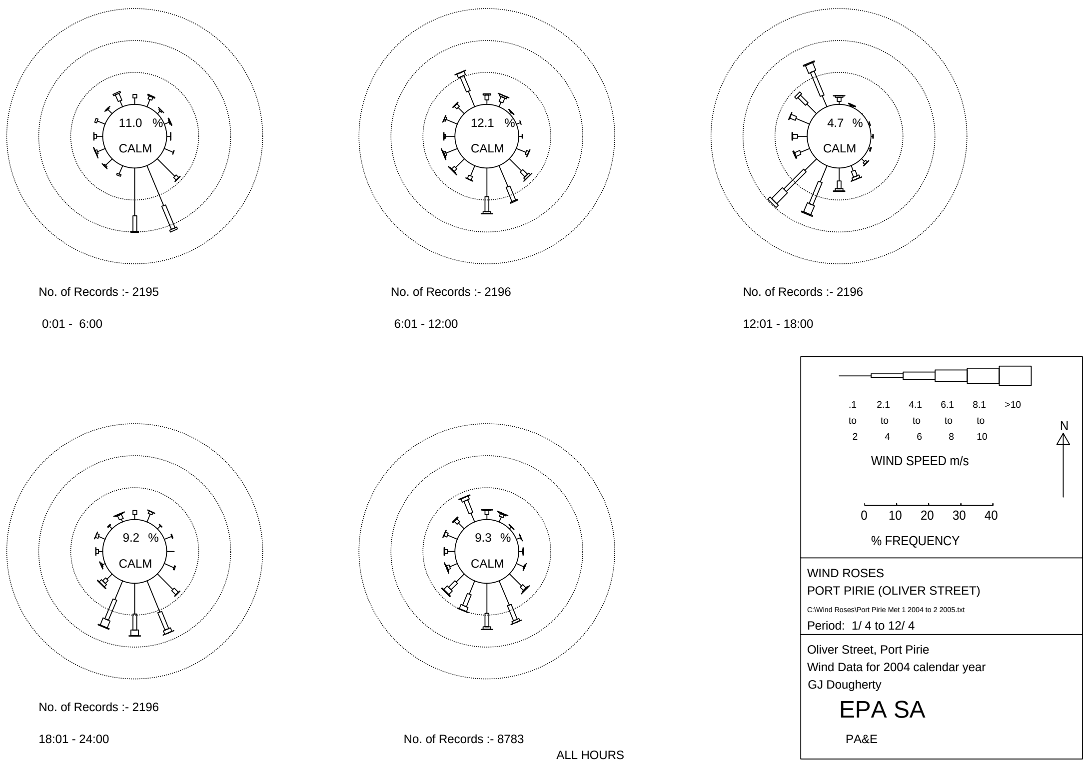
Standards Australia 1985, *AS 2800–1985*, Ambient air: Determination of particulate lead–High volume sampler gravimetric collection–Flame atomic absorption spectrometric method.

APPENDIX 1 WIND ROSES FOR OLIVER STREET MONITORING SITE FOR 2004 CALENDAR YEAR



APPENDIX 2 MONITORING SITE INFORMATION

Table 28 Metadata for Oliver Street monitoring site

Site name	**Oliver Street**
Map coordinates	
Datum	GDA 94
Projection	UTM 54, Zone 54
Easting	22184.4
Northing	632156.5
Site elevation	~10 metres
Street address	Corner of Oliver Street and Pugsley Street, Port Pirie
Date site established	May 2002 for monitoring campaign
Date site terminated	Continuing
List of exceptions to siting guidelines (AS 2922-1987)	Trees within 20 metres of site
Surrounding land use	Residential
Nearby emission sources	Railway lines (430 metres), grain silo (465 metres), plastic recycling plant (750 metres), lead smelter (3 km).
Pollutants monitored	Sulfur dioxide, nitrogen dioxide, ozone and particulate matter, as PM_{10}

Table 29 Australian Standard methods used for air quality monitoring in Port Pirie

Substance monitored	**Australian Standard Method**
Nitrogen dioxide	AS 3580.5.1–1993 *Methods for sampling and analysis of ambient air–determination of oxides of nitrogen–chemiluminescence method*
Ozone	AS 3580.6.1–1990 *Methods for sampling and analysis of ambient air–determination of ozone–direct reading instrumental method*
Sulfur dioxide	AS 3580.4.1–1990 *Methods for sampling and analysis of ambient air–determination of sulfur dioxide–direct reading instrumental method*
Particulate matter, as PM_{10}, by TEOM	AS 3580.9.8–2001 *Methods for sampling and analysis of ambient air– determination of suspended particulate matter, PM_{10}– continuous direct mass method using a tapered element oscillating microbalance analyser*
Particulate matter, as PM_{10}, by high volume sampling	AS 3580.9.6–2003 *Methods for sampling and analysis of ambient air–determination of suspended particulate matter, PM_{10}–high volume sampler with size-specific inlet–gravimetric method*
Total suspended particles, by high volume sampling	AS 3580.9.3–2003 *Methods for sampling and analysis of ambient air–determination of suspended particulate matter (TSP)–high volume sampler gravimetric method*

Table 30 Data for instrumentation used at Oliver Street monitoring site

Pollutant monitored	**Nitrogen dioxide**
Instrument type	Nitrogen oxides monitor
Make	Monitor Labs/Ecotech
Model	EC 9841B
Serial number	Various (as maintenance and calibration requirements need)
Minimum detection level	0.1 parts per billion (ppb)
Measuring units	parts per million (ppm)
Logging interval	10-minute average
Clock adjustment	Australian Central Standard Time (without daylight saving)

Pollutant monitored	**Ozone**
Instrument type	Ultraviolet photometric ozone analyser
Make	Thermo Electron Corporation
Model	49C
Serial number	Various (as maintenance and calibration requirements need)
Minimum detection level	1 ppb
Measuring units	ppm
Logging interval	10-minute average
Clock adjustment	Australian Central Standard Time (without daylight saving)

Pollutant monitored	**Sulfur dioxide**
Instrument type	Fluorescence monitor
Make	Monitor Labs/Ecotech
Model	ML9850B
Serial number	Various (as maintenance and calibration requirements need)
Minimum detection level	0.001 ppm
Measuring units	ppm
Logging interval	10-minute average
Clock adjustment	Australian Central Standard Time (without daylight saving)

Pollutant monitored	Particulate matter, as PM_{10}
Instrument type	Tapered element oscillating microbalance (TEOM)
Make	Rupprecht & Patashnick Co Inc
Model	1400AB
Serial number	Various (as maintenance and calibration requirements need)
Minimum detection level	0.001 $\mu g/m^3$
Measuring units	$\mu g/m^3$
Logging interval	10-minute average
Clock adjustment	Australian Central Standard Time (without daylight saving)

Pollutant monitored	Particulate matter, as PM_{10}
Instrument type	High volume sampler (HVS)
Make	Ecotech
Model	Hivol 3000
Serial number	Various (as maintenance and calibration requirements need)
Minimum detection level	0.1 mg (balance limit)
Measuring units	$\mu g/m^3$
Logging interval	24 hours
Clock adjustment	Australian Central Standard Time

Pollutant monitored	Particulate matter, as total suspended particles (TSP)
Instrument type	High volume sampler (HVS)
Make	Ecotech
Model	Hivol 3000
Serial number	Various (as maintenance and calibration requirements need)
Minimum detection level	0.1 mg (balance limit)
Measuring units	$\mu g/m^3$
Logging interval	24 hours
Clock adjustment	Australian Central Standard Time