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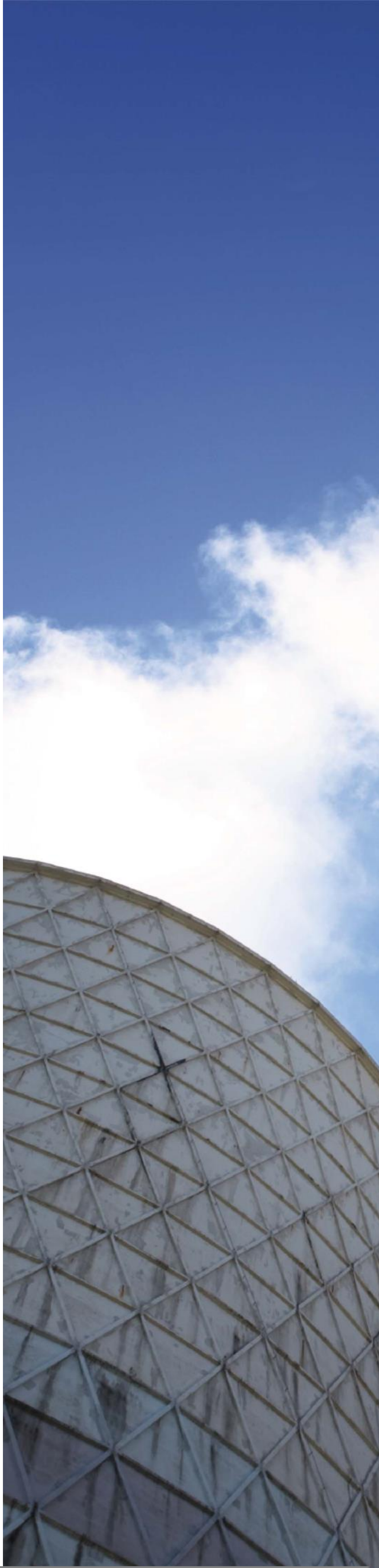

REPORT

ANALYSIS OF ODOUR COMPLAINTS AND AMBIENT AIR QUALITY IN WOLLAR AND COOKS GAP, NSW

Wilpinjong Coal Mine

Job No: **7983B**

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Pacific Environment Operations Pty ABN 86 127 101 642

BRISBANE
Level 1, 59 Melbourne Street, South Brisbane Qld 4101
PO Box 3306, South Brisbane Qld 4101
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

Unit 1, 22 Varley Street
Yeerongpilly, Qld 4105
Ph: +61 7 3004 6460

ADELAIDE
35 Edward Street, Norwood SA 5067
PO Box 3187, Norwood SA 5067
Ph: +61 8 8332 0960
Fax: +61 7 3844 5858

SYDNEY
Suite 1, Level 1, 146 Arthur Street
North Sydney, NSW 2060
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

MELBOURNE
Suite 62, 63 Turner Street, Port Melbourne Vic 3207
PO Box 23293, Docklands Vic 8012
Ph: +61 3 9681 8551
Fax: +61 3 9646 3408

PERTH
Level 1, Suite 3
34 Queen Street, Perth WA 6000
Ph: +61 8 9481 4961
Fax: +61 7 3844 5858

EXECUTIVE SUMMARY

In Wollar Village and Cooks Gap, NSW, community concerns have arisen in relation to odour nuisance. The perceived source of the odour is the spontaneous combustion of coal at the Wilpinjong Coal Mine (WCM), and the mine has received a number of complaints identifying this specific issue. In response to these complaints WCM implemented a monitoring program to measure the ambient concentrations of a range of pollutants at the two locations between March 2013 and July 2014.

Forty-five odour complaints were received by WCM during the monitoring period stated above (approximately one complaint every 10 days). All but one of the complaints originated in Wollar. Most complaints were received between late summer and mid-winter. In addition, most complaints were received in the morning (between 07:00 and 10:00).

The study focussed on the links between spontaneous combustion at the WCM and the odour complaints in Wollar. The most common complaints were "sulfur odour" and "spontaneous combustion odour", which was suggestive of elevated concentrations of H_2S. Overall average H_2S concentrations were indeed higher during periods prior to complaints than during periods without complaints. However, it seems unlikely that spontaneous combustion at the mine was the primary source of the odour nuisance. The reasons for this are as follows:

- Many negative and zero readings were obtained, indicating that concentrations were close to the instrument detection limit.
- Overall average H_2S concentrations for periods with and without complaints were below the levels that typically lead to complaints from those exposed. The concentrations of all other pollutants monitored were also below odour detection thresholds.
- The high level of dilution that occurs during the transport of pollution from WCM means that spontaneous combustion at the mine has very little impact on concentrations of H_2S (and other gaseous pollutants) at Wollar.
- During the hours of the day and months of the year when most odour complaints were received the wind direction was commonly *from* Wollar *to* the WCM.

The average concentrations of nitric oxide (NO) were significantly higher during periods prior to complaints than during periods without complaints, but again the concentrations were well below the human odour threshold. Other possible sources of odour include local traffic, domestic wood burning, and waste water treatment. However, no information was available for emission sources other than the WCM.

For all measured pollutants and metrics the concentrations at Wollar and Cooks Gap were significantly below the relevant air quality criteria identified in **Table 3-1**.

Given the low concentrations of all pollutants measured, and the absence of a clear indication that the WCM is the primary source of any of them, it is difficult to make any recommendations for ongoing monitoring at the mine. Fence-line monitoring of H_2S concentrations could be used as early detection measure that a spontaneous combustion event is occurring. However, there are currently no known applications of monitoring of this type in the mining industry.

CONTENTS

1 INTRODUCTION

In Wollar Village and Cooks Gap, NSW, community concerns have arisen in relation to odour nuisance. The perceived source of the odour is the spontaneous combustion of coal at the Wilpinjong Coal Mine (WCM), and the mine has received a number of complaints identifying this specific issue. In response to these complaints WCM implemented a monitoring program to measure the ambient concentrations of a range of pollutants at the two locations between March 2013 and July 2014.

This report presents the following:

- A discussion of the causes of spontaneous combustion, the pollutants released from spontaneous combustion events, and the health effects and odour thresholds of these pollutants.
- The ambient air quality criteria and goals for air pollutants that apply in NSW. Whilst these are not directly related to odour, it was considered important to place the measured pollutant concentrations in an air quality context.
- The monitoring methodology.
- The results from the monitoring program and analysis of the data.
- The conclusions from the monitoring program.

2 SPONTANEOUS COMBUSTION AND AIR POLLUTANTS

Spontaneous combustion is a type of combustion which occurs without an external heat source. Coal reacts with oxygen in the air, and in the absence of ventilation this leads to self-heating. The temperature of the coal can increase rapidly, to the point where the coal ignites. In open-cut coal mines such as the WCM, spontaneous combustion can occur in waste material and raw coal stockpiles. The WCM has developed a *Spontaneous Combustion Management Plan* which details the controls to be implemented for the management of spontaneous combustion at the site.

Whilst there has been a substantial amount of research on the prevention and control of spontaneous combustion, and the release of greenhouse gases (that is, carbon dioxide (CO_2) and methane (CH_4)), there is limited information on other air pollutants that are emitted **(Carras *et al.*, 2005**; **Day, 2008)**.

A review of the literature has identified that the following air pollutants may result from spontaneous combustion:

- Particulate matter (PM)
- Carbon monoxide (CO)
- Oxides of nitrogen (NO_x)
- Sulfur dioxide (SO_2)
- Hydrogen sulfide (H_2S)
- Polycyclic aromatic hydrocarbons (PAHs)
- Volatile organic compounds (VOCs)

The health effects and, where appropriate, the human odour thresholds of these pollutants are summarised in **Appendix A**.

3 AMBIENT AIR QUALITY STANDARDS

In Australia ambient air quality standards are set in the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) for CO, nitrogen dioxide (NO_2), photochemical oxidants (as ozone), sulfur dioxide (SO_2), lead, and particles with an aerodynamic diameter of less than 10 µm (PM_{10}). Advisory reporting standards are also set for particles with an aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$). The National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) sets 'investigation levels'[a] for specific VOCs (benzene, toluene, xylenes, formaldehyde and benzo(a)pyrene as a marker for PAHs). Ambient air quality monitoring to demonstrate compliance with the NEPM standards and investigation levels is only required at locations with populations greater than 25,000.

In NSW the Environment Protection Authority (EPA) does not specify ambient air quality standards *per se*, but sets criteria for the assessment of projects **(NSW DEC, 2005)**. For the purposes of project assessment, EPA has adopted the AAQ NEPM standards but also specifies criteria for a wider range of other pollutants and averaging periods not listed in the AAQ NEPM. The criteria that were considered to be relevant to this study are listed in **Table 3-1**.

Table 3-1: Assessment criteria for air pollutants in ambient air

Pollutant	Averaging period	Criterion		Source
		ppb	µg/m³	
Hydrogen sulfide (H_2S)	1 hour	5	7	**NZMfE (2002)**
Sulfur dioxide (SO_2)	10 minutes	250	712	**NSW DEC (2005)**
	1 hour	200	570	**NSW DEC (2005)**
	24 hours	8	228	**NSW DEC (2005)**
	Annual	2	60	**NSW DEC (2005)**
Nitrogen dioxide (NO_2)	1 hour	120	246	**NSW DEC (2005)**
	Annual	30	62	**NSW DEC (2005)**
Benzene	1 hour	9	29	**NSW DEC (2005)**
	3 minutes (carcinogen)	17	53	**Government of Victoria (2001)**
Toluene	1 hour	90	360	**NSW DEC (2005)**
	3 minutes (odour)	170	650	**Government of Victoria (2001)**
	3 minutes (toxicity)	3,200	12.3	**Government of Victoria (2001)**
Xylenes	1 hour	40	190	**NSW DEC (2005)**
	3 minutes (odour)	20	350	**Government of Victoria (2001)**
	3 minutes (toxicity)	2,700	11,400	**Government of Victoria (2001)**
PAHs (as benzo[a]pyrene)	1 hour	N/A	0.4	**NSW DEC (2005)**

ppb – parts per billion
µg/m³ – micrograms per cubic metre

Whilst criteria for other pollutants and metrics are specified by the EPA these were not considered to be important to the study. For example, CO is odourless and is not considered to be a concern in the ambient air of what is effectively a rural airshed. In the case of PM, since open-cut mining is itself a significant source of emissions it would be difficult, if not impossible, to isolate any PM emissions generated as result of spontaneous combustion from other PM emissions generated by the mining activities.

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[a] 'Investigation level' means the concentration of an air toxic which, if exceeded, requires an appropriate form of further investigation and evaluation.

4 METHODOLOGY

The study methodology was designed to allow the links between pollutant concentrations and perceived odour to be investigated. The different aspects of the methodology are summarised below.

