APPENDIX **F**
AIR QUALITY IMPACT ASSESSMENT

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AIR QUALITY IMPACT ASSESSMENT

MT ARTHUR COAL

Hansen Bailey on behalf of Hunter Valley Energy Coal Pty Ltd

Job No: 2787

28 August 2009

A PEL Company

PROJECT TITLE:	Mt Arthur Coal Consolidation Project
JOB NUMBER:	2787
PREPARED FOR:	James Bailey Hansen Bailey on behalf of Hunter Valley Energy Coal Pty Ltd
PREPARED BY:	Judith Cox
QA PROCEDURES CHECKED BY:	Nigel Holmes
APPROVED FOR RELEASE BY:	Nigel Holmes
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VERSION	**DATE**	**PREPARED BY**	**REVIEWED BY**
01	08.04.09	Judith Cox	Nigel Holmes
02	15.05.09	Judith Cox	Nigel Holmes

PAEHolmes a Division of Queensland Environment Pty Ltd
ABN 86 127 101 642

SYDNEY:
Suite 2B, 14 Glen Street
Eastwood NSW 2122
Ph: +61 2 9874 8644
Fax: +61 2 9874 8904

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

Email: info@paeholmes.com

Website: www.paeholmes.com

ES1 EXECUTIVE SUMMARY

Mt Arthur Coal is applying for a new Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to gain a single, contemporary planning approval for its open cut operations and the mining of additional areas within its current Mining Leases (ML) (the Project). The Project Application Boundary (EA Boundary) is shown on **Figure 2.1** and is consistent with the Project Approval area for the Mt Arthur Underground (MAU).

The Project continues all aspects of Mt Arthur Coals current activities and specifically, seeks approval for the following:

- Consolidation of all of Mt Arthur Coal's open cut mining related planning approvals into one contemporary Project Approval;
- Extension of the mine footprint to uncover additional coal reserves within the current MLs;
- Increasing the Mt Arthur Coal complex approved production levels by 8 Million tonnes per annum (Mtpa) up to 36 Mtpa run-of-mine coal. This will be achieved by;
  - Increasing open cut coal production by up to 8 Mtpa; and
  - Having the flexibility to increase either open cut or underground production by an additional 4 Mtpa if the maximum production from either underground or open cut methods is not being met (total to not exceed 36 Mtpa).
- Relocation of a section of Edderton Road in approximately 2019;
- Upgrading the existing Mt Arthur Coal Handling and Preparation Plant to wash up to 36 Mtpa of ROM coal and allow the inclusion of an ultra-fine coal circuit to re-process fines which will facilitate increased resource recovery and reduce water demand;
- Increasing the approved rail haulage capacity (in line with the increased coal production) from 19 Mtpa to 27 Mtpa, with the construction of a second rail loading facility and associated conveyor system;
- Modifications to existing infrastructure (such as workshop and bath house), construction of additional ROM coal hoppers and the extension of ROM and product coal stockpiles; and
- A total workforce of approximately 2,600 at peak production, which represents an increase of approximately 1,610 from current staffing levels and an estimated additional 720 positions directly attributable to the Project.

No changes to the mining method or hours of operation are proposed, although a gradual increase in the mobile equipment fleet will be required.

This report deals with air quality issues that will arise from this development and focuses on the following:

- The impacts likely to arise from emissions of dust from the proposed open cut and underground operations and the associated surface activities;
- The cumulative impacts likely to arise from emissions of dust from the Project considered in combination with emissions from nearby mining operations at Bengalla, Muswellbrook Coal Company and Drayton; and
- An assessment of the greenhouse gas emissions likely to arise from the Project.

Dust emissions inventories were developed for three stages of operations of the Project. These stages have been selected to represent the potential worst-case air quality impacts that the Project will have on different areas around the EA Boundary throughout its lifetime and enable a direct comparison with the predictions of the Mt Arthur North (MAN) EIS.

The emissions inventories developed for each of the stages have been used with local meteorological data and a modified version of the US EPA's ISCST3 model to predict the maximum 24-hour PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition (insoluble solids) over an area extending approximately 30 km (east-west) and 27 km (north-south). The modelling has been undertaken to show both the effects of the Project only and the cumulative effects of the Project with neighbouring mines and other sources of dust.

The assessment follows the Department of Environment and Climate Change (DECC) *'Approved Methods for the assessment of air pollution sources using dispersion models'*.

It is concluded that eight private residences, owned by five landowners, (Residences 206, 207, 208, 209, 210, 211, 212 and 226) will be impacted by dust levels exceeding the 24-hour average PM_{10} assessment criterion (at the 98.6th percentile, that is more than five days per year) of 50 µg/m^3. Six private residences and landowners (Residences 9, 28, 29, 210, 212 and 264) and one recreational receptor (10) will be impacted by dust levels exceeding the annual average PM_{10} assessment criterion of 30 μg/m^3 for the Project and other sources. No private residences will be impacted by dust levels exceeding the TSP assessment criterion of 90 µg/m^3 for the Project and other sources. Five private residences, owned by three landowners, (Residences 208, 209, 210, 211, and 212) will be impacted by dust levels exceeding the annual average 2 g/m^2/month (insoluble solids) deposition level assessment criteria from the Project alone. One private residence (Residence 212) will be impacted by dust levels exceeding the annual average 4 g/m^2/month (insoluble solids) deposition level assessment criteria from the Project and other sources.

It should be noted that Residence 9 is located in the existing Zone of Affection (ZOA) for Mt Arthur Coal, Residence 212 is located in the existing Bengalla ZOA, and that 'Residence' 10 is Muswellbrook Race Club Limited, and therefore not strictly a residence.

In summary, ten private residences, owned by seven landowners (not within an existing zone of affectation) are anticipated to be impacted by dust levels exceeding the relevant criteria.

Construction activities associated with the Project will have negligible emissions.

Spontaneous combustion events will continue to be managed and monitored to ensure minimal impact.

The CO_2 emissions released during the mining operations are small compared to the CO_2 emissions released during the combustion of the coal proposed for extraction. Mt Arthur Coal is committed to reviewing and monitoring Greenhouse Gas emissions and the activities that lead to GHG emissions, to ensure that these emissions are kept to the minimum practicable level and will attempt to keep the ratio of greenhouse gas emissions per tonne of coal produced as low as possible.

Based on scientific literature, and sampling undertaken at existing operations, it is unlikely that there will be any issues from blasting emissions.

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1 BACKGROUND

Hunter Valley Energy Coal Pty Ltd (HVEC), a wholly owned subsidiary of BHP Billiton operates the Mt Arthur Coal Complex (Mt Arthur Coal) which includes combined operations of the Mt Arthur North Mine, the Bayswater No. 2 Mine, Bayswater No. 3 Mine, South Pit Extension and the Mt Arthur Underground (MAU) Project. The Mt Arthur Coal Complex is located south west of Muswellbrook, off Thomas Mitchell Drive in the Muswellbrook Shire Council (MSC) Local Government Area (LGA) in the Upper Hunter Valley of NSW.

2 EXISTING OPERATIONS

The currently approved Mt Arthur Coal complex consists of the following mining areas (see **Figure 2.1**):

- Bayswater No. 2 open cut pit (extraction completed);
- Bayswater No. 3 open cut pit (operated since 1995);
- MAN open cut pit (operated since 2001);
- South Pit Extension open cut pit (approved in 2008 – extends the MAN South Pit 2.5 km south);
- Exploration Adit (commenced operations in 2007); and
- MAU Project approved in 2008.

Mt Arthur Coal currently has approval to produce up to 28 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal from the combined complex, of which 8 Mtpa is from underground mining methods.

Coal production from the MAN mining area has been the focus of Mt Arthur Coal's operations since 2002. Open cut coal mining is conducted via shovel and excavator. In 2008, coal was mined from the Glen Munro seam to the Ramrod Creek seam within the Wittingham coal measures. Open cut mining methods at Mt Arthur Coal allow the full recovery of all coal down to the Ramrod Creek seam.

Coal preparation, handling and loading is undertaken at the centralised Mt Arthur Coal, Coal Handling and Preparation Plant (CHPP), which is strategically located in a valley to minimise environmental impacts. Export coal is loaded onto trains via the Rail Loading Facility whilst domestic coal is transported via conveyor directly to Macquarie Generation's Bayswater Power Station.

Figure 2.1: Site Location

3 THE PROJECT

Mt Arthur Coal is applying to the Minister for Planning for a new Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to gain a single, contemporary planning approval for its open cut operations and the mining of additional areas within its current Mining Leases (ML) (the Project). The Project Application Boundary (EA Boundary) is shown on **Figure 2.1** and is consistent with the Project Approval area for the MAU.

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No changes to the mining method or hours of operation are proposed, although a gradual increase in the mobile equipment fleet will be required.

Air quality impacts have been assessed at the properties identified on **Figure 3.1** and **Figure 3.2**. Locations of sensitive receptors (i.e. residences) are identified as a blue dot. Note that there are currently no residences located on the properties identified on **Figure 3.2**.

Appendix A presents details of land ownership, the number of residences on each property, and those residences already located in the Zone of Affection (ZOA) for Mt Arthur Coal or other nearby coal mines.

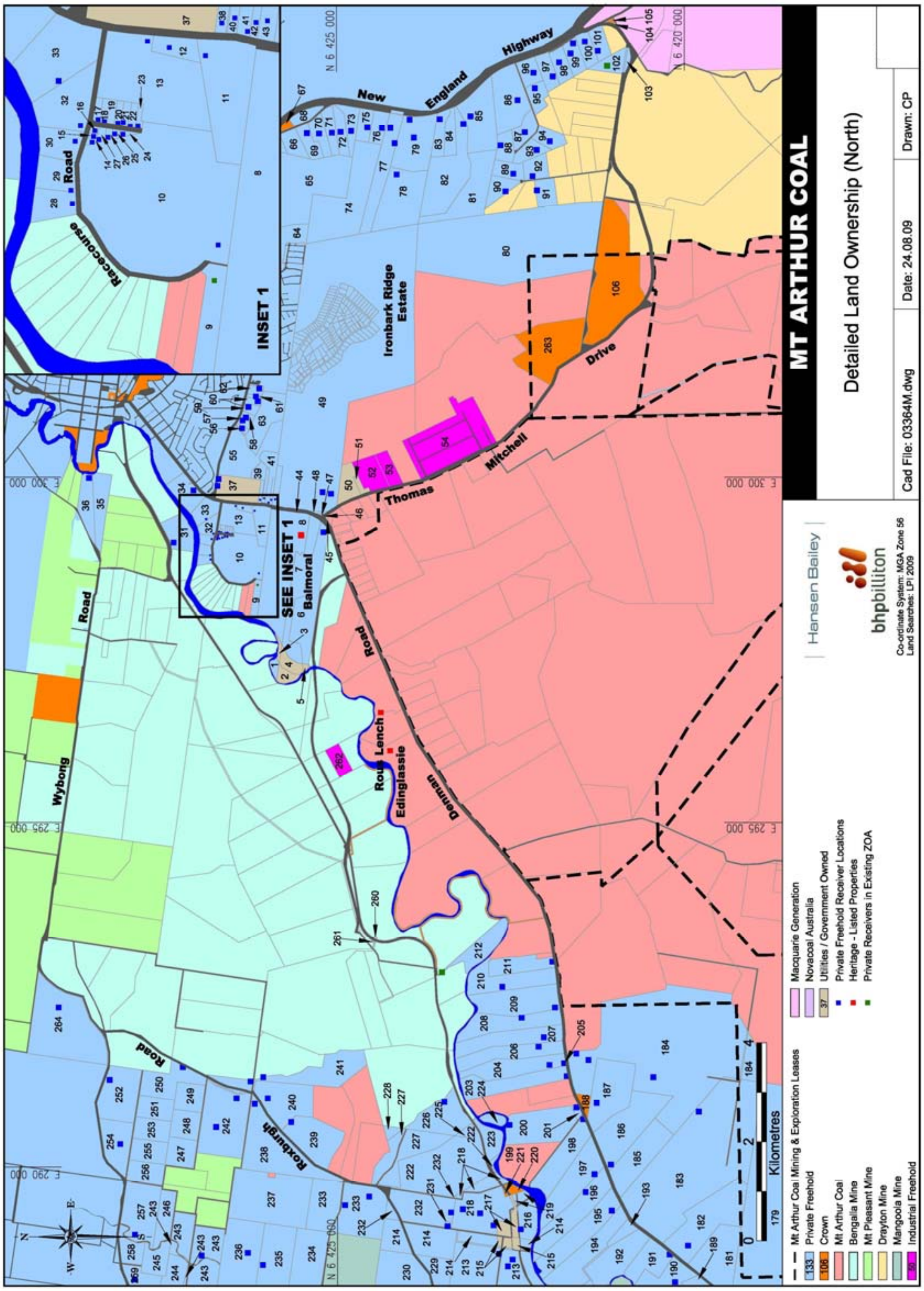


Figure 3.1: Land ownership and residence locations north

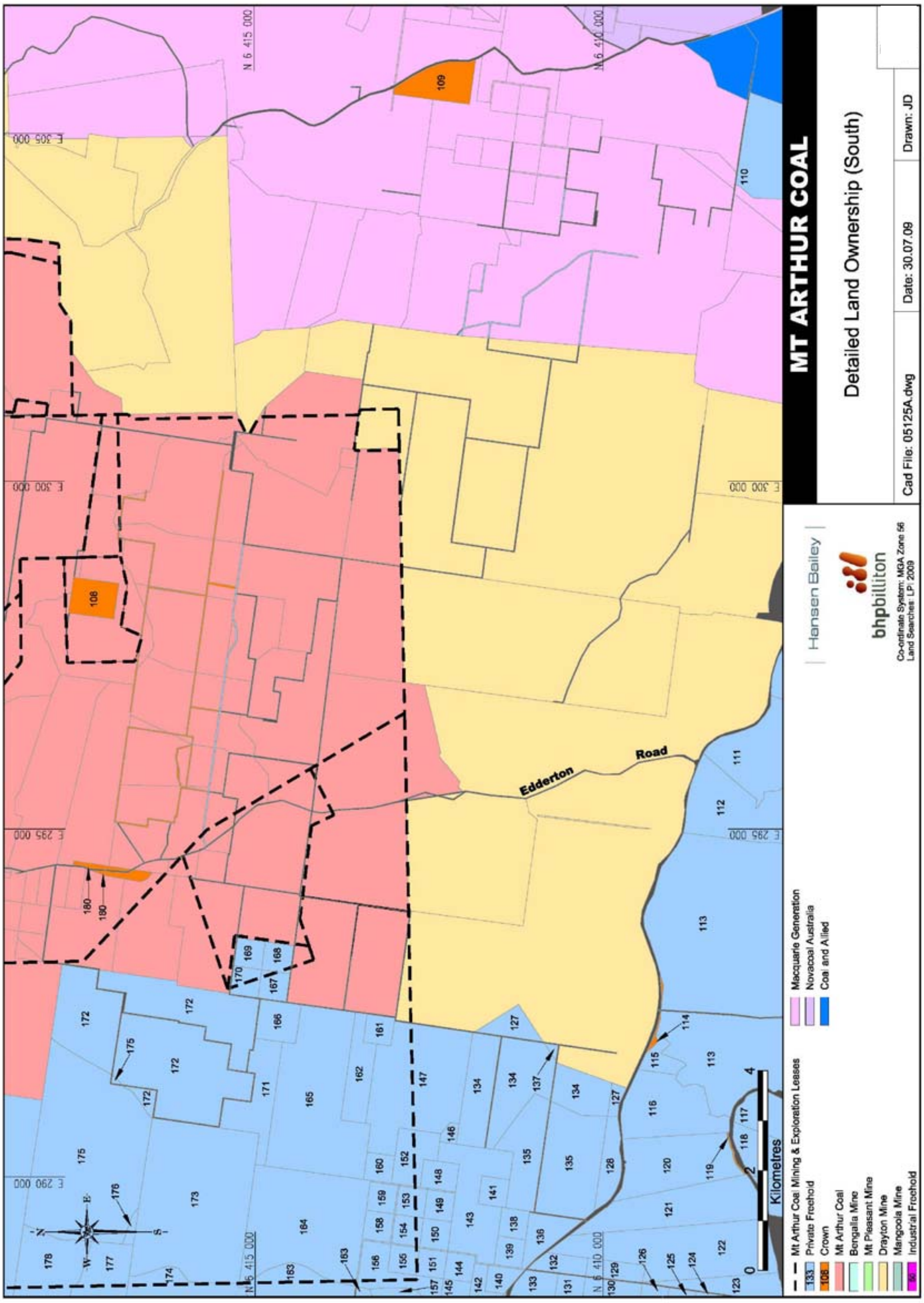


Figure 3.2: Land ownership south

4 AIR QUALITY CRITERIA

In its modelling and assessment guidelines, New South Wales Department of Environment and Climate Change (NSW DECC) specifies air quality assessment criteria relevant for assessing impacts from mining (**NSW DECC, 2005**). The assessment criteria are summarised in **Table 4.1**, **Table 4.2** and **Table 4.3**.

These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPMs (**NEPC, 1998**). However, the NSW DECC's criteria include averaging periods which are not included in the Ambient Air-NEPMs and references other, non-NEPM, measures of air quality, namely total suspended particulate matter (TSP) (see **Table 4.2**) and the insoluble component of deposited dust (see **Table 4.3**).

Table 4.1: NSW DECC Impact Assessment Criteria

Pollutant	Averaging period	Concentration: Parts per hundred million (pphm)	Concentration: µg/m³
Particulate Matter less than 10 micrograms (PM_{10})	1-day	-	50*
	Annual	-	30
Sulphur Dioxide (SO_2)	10 minutes	25	712
	1-hour	20	570
	1-day	8	228
	1-year	2	60
Nitrogen Dioxide (NO_2)	1-hour	12	246
	1-year	3	62
		Parts per million (ppm)	**mg/m³**
Carbon Dioxide (CO)	15 minutes	87	100
	1-hour	25	30
	8-hours	9	10

* Non-cumulative for purposes of impact assessment

Table 4.2: NSW DECC Assessment Criteria for TSP

Pollutant	Averaging period	Concentration
TSP	Annual	90 µg/m³

Table 4.3: NSW DECC Amenity Based Criteria for Dust Fallout

Pollutant	Averaging period	Maximum increase in deposited dust	Maximum allowable dust deposition
Deposited dust (insoluble)	Annual	2 g/m²/month	4 g/m²/month

In May 2003, NEPC released a variation to the NEPM (**NEPC, 2003**) to include advisory reporting standards for $PM_{2.5}$. The advisory reporting standards for $PM_{2.5}$ are a maximum 24-hour average of 25 µg/m³ and an annual average of 8 µg/m³. However, there is no time line for compliance. The aim of $PM_{2.5}$ NEPM was to gather sufficient data nationally to facilitate the review of the Ambient Air NEPM which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for particles as $PM_{2.5}$.

At this stage, the advisory reporting $PM_{2.5}$ standards are not part of the NSW DECC assessment criteria and while predictions have been made in this report as to the likely contribution that emissions from the Project will make to ambient $PM_{2.5}$ concentrations, these predictions have not been used to assess impacts against the proposed advisory standard. Predictions of $PM_{2.5}$ concentrations are provided in **Appendix B**.

The low sulphur content of Australian diesel, in combination with the fact that mining equipment is widely dispersed over mine sites, ensures that the sulphur dioxide (SO_2) goals will not be exceeded off-site, even in mining operations that use large quantities of diesel. For this reason, no detailed study is required to demonstrate that emissions of SO_2 from the Project will not significantly affect ambient SO_2 concentrations. Similarly, NO_x and CO emissions from the Project activities are too small and too widely dispersed to require a detailed modelling assessment.

Thus, the focus of the study is on the potential effects of particulate matter emissions.

5 EXISTING AIR QUALITY

5.1 Introduction

Air quality standards and goals refer to pollutant levels that include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality standards and goals (see **Section 4**) 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. It is important to note that the existing air quality conditions (that is, background conditions) will be influenced to some degree by the existing mining operations at Mt Arthur Coal and elsewhere.

Dust deposition and dust concentration (PM_{10}) is monitored in the vicinity of Mt Arthur operations. The locations of the monitoring sites are shown in **Figure 5.1**. There are eight high volume air samplers (HVAS) measuring 24-hour average concentrations of PM_{10} every sixth day and 21 dust deposition gauges (DDG) measuring the monthly average of deposited dust.

There are also four Tapered Element Oscillating Microbalances (TEOMs) continuously monitoring PM_{10} concentrations. However, these have only been operational since the end of 2008, and as such, there are insufficient data from which to determine any trends in the data. The TEOMs replaced GRIMMS which were continuously monitoring PM_{10} concentrations at the same locations. GRIMMs are useful to assist in the day-to-day management of the mine, however, the data are not suitable for assessment purposes and therefore the data have not been assessed.

The following sections discuss the dust deposition and PM_{10} HVAS monitoring results for the period 2002 to 2008.

5.2 PM_{10} concentrations

Figure 5.1 shows the locations of the HVAS's used to monitor PM_{10} concentrations. The HVAS's record 24-hour average concentrations every sixth day and these results are presented in **Figure 5.2**. From these time series data it can be seen that, generally, the PM_{10} concentrations in the area are lowest in the cooler, winter months when the prevailing winds are from the north-west, and highest in the warmer, summer months when the prevailing winds are most likely to be from the south-east.

The time series data also show that there are, at times, exceedances of the DECC's 24-hour PM_{10} ambient air quality goal of 50 µg/m^3 at all sites. However, a number of these exceedances are caused by widespread dust events. For example, on the 29th October 2003, a state wide dust storm was reported which coincided with a PM_{10} measurement day. It can be seen in **Figure 5.2** that all sites recorded levels above 50 µg/m^3 on that day. There are other occasions where the measured PM_{10} levels exceed 50 µg/m^3 at a number of different gauges at the same time. This would seem to indicate a widespread wind or bushfire event rather than a more localised source.

An analysis of winds in previous annual reports for the Mt Arthur Coal monitoring program has shown that higher 24-hour concentrations at Sheppard Avenue (Racecourse Road area) are generally recorded on days when winds are not blowing from the direction of the Mt Arthur Coal.

A summary of annual average PM_{10} data collected are presented in **Table 5.1** for the period 2002 to 2008. Two sites, South Muswellbrook and Sheppard Avenue, had less than six months of data available for early years, as these gauges had not yet been commissioned. No further investigation of PM_{10} concentrations has been carried out for the corresponding site in those years.

The results in **Table 5.1** show that all sites complied with the DECC's goal of 30 µg/m^3 from 2002 to 2008. Measurements were highest at the Sheppard Avenue and South Muswellbrook Sites, but still remain below the goal.

Table 5.1: Annual average PM_{10} concentration at each monitoring site (µg/m^3)

Station ID	Monitoring location	2002	2003	2004	2005	2006	2007	2008	Average
DF01	Roxburgh South	9.2	16.8	17.3	15.8	16.9	17.7	18.4	16.0
DF02	Windmill	20.2	19	18.7	16.5	15.8	16	13.5	17.1
DF03	Edderton	19.8	17.1	14.6	13.5	16.9	16.7	14.5	16.2
DF04	Wire Lane	24.9	23.7	23.1	19.7	18.2	22	20.3	21.7
DF05	Constable	23.6	21.3	19	16.6	17.5	17.4	16.3	18.8
DF06	Sheppard Ave	ND	*	27.6	21.8	27.3	27.4	21.4	25.1
DF07	South Muswellbrook	*	25.3	28.4	22.4	22.3	23.2	21	23.8
DF08	Denman Rd West	20.9	19.4	18	19.2	18.3	19.7	20.5	19.4

Notes:
ND – no data
* - less than six months data available

5.3 Dust Deposition

Figure 5.1 shows the locations of the 21 dust deposition gauges analysed in this assessment. The monthly data are presented in **Appendix C**, with the annual averages summarised in **Table 5.2**.

