

AIRBORNE PARTICLE MONITORING AT BALLARAT, FEBRUARY 2002 TO SEPTEMBER 2003

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SUMMARY

- As part of EPA's air monitoring plan for regional Victoria, a study was conducted at Ballarat to investigate airborne particle levels.
- Airborne particles affect air quality throughout Victoria. Particles smaller than 10 micrometres (PM₁₀) are one of the seven air pollutants for which Victoria has set air quality objectives and goals.
- Air quality in Ballarat is relatively good. On average, PM₁₀ levels in Ballarat were lower than those in Melbourne and Geelong on any given day. They also tended to follow the same pattern, because of common weather influences.
- Ballarat had fewer exceedences of the PM₁₀ air quality objective than Melbourne. Two exceedences were observed in the 20 months of monitoring, both the result of dust storms.
- The highest readings at Ballarat were caused by dust storms. Other high readings were caused by bushfires and local sources such as wood fires and vehicle emissions.
- EPA and national programs in relation to wood heaters and motor vehicles should lead to further improvements in air quality in Ballarat.
- EPA plans to perform follow up monitoring at Ballarat in 2005; monitoring gaseous and particle pollutants for a period of one year.

BACKGROUND

Until recently, Victoria's air quality monitoring concentrated on the Port Phillip (Melbourne–Geelong) region and the Latrobe Valley. EPA's air monitoring plan,¹ developed in 2001 in accordance with national guidelines, made a commitment to 'campaign' (exploratory) monitoring of particles smaller than 10 micrometres in diameter (PM₁₀) in other rural centres². From previous studies and knowledge of air pollution issues, particles are considered to be the most critical pollutant for monitoring. Regional cities are monitored sequentially for one to two years each. Monitoring at Bendigo during 2000–2001 has already been reported³. Campaign monitoring commenced at Shepparton in December 2003.

At Ballarat, a high-volume sampler was used to monitor PM₁₀. This instrument collects particles on a filter, which is then weighed to determine the concentration of PM₁₀ in the air during the exposure time. Twenty-four hour samples were collected on every sixth day.

PM₁₀ can also be monitored continuously by electronic instruments. This is done in the Port Phillip region and the Latrobe Valley. High-volume

¹ Ambient air quality NEPM monitoring plan Victoria, *EPA Publication 763*, available from www.epa.vic.gov.au.

² Bendigo, Ballarat, Wodonga (covered by monitoring at Albury), Shepparton, Mildura, Warrnambool

³ Air quality assessment of fine particles in Bendigo – a pilot study, *EPA Publication 869*, available from www.epa.vic.gov.au.

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sampling is used for campaign monitoring, aimed to assess whether ongoing monitoring is justified.

HEALTH EFFECTS OF PARTICLES

Particles have been associated with health effects on humans. Particles as PM₁₀ are capable of deep penetration into the human lung and are known to carry toxic material condensed or adsorbed on their surface.

High levels of particles can aggravate existing respiratory and cardiovascular disease, resulting in increased hospital admissions, emergency room visits and increases in daily mortality. Decreases in lung function, exacerbation of asthma and alteration in the body's defence mechanisms and lung clearance mechanisms have also been associated with airborne particles. Sensitive subgroups of the population include the elderly, children and people with existing respiratory or cardiovascular disease.

PM₁₀ is one of the seven air pollutants for which Victoria has set air quality objectives and goals.⁴ The objectives are pollutant concentrations (set to protect human health) against which air quality can be assessed. The goals specify the maximum permissible number of exceedences of the objective per year and a timeframe in which this goal must be met (by 2008). The objective for PM₁₀ averages over 24 hours (50 micrograms per cubic metre (µg m⁻³)) is not to be exceeded on more than five days per year.

While the objective applies throughout Victoria, ongoing monitoring to demonstrate compliance is not required if concentrations are reasonably

⁴ State Environment Protection Policy (Ambient Air Quality), *Victoria Government Gazette No. S19, 9 February 1999*, available from www.epa.vic.gov.au.

expected to be consistently lower than the objective. Campaign monitoring can be used to establish this, according to national guidelines.⁵

SOURCES OF PARTICLES IN BALLARAT

Industrial sources in Ballarat are relatively small and few in number. The National Pollutant Inventory shows that, averaged over a year, domestic wood fires were the main source of PM₁₀ emissions in the Ballarat urban area, followed by other fuel combustion, a brick works and motor vehicles.⁶ Particle levels would also be adversely influenced by dust and fires originating outside the region.