4.1 Study area

The study area and the locations of WCM, Wollar and Cooks Gap are depicted in **Figure 4-1**. Wollar is located approximately 6 km east-southeast of the mine, and Cooks Gap is approximately 13 km west-southwest of the mine.

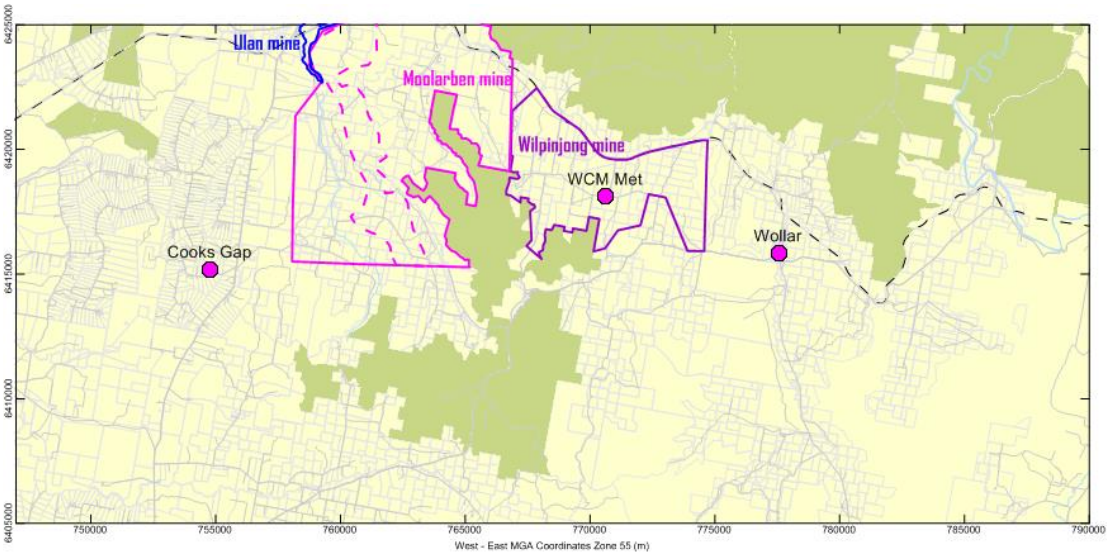

Figure 4-1: Study area

4.2 Odour complaints

Odour complaints were lodged directly with the WCM, and were logged as a matter of routine. For this study all complaints logged between 14/3/2013 and 23/6/2014 were provided to Pacific Environment, including the following information:

- The date and time of the complaint.
- The location of the complaint (Wollar or Cooks Gap)
- The nature of the complaint (*e.g.* “spontaneous combustion odour”, “sulfur odour”).

4.3 Monitoring locations

Air pollutants were monitored at Wollar and Cooks Gap. The monitoring locations were selected in consultation with NSW EPA, and were considered to be representative of the nearest residential areas to the WCM. In addition, samples of air were taken from spontaneous combustion sites at WCM.

4.4 Terrain

The terrain surrounding the WCM site is shown in **Figure 4-2**. The local terrain is complex, with many hills and valleys which would cause wind patterns to vary significantly across the local area. There is elevated terrain between WCM and Cooks Gap, and to a lesser extent between WCM and Wollar.

Figure 4-2: Terrain in the vicinity of WCM

4.5 Pollution measurement methods

The sampling of air pollutants was conducted by two different accredited laboratories on behalf of WCM. Measurements of H_2S, SO_2, NO, NO_2, NO_x and VOCs were made by Ecotech. VOCs and PAHs were measured by ALS. **Table 4-1** and **Table 4-2** present a summary of the sampling and analysis methods used by Ecotech and ALS, respectively. As noted in the Tables, VOC samples were collected and analysed using two different techniques:

- Field gas chromatography, which was used by Ecotech to continuously measure concentrations of benzene, toluene and *p*-xylene. The data were provided as five-minute averages.
- Summa canisters[b], which were used to measure a wider range of VOCs.

Table 4-1: Sampling and analysis methods – Ecotech

Parameter	Method	Description
H_2S	Ecotech Laboratory Manual	In-house Method 6.5: Hydrogen sulfide by fluorescence
SO_2	AS 3580.4.1 – 2008	Method 4.1: Determination of sulfur dioxide – direct reading instrumental method
	Ecotech Laboratory Manual	In-house Method 6.2: Sulfur dioxide by fluorescence
NO, NO_2, NO_x	AS 3580.5.1-1993	Method 5.1: Determination of oxides of nitrogen – chemiluminescence method
	Ecotech Laboratory Manual	In-house Method 6.1: Oxides of nitrogen by chemiluminescence
VOCs (benzene, toluene, *p*-xylene)	Gas Chromatography: Synspec GC955 Series Manual	
Vector wind speed (horizontal)	AS 3580.14 2011	Method 14: Meteorological monitoring for ambient air quality monitoring applications
	Ecotech Laboratory Manual	In-house Method 8.1: Wind speed (horizontal) by anemometer
Vector wind direction	AS 3580.14 2011	Method 14: Meteorological monitoring for ambient air quality monitoring applications
	Ecotech Laboratory Manual	In-house Method 8.3: Wind direction (horizontal) by anemometer

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[b] A Summa canister is a stainless steel container with internal surfaces that are coated to minimise reactions with target compounds.

Table 4-2: Sampling and analysis methods - ALS

Parameter	Method	Description
VOCs	Summa Canister	USEPA Method TO15 Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/ Mass Spectrometry (GC/MS)
PAHs	AS 3580.9.6–1990	Method for sampling of particulate matter – PM_{10} – high volume sampler with size-selective inlet
	EP077A	Analysis of HVAS filter paper for polycyclic aromatic hydrocarbons

4.6 Measurement periods and locations

The pollutants measured at each location, and the time periods covered in each case, are summarised in **Table 4-3**. In general there was a good data capture rate for the continuous measurements, although at Wollar some of the continuous VOC data were lost due to a fault with the first instrument that was installed (see **Appendix B**).

Table 4-3: Pollutants measured at each monitoring site

Type	Pollutant	Wollar	Cooks Gap	WCM
Continuous measurement (Ecotech)	Hydrogen sulfide (H_2S)	01/03/13 to 01/07/14	01/03/13 to 24/07/13(a)	-
	Sulfur dioxide (SO_2)	01/03/13 to 01/07/14	01/03/13 to 24/07/13	-
	Nitric oxide (NO)	01/03/13 to 01/07/14	01/03/13 to 24/07/13	-
	Nitrogen dioxide (NO_2)	01/03/13 to 01/07/14	01/03/13 to 24/07/13	-
	VOCs - Benzene	27/05/13 to 01/07/14	01/04/13 to 24/07/13(b)	-
	VOCs - Toluene	27/05/13 to 01/07/14	01/04/13 to 24/07/13(b)	-
	VOCs - *p*-Xylene	27/05/13 to 01/07/14(c)	01/04/13 to 24/07/13(b)	-
Summa canister (ALS)(d)	VOCs - multiple	15/05/13 and 29/05/13	15/05/13 and 29/05/13	12/06/14
Filter sample (ALS)(d)	16 PAHs	05/10/12 to 21/06/14	-	-

(a) No data 14/04/2013 to 20/05/2013
(b) No data 19/06/2013 to 17/07/2013
(c) No data 01/10/2013 to 18/02/2014
(d) 24-hour exposure

4.7 Meteorology

Meteorological parameters (wind speed and wind direction) were measured on a continuous basis by Ecotech at Wollar and Cooks Gap. Meteorological data were also available from a weather station at WCM, the location of which is shown in **Figure 4-1**, although these data were not used in the study.

5 RESULTS AND ANALYSIS

5.1 Odour complaints

Forty-five odour complaints were received by WCM between 14/3/13 and 23/6/14 (approximately one complaint every 10 days). All but one of the complaints originated in Wollar. The average number of complaints per day in each month is shown in **Figure 5-1**. Most complaints were received between late summer and mid-winter; 87% of all complaints were received between February and July. In addition, most complaints were received in the morning; more than 80% of the complaints were received between 07:00 and 10:00. The most common complaints were “sulfur odour” and “spontaneous combustion odour”.

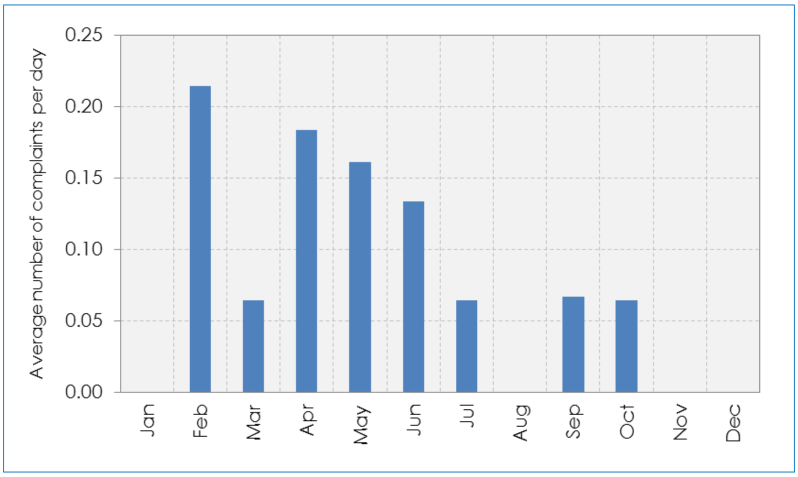

Figure 5-1: Average number of complaints per day in each month

5.2 Continuous air pollution measurements

5.2.1 Hydrogen sulfide

Figure 5-2 shows the one-hour average H_2S concentrations at Wollar Village and Cooks Gap. The one-hour average concentrations at both locations were well below the air quality criterion of 5 ppb. It is also worth noting that many negative and zero readings were obtained, indicating that concentrations were close to the instrument detection limit.

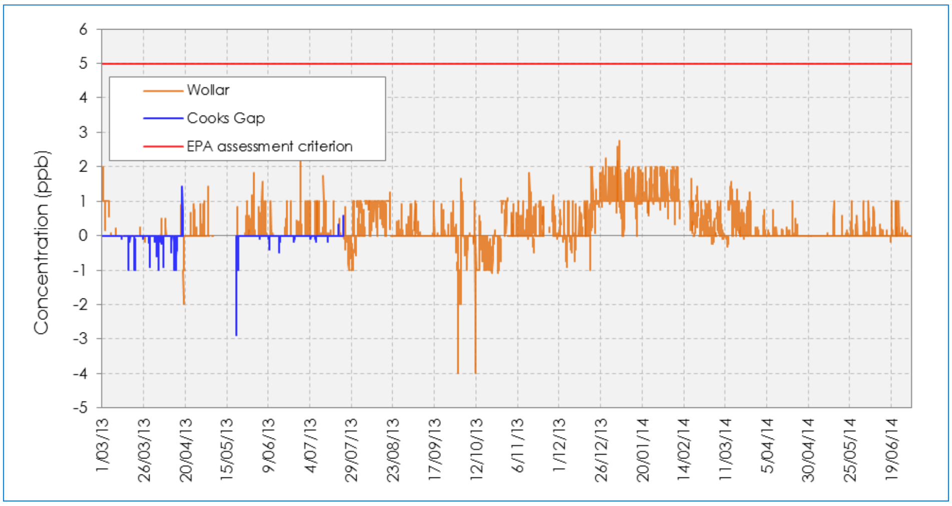

Figure 5-2: One-hour average H_2S concentrations at Wollar and Cooks Gap

5.2.2 Sulfur dioxide

The 10-minute and one-hour average SO_2 concentrations at Wollar Village and Cooks Gap are presented in **Figure 5-3** and **Figure 5-4**. Again, the concentrations were similar at the two locations, and all the measured values were well below the air quality criteria.

