proposed

Mt Arthur
UNDERGROUND PROJECT

Appendix 12

Air Quality Assessment

AIR QUALITY IMPACT ASSESSMENT: MT ARTHUR UNDERGROUND PROJECT

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Prepared for
Umwelt (Australia) Pty Limited

by

Holmes Air Sciences
Suite 2B, 14 Glen St
Eastwood NSW 2122
Phone : (02) 9874 8644
Fax : (02) 9874 8904
Email : has@holmair.com.au

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1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for Umwelt (Australia) Pty Limited (Umwelt). It provides an assessment of air quality impacts associated with the Mt Arthur Coal Underground Project ("the Project"). Umwelt is preparing an Environmental Assessment (EA) for the Project.

The assessment is based on a conventional approach following the procedures outlined by the NSW Department of Environment and Climate Change (DECC, formerly DEC). The DECC guidance document is titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**DEC, 2005**).

The assessment uses a computer-based dispersion model to predict ground-level dust concentrations and deposition levels due to the existing and proposed mining operations. Model predictions have been compared to relevant air quality criteria to assess the effect that the Project would have on the existing air quality environment.

In summary, the report provides information on the following:

- Proposed mining operations;
- Air quality criteria relevant for this Project;
- Meteorological and climatic conditions in the area;
- Methods used to estimate dust emissions from the mine;
- Expected dispersion and dust fallout patterns due to emissions from the Project; and
- Comparisons of model predictions with relevant air quality assessment criteria, including the consideration of cumulative effects.

The study also examines the impacts of all Mt Arthur Coal operations. These include the Mt Arthur North (MAN) open cut coal mine, including the proposed South Pit Extension (SPE) mining area (currently being assessed by the Department of Planning), and the proposed underground operations.

The extent of air quality impacts associated with the approved MAN open cut mine, which forms part of the Mt Arthur Coal operations, was identified in the MAN Environmental Impact Statement (EIS) (**URS, 2000**). Air quality impacts of the proposed SPE project were predicted in the Environmental Assessment (EA), prepared by **Umwelt (2006)**. An objective of the current study is to compare the impacts of all Mt Arthur Coal operations with impacts as presented in the MAN EIS, in addition to predicting the project specific impacts.

2. PROJECT DESCRIPTION

Mt Arthur Coal operates an open cut coal mine, located approximately five kilometres to the south-southwest of Muswellbrook in the upper Hunter Valley of NSW. Existing Mt Arthur Coal operations include three open cut mining areas; the Bayswater No. 2 mining area (where extraction is complete), the Bayswater No. 3 mining area and the MAN mining area. **Figure 1** shows the location of these mining areas and **Figure 2** shows the terrain in the study area.

Mt Arthur Coal are seeking approval for an underground mining operation in the Bayswater No. 3 mining area and adjacent exploration area to the west. The underground mine will access the coal reserves through the existing open cut pits and will build on existing Mt Arthur Coal infrastructure, including the coal handling and preparation plant (CHPP) and rail loading facility. New infrastructure will include pit-top facilities, such as offices, workshops and stores, as well as ROM stockpiles and conveyor and transfer stations. At the CHPP, a new plant module, new coal stockpiles and associated handling systems are proposed.

A 21-year concept mine plan has been developed which seeks to recover up to approximately 160 Mt of marketable coal. Longwall mining methods will be used in five seams and a production rate of approximately 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal is forecast.

The five target seams for the 21-year period are referred to as:

- Woodlands Hill;
- Glen Munro;
- Arrowfield;
- Bowfield; and
- Piercefield.

Underground mining will commence in the Woodlands Hill seam which will be accessed via the Saddlers Creek pit in the Bayswater No. 3 mining area. Coal from this seam will be brought to the surface by conveyor and transferred from the Saddlers Creek pit to the North Saddlers ROM facility. After passing through the crushing plant, ROM coal will be delivered by conveyor to the CHPP.

Mining of the Glen Munro seam will follow mining of the Woodlands Hill seam. Access to the Glen Munro seam will be from the Belmont Pit in Bayswater No.3 area. Coal will be brought to the surface via an underground conveyor and delivered to a ROM coal stockpile. The coal will be reclaimed from the stockpile by front-end-loader and delivered by truck to a dump station at the North Saddlers ROM facility. Coal will then be crushed and delivered by conveyor to the CHPP.

The Arrowfield, Bowfield and Piercefield seams cannot be accessed directly from existing open cut mining pits so a drift will be established from the base of the North Saddlers Pit. Coal will be brought to the surface via the drift and delivered by conveyor directly to the North Saddlers ROM facility. After passing through the crushing plant, it will then be delivered by conveyor to the CHPP. All underground mining stages will require up to four ventilation fans, operated concurrently during operations.

The Project will also include the conversion of an existing emergency ROM coal stockpile to a permanent stockpile, with an associated increase in capacity from 100,000 tonnes to 650,000 tonnes. The stockpile will be adjacent to the open cut ROM facility. The air quality impacts associated with this ROM coal stockpile have been assessed separately in **Section 7.3**.

Table 1 shows the proposed production schedule for the underground project. Also shown in this table is the concurrent staging of the MAN and SPE mining areas. These years have formed the basis of the dispersion modelling undertaken in this study.

Table 1 : Production schedule for Mt Arthur Underground Project

Underground mining stage	Underground mining year	Underground mine production (tpa)	Concurrent staging of MAN mine operations
Woodlands Hill	Year 5	6,000,000	MAN Year 10 / SPE Year 5
Glen Munro	Year 10	8,000,000	MAN Year 15 / SPE Year 10
Arrowfield	Year 15	7,000,000	MAN Year 21 / SPE Year 15

Underground mining operations will occur 24 hours per day and seven days per week.

Figure 3 shows the land owned by Mt Arthur Coal as well as the location of nearest privately owned and mine or power generator owned residences. The closest privately owned residences are along Denman Road, approximately four kilometres to the northwest of where the nearest significant surface activities will be located. Private residences are also located to the northeast of the CHPP, in the area referred to as Antiene.

3. AIR QUALITY CRITERIA

Table 2 and **Table 3** summarise the current air quality assessment criteria noted by the DECC. Generally, the air quality criteria relate to the total burden of dust in the air and not just the dust from the project. In other words, some consideration of background levels needs to be made when using these criteria to assess impacts. The estimation of appropriate background levels will be discussed further in **Section 4.3**.

The criteria in **Table 2** have been developed to protect against adverse health effects.

Table 2 : DECC assessment criteria for particulate matter concentrations

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 µg/m^3	Annual mean	National Health & Medical Research Council
Particulate matter < 10 µm (PM_{10})	50 µg/m^3	24-hour maximum*	DECC
	30 µg/m^3	Annual mean	DECC long-term reporting goal
	50 µg/m^3	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Council

** For coal mining operations in rural areas, this goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best-practice dust control measures.*

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3** shows the maximum acceptable increase in dust deposition over the existing dust levels. The criteria for dust fallout levels are set to protect against nuisance impacts (**DEC, 2005**).

Table 3 : DECC criteria for dust fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Table 4 shows the MAN development consent air quality goals and standards. Again, these levels relate to the total dust burden in the air and not just the dust from the MAN mining area.

Table 4 : Development consent air quality standards/goals for MAN

<table>
<tr><th>POLLUTANT</th><th>STANDARD / GOAL</th><th colspan="2">AVERAGING PERIOD</th><th>AGENCY</th></tr>
<tr><td>Total suspended particulate matter (TSP)</td><td>90 µg/m³</td><td colspan="2">Annual mean</td><td>NHMRC</td></tr>
<tr><td rowspan="2">Particulate matter < 10 µm (PM_{10})</td><td>150 µg/m³</td><td colspan="2">24-hour maximum (average of 99th percentile of 24-hour averages over three years)</td><td>US EPA</td></tr>
<tr><td>50 µg/m³</td><td colspan="2">Annual mean</td><td>US EPA</td></tr>
<tr><td colspan="5">NSW EPA amenity based criteria for dust fallout</td></tr>
<tr><td rowspan="2">Existing dust fallout level (g/m²/month)</td><td colspan="4">Maximum acceptable increase over existing fallout levels (g/m²/month)</td></tr>
<tr><td colspan="2">Residential</td><td colspan="2">Other</td></tr>
<tr><td>2</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">2</td></tr>
<tr><td>4</td><td colspan="2">0</td><td colspan="2">1</td></tr>
</table>

It can be seen that the current DECC goals (from **Table 2** and **Table 3**) are now more stringent than the MAN development consent goals (**Table 4**). Most notably, the maximum 24-hour average PM_{10} goal was reduced from 150 µg/m³ to 50 µg/m³ and the annual average PM_{10} goal was reduced from 50 µg/m³ to 30 µg/m³. The decrease from 150 µg/m³ to 50 µg/m³ is not as stringent as it first appears as the 150 µg/m³ relates to the total dust whereas, for open-cut mines employing best practice controls, the 50 µg/m³ is taken to be project only dust.

The DECC criteria for annual average dust fallout is now a maximum increase of 2 g/m²/month and a maximum total level of 4 g/m²/month which is consistent with the consent criteria for residential receptors.

4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology and local climatic conditions in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[1] and mixing height[2]. Two meteorological sites have been sourced for the purposes of this study; Macquarie Generation data and McLeans Hill data. The location of these meteorological monitoring sites is shown in **Figure 4**.

DECC have listed requirements for meteorological data that are used for air dispersion modelling in their *Approved Methods* (**DEC, 2005**). The requirements are as follows:

- Data must span at least one year;
- Data must be at least 90% complete; and
- Data must be representative of the area in which emissions are modelled.

Macquarie Generation has collected meteorological data near the mine (see **Figure 4**). As part of the MAN EIS, these data were processed into a form suitable for the ISCST3 dispersion model and data for the period November 1995 to October 1996 are available. However, only 81% of the data potentially available in a year were recorded which does not strictly satisfy the DECC's requirements list above. Therefore, an alternative weather data set from the Macquarie Generation data has been sourced for the project specific modelling.

A meteorological station was installed by Holmes Air Sciences in July 1999 specifically for the MAN project and operations. This station is located to the south of Denman Road and in the north of the MAN mining lease boundary (see **Figure 4**). The site is referred to as McLeans Hill and the weather station logs 10-minute records of temperature, wind speed, wind direction and sigma-theta (a measure of fluctuation in the horizontal wind direction) among other parameters. Data for 2004 are available for this study and during this year there were 8328 hours of data collected. This represents 95% data recovery.

Windroses generated from the 1995/1996 Macquarie Generation data are presented in **Figure 5**. It can be seen from this figure that, annually, the most common winds were from the southeast. In winter the most common winds are from the northwest while winds from the southeast prevail in summer. This pattern of winds is typical of conditions in the upper Hunter Valley. The average wind speed for the 1995/1996 dataset was 3.6 m/s.

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[1] In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[2] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

Figure 6 shows annual and seasonal windroses for McLeans Hill in 2004. The pattern of winds at this site in 2004 was very similar to that measured at the Macquarie Generation site. This may be expected given that the sites are less than two kilometres from each other and there is no significant intervening terrain. The average wind speed in 2004 was 3.3 m/s.

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. For the Macquarie Generation and McLeans Hill data, a stability class was assigned to each hour of the meteorological data using sigma-theta according to the method recommended by the US EPA (**US EPA, 1986**). **Table 5** shows the frequency of occurrence of the stability categories expected in the area.

The most common stability class for both locations was determined to be D class. This would suggest that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time.

Table 5 : Frequency of occurrence of stability classes in the study area

Stability Class	Macquarie Generation site (1995/1996 data)	McLeans Hill site (2004 data)
A	15.4	9.1
B	4.5	4.1
C	7.2	9.0
D	43.7	53.2
E	13.6	18.5
F	15.7	6.1
Total	100	100

Mixing height was determined using a scheme defined by **Powell** (**1976**) for day-time conditions and an approach described by **Venkatram**, (**1980**) for night-time conditions. These two methods provide a good estimate of mixing height in the absence of upper air data.

Given that there was over 90% data capture for a continuous year from the McLeans Hill site, these data were considered more suitable for dispersion modelling purposes than the Macquarie Generation data. The McLeans Hill data were therefore used in the dispersion modelling for the Project.

Joint wind speed, wind direction and stability class frequency tables for the McLeans Hill 2004 data are provided in **Appendix A**.

4.2 Local Climatic Conditions

The Bureau of Meteorology also collects climatic information in the vicinity of the study area. A range of climatic information collected from Jerrys Plains Post Office (located approximately 20 km to the south of Mt Arthur Coal) are presented in **Table 6** (**Bureau of Meteorology, 2007**). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of rain days per month.

Table 6 : Climate information for the study area

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean 9 am dry-bulb temperature (deg C)	23.3	22.7	21.3	17.9	13.5	10.5	9.2	11.3	15.2	18.9	21.1	23.1	17.3
Mean 9 am wet-bulb temperature (deg C)	19.2	19.3	17.9	14.9	11.5	8.9	7.6	8.9	11.7	14.4	16.2	18.1	14
Mean 9 am humidity (%)	67	72	71	71	77	79	78	72	65	60	59	60	69
Mean 3 pm dry-bulb temperature (deg C)	29.6	28.9	27.1	24.2	20	17.1	16.3	18.2	21.1	23.9	26.8	29	23.5
Mean 3 pm wet-bulb temperature (deg C)	21	21.1	19.6	17.1	14.5	12.2	11.1	12	13.9	16.1	17.8	19.6	16.3
Mean 3 pm relative humidity (%)	46	50	50	47	51	53	50	45	43	43	41	42	47
Mean daily maximum temperature (deg C)	31.8	30.9	29	25.3	21.2	17.9	17.3	19.4	22.8	26.2	29.3	31.4	25.2
Mean daily minimum temperature (deg C)	17.1	17.1	15	10.8	7.4	5.2	3.7	4.4	6.9	10.2	13.1	15.7	10.5
Mean rainfall (mm)	78.2	71.7	58.2	44.7	41.3	45.3	44.3	36.6	41.3	51.9	58.2	67.3	638.8
Median rainfall (mm)	65.5	46	45.7	32.5	29.9	28.8	36.3	30.5	33.8	47.6	48.9	55	644.1
Mean number of rain days	7.9	7.3	7.3	6.3	6.6	7.3	7	7	6.6	7.5	7.6	7.5	86

Climate averages for Station: 061086 JERRYS PLAINS POST OFFICE, Commenced: 1884; Last record: 2004; Latitude (deg S): -32.4972; Longitude (deg E): 150.9093; State: NSW. As at March 2007 the climate averages from the BoM website were determined from data up to 2004 and had not been updated with any newer data. Source: ***Bureau of Meteorology (2007)*** *website.*

Temperature data show that January is typically the warmest month with a mean daily maximum of 31.8°C. July is the coldest month with a mean daily minimum of 3.7°C.

Rainfall data collected at Jerrys Plains show that January is the wettest month with a mean rainfall of 78 mm over 8 rain days. Annually the area experiences, on average, 639 mm of rain.

4.3 Existing Air Quality

The DECC's air quality criteria generally refer to pollutant levels which include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality criteria (refer to **Section 3**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the Project is likely to contribute to these levels.

Dust deposition and dust concentration (PM_{10}) is monitored in the study area. The locations of the monitoring sites are shown in **Figure 4**. There are eight high volume air samplers, measuring PM_{10}, and 21 dust deposition gauges.

Mt Arthur Coal undertakes a comprehensive review of data from their air quality monitoring network on an annual basis. The most recent reviews were based on data collected in 2004, 2005 and 2006 (see **Holmes Air Sciences, 2005, 2006 and 2007**).

4.3.1 Dust Concentration

Table 7 presents the annual average and annual maximum PM_{10} concentrations for each high volume air sampler monitoring site in the study area for 2004, 2005 and 2006. Also shown in this table are estimates of the annual average TSP concentrations at each site, based on measured PM_{10} concentrations. As indicated in **Table 7**, the majority of the monitoring sites are on land owned by Mt Arthur Coal. The monitoring site at Wire Lane is on vacant land and is not adjacent to any residences.

