

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO – A PILOT STUDY

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## SUMMARY

The air quality in Bendigo has not been extensively monitored in the past and this study provides some valuable background information on airborne particles less than 10µm in diameter (PM<sub>10</sub>). Results from 16 months of monitoring show that the PM<sub>10</sub> objective of the State Environment Protection Policy (Ambient Air Quality)<sup>1</sup>[SEPP(AAQ)] was met except for one of the days monitored, and that Bendigo has relatively good air quality. An assessment of the requirement for future monitoring of PM<sub>10</sub> against the National Environment Protection Measure (Ambient Air Quality)<sup>2</sup> [NEPM] screening criteria indicates that future monitoring is warranted.

## BACKGROUND

### Health effects of particles

Health effects on humans have been associated with the size of particles inhaled. Particle sizes are expressed as µm - one millionth of a metre. These particles are capable of deep penetration into the human lung and are known to carry toxic material condensed or adsorbed on their surface. Generally, particles with diameters less than 10µm (PM<sub>10</sub>) are

capable of penetration into the upper and lower airways of the human body.

The measurement of PM<sub>10</sub> levels in Bendigo was initiated to investigate levels of fine particles and to determine whether the PM<sub>10</sub> objective of the SEPP(AAQ) was being met. Bendigo City has a population of 60,000 and apart from some particle monitoring related to the mining industry, little is known about PM<sub>10</sub> levels in the region.

### Sources of particles

Bendigo has some mining activity, but the major sources of fine particles are believed to be from domestic wood heating, agricultural activities, motor vehicles and dust storms. From the knowledge of industrial sources and vehicle numbers in the Bendigo region, air quality would be expected to meet SEPP(AAQ) objectives for most air pollutants. However, a potential pollutant of concern in Bendigo was PM<sub>10</sub>, as air emission inventories have shown that domestic wood combustion is the dominant source of particles (PM<sub>10</sub>) in winter.

### Air quality guidelines and objectives

The SEPP(AAQ) objective for PM<sub>10</sub> is 50µg/m<sup>3</sup> for an averaging period of 24 hours and is based on daily sampling. The long-term goal is to have less than five days annually with levels greater than the 50µg/m<sup>3</sup>.

<sup>1</sup> State environment protection policy (Ambient Air Quality) Victorian Government Gazette No.S.19 9 February 1999

<sup>2</sup> National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No.4 May 2001

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO – A PILOT STUDY

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The environmental outcome for the SEPP(AAQ) is ambient air quality that allows for the adequate protection of human health and well being. The SEPP(AAQ) establishes ambient air quality objectives for a number of pollutants and a monitoring and reporting protocol for assessing compliance with the objective. In essence, the protocol requires measurements of air quality that are representative of the air to which the general population is exposed.

The NEPM allows for screening procedures in order to assess whether pollutant concentrations might be expected to be consistently lower than the objective. These screening procedures may be used to assess whether monitoring is required in regions with populations greater than 25,000. The acceptance limit used in the screening procedure for PM<sub>10</sub> is that, at a representative monitoring location, the 5<sup>th</sup> highest daily reading (for one year of daily PM<sub>10</sub> data) must be less than 55 per cent of the PM<sub>10</sub> objective. If this is not the case, monitoring may be warranted.

## **PARTICLE MONITORING**

EPA has monitored particles (PM<sub>10</sub>) in Bendigo from February 2000 to June 2001 to establish whether particle levels in Bendigo meet the requirements of the SEPP(AAQ). An assessment of PM<sub>10</sub> data against the NEPM screening criteria used to assess future monitoring needs was also undertaken. PM<sub>10</sub> measurements were recorded for 24-hour periods, once every six days. Run-days were programmed to occur on the same days as sampling in Melbourne.

The main sources of PM<sub>10</sub> particles in Bendigo are believed to be from domestic wood heating, fuel reduction burns, agricultural activities, motor vehicles and dust storms. These sources of particles are

consistent with sources found in Melbourne and other regional centres such as Geelong. The contribution to total PM<sub>10</sub> from individual sources will vary from site to site.

Particle monitoring in Bendigo was performed in a residential area at the YWCA Townsend Street, Kennington. This location meets the criteria for a representative monitoring site as described in the NEPM.