WHERE AND WHEN DID EPA MONITOR?

The high-volume sampler was located in Llanberris Reserve, York Street,⁷ approximately 1km southeast of the centre of Ballarat (Figure 1). This site is considered to give typical residential exposure to particles in Ballarat.

⁵ Screening procedures, *National Environment Protection (Ambient Air Quality) Measure Technical Paper No 10*, available from www.ephc.gov.au.

⁶ Emissions in the National Pollutant Inventory can be viewed at www.npi.gov.au.

⁷ AMG coordinates 58375N, 7535E.

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Figure 1. Ballarat monitoring site

The first sample was obtained on 11 February 2002 and monitoring continued until 28 September 2003. During this period, results were shown progressively on EPA's web site.

AIR QUALITY AT BALLARAT IS RELATIVELY GOOD

The average particles level (PM_{10}) at Ballarat was $15.3\mu\text{g m}^{-3}$ (see Figure 2 and Appendix 1 for full details).

PM_{10} was also monitored at six sites in the Port Phillip region by high-volume samplers operating on the same days as at Ballarat. This enables a comparison of particle pollution in the two regions. Table 1 shows that averages during the same period were higher in the Port Phillip region. Ballarat's average was also lower than that for Bendigo in 2000–01 ($16.0\mu\text{g m}^{-3}$).

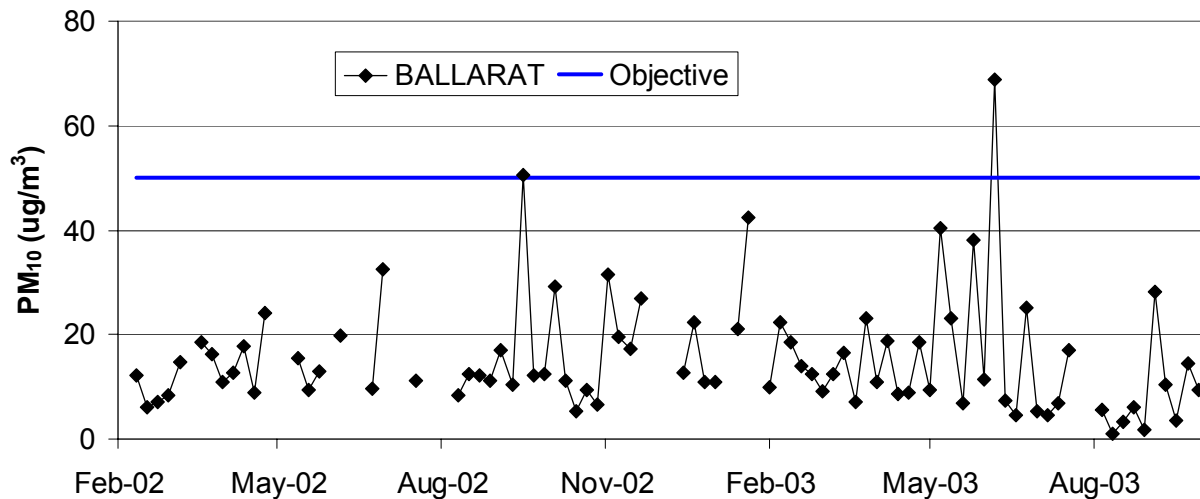


Figure 2. Daily average PM_{10}

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Table 1. Average PM₁₀ levels over the period of monitoring

Station	Location Category	Average ($\mu\text{g m}^{-3}$)
Ballarat	Residential	15.3
Alphington	Light industrial/ Residential	18.6
Richmond	Residential	22.0
Paisley	Industrial/ Residential	22.5
Geelong	Industrial/ Residential	20.6
RMIT	CBD	22.3
Collingwood	Light industrial/ Residential	27.8

CAUSES OF HIGHEST READINGS

The period of monitoring coincided with severe drought conditions and the worst Victorian bushfires on record.

The highest PM₁₀ levels measured at Ballarat are shown in Table 2. The likely causes have been identified by examining the colour and smell of the filters and the meteorological conditions. Strong northwest winds and distinctive orange filter papers implicate windborne dust as the cause on the two exceedence days (shown in bold). The event on 6 June 2003 was a widespread dust storm (unusual in winter) that caused much higher readings in Melbourne. On the other exceedence day, 15 September 2003, levels in Melbourne and Geelong, although elevated, were not as high as at Ballarat.