Table 5.2: Annual average Dust deposition data (insoluble solids) – 2003 to 2008 (g/m²/month)

Gauge	2003	2004	2005	2006	2007	2008	Average
DD1	3.4	2.2	2.2	2.8	2.3	2.1	2.5
DD2	**4.3**	3.7	*	**4.3**	*	*	4.1
DD3	3.7	2.6	3.2	3.6	3.9	3.0	3.4
DD4	1.8	1.7	1.7	1.9	1.8	1.8	1.8
DD5	2.7	3.1	3.0	2.2	2.8	2.2	2.6
DD6	2.1	1.2	1.8	1.6	3.1	1.9	2.0
DD7	3.1	*	1.8	2.2	1.2	1.3	1.9
DD8	1.0	1.2	1.3	1.2	1.1	1.8	1.3
DD9	1.6	1.3	1.1	1.0	1.1	1.1	1.2
DD10	1.8	1.9	1.9	2.1	2.2	1.9	2.0
DD11	3.1	*	*	3.5	2.9	2.2	2.9
DD12	2.8	1.9	2.1	2.7	2.1	1.9	2.3
DD13	1.7	1.8	1.4	1.6	1.5	1.4	1.6
DD14	1.4	1.2	1.0	1.1	0.9	1.1	1.1
DD15	1.9	1.9	2.4	2.4	2.5	1.8	2.2
DD16	**4.2**	3.7	3.3	**4.3**	3.1	3.3	3.7
DD17	3.5	**4.1**	2.3	2.3	2.2	2.1	2.8
DD18	2.7	2.6	2.1	3.0	3.2	2.0	2.6
DD19	2.7	2.4	2.3	2.7	2.5	2.2	2.5
DD20	2.9	2.3	3.4	3.6	2.9	3.0	3.0
DD21	2.1	2.2	2.1	2.8	1.8	1.9	2.2

** Less than 6 months of valid data available*
Figures in bold indicate concentrations above criteria

It is clear from the monitoring results presented in **Table 5.2**, that there are some sites which have previously exceeded the 4 g/m²/month (annual average) DECC criterion. These are sites DD2, DD16 and DD17. Site DD16 lies immediately to the north-west of the Mt Arthur Coal ML, across Denman Road on land owned by Mt Arthur Coal, and could potentially be affected by winds from the southeast blowing across the exposed mining areas. If this was the case you might expect to see elevated levels in the summer months when these winds predominate, such as occurred in 2004. However, there are also high levels measured in the winter months in other years, indicating other sources as well. DD16 is located between the Bengalla and Mt Arthur Coal operations and may therefore be expected to show higher levels than other gauges. DD17 recorded on result marginally above the criteria in 2004. Since that time, recorded dust deposition levels have decreased.

Measurements at deposition gauges are heavily influenced by local dust producing activities, and this can be seen in the large variation in levels over small distances. For example, DD1 has reported levels below 4 g/m²/month for the entire monitoring period while DD2, which is approximately 800 m south of DD1, exceeds this level in most years. It should be noted that DD2 is often contaminated. If the Mt Arthur Coal mining activities were the dominant source of dust for these gauges you would expect to see very similar results. It is therefore likely that there are local sources or contamination contributing to the observed levels. This is also the case for DD10 and DD11 which lie close to each other and in the same direction from the mine, but which show very different levels of deposition.

The gauges which consistently show the lowest deposition levels are those well away from the mining area to the south, DD6, DD7, DD8 and DD9. An exception to this rule however is DD10 which lies very close to the Mt Arthur Coal activities but has shown levels of less than 2.5 g/m²/month since 2002. It should be noted however, that winds from the NE which would bring material from Mt Arthur Coal, do not occur very often at this location.

Species: PM_{10}	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 30 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 5.1: Location of Mt Arthur Coal Mine monitoring sites

Figure 5.2: HVAS 24-hr average PM_{10} concentrations

6 METEOROLOGICAL DATA

6.1 Wind speed and direction

Meteorological data, consisting of wind speed, wind direction, the standard deviation of wind direction (sigma-theta) and temperature are required as inputs to the dispersion modelling. Data are collected at 10-minute intervals from the Macleans Hill meteorological station (see **Figure 5.1** for location). For the period April 2007 to March 2008 there are a total of 8,688 hours of data available. This corresponds to 98.9% of the data potentially available in a year.

Hourly average data collected over the period 2007/2008 were used to create annual and seasonal wind roses which are presented in **Figure 6.1**. The wind roses show that in summer, the wind is predominantly from the east-southeast, while in winter, the wind is predominantly from the west-northwest. Autumn and spring months experience a combination of these wind conditions.

Table 6.1 shows the frequency of occurrence of the different stability[1] categories expected in the area. Mixing height[2] was determined using a scheme defined by **Powell (1976)** for day time conditions and an approach described by **Venkatram (1980)** for night time conditions.

Table 6.1: Frequency of occurrence of stability classes in the study area

Stability Class	Percentage Frequency
A	7.6
B	4.1
C	9.6
D	55.3
E	17.0
F	6.4
Total	100

Joint wind speed, wind direction and stability class frequency tables are presented in **Appendix D**.

[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 those which 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.

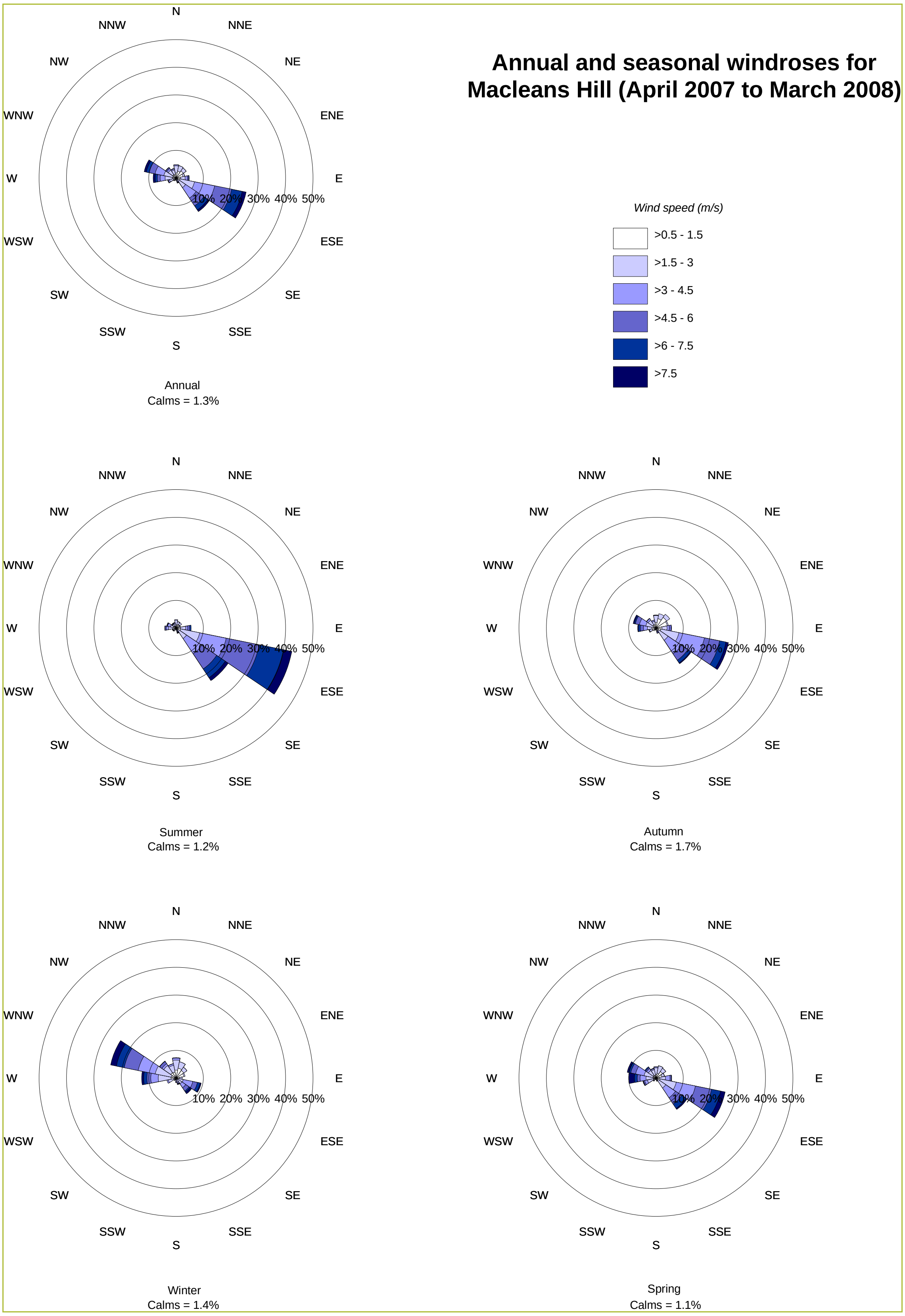


Figure 6.1: Annual and seasonal windroses for Macleans Hill (April 2007 to May 2008)

6.2 Temperature, humidity and rainfall

There are two Bureau of Meteorology monitoring stations located near Mt Arthur Coal, Scone Airport (Station number 061363) and Scone Soil Conservation Service (SCS) (Station Number 061089). These sites provide information on the long-term average values of climatic elements such as temperature, humidity, rainfall, the number of raindays per year etc. The station at Scone Airport has been in operation since 1988 whilst the station at Scone SCS has been in operation since 1950.

Table 6.2 and **Table 6.3** present temperature, humidity and rainfall data collected at Scone Airport and Scone SCS, respectively (**Bureau of Meteorology, 2009**). Temperature and humidity data consist of monthly means of 9am and 3pm 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 raindays per month.

The annual mean maximum and minimum temperatures experienced at Scone Airport are 24.1°C and 10.0°C respectively. On average January is the hottest month with an average maximum temperature of 31.1°C. July is the coldest month, with average minimum temperature of 3.4°C.

At Scone SCS, the annual mean maximum and minimum temperatures experienced are 24.0°C and 11.0°C respectively. On average January is the hottest month with an average maximum temperature of 30.9°C. July is the coldest month, with average minimum temperature of 4.7°C.

The annual mean relative humidity reading collected at 9am at Scone Airport is 74 percent, and at 3pm the annual mean is 47 percent. The month with the highest humidity on average is June with a 9am average of 86 percent, and the lowest is January with a 3pm average of 41 percent.

At Scone SCS, the annual average relative humidity reading collected at 9am is 69 percent, and at 3pm the annual average is 47 percent. The month with the highest humidity on average is June with a 9am average of 78 percent, and the lowest is November with a 3pm average of 41 percent.

Rainfall data collected at Scone Airport shows that December is the wettest month, with a mean rainfall of 80.1 mm over 9.3 days. The mean annual rainfall is 607.8 mm with a mean of 108.4 raindays.

At Scone SCS, the rainfall data shows that January is the wettest month, with a mean rainfall of 86.7 mm over 8.4 days. The mean annual rainfall is 647.8 mm with a mean of 93.5 raindays.

Table 6.2: Temperature, Humidity and Rainfall Data for Scone Airport

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9am Mean Dry-bulb and Wet-bulb Temperatures (ºC) and Relative Humidity (%)													
Dry-bulb	22.2	21.2	19.1	17.0	13.1	10.0	9.4	11.3	15.2	18.5	19.5	21.5	22.2
Wet-bulb	18.3	18.6	16.9	14.7	11.3	8.9	7.8	9.3	11.9	14.4	15.8	17.6	18.3
Humidity	70	77	82	76	80	86	83	74	67	62	67	67	74
3pm Mean Dry-bulb and Wet-bulb Temperatures (ºC) and Relative Humidity (%)													
Dry-bulb	29.8	28.8	26.6	23.5	19.5	16.1	15.6	17.6	20.7	23.6	25.7	28.3	23.0
Wet-bulb	20.2	20.5	19.6	16.4	13.9	11.8	10.9	11.7	14.2	16.0	17.6	19.2	16.0
Humidity	41	47	48	49	50	58	55	48	44	43	44	42	47
Daily Maximum Temperature (ºC)													
Mean	31.1	30.3	27.7	24.4	20.3	16.9	16.4	18.5	21.8	24.8	27.3	29.8	24.1
Daily Minimum Temperature (ºC)													
Mean	16.7	16.5	14.0	9.7	6.9	4.6	3.4	3.5	6.8	9.5	12.8	15.2	10.0
Rainfall (mm)													
Mean	57.6	55.9	47.1	33.3	37.4	49.1	40.5	45.9	35.5	53.4	69.2	80.1	607.8
Raindays (Number)													
Mean	8.1	7.8	8.5	6.4	9.9	11.8	10.9	9.0	7.9	8.3	10.5	9.3	108.4

Station number 061363; Commenced: 1988, Latest record: 2009; Latitude (deg S): -32.03; Longitude (deg E): 150.83

Source: ***Bureau of Meteorology (2009)***

Table 6.3: Temperature, Humidity and Rainfall Data for Scone SCS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9am Mean Dry-bulb and Wet-bulb Temperatures (ºC) and Relative Humidity (%)													
Dry-bulb	22.9	21.9	20.3	17.6	13.3	10.4	9.5	11.4	15.1	18.7	20.2	22.5	17.0
Wet-bulb	18.7	18.6	17.1	14.4	11.2	8.6	7.5	8.6	11.3	14.1	15.5	17.6	13.6
Humidity	67	73	72	70	76	78	75	68	62	59	61	61	69
3pm Mean Dry-bulb and Wet-bulb Temperatures (ºC) and Relative Humidity (%)													
Dry-bulb	29.3	28.5	26.4	23.0	19.0	15.6	14.9	17.1	20.1	23.3	25.8	28.5	22.6
Wet-bulb	20.2	20.2	18.7	16.0	14.0	11.4	10.4	11.2	13.2	15.5	17.0	18.8	15.6
Humidity	43	47	47	47	56	58	54	46	43	42	41	39	47
Daily Maximum Temperature (ºC)													
Mean	30.9	29.8	27.8	24.5	20.1	16.9	16.3	18.2	21.3	24.8	27.5	30.2	24.0
Daily Minimum Temperature (ºC)													
Mean	16.9	16.9	14.6	11.4	8.2	6.0	4.7	5.5	7.9	10.9	13.2	15.8	11.0
Rainfall (mm)													
Mean	86.7	77.2	51.5	39.7	47.5	44.7	35.9	39.6	39.1	59.7	59.6	68.8	647.8
Raindays (Number)													
Mean	8.4	7.6	6.9	6.4	7.6	9.1	7.7	7.6	7.0	8.6	8.3	8.3	93.5

Station number 061089; Commenced: 1950, Latest record: 2009; Latitude (deg S): -32.06; Longitude (deg E): 150.93

Source: ***Bureau of Meteorology (2009)***

7 APPROACH TO ASSESSMENT

In August 2005, DECC published *'Approved Methods for the assessment of air pollution sources using dispersion models'* (Approved Methods) (**NSW DEC, 2005**). The Approved Methods specify how assessments based on the use of air dispersion models should be undertaken. They include procedures 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 Project. The approach taken in this assessment follows as closely as possible to the approaches suggested by the Approved Methods.

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 (ISCMOD). ISCST3 is fully described in the user manual and the accompanying technical description (**US EPA, 1995a**).

The ISCST3 model has a tendency to overestimate short-term (24-hour) PM_{10} concentrations (**Holmes *et al*., 2007)**. To overcome this difficulty it has been modified to create ISCMOD. ISCMOD is identical to ISC 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 ISC. The change involves increasing the horizontal plume widths by a factor of 1.82 $(60 \text{ minutes} / 3 \text{ minute})^{0.2}$. The modifications improve the performance of the model in predicting 24-hour concentrations and make almost no difference to the annual average predictions.

A similar adjustment has been applied to account for the local surface roughness being different at the sites compared with the site where the original curves were developed. The sites have 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.

The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as $PM_{2.5}$, - referred to as FP (fine particulate), 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 **Section 8**).

The distribution of particles has been derived from measurements published by the State Pollution Control Commission (SPCC, now the DECC) **(SPCC, 1986)**. The distribution of particles in each particle size range is:

- $PM_{2.5}$ (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 undertaken using three ISC source groups with each group corresponding to a particle size category. Each source in the group was assumed to liberate particulate matter 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 into account, the model has the potential to significantly overstate impacts.

Operations were represented by a series of volume sources located according to the location of activities for the modelled scenarios (as shown on **Figure 8.1** to **Figure 8.3**). These correspond to operations as they are envisaged to occur in Years 2011, 2016, and 2022.

Dust concentrations and deposition rates have been predicted in the vicinity of the Project for the three stages of the proposed mining operations that were modelled. The local terrain has been taken into consideration for the modelling.

The modelling has been performed using the meteorological data discussed in **Section 6** and the dust emission estimates from **Section 8**. As an example, an ISCMOD input file is provided in **Appendix E**.

All activities have been modelled for 24hours per day. **Section 8** provides details of dust emissions and allocation of sources for each activity.

8 ESTIMATES OF EMISSIONS OF PARTICULATE MATTER

8.1 Introduction

This section discusses the calculation of the emissions for the assessment. Emissions have been calculated for the following:

- The surface operations from the Project; and
- Approved operations at other mines in the area.
-

8.2 Emissions from open cut and underground mining operations

The operation of the mine has been analysed and estimates of dust emissions from each operation for both open cut and underground mining operations have been made. The operations have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. The mining plans for the Project have been analysed and detailed emissions inventories have been prepared for three scenarios in total.

- 2011;
- 2016; and
- 2022.

Table 8.1 summarises the ROM coal and waste production schedule used to calculate the emissions from operations at Mt Arthur Coal.

Table 8.1: Open cut ROM coal and waste production schedule

ROM Waste Production		2011	2016	2022
MACLEANS HILL (MC)				
Topsoil Removed	(Mbcm)	0.08	0.00	0.00
Total Overburden Removed[(a)]	(Mbcm)	13.33	0.05	0.00
ROM Coal Removed	(Mt)	1.86	0.73	0.00
WINDMILL (WM)				
Topsoil Removed	(Mbcm)	0.08	0.20	0.00
Total Overburden Removed	(Mbcm)	23.48	57.68	62.41
ROM Coal Removed	(Mt)	4.18	11.20	11.94
HUON (HU)				
Topsoil Removed	(Mbcm)	0.06	0.08	0.09
Total Overburden Removed	(Mbcm)	17.97	17.04	21.95
ROM Coal Removed	(Mt)	3.28	3.11	3.21
CALOOL (CA)				
Topsoil Removed	(Mbcm)	0.00	0.04	0.04
Total Overburden Removed	(Mbcm)	4.71	19.94	17.19
ROM Coal Removed	(Mt)	1.77	3.79	2.73
ROXBURGH (RX)				
Topsoil Removed	(Mbcm)	0.06	0.09	0.00
Total Overburden Removed	(Mbcm)	23.90	34.91	23.16
ROM Coal Removed	(Mt)	4.00	6.23	5.62
AYREDALE (AY)				
Topsoil Removed	(Mbcm)	0.01	0.01	0.00
Total Overburden Removed	(Mbcm)	3.66	32.58	16.76
ROM Coal Removed	(Mt)	0.07	5.79	4.08
SADDLERS (Nth, Cen, Sth) (SN, SC, SS)				
Topsoil Removed	(Mbcm)	0.04	0.04	0.00
Total Overburden Removed	(Mbcm)	11.38	6.94	2.16
ROM Coal Removed	(Mt)	1.50	1.15	0.42
TOTALS				
Total topsoil	**(Mbcm)**	**0.33**	**0.46**	**0.13**
Total overburden	**(Mbcm)**	**98.42**	**169.15**	**143.63**
Total ROM	**(Mt)**	**16.66**	**32.00**	**28.00**
Rehandle ROM Coal @ 11.0%of ROM	(Mt)	1.83	3.52	3.08
Course Reject @ 12.0% of ROM	(Mt)	2.00	3.84	3.36

Some totals may not add up due to rounding
Mbcm – million bank cubic metres
Mt – million tonnes

Note: a) Total overburden includes topsoil removal

Emissions from the underground mining operations were assumed to be the maximum of the ratio of dust to ROM coal production calculated in **Holmes Air Sciences (2007a)**. The value of 0.18 kg/t was equally divided between emissions generated at the ROM stockpile and the CHPP area.

The detailed calculations are provided in **Appendix F**. This provides information on the equations used, the basic assumptions about material properties (e.g. moisture content, silt content etc), information on the way in which equipment will be used to undertake different mining operations and the quantities of materials that will be handled in each operation. It has been assumed that all major haul roads will be treated with a dust suppressant or road sealing product to minimise the generation of dust.

Figure 8.1 to **Figure 8.3** show the general progression of mining and associated activities over the life of the Project together with numbered locations that represent dust sources assumed in the modelling. The activities that are associated with each of the numbered locations are identified in **Appendix F**.

Table 8.2 presents the emission estimates for each year modelled. Detailed emission estimates are provided in **Appendix F**.