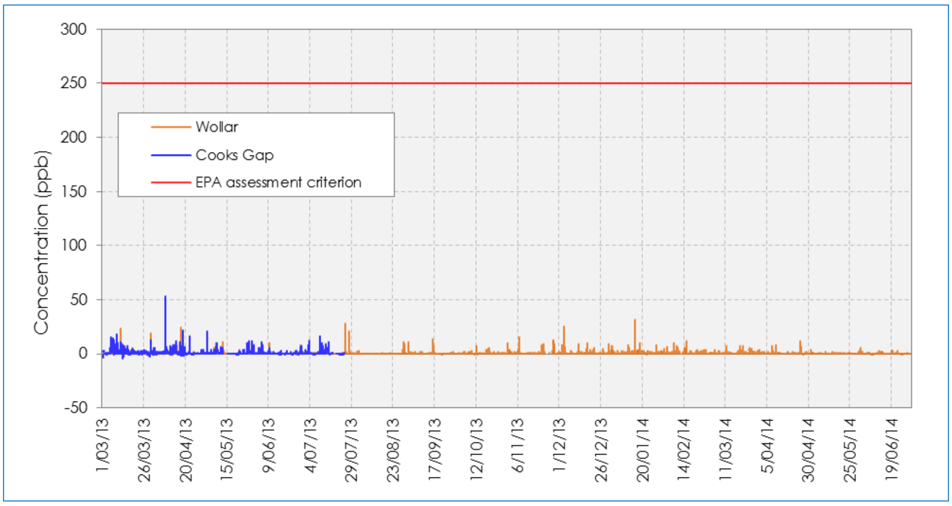

Figure 5-3: 10-minute average SO_2 concentrations at Wollar and Cooks Gap

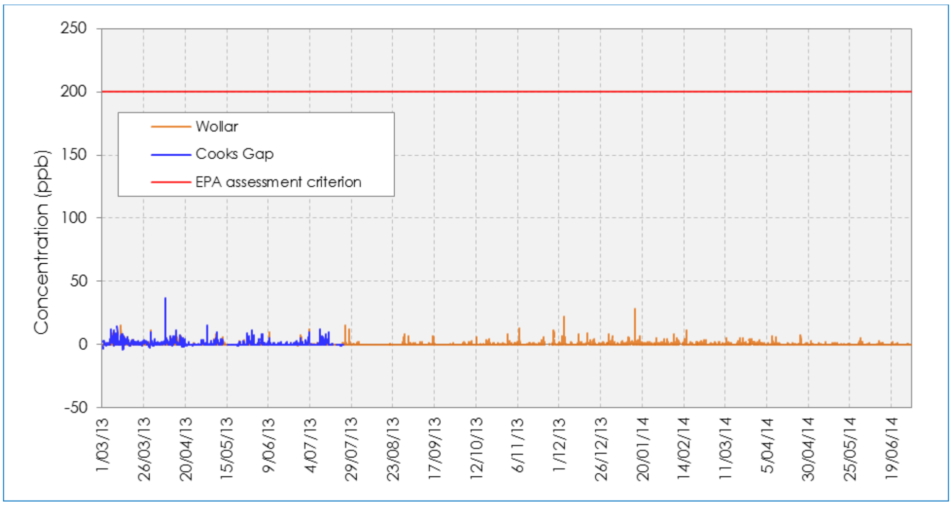

Figure 5-4: One-hour average SO_2 concentrations at Wollar and Cooks Gap

5.2.3 Nitrogen dioxide

The one-hour average NO_2 concentrations measured at Wollar Village and Cooks Gap are shown in **Figure 5-5**. All the measured values were well below the air quality criterion of 120 ppb.

The average NO_2 concentration during the whole monitoring period was 3.4 ppb. A comparison with the annual mean NO_2 concentrations at the OEH monitoring sites in Sydney – which are typically between around 15 ppb – is an indicator of the difference between rural and urban air quality.

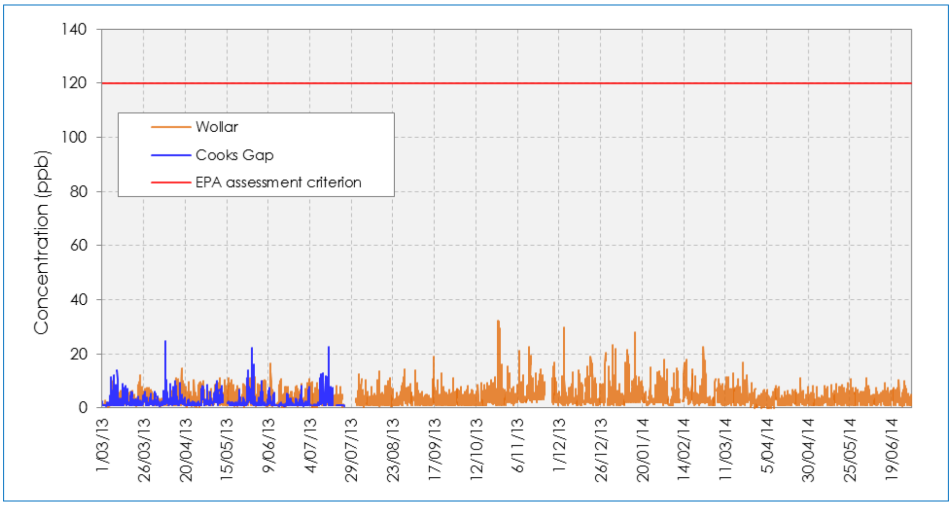

Figure 5-5: One-hour average NO_2 concentrations at Wollar and Cooks Gap

5.2.4 Benzene, toluene and xylenes

The concentrations of benzene, toluene and xylenes were very low.

Figure 5-6 shows the five-minute average concentrations of benzene as measured using field gas chromatography. The three-minute average air quality criterion specified by EPA Victoria is 17 ppb. This is designed to protect the population against the carcinogenic effects of benzene. Although the averaging period used in the study was slightly longer, all the measured concentrations were significantly below the criterion. This is likely that this would also have been the case for the three-minute average values. The one-hour average benzene concentrations were also well below the corresponding criterion of 9 ppb (**Figure 5-7**).

The equivalent plots for toluene are given in **Figure 5-8** and **Figure 5-9**. All the measured concentrations were well below the three-minute average criterion for odour of 170 ppb. As with benzene, it is likely that this would also have been the case for the three-minute average values. The one-hour average toluene concentrations were also well below the corresponding criterion of 90 ppb

Figure 5-10 and **Figure 5-11** show the five-minute and one-hour average concentrations of *p*-xylene. The five-minute average concentration was generally less than 1 ppb, although the concentration at Wollar became more variable during 2014 and exceeded 2 ppb on a few occasions. Nevertheless, these concentrations are an order of magnitude below the three-minute odour criterion for xylenes of 20 ppb. Similarly, the one-hour average concentrations were an order of magnitude lower than the corresponding criterion for xylenes of 40 ppb.

