

South Australia's Air Quality Monitoring Data Tables 2005

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ISBN 1 921125 23 3

October 2006

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CONTENTS

SUMMARY	1
AIR QUALITY MONITORING SITES AND METHODS	2
Air quality monitoring regions and sites	2
Air quality monitoring methods	6
MONITORING DATA TABLES	9
1 Carbon monoxide	
2 Nitrogen dioxide (annual average and 1-hour average)	11
3 Ozone (photochemical oxidants) (1-hour average)	12
4 Ozone (photochemical oxidants) (4-hour average)	13
5 Sulfur dioxide (annual average and 1-hour average)	14
6 Sulfur dioxide (annual average and 1-day average)	15
7 Airborne lead (annual average)	16
8 Particulate matter, PM ₁₀ , (1-day average) by TEOM Method	17
9 Particulate Matter, PM ₁₀ , (1-day sample) by high volume sampling	18
10 Particulate Matter, PM ₁₀ , (1-day sample) by high volume sampling	19
11 Particulate Matter, PM _{2.5} , (1-day average) by TEOM Method	20
12 Total Suspended Particles (1-day SAMPLE) by high volume sampling	21

LIST OF TABLES

Table 1 Monitoring sites in the Adelaide airshed, showing pollutants measured	3
Table 2 Monitoring sites in the Spencer Gulf airshed, show pollutants measured...	5

SUMMARY

This report is a compilation of the results of ambient air quality monitoring by the South Australian Environment Protection Authority (EPA) in 2005. It is to be read in conjunction with *South Australia's Air Quality 2005*.

The report covers the EPA monitoring sites in Adelaide, Port Augusta, Port Pirie and Whyalla, and the following substances were monitored at these sites:

- carbon monoxide
- nitrogen dioxide
- ozone
- sulfur dioxide
- lead (in Port Pirie only)
- particulate matter, as PM₁₀
- particulate matter, as PM_{2.5}
- total suspended particles.

AIR QUALITY MONITORING SITES AND METHODS

Air quality monitoring regions and sites

During 2005, ambient air quality monitoring was carried out by the South Australian Environment Protection Authority (EPA) at sites in the Adelaide airshed and in three regional centres in the Spencer Gulf airshed: Port Augusta, Whyalla and Port Pirie.

Substances monitored at these sites were:

- carbon monoxide
- nitrogen oxides including nitrogen dioxide
- ozone
- sulfur dioxide
- lead (at monitoring sites in Port Pirie only)
- particulate matter, as particles of equivalent aerodynamic diameter 10 micrometres or less (PM₁₀)
- particulate matter, as particles of equivalent aerodynamic diameter 2.5 micrometres or less (PM_{2.5})
- particulate matter, as total suspended particles (TSP).

Different types of monitoring sites have different objectives:

Performance monitoring station (PMS)	A monitoring site used to measure against the goals set by the National Environment Protection (Ambient Air Quality) Measure (Air NEPM), which should be operated in the same location for at least five years
Trend site	A PMS intended to remain in place for an extended period of at least 10 years to observe long-term changes in pollutant levels
Campaign site	A site used for a short-term screening study
NEPM Study site	A site for monitoring particulate matter, as PM _{2.5} , to provide data for study under a variation to the Air NEPM introduced in 2003
Industrial site	A site set up to monitor the environmental impact of industrial facilities on adjacent residential areas; such a site is not located as required by the Air NEPM so cannot be used as a PMS

Particulate matter, as PM₁₀, can be measured by two methods: the tapered element oscillating microbalance (TEOM), a continuously monitoring unit; or a high volume sampler (HVS) which is used to collect a 24-hour sample one day in six (or, for Whyalla, one day in three).

Table 1: Monitoring sites in the Adelaide airshed, showing pollutants measured

Monitoring site	Carbon monoxide (CO)	Sulfur dioxide (SO ₂)	Nitrogen oxides (NO _x)	Ozone (O ₃)	Particulate matter		
					≤ 2.5 μm (PM _{2.5})	≤ 10 μm (PM ₁₀)	(TSP)
Adelaide	Trend; PMS						
Elizabeth Downs	Trend; PMS		PMS	PMS		PMS (TEOM)	
Kensington Gardens			Trend; PMS	Trend; PMS		Trend; PMS (TEOM)	
Birkenhead						(TEOM)	
Netley			Trend; PMS	Trend; PMS	NEPM Study (TEOM)	Trend; PMS (TEOM, HVS)	
Northfield		PMS	Trend; PMS	Trend; PMS		Trend; PMS (HVS)	Trend; PMS (HVS)
Osborne						Industrial (HVS)	Industrial (HVS)