Table 8.2: Summary of estimated TSP emissions from the Project (kg/y)

ACTIVITY	2011	2016	2022
OB - Stripping topsoil - MC	4,402	0	0
OB - Stripping topsoil - WM	11,227	11,227	0
OB - Stripping topsoil - HU	3,188	4,593	4,775
OB - Stripping topsoil - CA	0	2,224	2,380
OB - Stripping topsoil - RX	3,442	5,046	0
OB - Stripping topsoil - AY	699	714	0
OB - Stripping topsoil - SN, SC, SS	2,352	1,994	0
OB - Drilling - MC	9,362	0	0
OB - Drilling - WM	16,490	40,551	43,839
OB - Drilling - HU	12,619	11,972	15,420
OB - Drilling - CA	3,309	14,008	12,075
OB - Drilling - RX	16,789	24,522	16,265
OB - Drilling - AY	2,568	22,883	11,769
OB - Drilling - SN, SC, SS	7,994	4,872	1,517
OB - Blasting - MC	33,290	0	0
OB - Blasting - WM	58,639	144,198	155,888
OB - Blasting - HU	44,874	42,571	54,835
OB - Blasting - CA	11,766	49,813	42,940
OB - Blasting - RX	59,700	87,201	57,839
OB - Blasting - AY	9,132	81,371	41,851
OB - Blasting - SN, SC, SS	28,428	17,325	5,395
OB - Sh/Ex/FELs loading - MC	66,886	0	0
OB - Sh/Ex/FELs loading - WM	117,817	289,723	313,211
OB - Sh/Ex/FELs loading - HU	90,162	85,534	110,174
OB - Sh/Ex/FELs loading - CA	23,640	100,084	86,275
OB - Sh/Ex/FELs loading - RX	119,950	175,204	116,209
OB - Sh/Ex/FELs loading - AY	18,349	163,491	84,086
OB - Sh/Ex/FELs loading - SN, SC, SS	57,117	34,810	10,841
OB - Hauling to emplacement - MC	204,044	0	0
OB - Hauling to emplacement - WM	691,701	1,688,073	1,670,168
OB - Hauling to emplacement - HU	427,777	501,684	909,165
OB - Hauling to emplacement - CA	96,831	799,563	775,639
OB - Hauling to emplacement - RX	666,890	1,221,221	738,079
OB - Hauling to emplacement - AY	121,373	1,231,250	767,805
OB - Hauling to emplacement - SN, SC, SS	156,080	139,299	43,718
OB - Emplacing at dumps - MC	66,886	0	0
OB - Emplacing at dumps - WM	117,817	289,723	313,211
OB - Emplacing at dumps - HU	90,162	85,534	110,174
OB - Emplacing at dumps - CA	23,640	100,084	86,275
OB - Emplacing at dumps - RX	119,950	175,204	116,209
OB - Emplacing at dumps - AY	18,349	163,491	84,086
OB - Emplacing at dumps - SN, SC, SS	57,117	34,810	10,841
OB - Dozers on O/B - MC	77,916		
OB - Dozers on O/B - WM	137,246	245,811	268,061
OB - Dozers on O/B - HU	105,029	72,570	94,292
OB - Dozers on O/B - CA	27,538	84,915	73,838
OB - Dozers on O/B - RX	139,730	148,649	99,457
OB - Dozers on O/B - AY	21,374	138,711	71,965
OB - Dozers on O/B - SN, SC, SS	66,535	29,534	9,278
OB - Dozers on Rehabilitation - total	304,607	381,277	326,590
CL - Dozers ripping - MC	6,105	0	0
CL - Dozers ripping - WM	13,727	25,528	25,008
CL - Dozers ripping - HU	10,759	6,654	6,721
CL - Dozers ripping - CA	5,824	8,105	5,726
CL - Dozers ripping - RX	13,124	13,327	11,770
CL - Dozers ripping - AY	245	12,385	8,541
CL - Dozers ripping - SN, SC, SS	4,913	2,464	878
CL - Loading ROM to trucks - MC	125,613	0	0
CL - Loading ROM to trucks - WM	282,440	806,034	806,623
CL - Loading ROM to trucks - HU	221,387	210,108	216,773
CL - Loading ROM to trucks - CA	119,840	255,901	184,680
CL - Loading ROM to trucks - RX	270,040	420,810	379,629

ACTIVITY	2011	2016	2022
CL - Loading ROM to trucks - AY	5,031	391,049	275,478
CL - Loading ROM to trucks - SN, SC, SS	101,086	77,803	28,310
CL - Hauling ROM coal to dump hopper - MC	69,455	0	0
CL - Hauling ROM coal to dump hopper - WM	194,484	633,437	706,498
CL - Hauling ROM coal to dump hopper - HU	153,426	165,739	192,998
CL - Hauling ROM coal to dump hopper - CA	70,655	210,515	157,032
CL - Hauling ROM coal to dump hopper - RX	129,549	230,335	260,934
CL - Hauling ROM coal to dump hopper - AY	3,361	239,724	152,009
CL - Hauling ROM coal to dump hopper - SN, SC,SS	96,583	82,624	30,064
CL - unloading ROM coal at stockpile/hopper - MC	87,929	0	0
CL - unloading ROM coal at stockpile/hopper - WM	197,708	564,224	564,636
CL - unloading ROM coal at stockpile/hopper - HU	154,971	147,075	151,741
CL - unloading ROM coal at stockpile/hopper - CA	83,888	179,131	129,276
CL - unloading ROM coal at stockpile/hopper - RX	189,028	294,567	265,740
CL - unloading ROM coal at stockpile/hopper - AY	3,522	273,734	192,835
CL - unloading ROM coal at stockpile/hopper - SN, SC, SS	70,760	54,462	19,817
CL - Rehandle ROM coal at stockpile/hopper	86,659	166,451	145,645
CL - Handling coal at CHPP	7,483	14,372	12,576
CL - Dozers at CHPP	234,451	234,451	234,451
CL - Transporting rejects back to CA	39,812	106,698	96,499
CL - Transporting rejects back to RX	32,395	70,994	78,006
CL - Loading product coal stockpile	2,254	4,330	3,789
CL - Loading coal to trains	2,254	4,330	3,789
WE - OB spoil area - All pits	8,301,909	8,361,827	8,768,447
WE - Open pit - All pits	2,505,150	2,559,374	2,553,952
WE - ROM stockpiles	36,149	72,299	72,299
WE - Product stockpiles	11,086	11,086	11,086
Grading roads	73,856	73,856	73,856
Underground_ROM/crushing stockpile area	720,000	360,000	720,000
Underground_CHPP area	720,000	360,000	720,000
TOTAL DUST EMISSIONS FROM O/C (kg)	**18,591,695**	**25,933,139**	**24,584,544**
ROM coal production (O/C) (t)	16,659,989	32,000,000	28,000,000
ROM: dust Ratio (O/C) (kg/t)	0.90	1.23	1.14

Notes:
See **Figure 8.1** to **Figure 8.3** for pit locations
MC = Macleans Hill; WM = Windmill; HU = Huon; CA = Calool; RX = Roxburgh; AY = Ayredale
SN, SC, SS = Saddlers (North, Central, South) –
OB = Overburden; CL = Coal; WE = Wind erosion emissions

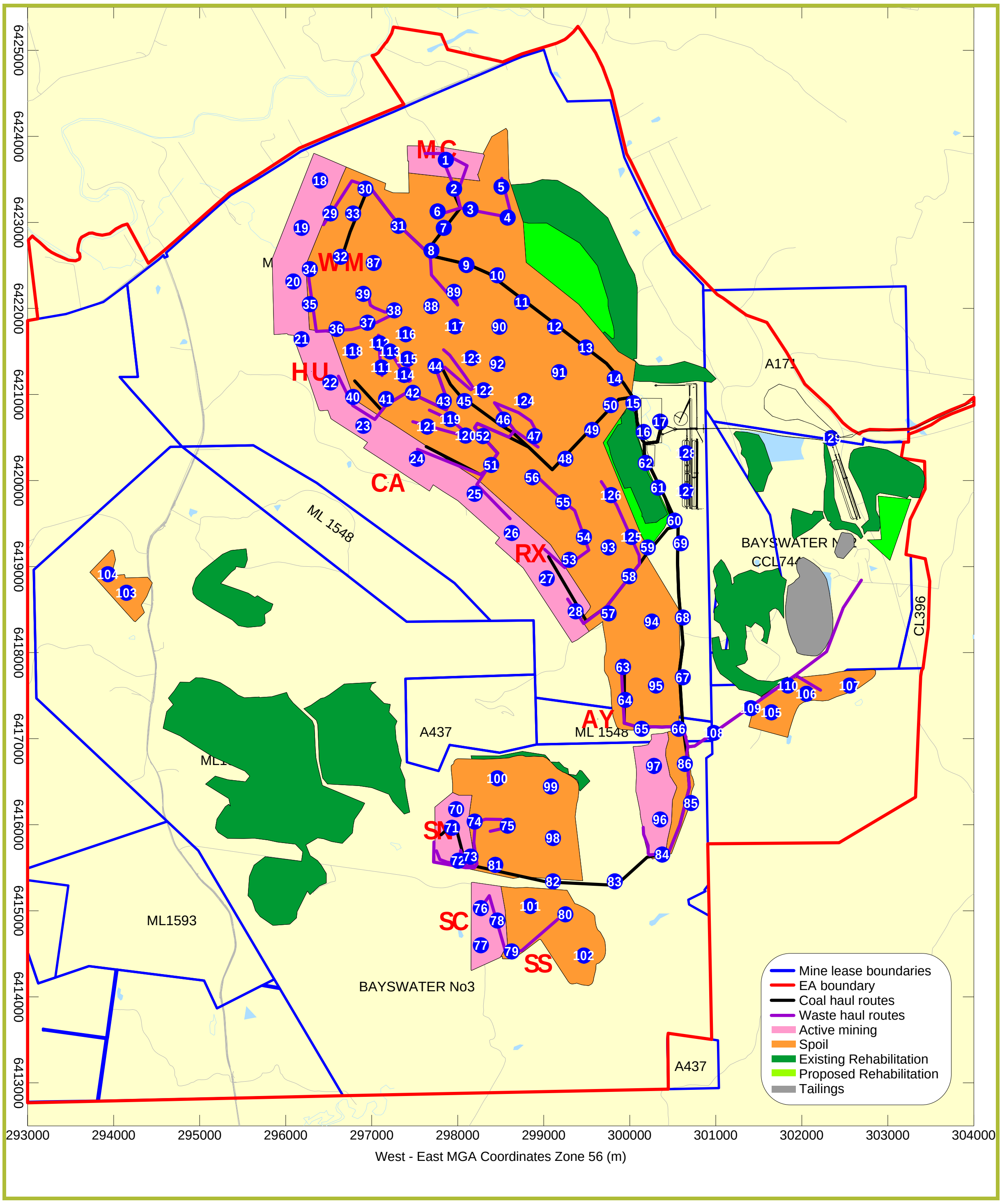


Figure 8.1: Modelling sources locations – 2011

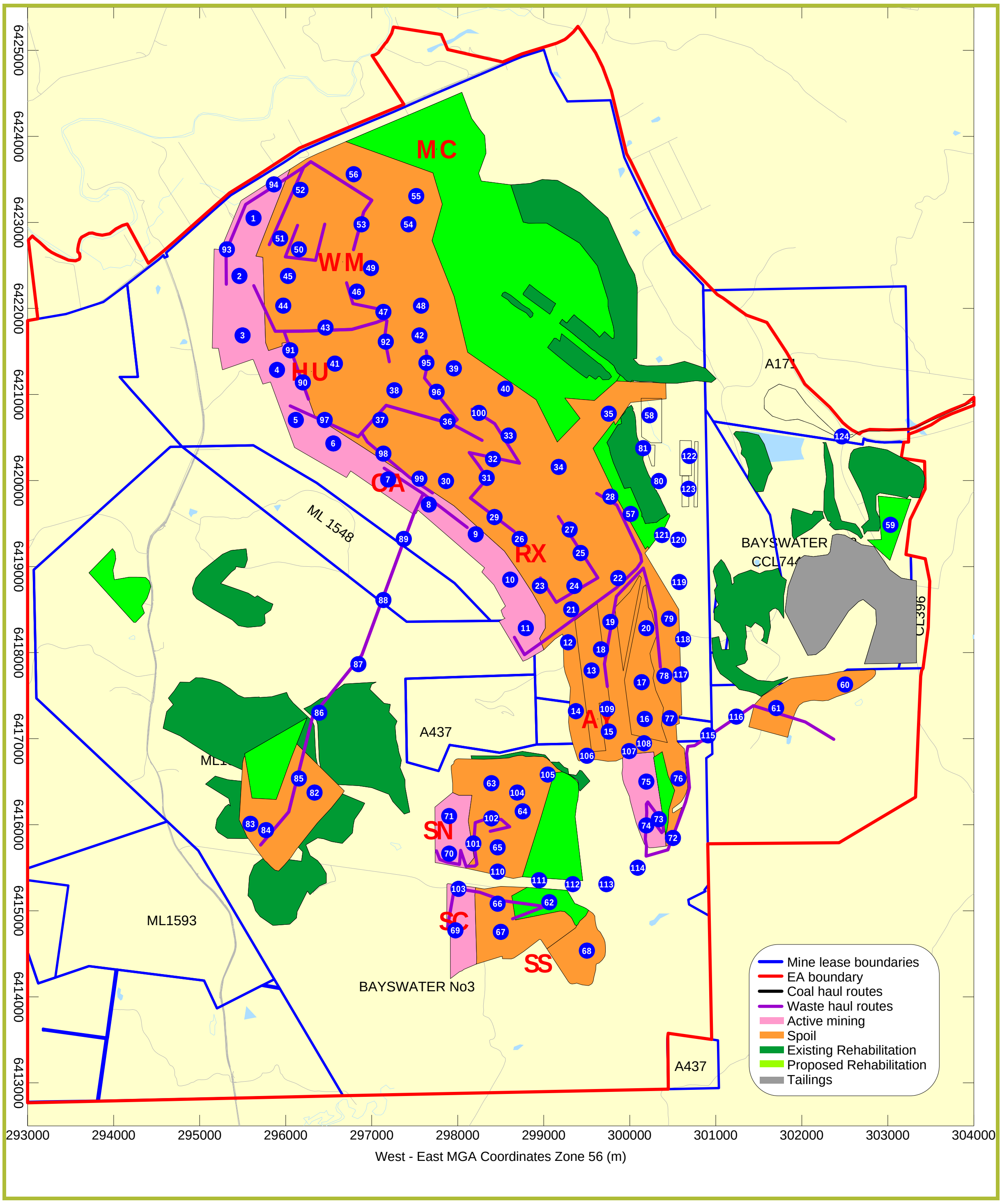


Figure 8.2: Modelling sources locations – 2016

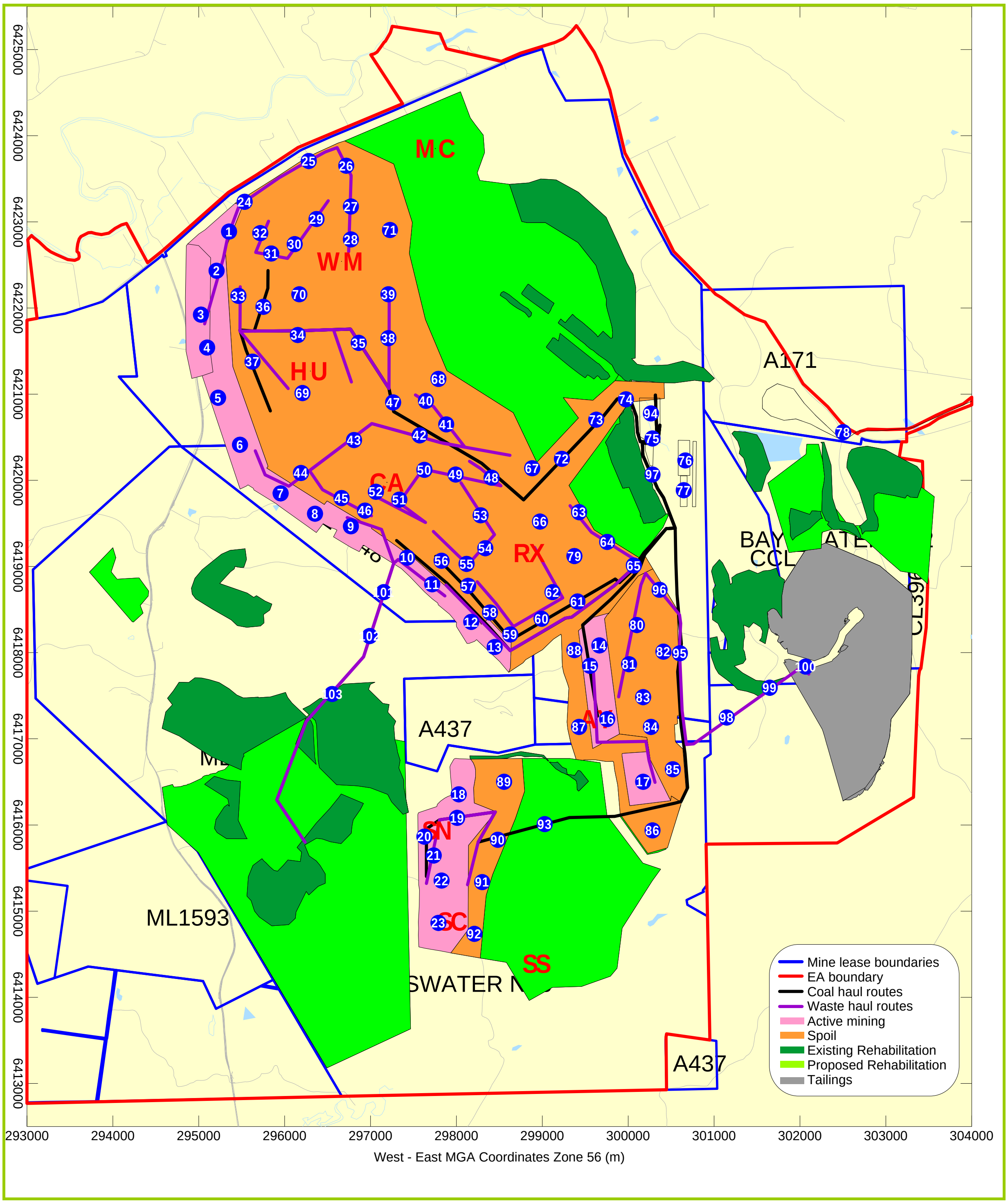


Figure 8.3: Modelling sources locations – 2022

8.3 Emissions from neighbouring mines

The inventories used in the modelling include operations in the Project and estimates of emissions from nearby mines. The locations of the nearby mines are shown in **Figure 8.4**.

The estimated emissions for the neighbouring mines have been taken from the Environmental Impact Statements (EIS's) for following mines:

- Bengalla (included in 2011 and 2016) (**Holmes Air Sciences, 2006b**);
- Muswellbrook Coal Company (MCC) (included in 2011) (**Holmes Air Sciences, 2002b**); and
- Drayton (included in 2011 and 2016) (**Holmes Air Sciences, 2007b**).
- The approvals for all the mines listed above have expired by 2022, and therefore have not been included in the assessment of this year.
- It is also noted that there are other approved mines in the vicinity of the site, namely Mt Pleasant and Anvil Hill (now referred to as Mangoola). However, the most recent EIS's for Anvil Hill (**Holmes Air Sciences, 2006c**) and Mt Pleasant (**Zib, 1997**) show minimal impact at the residences most affected by the proposed operations of Mt Arthur Coal. In addition, Mt Pleasant has not yet begun operation and therefore it is not possible to know with any certainty the timing of its development.
- Where data were not available for the precise years of the Project, data were interpolated or extrapolated from the available previously calculated emissions data. **Table 8.3** presents a summary of the estimated emissions.

Whilst the preferred approach to the cumulative impact assessment would be to sum the predicted concentrations to the measured concentrations, this is not a practical approach for two main reasons:

- The monitoring data are only applicable to the current activities in the area and do not take account of changes in activities in the future.
- The monitoring data are only applicable to the location where the samples are taken from.

In the cumulative modelling work, each neighbouring mine has been treated as a number of volume sources. These have been located at the apparent points of major emission as estimated from the known locations of the pits and/or major dust sources on the mine or facility.

Sources have been considered in three classes covering all dust emission sources for which there are emission factor equations for open cut mines.

1. Wind erosion sources where emissions vary with the hourly average wind speed according to the cube of the wind speed.
2. Loading and dumping operations where emissions vary with wind speed raised to the power of 1.3.
3. All other sources where emissions are assumed to be independent of wind speed.

For neighbouring mines, the proportion of emissions in each of these categories has been assumed to be:

- 0.732 for emissions independent of wind speed;
- 0.135 for emissions that depend on wind speed (such as loading and dumping); and
- 0.133 for wind erosion sources.

These factors are based on a detailed analysis of mine dust inventories undertaken as part of the MAN EIS (**URS, 2000**), and have subsequently been accepted as appropriate and routinely applied to subsequent air quality impact assessments for mining operations over the last nine years.

Table 8.3: Summary of estimated TSP dust emissions from other mines (kg/y)

Mine	2011	2016
Bengalla (WI)	5,947,795	6,384,180
Bengalla (WS)	1,140,673	1,224,363
Bengalla (WE)	1,059,196	1,136,909
Drayton (WI)	4,619,295	2,827,178
Drayton (WS)	885,892	542,199
Drayton (WE)	822,614	503,470
Muswellbrook Coal Company (WI)	710,266	Conditions of Consent expire in 2015
Muswellbrook Coal Company (WS)	136,215	
Muswellbrook Coal Company (WE)	126,486	

Notes:
WI = Wind insensitive emissions; WS = Wind sensitive emissions; WE = Wind erosion emissions

8.4 Estimated emissions from distant mines and other sources

In addition to the mines identified in **Section 8.4**, distant mines and other sources will contribute to $PM_{2.5}$, PM_{10}, TSP concentrations and to dust deposition in the area. Estimating the background allowance for distant mines and non-mining sources is difficult and depends on local land use and the associated emission sources, as well as climate, soil type etc.

In previous assessments, the approach taken has been to compare the predicted impacts due to the Project and other mines at nearby monitoring locations. From this an estimate of the contribution by distant mines and other sources was made and a single figure estimate of annual average background PM_{10} and TSP concentrations was added to all the predicted impacts.

However, it is recognised, that there is in reality, spatial variation in the contribution that distant mines and other sources make to the ambient concentrations of annual average PM_{10} and TSP where open cut mining and other emission sources (e.g. residential roads, power stations) are located compared with areas where open-cut mining is not active.

Appendix G describes the approach taken in this assessment to determine the spatially varying grid to be included with for annual average predictions for PM_{10} and TSP.

The approach taken for deposited dust has not been revised. The annual average quantity of deposited dust contributed by these other sources has been set at 0.5 g/m^2/month.

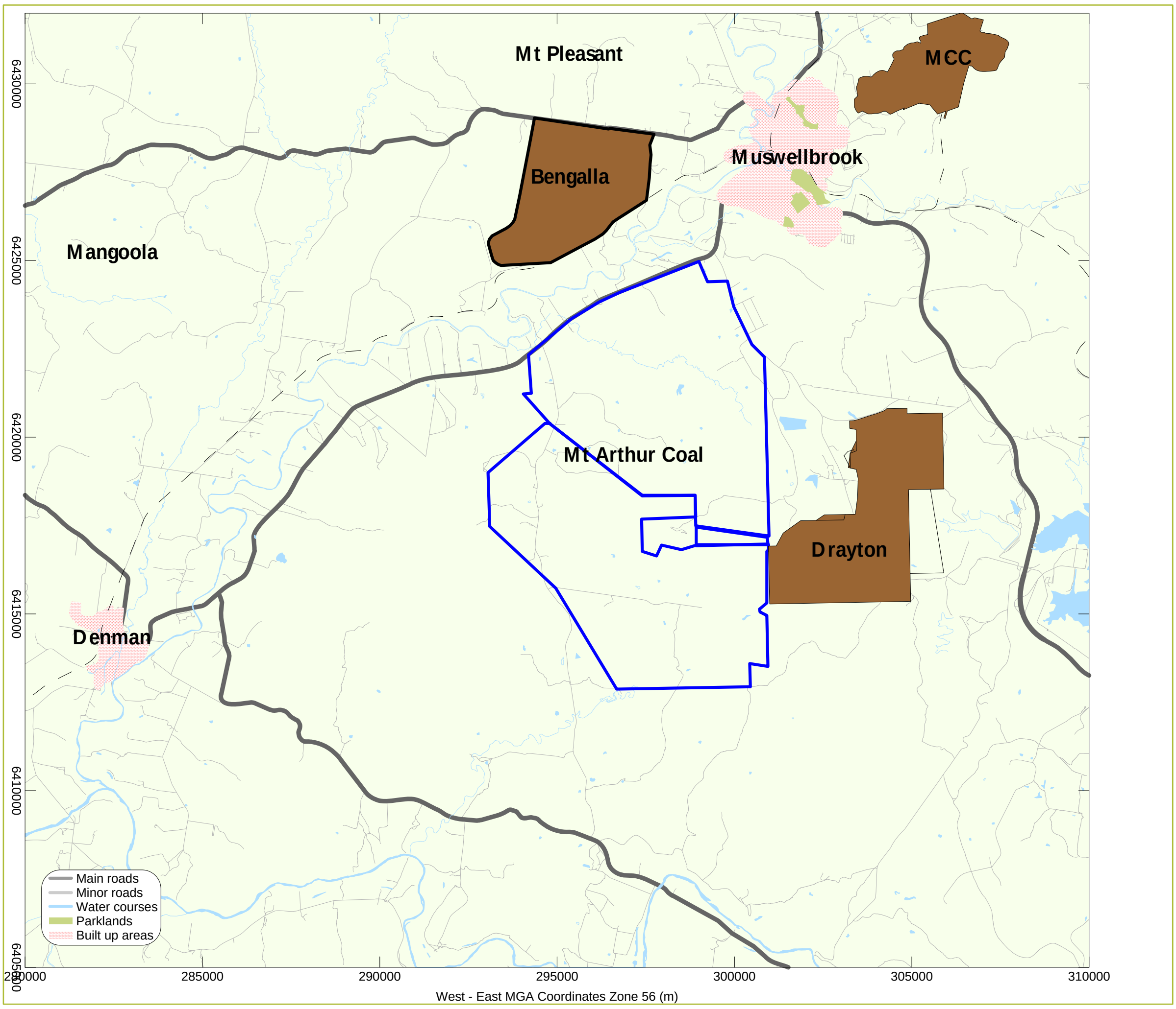


Figure 8.4: Location of other nearby mines

9 ASSESSMENT OF IMPACTS – PARTICULATE MATTER

9.1 Assessment Criteria

The air quality criteria used for identifying which properties are likely to experience air quality impacts are those specified in the NSW DECC's Approved Methods. These have been applied in the assessment process following the practices used in contemporary approvals for mining projects in NSW.

