



ENVIRONMENT REPORT

AIR MONITORING IN CORIO 2003–07

Publication 1022.1* June 2007

SUMMARY

This report updates EPA Publication 1022. It presents the results of continuous air monitoring conducted by EPA Victoria at Geelong Grammar from 2002 to March 2007, alongside the results of weekly air monitoring at four schools in the Corio area of Geelong from August 2004 to August 2005.

The findings of this report support those of EPA's previous studies: air quality in Corio is generally good and is similar to air quality in Melbourne and Geelong.

Over the past four years the benzene levels measured in Corio have dropped. This is due in part to the national cleaner fuel standards. EPA requires industries in the area to continue to measure and reduce emissions. This is expected to continue to improve air quality in Corio over coming years.

AIM

The aim of this monitoring program was to measure and assess the significance of levels of industrial and motor vehicle-related air pollutants – including benzene, toluene, 1,3-butadiene, ethylbenzene, xylene, nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) – in Corio by:

- assessing results against State and national objectives

- comparing results with those from EPA air monitoring stations in Melbourne and Geelong South.

BACKGROUND

EPA has measured air quality in Geelong (population 200 000) since 1991. Results have shown that air quality in Geelong is generally good. Corio is a heavily industrialised area of Geelong and EPA has conducted additional monitoring in Corio since 2002.

Previous monitoring conducted next to the Princes Highway in 2002 and 2003, at Geelong Grammar between 2002 and 2005, and at 3 schools in the area between 2004 and 2005 has shown that air quality in Corio is also generally good (EPA publications 911, 999 and 1022).

There has been an increased focus nationally on pollutants such as benzene, toluene and xylenes. Refineries and motor vehicles are significant sources of these pollutants and for this reason EPA has conducted monitoring around the refinery in Corio. Shell, through its EPA licence, has also been required to conduct additional monitoring in Corio and reduce emissions of these pollutants. This report incorporates monitoring data from 2006 and up to the end of March 2007.

Table 1: Monitoring site details.

Monitoring site	Location	Pollutants measured	Monitoring period
North Shore Primary School	Tallis St, Norlane	Benzene, toluene, xylenes, ethylbenzene and 1,3-butadiene	August 2004 - August 2005
Corio Primary School	Hendy St, Corio	Benzene, toluene, xylenes, ethylbenzene, and 1,3-butadiene	August 2004 - August 2005
Rosewall Primary School	Sharland Rd, Rosewall	Benzene, toluene, xylenes, ethylbenzene, and 1,3-butadiene	August 2004 - August 2005
Princess Highway	Cnr Princess Hwy and Plantation Rd, Corio	Sulfur dioxide, nitrogen dioxide	October 2002 - May 2003
Geelong Grammar	Corio	Benzene, toluene, xylenes, ethylbenzene, 1,3-butadiene Benzene, toluene, nitrogen dioxide, sulfur dioxide	August 2004 - August 2005 December 2002 - March 2007

* This replaces publication 1022, issued March 2006.

METHODOLOGY

Monitoring sites

The locations of the monitoring sites in Corio are shown in Figure 1. Details of monitoring sites are given in Table 1.

Measurements

Volatile organic compounds

Benzene, toluene, xylene, ethylbenzene and 1,3-butadiene samples were collected at Corio, Rosewall and North Shore Primary Schools, and Geelong Grammar. Samples were collected in stainless steel fused silica-coated canisters and analysed according to USEPA method TO 15. Samples were taken once a week, for 24 hours each time¹, from August 2004 to August 2005. The detection limit for benzene and toluene was $1 \mu\text{g}/\text{m}^3$ and the measurement uncertainty at the levels measured in this study was $\pm 1 \mu\text{g}/\text{m}^3$.

Benzene and toluene were also monitored continuously at Geelong Grammar using a UV-visible spectrometer and the technique of differential optical absorption spectrometry (DOAS). The technique involved passing a light beam over a distance of approximately 400 metres from a light source to a receiver. The amount of absorption of light energy at specific wavelengths is proportional to the concentration of the pollutant. The monitoring equipment was installed at Geelong Grammar School, approximately 500 metres due east of the north-east corner of the refinery site.

EPA has been accredited by the National Association of Testing Authorities (NATA) for conducting sampling and analysis for these pollutants using USEPA method TO 15 and DOAS.² The benzene continuous monitoring data has been independently reviewed. The review report is available on EPA's website, www.epa.vic.gov.au.

Hourly averages from continuous monitoring are considered to be accurate to $\pm 5 \mu\text{g}/\text{m}^3$ for toluene and benzene. Levels were retrieved from the analyser as five-minute averages and converted to one-hour average levels. Benzene and toluene results associated with instrument light intensity of 5% or above were considered valid data³.

¹ Samples were taken on different days some weeks and occasionally a week was skipped. Samplers were calibrated to sample for 24 hours only (at which time canisters reach atmospheric pressure and cannot take in any more sample), although sometimes a longer time passed before they were picked up.

² NATA accreditation was gained on May 25 2006.

³ Results obtained at lower light levels have higher uncertainty and can only be used indicatively. The data obtained at lower light levels showed a similar pattern to the valid data.

Nitrogen dioxide and sulfur dioxide

Nitrogen dioxide and sulfur dioxide were monitored continuously at Geelong Grammar using DOAS as described above. Hourly averages from continuous monitoring are considered to be accurate to $\pm 2 \mu\text{g}/\text{m}^3$. Results associated with instrument light intensity of 50% or above for sulfur dioxide and 60% or above for nitrogen dioxide were considered valid data.³

Data capture

EPA seeks to ensure valid data is recorded and available for more than 90% of any period the instrument is operating. The data capture for continuous monitoring for each pollutant from December 2002 to March 2007 is shown in Appendix 1. The data capture target was met for all periods except for April 2005 to August 2005.

The DOAS equipment was not operational at times from 23 April 2005 to the 1 September 2005.⁴ Canister monitoring results obtained during the periods when the continuous data was not available suggest that the pattern of concentrations for benzene and toluene would have been similar to the pattern reported in this publication.

Objectives

State and national levels for the air pollutants covered in this report are set in three separate documents as summarised below and in Table 2:

The *National Environment Protection (Air Toxics) Measure [Air Toxics (NEPM)]* specifies monitoring investigation levels for benzene, toluene and xylenes as annual and 24-hour averages for toluene and xylene.

The *State Environment Protection Policy (Ambient Air Quality)* specifies environmental quality objectives for sulfur dioxide as one-hour, 24-hour and annual averages and nitrogen dioxide as one-hour and annual averages.

The *State Environment Protection Policy (Air Quality Management)* specifies intervention levels for benzene, toluene, xylenes, 1,3-butadiene, sulfur dioxide and nitrogen dioxide as one-hour averages.