For the days monitored, the SEPP(AAQ) objective for PM<sub>10</sub> (50 µg/m<sup>3</sup>) was exceeded on only one day. The PM<sub>10</sub> exceedance occurred during summer on 4 February 2000 (53 µg/m<sup>3</sup>).

Bendigo PM<sub>10</sub> levels show similar general trends to Melbourne, but levels are generally lower than in Melbourne. The occasional large differences are most likely associated with local PM<sub>10</sub> sources or local meteorological events. The mean PM<sub>10</sub> difference between Bendigo and corresponding Melbourne sites in Alphington and Richmond on the same run days was approximately 13 per cent. Figure 1 shows the particle levels for Bendigo compared with Melbourne PM<sub>10</sub> sites that are similarly situated in residential locations.

Bendigo also showed similar PM<sub>10</sub> trends to Geelong, although PM<sub>10</sub> levels were generally lower in Bendigo. The mean PM<sub>10</sub> difference between Bendigo and Geelong was approximately 7 per cent. Figure 2 shows the particle levels for Bendigo compared with Geelong.

PM<sub>10</sub> data for all sites for the period February 2000 to June 2001 are contained in Appendix 1.

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO - A PILOT STUDY

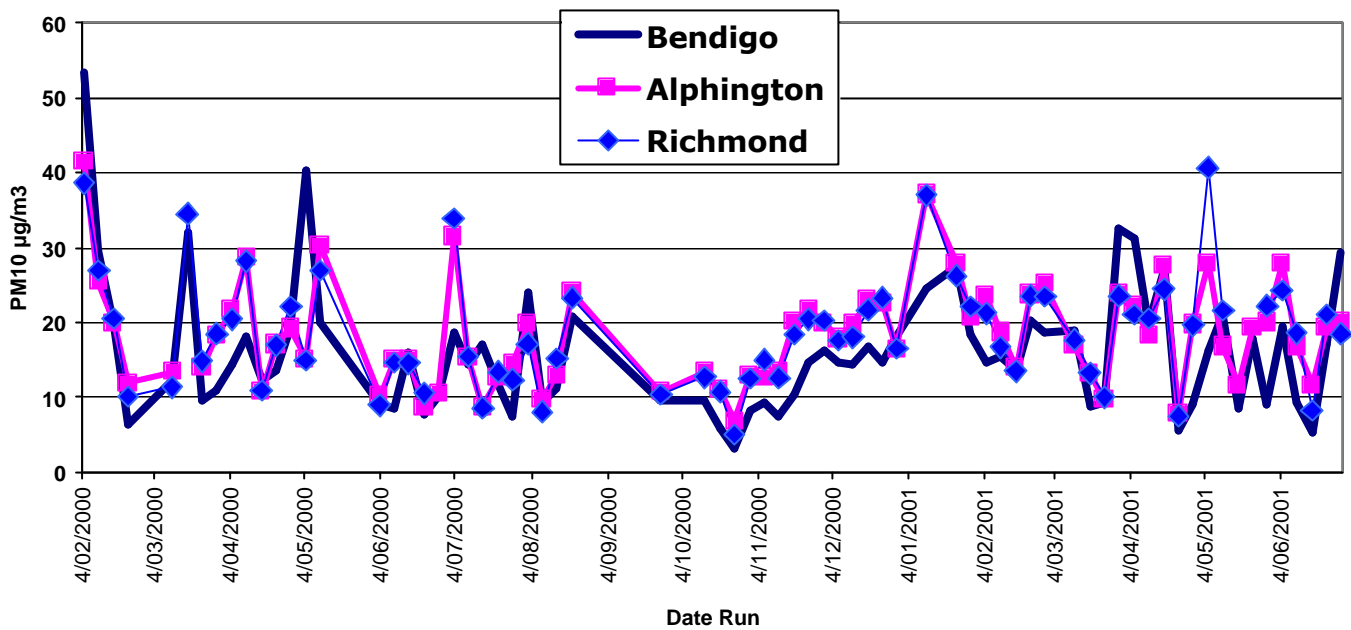


Figure 1: Melbourne PM10 sites Alphington and Richmond compared with Bendigo (February 2000-June 2001)