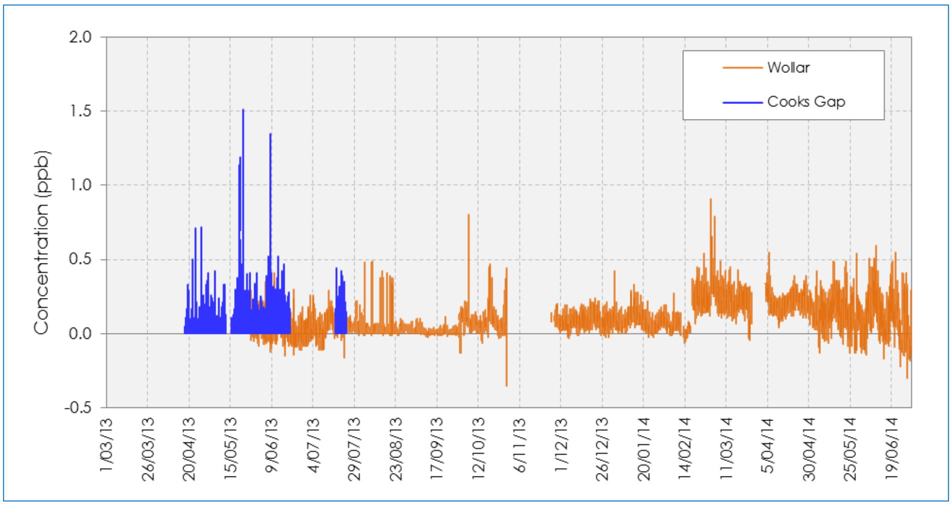

Figure 5-6: Five-minute average benzene concentrations at Wollar and Cooks Gap

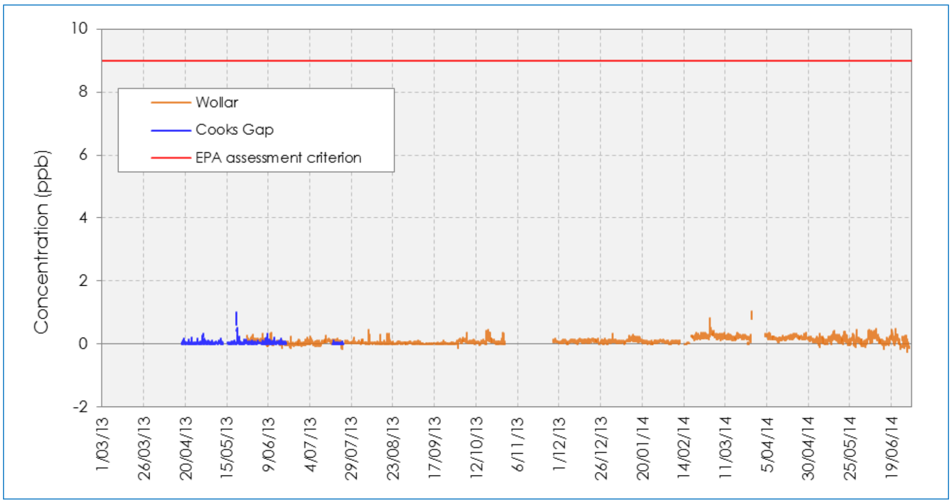

Figure 5-7: One-hour average benzene concentrations at Wollar and Cooks Gap

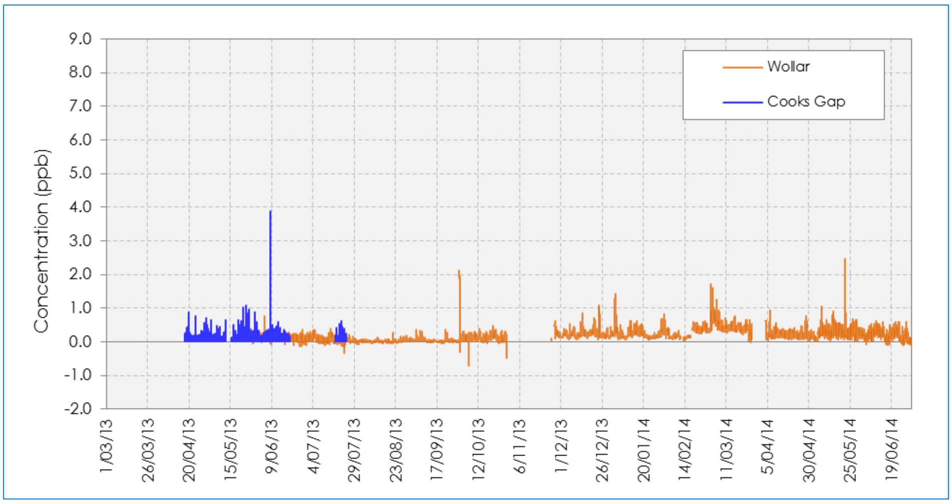

Figure 5-8: Five-minute average toluene concentrations at Wollar and Cooks Gap

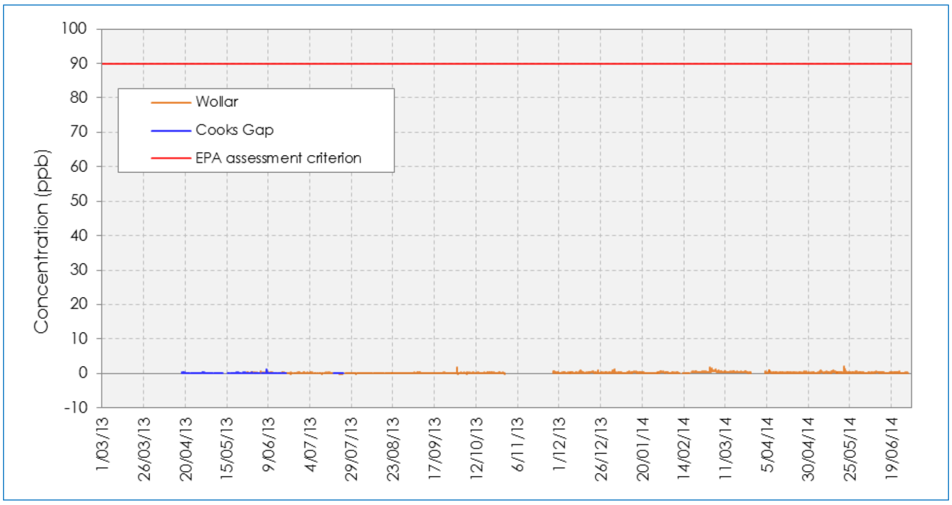

Figure 5-9: One-hour average toluene concentrations at Wollar and Cooks Gap

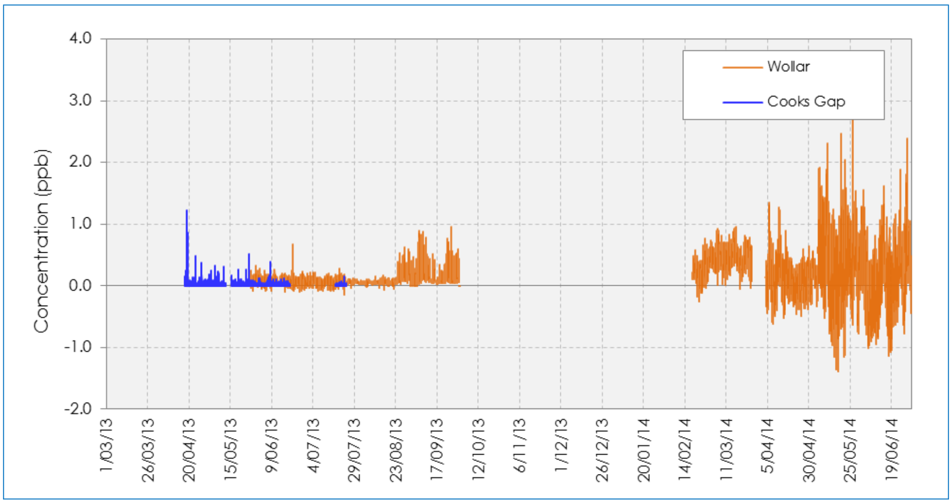

Figure 5-10: Five-minute average *p*-xylene concentrations and Wollar and Cooks Gap

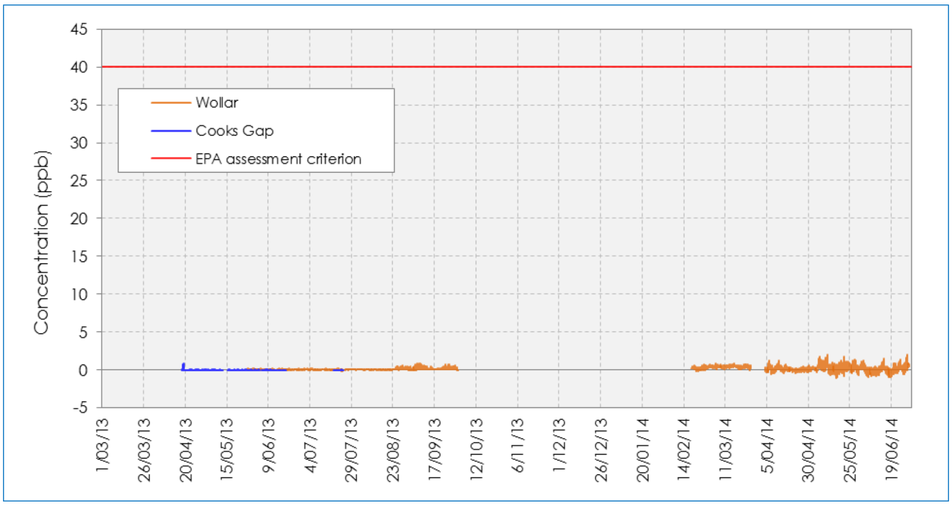

Figure 5-11: One-hour average *p*-xylene concentrations and Wollar and Cooks Gap

5.3 Summa canister measurements

The results from the Summa canisters (VOCs and sulfur compounds) are provided in **Appendix C**, and are summarised below.

5.3.1 Wollar and Cooks Gap

For the Wollar and Cooks Gap sites the concentrations of almost all compounds were below the Level of Recognition (LOR) - the lowest level the analytical equipment could measure. The only compounds with concentrations higher than the LOR were Freon-12, chloromethane, dichloromethane (Wollar only) and toluene.

Freon-12 is an odourless refrigerant and aerosol spray propellant. Manufacturing of Freon-12 was discontinued in the 1990s due to concerns relating to the ozone layer. Freons remain in the atmosphere for many years, and their presence in air samples is not unusual. The maximum measured concentration was 0.6 ppb on 15 May at both sites, only just above the LOR of 0.5 ppb. There are no air quality standards for Freon-12.

Chloromethane was also once widely used as a refrigerant. The maximum measured concentration was 1.1 ppb on 29/05/2013 at Cooks Gap. NSW EPA sets an air quality criterion of 900 ppb as a one-hour average. Since the summa canisters are exposed for 24 hours it is not possible to make a direct comparison. However, even if all the measured chloromethane had been detected by the canisters in a single one-hour period, the concentration would be significantly below the criterion.

Dichloromethane is used as a solvent. The maximum measured concentration was 0.5 ppb on 15/03/2013 at Wollar. NSW EPA sets an air quality criterion of 900 ppb as a one-hour average. Again, even if all the measured dichloromethane had been detected by the canisters in a single one-hour period, the concentration would be significantly below the criterion.

A similar reasoning applies to toluene, for which the maximum concentration was 1.7 ppb recorded at Wollar on 15/05/2013. This can be compared with the one-hour EPA criterion of 90 ppb. There were no continuous measurements of toluene at Wollar on this date.

5.3.2 Wilpinjong Coal Mine

As would be expected, the concentrations of various compounds in the spontaneous combustion samples from the mine were relatively high. However, in most cases the compounds that had high concentrations in the WCM data were not measured at Wollar and Cooks Gap. Although the dates of the samples are quite different, if it is assumed that the samples are representative then for those compounds that were measured at both WCM and either Wollar or Cooks Gap the concentrations are greatly reduced during transport. This is explored further in **Section 5.7**.

5.4 HVAS filter measurements

PAH concentrations were determined by ALS by analysing the filter papers from the high volume air sampler (HVAS) in Wollar. The concentrations of most compounds in most samples were below the level of recognition (LOR) of the analysis method. In order to determine compliance with the NSW EPA impact assessment criterion, the recorded values of micrograms (μg) per filter paper was combined with the flow-rate through the HVAS to determine the concentration. The concentration of each PAH was then multiplied by a potency equivalency factor (PEF) and summed to express the total PAH concentration as benzo[a]pyrene-equivalents. The result is numerically equivalent to summing the risks attributable to individual PAH in the mixture for comparison against the criterion. The results of these calculations are given in **Appendix D**. Based on this analysis, all measured PAH levels were significantly below the air quality criterion.

5.5 Wind speed and direction

The conventional approach for presenting information on wind speed and direction is to use a 'wind rose'. Some guidance on the interpretation of wind roses is provided in **Figure 5-12**.

How to read a wind rose

A wind rose shows the frequency of occurrence of winds by direction and strength, presented as 16 bars that correspond to the compass points (N, NNE, NE, etc). The length of each bar represents the frequency of occurrence of winds from that direction, and the colours of the bar sections correspond to wind speed categories, the darker colours representing stronger winds.