Notes on monitoring sites:

Adelaide (Hindley Street)	A trend and performance monitoring site in the inner city for 'upper bound' carbon monoxide levels that operated from 18 March 1988 to 30 June 2005.
Birkenhead (Hughes Street)	An industrial monitoring site, located in the grounds of the Birkenhead Primary School; monitoring for particulate matter, as PM ₁₀ , by TEOM began at this site on 21 June 2005.
Elizabeth Downs (Heard Street)	A suburban trend and performance monitoring site for carbon monoxide, and a PMS for nitrogen oxides and ozone, with monitoring starting in January 2002. Performance monitoring for particulate matter, as PM ₁₀ , began on 31 May 2004; a monitoring campaign for sulfur dioxide was conducted from May 2002 to 31 March 2004.
Kensington Gardens (East Terrace)	A suburban monitoring site used for trend and performance monitoring for nitrogen oxides and ozone (since 21 September 2001) and particulate matter, as PM ₁₀ (since 6 June 2002); PM _{2.5} particulate matter was monitored for the NEPM Study from June 2002 to 12 March 2004. Campaign monitoring for sulphur dioxide took place at this site, from 13 August 2002 to 7 January 2005.
Netley (Transport Avenue)	A monitoring site at the EPA Air Quality Laboratory in a western industrial suburb, used for trend and performance monitoring for nitrogen oxides and ozone (since 1979) and for PM ₁₀ particulate matter by TEOM (since 21 September 2001) and HVS monitoring for PM _{2.5} particulate matter for the NEPM study began on 4 September 2001 and continues.

Northfield
(Hampstead Road) A monitoring site located at the Hampstead Centre, used since 1979 for trend and performance monitoring for nitrogen oxides and ozone. Sulfur dioxide has been monitored since 15 October 2002; HVS was used to monitor TSP from June 1995 to 13 September 2005, and PM₁₀ from 8 February 2003 to 13 September 2005

Osborne
(Mersey Road) A monitoring site on the boundary of a mineral processing plant to determine the air pollution impact on the surrounding residential area; PM₁₀ and TSP data was collected by HVS on one day in six at this site from 2 July 1988 to 13 September 2005

Recently discontinued monitoring sites:

Christies Beach
(Winnerah Road) A suburban monitoring site established in 1992 to monitor sulfur dioxide in the air near the Port Stanvac oil refinery; monitoring ceased on 31 December 2004 after the refinery was decommissioned in July 2003.

Gawler
(Popham Avenue) A suburban monitoring site where nitrogen oxides and ozone were monitored from January 2002 to 19 October 2004, and PM₁₀ particulate matter was monitored from June 2002 to 22 October 2004.

Table 2: Monitoring sites in the Spencer Gulf airshed, showing pollutants measured

Monitoring site	Carbon monoxide (CO)	Sulfur dioxide (SO ₂)	Nitrogen oxides (NO _x)	Ozone (O ₃)	Particulate matter			Lead (Pb)
					≤ 2.5 μm (PM _{2.5})	≤ 10 μm (PM ₁₀)	(TSP)	
Port Augusta								
Hospital							Trend; PMS (HVS)	
Port Pirie								
Port Pirie South		Campaign	Campaign	See notes below			Trend; PMS (HVS & TEOM)	Trend; PMS (HVS)
Port Pirie West #1							Trend; PMS (HVS)	Trend; PMS (HVS)
Port Pirie West #2							Health Study (TEOM)	
Risdon Pk							Trend; PMS (HVS)	Trend; PMS (HVS)
Port Pirie								Industrial (HVS)
Whyalla								
Whyalla #1							Industrial (HVS)	Industrial (HVS)
Whyalla #2							Industrial (TEOM)	
Whyalla Norrie #1		Campaign	Campaign	Campaign				
Whyalla Norrie #2							Trend; PMS (HVS)	Trend; PMS (HVS)

Notes on monitoring sites:

Port Augusta

Port Augusta A monitoring site located in the grounds of the local hospital; PM₁₀ particulate matter has been monitored by HVS since 1 August 1996.