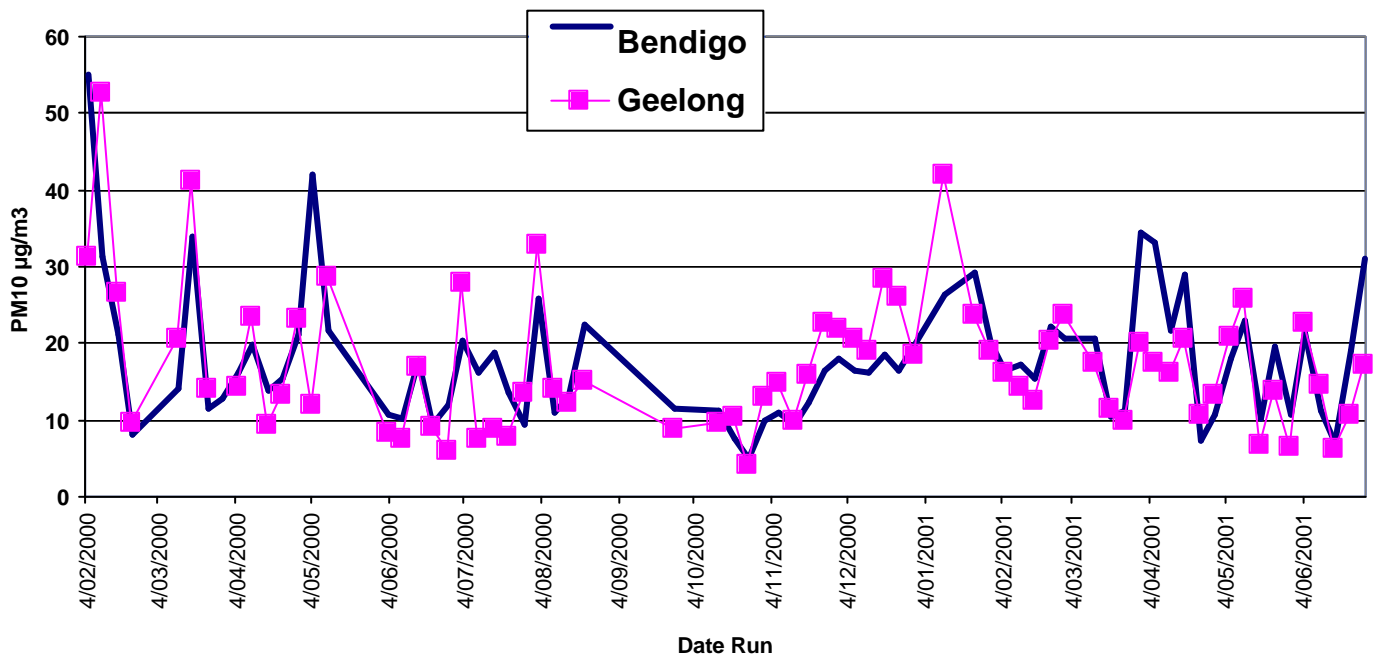


Figure 2: Regional PM10 sites Geelong and Bendigo (February 2000-June 2001)

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO – A PILOT STUDY

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During summer months high levels of PM<sub>10</sub> are usually associated with high wind speeds which entrain settled dust or soil. It is most likely the high PM<sub>10</sub> value on 4 February 2000 was associated with strong winds that may have carried soil particles, rather than originating from combustion sources.

The major source of elevated PM<sub>10</sub> in Bendigo during autumn/winter months was expected to be wood smoke from residential heating or fuel reduction burns. During these months wind speeds are lower and pollutants such as wood smoke are poorly dispersed leading to high particle concentrations. However, the PM<sub>10</sub> results for the 2000 autumn/winter and 2001 autumn periods in Bendigo show levels generally well below the SEPP(AAQ) objective and below Melbourne and Geelong. The absence of high PM<sub>10</sub> levels in autumn/winter periods suggests that wood smoke is not a pollutant of major concern in Bendigo and suggests that Bendigo has relatively good air quality.

## **FUTURE MONITORING**

For the Bendigo study, PM<sub>10</sub> measurements were only recorded every sixth day. There were four days in autumn, two days in summer and one day in winter months when PM<sub>10</sub> exceeded 55 per cent of the NEPM

objective (28µg/m<sup>3</sup>), indicating that the screening criteria are unlikely to be met and that future PM<sub>10</sub> monitoring in Bendigo is warranted.