In this example, 30% of winds are from the ESE direction, and the winds from this direction have the following speed distribution:

- 10% between 1.5 m/s and 3 m/s
- 10% between 3 m/s and 4.5 m/s
- 7% between 4.5 m/s and 6 m/s
- 3% between 6 m/s and 7.5 m/s

Predominant wind direction ←

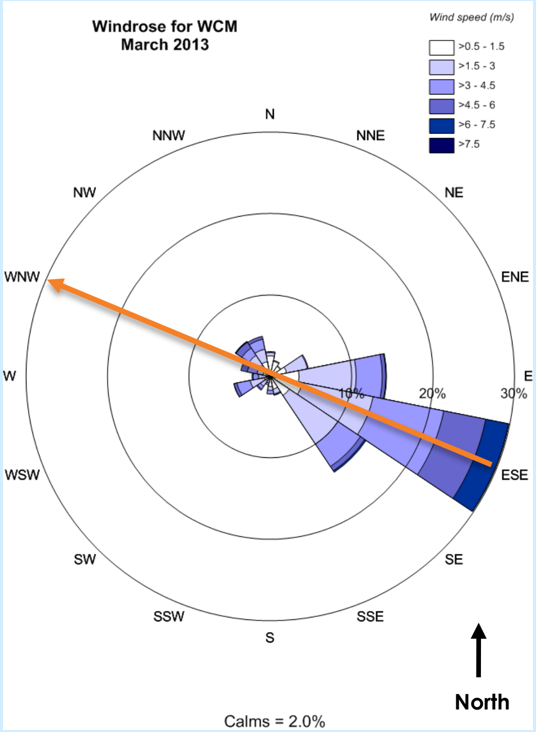

Figure 5-12: Interpretation of a wind rose

Given that all but one of the odour complaints originated in Wollar, only the wind data for this location were examined in detail. Wind roses for Wollar by hour of day and by month of the year are shown in **Figure 5-13** and **Figure 5-14** respectively.

Between 20:00 and 08:00 the wind at Wollar tended to be quite weak and from a southerly direction, whereas during the daytime the winds were stronger and mainly from either an easterly or westerly direction. From November to March the winds were from mainly an easterly direction, with some south-westerlies. Between April and October the winds were predominantly from the south and the west.

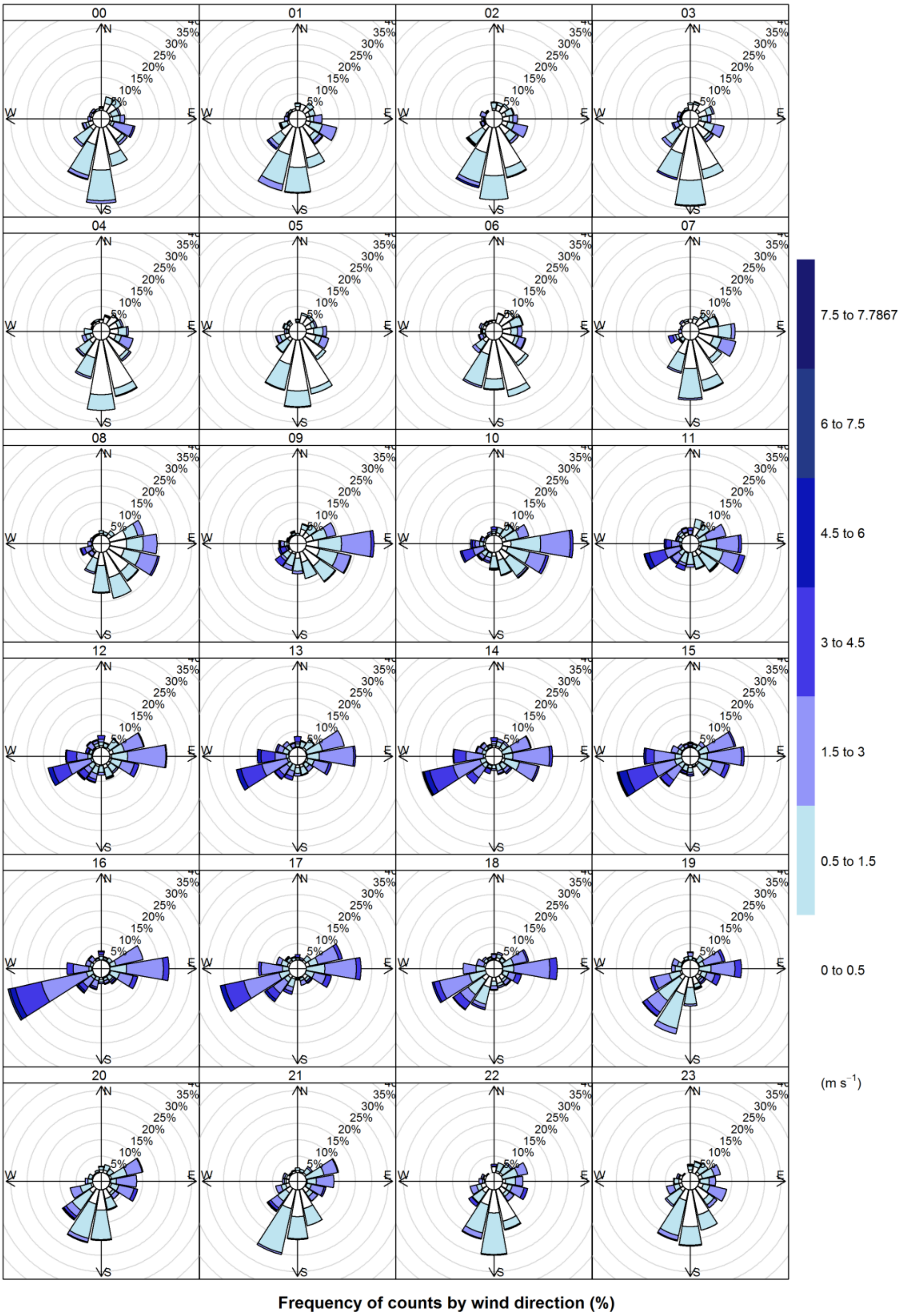

Figure 5-13: Wind roses for Wollar by hour of day (March 2013 to May 2014)

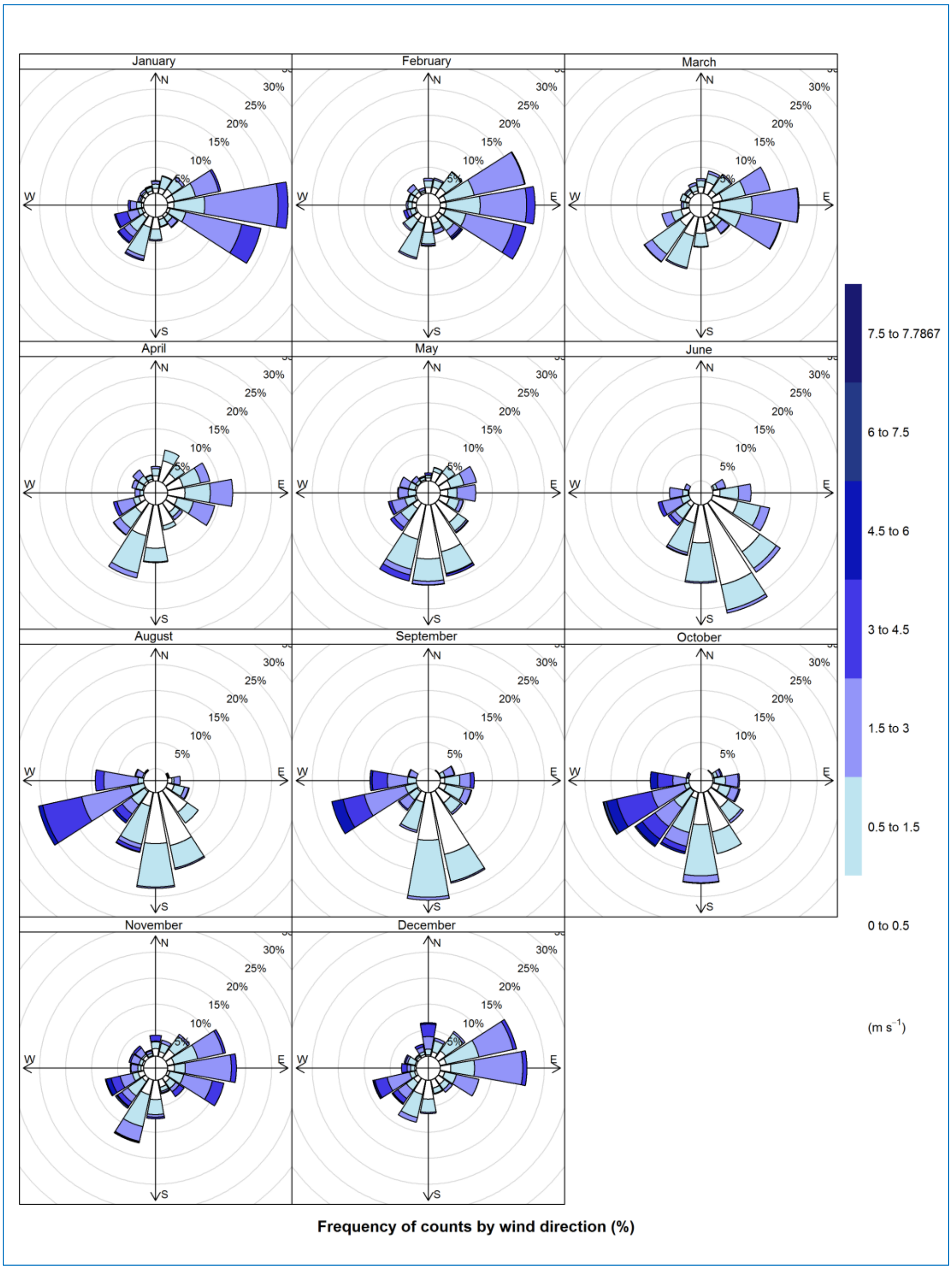

Figure 5-14: Wind roses for Wollar by month of year (March 2013 to May 2014 - no data for July 2013)

5.6 Pollutant concentrations and complaints

The measurements at the Wollar site were analysed to determine whether the concentrations of air pollutants were linked to odour complaints. The average concentrations during the periods prior to complaints were compared with the average concentrations during periods without complaints. Only the Wollar site was considered because most of the complaints related to this location. Comparisons were made for both the five-minute period and one-hour period immediately prior to a complaint being received. This was to allow, in principle, for the possibility of transport of pollutants over different distances (*i.e.* for local and more distant sources), although the distance between the source and the receptor is not the only factor influencing concentrations.

Figure 5-15 and **Figure 5-16** show the overall average five-minute and one-hour concentrations of SO_2, H_2S, benzene, toluene and *p*-xylene at the Wollar monitoring site for periods with and without complaints, including the 95% confidence intervals. The patterns were similar for the two averaging periods.