Table 7 : Summary of dust concentration data collected in 2004, 2005 and 2006

Site	2004	2005	2006	Air quality criteria
Annual average PM_{10} ($\mu g/m^3$)				
Constable#	19	17	18	50 µg/m³ (Development consent) 30 µg/m³ (Current DECC criteria)
Denman Rd West#	18	19	18	
South Muswellbrook	28	22	22	
Sheppard Ave	28	22	27	
Windmill#	19	16	16	
Edderton#	15	13	16	
Roxburgh South#	17	16	17	
Wire Lane	23	19	18	
Annual average TSP ($\mu g/m^3$)*				
Constable#	47	42	45	90 µg/m³ (Development consent) 90 µg/m³ (Current DECC criteria)
Denman Rd West#	45	47	45	
South Muswellbrook	71	56	55	
Sheppard Ave	69	55	68	
Windmill#	47	41	40	
Edderton#	37	34	40	
Roxburgh South#	43	39	43	
Wire Lane	58	49	45	
Highest 24-hour average PM_{10} ($\mu g/m^3$) (second highest 24-hour average PM_{10} in parentheses)				
Constable#	59 (47)	63[d] (49)	46 (36)	150 µg/m³ (Development consent) 50 µg/m³ (Current DECC criteria)
Denman Rd West#	48 (43)	85[e] (72[d])	44 (43)	
South Muswellbrook	**169[a] (155[c])**	61 (59[f])	66 (44)	
Sheppard Ave	63 (60)	47 (47)	96 (89)	
Windmill#	58 (50)	60[d] (43)	37 (34)	
Edderton#	40 (35)	43 (31)	72 (51)	
Roxburgh Sth#	50 (49)	42 (33)	35 (33)	
Wire Lane	110[b] (58)	57 (42[d])	48 (34)	

[*] Estimated from PM_{10} by assuming that monitored annual average PM_{10} levels will be approximately 40% of annual average TSP levels.
[a] ash was recorded on the filter paper. Cause unknown.
[b] a slight ash odour and discolouration was noted about this measurement. Cause unknown.
[c] red dust recorded on filter paper. Most likely cause is cars doing burnouts on the adjacent dirt road.
[d] bushfires in the vicinity of the mine.
[e] heavy grey dust on filter paper. Likely to be due to nearby farming activity.
[f] heavy red/brown dust, most likely from traffic on adjacent dirt road.
 # On land owned by Mt Arthur Coal

Between 2004 and 2006 the annual average PM_{10} concentrations were below both the development consent goal of 50 $\mu g/m^3$ and also the current DECC assessment criterion of 30 $\mu g/m^3$ at all monitoring locations. The highest levels were recorded at the South Muswellbrook and Sheppard Avenue sites in 2004 with 28 $\mu g/m^3$. It is likely that these two sites have recorded higher levels than the other site because of the influence of emissions from activities in Muswellbrook, as well as emissions from mining.

It can also be seen from **Table 7**, and from reference to the site locations in **Figure 4**, that the higher average PM_{10} concentrations were generally recorded to the east of Mt Arthur Coal while lower levels were generally recorded to the west. The range of annual average PM_{10}

concentrations for the 2004 to 2006 period was between 13 µg/m^3 (Edderton in 2005) and 28 µg/m^3 (South Muswellbrook and Sheppard Avenue in 2004). The mode, median and average of all annual PM_{10} concentrations in **Table 7** are 19, 18 and 19 µg/m^3 respectively.

Annual average TSP concentrations were derived from the PM_{10} measurements by assuming that 40% of the TSP was PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**). Use of this relationship indicates that annual average TSP concentrations were below both the development consent goal and DECC assessment criterion of 90 µg/m^3.

Maximum 24-hour average PM_{10} concentrations above the consent limit of 150 µg/m^3 have only been recorded at the South Muswellbrook site in 2004. Possible contamination of the samples was reported with the samples above the 150 µg/m^3 limit.

Many of the monitoring sites have recorded maximum 24-hour average concentrations above the current DECC criterion of 50 µg/m^3. The reviews of air quality monitoring data found that these maxima were generally due to events such as bushfires, which often produce elevated concentrations over large geographical areas.

4.3.2 Dust Deposition

Insoluble solids data collected in 2004 and 2005 from the 21 dust deposition gauges are presented in **Table 8**.

Table 8 : Summary of dust deposition data collected in 2004, 2005 and 2006

Gauge	Annual average insoluble solids (g/m^2/month)			
	2004	2005	2006	Air quality criteria
DD1	2.2	2.2	2.8	4 g/m^2/month (Development consent) 4 g/m^2/month (Current DECC criteria)
DD2	3.7	**4.6**	**4.3**	
DD3	3.8	**4.3**	3.6	
DD4	1.7	1.7	1.9	
DD5	**5.0**	3.0	2.2	
DD6	1.2	1.8	1.6	
DD7	**5.3**	1.8	2.2	
DD8	1.2	1.3	1.2	
DD9	1.3	1.1	1.0	
DD10	2.4	1.9	2.1	
DD11	**8.5**	**6.0**	**4.7**	
DD12	2.7	2.1	2.7	
DD13	1.8	1.4	1.6	
DD14	1.2	1.0	1.1	
DD15	3.0	3.8	2.4	
DD16	**4.9**	4.0	**4.3**	
DD17	**4.1**	2.3	2.3	
DD18	2.6	2.1	3.0	
DD19	2.9	2.3	2.7	
DD20	2.3	3.4	**4.1**	
DD21	3.6	2.1	2.8	
All sites	**3.1**	**2.6**	**2.6**	

Eight of the 21 dust deposition gauges have historically measured annual average dust deposition above the DECC's 4 g/m^2/month criteria. These include gauges 2, 3, 5, 7, 11, 16, 17 and 20. It should be noted that these gauges are all located on Mt Arthur Coal land and not near to any residential receivers (refer to **Figure 4**).

Dust deposition measurements generally reflect the influence of activities occurring very close to the monitoring site. The gauges are also particularly susceptible to contamination by bird droppings and insects for example. Thus, the average from all sites has been calculated and included in the table above to provide an indication of annual average fallout levels in the study area.

5. ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at open-cut and underground coal mines. Total dust emissions due to the Project have been estimated by analysing the mine plan for selected years of operation and identifying the location and intensity of dust generating activities.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. This study draws on US EPA emission factors for mining operations that were subject to significant revisions in 2003. The emission factors applied are considered to be the most up to date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The assessment has considered three underground mining scenarios as follows:

- Year 5, Woodlands Hill seam;
- Year 10, Glen Munro seam; and
- Year 15, Arrowfield seam.

The above scenarios also coincide approximately with MAN open cut operations for Year 10, 15 and 21 respectively.

The operational description for the Project has been used to determine haul road distances and routes, stockpile and pit areas and locations, activity operating hours, truck sizes and other details necessary to estimate dust emissions for each year.

The most significant dust generating activities from the underground operations have been identified and the dust emission estimates during the three operational years selected are presented below in **Table 9**.

Details of the dust emission calculations are presented in **Appendix B**. The estimated emissions take account of proposed air pollution controls including passive controls such as those inbuilt into the mine plan, including stockpile size and alignment and length of haul roads. Active controls such as the intensity of watering and extent of rehabilitation are also considered in the emission calculations.

Table 9 : Estimated dust emissions due to proposed underground mining operations

ACTIVITY	Annual TSP emission rate (kg/y)		
	Year 5 Woodlands Hill	Year 10 Glen Munro	Year 15 Arrowfield
Loadout to Glen Munro ROM coal stockpile	-	3,705	-
Loading coal to trucks by FEL	-	540,426	-
Hauling ROM coal to North Saddlers ROM facility	-	413,333	-
Loadout to Saddlers ROM stockpile or dump hopper	2,779	3,705	3,242
Dozer working on coal stockpile(s)	152,800	152,800	152,800
Transfer station between stockpiles and crushing	2,779	3,705	3,242
Primary and secondary coal crushing	2,779	3,705	3,242
1st transfer station to CHPP	2,779	3,705	3,242
2nd transfer station to CHPP	2,779	3,705	3,242
Handling of coal at CHPP	13,894	18,525	16,209
Loading to CHPP product coal stockpiles	2,779	3,705	3,242
Loading to rail facility product coal stockpiles	2,779	3,705	3,242
Dozers on CHPP and rail facility coal stockpiles	171,539	171,539	171,539
Loading of coal to trains	2,779	3,705	3,242
Wind erosion from ROM stockpiles	4,854	9,709	4,854
Additional wind erosion from MAN stockpiles	24,632	24,632	24,632
Ventilation shaft(s)	69,379	69,379	69,379
Total dust (kg)	**459,328**	**1,433,688**	**465,349**
Annual ROM production (t)	**6,000,000**	**8,000,000**	**7,000,000**
Ratio of dust to production (kg/t)	**0.08**	**0.18**	**0.07**

6. APPROACH TO ASSESSMENT

In August 2005, the DECC published guidelines for the assessment of air pollution sources using dispersion models (**DEC, 2005**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The approach taken in this assessment follows as closely as possible to the approaches suggested by the guidelines.

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The model used was a modified version of the US EPA ISCST3 model, referred to as ISCMOD (see discussion later in this section). The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as $PM_{2.5}$ or FP (fine particles), 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA (see **Appendix B**).

The distribution of particles has been derived from measurements published by the **SPCC (1986)**. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5\text{-}10}$ (CM) is 34.4% of TSP; and
- $PM_{10\text{-}30}$ (Rest) is 60.9% of TSP.

Modelling was done using three ISC source groups with each group corresponding to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 µm. The predicted concentration in the three plot output files for each group were then combined according to the weightings in the dot points above to determine the concentration of PM_{10} and TSP.

The ISC model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on mining operations where wind speed is an important factor in determining the rate at which dust is generated.

Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a mine site would correspond with periods of low dust generation because wind erosion and other wind dependent emissions rates will be low. Light winds also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Mining operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. **Figure 7** shows the location of the modelled sources.

Dust concentrations and deposition rates have been predicted over the extent of **Figure 1** with the surface facilities of the underground mine located approximately in the centre. Model predictions have been made at 330 discrete receptors, including residential locations, located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearest sensitive areas whilst still maintaining acceptable model run times.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. Local terrain has been included in the modelling. All activities have been modelled for 24 hours per day. **Appendix B** provides a summary of dust emissions, hours of emission and allocation of sources for each activity.

As discussed above, a model referred to as ISCMOD has been used. The model was developed in an effort to provide more accurate 24-hour average PM_{10} predictions than the ISCST3 model. ISCMOD is identical to ISCST3 except that the horizontal plume spreading dispersion curves have been modified to adopt the recommendations of the American Meteorological Society's (AMS) expert panel on dispersion curves (**Hanna, 1977**) and the suggestions made by **Arya (1999)**. The suggested changes were recommended because, as the AMS panel notes, the original horizontal dispersion curves relate to an averaging time of three minutes and they recommend that these be adjusted to the one hour curves required by ISCST3. The change involves increasing the horizontal plume widths by a factor of 1.82 $(60 \text{ minutes} / 3 \text{ minute})^{0.2}$.

A similar adjustment has been applied to account for the local surface roughness being different at the Project site compared with the site where the original curves were developed. The Project site has been taken to have a surface roughness of 0.3 m compared with 0.03 m for the original curves. The adjustment leads to an increase in the horizontal and vertical curves by a factor of $(0.3 \text{ m}/ 0.03 \text{ m})^{0.2}$ namely 1.6. Performance of ISCMOD is assessed by **Holmes *et al* (2007)**.

ISCMOD was used in this instance as it is from a model that is the most widely used model in NSW for assessing the dust impacts of extractive industries. AUSPLUME is the DECC's model of first choice but it has had limited use in dust modelling applications. AUSPLUME is also not able to handle the large number of sources needed to realistically represent the mine and its time-varying emissions.

To assess the air quality impacts of the Project, the emissions associated with the underground activities have been modelled and predictions have been compared with the current DECC air quality assessment criteria. Results for "Project only" emissions have been compared with the "project only" assessment criteria. Contour plots have been created from the results in order to assess the likely contribution of the underground activities to local air quality.

In addition, the cumulative impacts of the Project have been assessed by adding model predictions made at each of the high volume air sampler monitoring locations (discussed in **Section 4.3.1**) to the measured levels at these locations. Predictions were then compared with the current DECC assessment criteria.

7. ASSESSMENT OF IMPACTS

7.1 Model Results for Underground Operations

Dust concentrations and deposition rates for the selected years of assessment have been presented as isopleth diagrams in **Figures 8** to **10**. These figures include the following:

1. Predicted maximum 24-hour average PM_{10} concentration;
2. Predicted annual average PM_{10} concentration;
3. Predicted annual average TSP concentration; and
4. Predicted annual average dust deposition.

In examining the maximum 24-hour average contour plots it should be noted that plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration at each location for the worst day in the year. The maxima are used to show the highest concentrations predicted to be reached under the modelled conditions.

The contour plots show predicted concentrations and deposition levels due only to modelled dust sources associated with the Project. That is, the predictions do not include contributions from other parts of the Mt Arthur Coal mine, other mines or existing non-mine sources.

The air quality criteria used for deciding which areas are likely to experience air quality impacts are those specified by the DECC. The air quality criteria are listed in **Table 2** and **Table 3** and are summarised as follows:

- 50 $\mu g/m^3$ for 24-hour PM_{10} for the Project considered alone;
- 30 $\mu g/m^3$ for annual average PM_{10} due to the Project and other sources;
- 90 $\mu g/m^3$ for annual TSP concentrations due to the Project and other sources;
- 2 g/m^2/month for annual average deposition (insoluble solids) due to the Project considered alone; and
- 4 g/m^2/month for annual predicted cumulative deposition (insoluble solids) due to the Project and other sources.

Figure 8 shows model predictions for Year 5. Maximum 24-hour average PM_{10} concentrations are predicted to be of the order of 2 $\mu g/m^3$ or less at the nearest privately owned residences. Predictions outside Mt Arthur Coal land are of the order of 5 $\mu g/m^3$ or less. The model predictions are well below the DECC's 50 $\mu g/m^3$ criterion.

Annual average PM_{10} concentrations for Year 5 are predicted to be 2 $\mu g/m^3$ or less, outside Mt Arthur Coal land. TSP concentrations are also predicted to be less than 2 $\mu g/m^3$. Note that background concentrations need to be considered for annual average PM_{10} and TSP when comparing the model predictions with the air quality criteria.

Dust deposition outside Mt Arthur Coal land for Year 5 is predicted to be 0.2 g/m^2/month or less. This is below the 2 g/m^2/month criterion for the Project considered alone.

Model results for Year 10 (see **Figure 9**) are higher than for Year 5. This increase largely reflects the increase in dust emissions that would be associated with transporting the ROM coal by truck to the North Saddlers ROM coal facility, which is unique to the Year 5 (Glen Munro) scenario. At the nearest privately owned residences the model predictions are still quite low. For maximum 24-hour average PM_{10} up to 5 µg/m^3 is predicted. For annual average PM_{10} and TSP, model predictions are of the order of 1 and 2 µg/m^3 respectively at the nearest privately owned residences. Annual average dust deposition predictions are 0.2 g/m^2/month or less.

Model results for Year 15 (see **Figure 10**) are very similar to results for Year 5.

Table 10 summarises the model results for the high volume air sampler monitoring locations. In this assessment, some of the monitoring locations can be taken to be representative of the sensitive receptor locations (by comparing the residence locations in **Figure 3** with the residence locations in **Figure 4**), whilst other sites characterise the proposed mining area. For example, "Denman Road West" would be representative of the background levels for the nearest privately owned residences in the northwest (noting that this location is on Mt Arthur Coal owned land). "Wire Lane" would be representative of nearest residences in the "Antiene" area. "Edderton" and "Roxburgh South" (both on land owned by Mt Arthur Coal) would be representative of the proposed mining area.