Port Pirie

Port Pirie South (Oliver Street) PM₁₀ particulate matter and TSP, with lead determinations, have been monitored by HVS at this site from May 1984 to August 1988, resuming on 8 October 1998. Monitoring for particulate matter (PM₁₀) by TEOM began on 27 June 2003; monitoring for sulphur dioxide began on 26 June 2002; campaign monitoring for nitrogen oxides and ozone took place from mid-May 2002 to 31 July.

	2005. The ozone monitoring data is not reported here because it appears to have been affected by an interfering substance.
Port Pirie West #1 (214 The Terrace)	A monitoring site located at the Port Pirie West Primary School; TSP and lead data have been collected since May 1984.
Port Pirie West #2 (58 The Terrace)	A TEOM unit, continuously monitoring PM ₁₀ particulate matter, began operation at this residential site on 24 August 2005 and is being operated by EPA on behalf of the Department of Health.
Risdon Park (Senate Road)	A monitoring site located in Frank Green Park, near the intersection of Senate Road and Halliday Street; TSP and lead data have been collected since March 1999
Port Pirie (Ellen Street)	A monitoring site located near the boundary of the lead smelter, so Air NEPM criterion for lead is not applicable; monitoring for TSP and lead began June 1984, stopped in August 1998 and resumed in July 2001.

Whyalla

Whyalla #1 (Hummock Hill)	A monitoring site close to the boundary of the steel works, established to study the concentrations of dust near the pelletising plant; monitoring for TSP began in 1989 and for PM ₁₀ particulate matter in 1990. In May 2000, the monitoring site was relocated to its current position; the sampling frequency was increased from one day in six to one day in three in May 2002.
Whyalla #2 (Walls Street)	An industrial compliance site where continuous monitoring for PM ₁₀ particulate matter with a TEOM unit began in July 2003. The site was relocated approximately six metres due north on 29 June 2004.
Whyalla Norrie #1 (Nicolson Avenue)	A site established in 2004 for a campaign to monitor ozone and nitrogen dioxide (from 8 January 2004) and sulphur dioxide (from 30 March 2004).
Whyalla Norrie #2 (Civic Park)	A background monitoring site for particulate monitoring in Whyalla: TSP has been monitored since 1989 and PM ₁₀ particulate matter since October 2001 Sampling frequency increased from one day in six to one day in three in May 2002.

Air quality monitoring methods

Carbon monoxide (non-dispersive infrared absorption)

Carbon monoxide is measured using a non-dispersive infrared analyser of the gas filter correlation type. A pre-filtered air sample is drawn through a sample cell. Infrared radiation is passed through the sample cell and a carbon monoxide-free reference cell. The analyser compares the light intensities measured for the sample cell and the reference cell to determine the infrared light absorbed by carbon monoxide in the sample cell. From this, the concentration of carbon monoxide can be calculated.

Nitrogen oxides (chemiluminescence)

Nitric oxide, nitrogen dioxide and total nitrogen oxides are measured using gas-phase chemiluminescence.

The air sample is split into two parts: sample A and sample B.

Sample A is passed over a heated catalyst to convert all its nitrogen dioxide into nitric oxide. The sample then goes to a reaction chamber where it is mixed with ozone. The ozone reacts with all the nitric oxide to produce nitrogen dioxide and chemiluminescent light. The light is detected with a photomultiplier and represents the total nitrogen oxides in the sample.

Sample B is sent directly to the reaction chamber and the light that it produces on reaction with ozone represents only the nitric oxide in the sample.

The difference between Sample A (total nitrogen oxides) and Sample B (nitric oxide) represents the amount of nitrogen dioxide in the original sample of air.

Ozone (ultraviolet photometry)

An ultraviolet photometric analyser is used to measure ozone. A filtered sample of air is drawn through the analyser and the ozone concentration is determined by measuring the reduction in intensity of ultraviolet light passing through the measurement cell.

Sulfur dioxide (fluorescence)

Sulfur dioxide measurements rely on the excitation of the sulfur dioxide molecule in the presence of ultraviolet light. The excited sulfur dioxide molecule emits photons of light as the molecule returns to its ground state (lowest energy state) and the emitted light is measured in a photomultiplier. Hydrocarbons interfere with the fluorescence so are removed by a scrubbing system before analysis.

Particulate matter (tapered element oscillating microbalance)

Continuous particulate matter concentrations (PM_{10} and $PM_{2.5}$) are measured by the tapered element oscillating microbalance (TEOM). The instrument draws air through a filter at a constant flow rate and at constant temperature. The mass of particulate matter on the filter is determined from the measured change in frequency at which the element attached to the filter is oscillating. The TEOM instrument uses an impacting mechanism to separate particles and measures PM_{10} and $PM_{2.5}$ as their equivalent aerodynamic diameters.