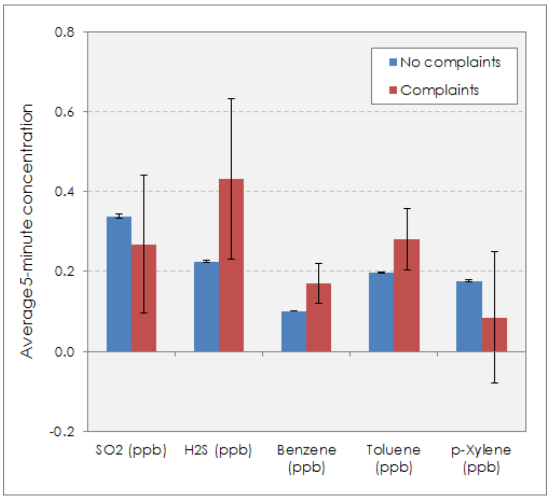

Figure 5-15: Average 5-min concentrations of sulfur and organic compounds at Wollar prior to periods with odour complaints and during other periods with no complaints

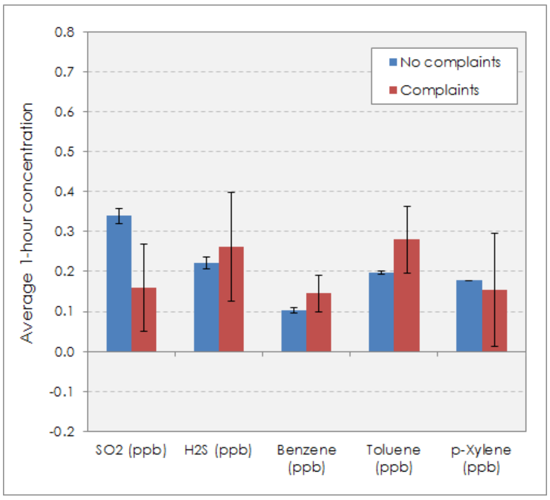

Figure 5-16: Average one-hour concentrations of sulfur and organic compounds at Wollar prior to periods with odour complaints and during other periods with no complaints

The complaints received by WCM related mainly to sulfurous odours. This is suggestive of H_2S, which has a distinctive smell (rotten eggs) that can be detected by humans at very low concentrations. It can be seen that both the five-minute average and one-hour average H_2S concentrations were indeed higher during periods prior to complaints than during periods without complaints. However, it is important to note the following:

- The lowest non-zero H_2S concentration that the instrument could record was 1 ppb. Any concentration greater than or equal to 0.5 ppb was reported as 1 ppb, but any concentration lower than 0.5 ppb was reported as zero. The average H_2S concentrations were very low in all cases (0.2-0.4 ppb), reflecting the fact that many zero values were recorded, and were effectively below the detection limit of the instrument.

- The maximum five-minute average H_2S concentration for a period prior to an odour complaint was 2 ppb, but this concentration only occurred twice. The most common H_2S concentration during the period prior to a complaint was zero. The H_2S concentrations were mostly below the human odour detection threshold. According to **WHO Regional Office for Europe (2000)**, H_2S has an odour detection threshold of between around 0.2 and 2.0 $\mu g/m^3$ (around 0.13 -1.3 ppb), but its characteristic smell appears at concentrations that are three-to-four times higher than the threshold. Only average H_2S concentrations exceeding 7 $\mu g/m^3$ (4.7 ppb) are likely to produce complaints among persons exposed.

The maximum five-minute average SO_2 concentration of 0.05 ppm was also well below the odour detection threshold (0.7-4.8 ppm). The situation was even more pronounced for the organic pollutants; the maximum five-minute average concentrations of benzene (0.9 ppb), toluene (2.5 ppb) and p-xylene (3.4 ppb) were orders of magnitude below the corresponding odour detection thresholds (1.5 ppm, 2.0 ppm, 0.6 ppm).

Interestingly, the average concentrations of NO were significantly higher during periods with complaints than during periods without complaints, and NO_2 concentrations were also higher (**Figure 5-17** and **Figure 5-18**). As with the other pollutants, the maximum NO and NO_2 concentrations were well below the corresponding human odour thresholds (0.3-1 and 1-6 ppm respectively). It is possible that a local activity (involving fuel combustion) may be a source of odour.

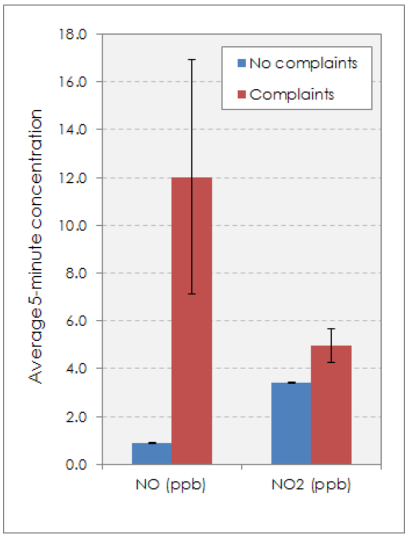

Figure 5-17: Average 5-min NO and NO_2 concentrations at Wollar prior to periods with odour complaints and during other periods with no complaints

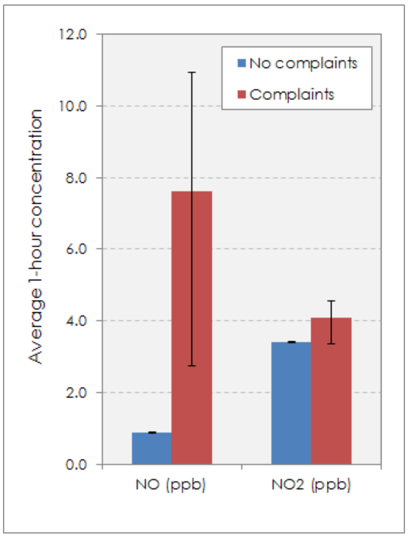

Figure 5-18: Average one-hour NO and NO_2 concentrations at Wollar prior to periods with odour complaints and during other periods with no complaints

There were many more periods without complaints than with complaints, which could have biased the results, and some temporal detail is always lost when averaging concentrations. However, it was not possible to know from the complaints log alone when a given odour had been detected[c] and how this related to possible odour-generating events. The maximum values (of the 5-minute average concentrations) were therefore also investigated, and it was found that for all pollutants the maximum concentration during the periods with a complaint was lower than the maximum concentration for the periods with no complaint.

For completeness it is noted that an odour complaint on 15/03/2013 coincided with the highest measured concentration of dichloromethane. However, the odour detection threshold for this compound (10,000 ppb) is orders of magnitude higher than the measured concentration.

5.7 Dilution of pollutants from spontaneous combustion

If it is assumed that the WCM is the source of the pollutants leading to odour complaints (notably H_2S), then during the transport[d] of air from the mine to Wollar the concentrations of pollutants will be diluted considerably. This can be seen from the information in **Table 5-1**. Samples of air from spontaneous combustion sites at WCM were obtained on 12 June 2014 at 12:30. The concentrations of a wide range of compounds in the samples were then determined in the laboratory. Some of the pollutants were measured at both Wilpinjong and Wollar. The concentrations of these pollutants from the spontaneous combustion sites were compared with the maximum five-minute average values for the afternoon of 12 June in Wollar. The results provided indicative dilution factors of between around 5,000 and 50,000. The

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[c] For example, a complaint may be logged some time after an odour has been detected.

[d] The transport time of the air from Wilpinjong to Wollar (assuming an average wind speed of 2.5 m/s and a distance as the crow flies of 6.5 km) would be around 45 minutes. This is based on very simple assumptions concerning the movement of air masses, and the transport time for any given odour-generating event could be longer or shorter.

H_2S concentration at Wollar on the afternoon of 12 June 2014 was actually reported as zero (and no odour complaints were received on this day). In addition, the data presented in **Appendix E** shows that the concentrations of several other compounds were highly diluted at Wollar and/or Cooks Gap relative to WCM.

Table 5-1: Concentrations of pollutants in spontaneous combustion samples from Wilpinjong coal mine and at Wollar

Pollutant	Concentration range in spon com samples @12:30 on 12/6/14 (ppb)	Max. 5-min. average concentration at Wollar on 12/6/14 after 12:30 (ppb)	Effective minimum dilution factor
Benzene	11,400 to 15,600	0.21	~54,000
Toluene	8,330 to 11,100	0.33	~25,000
Meta- & para-xylene	3880 to 5,550	0.82[a]	~4,700
H_2S	3,866 to 9,040	0	∞

(a) p-xylene

If the spontaneous combustion samples are representative, then it can be concluded that the mine has very little impact on H_2S concentrations at Wollar. However, this conclusion is based on just two samples at the spontaneous combustion sites, so could be tested more thoroughly to better define the effective minimum dilution factor.

5.8 Pollutant concentrations and wind direction

An examination of the timing of the complaints and the wind data from the Wollar monitoring site is instructive, and shows that few complaints were associated with winds from the direction of WCM.

For example, around 80% of complaints were obtained between around 07:00 and 10:00 in the morning. Wollar is approximately east-south-east of WCM. However, it can be seen from **Figure 5-13** that between 07:00 and 10:00 the wind is blowing predominantly from the south-eastern quadrant (i.e. *from* Wollar *to* WCM). Similarly, more than 85% of complaints were received between February and June. Again, only a small proportion of winds were from the direction of WCM during these months.

The wind direction at Wollar was from the direction of WCM (taken to be within +/- 45° of west-north-west) for only two complaints (out of 29) based on the five-minute average data, and for only five complaints based on the one-hour data.

6 CONCLUSIONS

The following conclusions have been drawn from this study:

- For all measured pollutants and metrics the concentrations at Wollar and Cooks Gap were significantly below the relevant air quality criteria and odour thresholds.

- The study focussed on the links between spontaneous combustion at the WCM and odour complaints in Wollar. The complaints related mainly to sulfurous odours, which was suggestive of elevated concentrations of H_2S. Overall average H_2S concentrations were indeed higher during periods prior to complaints than during periods without complaints. However, it seems unlikely that spontaneous combustion at the mine was the primary source of the odour nuisance. The reasons for this are as follows:
    - Overall average H_2S concentrations for periods with and without complaints were below the detection limit of the instrument.
    - Overall average H_2S concentrations for periods with and without complaints were below the levels that typically lead to complaints from those exposed. The concentrations of all other pollutants monitored were also below odour detection thresholds.
    - The high level of dilution that occurs during the transport of pollution from WCM means that spontaneous combustion at the mine has very little impact on concentrations of H_2S (and other gaseous pollutants) at Wollar.
    - During the hours of the day and months of the year when most odour complaints were received the wind direction was commonly *from* Wollar *to* the WCM.

- The average concentrations of NO were significantly higher during periods prior to complaints than during periods without complaints, but again the concentrations were well below the human odour threshold.

- Given the low concentrations of all pollutants measured, and the absence of a clear indication that the WCM is the primary source of any of them, it is difficult to make any recommendations for ongoing monitoring at the mine. Fence-line monitoring of H_2S concentrations could be used as early detection measure that a spontaneous combustion event is occurring. However, there are currently no known applications of monitoring of this type in the mining industry.

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Appendix A: Health effects of air pollutants

This Appendix provides an overview of each pollutant, the associated human health aspects and - where available - information on current levels in NSW.