Table 10 : Project only predictions at selected locations

Location	Prediction due to Year 5	Prediction due to Year 10	Prediction due to Year 15	Project only criteria
Maximum 24-hour average PM_{10} concentrations (µg/m^3)				
Constable#	0.7	2.5	0.7	50
Denman Rd West#	0.9	3.4	0.9	50
South Muswellbrook	0.9	1.1	0.9	50
Sheppard Ave	1.1	1.3	1.1	50
Windmill#	1.2	5.4	1.2	50
Edderton#	3.5	4.7	2.8	50
Roxburgh South#	2.0	26.8	2.0	50
Wire Lane	3.2	4.8	3.2	50
Annual average PM_{10} concentrations (µg/m^3)				
Constable#	0.1	0.3	0.1	-
Denman Rd West#	0.1	0.3	0.1	-
South Muswellbrook	<0.05	0.1	<0.05	-
Sheppard Ave	<0.05	0.1	<0.05	-
Windmill#	0.2	0.7	0.2	-
Edderton#	0.5	1.2	0.4	-
Roxburgh South#	0.3	2.7	0.3	-
Wire Lane	0.3	0.4	0.3	-
Annual average TSP concentrations (µg/m^3)				
Constable#	0.1	0.3	0.1	-
Denman Rd West#	0.2	0.4	0.2	-
South Muswellbrook	<0.05	0.1	<0.05	-
Sheppard Ave	<0.05	0.1	<0.05	-
Windmill#	0.2	0.9	0.2	-
Edderton#	0.5	1.3	0.5	-
Roxburgh South#	0.3	3.7	0.4	-

Location	Prediction due to Year 5	Prediction due to Year 10	Prediction due to Year 15	Project only criteria
Wire Lane	0.3	0.5	0.3	-
Annual average dust deposition (g/m²/month)				
Constable#	0.01	0.02	0.01	2
Denman Rd West#	0.01	0.03	0.01	2
South Muswellbrook	<0.005	<0.005	<0.005	2
Sheppard Ave	<0.005	<0.005	<0.005	2
Windmill#	0.01	0.11	0.01	2
Edderton#	0.01	0.03	0.01	2
Roxburgh South#	0.02	0.52	0.03	2
Wire Lane	0.01	0.02	0.01	2

 # On land owned by Mt Arthur Coal

Table 11 shows the model predictions including the addition of the measured levels from the monitoring location. Note that, for the purposes of the assessment, the highest measured level between 2004 and 2006 was added to the model predictions at each site. This is a conservative approach.

It can be seen from **Table 10** that model predictions are generally highest at the Mt Arthur Coal owned "Roxburgh South" site. This is due to the proximity of the site to the Belmont Pit and ROM facility. The "Roxburgh South" site is not in an area that is representative of nearest residences.

Table 11 : Cumulative predictions at selected locations

Location	Highest measured level between 2004 and 2006	Prediction due to Year 5 including background	Prediction due to Year 10 including background	Prediction due to Year 15 including background	Cumulative criteria
Annual average PM_{10} concentrations (µg/m³)					
Constable#	19	19.1	19.3	19.1	30
Denman Rd West#	19	19.1	19.3	19.1	30
South Muswellbrook	28	28.0	28.1	28.0	30
Sheppard Ave	28	28.0	28.1	28.0	30
Windmill#	19	19.2	19.7	19.2	30
Edderton#	16	16.5	17.2	16.4	30
Roxburgh South#	17	17.3	19.7	17.3	30
Wire Lane	23	23.3	23.4	23.3	30
Annual average TSP concentrations (µg/m³)					
Constable#	47	47.1	47.3	47.1	90
Denman Rd West#	47	47.2	47.4	47.2	90
South Muswellbrook	71	71.0	71.1	71.0	90
Sheppard Ave	69	69.0	69.1	69.0	90
Windmill#	47	47.2	47.9	47.2	90
Edderton#	40	40.5	41.3	40.5	90
Roxburgh South#	43	43.3	46.7	43.4	90
Wire Lane	58	58.3	58.5	58.3	90

 # On land owned by Mt Arthur Coal

At each monitoring site the predicted maximum 24-hour average PM_{10} concentrations are well below the 50 µg/m³ criterion for all future scenarios. Cumulative annual average PM_{10} and TSP concentrations are predicted to be below the 30 and 90 µg/m³ criteria respectively. Annual average dust deposition is predicted to be below the 2 g/m^2/month goal (Project only). Compliance with the 4 g/m^2/month goal (total dust fallout) is also predicted at each monitoring site when 3.1 g/m^2/month (highest average of all locations between 2004 and 2006) is assumed to be the typical background dust fallout level and this is added to the model predictions.

There are, however, some limitations to the modelling approach adopted above. The key limitation is that background concentrations at the monitoring sites have been assumed to be the same for future years. In reality, measured levels at each site may undergo variation in the future and would reflect, to some degree, the change in location and activity levels at nearby mining operations.

Given that the more conservative year of background data was selected and that the increment of the Project to off-site locations is predicted to be small[3], the limitation described above would not change the conclusions of this assessment.

7.2 Comparison with MAN EIS

As discussed in **Section 1**, one objective of the current study was to examine the differences between the dust impacts of the approved MAN operations, as predicted in the EIS, with all Mt Arthur Coal operations, including the proposed SPE as well as the underground project. Essentially, this section seeks to update the extent of impacts predicted in the EIS to reflect the introduction of recent projects into Mt Arthur Coal operations. The EIS model also included dust impacts associated with the Bengalla and Mt Pleasant mines to the north of MAN and the Bayswater No. 3 and Drayton mines to the south.

In the assessment of air quality impacts for the SPE project (**Holmes Air Sciences, 2007**), the results provided an update to the EIS results to reflect the inclusion of the SPE. The current study simply adds the annual average predictions due to the underground project to the updated EIS results. Comparisons of the impact zones were then made with the original MAN EIS results (**URS, 2000**).

The extent of impacts predicted in the EIS compared with impacts predicted for Mt Arthur Coal operations with SPE and the underground project are shown by **Figures 11** to **13**. These figures show the impact zone determined for the EIS and the new impact zone defined with the inclusion of SPE and the underground project. For this analysis the air quality criteria that applied at the time of the EIS have been referenced. Predictions of maximum 24-hour average PM_{10} are not included since this was not modelled for the MAN EIS.

The extent of air quality impacts for the Project in Year 5 is shown by **Figure 11**. Cumulative annual average PM_{10} predictions show that the new impact zone defined for the Mt Arthur Coal operations is close to the impact zone defined in the EIS. It is useful to note that the 45 µg/m^3 contour was taken to represent the extent of impacts. This level represents the original 50 µg/m^3 goal minus 5 µg/m^3, due to non-modelled sources. For annual average TSP, the EIS assumed that non-modelled sources contributed 10 µg/m^3.

Compared with the EIS predictions, the impacts for Mt Arthur Coal with the underground operations and SPE are predicted to be marginally lower to the northwest and marginally higher to the southeast of the operations on mine owned land. This represents the change in the

[3] The highest predicted annual average PM_{10} concentration at the most affected private residence due to emissions from the underground mining assessed in the report is 1 µg/m^3. Annual average TSP and deposition are similarly small.

distribution of dust sources around the mine site that were associated with the SPE project. Some differences can also be explained by the use of ISCMOD instead of ISCST3, as used in the EIS.

Annual average TSP and dust deposition levels for the underground operations in Year 5 exhibit a similar trend to annual average PM_{10} with slight decreases to the northwest and slight increases to the southeast on mine owned land. In fact, this trend is predicted for all the modelled years (see **Figures 12** and **13**). In Year 10 of the underground operations, however, there are some new areas of impact for dust deposition around the proposed surface facilities. These areas are well within the boundary of Mt Arthur Coal land.

In areas where the extent of air quality impacts is predicted to be greater than for the EIS the new "zone of affectation" in each year with SPE would remain on mine owned land and not encroach into any new sensitive receptor areas. The differences between the EIS predictions and the SPE predictions are considered to be small and the changes to off-site air quality would be difficult to detect.

7.3 Conversion of Emergency ROM Coal Stockpile to Permanent Stockpile

As discussed in **Section 2**, the Project will also include the conversion of an existing emergency ROM coal stockpile, located near the open cut ROM facility, to a permanent stockpile. The conversion will increase the capacity of the stockpile and extend the existing footprint to the south.

The existing emergency stockpile is loaded into the CHPP ROM feed hoppers using trucks and front end loaders, and shaped as required using a dozer. As the existing stockpile is an emergency stockpile, there are no permanent dust controls, with dust suppression undertaken using a water cart.

Conversion of the emergency stockpile to a permanent stockpile is summarised as follows:

- Increase the total footprint of the stockpile by approximately 2 ha to a total size of approximately 11 ha, which allows the capacity to increase from 100,000 tonnes to 650,000 tonnes;

- Management procedures will be the same as for the existing stockpile except that permanent water sprays, or equivalent, will be installed for dust control; and

- Approximately 10% of the open-cut ROM coal is expected to pass through the stockpile.

Air quality impacts of the proposed stockpile have been assessed by calculating the additional dust emissions due to wind erosion only. Note that emissions from loading to stockpiles have already been accounted for in the dust emission calculations in **Section 5**. The difference to total dust emissions from inclusion of the stockpile has then been examined and qualitatively assessed in the context of the dispersion model predictions from **Section 7.1**.

Estimated annual dust emissions from the stockpile are shown below in **Table 12**. The calculations show that the total dust emissions from the Underground Project would increase by between 1% and 4%, with the extended ROM coal stockpile. The increase in the year with the highest predicted dust emissions (year 10) would be 1%. Calculations have assumed that the water sprays, or equivalent dust controls, will reduce the wind erosion emissions from the stockpile by 50% (**NPI, 2001**).

Table 12 : Estimated dust emissions from proposed stockpile

ACTIVITY	Annual TSP emission rate (kg/y)		
	Year 5 Woodlands Hill	**Year 10 Glen Munro**	**Year 15 Arrowfield**
Wind erosion from additional stockpile near CHPP, assuming 50% control on dust emissions through the use of water sprays or equivalent measures	18,587	18,587	18,587
Total dust from underground mining operations, including dust from stockpile above (kg)	477,915	1,452,275	483,935
Total dust from underground mining operations, without dust from stockpile above (kg)	459,328	1,433,688	465,349
Percentage increase in calculated dust emission with stockpile (%)	4	1	4

As an indication of how the increased emissions would translate into increased off-site air quality impacts, the model results from **Table 10** can be increased by 4%, as a worst case. This is a simplified approach that does not take into account the location of the stockpile, however for the purposes of this exercise it provides a sufficient level of assessment. Increasing the model results by up to 4% will still readily demonstrate compliance with both the project increment and cumulative air quality criteria noted by the DECC.

Therefore, the proposed stockpile is predicted to result in an acceptable level of air quality impact.

8. SPONTANEOUS COMBUSTION

Emissions of odour and particulate matter can occur if self-heating of the coal is allowed to occur without proper control. Self-heating of coal occurs at different rates depending on the composition of the coal and how it is managed. This process is known as spontaneous combustion. Where spontaneous combustion occurs, it has the potential to lead to emissions of smoke and odour.

As with all underground coal mining operations, there are two key areas of spontaneous combustion risk that will require management as part of the Project. These are as follows:

1. the potential for spontaneous combustion in coal stockpiles on the surface; and
2. the potential for spontaneous combustion in underground mining areas.

Different management measures are used to manage these risks.

The propensity for spontaneous combustion of the coal to be mined as part of the Underground Project has been tested and found to be consistent with that in the Whittingham coal measures across the Hunter Valley coalfield, including at Mt Arthur Coal's existing Bayswater No. 3 and MAN open cut mining areas. The Whittingham coal measures generally have a lower propensity for spontaneous combustion compared with the Greta coal measures found in Bayswater No.2 mining area and the Drayton mine.

8.1 Management of Coal Stockpiles

A coal stockpile spontaneous combustion management plan will be developed as part of the Project. This plan will be developed from the existing management plans and programs that Mt Arthur Coal has in place for the existing open cut operations. The plan will include measures to reduce the spontaneous combustion risk such as the use of water sprays and prudent stockpile management. With these controls in place, there is a low risk of a significant spontaneous combustion event occurring in a coal stockpiling area associated with the Project.

8.2 Management of Spontaneous Combustion Risk in Underground Mining Areas

Management of spontaneous combustion risk in underground mining areas is a key safety management issue for any underground coal mining operation and has been a key consideration in mine planning for this Project. A comprehensive management plan and program will be implemented as part of this project to manage spontaneous combustion risk.

Two of the key aspects of the management plan will be:

- careful design and management of the mine ventilation system to minimise the amount of oxygen entering the goaf (mined out areas), thus minimising the risk of spontaneous combustion; and
- effective remediation of subsidence cracking and the use of nitrogen inertisation to speed up the process of the goaf becoming inert.

With these management controls in place, there is a low likelihood of a significant spontaneous combustion event occurring.

8.3 Impact Assessment

Spontaneous combustion in coal stockpiles or in underground mining areas has the potential to result in emissions of smoke and odour. For underground mining areas, these emissions would occur through ventilation shafts. Given the management controls that will be in place as part of the project, the likelihood of a spontaneous combustion event occurring with consequent off-site air quality impacts is low.

Given the sporadic nature of such and the low likelihood of a significant event occurring, spontaneous combustion odour and particulate matter emissions from the Project are difficult to quantify. However, since the nearest residential receptors are approximately 5 km from the nearest surface facilities and greater than 1.5 km from the nearest proposed ventilation shaft, the potential for adverse odour and particulate matter impacts to be observed is considered to be negligible.

The potential for odour and dust generation due to a spontaneous combustion event is therefore considered to be low and it follows that the frequency of these events would also be low.

9. CONCLUSIONS

This report has assessed the air quality impacts of the proposed Mt Arthur Coal underground project. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities associated with the proposal. The dispersion modelling took account of the local meteorology and terrain information and used dust emission estimates to predict the air quality impacts for three future mining scenarios.

Air quality monitoring data have shown that annual average PM_{10} concentrations have been and are currently below the DECC's current air quality criteria at the monitored locations. Concentrations of TSP, inferred from the PM_{10} concentrations, also show compliance with the current DECC criterion.

Measured 24-hour average PM_{10} concentrations above the DECC's 24-hour average criterion have been recorded in the past. These exceedances are generally associated with widespread events, such as bushfires and regional dust storms, and events such as these may continue to result in elevated levels on occasions.

Results from the dispersion modelling suggested that the incremental increase to off-site dust concentrations and deposition levels due to activities associated with the Project would be small. Activities associated with the underground mining would therefore not be expected to cause exceedances of current DECC air quality assessment criteria at sensitive receptor locations.

The assessment also compared predicted air quality impacts of the Mt Arthur Coal operations, including the proposed SPE and the underground mine, to the original predictions in the MAN EIS. The dispersion modelling indicated that the extent of air quality impacts for all Mt Arthur Coal operations would be similar to the extent predicted without the underground mine. Based on these findings, the extent of air quality impacts of the Project are therefore taken to be acceptable.

A comprehensive spontaneous combustion management plan will be implemented as part of the project and will ensure that spontaneous combustion events are kept to a minimum, or avoided completely. Odour and dust impacts from any spontaneous combustion events that do occur are considered to be negligible, given the implementation of a management plan and the relatively large distance to the nearest sensitive receptors.