Table 2. Highest readings at Ballarat

Date	PM ₁₀ ($\mu\text{g m}^{-3}$)	Cause
29/06/02	32.4	Dust
15/09/02	50.6	Dust
3/10/03	29.3	Local
2/11/02	31.5	Local
19/01/03	42.3	Bushfire
7/05/03	40.4	Local
25/05/03	38.0	Local
6/06/03	68.8	Dust
4/09/03	28.1	Local or dust

Widespread bushfires during the 2002-03 summer caused elevated PM₁₀ readings in Melbourne and affected air quality throughout Victoria. On 19 January 2003 extensive fires were burning in northeast Victoria. On this day, surface winds at Ballarat were moderate to fresh from the southeast and the filter smelled of wood smoke.

Days associated with local causes in Table 2 had lower winds and darker filters smelling of combustion products, implicating wood fires and motor vehicles. These causes are more amenable to emission controls.

THE PARTICLES OBJECTIVE WAS ACHIEVED ON ALL BUT TWO DAYS

The objective of $50\mu\text{g m}^{-3}$ was exceeded at Ballarat on two days during the 20 months of monitoring. Strict compliance with the goal cannot be demonstrated as Ballarat monitoring was on every sixth day (the allowed five exceedences per year

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assume continuous monitoring). Eighty of the 82 readings (97.6 per cent) met the objective, compared with 360 out of 365 (98.7 per cent) required by the goal. There were fewer exceedences at Ballarat than at any of the Port Phillip sites except Alphington where, due to instrument failure, two likely exceedence days were not recorded (Table 3). Collingwood, which is a peak station to monitor vehicle emissions, recorded the highest number of exceedences. Table 3 also shows the number of exceedences after those that resulted from the January 2003 bushfire period were subtracted.

Table 3. How often the objective was exceeded

Site	Exceedences in 20-month period	Without bushfires
Ballarat	2	2
Alphington	1 ^a	0
Richmond	3	1
Geelong South	4	3
Paisley	4	2
RMIT	3	1
Collingwood	5	3

a Readings were not available from Alphington on two days (25/01/03 and 06/06/03) when all other Port Phillip stations recorded an exceedence.

METEOROLOGICAL INFLUENCES

In Figure 3 the Ballarat readings are compared with those measured at stations in the Port Phillip region. Although the Ballarat readings were usually lower, there is a tendency to follow the highs and lows seen in Melbourne and Geelong. This is because the weather conditions influencing particle levels tend to occur on a regional scale. These include:

- high winds, generating dust from the ground;
- calm conditions, allowing pollution to accumulate, particularly overnight;
- rain, which settles dust;
- drought conditions, which exacerbate dust and fire risk; and
- extreme fire danger, leading to particulate emissions from widespread bushfires.

Similar regional influences were found at Bendigo when particles were monitored in 2000-01 (EPA Publication 869).

IMPROVING BALLARAT'S AIR QUALITY

While air quality in Ballarat is relatively good, EPA and national programs should lead to further improvements. Specifically:

- *Wood heaters:* Wood smoke can be a significant source of particle pollution in the winter months. Wood heaters that operate correctly and meet the Australian Standard AS/NZS 4013 produce significantly less particles than open fireplaces and heaters that do not meet the Australian Standard. EPA is developing a waste management policy to incorporate this standard into Victorian legislation. The policy will require that all wood heaters manufactured and supplied in Victoria meet the Australian Standard. The policy also commits EPA to continue to work with industry, government agencies and other stakeholders to identify ways of reducing emissions from wood heaters, and to continue to provide information