Results above the specified levels require further evaluation.

⁴ During April and September 2005 no data was collected due to instrument malfunction and subsequent repairs and maintenance.

Table 2: Investigation Levels, Objectives and Intervention Levels

Substance	One-hour average		24-hour average		Annual average	
	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb
Benzene	75 ^A	24 ^A			9.6 ^C	3 ^C
Toluene	1880 ^A	500 ^A	3770 ^C	1000 ^C	377 ^C	100 ^C
Xylenes	2080 ^A	480 ^A	943 ^C	250 ^C	754 ^C	200 ^C
1,3-butadiene	110 ^A	50 ^A				
Ethylbenzene						
Nitrogen dioxide	263 ^A 225 ^B	140 ^A 120 ^B			56 ^B	30 ^B
Sulfur dioxide	549 ^A 522 ^B	210 ^A 200 ^B	209 ^B	80 ^B	52 ^B	20 ^B

A: State Environment Protection Policy (Air Quality Management) (intervention levels)

B: State Environment Protection Policy (Ambient Air Quality) (environmental quality objective)

C: National Environment Protection (Air Toxics) Measure (monitoring investigation level)

No value means that there is no State intervention level or objective or national investigation level

Data analysis and presentation

The pollutants measured in Corio were compared to monitoring data from selected EPA air monitoring stations in Geelong and Melbourne (EPA 1000, EPA 951, EPA 911, EPA 948, EPA 974). The EPA air monitoring station in Paisley (Altona North) is indicative of air quality near Victoria's other oil refinery, Mobil (Altona).

Note that the monitoring period for some sites and pollutants does vary and this needs to be taken into account when comparing sites.

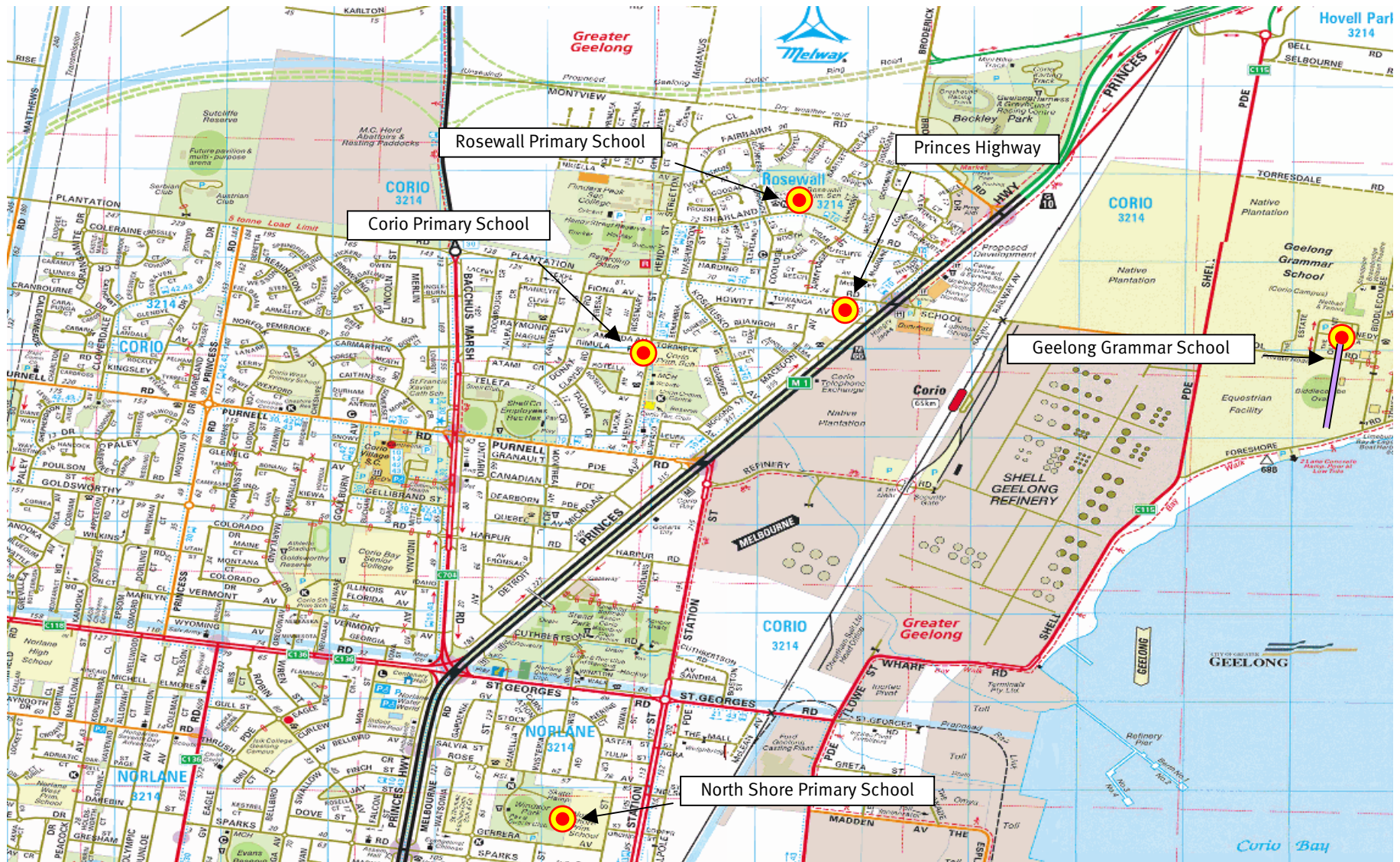


Figure 1: Location of monitoring sites in Corio

RESULTS

Benzene

Benzene monitoring in Corio has been previously reported by EPA (EPA 999&1022). Results are updated here.

Benzene, which is a known human carcinogen, is an aromatic hydrocarbon found in petrol and is used for a range of industrial purposes. In Corio, the refinery and motor vehicles are the main sources of benzene emissions to air (Air Toxics NEPM-Benzene Health Review 2003). National cleaner fuel standards required that refineries reduce benzene levels in petrol from around four per cent to less than one per cent from 2006 (Fuel Standard (Petrol) Determination 2001). This reduced benzene emissions from the refinery and from vehicles.

24-hour sampling results

Annual average benzene levels for the Corio sites (1.2–2.2 $\mu\text{g}/\text{m}^3$) were below the national monitoring investigation level of 9.6 $\mu\text{g}/\text{m}^3$, as shown in Figure 3. Results were similar to or lower than levels found in Melbourne (population 3.6 million). Results are summarised in Appendix 2.

Continuous sampling results

As reported in publication 999 benzene levels went above the Victorian intervention level (75 $\mu\text{g}/\text{m}^3$) for two hours in 2003 with the refinery identified as the likely source.