Oxides of Nitrogen

Oxides of nitrogen (NO_x) are produced during spontaneous combustion and are comprised of nitric oxide (NO) and nitrogen dioxide (NO_2). NO is much less harmful to humans than NO_2 and is not generally considered an air quality problem at the concentrations normally found in Australia. In open-cut mining, such as the WCM, there is also potential for NO_2 to form as a result of the oxidation of ammonium nitrate during blasting. A recent report published by ACARP(Australian Coal Association Research Program) measured NO_2 concentrations in the ambient air near the fence line of a large open-cut coal mine in the Hunter Valley between April 2011 and October 2012 (**Day *et al.*, 2013**). The report concluded that most of the NO2 present in ambient air at the monitoring locations appeared to be derived from sources other than blasting, with vehicle operation within the mine apparently a major source along with other significant sources from outside the mine e.g. power stations, traffic on nearby roads, and railways.

NO_2 is the regulated oxide of nitrogen in NSW and effects of exposure to NO_2 include irritation of the lungs and lower resistance to respiratory infections such as influenza. The effects of short-term exposure are still unclear, however, continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. Concern with NO is related to its transformation to NO_2 and its role in the formation of photochemical smog.

The NSW State of the Environment report 2012 (**NSW EPA, 2012**) states that measured concentrations have not exceeded the one-hour-average standard since 1998; from 2002–2007 the highest one-hour value recorded in Sydney was only 75% of the standard. Over this period, maximum concentrations were lower still in the Illawarra and Lower Hunter regions.

Sulfur dioxide

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide gases (SO_x). These gases are formed when for instance fuel containing sulfur (mainly coal and oil) is burned (or spontaneously combusts). The major health concerns associated with exposure to high concentrations of SO_2 include effects on breathing, respiratory illness, alterations in pulmonary defences, and aggravation of existing cardiovascular disease. SO_2 is a major precursor to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility.

Current scientific evidence links short-term exposures to SO_2, ranging from 5 minutes to 24 hours, with an array of adverse respiratory effects including bronchoconstriction and increased asthma symptoms. These effects are particularly important for asthmatics at elevated ventilation rates (e.g., while exercising or playing).

As a result of regulatory efforts, from 1994 to 2011 concentrations of SO_2 in NSW have been low, with no exceedances recorded. Maximum hourly ambient concentrations in Sydney were less than 25% of the standard. Higher concentrations are observed in the Illawarra and Lower Hunter regions as a result of industrial emissions, although these are also below the standard (**NSW EPA, 2012**).

Hydrogen sulfide

Hydrogen sulfide (H_2S) is a flammable, colourless gas with a characteristic odour of rotten eggs. H_2S occurs both naturally and from human processes. It is released from volcanoes, sulfur springs, undersea vents, swamps, salt marshes, and stagnant bodies of water, and is found in association with crude petroleum and natural gas. It is also associated with municipal sewers and sewage treatment plants, landfill gases, manure handling operations, and pulp and paper operations.

H_2S odour can be easily detected at concentrations much lower than are harmful to health, with its smell being easily perceptible at concentrations well below 1 part per million (ppm) in air. The literature reports a wide range of odour thresholds for H_2S (that is the level at which it can be smelt), with the lowest reported to be at levels of between 0.0005 – 0.01 ppm (**Ruth, 1986**). Others have reported the odour threshold to be in the range 0.003 - 0.02 ppm (**USEPA, 2003**).

The odour increases as the gas becomes more concentrated, with the strong rotten egg smell recognisable up to 30 ppm. Above this level, the gas is reported to have a sickeningly sweet odour up to around 100 ppm. However, at concentrations above 100 ppm, a person's ability to detect the gas is affected by rapid temporary paralysis of the olfactory nerves in the nose, leading to a loss of the sense of smell. This means that the gas can be present at dangerously high concentrations, with no perceivable odour.

No measurements of H_2S in ambient air in Australia were identified. However, **World Health Organisation (2003)** states that the concentration of hydrogen sulfide in air in unpolluted areas is very low, between 0.03 $\mu g/m^3$ (0.00002 ppm) and 0.1 $\mu g/m^3$ (0.00007 ppm).

Volatile organic compounds (VOCs)

VOCs are a very large group of compounds that can be found in ambient air. As would be expected with a very large group of compounds, the potential health effects can vary quite widely. The range of effects can be from irritation of the skin or the respiratory tract (e.g., wheezing, coughing, difficulty breathing) to an increased risk of developing cancer with long-term inhalation exposure. The VOCs measured in real-time as part of this monitoring program were benzene, toluene and xylene (BTX). Further information on each of these is provided in the following paragraphs. Other VOCs were also measured using summa canisters.

Benzene

The health effects of benzene depend on how much benzene you have been exposed to, for how long, and your current state of health. Exposure can result in symptoms such as skin and eye irritations, drowsiness, dizziness, headaches, and vomiting. Benzene is carcinogenic and long-term exposure at various levels can affect normal blood production and can be harmful to the immune system. It can cause Leukaemia (cancer of the tissues that form white blood cells) and has also been linked with birth defects in animals and humans.

Benzene evaporates very quickly and so the most common exposure is from breathing air containing benzene. Most people are exposed outdoors to low levels of benzene from tobacco smoke and vehicle exhaust. Smoking cigarettes and passive smoking, especially indoors, increases the intake of benzene to higher levels. People living near industries that produce or use benzene, or near busy roads may also be exposed to higher levels in the surrounding air.

Xylenes

Xylenes may irritate the eyes, nose and throat. They may cause stomach problems, drowsiness, loss of memory, poor concentration, nausea, vomiting, abdominal pain and incoordination. Xylene will enter the body if we breathe in contaminated air, or breathe tobacco smoke. It can also be absorbed through the skin if liquid xylene is in contact with the skin. The most common ways to be exposed to xylene are from petrol, automotive exhaust or when using consumer products containing xylene, especially if there is not good ventilation.

Toluene

Toluene is a colourless, flammable liquid. It occurs naturally in petroleum crude oil. Petroleum crude oil is by far the largest source of toluene. The most likely way to be exposed to toluene is by smoking or using consumer products containing toluene (paints, varnish, nail polish, paint cleaners, stain removers, etc.) especially if there is not good ventilation. Short-term exposure to high levels of toluene results first in light-headedness and euphoria, followed by dizziness, sleepiness, unconsciousness, and in some cases death.

Polycyclic aromatic hydrocarbons (PAHs)

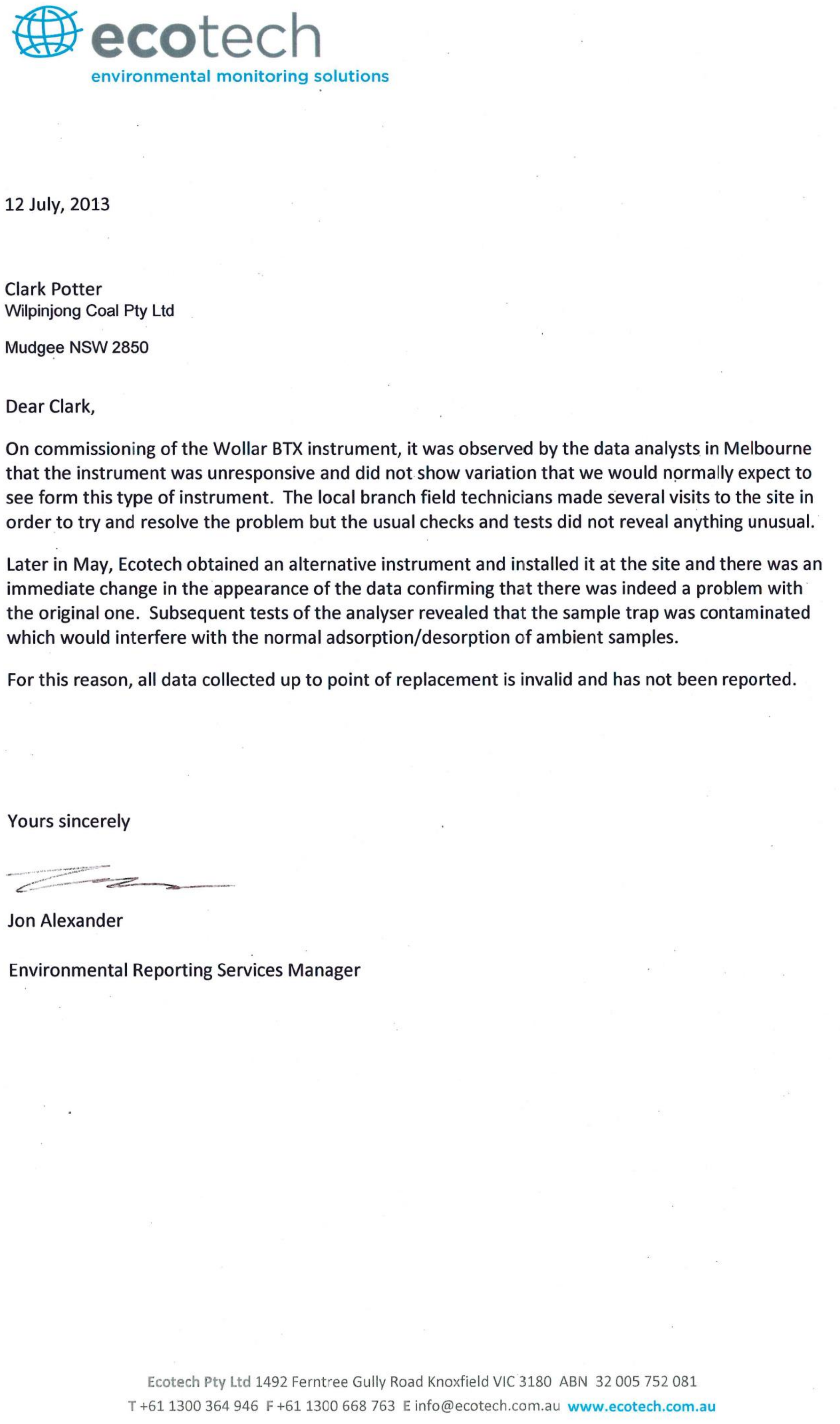
Polycyclic aromatic hydrocarbons (PAHs) are a mixture of organic compounds released into the atmosphere as gases or particles during the incomplete combustion of organic material.

PAHs have a number of sources including:

- Cars, trucks, ships and aircraft.
- Industrial-power generation, steelworks, coke ovens, aluminium production, cement kilns, oil refining and waste incineration.
- Domestic-primarily combustion for heating and cooking, especially solid fuel heaters using wood and coal.
- Fires-burning of vegetation in agricultural processes and bushfires.

Although many different PAHs have been identified, there is limited published toxicological data on them. One of the best characterised and most toxic PAH is benzo(a)pyrene, which is generally used as the indicator PAH.

Appendix B: Wollar instrument failure - Ecotech letter



ecotech
environmental monitoring solutions

12 July, 2013

Clark Potter
Wilpinjong Coal Pty Ltd

Mudgee NSW 2850

Dear Clark,

On commissioning of the Wollar BTX instrument, it was observed by the data analysts in Melbourne that the instrument was unresponsive and did not show variation that we would normally expect to see form this type of instrument. The local branch field technicians made several visits to the site in order to try and resolve the problem but the usual checks and tests did not reveal anything unusual.