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APPENDIX A
JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLES

STATISTICS FOR FILE: C:\Jobs\Bengalla\metdata\McLeansH\man2004.isc
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.003002	0.001921	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.005043
NE	0.002041	0.001561	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.003722
ENE	0.002161	0.001801	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003963
E	0.002161	0.002041	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004203
ESE	0.002161	0.005043	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.007565
SE	0.001681	0.005283	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.007205
SSE	0.003242	0.003242	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.006724
S	0.001681	0.001321	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003002
SSW	0.000720	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001681
SW	0.001081	0.001321	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002402
WSW	0.002642	0.002522	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.005524
W	0.002522	0.004083	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.006724
WNW	0.003602	0.004083	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007685
NW	0.004083	0.004323	0.000600	0.000120	0.000000	0.000000	0.000000	0.000000	0.009126
NNW	0.003122	0.003842	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006964
N	0.004083	0.001561	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.005884
CALM									0.003602
TOTAL	0.039986	0.044909	0.002281	0.000240	0.000000	0.000000	0.000000	0.000000	0.091018

MEAN WIND SPEED (m/s) = 1.58
NUMBER OF OBSERVATIONS = 758

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002402	0.000841	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.003362
NE	0.000720	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001321
ENE	0.000600	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001081
E	0.000720	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.001441
ESE	0.000720	0.001681	0.002041	0.000120	0.000000	0.000000	0.000000	0.000000	0.004563
SE	0.000240	0.002762	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.003963
SSE	0.000480	0.001081	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.001921
S	0.000360	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000600
SSW	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000360
SW	0.000000	0.000000	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
WSW	0.000360	0.000720	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.001441
W	0.000841	0.002642	0.000841	0.000120	0.000000	0.000000	0.000000	0.000000	0.004443
WNW	0.001441	0.002161	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.004083
NW	0.001561	0.001561	0.001441	0.000240	0.000000	0.000000	0.000000	0.000000	0.004803
NNW	0.001321	0.002161	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.004083
N	0.001561	0.001561	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003122
CALM									0.000600
TOTAL	0.013569	0.019092	0.007205	0.000841	0.000000	0.000000	0.000000	0.000000	0.041306

MEAN WIND SPEED (m/s) = 2.12
NUMBER OF OBSERVATIONS = 344

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.003722	0.002522	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.006604
NE	0.000841	0.000841	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001681
ENE	0.000240	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000480
E	0.000000	0.000961	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.001441
ESE	0.000120	0.001921	0.007565	0.001441	0.000000	0.000000	0.000000	0.000000	0.011047
SE	0.000480	0.002281	0.004923	0.001081	0.000000	0.000000	0.000000	0.000000	0.008766
SSE	0.000240	0.000961	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.001681
S	0.000120	0.000000	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000240
SSW	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
SW	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
WSW	0.000841	0.000720	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.001801
W	0.001561	0.001561	0.003362	0.001681	0.000000	0.000000	0.000000	0.000000	0.008165
WNW	0.001321	0.003362	0.007325	0.001801	0.000000	0.000000	0.000000	0.000000	0.013809
NW	0.000841	0.003362	0.005043	0.007805	0.000000	0.000000	0.000000	0.000000	0.017051
NNW	0.000841	0.002281	0.001441	0.001801	0.000000	0.000000	0.000000	0.000000	0.006364
N	0.003482	0.004203	0.000720	0.000240	0.000000	0.000000	0.000000	0.000000	0.008646
CALM									0.002161
TOTAL	0.014890	0.025216	0.031940	0.015970	0.000000	0.000000	0.000000	0.000000	0.090178

MEAN WIND SPEED (m/s) = 3.04
NUMBER OF OBSERVATIONS = 751

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.012248	0.021734	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.034462
NE	0.008646	0.004203	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.013208
ENE	0.003362	0.001681	0.000120	0.000120	0.000000	0.000000	0.000000	0.000000	0.005283
E	0.002281	0.003002	0.001681	0.001441	0.000600	0.000000	0.000000	0.000000	0.009006
ESE	0.002281	0.013689	0.027498	0.034822	0.027017	0.013569	0.003602	0.001321	0.123799
SE	0.001201	0.010687	0.023175	0.028338	0.019332	0.011167	0.003362	0.001321	0.098583
SSE	0.001321	0.003242	0.001801	0.003362	0.000600	0.000600	0.000000	0.000000	0.010927
S	0.000240	0.000841	0.000720	0.000480	0.000480	0.000000	0.000000	0.000000	0.002762
SSW	0.000240	0.001321	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.002281
SW	0.001081	0.000480	0.000480	0.000240	0.000000	0.000120	0.000000	0.000000	0.002402
WSW	0.001441	0.003002	0.001561	0.000961	0.000360	0.000000	0.000120	0.000000	0.007445
W	0.003602	0.008766	0.005043	0.009006	0.005764	0.003362	0.001201	0.000961	0.037704
WNW	0.003722	0.009606	0.014049	0.028939	0.015370	0.004083	0.001681	0.001321	0.078770
NW	0.004683	0.017051	0.009846	0.003722	0.004563	0.001201	0.000961	0.000000	0.042027
NNW	0.004923	0.012368	0.005403	0.000841	0.000240	0.000120	0.000000	0.000000	0.023895
N	0.007685	0.024135	0.004203	0.000720	0.000120	0.000000	0.000000	0.000000	0.036864
CALM									0.002281
TOTAL	0.058958	0.135807	0.096902	0.113232	0.074448	0.034222	0.010927	0.004923	0.531700

MEAN WIND SPEED (m/s) = 4.25
NUMBER OF OBSERVATIONS = 4428

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.008525	0.009846	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.018372
NE	0.005644	0.006724	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012368
ENE	0.003122	0.001201	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004323
E	0.002642	0.003602	0.000720	0.000240	0.000000	0.000000	0.000000	0.000000	0.007205
ESE	0.002762	0.011167	0.008285	0.001201	0.000000	0.000000	0.000000	0.000000	0.023415
SE	0.001921	0.007925	0.008285	0.002041	0.000000	0.000000	0.000000	0.000000	0.020173
SSE	0.001321	0.002642	0.002642	0.000240	0.000000	0.000000	0.000000	0.000000	0.006844
S	0.000600	0.001321	0.001681	0.000240	0.000000	0.000000	0.000000	0.000000	0.003842
SSW	0.000240	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000841
SW	0.000961	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.001441
WSW	0.000961	0.002281	0.002161	0.000120	0.000000	0.000000	0.000000	0.000000	0.005524
W	0.002522	0.006484	0.011287	0.001201	0.000000	0.000000	0.000000	0.000000	0.021494
WNW	0.001801	0.011287	0.012488	0.001921	0.000000	0.000000	0.000000	0.000000	0.027498
NW	0.002522	0.003963	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.006604
NNW	0.002522	0.003242	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005764
N	0.005163	0.010207	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.015850
CALM									0.003722
TOTAL	0.043228	0.082853	0.048271	0.007205	0.000000	0.000000	0.000000	0.000000	0.185279

MEAN WIND SPEED (m/s) = 2.36
NUMBER OF OBSERVATIONS = 1543

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002762	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003722
NE	0.002161	0.000841	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003002
ENE	0.001081	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001561
E	0.001561	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002522
ESE	0.002281	0.001561	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
SE	0.002161	0.002161	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004323
SSE	0.000360	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001321
S	0.001441	0.000720	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002161
SSW	0.000720	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001201
SW	0.000720	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001081
WSW	0.001441	0.004083	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005524
W	0.002762	0.007445	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010207
WNW	0.002161	0.003482	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005644
NW	0.001321	0.000720	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002041
NNW	0.001801	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002762
N	0.002161	0.000720	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002882
CALM									0.006724
TOTAL	0.026897	0.026897	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.060519

MEAN WIND SPEED (m/s) = 1.45
NUMBER OF OBSERVATIONS = 504

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.032661	0.037824	0.001081	0.000000	0.000000	0.000000	0.000000	0.000000	0.071566
NE	0.020053	0.014769	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.035303
ENE	0.010567	0.005884	0.000120	0.000120	0.000000	0.000000	0.000000	0.000000	0.016691
E	0.009366	0.011047	0.003002	0.001801	0.000600	0.000000	0.000000	0.000000	0.025817
ESE	0.010327	0.035062	0.045749	0.037584	0.027017	0.013569	0.003602	0.001321	0.174232
SE	0.007685	0.031100	0.037584	0.031460	0.019332	0.011167	0.003362	0.001321	0.143012
SSE	0.006964	0.012128	0.005403	0.003722	0.000600	0.000600	0.000000	0.000000	0.029419
S	0.004443	0.004443	0.002522	0.000720	0.000480	0.000000	0.000000	0.000000	0.012608
SSW	0.002281	0.003482	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.006484
SW	0.003963	0.002522	0.000720	0.000240	0.000000	0.000120	0.000000	0.000000	0.007565
WSW	0.007685	0.013329	0.004443	0.001321	0.000360	0.000000	0.000120	0.000000	0.027257
W	0.013809	0.030980	0.020653	0.012008	0.005764	0.003362	0.001201	0.000961	0.088737
WNW	0.014049	0.033982	0.034222	0.032781	0.015370	0.004083	0.001681	0.001321	0.137488
NW	0.015010	0.030980	0.017051	0.011888	0.004563	0.001201	0.000961	0.000000	0.081652
NNW	0.014529	0.024856	0.007445	0.002642	0.000240	0.000120	0.000000	0.000000	0.049832
N	0.024135	0.042387	0.005644	0.000961	0.000120	0.000000	0.000000	0.000000	0.073247
CALM									0.019092
TOTAL	0.197526	0.334774	0.186599	0.137488	0.074448	0.034222	0.010927	0.004923	1.000000

MEAN WIND SPEED (m/s) = 3.29
NUMBER OF OBSERVATIONS = 8328

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

- A : 9.1%
- B : 4.1%
- C : 9.0%
- D : 53.2%
- E : 18.5%
- F : 6.1%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0180	0116	0051
02	0000	0000	0000	0187	0118	0042
03	0000	0000	0000	0189	0114	0044
04	0000	0000	0000	0170	0124	0053
05	0000	0000	0000	0177	0121	0049
06	0004	0000	0006	0200	0102	0035
07	0014	0006	0032	0216	0059	0020
08	0037	0033	0077	0196	0003	0001
09	0055	0046	0097	0149	0000	0000
10	0096	0051	0088	0112	0000	0000
11	0119	0031	0077	0120	0000	0000
12	0118	0037	0065	0127	0000	0000
13	0099	0034	0080	0134	0000	0000
14	0096	0033	0073	0145	0000	0000
15	0073	0036	0066	0172	0000	0000
16	0033	0028	0060	0214	0006	0006
17	0014	0009	0030	0262	0026	0006
18	0000	0000	0000	0227	0101	0019
19	0000	0000	0000	0211	0114	0022
20	0000	0000	0000	0208	0111	0028
21	0000	0000	0000	0205	0111	0031
22	0000	0000	0000	0219	0102	0026
23	0000	0000	0000	0214	0109	0024
24	0000	0000	0000	0194	0106	0047

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0063	0048	0165	0887	1502	0486
<=1000 m	0330	0161	0280	1432	0006	0009
<=1500 m	0365	0135	0306	1293	0035	0009
<=2000 m	0000	0000	0000	0378	0000	0000
<=3000 m	0000	0000	0000	0392	0000	0000
>3000 m	0000	0000	0000	0046	0000	0000

MIXING HEIGHT BY HOUR OF DAY

Hour	0000 to 0100	0100 to 0200	0200 to 0400	0400 to 0800	0800 to 1600	1600 to 3200	Greater than 3200
01	0048	0079	0049	0066	0062	0043	0000
02	0045	0091	0038	0074	0061	0037	0001
03	0037	0097	0052	0077	0050	0034	0000
04	0044	0107	0048	0073	0045	0030	0000
05	0095	0097	0038	0061	0041	0015	0000
06	0083	0099	0098	0038	0024	0005	0000
07	0110	0059	0103	0072	0003	0000	0000
08	0000	0060	0127	0160	0000	0000	0000
09	0000	0000	0093	0176	0078	0000	0000
10	0000	0000	0000	0227	0120	0000	0000
11	0000	0000	0000	0142	0205	0000	0000
12	0000	0000	0000	0092	0255	0000	0000
13	0000	0000	0000	0000	0347	0000	0000
14	0000	0000	0000	0000	0347	0000	0000
15	0000	0000	0000	0000	0347	0000	0000
16	0000	0000	0000	0000	0347	0000	0000
17	0003	0004	0005	0009	0313	0013	0000
18	0006	0037	0054	0016	0198	0035	0001
19	0012	0050	0078	0031	0059	0109	0008
20	0016	0048	0080	0033	0054	0106	0010
21	0017	0065	0064	0033	0074	0090	0004
22	0015	0068	0051	0045	0086	0080	0002
23	0013	0081	0051	0061	0075	0065	0001
24	0035	0082	0046	0055	0073	0056	0000

APPENDIX B
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : Mt Arthur Coal Underground Project

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
Year 5 (Woodlands Hill)											
Loadout to Glen Munro ROM coal stockpile	0	0	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Loading coal to trucks by FEL	0	0	t/y	0.06755	kg/t	6	moisture content of coal in %				
Hauling ROM coal to North Saddlers ROM facility	0	0	t/y	0.05167	kg/t	240	t/truck load	12.4	km/return trip	1.0	kg/VKT
Loadout to Saddlers ROM stockpile or dump hopper	2779	6000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Dozer working on coal stockpile(s)	152800	7644	h/y	20.0	kg/h	5	silt content - %	6	moisture content - %		
Transfer station between stockpiles and crushing	2779	6000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Primary and secondary coal crushing	2779	6000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
1st transfer station to CHPP	2779	6000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
2nd transfer station to CHPP	2779	6000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Handling of coal at CHPP	13894	6000000	t	0.00232	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Loading to CHPP product coal stockpiles	2779	6000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Loading to rail facility product coal stockpiles	2779	6000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Dozers on CHPP and rail facility coal stockpiles	171539	22932	h/y	7.5	kg/h	4	silt content - %	10	moisture content - %		
Loading of coal to trains	2779	6000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Wind erosion from ROM stockpiles	4854	2	ha	3236.2	kg/ha/y	86	Average number of raindays	5	silt content in %	17.6873	% of winds above 5.4 m/s
Additional wind erosion from MAN stockpiles	24632	10	ha	2588.9	kg/ha/y	86	Average number of raindays	4	silt content in %	17.6873	% of winds above 5.4 m/s
Ventilation shaft(s)	69379					1584000	m3/h	5	mg/m3	8760	h/y
Year 10 (Glen Munro)											
Loadout to Glen Munro ROM coal stockpile	3705	8000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Loading coal to trucks by FEL	540426	8000000	t/y	0.06755	kg/t	6	moisture content of coal in %				
Hauling ROM coal to North Saddlers ROM facility	413333	8000000	t/y	0.05167	kg/t	240	t/truck load	12.4	km/return trip	1.0	kg/VKT
Loadout to Saddlers ROM stockpile or dump hopper	3705	8000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Dozer working on coal stockpile(s)	152800	7644	h/y	20.0	kg/h	5	silt content - %	6	moisture content - %		
Transfer station between stockpiles and crushing	3705	8000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Primary and secondary coal crushing	3705	8000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
1st transfer station to CHPP	3705	8000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
2nd transfer station to CHPP	3705	8000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Handling of coal at CHPP	18525	8000000	t	0.00232	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Loading to CHPP product coal stockpiles	3705	8000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		

Loading to rail facility product coal stockpiles	3705	8000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Dozers on CHPP and rail facility coal stockpiles	171539	22932	h/y	7.5	kg/h	4	silt content - %	10	moisture content - %		
Loading of coal to trains	3705	8000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Wind erosion from ROM stockpiles	9709	3	ha	3236.2	kg/ha/y	86	Average number of raindays	5	silt content in %	17.6873	% of winds above 5.4 m/s
Additional wind erosion from MAN stockpiles	24632	10	ha	2588.9	kg/ha/y	86	Average number of raindays	4	silt content in %	17.6873	% of winds above 5.4 m/s
Ventilation shaft(s)	69379					1584000	m3/h	5	mg/m3	8760	h/y
Year 15 (Arrowfield)											
Loadout to Glen Munro ROM coal stockpile	0	0	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Loading coal to trucks by FEL	0	0	t/y	0.06755	kg/t	6	moisture content of coal in %				
Hauling ROM coal to North Saddlers ROM facility	0	0	t/y	0.05167	kg/t	240	t/truck load	12.4	km/return trip	1.0	kg/VKT
Loadout to Saddlers ROM stockpile or dump hopper	3242	7000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Dozer working on coal stockpile(s)	152800	7644	h/y	20.0	kg/h	5	silt content - %	6	moisture content - %		
Transfer station between stockpiles and crushing	3242	7000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Primary and secondary coal crushing	3242	7000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
1st transfer station to CHPP	3242	7000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
2nd transfer station to CHPP	3242	7000000	t/y	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Handling of coal at CHPP	16209	7000000	t	0.00232	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Loading to CHPP product coal stockpiles	3242	7000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Loading to rail facility product coal stockpiles	3242	7000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Dozers on CHPP and rail facility coal stockpiles	171539	22932	h/y	7.5	kg/h	4	silt content - %	10	moisture content - %		
Loading of coal to trains	3242	7000000	t	0.00046	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
Wind erosion from ROM stockpiles	4854	2	ha	3236.2	kg/ha/y	86	Average number of raindays	5	silt content in %	17.6873	% of winds above 5.4 m/s
Additional wind erosion from MAN stockpiles	24632	10	ha	2588.9	kg/ha/y	86	Average number of raindays	4	silt content in %	17.6873	% of winds above 5.4 m/s
Ventilation shaft(s)	69379					1584000	m3/h	5	mg/m3	8760	h/y

The dust emission inventories have been prepared using the operational description of the proposed mining activities provided by Umwelt. Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factor equations used for the study are described below. The emission factor derived from the application of the equation, with variables applicable to the Project, are shown in the fifth column of the table above.