Benzene levels remained below the intervention level during 2004, 2005 (EPA 1022), 2006 and until March 2007. Although no continuous data was collected during May to August 2005, levels are expected to be similar to the same months in 2004. This is supported by the 24-hour (canister) monitoring results during these months.

From January 2006 to March 2007 there were two hours where levels approached the Intervention Level. One was measured on 22 January 2006 between 2

and 3 am (72 $\mu\text{g}/\text{m}^3$) and another on 15 July 2006 between 1 and 2 am (65 $\mu\text{g}/\text{m}^3$).

The elevated level measured in January 2006 occurred during light, varying wind conditions. The exact source of the elevated benzene measurement in January is uncertain. The elevated benzene level in July occurred during light south south-west winds indicating the likely source to be the refinery.

As shown in Table 3 for each year since 2003 the number of hours where benzene concentrations were elevated has decreased. From 2004 there have been no hourly concentrations above the Intervention Level. The number of hours where concentrations went above one-fifth (15 $\mu\text{g}/\text{m}^3$) the Intervention Level has also decreased since 2003. This is further illustrated in Figure 2. This is likely to be due to improvements in refinery processes during that time and the introduction of cleaner fuel standards. Further reduction in benzene emissions from the refinery is expected as additional improvements required by the EPA Licence are implemented. The average level for the whole monitoring period is less than 5 $\mu\text{g}/\text{m}^3$. Results are shown in Appendix 3.

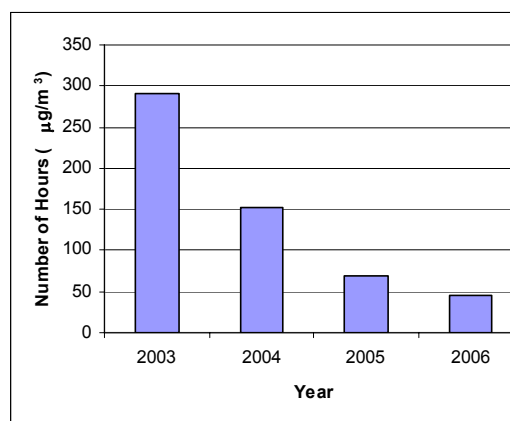


Figure 2: Number of hours benzene concentrations measured above 15 $\mu\text{g}/\text{m}^3$ (See Table 3)⁵.

Table 3: Frequency of continuous benzene levels measured in specified concentration ranges

One-hour levels	2003	2004	2005	2006
0–15 $\mu\text{g}/\text{m}^3$	96.74%	98.12%	98.72%	99.40%
15–75 $\mu\text{g}/\text{m}^3$	3.24%	1.88%	1.28%	0.60%
>75 $\mu\text{g}/\text{m}^3$ *	0.02%	0.00%	0.00%	0.00%

* Intervention Level

⁵ The number of hours in 2005 may be higher because of the period when the instrument was offline.

Toluene, xylenes, ethylbenze and 1,3-butadiene

Toluene, ethylbenzene, xylenes and 1,3-butadiene are toxic compounds and irritants (Air Toxics NEPM-Toluene Health Review May 2003, Air Toxics NEPM-Xylenes Health Review May 2003). 1,3-butadiene is also a possible human carcinogen.

According to the National Pollution Inventory (NPI) (see www.npi.gov.au) the refinery and motor vehicles are the main sources of toluene, ethylbenzene and xylenes emissions to air in Corio. Toluene and xylenes are also used for a range of industrial purposes, and are commonly used solvents (for example, in paint). The major sources of 1,3-butadiene in Corio are motor vehicles and wood burning. The refinery is also a source.

24-hour sampling results

The average 24-hour toluene levels for each Corio monitoring site are shown in Figure 4 along with data from EPA air monitoring stations (note different years). Toluene levels in Corio were well below the national annual and 24-hour average monitoring investigation level. Levels were similar or lower than those found in Melbourne.

Results of all samples taken in Corio are shown in Appendix 4.

At the Corio sites, average xylenes, levels were well below the national annual and 24-hour average investigation levels. Average levels for xylenes, ethylbenzene and 1,3-butadiene were lower than levels found in Melbourne and next to busy roads. Results are shown in Appendix 5 along with data from EPA air monitoring stations (note different years).

Continuous sampling results

Hourly toluene levels for the monitoring period were typically well below the Victorian intervention levels ($1880 \mu\text{g}/\text{m}^3$) and averaged $10 \mu\text{g}/\text{m}^3$ (See Appendix 6). Toluene levels approached the intervention level for one hour on the evening of 31 August 2003, peaking at $1714 \mu\text{g}/\text{m}^3$. At the time the wind direction was from the refinery. The benzene-toluene ratio was not typical of petrol (benzene level was $63 \mu\text{g}/\text{m}^3$). Toluene is a common solvent. The cause of this elevated concentration remains unclear.

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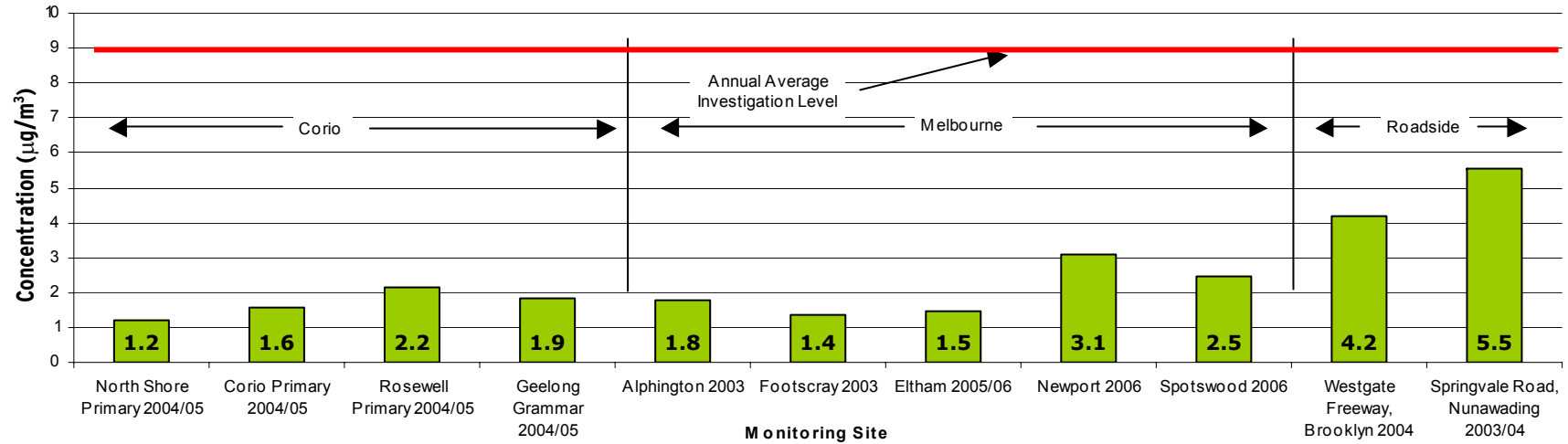


Figure 3: Annual average benzene levels in Corio and Melbourne.