Particulate matter (high-volume sampling)

One-day samples of particulate matter, as PM_{10} and total suspended particles (TSP) are collected using high-volume samplers (HVS). The sampler draws air through a filter paper in an evenly distributed pattern at a known constant airflow rate for 24 hours. The resulting increase in the weight of the filter paper is the total airborne particulate material in the air volume (airflow rate x time). The airflow rate is automatically controlled to within ± 1 standard cubic metre per hour. The high-volume samplers conform to Australian Standard 2724.3 and are sited as specified by AS 2922.

Lead

The sample of particulate material collected on the filter paper of the high-volume sampler is analysed by atomic absorption spectroscopy for lead using a nitric acid extraction method as specified by Australian Standard 2800.

Air quality monitoring data tables

1: Carbon monoxide

Air NEPM Standard 9.0 ppm (8-hour average)
 Maximum allowable exceedences One day a year

Monitoring site	Data recovery (%)	No. days NEPM Std exceeded	Annual average (ppm)	Maximum (ppm)	Percentiles of daily peak 8-hour average (ppm)		
					99 th	95 th	90 th
Adelaide ¹	45	0	0.9	5.0	4.8	3.4	3.0
Elizabeth Downs	94	0	0.0	0.8	0.6	0.4	0.3

1 Incomplete data for 2005: monitoring at the Adelaide site concluded on 30 June 2005

ppm parts per million

2: Nitrogen dioxide (annual average and 1-hour average)

Air NEPM Standard (annual average)	0.03 ppm
Maximum allowable exceedences	None
Air NEPM Standard (1-hour average)	0.12 ppm
Maximum allowable exceedences	One day a year

Monitoring site	Data recovery (% hours)	No. days NEPM Std exceeded	Annual average (ppm)	1-hour maximum (ppm)	Percentiles of daily peak 1-hour average (ppm)		
					99 th	95 th	90 th
Elizabeth Downs	95	0	0.004	0.038	0.031	0.025	0.023
Kensington Gdns	97	0	0.005	0.031	0.029	0.026	0.024
Netley	97	0	0.009	0.051	0.042	0.034	0.031
Northfield	94	0	0.006	0.039	0.035	0.030	0.028
Port Pirie South ¹	59	0	0.003	0.023	0.022	0.020	0.017
Whyalla Norrie #1	80	0	0.003	0.025	0.023	0.021	0.018

1 Incomplete data for 2005: monitoring at the Port Pirie South site concluded on 11 August 2005

ppm parts per million

3: Ozone (photochemical oxidants) (1-hour average)

Air NEPM Standard 0.10 ppm (1-hour average)
 Maximum allowable exceedences One day a year

Monitoring site	Data recovery (% hours)	No. days NEPM Std exceeded	Annual average (ppm)	Maximum (ppm)	Percentiles of daily peak 1-hour average (ppm)		
					99 th	95 th	90 th
Elizabeth Downs	97	0	0.020	0.062	0.057	0.041	0.036
Kensington Gdns	98	0	0.021	0.061	0.053	0.044	0.039
Netley	97	0	0.016	0.079	0.054	0.041	0.037
Northfield	94	0	0.018	0.060	0.049	0.040	0.036
Whyalla Norrie #2	94	0	0.021	0.046	0.040	0.036	0.034

ppm parts per million

4: Ozone (photochemical oxidants) (4-hour average)

Air NEPM Standard 0.08 ppm (4-hour average)
 Maximum allowable exceedences One day a year

Monitoring site	Data recovery (%)	No. days NEPM Std exceeded	Annual average (ppm)	Maximum (ppm)	Percentiles of daily peak 4-hour average (ppm)		
					99 th	95 th	90 th
Elizabeth Downs	99	0	0.020	0.056	0.049	0.038	0.034
Kensington Gdns	100	0	0.021	0.055	0.050	0.040	0.037
Netley	99	0	0.016	0.072	0.048	0.038	0.034
Northfield	96	0	0.018	0.054	0.046	0.036	0.035
Whyalla Norrie #1	96	0	0.021	0.044	0.038	0.035	0.033

ppm parts per million

5: Sulfur dioxide (annual average and 1-hour average)