Loading coal to stockpiles / coal transfer points / loading to trains
Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. Equation 1 shows the relationship between these variables.

Equation 1

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \qquad kg/t$$

where,
E_{TSP} = *TSP emissions*
$k = 0.74$
U = *wind speed (m/s)*
M = *moisture content (%)*
[where $0.25 \le M \le 4.8$*]*

Loading coal by FEL
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in Equation 2.

Equation 2

$$E_{TSP} = \frac{0.58}{M^{1.2}} \qquad \text{kg/t}$$

where,
E_{TSP} = TSP emissions
M = moisture (%)

Hauling coal on unsealed surfaces
After the application of water the emission factor used for trucks hauling overburden or ROM coal on unsealed surfaces was 1 kg per vehicle kilometre travelled (kg/VKT).

Dozers on coal stockpiles
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in Equation 3.

Equation 3

$$E_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}} \qquad \text{kg/hour}$$

where,
E_{TSP} = TSP emissions
S = silt content (%), and
M = moisture (%)

Primary and secondary coal crushing
There are currently no specific emission factors for these activities however, in practice, these will form a very small contribution of the overall dust emissions from a coal mine. In the absence of specific emission factors, TSP emission were estimated by Equation 1.

Wind erosion from stockpiles
The emission factor for wind erosion is given in Equation 4 below.

Equation 4

$$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right) \qquad \text{kg/ha/day}$$

where,
s = silt content (%)
p = number of raindays per year, and
f = percentage of the time that wind speed is above 5.4 m/s

Dust emissions from ventilation shafts
Assumes that the particulate matter concentration in the ventilation outlets are at 5 mg/m^3. Measurements made by **HLA Envirosciences (1999)** at the Cumnock Colliery, Ravensworth showed that particulate matter concentrations in ventilation outlets were of the order of 3.5 mg/m^3.

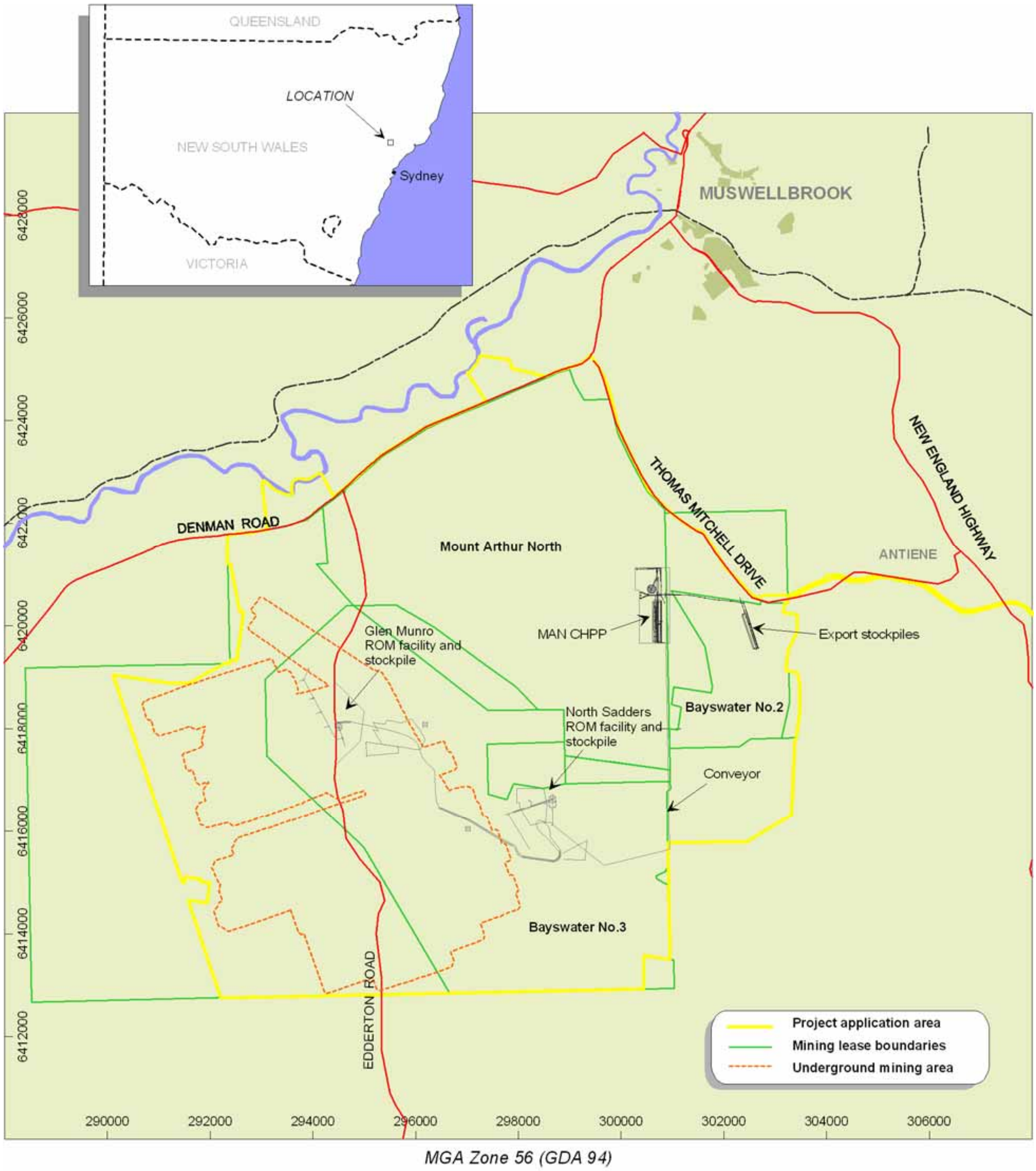
Summary of modelled activities, emissions and locations
A summary of dust emission estimates for each activity, activity type, location of emission sources and activity hours are provided below. Only information for Year 5 is shown below but other scenarios, as well as ISC model input files, can be provided on request. The location of the sources can be obtained from **Figure 7**.

```
 -------------------------------      25-Jun-2007 16:26
  DUST EMISSION CALCULATIONS V2
 -------------------------------

 Output emissions file  : C:\Jobs\MANUG\iscmod\y05_WD\emiss.dat
 Meteorological file    : C:\Jobs\MANUG\metdata\McLeansH\man2004.isc
 Number of dust sources : 16
 Number of activities   : 17
 No-blast conditions    : None
 Wind sensitive factor  : 1.821 (1.821 adjusted for activity hours)
 Wind erosion factor    : 91.757

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Loadout to Glen Munro ROM coal stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading coal to trucks by FEL
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal to North Saddlers ROM facility
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loadout to Saddlers ROM stockpile or dump hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
```

```
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer working on coal stockpile(s)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 152800 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transfer station between stockpiles and crushing
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Primary and secondary coal crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 1st transfer station to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 2nd transfer station to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 1
5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling of coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 13894 kg/y
 FROM SOURCES  : 5
6 7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to CHPP product coal stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 5
6 7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to rail facility product coal stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on CHPP and rail facility coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 171539 kg/y
 FROM SOURCES  : 8
6 7 8 9 10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading of coal to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2779 kg/y
 FROM SOURCES  : 1
13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 4854 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

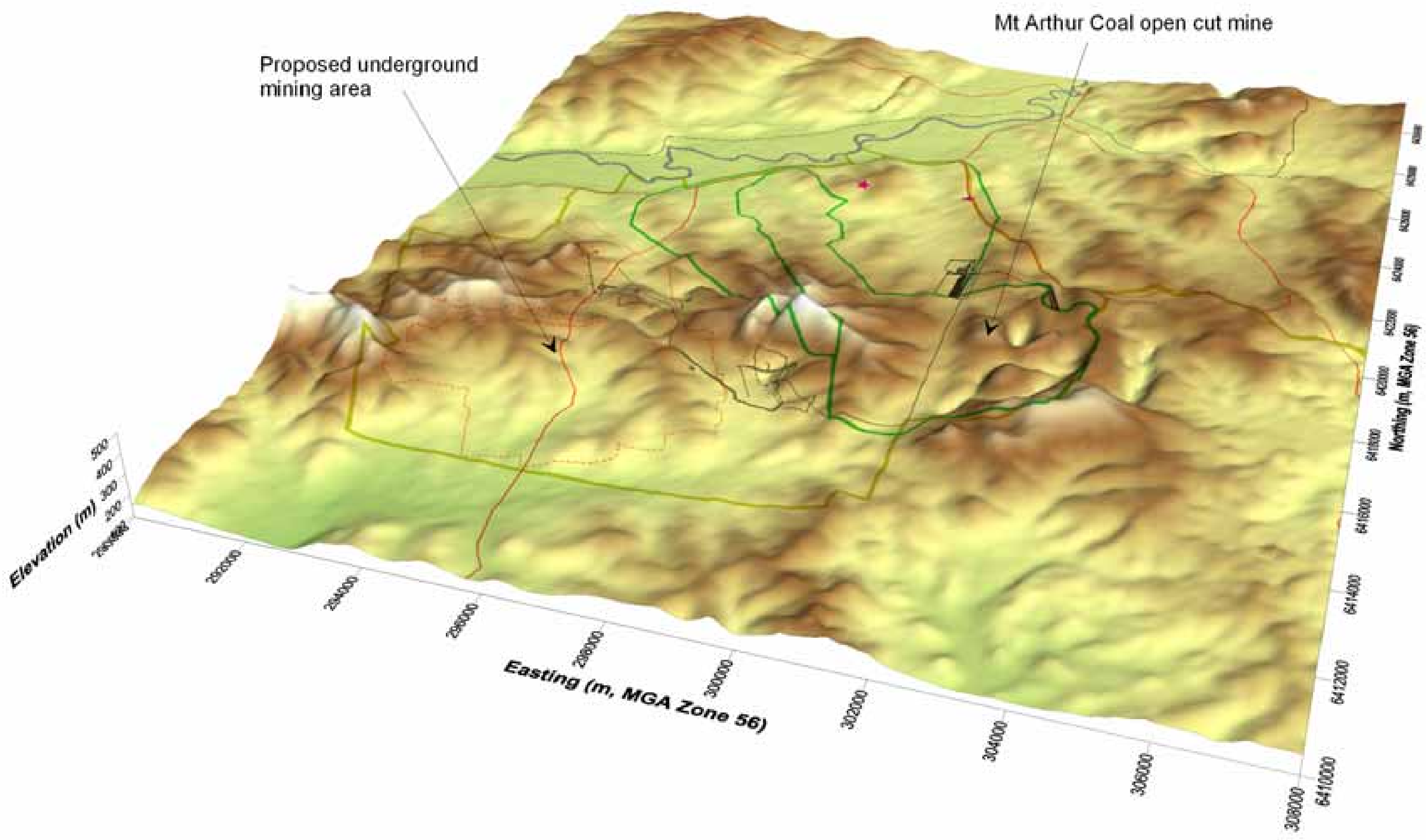
```
 ACTIVITY NAME : Additional wind erosion from MAN stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 24632 kg/y
 FROM SOURCES  : 8
6 7 8 9 10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Ventilation shaft(s)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 69379 kg/y
 FROM SOURCES  : 3
14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