(Note, Brooklyn and Nunawading concentrations are averages for 6 and 4 months sampling periods, respectively)

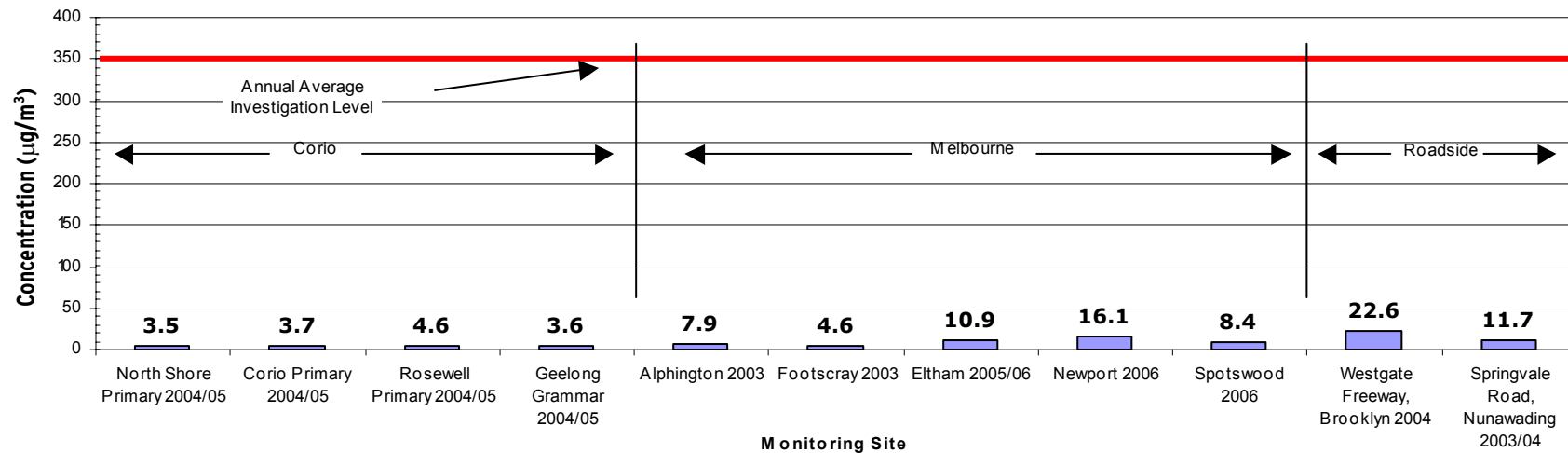


Figure 4: Annual average toluene levels in Corio and Melbourne Note,

(Note, Brooklyn and Nunawading concentrations are averages for 6 and 4 months sampling periods, respectively)

Nitrogen dioxide

Nitrogen oxides in urban air come mainly from motor vehicles and other combustion sources. Nitrogen dioxide affects breathing and the body's defence mechanisms. Some nitrogen dioxide is emitted directly from vehicles, the rest forms in air after relatively harmless nitric oxide emissions react with ozone and ultraviolet light.

According to the NPI the main sources of nitrogen oxides in Corio are the refinery and motor vehicles. The majority is emitted as nitric oxide and is converted to nitrogen dioxide in air some distance from the refinery.

Peak and average one-hour nitrogen dioxide levels for Corio, Geelong South and Melbourne are shown in Table 4.

Levels of nitrogen dioxide were below the Victorian intervention level (140 ppb) at all sites (see Appendix 7). Annual average levels were below the environmental quality objectives specified in the State Environment Protection Policy and were generally similar to those in Geelong and Melbourne.

Peak nitrogen dioxide levels in Corio were above peak levels in Geelong and Melbourne. Analysis of nitrogen dioxide data indicated that there was no correlation of levels with wind direction. It is most likely that higher peak levels are a result of combined emissions from

both motor vehicles and industry. A similar conclusion was reached when elevated levels of nitrogen dioxide were measured next to the Princes Highway in Corio in 2003 (EPA 911).

Sulfur Dioxide

Sulfur dioxide is an irritant gas that affects breathing; the main source of sulfur dioxide in Victoria is industry. The major sources of sulfur dioxide in Geelong and Corio are the refinery and the aluminium smelter.

Peak and average one-hour sulfur dioxide levels for Corio, Geelong South and Melbourne are shown in Table 5. Levels of sulfur dioxide remained below Victorian intervention levels and environmental quality objectives at all sites (see Appendix 8).

Peak and average sulfur dioxide levels in Corio were generally above those in Geelong South and Melbourne.

Analysis of sulfur dioxide data at Geelong Grammar indicated that the majority of elevated levels occurred when the wind was from the south-west, which indicates the refinery as the source. Similar sulfur dioxide levels were measured by EPA in 2003 on the other side of the refinery (corner of Princes Highway and Plantation Road) (EPA 911).

Table 4: Maximum and average one-hour nitrogen dioxide levels (ppb) for Corio, Geelong South and Melbourne

Site	Monitoring period	Maximum one-hour average	Monitoring period average
Geelong Grammar, Corio	December 2002 – December 2006	109 [#]	8
Cnr Princes Hwy and Plantation Rd, Corio	October 2002 – May 2003	94	11
Geelong South	December 2002 – December 2006	50	6
Paisley	December 2002 – December 2006	79	10
Alphington	December 2002 – December 2006	69	12
Objectives		140 ^A 120 ^B	30 ^C

A State Environment Protection Policy (Air Quality Management), intervention level

B State Environment Protection Policy (Ambient Air Quality), environmental quality objective (hour)

C State Environment Protection Policy (Ambient Air Quality), environmental quality objective (annual)

Incorrectly reported as 119 ppb in EPA Publication 1022



Table 5: Maximum and average one-hour SO₂ (ppb) levels for Corio, Geelong South and Melbourne

Site	Monitoring period	Maximum one-hour average	Monitoring period average
Geelong Grammar, Corio	December 2002 – December 2006	51 [#]	1
Cnr Princes Hwy and Plantation Rd, Corio	October 2002 – May 2003	120	6
Geelong South	December 2002 – December 2006	69	0
Paisley	December 2002 – December 2006	53	1
Alphington	December 2002 – December 2006	21	0
Objectives		210 ^A 200 ^B	20 ^{BB}

A State Environment Protection Policy (Air Quality Management), intervention level

B State Environment Protection Policy (Ambient Air Quality), environmental quality objective (hour)

BB State Environment Protection Policy (Ambient Air Quality), environmental quality objective (annual)

Incorrectly reported as 74 ppb in EPA Publication 1022

CONCLUSIONS

Benzene

Average benzene levels in Corio were below the national annual monitoring investigation levels.