The criteria are:

- 50 $\mu g/m^3$ for 24-hour average 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 average TSP concentrations due to the Project alone 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 average predicted cumulative deposition (insoluble solids) due to the Project and other sources.

Similar predictions for 24-hour and annual average $PM_{2.5}$ concentrations for the Project by itself and the Project considered with the effects of other mines are provided in **Appendix B**.

Following practice established in recent conditions of consent, with the exception of the 2 g/m^2/month goal and the 24-hour PM_{10}, the assessment criteria are interpreted to be cumulative assessment criteria.

The following sections provide a summary of the affected residences and at what stage in the life of the Project the effects are predicted to occur.

9.2 Assessment Approach

The annual average concentrations, dust concentrations and deposition rates for the selected years of assessment have been presented as isopleth diagrams showing the following:

1. Predicted annual average PM_{10} concentration.
2. Predicted annual average TSP concentration.
3. Predicted annual average dust deposition.

Rather than provide a detailed discussion of each isopleth figure, the results have been summarised in tabular form for each year. The nearby residences are listed, with those that are predicted to experience particulate matter deposition or concentration levels above the NSW DECC's assessment criteria highlighted. The contour plots of dust concentrations and deposition levels show the areas of land that are affected by dust at different levels. However, concentration and deposition levels at residences are of particular interest. The locations of neighbouring properties (and where applicable, residences) are shown in **Figure 3.1** and **Figure 3.2**.

In recent conditions of consent, the Department of Planning has interpreted the 24-hour PM_{10} criterion of 50 $\mu g/m^3$ as being applicable to the Project when considered in isolation (at the 98.6th percentile), and the US EPA 24-hour PM_{10} standard of 150 $\mu g/m^3$ has been taken to be the cumulative criterion (at the 99th percentile). The application of the 24-hour PM_{10} criteria applies in this way when the mine can demonstrate that it will or does employ best-practice dust control measures including the use of real-time monitoring and reactive dust measures. It is important to the note that it is not possible to accurately predict the cumulative PM_{10} 24-hour concentrations using dispersion modelling. Experience shows that these worst-case 24-hour PM_{10} concentrations are strongly influenced by other sources in the area. The events such as bushfires and dust storms, which are essentially unpredictable, have a dominant effect on the worst-case PM_{10} concentrations. Therefore cumulative PM_{10} 24-hour average predictions have not been included in the assessment.

For the 24-hour average PM_{10} predictions due to the Project on its own, a table of the predicted impacts at the nearby residence is presented for each year of the assessment (see **Section 9.4**). For those residences where the criterion of 50 $\mu g/m^3$ is predicted to be exceeded, an assessment of the number of days in the year above the criteria has also been presented.

9.3 Annual average PM10, TSP and dust deposition predictions

9.3.1 2011

Figure 9.1 to **Figure 9.6** show the predicted annual average PM_{10} and TSP concentrations and dust deposition levels for operations in 2011 showing the effects of the Project by itself and the Project in combination with other sources.

Table 9.1 presents the results for all residences in the vicinity of the EA Boundary and highlights in bold those figures that represent an exceedance of either the relevant project specific or cumulative goal.

It should be noted that of the criteria that are used to assess impacts, (i.e. 24-hour PM_{10}, annual average PM_{10}, annual average TSP and annual average deposition), only two are applicable for the Project considered in isolation. These are the 50 $\mu g/m^3$ 24-hour PM_{10} goal, which, for projects committing to best practice dust controls, should not be exceeded by the project in isolation (the results for 24-hour average PM_{10} concentrations are presented in **Section 9.4**) and the annual 2 g/m^2/month deposition limit for insoluble solids. The value of examining the effects of the Project by itself for the other parameters is that this allows the extent to which the Project contributes to the cumulative impacts to be quantified. This is useful when deciding the extent to which the Project contributes to exceedances that may arise due to the combined effect with all sources of dust.

In summary for 2011, the following exceedances are identified:

- Annual average deposition above 2 g/m2/month due to the Project considered in isolation – No residences affected – see **Figure 9.3**.
- Annual average PM_{10} above 30 $\mu g/m^3$ due to the Project and other mines and other sources – Three private residences and one recreational facility (9[a], 10[b], 28 and 29) - see **Figure 9.4**.
- Annual average TSP above 90 $\mu g/m^3$ due to the Project and other mines and other sources – No residences affected – see **Figure 9.5**.
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – No residences affected – see **Figure 9.6**.

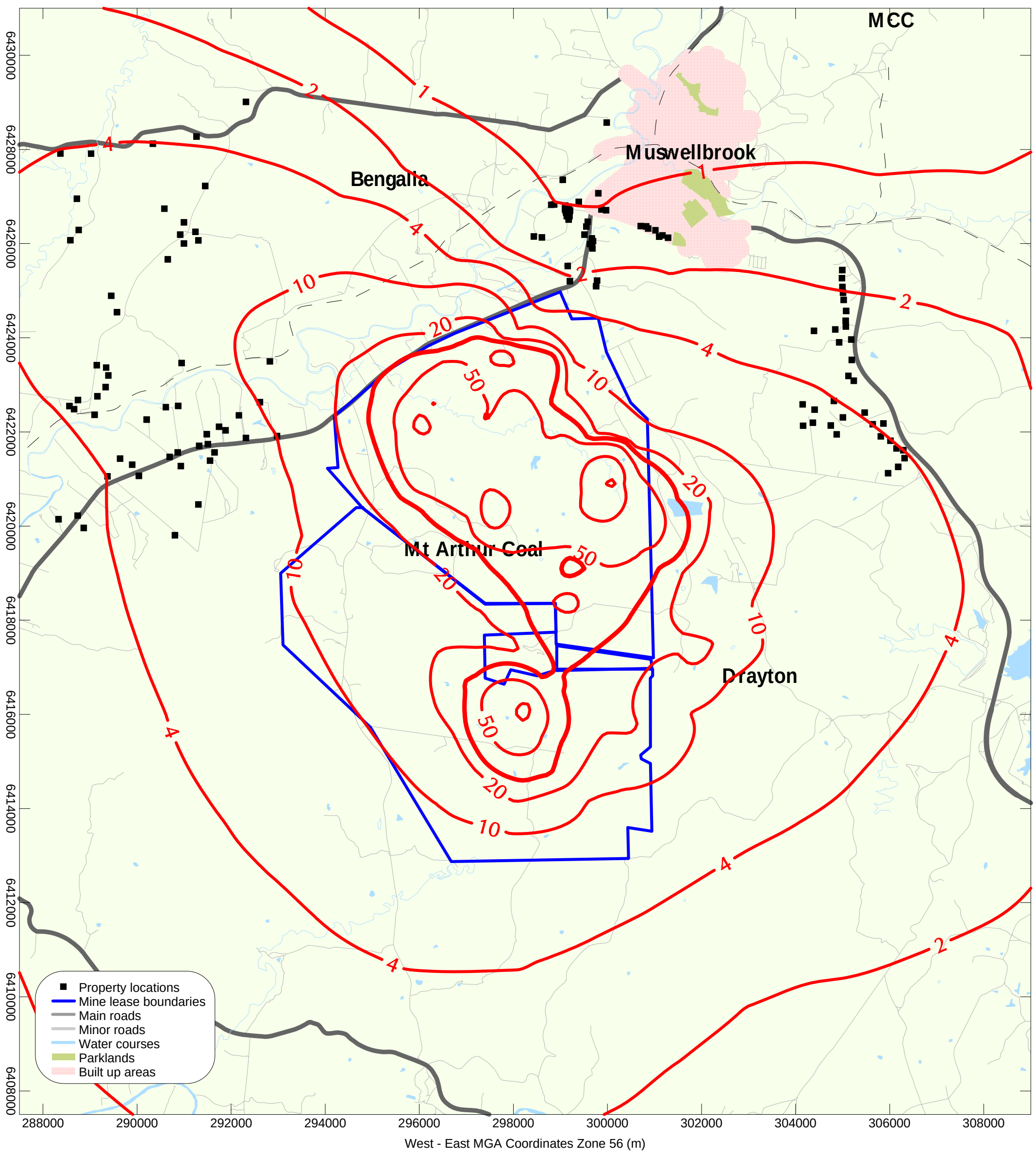
[a] Residence 9 is located in the existing Mt Arthur Coal ZOA.
[b] 'Residence' 10 is Muswellbrook Race Club Limited, therefore not strictly a residence.

Table 9.1: Summary of predicted annual average air quality impacts for 2011

ID	2011 – Project alone			2011 – Project and other mines and other sources		
	Annual average concentrations					
	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)
	Assessment criteria					
	30	*90*	*2*	*30*	*90*	*4*
6	2	2	0.1	26	63	1.5
8	2	2	0.1	27	65	1.6
9	1	1	0.1	**32**	71	2.2
10	1	1	0.1	**31**	70	2.0
11	1	1	0.0	27	66	1.6
12	1	1	0.0	27	66	1.5
13	1	1	0.0	27	66	1.5
14	1	1	0.0	29	68	1.8
15	1	1	0.0	29	68	1.8
16	1	1	0.0	29	68	1.7
17	1	1	0.0	29	68	1.7
18	1	1	0.0	29	68	1.7
20	1	1	0.0	29	68	1.7
21	1	1	0.0	29	68	1.7
22	1	1	0.0	29	69	1.7
23	1	1	0.0	29	69	1.7
24	1	1	0.0	29	69	1.8
25	1	1	0.0	29	69	1.7
26	1	1	0.0	29	69	1.8
27	1	1	0.0	29	68	1.8
28	1	1	0.0	**31**	70	2.0
29	1	1	0.0	**31**	69	1.9
30	1	1	0.0	29	68	1.8
31	1	1	0.0	29	66	1.7
32	1	1	0.0	29	67	1.7
33	1	1	0.0	28	65	1.6
34	1	1	0.0	26	62	1.4
36	1	1	0.0	23	54	0.9
37	1	1	0.0	26	62	1.4
37	1	1	0.0	27	63	1.4
39	1	1	0.0	27	65	1.5
40	1	1	0.0	26	65	1.5
41	1	1	0.0	27	65	1.5
42	1	2	0.1	26	64	1.5
43	1	2	0.1	26	64	1.5
49	2	2	0.1	25	61	1.4
49	2	3	0.1	25	61	1.4
56	1	1	0.0	25	60	1.2
57	1	1	0.0	25	59	1.1
58	1	1	0.0	25	59	1.1
59	1	1	0.0	24	59	1.1
60	1	2	0.0	24	59	1.1
61	1	2	0.0	24	58	1.1
62	2	2	0.0	24	58	1.1
69	2	2	0.0	19	49	0.7
70	2	2	0.0	19	49	0.7
71	2	2	0.1	19	49	0.7
72	2	2	0.1	19	49	0.7
73	2	2	0.1	19	49	0.7
75	2	2	0.1	19	48	0.7
76	2	3	0.1	19	48	0.8
77	3	3	0.1	19	49	0.8
77	2	3	0.1	19	48	0.8

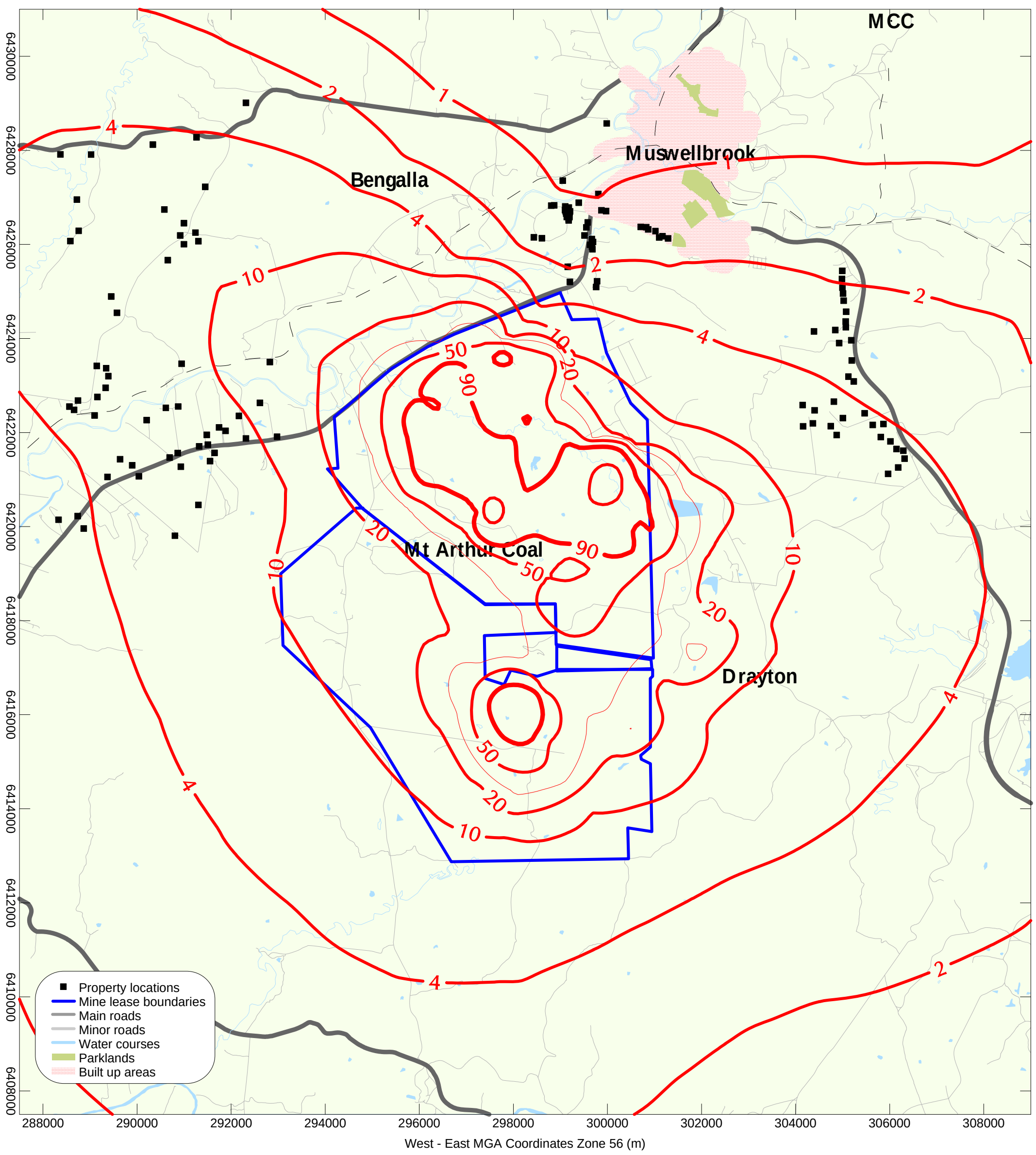
ID	2011 – Project alone PM10 (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)	2011 – Project and other mines and other sources PM10 (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)
	Annual average concentrations					
	Assessment criteria					
	30	*90*	*2*	*30*	*90*	*4*
78	3	3	0.1	20	50	0.8
79	3	3	0.1	19	48	0.8
79	3	3	0.1	19	49	0.8
82	3	4	0.2	19	49	0.8
83	3	3	0.1	19	48	0.8
85	3	4	0.2	19	49	0.8
86	4	4	0.2	20	49	0.8
87	4	5	0.3	20	49	0.9
88	4	4	0.2	20	50	0.9
89	5	5	0.3	20	50	0.9
90	5	5	0.3	20	51	0.9
91	5	6	0.4	20	51	1.0
92	5	5	0.3	20	51	1.0
93	5	5	0.3	20	50	0.9
94	5	5	0.3	20	50	1.0
95	4	4	0.2	20	49	0.9
96	4	4	0.2	20	48	0.8
97	4	4	0.3	20	49	0.9
98	4	4	0.3	20	48	0.9
99	4	4	0.3	20	49	0.9
99	4	4	0.3	20	49	0.9
100	4	4	0.3	21	49	0.9
101	4	5	0.3	21	50	0.9
102	5	5	0.3	22	51	1.0
182	4	4	0.2	15	39	0.8
183	5	6	0.4	17	40	0.9
184a	7	7	0.6	18	42	1.2
184b	6	7	0.6	18	41	1.2
184c	6	7	0.5	17	41	1.1
186	5	5	0.4	16	40	0.9
187	6	6	0.5	17	41	1.1
190	3	3	0.2	15	39	0.7
191	4	4	0.2	15	39	0.8
195	4	4	0.3	16	39	0.9
196	4	5	0.3	16	40	0.9
197	4	5	0.4	16	40	0.9
198	5	6	0.5	17	41	1.1
200	6	7	0.6	18	42	1.2
201	6	6	0.5	17	41	1.1
203	6	7	0.6	18	41	1.2
204	7	7	0.6	18	42	1.3
205	7	7	0.6	18	42	1.2
206	7	8	0.7	19	43	1.4
207	7	8	0.8	19	43	1.4
208	8	9	1.0	20	46	1.6
209	8	9	0.8	20	44	1.5
210	10	12	1.3	22	50	2.0
211	10	11	1.1	21	48	1.8
212	12	14	1.9	27	56	2.6
213	4	5	0.3	16	40	0.9
213	4	5	0.4	16	41	0.9
213	4	5	0.3	16	40	0.9
216	4	5	0.4	16	40	0.9
218	5	5	0.5	17	41	1.0

ID	2011 – Project alone PM10 ($\mu g/m^3$)	TSP ($\mu g/m^3$)	Dust deposition ($g/m^2/month$)	2011 – Project and other mines and other sources PM10 ($\mu g/m^3$)	TSP ($\mu g/m^3$)	Dust deposition ($g/m^2/month$)
	Annual average concentrations					
	Assessment criteria					
	30	*90*	*2*	*30*	*90*	*4*
218	5	6	0.5	17	42	1.1
218	5	5	0.4	17	41	1.0
226	8	9	0.9	20	45	1.5
231	5	6	0.5	17	42	1.1
232	5	6	0.5	18	42	1.1
233	6	7	0.7	19	44	1.3
233	6	7	0.7	19	44	1.3
235	5	6	0.5	18	43	1.2
236	5	6	0.6	19	43	1.2
238	7	7	0.8	22	48	1.5
239	7	8	0.9	21	47	1.5
240	7	8	0.9	22	48	1.6
241	7	8	0.9	23	49	1.6
242	6	7	0.8	22	48	1.5
242	6	6	0.7	22	47	1.4
242	7	7	0.9	23	49	1.6
243	5	5	0.5	19	44	1.2
250	5	6	0.6	25	50	1.7
252	4	4	0.4	25	50	1.7
254	4	4	0.5	23	47	1.4
257	4	4	0.4	20	45	1.2
259	4	4	0.4	19	44	1.1
264	3	3	0.3	28	54	2.3



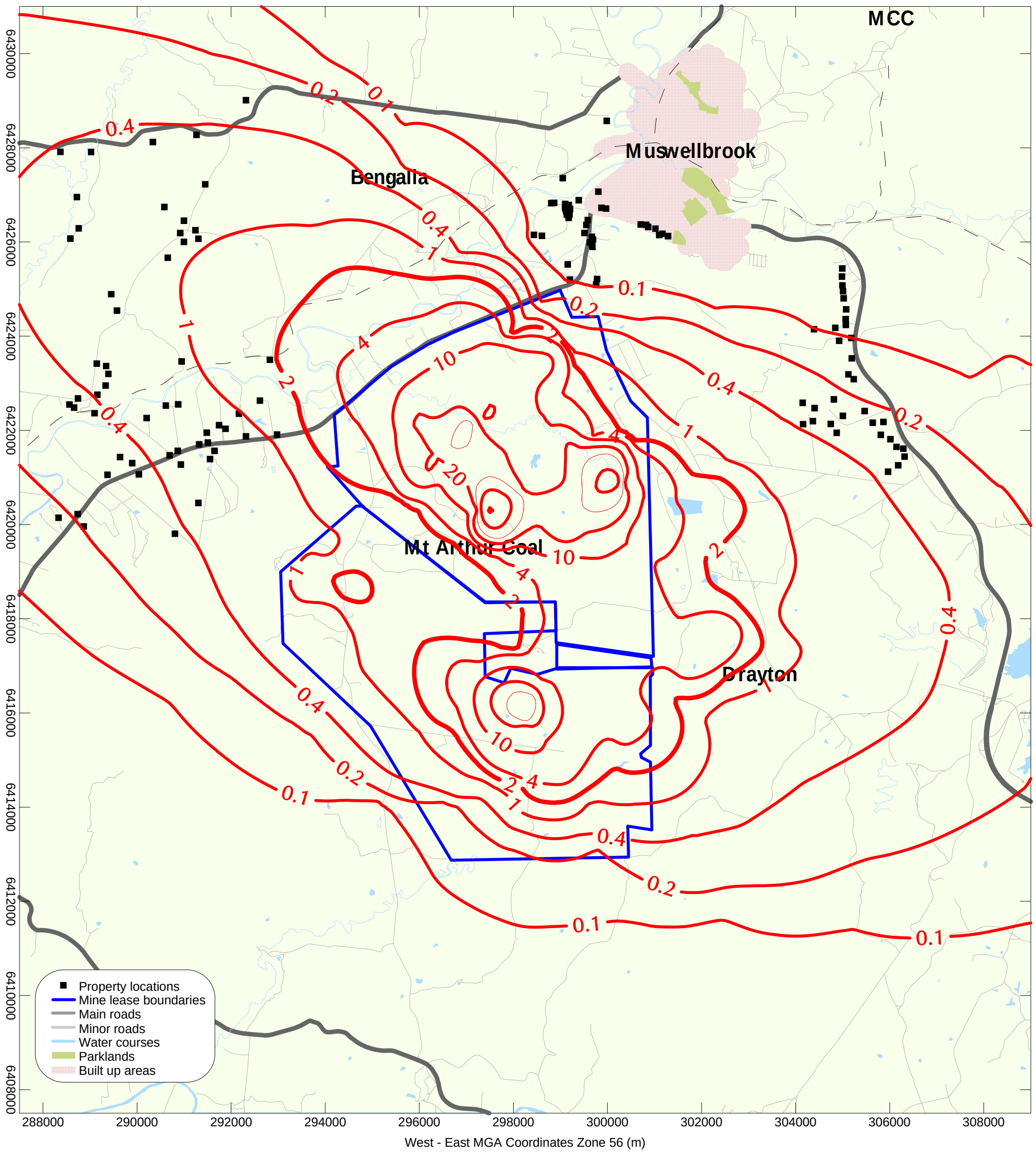
Species: PM_{10}	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** $\mu g/m^3$	**Assessment criteria:** NEPM = 30 $\mu g/m^3$	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.1: Predicted annual average PM_{10} concentration due to emissions from the Project alone in 2011