Later in May, Ecotech obtained an alternative instrument and installed it at the site and there was an immediate change in the appearance of the data confirming that there was indeed a problem with the original one. Subsequent tests of the analyser revealed that the sample trap was contaminated which would interfere with the normal adsorption/desorption of ambient samples.

For this reason, all data collected up to point of replacement is invalid and has not been reported.

Yours sincerely

Jon Alexander

Environmental Reporting Services Manager

Ecotech Pty Ltd 1492 Ferntree Gully Road Knoxfield VIC 3180 ABN 32 005 752 081
T +61 1300 364 946 F +61 1300 668 763 E info@ecotech.com.au www.ecotech.com.au

Appendix C: Summa canister results (VOCs and sulfur compounds)

Table C1: Summa canister results

Compound	LOR	Wollar	Cooks Gap	Wollar	Cooks Gap	WCM #1	WCM #2
		15-May-13		29-May-13		12-Jun-14	
	ppb	ppb		ppb		ppb	
Freon-12	0.5	**0.6**	**0.6**	<0.5	<0.5	<10.0	<10.0
Chloromethane	0.5	**0.6**	**0.5**	**0.8**	**1.1**	131	64
Freon-114	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
Propene	0.5					84,200	67,800
Propane	0.5					143,000	115,000
Vinylchloride	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
Bromomethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
2-Methylpropane	0.5					12,400	3,610
Chloroethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
1-Butene	0.5					4,700	2,660
Freon-11	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
1.1-Dichloroethene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
n-Butane	0.5					37,500	29,700
Dichloromethane	0.5	**0.5**	<0.5	<0.5	<0.5	<10.0	<10.0
trans-2-Butene	0.5					5,510	2,830
cis-2-Butene	0.5					3,790	1,940
Freon-113	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
1.1-Dichloroethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
2-Methylbutane	0.5					4,040	2,270
1-Pentene	0.5					3,500	2,070
cis-1.2-Dichloroethene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
Chloroform	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
n-Pentane	0.5					10,900	5,540
1.2-Dichloroethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
trans-2-Pentene	0.5					2,740	1,660
1.1.1-Trichloroethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
cis-2-Pentene	0.5					1,330	835
2-Methyl-1.3-butadiene	0.5					504	340
Benzene	0.5	<0.5	<0.5	<0.5	<0.5	15,600	11,400
2.2-Dimethylbutane	0.5					36	24
Carbon tetrachloride	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
1.2-Dichloropropane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
2.3-Dimethylbutane	0.5					266	165
2-Methylpentane	0.5					1,520	906
Trichloroethene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
cis-1.3-Dichloropropylene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
Cyclopentane	0.5					2,050	1,440
trans-1.3-Dichloropropene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
1.1.2-Trichloroethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
3-Methylpentane	0.5					657	442
1-Hexene	0.5					3,560	2,070
Toluene	0.5	**1.7**	<0.5	**0.7**	**0.5**	11,100	8,330
1.2-Dibromoethane(EDB)	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
n-Hexane	0.5					6,100	3,780
2.4-Dimethylpentane	0.5					<10.0	<10.0
Tetrachloroethene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
Chlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
Methylcyclopentane	0.5					2,160	1,440
Ethylbenzene	0.5	<0.5	<0.5	<0.5	<0.5	1330	949
meta-&para-Xylene	1.0	<1.0	<1.0	<1.0	<1.0	5,550	3,880
2-Methylhexane	0.5					931	561
Styrene	0.5	<0.5	<0.5	<0.5	<0.5	206	156
1.1.2.2-Tetrachloroethane	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
2.3-Dimethylpentane	0.5					342	225

ortho-Xylene	0.5	<0.5	<0.5	<0.5	<0.5	1,750	1,240
3-Methylhexane	0.5					568	345
4-Ethyltoluene	0.5	<0.5	<0.5	<0.5	<0.5	527	410
1.3.5-Trimethylbenzene	0.5	<0.5	<0.5	<0.5	<0.5	852	618
1.2.4-Trimethylbenzene	0.5	<0.5	<0.5	<0.5	<0.5	1470	1060
1.3-Dichlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
n-Heptane	0.5					521	345
Benzylchloride	0.5					<10.0	<10.0
Methylcyclohexane	0.5					853	567
1.4-Dichlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
2.3.4-Trimethylpentane	0.5					<10.0	<10.0
1.2-Dichlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
2-Methylheptane	0.5					694	469
1.2.4-Trichlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
3-Methylheptane	0.5					286	173
Hexachlorobutadiene	0.5	<0.5	<0.5	<0.5	<0.5	<10.0	<10.0
n-Octane	0.5					3,480	2,100
Acetone	0.5					<10.0	<10.0
Bromodichloromethane	0.5					<10.0	<10.0
1.3-Butadiene	0.5					<10.0	<10.0
n-Nonane	0.5					2,390	1,550
Carbondisulfide	0.5					644	436
2-Chlorotoluene	0.5					<10.0	<10.0
1-Chloro-2-propene(Allyl	0.5					<10.0	<10.0
Cyclohexane	0.5					610	414
Dibromochloromethane	0.5					<10.0	<10.0
1.4-Dioxane	0.5					<10.0	<10.0
2-Ethyltoluene	0.5					1380	942
Ethylacetate	0.5					<10.0	<10.0
n-Decane	0.5					1700	1080
trans-1.2-Dichloroethene	0.5					<10.0	<10.0
Heptane	0.5					4,720	2,890
Hexane	0.5					5,800	3,590
3-Ethyltoluene	0.5					527	376
Isooctane	0.5					<10.0	<10.0
IsopropylAlcohol	0.5					<10.0	<10.0
1.2.3-Trimethylbenzene	0.5					511	370
2-Butanone(MEK)	0.5					1340	974
1.4-Diethylbenzene	0.5					103	78
Methyliso-Butylketone	0.5					<10.0	<10.0
1.3-Diethylbenzene	0.5					511	374
2-Hexanone(MBK)	0.5					<10.0	<10.0
n-Undecane	0.5					1,400	991
Methyltert-ButylEther(MTBE)	0.5					<10.0	<10.0
n-Dodecane	0.5					795	700
Tetrahydrofuran	0.5					<10.0	<10.0
Bromoform	0.5					<10.0	<10.0
VinylAcetate	0.5					<10.0	<10.0
Vinylbromide	0.5					<10.0	<10.0
Ethanol	0.5					189	98
Acetonitrile	0.5					<10.0	<10.0
Acrolein	0.5					<10.0	<10.0
Acrylonitrile	0.5					<10.0	<10.0
tert-Butylalcohol	0.5					<10.0	<10.0
2-Chloro-1.3-butadiene	0.5					<10.0	<10.0
Di-isopropylEther	0.5					<10.0	<10.0
Ethyltert-ButylEther(ETBE)	0.5					<10.0	<10.0
tert-AmylMethylEther(TAME)	0.5					<10.0	<10.0
MethylMethacrylate	0.5					<10.0	<10.0

1.1.1.2-Tetrachloroethane	0.5					<10.0	<10.0
Isopropylbenzene	0.5					80	59
n-Propylbenzene	0.5					366	267
tert-Butylbenzene	0.5					<10.0	<10.0
sec-Butylbenzene	0.5					25	18
2-isopropyltoluene	0.5					<10.0	<10.0
n-Butylbenzene	0.5					240	178
Naphthalene	0.5					1010	972
Hydrogen sulfide	20			<20	<20	9,040	4,140
Carbonyl sulfide	5			<5	<5	4,580	3,400
Dimethyl sulfide	1			<0.5	<0.5	<10	<10
Methane thiol	5			<5	<5	<50	<50
Ethane thiol	5			<5	<5	<50	<50

Appendix D: HVAS filter results (PAHs)

Table D1: PAHs as benzo[a]pyrene equivalents

Sample date	Compound	Filter mass (µg)	Concentration (µg/m³)	PEF	BaP equiv. (µg/m³)	Total BaP equiv. (µg/m³) *Criterion = 0.4 µg /m³ (1-hour average)*
3/04/2013	Indeno(1.2.3.cd)pyrene	0.22	1.09E-04	0.1	1.09E-05	1.09E-05
29/04/2013	Benzo(a)pyrene	0.21	1.04E-04	1	1.04E-04	1.16E-04
	Indeno(1.2.3.cd)pyrene	0.24	1.19E-04	0.1	1.19E-05	
3/05/2013	Benzo(b)fluoranthene	0.32	1.59E-04	0.1	1.59E-05	1.59E-05
21/05/2013	Benzo(b)fluoranthene	0.43	2.13E-04	0.1	2.13E-05	2.13E-05
27/05/2013	Benzo(b)fluoranthene	0.3	1.49E-04	0.1	1.49E-05	1.49E-05
20/06/2013	Benzo(b)fluoranthene	0.49	2.43E-04	0.1	2.43E-05	2.43E-05
26/06/2013	Benzo(b)fluoranthene	0.3	1.49E-04	0.1	1.49E-05	1.49E-05
2/07/2013	Benzo(b)fluoranthene	0.34	1.69E-04	0.1	1.69E-05	1.69E-05
8/07/2013	Benzo(a)pyrene	0.25	1.24E-04	1	1.24E-04	1.49E-04
	Benzo(b)fluoranthene	0.5	2.48E-04	0.1	2.48E-05	
14/07/2013	Benzo(b)fluoranthene	0.32	1.59E-04	0.1	1.59E-05	1.59E-05
26/07/2013	Benzo(b)fluoranthene	0.44	2.18E-04	0.1	2.18E-05	2.18E-05
10/01/2014	Indeno(1.2.3.cd)pyrene	0.129	6.40E-05	0.1	6.40E-06	6.40E-06
16/01/2014	Chrysene	0.104	5.16E-05	0.01	5.16E-07	5.53E-06
	Indeno(1.2.3.cd)pyrene	0.101	5.01E-05	0.1	5.01E-06	
22/04/2014	Benzo(b)fluoranthene	0.129	6.40E-05	0.1	6.40E-06	6.40E-06
16/05/2014	Benzo(b)fluoranthene	0.142	7.04E-05	0.1	7.04E-06	7.04E-06
22/05/2014	Benzo(b)fluoranthene	0.147	7.29E-05	0.1	7.29E-06	7.29E-06
28/05/2014	Benzo(b)fluoranthene	0.122	6.05E-05	0.1	6.05E-06	6.05E-06
9/06/2014	Benzo(b)fluoranthene	0.282	1.40E-04	0.1	1.40E-05	2.06E-05
	Indeno(1.2.3.cd)pyrene	0.134	6.65E-05	0.1	6.65E-06	
21/06/2014	Benzo(a)pyrene	0.248	1.23E-04	1	1.23E-04	1.54E-04
	Benzo(b)fluoranthene	0.378	1.88E-04	0.1	1.88E-05	
	Indeno(1.2.3.cd)pyrene	0.239	1.19E-04	0.1	1.19E-05	