Peak hourly benzene levels were below the Victorian intervention level from December 2002 to March 2007 except for two hours in 2003.

Benzene levels in Corio were found to be similar to or lower than levels in Melbourne. The frequency of elevated benzene levels has dropped over each of the past three years and this trend is expected to continue.

Toluene

Toluene levels in Corio were below national monitoring investigation levels and the State intervention level.

Toluene levels in Corio were found to be similar to levels in Melbourne and lower than those next to busy roads.

Xylenes, ethylbenzene and 1,3-butadiene

Xylenes, levels in Corio were below national monitoring investigation levels.

Xylenes, ethylbenzene and 1,3-butadiene levels in Corio were lower than levels in Melbourne and those next to busy roads.

Nitrogen dioxide and sulfur dioxide

Nitrogen dioxide and sulfur dioxide levels in Corio remained below the State intervention level and objectives.

Average nitrogen dioxide levels in Corio were similar to levels in Melbourne and Geelong South.

Peak nitrogen dioxide levels in Corio were above levels in Melbourne and Geelong South.

Average and peak sulfur dioxide levels in Corio were above levels in Melbourne and Geelong South.

FUTURE MONITORING

As a requirement of its EPA licence, Shell will be conducting ongoing monitoring for particles, benzene and sulfur dioxide in Corio. EPA will continue to assess these results.

REFERENCES

- NEP(Air Toxics)M: *National Environment Protection (Air Toxics) Measure* April 2004.
- SEPP(AQM): *State Environment Protection Policy (Air Quality Management) 2001*, Government of Victoria.
- SEPP(AAQ): *State Environment Protection Policy (Ambient Air Quality) 1999*, Government of Victoria.
- EPA 911: *Air Monitoring at Corio – October 2002 to May 2003*, EPA Publication 911.
- EPA 948: *Air monitoring at Nunawading - September 2003 to February 2004*, EPA Publication 948.
- EPA 974: *Air monitoring alongside the Westgate Freeway in Brooklyn – March to November 2004*, EPA Publication 974.
- EPA 999: *Benzene air monitoring In Corio 2003–05*, EPA Publication 999.
- EPA 951: *Victoria's air quality 2003*, EPA publication 951.
- EPA 1000: *Victoria's air quality 2004*, EPA publication 1000.
- EPA 1022: *Air Monitoring in Corio 2003–05*.
- Air Toxics NEPM-Benzene Health Review available at www.ephc.gov.au/nepms/air/air_toxics.html
- Air Toxics NEPM-Toluene Health Review May available at www.ephc.gov.au/nepms/air/air_toxics.html
- Air Toxics NEPM-Xylenes Health Review available at www.ephc.gov.au/nepms/air/air_toxics.html
- Fuel Standard (Petrol) Determination 2001 available at scaleplus.law.gov.au/html/instruments/0/33/0/2004081702.htm



APPENDIX 1: DATA CAPTURE FOR CONTINUOUS MONITORING BY DOAS FROM 2003 TO 2007.

	Benzene	Toluene	Nitrogen dioxide	Sulfur dioxide
Valid light intensity Year	5%	5%	60%	50%
2003	94%	96%	97%	97%
2004	92%	97%	98%	97%
2005*	62%	67%	69%	67%
2006	95%	96%	97%	97%
2007	94%	94%	94%	94%

* Data capture excluding the period when the instrument was not operational in 2005 was 87, 95, 97, 94 percent for benzene, toluene, nitrogen dioxide and sulfur dioxide respectively.

There are three reasons that result in data not being reported:

- The instrument is not operating and no data is recorded.
- The light intensity is below the acceptable criteria and the data is invalid.
- Data collected during calibration and maintenance of the instrument is invalid.

The proportion of time for which data is recorded and that data is valid is referred to as 'data capture'.

APPENDIX 2: DAILY BENZENE LEVELS FOR CORIO, AUGUST 2004 TO AUGUST 2005 ($\mu\text{g}/\text{m}^3$).

Date	North Shore PS	Corio PS	Rosewall PS	Geelong GS
11-Aug-04	< 1.1	< 1.1	7.7	11.9
17-Aug-04	1.8	2.0	2.5	2.0
26-Aug-04	1.5	1.1	1.0	1.2
31-Aug-04	< 1.1	< 1.1	1.1	1.5
6-Sep-04	2.5	2.3	1.8	1.1
15-Sep-04	< 1.1	< 1.1	1.4	< 1.1
21-Sep-04	1.8	< 1.1	< 1.1	< 1.1
29-Sep-04	1.9	2.0	4.4	< 1.1
8-Oct-04	< 1.1	< 1.1	< 1.1	2.7
12-Oct-04	< 1.1	< 1.1	< 1.1	< 1.1
19-Oct-04	< 1.1	2.6	3.7	< 1.1
28-Oct-04	< 1.1	< 1.1	< 1.1	< 1.1
3-Nov-04	< 1.1	< 1.1	2.3	< 1.1
8-Nov-04	< 1.1	< 1.1	2.0	< 1.1
16-Nov-04	NA	1.2	1.1	< 1.1
24-Nov-04	< 1.1	1.3	1.4	< 1.1
2-Dec-04	< 1.1	1.0	1.1	< 1.1
8-Dec-04	< 1.1	1.1	3.2	< 1.1
14-Dec-04	< 1.1	< 1.1	< 1.1	1.2
21-Dec-04	< 1.1	1.4	2.4	< 1.1
2-Jan-05	< 1.1	1.2	< 1.1	< 1.1
6-Jan-05	1.1	< 1.1	1.4	2.7
12-Jan-05	1.8	1.5	1.2	2.1
19-Jan-05	2.8	1.8	4.3	1.8
24-Jan-05	1.6	2.9	5.7	1.3
5-Feb-05	< 1.1	1.1	1.7	5.5
20-Feb-05	1.7	2.5	2.8	1.4
24-Feb-05	1.0	1.7	1.6	7.3
3-Mar-05	2.1	2.6	1.9	3.2
22-Mar-05	< 1.1	1.0	3.3	< 1.1
31-Mar-05	3.5	2.9	1.1	< 1.1
7-Apr-05	< 1.1*	1.5	3.6	< 1.1
13-Apr-05	1.5*	2.8*	2.9	1.6
20-Apr-05	1.6	< 1.1*	2.2	1.4
27-Apr-05	4.1	6.4*	9.1	13.3
5-May-05	< 1.1*	< 1.1	< 1.1	1.4
11-May-05	< 1.1*	< 1.1	< 1.1	1.0
17-May-05	1.9	1.4*	2.2	1.7
24-May-05	< 1.1*	< 1.1*	< 1.1	< 1.1
31-May-05	< 1.1*	< 1.1	< 1.1	1.7