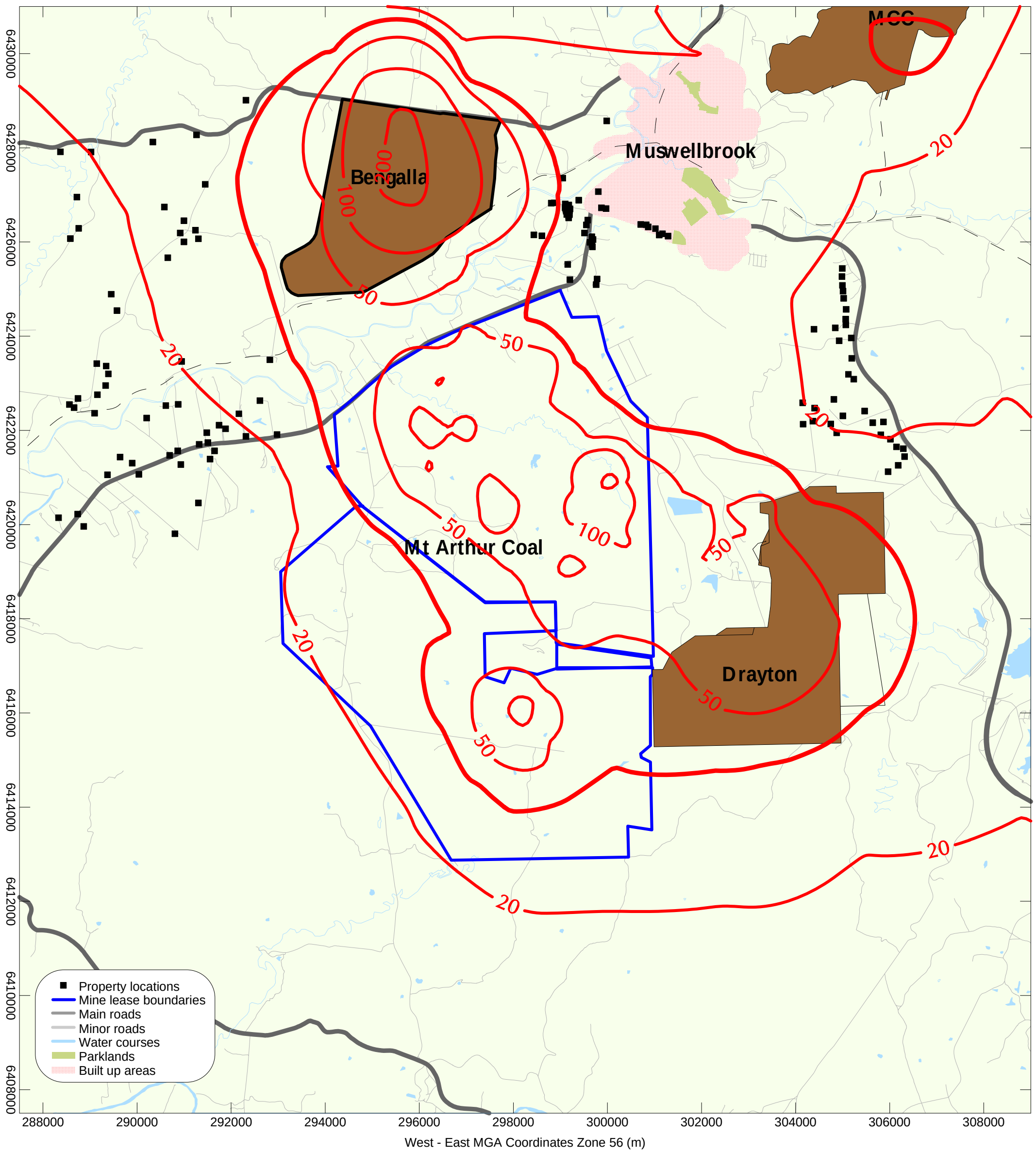
Species: TSP	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m³	**Assessment criteria:** NEPM = 90 µg/m³	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.2: Predicted annual average TSP concentration due to emissions from the Project alone in 2011



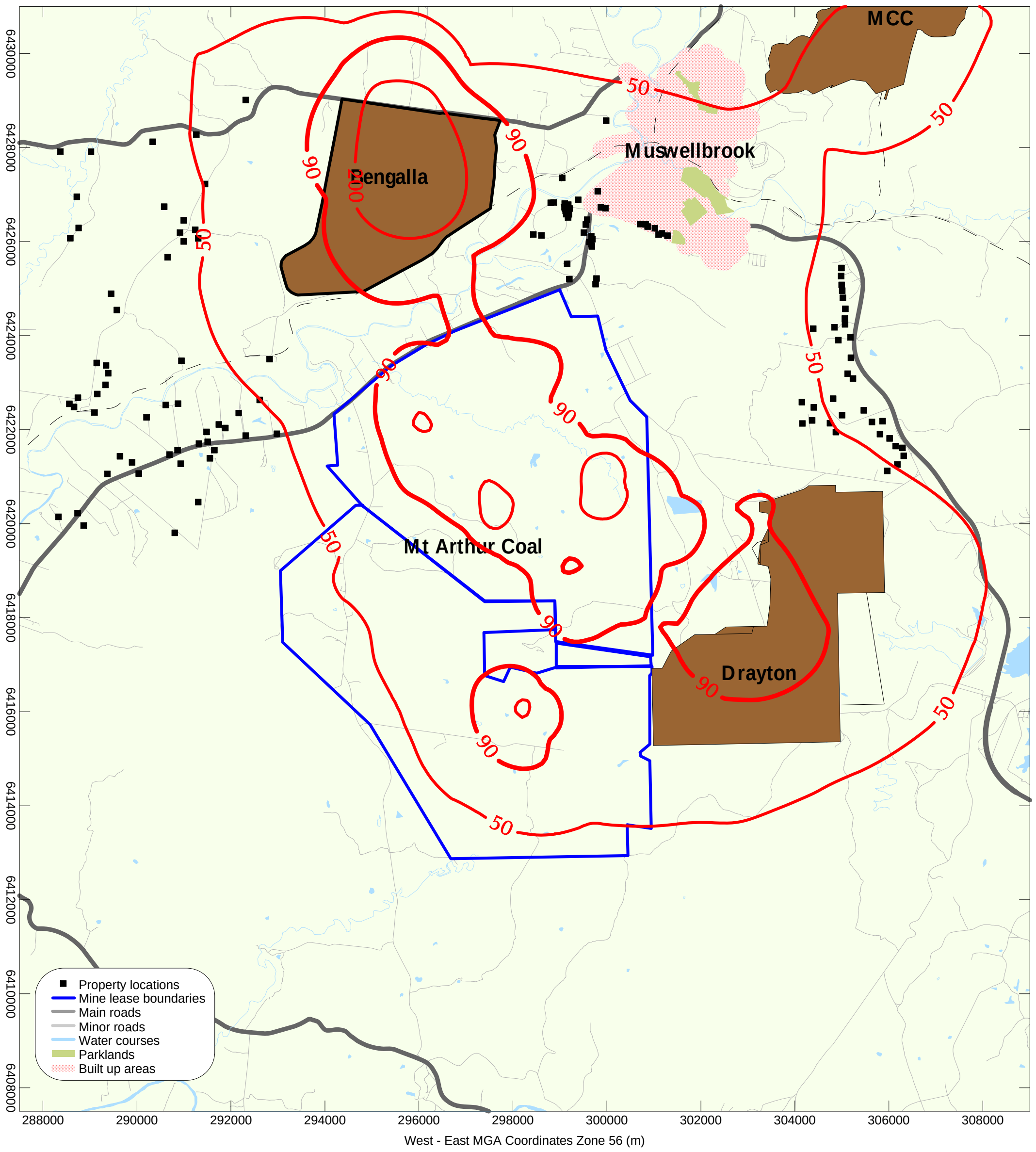
Species: Dust deposition	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** $g/m^2/month$	**Assessment criteria:** NSW DECC = 2 $g/m^2/month$	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.3: Predicted annual average dust deposition concentration due to emissions from the Project alone in 2011



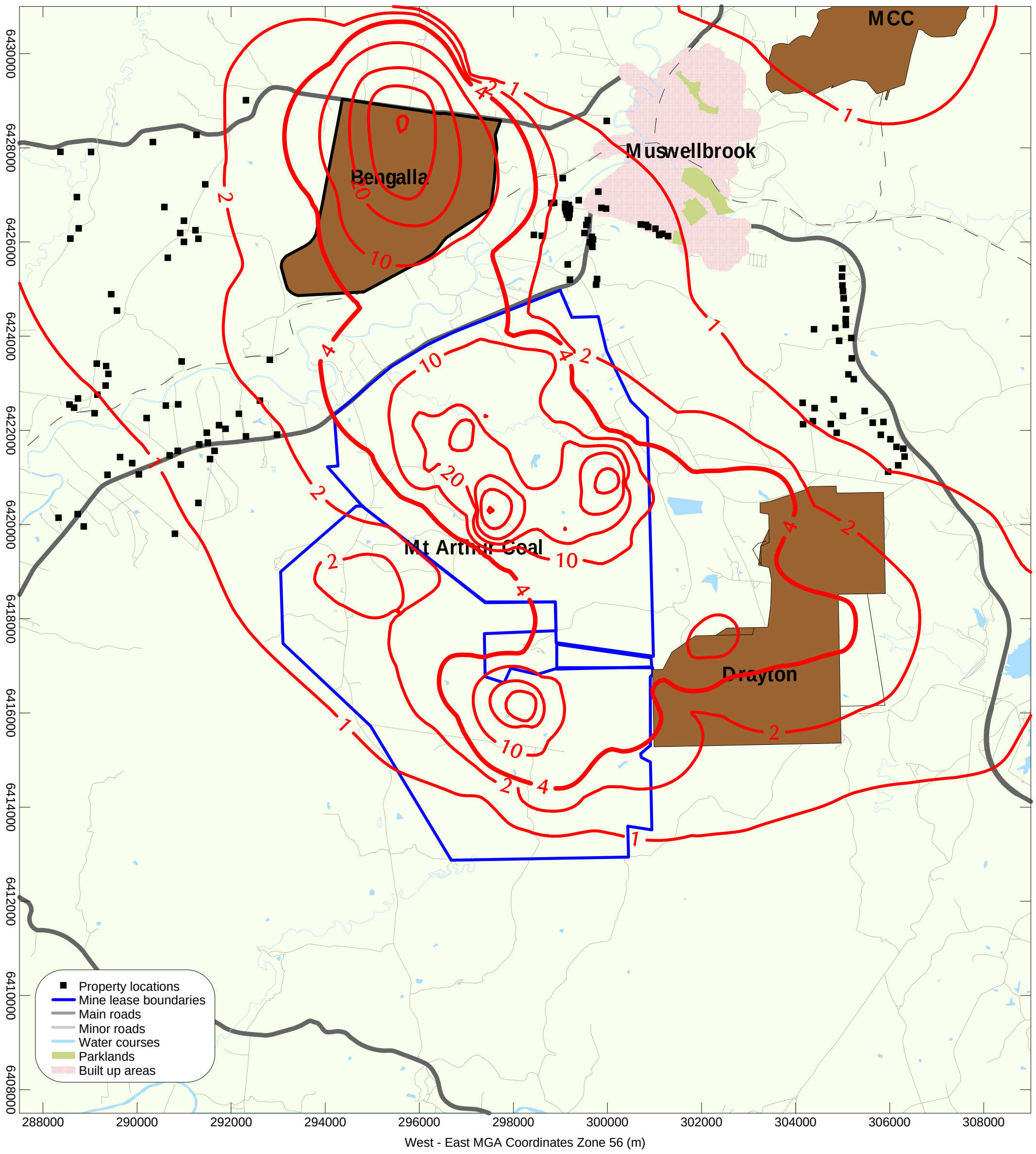
Species: PM_{10}	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project and other sources	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** $\mu g/m^3$	**Assessment criteria:** NEPM = 30 $\mu g/m^3$	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.4: Predicted annual average PM_{10} concentration due to emissions from the Project and other sources in 2011



Species: TSP	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project and other sources	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 90 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.5: Predicted annual average TSP concentration due to emissions from the Project and other sources in 2011



Species: Dust deposition	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2011 Project and other sources	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** g/m^2/month	**Assessment criteria:** NSW DECC = 4 g/m^2/month	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.6: Predicted annual average dust deposition concentration due to emissions from the Project and other sources in 2011

9.3.2 2016

Figure 9.7 to **Figure 9.12** show the predicted PM_{10} and TSP concentrations and dust deposition levels for operations in 2016 showing the effects of the Project by itself and the Project in combination with other sources.

Table 9.2 presents the results for all residences in the vicinity of the Project Site.

In summary for 2016 the following exceedances are identified:

- Annual average deposition above 2 g/m^2/month due to the Project considered in isolation – Two residences affected (210 and 212[a]) – see **Figure 9.9**.
- Annual average PM_{10} above 30 $\mu g/m^3$ due to the Project and other mines and other sources – Three private residences affected (210, 212[a] and 264) – see **Figure 9.10**.
- Annual average TSP above 90 $\mu g/m^3$ due to the Project and other mines and other sources – No residences affected – see **Figure 9.11**.
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – No residences affected – see **Figure 9.12**.

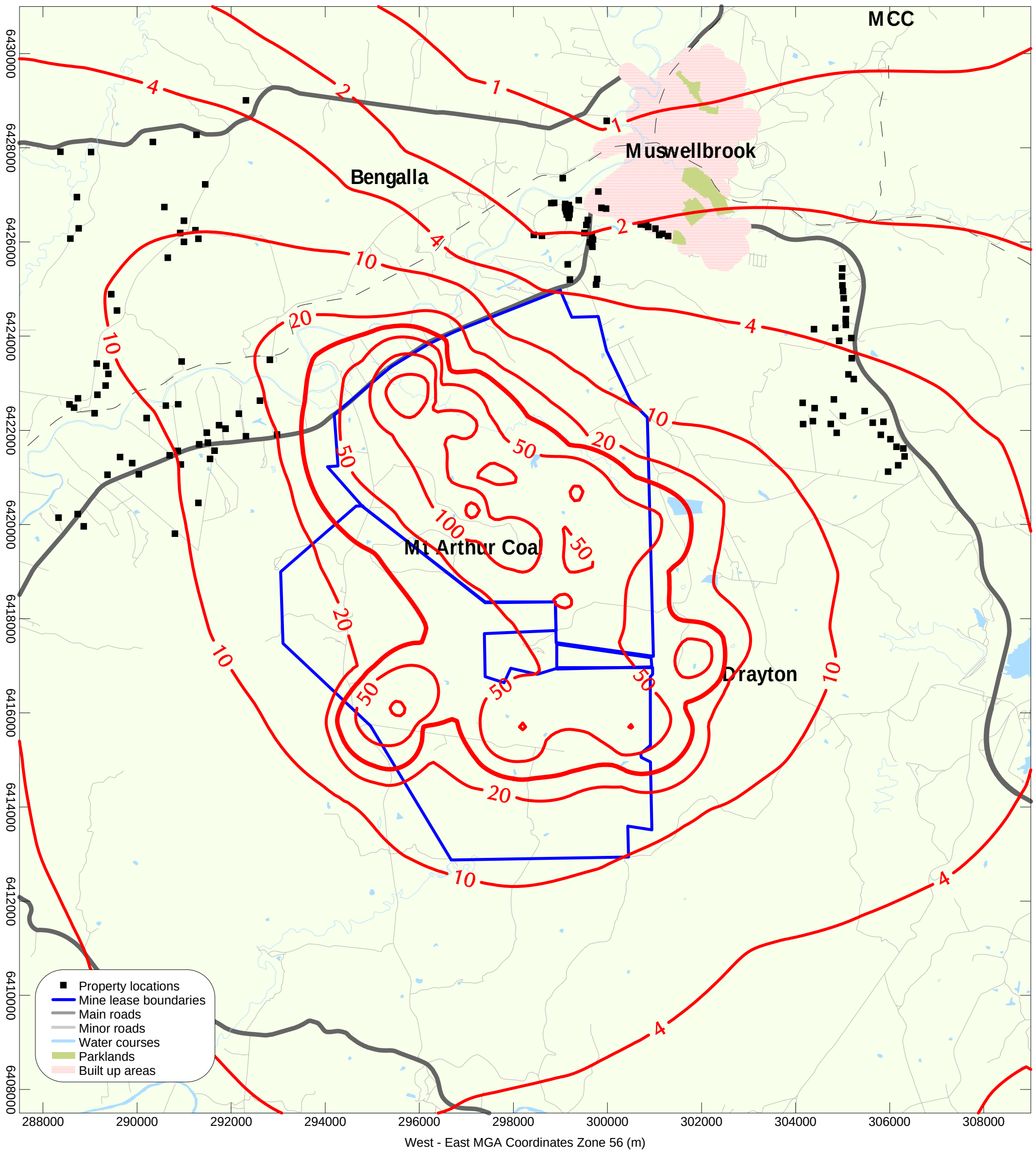
[a] Residence 212 is located in Bengalla ZOA

Table 9.2: Summary of predicted annual average air quality impacts for 2016

	2016 – Project alone			2016 - Project and other sources		
	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)
	Assessment criteria					
ID	***30***	***90***	***2***	***30***	***90***	***4***
6	3	4	0.1	24	60	1.3
8	3	3	0.1	24	61	1.3
9	2	2	0.1	27	65	1.7
10	2	2	0.1	26	65	1.6
11	2	2	0.1	25	63	1.3
12	2	2	0.1	25	63	1.3
13	2	2	0.1	25	63	1.2
14	2	2	0.0	26	64	1.4
15	2	2	0.0	26	64	1.4
16	2	2	0.0	26	64	1.4
17	2	2	0.0	25	64	1.3
18	2	2	0.0	26	64	1.3
20	2	2	0.1	26	64	1.4
21	2	2	0.1	26	64	1.4
22	2	2	0.1	26	65	1.4
23	2	2	0.1	26	65	1.4
24	2	2	0.1	26	65	1.4
25	2	2	0.1	26	64	1.4
26	2	2	0.0	26	64	1.4
27	2	2	0.0	26	64	1.4
28	2	2	0.0	27	65	1.5
29	2	2	0.0	26	64	1.5
30	2	2	0.0	26	63	1.4
31	1	1	0.0	25	61	1.3
32	2	2	0.0	26	63	1.3
33	2	2	0.0	25	61	1.3
34	1	2	0.0	24	59	1.1
36	1	1	0.0	21	52	0.8
37	2	2	0.0	24	59	1.1
37	2	2	0.0	24	60	1.1
39	2	2	0.1	24	62	1.2
40	2	2	0.1	24	62	1.2
41	2	2	0.1	24	62	1.2
42	2	2	0.1	24	62	1.2
43	2	2	0.1	24	61	1.2
49	3	3	0.1	24	59	1.2
49	3	4	0.1	23	59	1.2
56	2	2	0.0	23	58	1.0
57	2	2	0.0	23	57	1.0
58	2	2	0.0	23	57	1.0
59	2	2	0.0	23	57	1.0
60	2	2	0.1	23	57	0.9
61	2	2	0.0	23	57	0.9
62	2	2	0.1	23	56	0.9
69	2	3	0.1	19	48	0.7
70	3	3	0.1	19	48	0.7
71	3	3	0.1	19	48	0.7
72	3	3	0.1	19	48	0.7
73	3	3	0.1	19	48	0.7
75	3	3	0.1	19	48	0.7
76	3	4	0.1	19	48	0.7
77	4	4	0.1	19	49	0.7
77	3	4	0.1	19	48	0.7

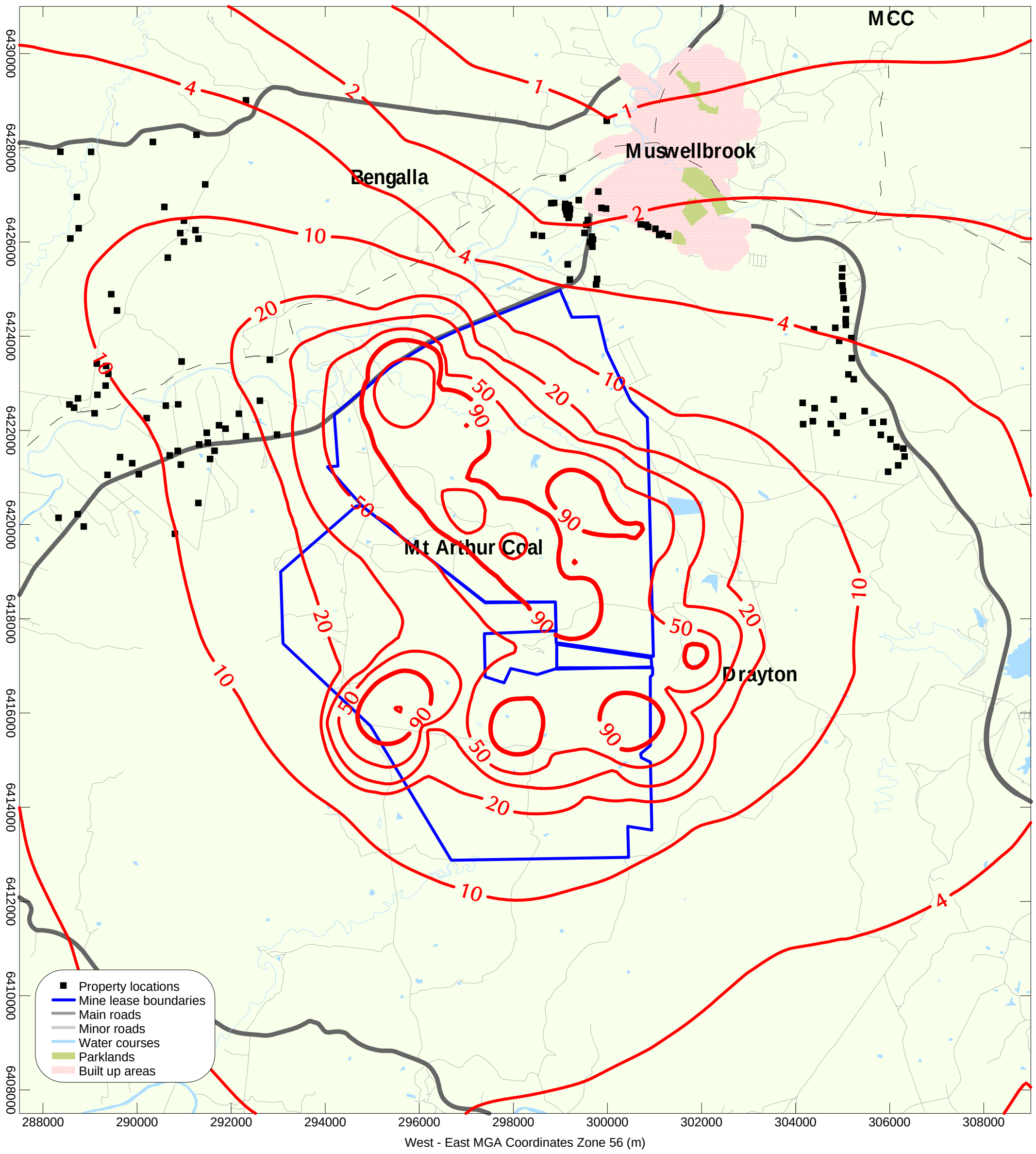
ID	2016 – Project alone			2016 - Project and other sources		
	PM_{10} (µg/m^3)	TSP (µg/m^3)	Dust deposition (g/m^2/month)	PM_{10} (µg/m^3)	TSP (µg/m^3)	Dust deposition (g/m^2/month)
	Assessment criteria					
	30	***90***	***2***	***30***	***90***	***4***
78	4	4	0.1	19	49	0.8
79	4	4	0.1	19	48	0.7
79	4	4	0.1	19	49	0.7
82	5	5	0.2	20	49	0.8
83	4	4	0.1	19	48	0.7
85	5	5	0.2	20	49	0.8
86	5	6	0.2	20	49	0.8
87	6	6	0.2	20	50	0.8
88	5	6	0.2	20	50	0.8
89	6	6	0.3	20	51	0.9
90	6	6	0.3	20	51	0.9
91	7	7	0.3	21	52	0.9
92	6	7	0.3	20	51	0.9
93	6	7	0.3	20	50	0.9
94	6	7	0.3	21	50	0.9
95	5	6	0.2	20	49	0.8
96	5	5	0.2	20	48	0.8
97	6	6	0.2	20	49	0.8
98	5	6	0.2	20	49	0.8
99	5	6	0.2	21	48	0.8
99	6	6	0.2	21	49	0.8
100	6	6	0.3	21	49	0.9
101	6	6	0.3	21	49	0.9
102	6	7	0.3	22	50	0.9
182	6	7	0.3	18	42	0.8
183	9	10	0.5	20	44	1.0
184a	12	13	1.0	23	47	1.6
184b	12	13	0.9	23	47	1.5
184c	11	12	0.6	22	45	1.2
186	8	9	0.5	20	43	1.1
187	10	11	0.7	21	45	1.3
190	6	6	0.3	18	41	0.8
191	6	6	0.3	18	42	0.8
195	7	7	0.4	19	42	1.0
196	8	8	0.5	19	43	1.1
197	8	8	0.5	19	43	1.1
198	10	10	0.7	21	45	1.3
200	11	12	0.9	23	47	1.5
201	10	11	0.7	22	46	1.3
203	12	13	0.9	23	47	1.5
204	12	14	1.1	24	48	1.7
205	12	13	1.0	23	48	1.6
206	14	15	1.3	25	50	1.9
207	14	15	1.3	26	50	1.9
208	16	18	1.7	28	54	2.3
209	16	17	1.4	27	51	2.1
210	19	22	**2.3**	**31**	60	3.0
211	20	22	2.0	30	58	2.7
212	22	25	**3.2**	**38**	69	3.9
213	7	8	0.5	19	43	1.1
213	8	8	0.6	20	44	1.1
213	7	8	0.5	19	43	1.1
216	8	8	0.6	20	44	1.1
218	9	10	0.7	21	45	1.3
218	9	10	0.8	22	46	1.3