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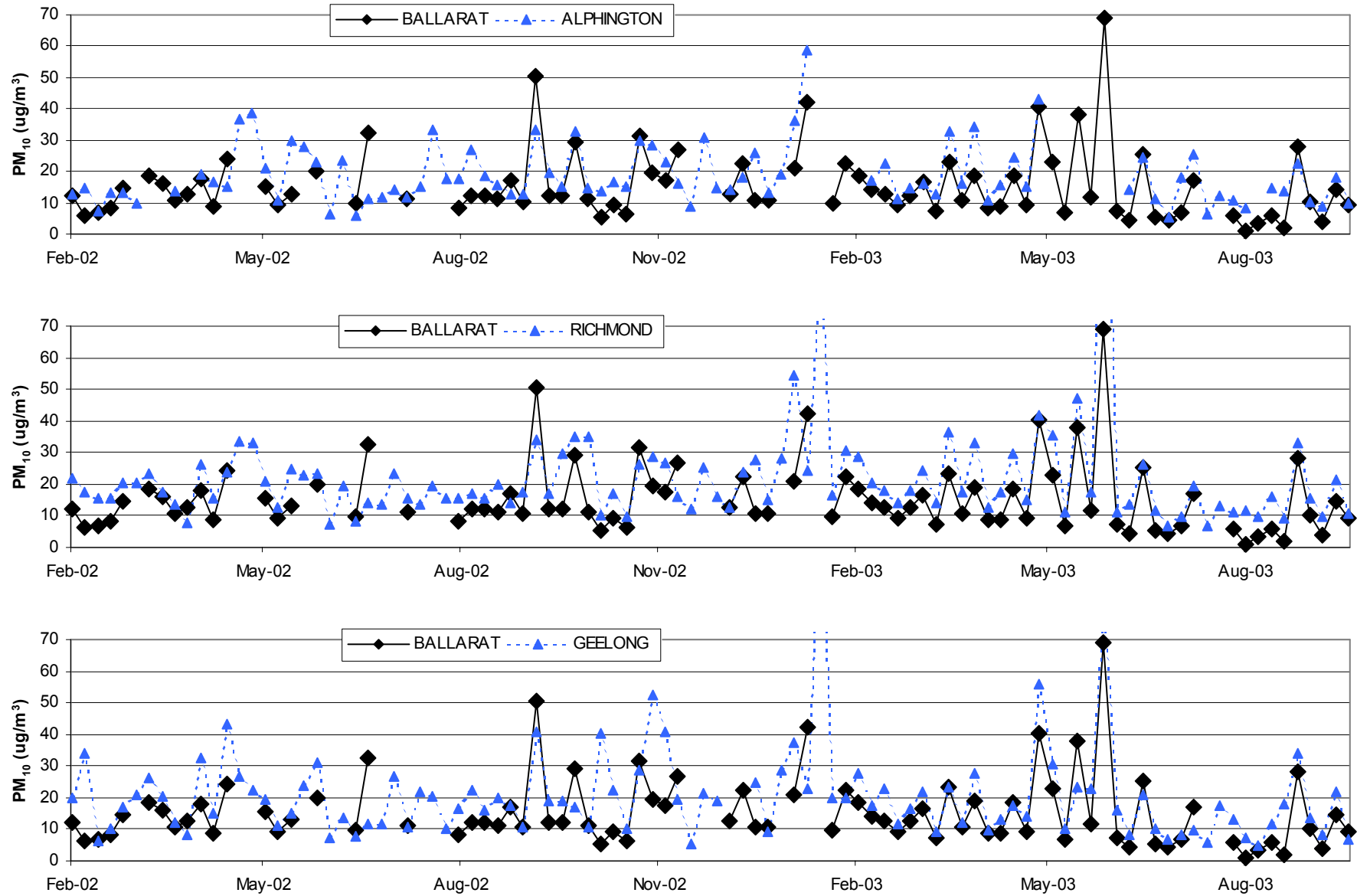


Figure 3. Comparisons between PM₁₀ in Ballarat and Port Phillip region

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to industry and the community about solid fuel heating and its environmental impacts.

- *Motor Vehicles:* Motor vehicle emissions are an issue in all urban environments. More stringent emissions standards for new motor vehicles were recently introduced and will ensure that the emissions performance from all new vehicles entering the Australian market will continue to improve. In addition, national fuel quality standards that will come into place between 2004 and 2006 will improve emissions from vehicles – in particular, particle emissions from diesel vehicles. EPA has also been working on a number of programs aimed at decreasing emissions from in-service vehicles by working with the motor vehicle service and repair industry to improve the maintenance of vehicles.

CONCLUSION

In order to increase our understanding of particle levels in regional Victoria, EPA's monitoring plan identifies six centres requiring campaign monitoring.

Monitoring conducted at Ballarat for a 20 month period during 2002-03 indicated that air quality was relatively good, with particles levels being on average below that of the Melbourne-Geelong region. However, two exceedences of the objective level were recorded, as a result of wind-blown dust. Due to the influence of common weather patterns, levels at Ballarat correlated with levels in Melbourne-Geelong.

The results indicate that further monitoring of PM₁₀ is desirable at Ballarat (as was found at Bendigo). This need will initially be met by moving a mobile air monitoring laboratory (monitoring both gaseous and particle pollutants) around the major rural centres in Victoria (located first at Bendigo in 2004, followed by Ballarat in 2005).