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7-Jun-05	2.2*	11.6	12.3	3.6
15-Jun-05	1.4*	< 1.1	< 1.1	< 1.1
22-Jun-06	1.0	< 1.1*	1.2	2.0
30-Jun-05	5.0*	2.6	1.6	< 1.1
5-Jul-05	< 1.1*	1.9	1.3	< 1.1
17-Jul-05	< 1.1*	1.4	1.3	< 1.1
1-Aug-05	2.5	1.1*	1.1	3.2
11-Aug-05	< 1.1	< 1.1*	< 1.1	1.6
17-Aug-05	1.1	1.1*	< 1.1	< 1.1
25-Aug-05	1.1*	1.7	1.3	2.2
Annual average	1.2	1.6	2.2	1.9
Objective	9.6 ^A			

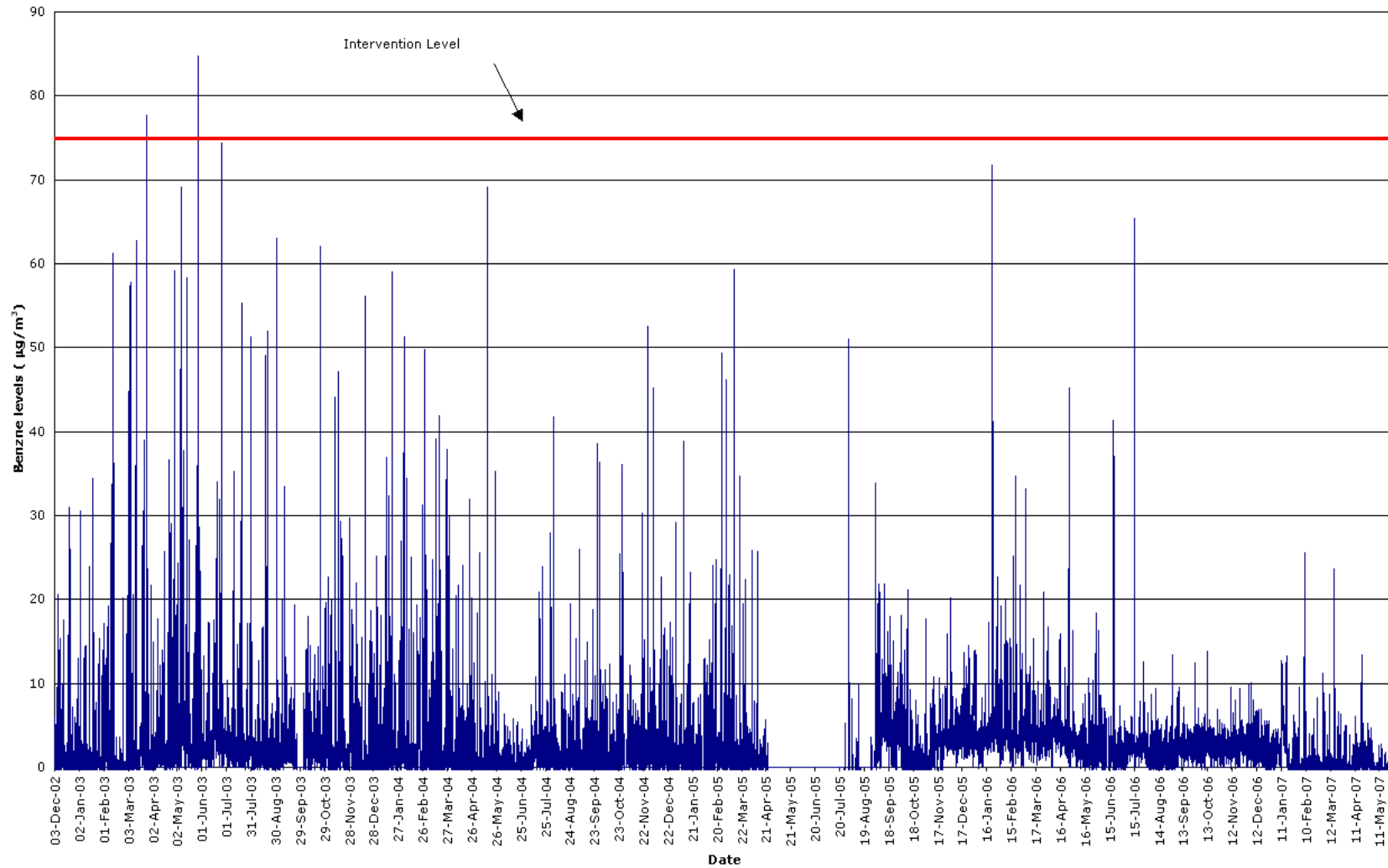
A *National Environment Protection (Air Toxics) Measure*, annual average Investigation Level

NOTE: <1.1 indicates benzene concentration below detection limit. In calculating averages these results are taken as half the detection limit (0.6 µg/m³)

* Sample period was possibly shorter than 24 hours (20–30 min), due to a problem with a flow controller. The flow controller was used at the North Shore PS and Corio PS sites only; the average result for North Shore PS would be 1.3 µg/m³ if these results were excluded. The average for the Corio PS site would be unaffected.



APPENDIX 3: EPA HOURLY BENZENE LEVELS FOR GEELONG GRAMMAR, CORIO (DECEMBER 2002 TO MAY 2007)



APPENDIX 4: DAILY TOLUENE LEVELS FOR CORIO, AUGUST 2004 TO AUGUST 2005 ($\mu\text{g}/\text{m}^3$).