Weather data from the Bureau of Meteorology site at Bendigo airport were used to assess conditions for the days when particle levels exceeded the NEPM screening criteria (Table 1). Generally it was found that most high particle days (greater than 28µg/m<sup>3</sup>) in Bendigo occurred with moderate to high temperature and wind speed. For these days the main source of PM<sub>10</sub> is likely to be wind carried soil. Although bushfire smoke might have been a contributor, the light tan colour of the sample filter papers suggested that soil particles were more dominant than dark-coloured carbonaceous particles that might originate from fire. For all days on which the 28µg/m<sup>3</sup> limit was exceeded (except 28 June 2001), the ambient temperatures suggest that domestic wood heating would not have been widely used. On 28 June 2001 ambient temperatures and wind speeds were low. With such cold temperatures, wood heaters were probably widely used and the combination of low temperatures and wind speeds could have led to poor dispersion of pollutants such as wood smoke. Therefore, for this day wood smoke would have been the most likely source of PM<sub>10</sub>.

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO – A PILOT STUDY

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**Table 1: Meteorological conditions for days exceeding the NEPM screening criteria**

| Date    | PM <sub>10</sub> (µg/m <sup>3</sup> ) | Temperature Range (°C) | Maximum Wind Speed (m/s) | Predominant Wind Direction |
|---------|---------------------------------------|------------------------|--------------------------|----------------------------|
| 4/2/00  | 53                                    | 21-38                  | 8                        | north                      |
| 10/2/00 | 29                                    | 22-36                  | 8                        | north                      |
| 17/3/00 | 32                                    | 16-34                  | 7                        | north                      |
| 4/5/00  | 40                                    | 13-17                  | 6                        | south                      |
| 30/3/01 | 33                                    | 9-23                   | 5                        | south-east                 |
| 5/4/01  | 31                                    | 9-24                   | 5                        | south-west                 |
| 28/6/01 | 29                                    | -3-12                  | 3                        | north                      |

## CONCLUSIONS

A pilot study of PM<sub>10</sub> levels in Bendigo revealed that particle levels met the objectives of the SEPP(AAQ), except for one day of the days monitored. The PM<sub>10</sub> levels were generally lower than Melbourne and Geelong sites similarly situated in residential areas. This suggests that Bendigo has relatively good air quality.

Although wood smoke from domestic wood heating was a potential pollutant of concern in Bendigo, the absence of high PM<sub>10</sub> levels in autumn/winter months suggests that wood smoke is not a major problem. The highest levels of PM<sub>10</sub> occurred during warm weather and this suggests that wind carried soil was a likely contributor.

Application of the NEPM screening procedures to the Bendigo PM<sub>10</sub> data suggests that the screening criteria have not been met and future monitoring in Bendigo is warranted.

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO – A PILOT STUDY

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## APPENDIX 1: PM<sub>10</sub> (µg/m<sup>3</sup>) February 2000 to June 2001

| Date Run | Bendigo | Geelong | Alphington | Collingwood | Richmond |
|----------|---------|---------|------------|-------------|----------|
| 4/02/00  | 53      | 31      | 41         | 47          | 39       |
| 10/02/00 | 29      | 53      | 25         | 33          | 27       |
| 16/02/00 | 19      | 27      | 20         | 30          | 21       |
| 22/02/00 | 6       | 10      | 12         | 20          | 10       |
| 11/03/00 | 12      | 21      | 13         | 20          | 11       |
| 17/03/00 | 32      | 41      |            | 45          | 35       |
| 23/03/00 | 10      | 14      | 14         | 19          | 15       |
| 29/03/00 | 11      |         | 18         | 21          | 18       |
| 4/04/00  | 14      | 14      | 22         | 30          | 20       |
| 10/04/00 | 18      | 23      | 29         | 37          | 28       |
| 16/04/00 | 12      | 9       | 11         | 11          | 11       |
| 22/04/00 | 14      | 13      | 17         | 18          | 17       |
| 28/04/00 | 19      | 23      | 19         | 30          | 22       |
| 4/05/00  | 40      | 12      | 15         | 22          | 15       |
| 10/05/00 | 20      | 29      | 30         | 39          | 27       |
| 3/06/00  | 9       | 8       | 10         | 14          | 9        |
| 9/06/00  | 8       | 8       | 15         | 15          | 15       |
| 15/06/00 | 16      | 17      | 15         | 14          | 14       |
| 21/06/00 | 8       | 9       | 9          | 10          | 10       |
| 27/06/00 | 10      | 6       | 11         | 12          |          |
| 3/07/00  | 19      | 28      | 31         | 43          | 34       |
| 9/07/00  | 14      | 8       | 15         | 18          | 15       |
| 15/07/00 | 17      | 9       | 9          | 11          | 9        |
| 21/07/00 | 12      | 8       | 13         | 13          | 13       |
| 27/07/00 | 7       | 14      | 14         | 17          | 12       |
| 2/08/00  | 24      | 33      | 20         | 26          | 17       |
| 8/08/00  | 9       | 14      | 10         | 13          | 8        |
| 14/08/00 | 11      | 12      | 13         | 17          | 15       |
| 20/08/00 | 21      | 15      | 24         | 27          | 23       |
| 25/09/00 | 10      | 9       | 11         | 17          | 10       |
| 13/10/00 | 9       | 10      | 13         | 14          | 13       |
| 19/10/00 | 6       | 10      | 11         | 20          | 11       |
| 25/10/00 | 3       | 4       | 7          | 6           | 5        |
| 31/10/00 | 8       | 13      | 13         | 19          | 12       |
| 6/11/00  | 9       | 15      | 13         | 18          | 15       |
| 12/11/00 | 8       | 10      | 13         | 6           | 13       |
| 18/11/00 | 10      | 16      | 20         | 22          | 18       |