FIGURES

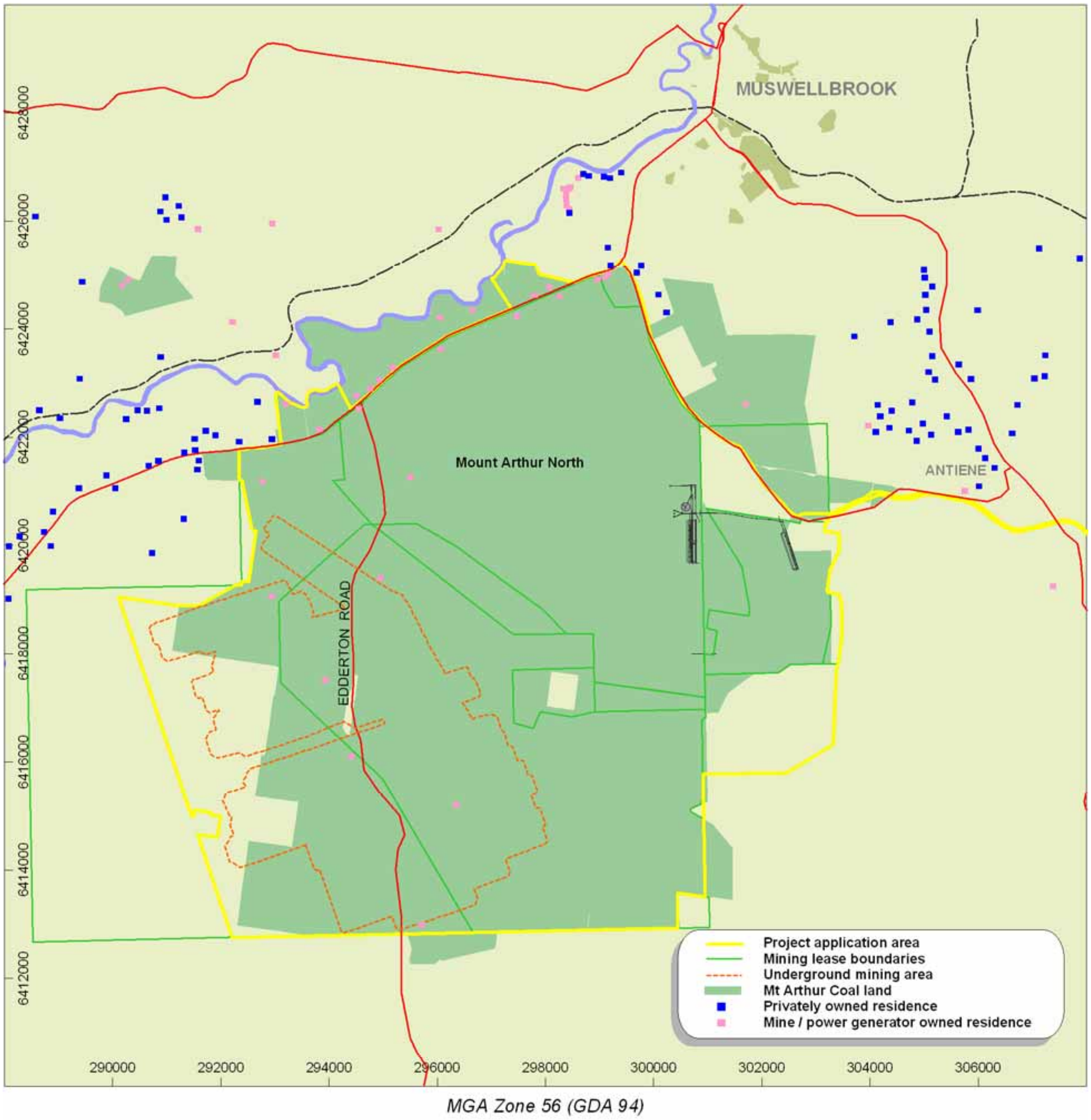


Location of Mt Arthur Underground Project

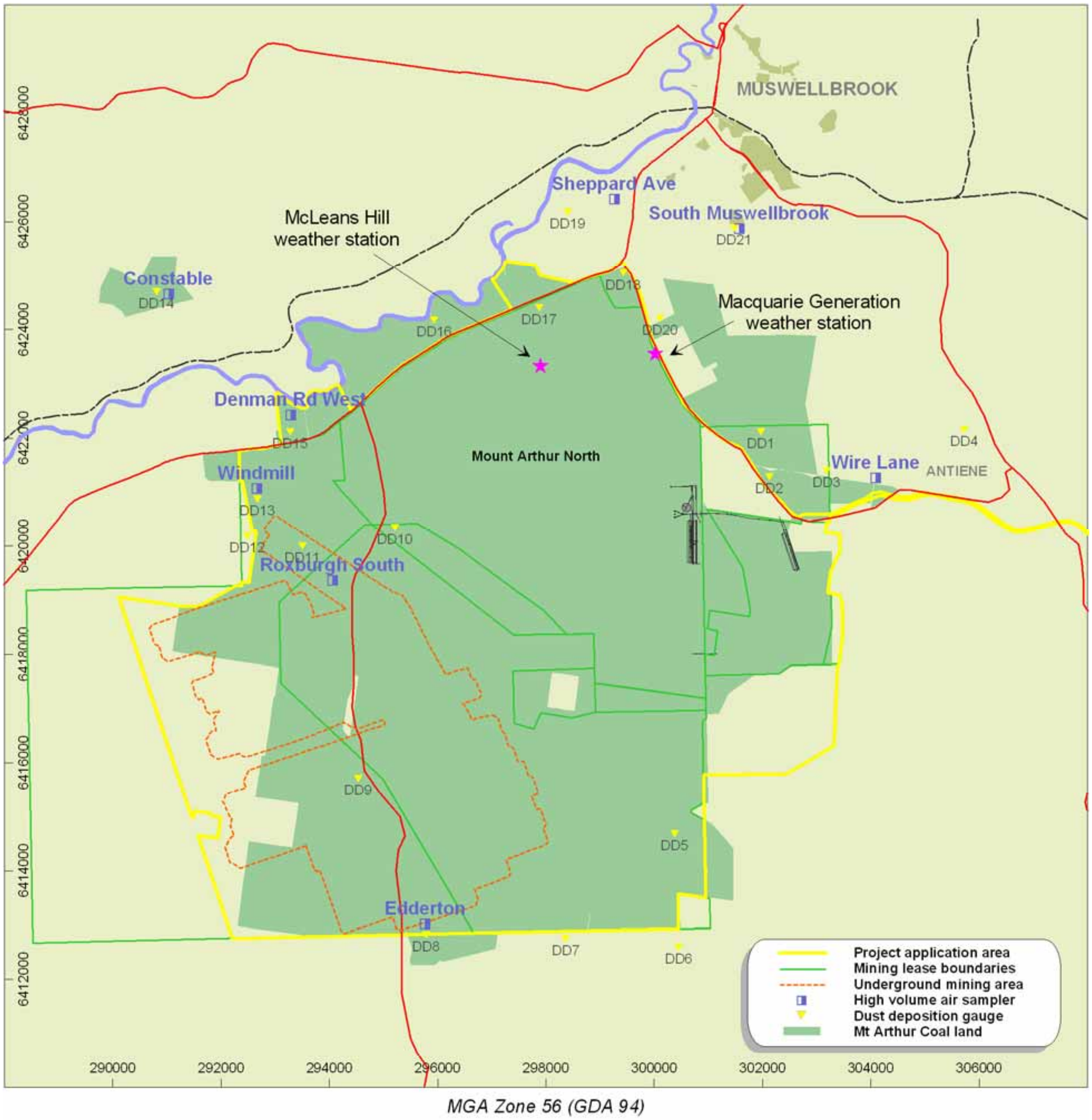
FIGURE 1



Pseudo three-dimensional representation of the local terrain



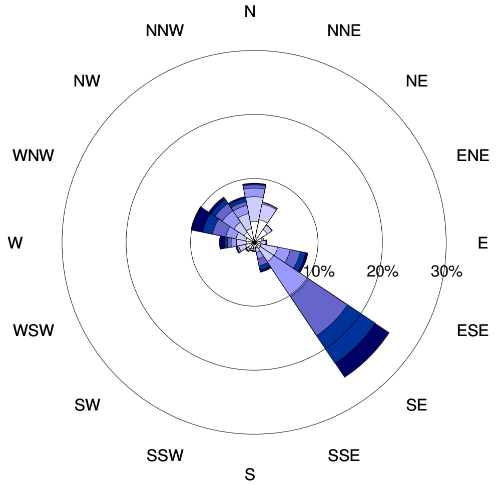
Land ownership and residential properties



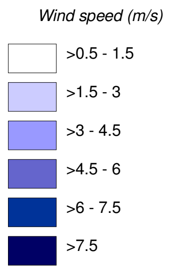
Meteorological and ambient air quality monitoring sites

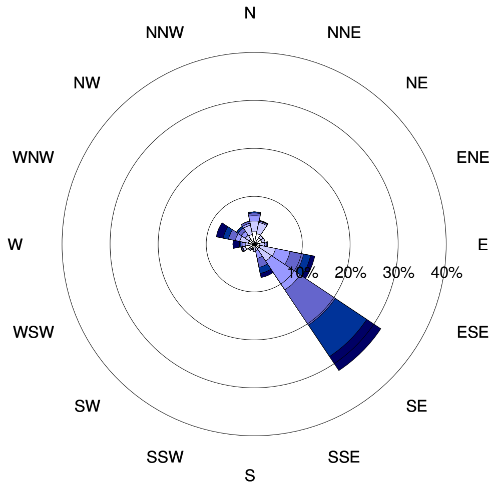
FIGURE 4

Annual and seasonal windroses for MAN (Maquarie Generation data - 1995/1996)

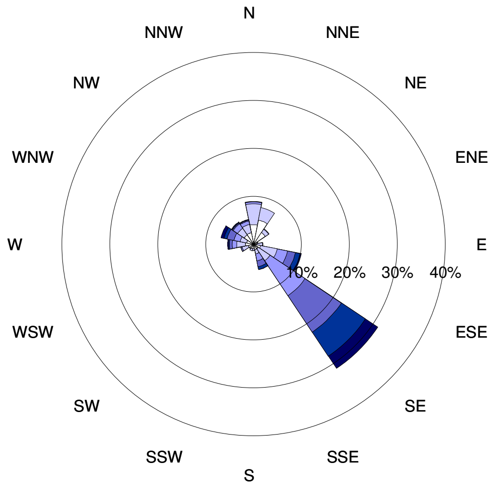


Annual
Calms = 0.0%

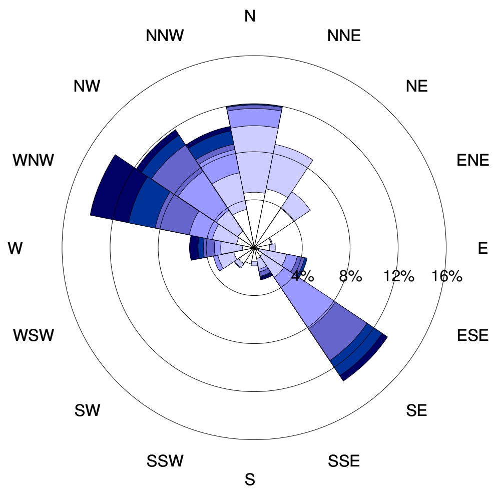




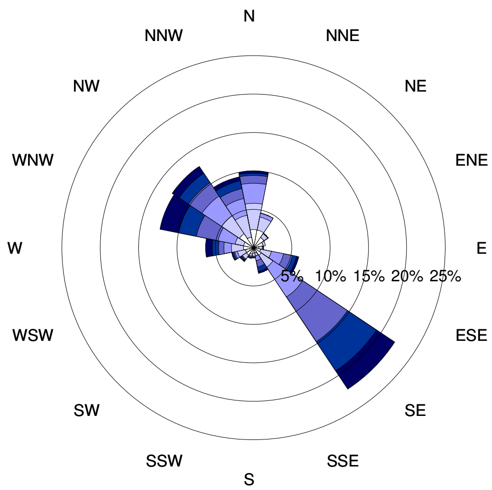
Summer
Calms = 0.0%



Autumn
Calms = 0.0%



Winter
Calms = 0.0%



Spring
Calms = 0.0%

FIGURE 5

Annual and seasonal windroses for McLeans Hill (2004)

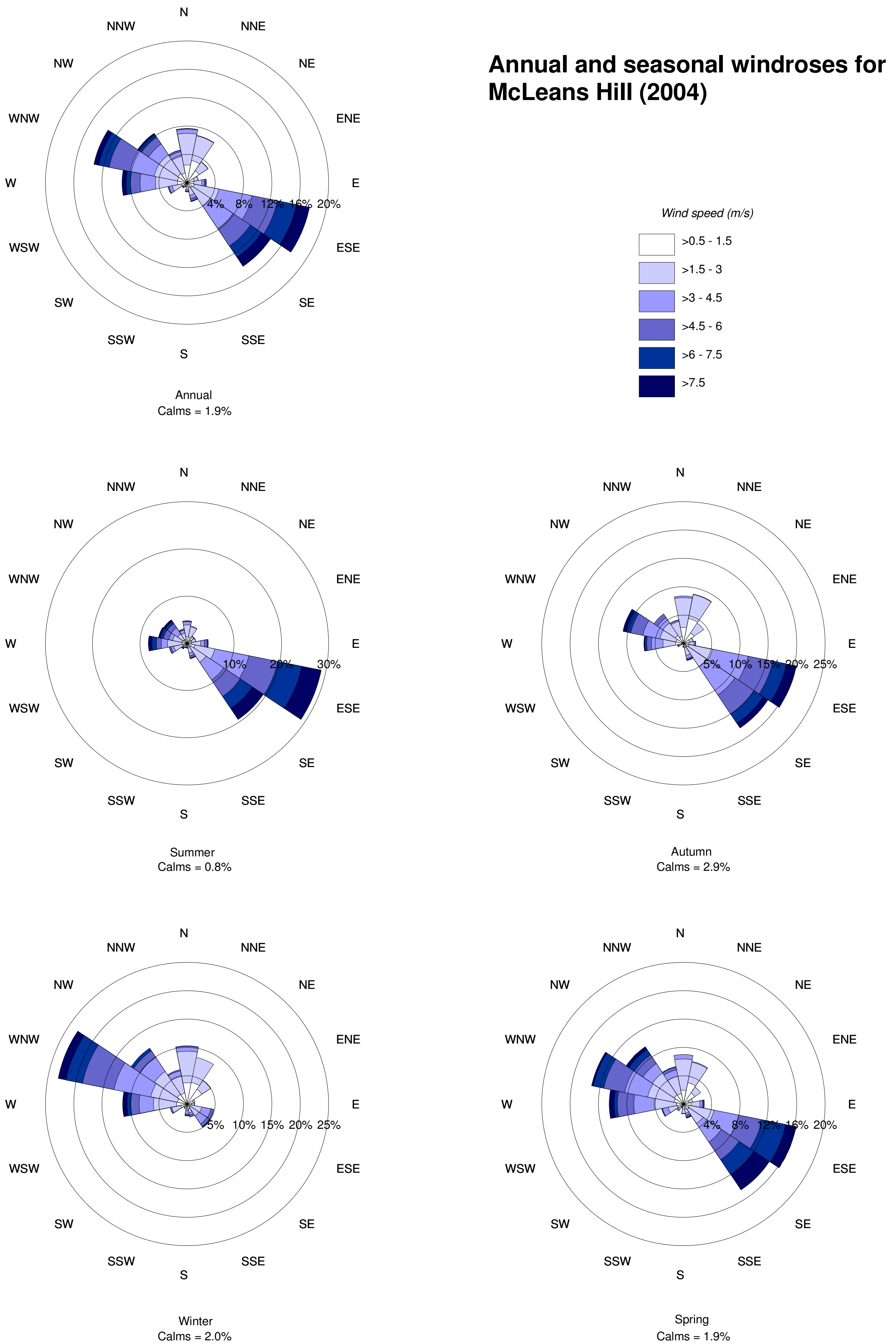
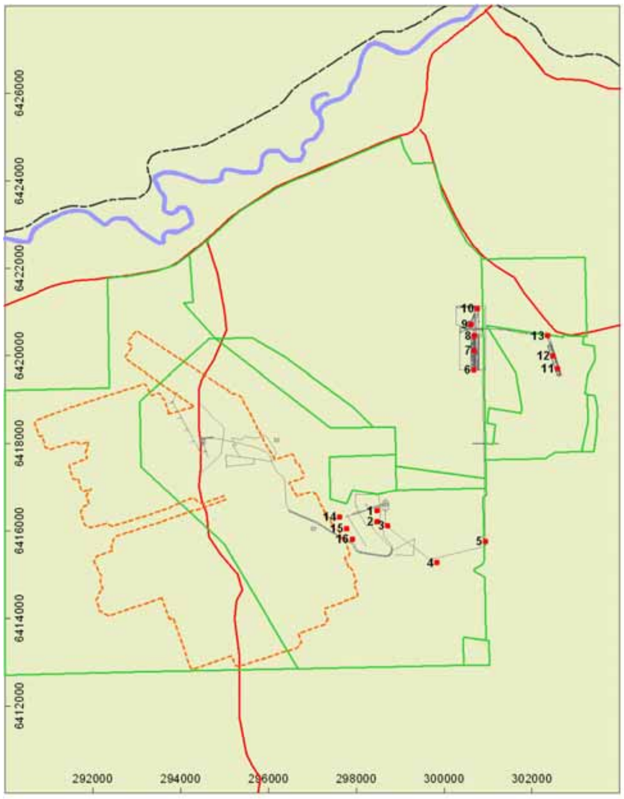
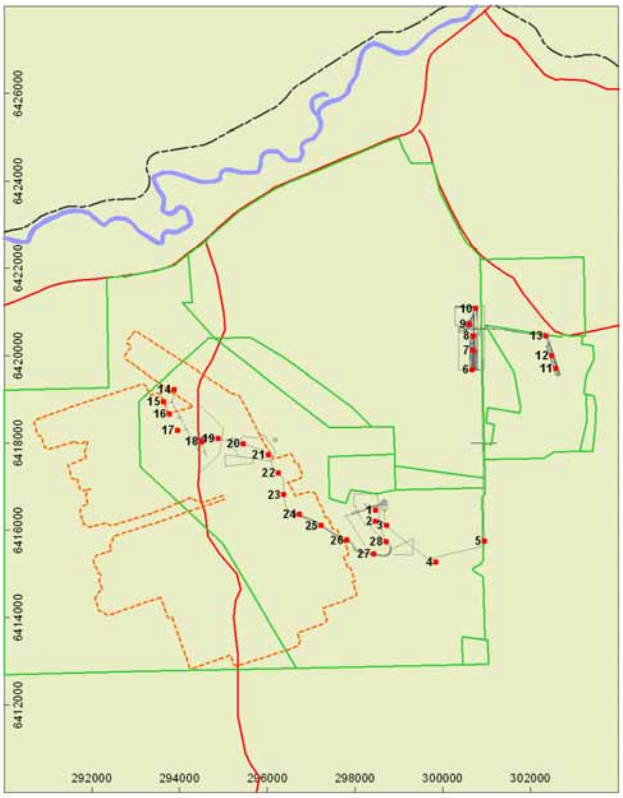