Date	North Shore PS	Corio PS	Rosewall PS	Geelong GS
11-Aug-04	< 1.1	< 1.1	18.7	26.4
17-Aug-04	2.8	4.0	4.0	2.6
26-Aug-04	2.4	1.5	2.3	1.5
31-Aug-04	1.4	1.9	2.4	2.7
6-Sep-04	5.1	5.4	3.9	1.8
15-Sep-04	5.5	1.2	2.0	1.6
21-Sep-04	4.4	1.4	< 1.1	< 1.1
29-Sep-04	4.7	3.7	5.4	1.4
8-Oct-04	1.3	< 1.1	< 1.1	5.5
12-Oct-04	9.7	NA	13.6	8.7
19-Oct-04	< 1.1	4.6	5.8	< 1.1
28-Oct-04	< 1.1	1.3	1.8	1.5
3-Nov-04	2.1	3.3	4.0	1.9
8-Nov-04	< 1.1	1.5	3.7	< 1.1
16-Nov-04	NA	2.1	2.7	2.3
24-Nov-04	< 1.1	2.6	2.8	1.2
2-Dec-04	1.5	1.6	2.0	1.8
8-Dec-04	< 1.1	1.7	6.5	< 1.1
14-Dec-04	1.5	< 1.1	1.5	4.0
21-Dec-04	2.9	1.7	4.1	< 1.1
2-Jan-05	2.0	3.8	1.9	< 1.1
6-Jan-05	< 1.1	< 1.1	1.4	3.6
12-Jan-05	1.9	3.3	1.6	2.0
19-Jan-05	3.9	4.1	6.6	2.3
24-Jan-05	3.6	2.8	8.4	1.3
5-Feb-05	< 1.1	< 1.1	1.3	7.0
20-Feb-05	1.8	3.6	6.7	1.2
24-Feb-05	< 1.1	1.7	1.9	10.9
3-Mar-05	3.1	1.6	2.5	3.9
22-Mar-05	5.6	4.3	10.2	5.4
31-Mar-05	22.5	5.0	4.9	1.8
7-Apr-05	1.7*	12.8	8.0	2.8
13-Apr-05	4.1*	4.7*	5.1	4.8
20-Apr-05	8.2	2.1*	7.3	5.8
27-Apr-05	17.0	19.7*	14.2	18.5
5-May-05	2.5*	5.2	2.7	2.6
11-May-05	1.3*	5.4	1.5	2.7
17-May-05	7.4	3.9*	5.6	4.1



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24-May-05	1.2*	< 1.1*	5.4	1.2
31-May-05	1.2*	3.7	2.0	4.6
7-Jun-05	4.1*	23.8	22.1	6.9
15-Jun-05	3.1*	3.6	< 1.1	< 1.1
22-Jun-06	3.7	< 1.1*	2.0	2.7
30-Jun-05	9.8*	6.2	3.2	2.2
5-Jul-05	< 1.1*	5.3	2.5	< 1.1
17-Jul-05	< 1.1*	2.9	2.5	< 1.1
1-Aug-05	5.0	1.9*	2.1	4.4
11-Aug-05	1.9	< 1.1*	< 1.1	2.7
17-Aug-05	2.6	1.9*	< 1.1	< 1.1
25-Aug-05	1.8*	3.8	3.9	5.7
Average	3.5	3.7	4.6	3.6
Investigation Level	377 ^A 3770 ^B			

A *National Environment Protection (Air Toxics) Measure*, annual average Investigation Level

B *National Environment Protection (Air Toxics) Measure*, 24-hour average Investigation Level

<1.1 indicates toluene concentration below detection limit. In calculating averages these results are taken as half the detection limit (0.6 µg/m³)

* Sample period was possibly shorter than 24 hours (20–30 min) due to a problem with a flow controller. The flow controller was used at the North Shore PS and Corio PS sites only; the average results for North Shore PS and Corio PS would be 3.8 and 3.6 µg/m³ respectively if these results were excluded.

APPENDIX 5: AVERAGE LEVELS ($\mu\text{g}/\text{m}^3$) OF ETHYLBENZENE, XYLENES AND 1,3-BUTADIENE IN CORIO AND MELBOURNE

Monitoring site	Monitoring period	Ethylbenzene	Xylenes	1,3-butadiene
Eltham East PS, Eltham	05/05 – 09/05, 12/05 – 03/06	0.9	3.0	< 0.9
Craig Street, Spotswood	01/06 – 01/07	0.9	4.3	< 0.9
Home Road, Newport	01/06 – 01/07	3.9	20.4	< 0.9
North Shore Primary School, Corio	08/04 – 08/05	<0.9 ¹	2.1	<0.9 ²
Corio Primary School, Corio	08/04 – 08/05	< 0.9	2.1	< 0.9
Rosewall Primary School, Corio	08/04 – 08/05	< 0.9	2.5	< 0.9
Geelong Grammar, Corio	08/04 – 08/05	< 0.9	2.1	< 0.9
Alphington, Melbourne	05/03 – 03/04	1.6	6.2	ND ³
Footscray, Melbourne	05/03 – 03/04	1.7	5.7	ND ³
Westgate Freeway Brooklyn, Melbourne	03/04 – 11/04	2.2	6.9	< 0.9
Springvale Road Nunawading, Melbourne	09/03 – 02/04	1.7	7.8	< 0.9
Investigation Level		NS ⁶	754 ⁵	NS ⁴