Air NEPM Standard (annual average)	0.02 ppm
Maximum allowable exceedences	None
Air NEPM Standard (1-hour average)	0.20 ppm
Maximum allowable exceedences	One day a year

Monitoring site	Data recovery (% hours)	No. days NEPM Std exceeded	Annual average (ppm)	Maximum (ppm)	Percentiles of daily peak 1-hour average (ppm)		
					99 th	95 th	90 th
Northfield	93	0	0.000	0.015	0.008	0.004	0.003
Port Pirie South	94	29	0.009	0.721	0.391	0.234	0.186
Whyalla Norrie #1	95	0	0.001	0.052	0.026	0.011	0.006

ppm parts per million

6: Sulfur dioxide (annual average and 1-day average)

Air NEPM Standard (annual average)	0.02 ppm
Maximum allowable exceedences	None
Air NEPM Standard (1-day average)	0.08 ppm
Maximum allowable exceedences	One day a year

Monitoring site	Data recovery (% days)	No. days NEPM Std exceeded	Annual average (ppm)	Maximum (ppm)	Percentiles of daily peak 1-day average (ppm)		
					99 th	95 th	90 th
Northfield	96	0	0.000	0.004	0.002	0.001	0.000
Port Pirie South	95	0	0.009	0.072	0.054	0.033	0.023
Whyalla Norrie #1	98	0	0.001	0.007	0.004	0.002	0.002

ppm parts per million

7: Airborne lead (annual average)

Airborne lead levels are monitored at four sites in Port Pirie:

- Oliver Street, **Port Pirie South**
- Port Pirie West Primary School, 214 The Terrace, **Port Pirie West #1**
- Frank Green Park, Senate Road, **Risdon Park**
- Ellen Street, **Port Pirie**.

The lead determinations are made on TSP samples collected by HVS, one day in six.

Air NEPM Standard 0.50 $\mu\text{g}/\text{m}^3$ (1-year average)

Maximum allowable exceedences None

Monitoring site	No. of valid samples	Annual average ($\mu\text{g}/\text{m}^3$)	Maximum daily value ($\mu\text{g}/\text{m}^3$)	2 nd highest daily value ($\mu\text{g}/\text{m}^3$)	90 th percentile value ($\mu\text{g}/\text{m}^3$)	Median daily value ($\mu\text{g}/\text{m}^3$)
Port Pirie South	60	0.60	5.51	4.80	1.38	0.21
Port Pirie West #1	58	0.73	6.08	3.65	1.84	0.31
Risdon Park	60	0.25	1.35	1.29	0.68	0.10
Port Pirie	58	3.46	21.12	14.62	8.59	1.77

$\mu\text{g}/\text{m}^3$ micrograms per cubic metre

8: Particulate matter, PM₁₀ (1-day average) by TEOM method

Air NEPM Standard 50 µg/m³ (1-day average)
 Maximum allowable exceedences Five days per year

Monitoring site	No. of valid days	No. days NEPM Std exceeded	Average (µg/m ³)	Maximum (µg/m ³)	2 nd highest (µg/m ³)	6 th highest (µg/m ³)	90 th percentile (µg/m ³)	Median value (µg/m ³)
Elizabeth Downs	347	6	17.6	84.8	77.3	53.7	30.0	14.9
Kensington Gardens	357	2	15.2	76.2	51.6	37.8	24.1	13.7
Birkenhead ¹	194	0	18.7	49.9	43.3	38.9	29.4	17.0
Netley	328	6	19.9	58.7	56.2	51.2	32.3	17.9
Port Pirie South	347	6	20.3	464.3	88.7	50.2	31.6	16.6
Port Pirie West #2 ^{2,3}	122	See note 3	19.0	95.6	72.7	38.0	29.8	16.4
Whyalla #2 ³	356	See note 3	24.3	151.8	142.5	109.1	46.9	17.5

1 Incomplete data for 2005: monitoring at the Birkenhead site began 21 June 2005.

2 Incomplete data for 2005: monitoring at the Port Pirie West #2 site began on 24 August 2005. This monitoring site is operated by EPA on behalf of the South Australian Department of Health.

3 The two sites are not designated as performance monitoring sites for the Air NEPM, so the data is not compared to the Air NEPM Standard.