ID	2016 – Project alone			2016 - Project and other sources		
	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)
	Assessment criteria					
	30	*90*	*2*	*30*	*90*	*4*
218	8	9	0.6	20	45	1.2
226	14	15	1.4	27	53	2.0
231	9	10	0.7	21	46	1.3
232	9	10	0.8	22	47	1.4
233	10	11	1.0	23	49	1.6
233	11	11	1.0	23	49	1.6
235	8	9	0.8	21	46	1.4
236	8	9	0.8	22	47	1.4
238	10	11	1.1	27	53	1.9
239	11	12	1.2	27	53	1.9
240	10	12	1.2	28	54	1.9
241	10	12	1.2	29	56	2.1
242	9	10	1.0	28	54	1.9
242	8	9	0.9	26	52	1.8
242	10	11	1.1	29	55	2.0
243	7	8	0.7	22	47	1.4
250	7	8	0.7	30	57	2.2
252	5	5	0.5	30	56	2.3
254	6	6	0.5	26	51	1.8
257	6	6	0.6	23	47	1.4
259	6	6	0.5	22	46	1.3
264	3	3	0.3	**31**	57	2.6



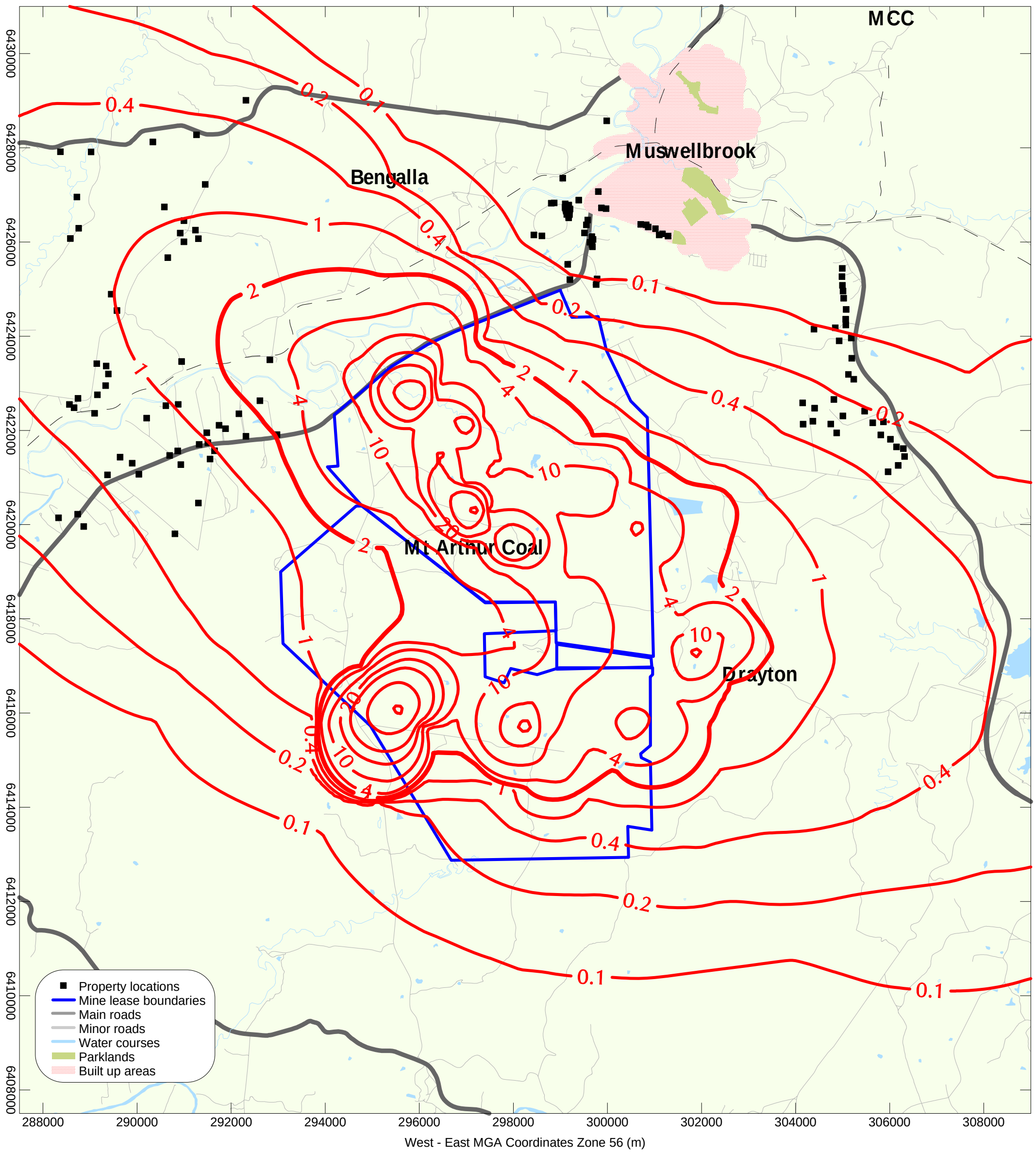
Species: PM$_{10}$	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2016 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 30 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.7: Predicted annual average PM$_{10}$ concentration due to emissions from the Project alone in 2016



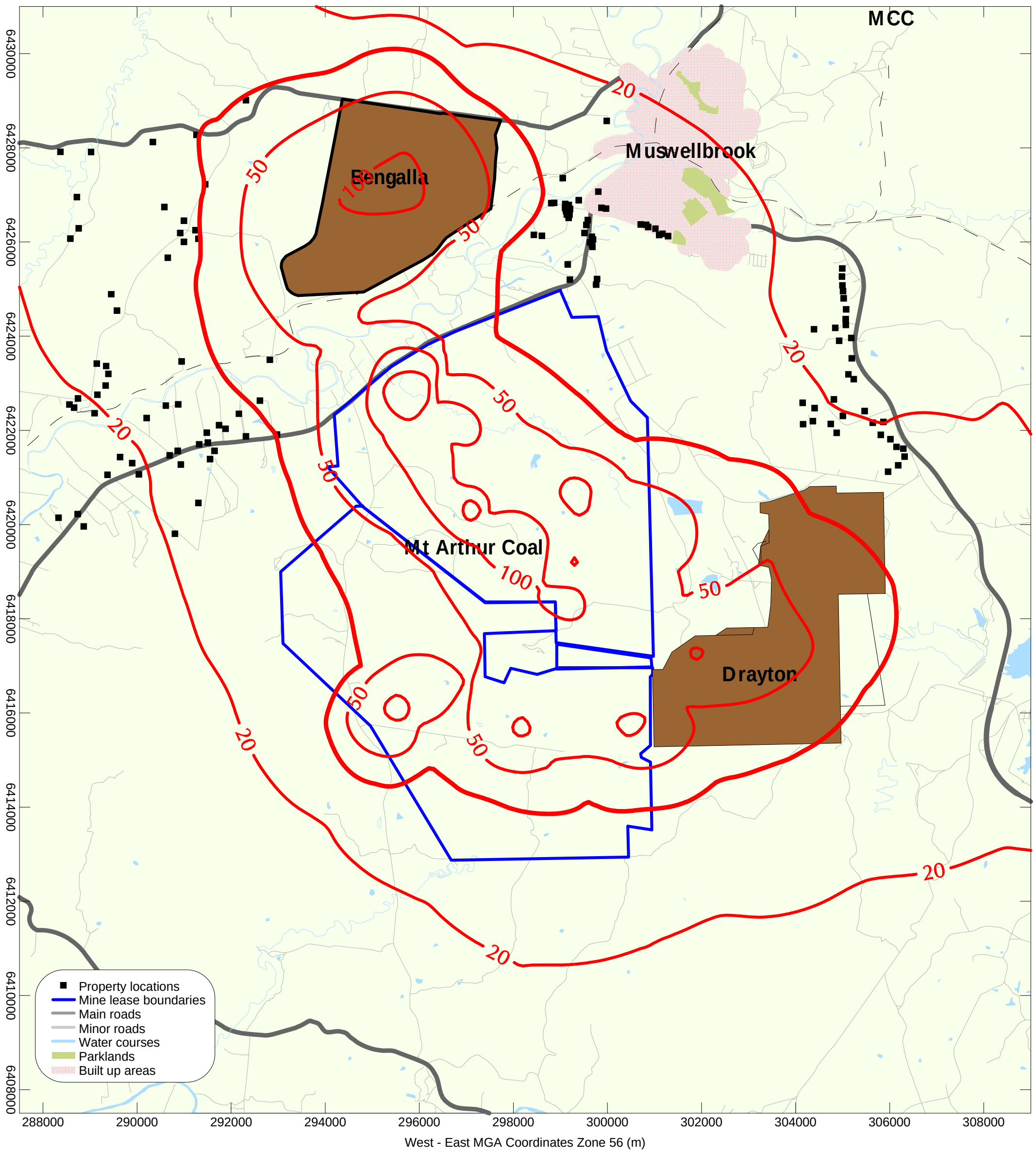
Species: TSP	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2016 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 90 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.8: Predicted annual average TSP concentration due to emissions from the Project alone in 2016



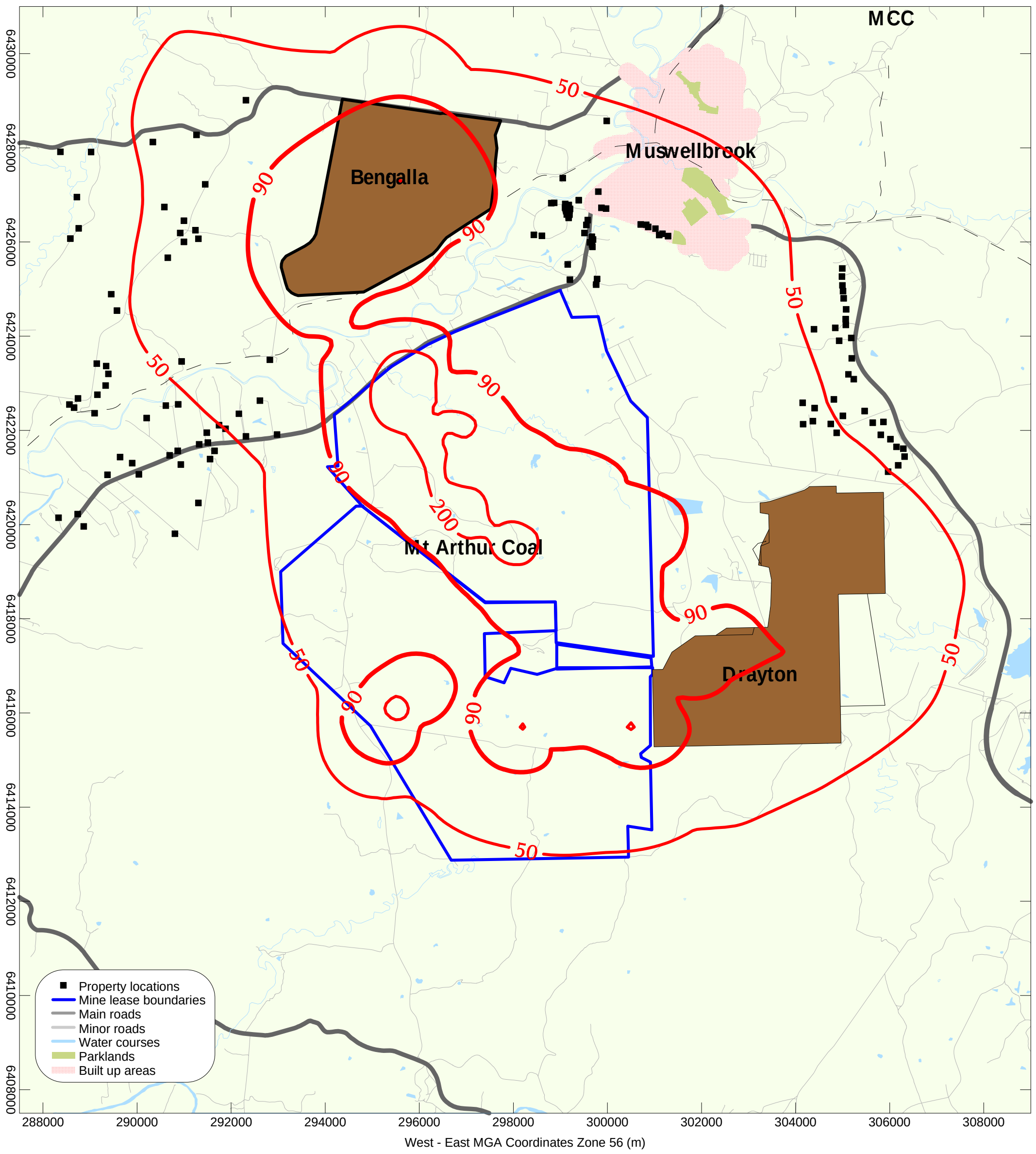
Species: Dust deposition	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2016 Project only	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** $g/m^2/month$	**Assessment criteria:** NSW DECC = 2 $g/m^2/month$	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.9: Predicted annual average dust deposition concentration due to emissions from the Project alone in 2016



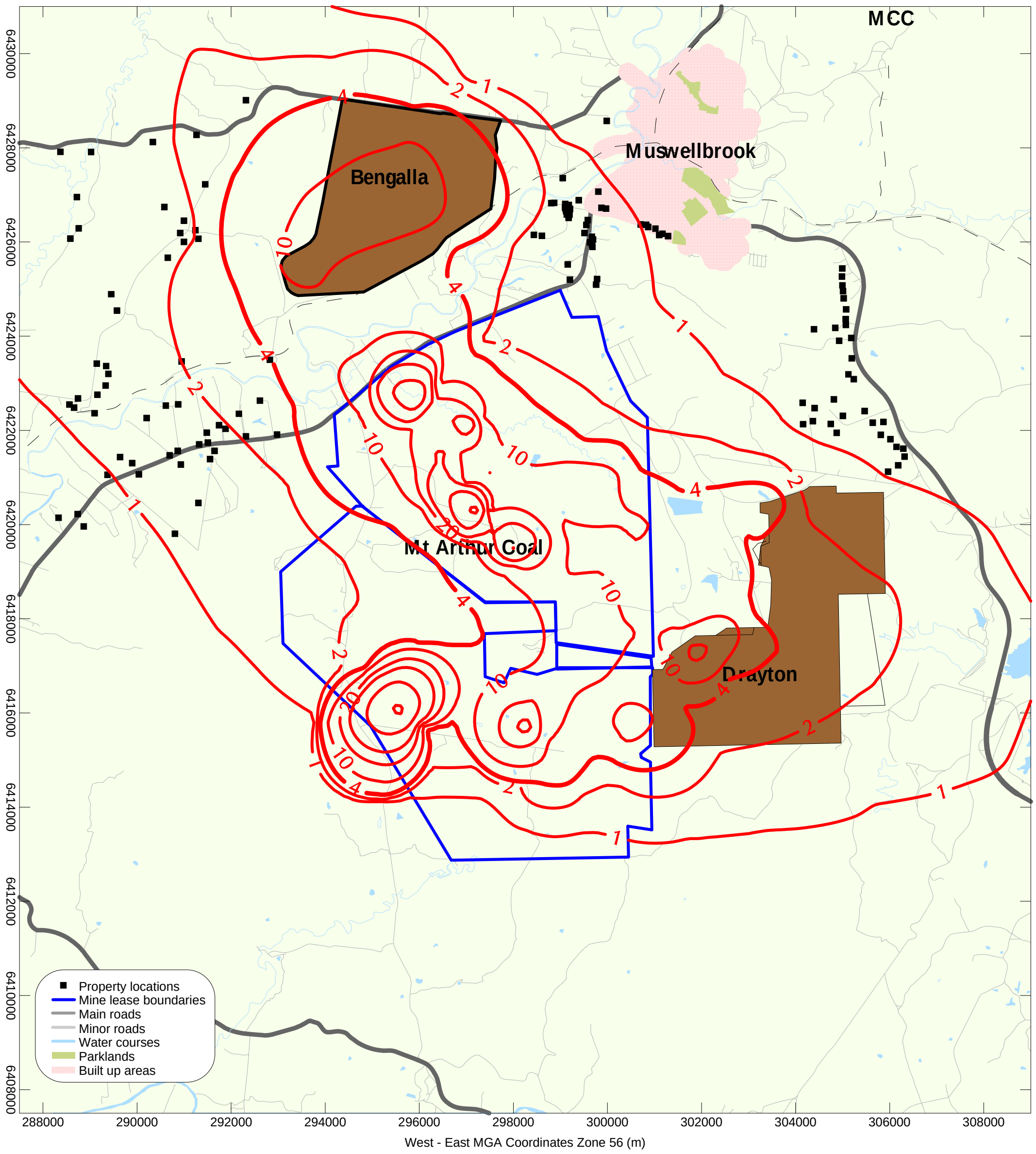
Species: PM$_{10}$	Averaging Time: Annual	Percentile: Maximum	Scenario: 2016 Project and other sources	Location: Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 30 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.10: Predicted annual average PM$_{10}$ concentration due to emissions from the Project and other sources in 2016



Species:	Averaging Time:	Percentile:	Scenario:	Location:
TSP	Annual	Maximum	2016 Project and other sources	Mt Arthur Coal
Model Used:	**Units:**	**Assessment criteria:**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	NEPM = 90 µg/m^3	Macleans Hill 2007-2008	J Cox

Figure 9.11: Predicted annual average TSP concentration due to emissions from the Project and other sources in 2016



Species: Dust deposition	Averaging Time: Annual	Percentile: Maximum	Scenario: 2016 Project and other sources	Location: Mt Arthur Coal
Model Used: ISCMOD	**Units:** g/m^2/month	**Assessment criteria:** NSW DECC = 4 g/m^2/month	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.12: Predicted annual average dust deposition concentration due to emissions from the Project and other sources in 2016

9.3.3 2022

Figure 9.13 to **Figure 9.18** show the predicted PM_{10} and TSP concentrations and dust deposition levels for operations in 2022 showing the effects of the Project by itself and the Project in combination with other sources.

Table 9.3 presents the results for all residences in the vicinity of the Project Site.

In summary for 2022 the following exceedances are identified.

- Annual average deposition above 2 g/m^2/month due to the Project considered in isolation – Five residences (owned by three landowners) affected (208, 209, 210, 211 and 212[a]) – see **Figure 9.15**.
- Annual average PM_{10} above 30 $\mu g/m^3$ due to the Project and other mines and other sources – No residences affected – see **Figure 9.16**.
- Annual average TSP above 90 $\mu g/m^3$ due to the Project and other mines and other sources – No residences affected – see **Figure 9.17**.
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – One residence affected (212[b]) – see **Figure 9.18**.