ACKNOWLEDGEMENTS

EPA gratefully acknowledges the assistance of Ballarat City Council who collected filter papers from the high-volume sampler, and Ballarat Goldfields NL, who provided the monitoring site.

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APPENDIX 1: RESULTS OF PM₁₀ MONITORING BY HIGH-VOLUME SAMPLER

Readings are in $\mu\text{g m}^{-3}$ averaged over 24 hours (midnight to midnight) every sixth day.

Date	PM ₁₀ ($\mu\text{g m}^{-3}$)						
	Ballarat	Alphington	Collingwood	Richmond	Paisley	Geelong	RMIT
11/02/02	12.2	12.7	24.5	21.9	18.1	19.8	18.2
17/02/02	6.1	14.9	20.6	17.7	16.9	34.2	19.3
23/02/02	7.0	7.2	9.4	15.6	4.4	6.2	
1/03/02	8.3	13.2		15.7	10.6	10.3	14.8
7/03/02	14.6	13.2	19.1	20.3	15.6	17.1	18.4
13/03/02		9.8	22.4	20.4	11.6	20.9	18.7
19/03/02	18.5		38.7	23.2	23.9	26.4	27.3
25/03/02	16.3		23.4	17.7	18.3	20.4	20.8
31/03/02	10.8	13.6	15.8	13.5	11.2	12.3	13.1
6/04/02	12.8		24.6	8.0	8.7	8.1	9.5
12/04/02	17.8	19.0	38.2	26.1	13.8	32.6	31.0
18/04/02	8.9	16.9	25.1	15.6		15.3	15.9
24/04/02	24.2	15.1	35.0	23.6	40.3	43.4	27.0
30/04/02		36.8	46.4	33.6	27.1	26.9	
6/05/02		38.7	41.0	33.0	34.1	22.4	33.2
12/05/02	15.4	21.1	26.2	20.9	19.9	19.4	21.2
18/05/02	9.5	10.8	18.0	12.5	14.2	11.4	15.4
24/05/02	12.9	30.0	37.4	24.6	22.7	15.1	27.6
30/05/02		28.0	31.9	22.6	30.8	23.7	22.7
5/06/02	19.8	23.2	29.7	23.5	27.1	31.3	27.9
11/06/02		6.3	9.3	7.5	9.5	7.5	6.9
17/06/02		23.7	31.7	19.5	15.7	13.7	18.5
23/06/02	9.6	5.8	10.5	8.3	7.4	7.9	9.4
29/06/02	32.4	11.3	19.8	14.3	15.2	11.5	
5/07/02		11.6	18.5	13.8	25.5	11.9	16.3
11/07/02		14.0	30.3	23.4	29.2	26.7	29.0
17/07/02	11.3	11.9	19.4	15.7	15.1	10.6	18.1
23/07/02		15.1	17.6	13.8	16.5	21.8	14.4
29/07/02		33.2	29.3	19.4		20.5	17.5
4/08/02		17.4	18.5	15.5		10.3	14.9
10/08/02	8.5	17.5	19.4	15.6		16.3	18.1
16/08/02	12.4	27.0	28.0	16.8		22.2	14.4
22/08/02	12.2	18.6	22.7	15.6	15.0	16.0	16.7
28/08/02	11.2	15.6	35.7	20.1	15.7	20.2	21.7
3/09/02	16.9	12.8	16.2	14.2	17.1	17.4	15.3
9/09/02	10.5	12.7	18.9	17.4	11.7	10.6	17.7
15/09/02	50.6	33.2	42.5	34.2	43.6	40.6	41.2
21/09/02	12.2	19.8	18.7	17.1	21.4	18.8	17.9
27/09/02	12.4	15.0	27.8	29.7	15.0	18.9	24.5
3/10/02	29.3	33.0	47.6	34.8	47.5	17.0	38.0
9/10/02	11.2	14.6	20.4	35.1	12.6	10.7	17.7
15/10/02	5.2	13.6	17.2	10.2	18.5	40.5	9.9
21/10/02	9.4	16.6	20.1	16.8	21.2	22.1	17.1
27/10/02	6.5	15.2	11.5	9.9	6.0	10.3	10.4
2/11/02	31.5	29.6	32.2	26.0	19.2	28.5	27.2
8/11/02	19.7	28.3	30.6	28.6	13.4	52.6	28.3
14/11/02	17.4	23.1	22.5	26.7	22.6	40.7	27.1
20/11/02	26.8	16.4	21.0	16.0	15.7	19.6	10.9
26/11/02		8.6	14.4	12.0	9.0	5.5	13.4
2/12/02		30.6	38.9	25.5	13.6	21.6	27.2
8/12/02		14.4	22.6	16.2	14.5	19.2	17.0