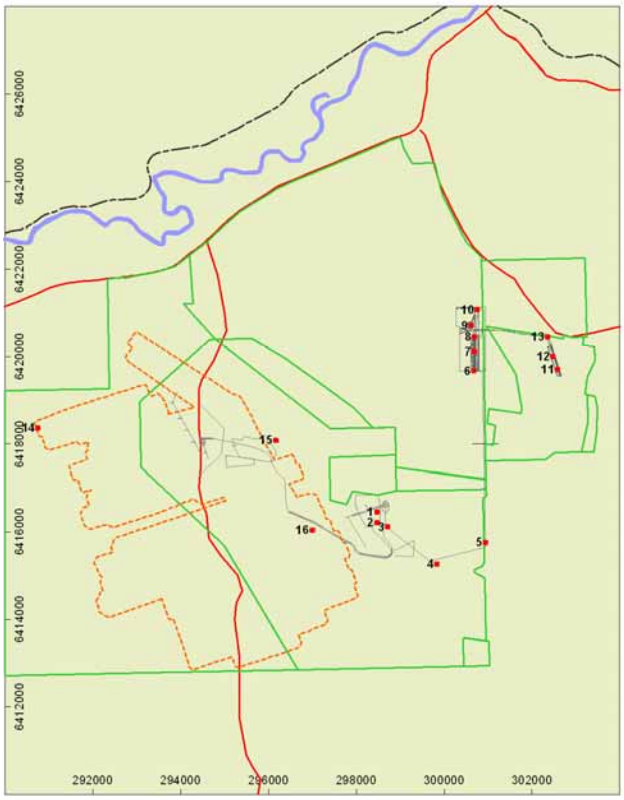
FIGURE 6



Year 5 - Woodlands Hill



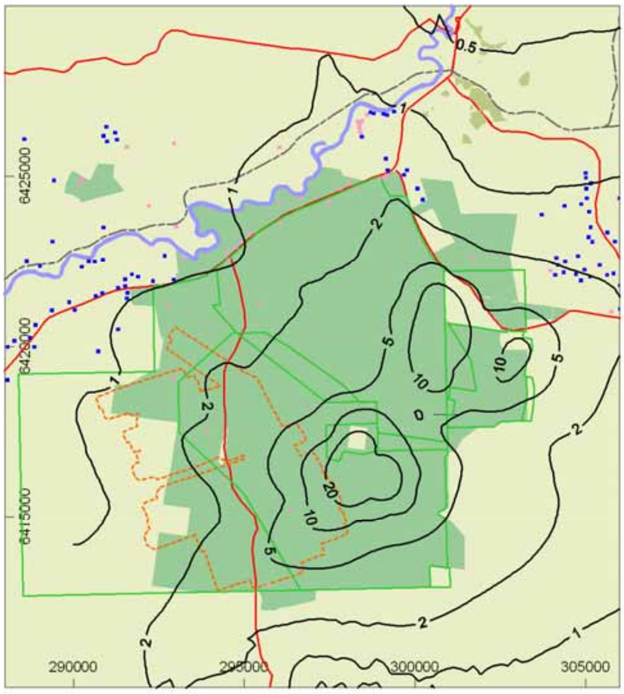
Year 10 - Glen Munro



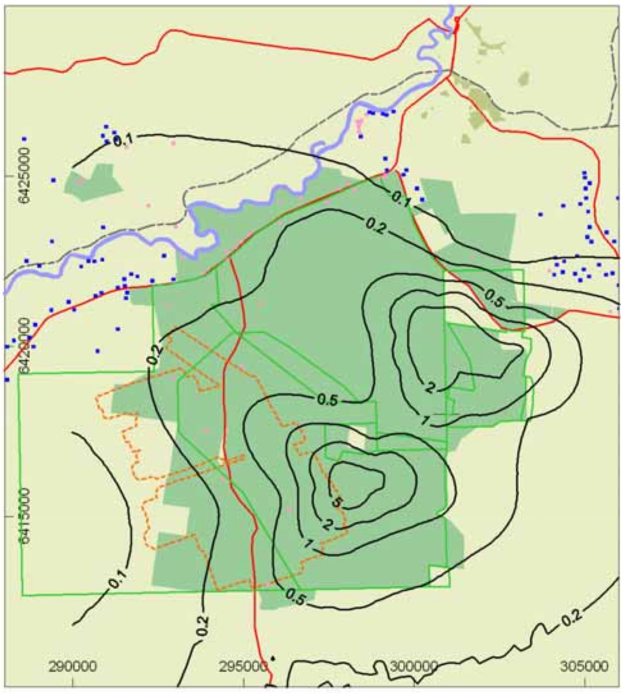
Year 15 - Arrowfield

1 *Modelled dust sources*

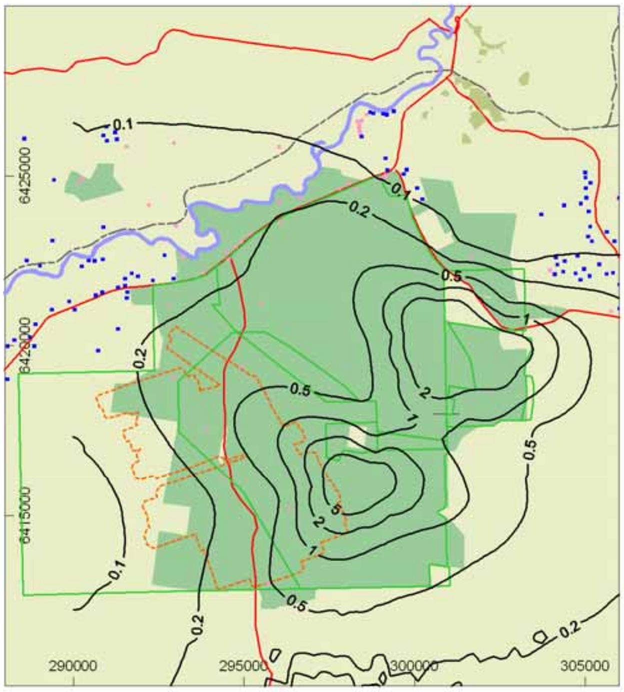
Modelled underground mining stages and dust source locations



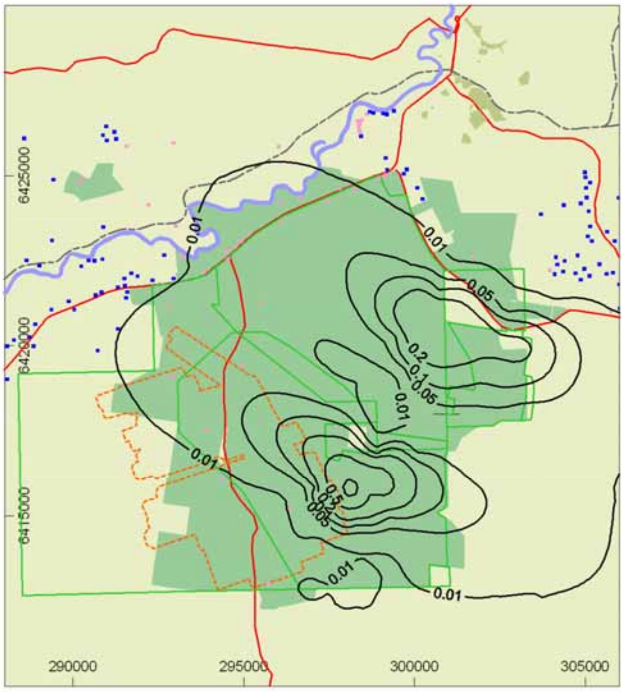
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



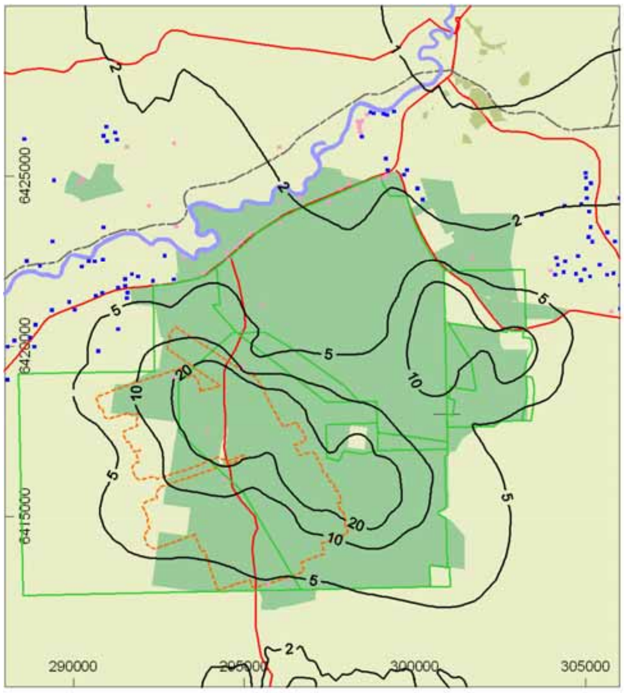
Annual average TSP - µg/m^3



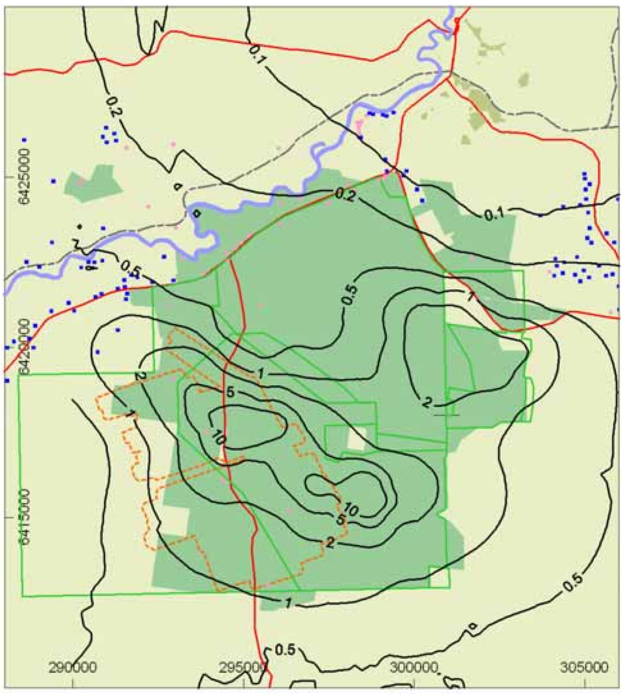
Annual average dust deposition - g/m^2/month

Mining lease boundaries
Underground mining area
Mt Arthur Coal land
Privately owned residence
Mine / power generator owned residence

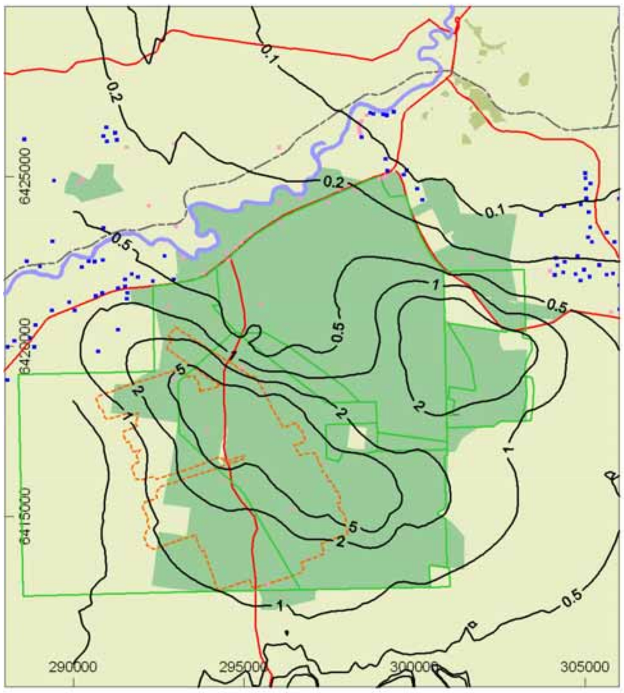
Dispersion model predictions for Underground Project Year 5 (Woodlands Hill)



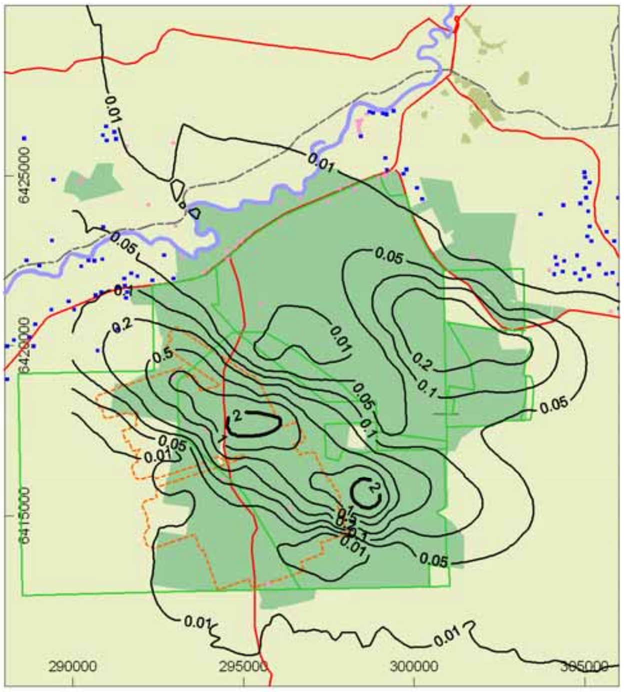
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



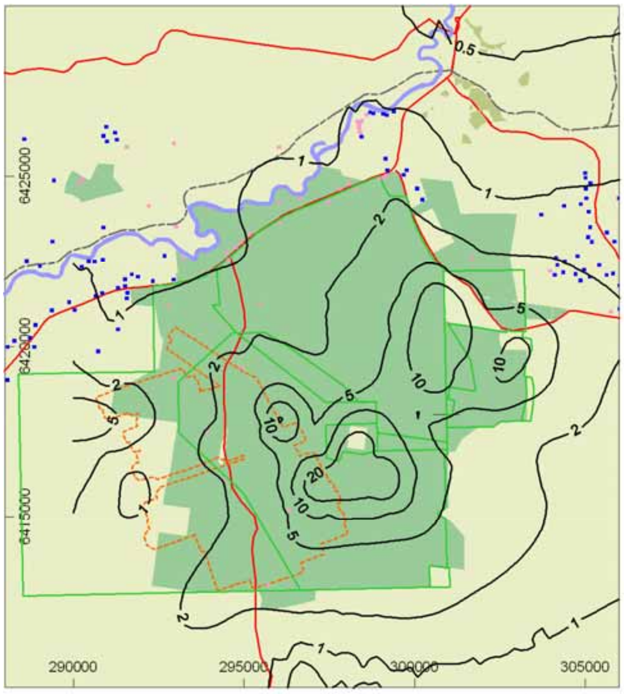
Annual average TSP - µg/m^3



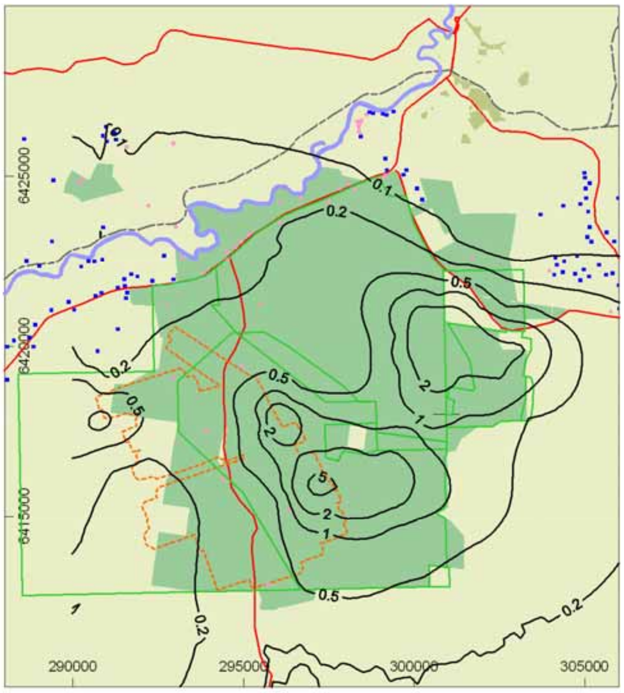
Annual average dust deposition - g/m^2/month

- Mining lease boundaries
- Underground mining area
- Mt Arthur Coal land
- Privately owned residence
- Mine / power generator owned residence

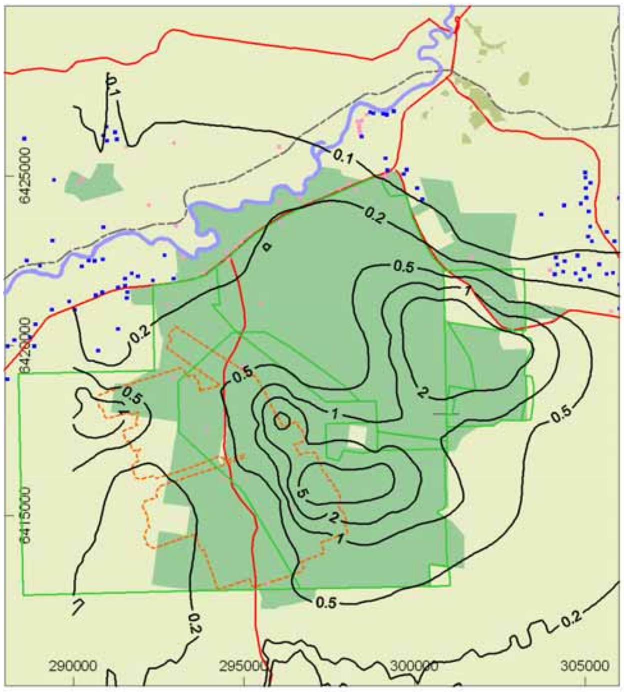
Dispersion model predictions for Underground Project Year 10 (Glen Munro)