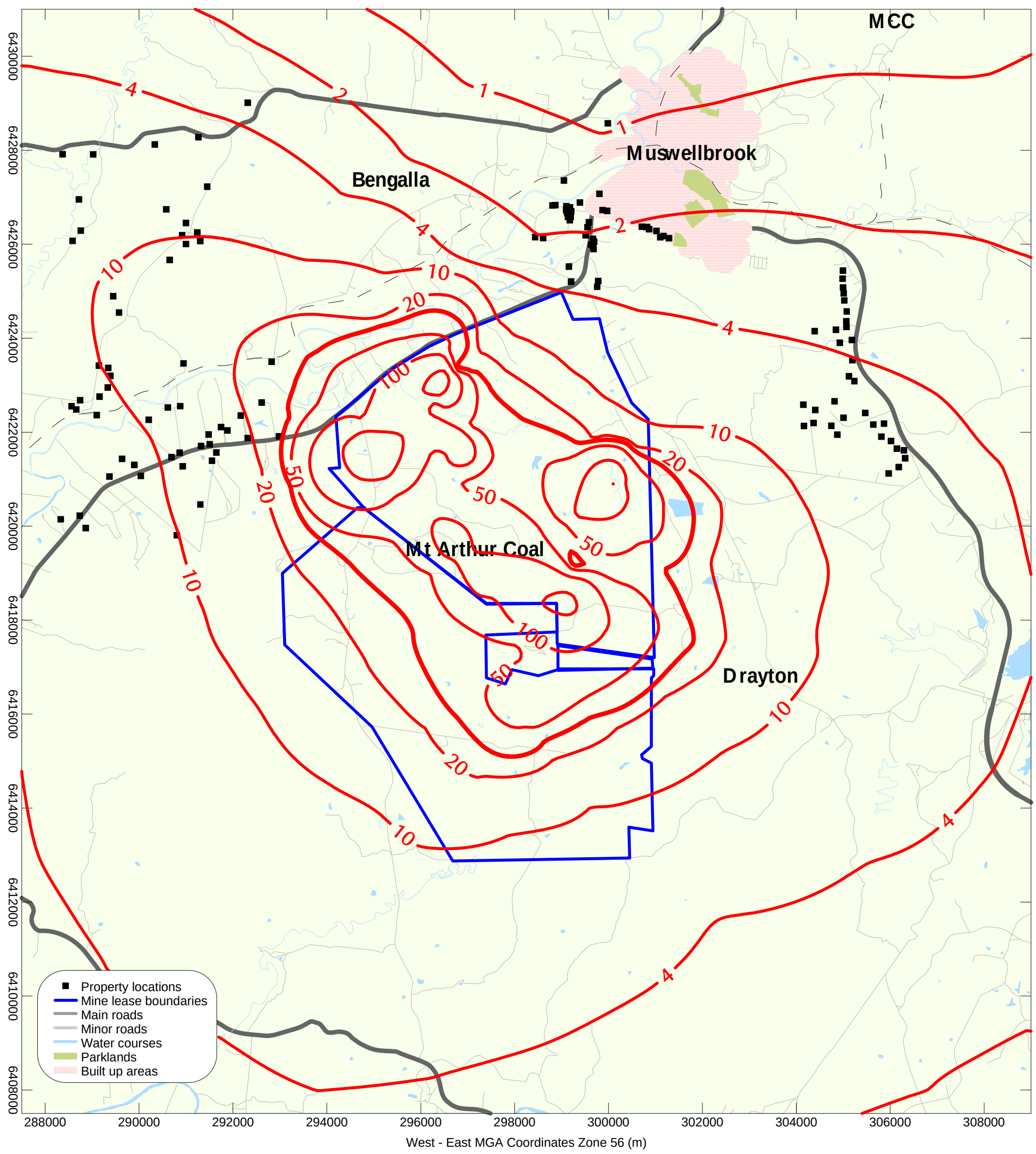
[a] Residence 212 is located in the Bengalla ZOA

Table 9.3: Summary of predicted annual average air quality impacts for 2022

ID	2022 – Project alone			2022 - Project and other sources		
	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)
	Assessment criteria					
	30	*90*	*2*	*30*	*90*	*4*
6	3	4	0.1	16	52	0.6
8	3	3	0.1	16	52	0.6
9	2	2	0.1	16	52	0.6
10	2	2	0.1	16	53	0.6
11	2	2	0.1	17	54	0.6
12	2	2	0.1	17	54	0.6
13	2	2	0.1	17	54	0.6
14	2	2	0.0	17	54	0.5
15	2	2	0.0	17	54	0.5
16	2	2	0.0	17	54	0.5
17	2	2	0.0	17	54	0.5
18	2	2	0.0	17	54	0.5
20	2	2	0.0	17	54	0.5
21	2	2	0.0	17	54	0.5
22	2	2	0.1	17	55	0.5
23	2	2	0.1	17	55	0.6
24	2	2	0.0	17	54	0.5
25	2	2	0.0	17	54	0.5
26	2	2	0.0	17	54	0.5
27	2	2	0.0	17	54	0.5
28	2	2	0.0	16	53	0.5
29	2	2	0.0	16	53	0.5
30	2	2	0.0	17	53	0.5
31	1	1	0.0	16	51	0.5
32	2	2	0.0	17	53	0.5
33	2	2	0.0	17	52	0.5
34	1	2	0.0	17	51	0.5
36	1	1	0.0	16	46	0.5
37	2	2	0.0	17	52	0.5
37	2	2	0.0	17	52	0.5
39	2	2	0.1	17	54	0.6
40	2	2	0.1	17	54	0.6
41	2	2	0.1	17	54	0.6
42	2	3	0.1	17	53	0.6
43	2	3	0.1	17	53	0.6
49	3	4	0.1	17	52	0.6
49	4	4	0.1	17	52	0.6
56	2	2	0.0	18	52	0.5
57	2	2	0.0	18	51	0.5
58	2	2	0.0	18	52	0.5
59	2	2	0.0	18	51	0.5
60	2	2	0.1	18	51	0.6
61	2	2	0.1	18	51	0.5
62	2	2	0.1	18	51	0.6
69	2	3	0.1	16	45	0.6
70	3	3	0.1	16	45	0.6
71	3	3	0.1	16	45	0.6
72	3	3	0.1	16	45	0.6
73	3	3	0.1	16	45	0.6
75	3	3	0.1	17	45	0.6
76	3	3	0.1	17	46	0.6
77	3	4	0.1	17	46	0.6
77	3	4	0.1	17	46	0.6

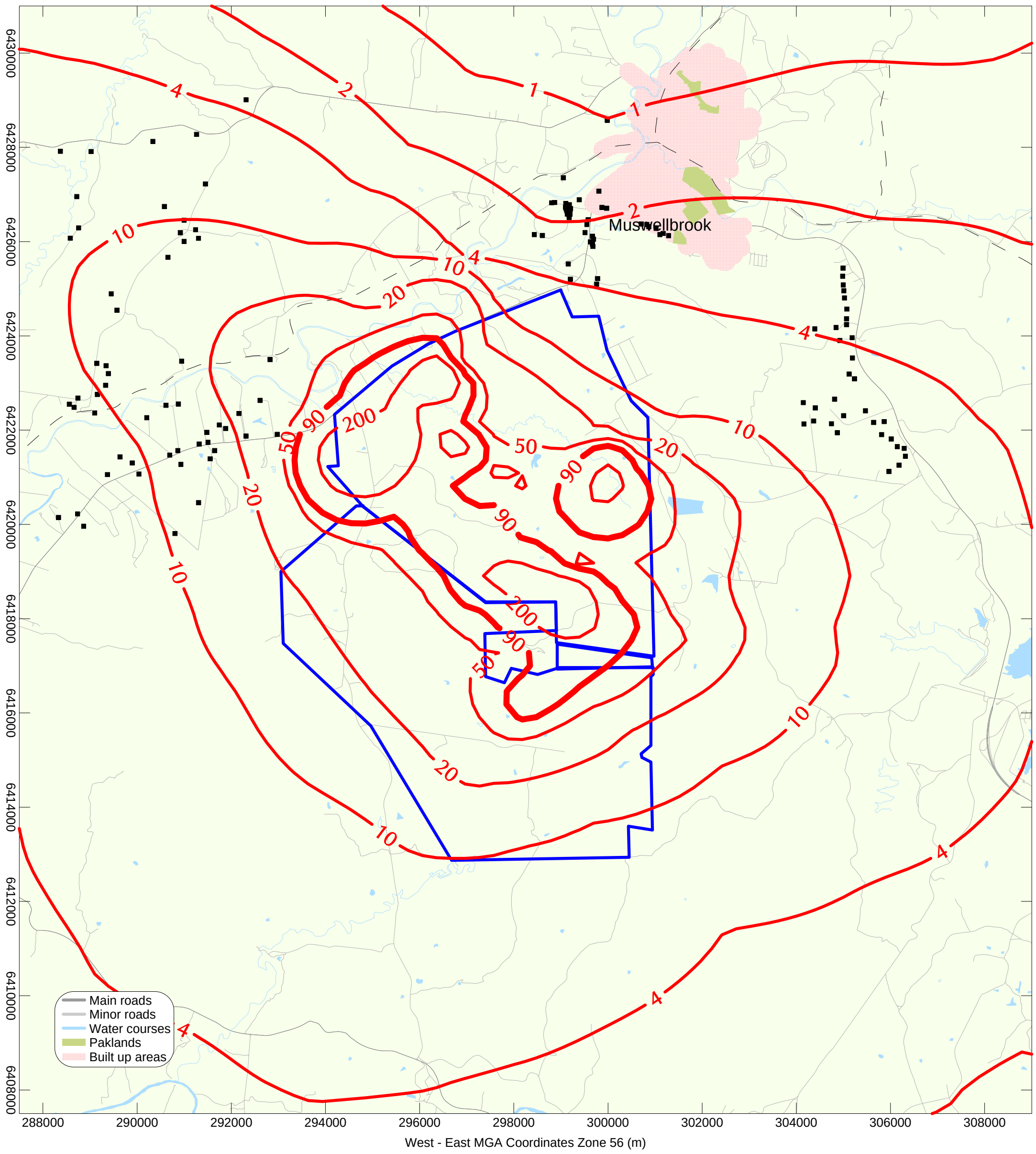
ID	2022 – Project alone			2022 - Project and other sources		
	PM_{10} (µg/m^3)	TSP (µg/m^3)	Dust deposition (g/m^2/month)	PM_{10} (µg/m^3)	TSP (µg/m^3)	Dust deposition (g/m^2/month)
	Assessment criteria					
	30	***90***	***2***	***30***	***90***	***4***
78	4	4	0.1	17	47	0.6
79	4	4	0.1	17	46	0.6
79	4	4	0.1	17	46	0.6
82	4	5	0.1	17	46	0.6
83	4	4	0.1	17	46	0.6
85	4	5	0.2	17	46	0.7
86	5	5	0.2	17	46	0.7
87	6	6	0.2	18	47	0.7
88	5	6	0.2	17	47	0.7
89	6	6	0.2	18	48	0.7
90	6	6	0.2	18	48	0.7
91	7	7	0.3	18	49	0.8
92	6	7	0.3	18	48	0.8
93	6	6	0.3	18	48	0.8
94	6	7	0.3	18	48	0.8
95	5	6	0.2	18	46	0.7
96	5	5	0.2	18	46	0.7
97	5	6	0.2	18	46	0.7
98	5	6	0.2	18	46	0.7
99	5	6	0.2	18	46	0.7
99	5	6	0.2	18	46	0.7
100	5	6	0.3	18	46	0.8
101	6	6	0.3	18	46	0.8
102	6	7	0.3	18	46	0.8
182	6	7	0.3	14	38	0.8
183	10	10	0.4	16	40	0.9
184a	14	16	1.3	19	43	1.8
184 b	14	15	1.2	19	43	1.7
184c	12	13	0.7	18	42	1.2
186	9	9	0.6	15	39	1.1
187	11	12	0.9	17	41	1.4
190	6	6	0.2	14	38	0.7
191	6	6	0.3	14	38	0.8
195	7	8	0.5	15	38	1.0
196	8	9	0.6	15	39	1.1
197	8	9	0.6	15	39	1.1
198	11	12	0.8	17	41	1.3
200	12	13	1.2	18	42	1.7
201	11	12	0.9	17	41	1.4
203	13	15	1.2	18	43	1.7
204	14	16	1.4	19	44	1.9
205	14	16	1.3	19	43	1.8
206	16	18	1.7	20	45	2.2
207	17	19	1.8	21	46	2.3
208	19	22	**2.3**	23	49	2.8
209	19	21	**2.1**	23	48	2.6
210	23	27	**3.2**	26	56	3.7
211	25	29	**3.1**	29	58	3.8
212	24	29	**3.9**	29	60	**4.4**
213	8	8	0.6	15	40	1.1
213	8	9	0.7	16	40	1.2
213	8	8	0.6	15	40	1.1
216	8	9	0.7	16	40	1.2
218	10	10	0.9	17	41	1.4

ID	2022 – Project alone			2022 - Project and other sources		
	PM10 (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	Dust deposition (g/m²/month)
	Assessment criteria					
	30	*90*	*2*	*30*	*90*	*4*
218	10	11	0.9	17	42	1.4
218	9	10	0.8	16	41	1.3
226	15	17	1.7	21	47	2.2
231	10	11	0.9	17	42	1.4
232	10	11	0.9	17	42	1.4
233	11	12	1.1	18	44	1.6
233	11	12	1.2	18	44	1.7
235	8	9	0.8	17	42	1.3
236	8	9	0.8	17	42	1.3
238	10	11	1.1	18	44	1.6
239	11	12	1.3	19	45	1.8
240	10	12	1.2	18	44	1.7
241	10	11	1.2	18	44	1.7
242	9	10	1.0	18	43	1.5
242	8	9	0.9	17	42	1.4
242	10	11	1.1	18	44	1.6
243	7	8	0.7	17	41	1.2
250	7	7	0.7	16	41	1.2
252	5	5	0.4	15	40	1.0
254	5	6	0.5	16	40	1.0
257	6	6	0.6	16	41	1.1
259	6	6	0.5	16	41	1.0
264	3	3	0.2	15	39	0.8



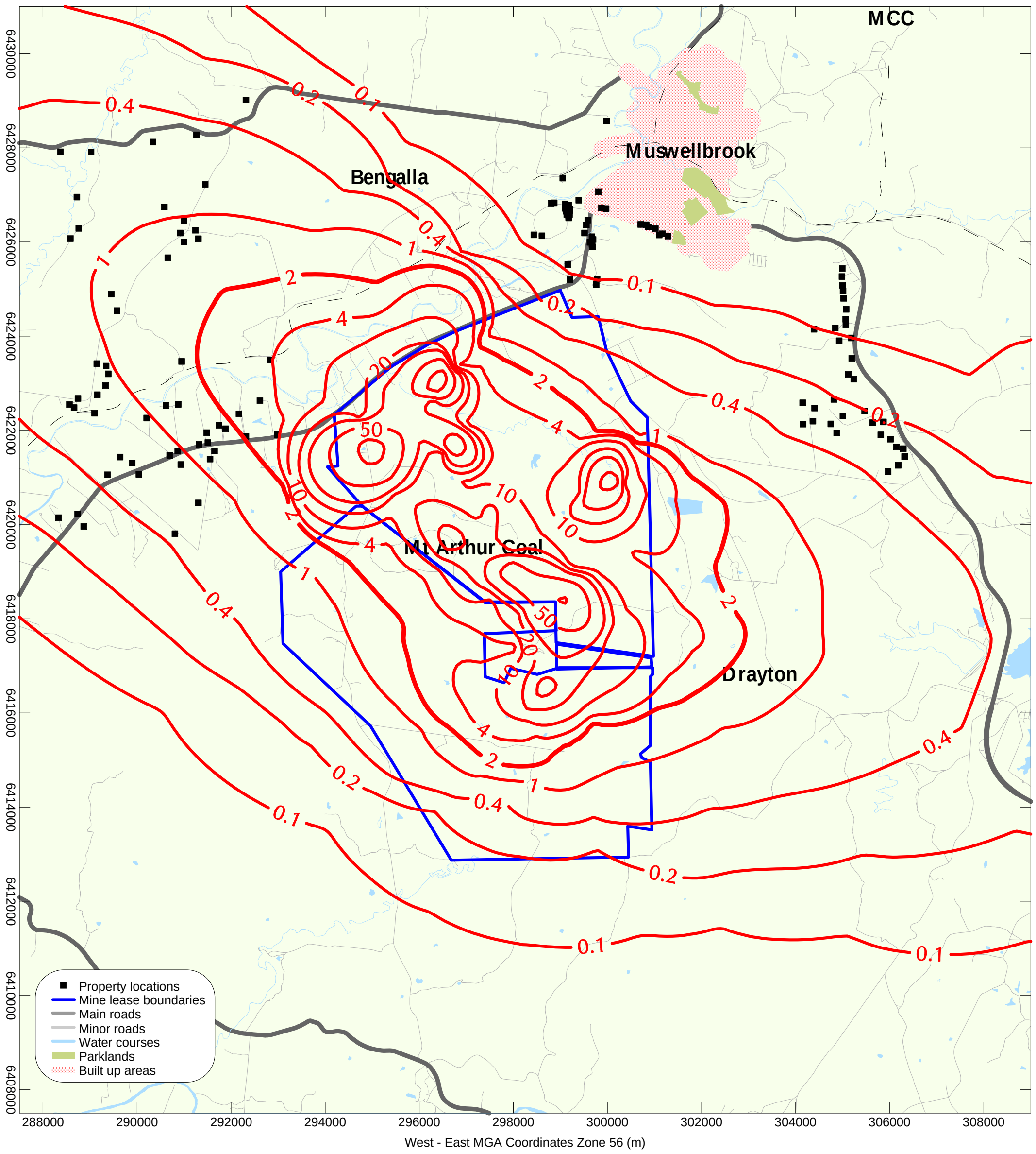
Species: PM$_{10}$	Averaging Time: Annual	Percentile: Maximum	Scenario: 2022 Project only	Location: Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 30 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.13: Predicted annual average PM$_{10}$ concentration due to emissions from the Project alone in 2022



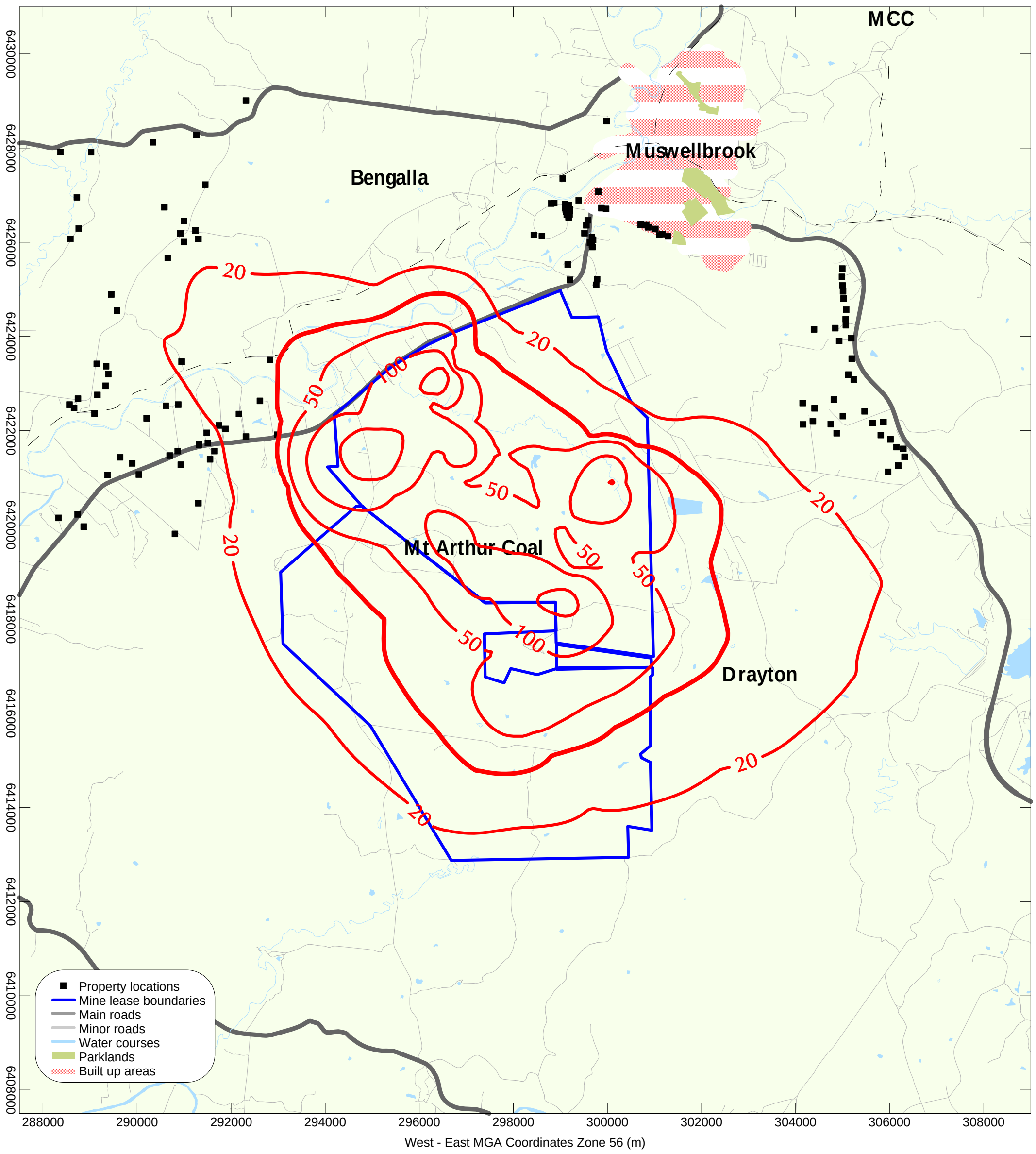
Species:	Averaging Time:	Percentile:	Scenario:	Location:
TSP	Annual	Maximum	2022 Project only	Mt Arthur Coal
Model Used:	**Units:**	**Assessment criteria:**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	NEPM = 90 µg/m^3	Macleans Hill 2007-2008	J Cox

Figure 9.14: Predicted annual average TSP concentration due to emissions from the Project alone in 2022



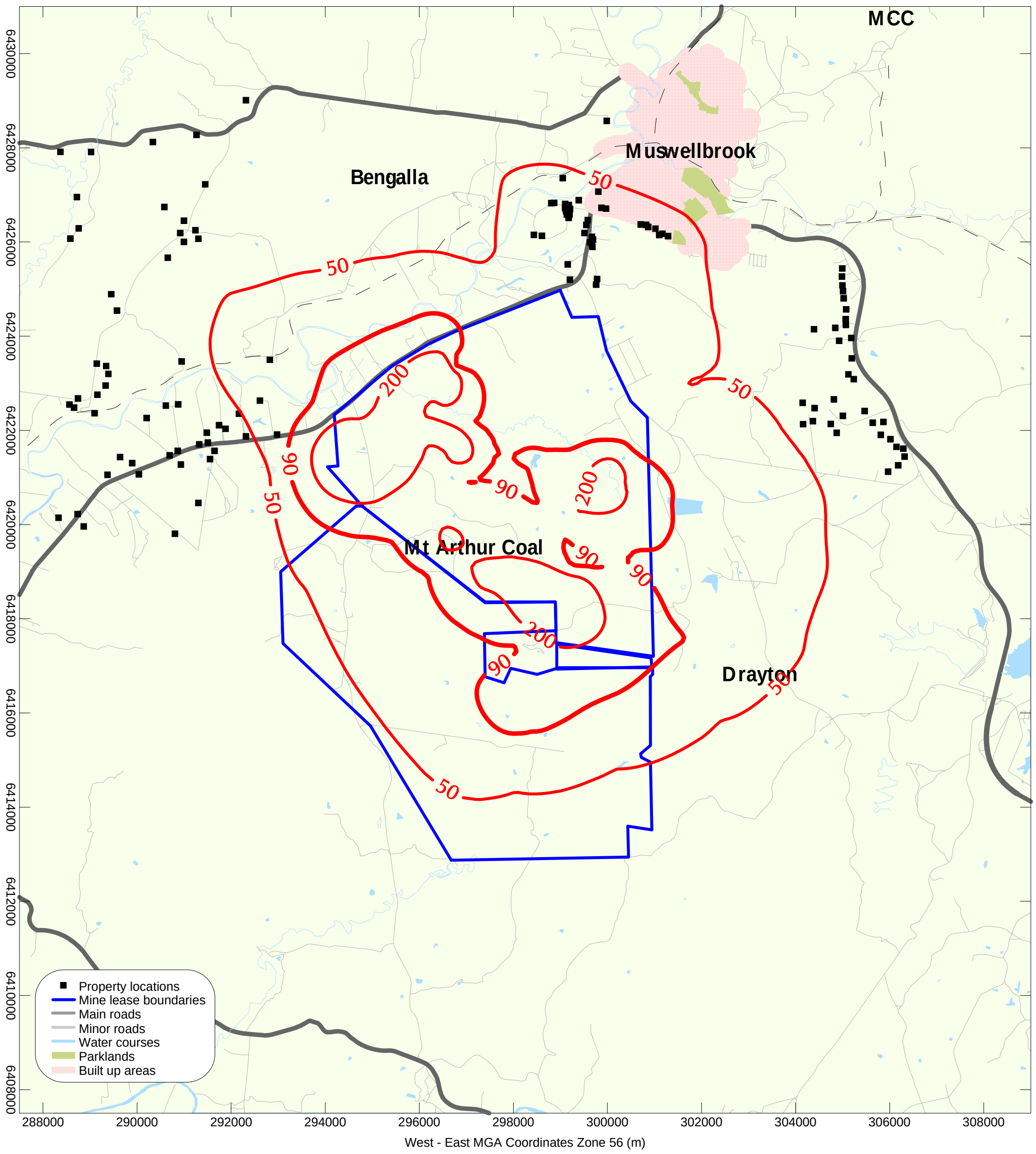
Species: Dust deposition	Averaging Time: Annual	Percentile: Maximum	Scenario: 2022 Project only	Location: Mt Arthur Coal
Model Used: ISCMOD	**Units:** g/m²/month	**Assessment criteria:** NSW DECC = 2 g/m²/month	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.15: Predicted annual average dust deposition concentration due to emissions from the Project alone in 2022