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Date	PM ₁₀ (µg m ⁻³)						
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14/12/02	12.7	14.1	18.5	12.6	14.8		
20/12/02	22.3	18.1	28.9	23.8	16.2		26.9
26/12/02	10.8	26.1	30.5	27.8	24.9	24.6	27.8
1/01/03	10.8	13.1	9.9	14.8	9.1	9.2	10.0
7/01/03		18.9	32.3	28.2	21.6	28.8	27.2
13/01/03	21.1	36.4	65.7	54.7	45.4	37.3	64.8
19/01/03	42.3	58.6	27.8	24.1	72.4	22.9	25.6
25/01/03			96.4	89.7	107.5	116.1	98.2
31/01/03	9.9		19.4	16.7	18.6	20.0	21.2
6/02/03	22.3		34.7	30.5	42.1	19.7	18.2
12/02/03	18.5		35.9	28.9	32.5	27.6	29.1
18/02/03	14.0	17.3	27.8	20.2	16.0	17.5	17.1
24/02/03	12.5	22.6	21.8	17.9	18.8	22.9	15.4
2/03/03	9.1	11.4	15.8	14.3	18.7	11.6	14.6
8/03/03	12.5	14.5	21.7	18.0	16.1	16.7	16.5
14/03/03	16.4	16.0	31.1	24.1	34.7	21.9	21.6
20/03/03	7.2	12.6	14.6	13.9	14.4	9.4	13.8
26/03/03	23.1	32.6	41.5	36.6	27.1	23.2	43.0
1/04/03	10.9	16.0	28.9	17.5	17.8	12.3	18.7
7/04/03	18.8	34.3	47.0	33.1	37.0	27.6	34.2
13/04/03	8.6	10.8	14.2	12.8	12.2	9.8	10.9
19/04/03	9.0	15.8	19.2	17.7	12.1	13.2	13.0
25/04/03	18.7	24.4	30.4	29.5	25.0	17.5	26.3
1/05/03	9.3	15.1	17.8	15.3	14.3	14.1	16.6
7/05/03	40.4	43.3	55.2	41.8	59.8	55.9	45.5
13/05/03	23.0		56.0	35.3	49.0	30.6	38.2
19/05/03	6.9			11.3	13.2	10.3	12.1
25/05/03	38.0		48.5	47.3	35.1	23.5	
31/05/03	11.5		22.2	17.5	37.3	22.8	20.2
6/06/03	68.8		193.9	161.7	133.3	81.1	162.6
12/06/03	7.3		14.9	11.2	22.2	16.3	14.5
18/06/03	4.5	14.4	14.6	13.8	6.8	8.4	10.1
24/06/03	25.3	24.6	39.2	26.4	25.5	21.0	27.7
30/06/03	5.3	11.1	19.0	11.7	10.2	10.2	11.5
6/07/03	4.5	5.4	9.1	6.8	6.3	6.8	6.1
12/07/03	6.8	18.3	9.2	9.6	7.3	8.2	8.6
18/07/03	16.9	25.4	35.2	19.4	17.8	9.6	19.6
24/07/03		6.4	7.3	6.7	6.4	6.0	5.7
30/07/03		12.4	15.2	13.3	11.1	17.7	14.2
5/08/03	5.7	10.9	13.7	11.4	14.6	13.1	12.4
11/08/03	1.0	8.4	11.1	11.7		7.1	13.0
17/08/03	3.3		12.2	9.9	8.9	4.8	9.7
23/08/03	6.1	14.6	28.1	15.9	24.1	11.8	15.5
29/08/03	1.9	13.6	13.7	9.3	14.5	18.0	10.1
4/09/03	28.1	22.6	39.3	33.0	31.0	34.0	34.8
10/09/03	10.3	10.0	16.6	15.5	13.8	13.5	16.2
16/09/03	3.7	9.1	11.3	9.7	9.3	8.2	11.2
22/09/03	14.4	18.1	29.0	21.6	21.6	21.7	22.8
28/09/03	9.5	9.8	13.4	10.9	10.0	6.7	10.3
Average	15.3	18.6	27.8	22.0	22.5	20.6	22.3