µg/m³ micrograms per cubic metre

9: Particulate matter, PM₁₀ (1-day sample) by high volume sampling

Air NEPM Standard 50 µg/m³ (1-day average)
 Maximum allowable exceedences Five days per year

Monitoring site	No. of valid days	No. days NEPM Std exceeded ⁴	Average (µg/m ³)	Maximum (µg/m ³)	2 nd highest (µg/m ³)	6 th highest (µg/m ³)	90 th percentile (µg/m ³)	Median value (µg/m ³)
Netley ¹	57	2	23.5	91.0	79.1	43.2	41.4	20.1
Northfield ^{1, 2}	42	1	19.0	67.6	33.4	31.4	31.9	16.9
Port Pirie South	60	1	21.8	118.3	44.8	30.2	29.8	19.9
Whyalla Norrie #2 ³	100	1	16.2	80.6	40.7	28.6	25.7	13.6

1 Monitoring by HVS, one day in six.

2 Incomplete data for 2005: monitoring at the Northfield site concluded on 13 September 2005.

3 Monitoring by HVS, one day in three, at Whyalla monitoring sites.

4 HVS, one day in three or one day in six, does not meet the Air NEPM requirement for 75% data recovery.

µg/m³ micrograms per cubic metre

10: Particulate matter, PM₁₀ (1-day sample) by high volume sampling

Monitoring site ¹	No. of valid days	Average (µg/m ³)	Maximum (µg/m ³)	2 nd highest (µg/m ³)	6 th highest (µg/m ³)	90 th percentile (µg/m ³)	Median value (µg/m ³)
Osborne ^{2,3}	40	22.1	48.5	45.1	33.8	36.4	21.2
Port Augusta ³	52	18.8	38.3	33.3	32.0	31.9	19.5
Whyalla #1 ⁴	117	41.6	274.2	256.0	167.0	99.2	20.5

1 Sites not designated as PMS for the Air NEPM, so data not compared to the Air NEPM standard

2 Incomplete data for 2005: monitoring at the Osborne site concluded on 13 September 2005

3 Monitoring by HVS, one day in six

4 Monitoring by HVS, one day in three, at Whyalla monitoring sites

µg/m³ micrograms per cubic metre

11: Particulate matter, PM_{2.5} (1-day average) by TEOM method

Air NEPM Advisory Reporting Standard	25 µg/m ³ (1-day average)
Air NEPM Advisory Reporting Standard	8 µg/m ³ (annual average)

Monitoring site	No. of valid days	Average (µg/m ³)	Maximum (µg/m ³)	2 nd highest (µg/m ³)	6 th highest (µg/m ³)	90 th percentile (µg/m ³)	Median value (µg/m ³)
Netley	352	7.9	16.9	16.7	15.1	11.7	7.3

µg/m³ micrograms per cubic metre

12: Total suspended particles (1-day sample) by high volume sampling

There are currently no standards for TSP. The *World Health Organization Guidelines for Air Quality* (1999) sets a standard of 120 $\mu\text{g}/\text{m}^3$, but WHO *Guidelines for Air Quality* (2000) do not specify a standard for TSP.

Monitoring site	No. of valid days	Average ($\mu\text{g}/\text{m}^3$)	Maximum ($\mu\text{g}/\text{m}^3$)	2 nd highest ($\mu\text{g}/\text{m}^3$)	6 th highest ($\mu\text{g}/\text{m}^3$)	90 th percentile ($\mu\text{g}/\text{m}^3$)	Median value ($\mu\text{g}/\text{m}^3$)
Northfield ^{1, 2}	42	47.5	202.9	96.9	72.3	75.4	44.1
Osborne ^{1, 2}	39	44.9	124.5	87.8	67.9	73.3	44.1
Port Pirie South ¹	60	44.7	268.7	100.2	63.0	62.9	38.4
Port Pirie West #1 ¹	58	54.2	483.8	83.5	72.8	72.7	45.4
Risdon Park ¹	60	48.8	337.6	99.2	71.3	68.6	40.1
Port Pirie ¹	58	68.5	514.0	177.9	98.7	98.6	57.4
Whyalla Norrie #2 ³	111	32.4	211.0	85.0	66.0	57.7	26.4
Whyalla #1 ³	117	130.3	944.1	863.3	609.5	290.9	52.2

1 Monitoring by HVS, one day in six

2 Incomplete data for 2005: monitoring at Northfield site and Osborne site concluded on 13 September 2005

3 Monitoring by HVS, one day in three, at Whyalla monitoring sites

$\mu\text{g}/\text{m}^3$ micrograms per cubic metre