1 <0.9 indicates concentration was below detection limit for ethylbenzene

2 <0.9 indicates concentration was below detection limit for 1,3-butadiene

3 ND = not determined.

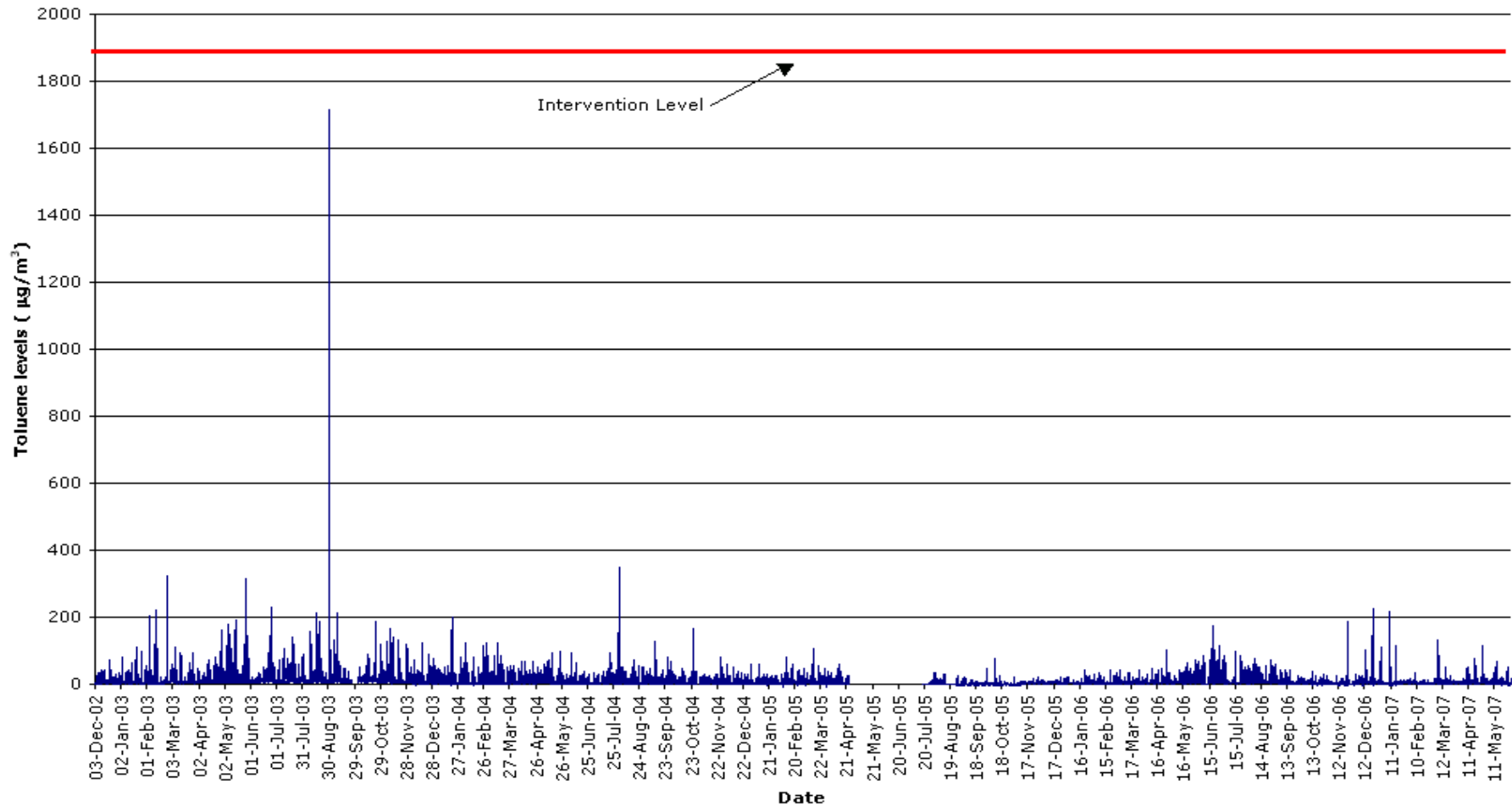
4 NS = not specified.

5 Annual average [Air Toxics NEPM]

6 NS = not specified.



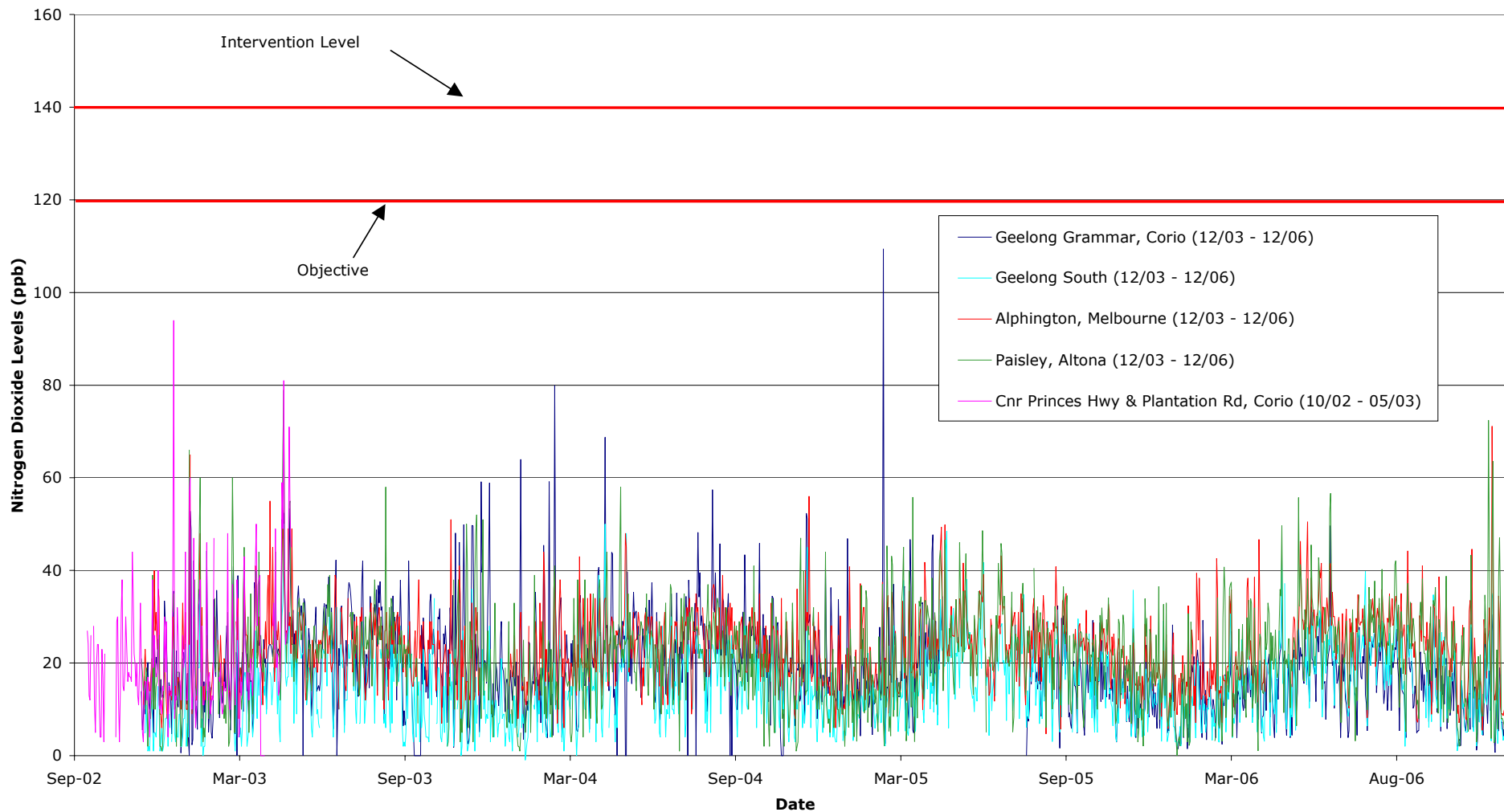
APPENDIX 6: EPA HOURLY TOLUENE LEVELS FOR GEELONG GRAMMAR, CORIO (DECEMBER 2002 TO MAY 2007)



Note 2007 data has increased uncertainty. Results may be up to 65% lower than the true value.



APPENDIX 7: DAILY NITROGEN DIOXIDE MAXIMUM HOURLY AVERAGES FOR CORIO, GEELONG SOUTH AND MELBOURNE





APPENDIX 8: DAILY SULFUR DIOXIDE MAXIMUM HOURLY AVERAGES FOR CORIO, GEELONG SOUTH AND MELBOURNE