# AIR QUALITY ASSESSMENT OF FINE PARTICLES IN BENDIGO – A PILOT STUDY

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| <b>Date Run</b> | <b>Bendigo</b> | <b>Geelong</b> | <b>Alphington</b> | <b>Collingwood</b> | <b>Richmond</b> |
|-----------------|----------------|----------------|-------------------|--------------------|-----------------|
| 24/11/00        | 15             | 23             | 22                | 22                 | 20              |
| 30/11/00        | 16             | 22             | 20                | 21                 | 20              |
| 6/12/00         | 15             | 21             | 18                | 19                 | 18              |
| 12/12/00        | 14             | 19             | 20                | 20                 | 18              |
| 18/12/00        | 17             | 28             | 23                | 24                 | 22              |
| 24/12/00        | 15             | 26             | 23                | 21                 | 23              |
| 30/12/00        | 18             | 18             | 16                | 18                 | 16              |
| 11/01/01        | 24             | 42             | 37                | 47                 | 37              |
| 23/01/01        | 27             | 24             | 28                | 30                 | 26              |
| 29/01/01        | 18             | 19             | 21                | 24                 | 22              |
| 4/02/01         | 15             | 16             | 23                | 24                 | 21              |
| 10/02/01        | 15             | 14             | 19                | 17                 | 17              |
| 16/02/01        | 14             | 12             | 14                | 16                 | 13              |
| 22/02/01        | 20             | 20             | 24                | 26                 | 24              |
| 28/02/01        | 19             | 24             | 25                | 26                 | 23              |
| 12/03/01        | 19             | 17             | 17                | 17                 | 18              |
| 18/03/01        | 9              | 11             | 13                | 13                 | 13              |
| 24/03/01        | 9              | 10             | 10                | 14                 | 10              |
| 30/03/01        | 33             | 20             | 24                | 30                 | 24              |
| 5/04/01         | 31             | 18             | 22                | 28                 | 21              |
| 11/04/01        | 20             | 16             | 18                | 21                 | 21              |
| 17/04/01        | 27             | 21             | 28                |                    | 24              |
| 23/04/01        | 6              | 11             | 8                 | 9                  | 8               |
| 29/04/01        | 9              | 13             | 20                |                    | 20              |
| 5/05/01         | 16             | 21             | 28                | 35                 | 41              |
| 11/05/01        | 21             | 26             | 17                | 42                 | 22              |
| 17/05/01        | 8              | 7              | 12                | 13                 |                 |
| 23/05/01        | 18             | 14             | 19                | 23                 |                 |
| 29/05/01        | 9              | 6              | 20                | 31                 | 22              |
| 4/06/01         | 20             | 23             | 28                | 39                 | 24              |
| 10/06/01        | 9              | 15             | 17                | 22                 | 19              |
| 16/06/01        | 5              | 6              | 12                | 12                 | 8               |
| 22/06/01        | 17             | 11             | 19                | 23                 | 21              |
| 28/06/01        | 29             | 17             | 20                | 32                 | 18              |