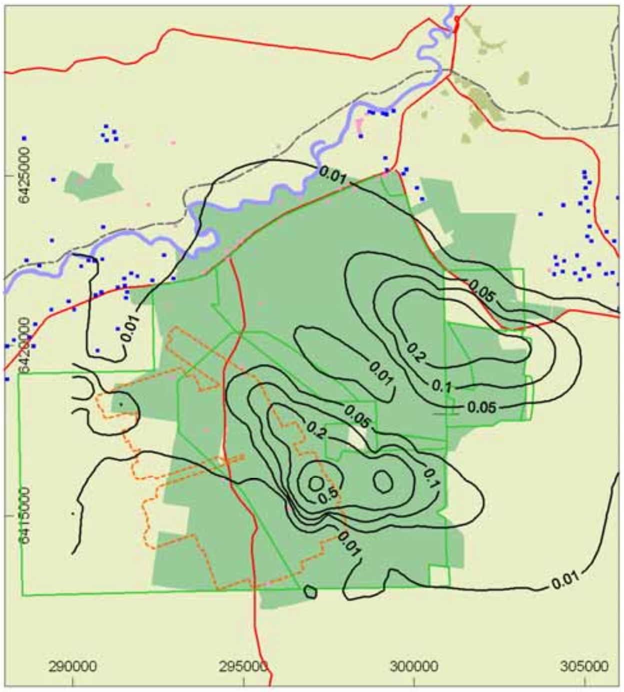
Maximum 24-hour average PM_{10} - µg/m^3



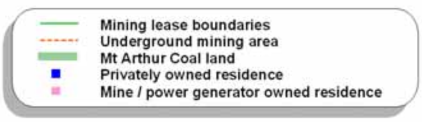
Annual average PM_{10} - µg/m^3



Annual average TSP - µg/m^3



Annual average dust deposition - g/m^2/month

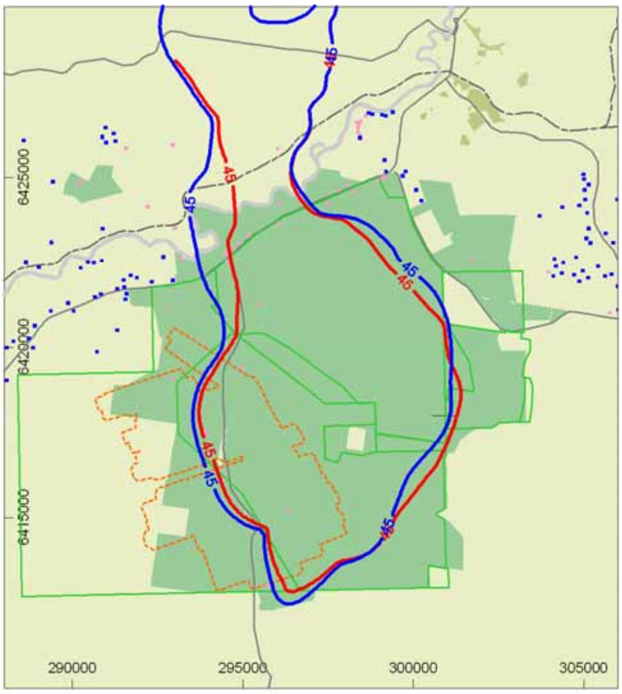


Dispersion model predictions for Underground Project Year 15 (Arrowfield)

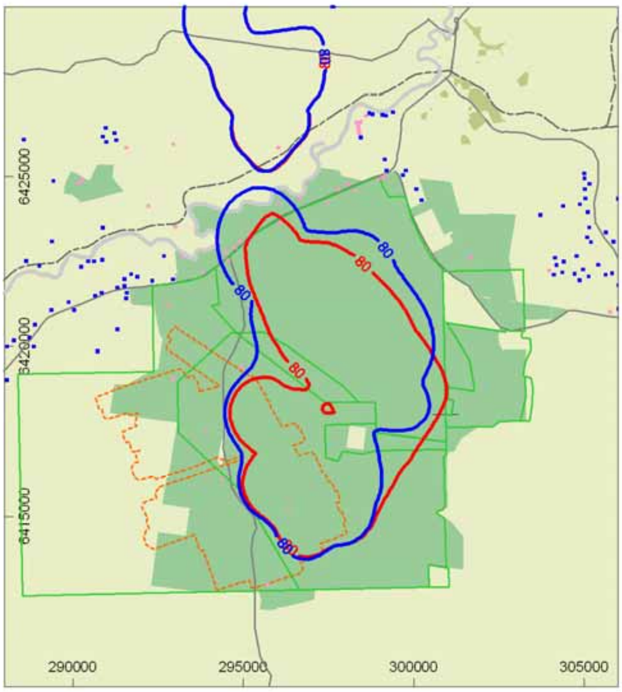
FIGURE 10

Comparison of MAN Year 10 EIS results with proposed Mt Arthur Coal operations, including Underground Project Year 5

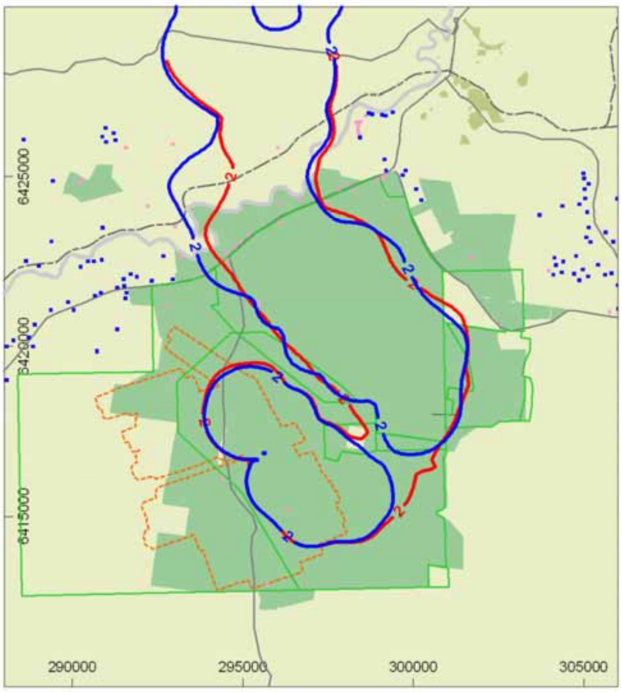
- Mining lease boundaries
- Underground mining area
- Mt Arthur Coal land
- Privately owned residence
- Mine / power generator owned residence
- Impact zone from MAN EIS (URS, 2000)
- New impact zone (includes MAN, SPE and Underground)



Annual average PM_{10} - µg/m^3



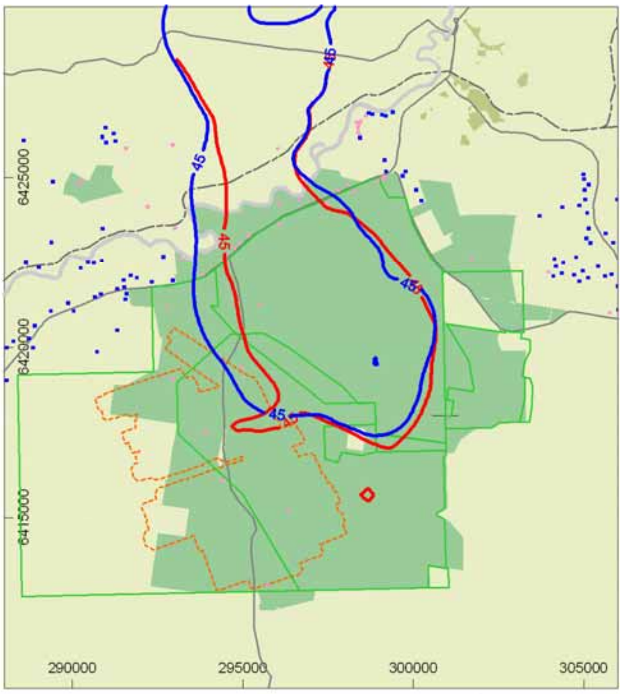
Annual average TSP - µg/m^3



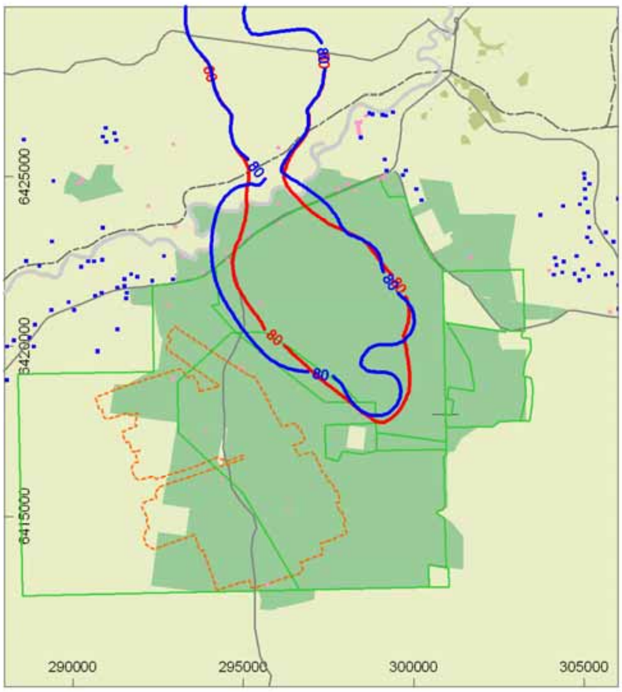
Annual average dust deposition - g/m^2/month

Comparison of MAN Year 15 EIS results with proposed Mt Arthur Coal operations, including Underground Project Year 10

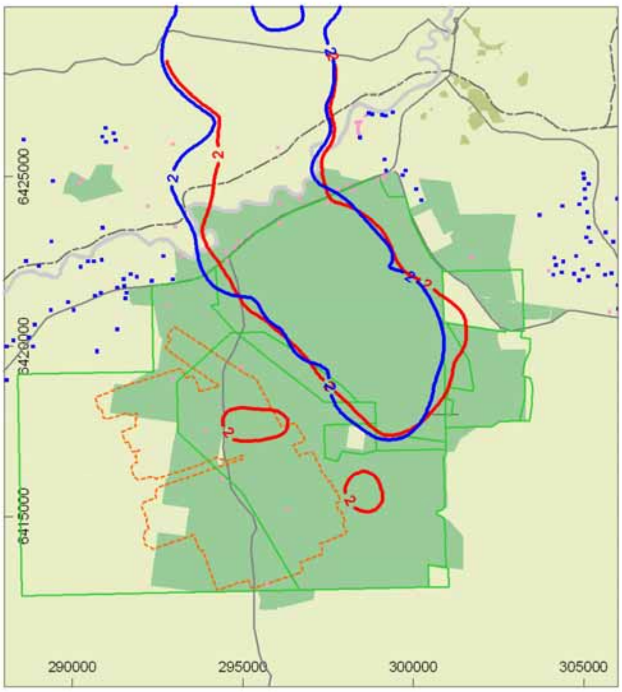
- Mining lease boundaries
- Underground mining area
- Mt Arthur Coal land
- Privately owned residence
- Mine / power generator owned residence
- Impact zone from MAN EIS (URS, 2000)
- New impact zone (includes MAN, SPE and Underground)



Annual average PM_{10} - µg/m^3



Annual average TSP - µg/m^3



Annual average dust deposition - g/m^2/month

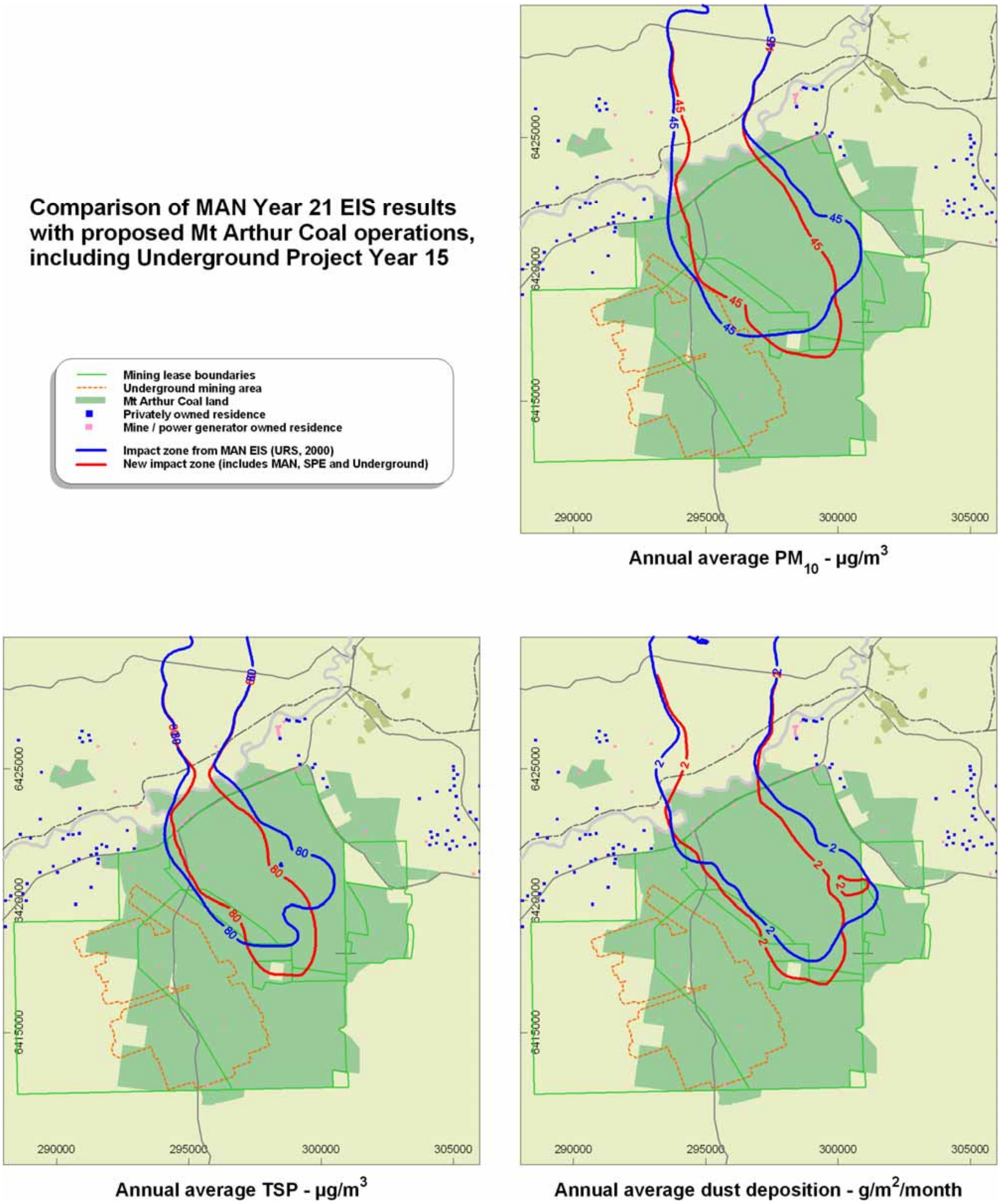

Comparison of MAN Year 21 EIS results
with proposed Mt Arthur Coal operations,
including Underground Project Year 15
Mining lease boundaries
Underground mining area
Mt Arthur Coal land
Privately owned residence
Mine / power generator owned residence
Impact zone from MAN EIS (URS, 2000)
New impact zone (includes MAN, SPE and Underground)
6425000
6420000
6415000
290000
295000
300000
305000
45
80
2
Annual average PM$_{10}$ - µg/m^3
Annual average TSP - µg/m^3
Annual average dust deposition - g/m^2/month

FIGURE 13