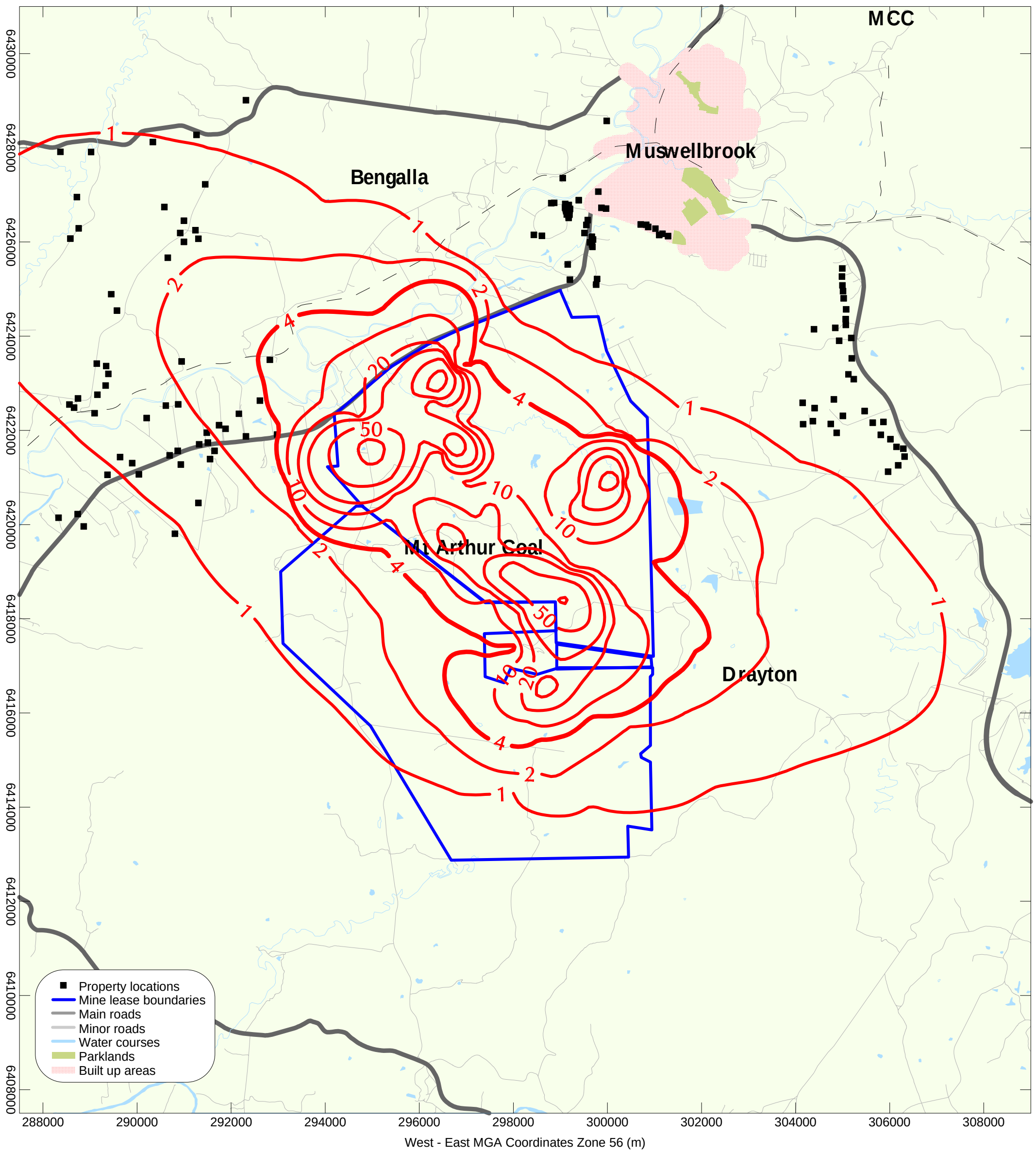
Species: PM10	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2022 Project and other sources	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria:** NEPM = 30 µg/m^3	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.16: Predicted annual average PM_{10} concentration due to emissions from the Project and other sources in 2022



Species:	**Averaging Time:**	**Percentile:**	**Scenario:**	**Location:**
TSP	Annual	Maximum	2022 Project and other sources	Mt Arthur Coal
Model Used:	**Units:**	**Assessment criteria:**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	NEPM = 90 µg/m^3	Macleans Hill 2007-2008	J Cox

Figure 9.17: Predicted annual average TSP concentration due to emissions from the Project and other sources in 2022



Species: Dust deposition	**Averaging Time:** Annual	**Percentile:** Maximum	**Scenario:** 2022 Project and other sources	**Location:** Mt Arthur Coal
Model Used: ISCMOD	**Units:** g/m^2/month	**Assessment criteria:** NSW DECC = 4 g/m^2/month	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure 9.18: Predicted annual average dust deposition concentration due to emissions from the Project and other sources in 2022

9.4 24-hour average PM_{10} concentrations

Table 9.4 presents the predicted maximum 24-hour PM_{10} concentrations at the residences and highlights in bold those figures that are predicted to exceed the criteria by more than 5 days.

In summary, the following properties are predicted to experience an exceedance of the 24-hour PM_{10} assessment criteria, due to emissions from the Project only:

- 2011 – no exceedances;
- 2016 – 14 private residences, owned by 11 landowners (91,184[a], 204-212[b], and 226); and
- 2022 – 20 private residences, owned by 14 landowners (91, 94, 183, 184[a], 187, 200, 201, 203-212[b], and 226).

As discussed in **Section 9.2**, recent Conditions of Consent issued by the Department of Planning (for example, Integra North Open Cut) have required acquisition of properties if the 24-hour average PM_{10} concentration is exceeded more than five times per year (i.e. the 98.6th percentile), due to emissions from the Project alone. This is in line with the NEPM requirements as it is understood the criteria could be exceeded due to natural events such as bushfires.

Table 9.5 summarises the number of days predicted to exceed the 24-hour average PM_{10} concentration. The private residences (highlighted in bold in **Table 9.5**) which are predicted to exceed the criteria by more than five days for one or more years are:

- 2016 – five residences, owned by three landowners, (208 to 212[b]); and
- 2022 – eight residences, owned by five landowners, (206 to 212 [b], 226).

[a] Note that property 184 consists of three residences
[b] Residence 212 is located in Bengalla ZOA

Table 9.4: Summary of maximum predicted 24-hour average PM_{10} concentrations (µg/m³)

ID	2011	2016	2022
	Assessment criteria = 50 µg/m³		
6	24	36	45
8	21	30	35
9	20	27	26
10	20	27	26
11	15	22	24
12	14	21	23
13	14	21	22
14	16	20	22
15	16	20	21
16	16	20	21
17	16	20	21
18	16	20	21
20	16	20	21
21	16	20	22
22	16	21	22
23	16	21	22
24	16	21	22
25	16	21	22
26	16	21	22
27	16	20	22
28	16	22	22
29	16	21	22
30	16	20	21
31	14	19	18
32	16	19	21
33	15	18	19
34	12	18	17
36	11	14	14
37	13	20	20
37	14	21	21
39	15	24	27
40	15	25	28
41	16	25	29
42	16	26	30
43	16	27	30
49	27	33	41
49	25	33	41
56	17	26	28
57	17	27	29
58	18	27	29
59	19	28	29
60	21	29	30
61	22	30	30
62	23	31	31
69	15	24	22
70	17	25	24
71	18	26	26
72	20	28	28
73	21	30	31
75	24	33	34
76	26	36	37
77	27	39	39
77	27	38	39
78	27	37	38
79	30	43	43
79	28	41	41
82	30	41	40
83	29	41	40
85	29	39	39
86	29	38	40
87	32	42	44
88	32	42	42
89	35	46	47
90	37	49	48
91	38	**51**	**52**
92	36	48	49
93	35	45	47
94	37	47	**52**
95	31	41	44
96	30	40	43

ID	2011	2016	2022
	Assessment criteria = 50 µg/m^3		
97	32	45	48
98	32	46	47
99	31	47	46
99	30	47	44
100	31	47	43
101	32	47	43
102	33	47	45
182	20	35	35
183	26	49	**51**
184a	28	**53**	**64**
184b	27	**51**	**63**
184c	28	**53**	**59**
186	20	37	42
187	24	45	**53**
190	19	32	33
191	19	33	34
195	18	32	36
196	20	35	38
197	20	35	40
198	24	42	50
200	28	49	**54**
201	25	44	**52**
203	28	49	**58**
204	30	**53**	**59**
205	29	**51**	**61**
206	32	**57**	**66**
207	33	**57**	**66**
208	35	**64**	**77**
209	34	**65**	**75**
210	38	**75**	**88**
211	40	**81**	**95**
212	45	**86**	**92**
213	22	37	39
213	22	37	39
213	23	38	40
216	23	39	41
218	24	41	43
218	24	42	44
218	24	42	45
226	29	**55**	**60**
231	23	41	43
232	24	42	44
233	24	44	45
233	24	45	47
235	21	35	35
236	21	35	35
238	25	42	41
239	27	46	45
240	26	44	43
241	26	43	43
242	23	36	35
242	24	39	39
242	25	41	42
243	19	33	32
250	21	34	33
252	17	30	30
254	17	27	26
257	17	28	27
259	17	28	27

Table 9.5: Number of day's 24-hour PM_{10} average concentrations predicted to exceed criteria due to Project alone

ID	2016	2022
	No. of days above criteria[(a)]	
91	1	1
94	-	1
183	-	1
184a	1	4
184b	1	3
184c	1	3
187	-	1
200	-	1
201	-	1
203	-	3
204	2	5
205	2	4
206	2	**9**
207	2	**9**
208	**8**	**20**
209	**5**	**20**
210	**20**	**38**
211	**25**	**46**
212[(b)]	**35**	**52**
226	2	**6**

Note:

a) Numbers in bold identify those residences where the 24-hour average PM_{10} criterion is predicted to be exceeded more than five times in a year.

b) Residence 212 is located in Bengalla ZOA.

9.5 Summary of impacted residences

Table 9.6 summarises the residences where the impacts are predicted to exceed the assessment criteria. The 24-hour criterion due to the Project alone has been compared with the Department of Planning acquisition criterion of 50 µg/m^3 at the 98.6th percentile.

Table 9.6: Summary of residences and years where impacts are predicted to exceed assessment criteria

	PM_{10}		TSP ($\mu g/m^3$)	Dust deposition ($g/m^2/month$)	
	Averaging period				
	24-hour	Annual	Annual	Annual	
	Project alone[a]	Project & other sources	Project & other sources	Project alone	Project & other sources
	Impact Assessment Criteria				
ID	*50*	*30*	*90*	*2*	*4*
9[b]	-	Year 2011	-	-	-
10[c]	-	Year 2011	-	-	-
28	-	Year 2011	-	-	-
29	-	Year 2011	-	-	-
206	Year 2022	-	-	-	-
207	Year 2022	-	-	-	-
208	Year 2016 Year 2022	-	-	Year 2022	-
209	Year 2016 Year 2022	-	-	Year 2022	-
210	Year 2016 Year 2022	Year 2016	-	Year 2016 Year 2022	-
211	Year 2016 Year 2022		-	Year 2022	-
212[c]	Year 2016 Year 2022	Year 2016	-	Year 2016 Year 2022	Year 2022
226	Year 2022	-	-	-	-
264	-	Year 2016	-	-	-

Notes:

a) Only includes residences where the predicted concentrations exceed the 24-hour average PM_{10} impact assessment criteria on more than five days.

b) Residence 9 is located in the existing Mt Arthur Coal ZOA.

c) 'Residence' 10 is Muswellbrook Race Club Limited, and therefore not strictly a residence.

d) Residence 212 is located in the Bengalla ZOA.

10 RELOCATION OF EDDERTON ROAD

As discussed in **Section 3**, the Project also includes the relocation of Edderton Road. The construction works are anticipated to be completed during 2019, and last for approximately 32 weeks.

As shown on **Figure 10.1,** there are two options under consideration. While dust would be generated from earthworks associated with the proposed relocation, there are a number of safeguards that can be put in place during these types of operations to ensure there is no detrimental impact on the local air quality. Therefore the impacts have not been specifically modelled.

Nominal equipment to be used during the construction works will include:

- Scrapers;
- Graders;
- Excavators;
- Backhoes;
- Crane;
- Smooth drum rollers;
- Pad foot rollers;
- Flat bed trucks;
- Fuel Truck;
- Water carts; and
- Dozers.

Mitigation measures to ensure minimal dust generation during construction may include:

- Establishment of vegetation on all disturbed areas as each stage is completed;
- All roadways, entrances and main traffic areas will be compacted, sealed or coated with a dust suppressant or mist spray regularly;
- Establishment of wind breaks composed of earth banks and other screens to protect areas by reducing capacity of the wind to raise dust;
- Trucks entering and leaving the site being well maintained in accordance with the manufacturer's specification to comply with all relevant regulations;
- Truck movements controlled on site and restricted to designated roadways;
- Truck wheel washes or other dust removal procedures being installed to minimise transport of dust offsite; and
- Modifying construction activities during periods of high wind.

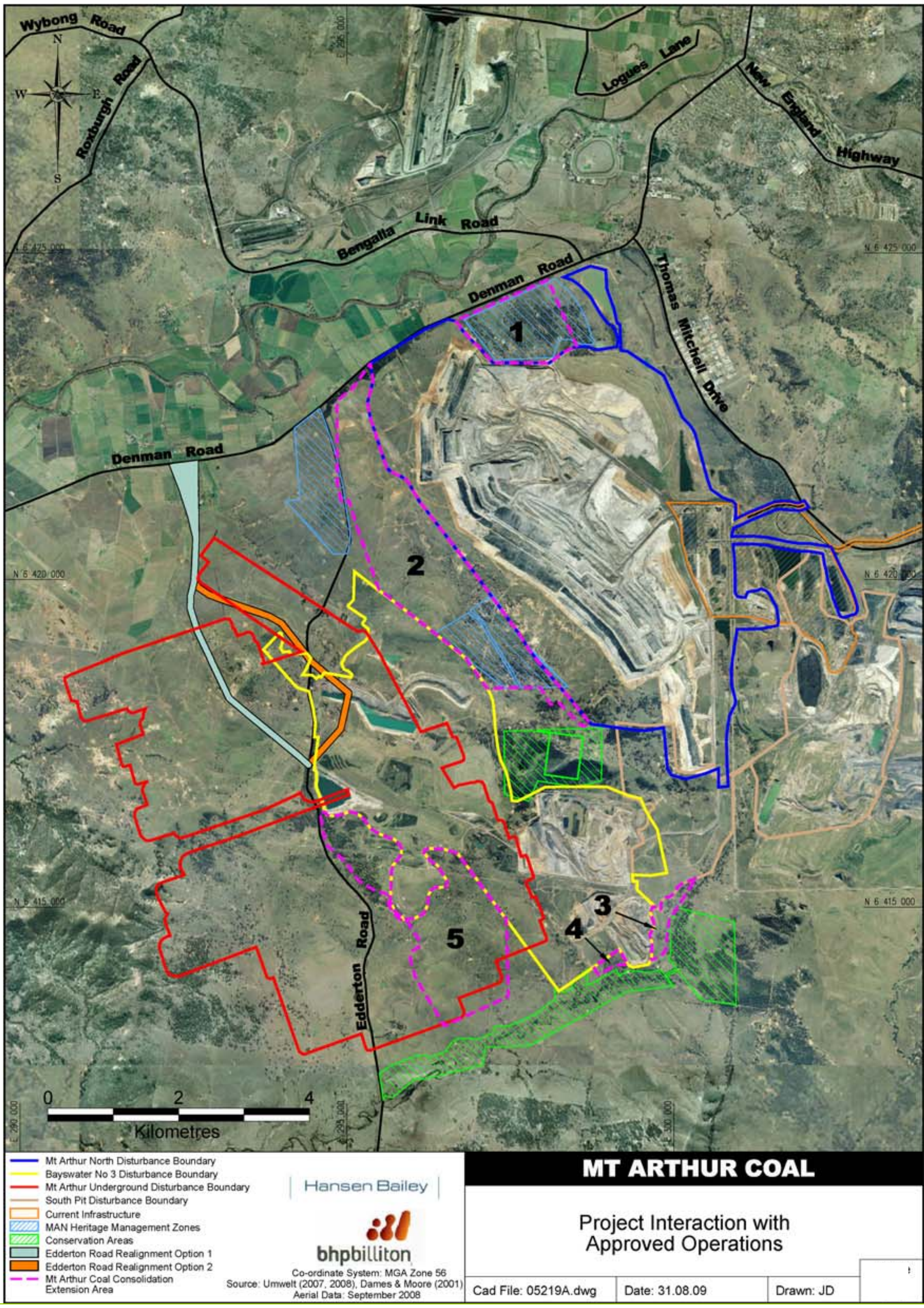


Figure 10.1: Edderton Road – proposed relocation options

11 SPONTANEOUS COMBUSTION

11.1 Introduction

Spontaneous combustion occurs when coal and other carbonaceous materials undergo natural oxidation and generate heat. Under the right conditions, the heat from the oxidation reaction can build-up to a point where the coal and contaminated overburden materials will ignite and burn. For self-heating to occur, the composition of the coal must be such that low temperature oxidation can occur. Further the material must be confined in such a way that heat from the oxidation is trapped, allowing the temperature to build-up, but not so confined as to preclude the ingress of oxygen to the combustible material at a rate sufficient to promote the combustion and release of heat energy. The ventilation of the coal must not be rapid as to remove the heat.

Once the coal reaches a high enough temperature it will liberate smoke (i.e. fine particulate matter), steam and volatile organic compounds, some of which are odorous and some of which are harmful.

Historically, the areas at Mt Arthur Coal most susceptible to spontaneous combustion have been confined to the old Bayswater No. 2 and the Drayton sub-lease areas where the seams in the Greta Coal measures were mined. This area is now used for coal beneficiation and stockpiling, washery rejects emplacement, workshops, and deployment facilities. Where final rehabilitation has been completed, no spontaneous combustion has occurred.

The Wittingham Coal Measures at Bayswater No. 3 and Mt. Arthur North contain lower levels of carbon and sulphur in the interburden and overburden waste than the Greta Coal Measures, resulting in lower propensity to heating.

The following sections discuss the status of spontaneous combustion at Mt Arthur Coal and the measures that are currently being employed to minimise spontaneous combustion.

11.2 Monitoring and control of spontaneous combustion

Mt Arthur Coal maintains documented procedures and processes, the aim of which is to prevent, manage, monitor, control and report outbreaks of spontaneous combustion.

11.2.1 Monitoring

Table 11.1 presents a summary of the spontaneous combustion events that occurred during 2008.

Table 11.1: Mt Arthur Coal spontaneous combustion summary 2008

Month	Outbreak area at start of month (m^2)	Area of new or recurring outbreaks (m^2)	Area naturally extinguished (m^2)	Balance area of outbreaks (m^2)
January	45	0	0	45
February	45	0	0	45
March	45	0	0	45
April	45	0	0	45
May	45	0	0	45
June	45	0	0	45
July	38	0	7	38
August	55	17	0	55
September	55	0	0	55
October	50	0	5	50
November	48	0	5	48
December	43	0	5	43

Source: **BHPBilliton (2008)**

11.2.2 Preventative measures

Preventative measures include:

- Overburden areas
  - Identification of mine interburden and overburden waste material susceptible to spontaneous combustion ahead of mining to identify material bands that need to be selectively handled;
  - Preferential scheduling of mining of thin seam splits to reduce the overall carbon content in overburden emplacement areas;
  - Minimisation of unplanned coal losses and volume of carbonaceous material sent to overburden emplacement areas;
  - Maintaining overburden lift heights to a maximum of 20 meters increase stability and compaction of the emplacement area to reduce air and heat flow through the overburden;
  - Selective placement of carbonaceous material in thin layers in active dumps where it can be rapidly buried to reduce its exposure;
  - Ensuring carbonaceous material is buried in a short space of time that prevents heating with a minimum depth of inert cover of 10 meters where feasible;
  - Ensuring that loose carbonaceous material is not used to form safety windrows or other mound constructions from which heat may be generated; and
  - Disposing of coarse reject in thin layers in overburden emplacement areas ahead of active tip faces and ensuring it is buried as soon as possible.
- Product coal stockpiles
  - Managing stockpiles to a maximum level of 500,000 tonnes to prevent self-heating in the coal managed pads;
  - Limiting the stockpile height to 25 m or less;

- Limiting the amount of time that coal is to remain on a stockpile to below the 'shelf life' for that coal type;
- Ensuring access is available to all stockpile areas to enable coal rehandling in the event that excessive heating is measured or spontaneous combustion occurs;

11.2.3 Control measures

Control measures of spontaneous combustion outbreaks at Mt Arthur Coal include:

- Overburden
  - For loose heaps of material showing signs of spontaneous combustion:
  - Spreading the 'hot' material and compaction with a dozer; and/or
  - Saturating the area with water from water carts or mobile sprays; and/or
  - Sealing the hot area with inert material.
  - For overburden emplacement areas showing signs of spontaneous combustion:
  - Battering off the face if possible; and/or
  - Covering the active face with inert material and, where possible, compact with a dozer; and/or
  - Reviewing the type of overburden and the emplacement technique to identify possible improvements.
  - Monitoring of the effectiveness of control measures completed and reporting of finding to relevant personnel.
- Product coal stockpiles
  - To control self-heating within product stockpiles the coal will be turned, spread out or removed before ignition occurs.
  - If ignition does occur, the affected area will be dug out and removed from the body of the stockpile and saturated with water to extinguish the heating.

11.3 Auditing, reporting and review

Mt Arthur Coal reviews the status and effectiveness of spontaneous combustion management on an annual basis. During the course of the audit, attention is paid to the success of the prevention and control measures implemented during the year and general relevance and effectiveness of the documented procedures and processes.

Performance reports are provided on an annual basis to the Department of Primary Industries – Mineral Resources (DPI-MR) and other Government Agencies as well as the Community Consultative Committee (CCC) in the Annual Environmental Management Report (AEMR).

The documented procedures and processes are reviewed as part of the EMS. The review considers the effectiveness and relevance of the procedures and processes to the contemporary operation, available knowledge and best practice.

12 GREENHOUSE GAS EMISSIONS

12.1 Introduction

In November 2006, the NSW Land and Environment Court handed down a landmark decision (the judgement of Her Honour Pain J in the matter of *Gray v The Minister for Planning and ors NSWLEC 720*) which requires all new industry developments to undertake a global warming impact study in the context of the principles of ecologically sustainable development (ESD).

For the purposes of this report, the ESD principles have been taken to be those defined by the Department of Planning (**DUAP, 2000**), which are as follows.

1. The precautionary principle – namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
2. Inter-generational equity – namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
3. Conservation of biological diversity and ecological integrity.
4. Improved valuation and pricing of environmental resources.

This section examines the scientific principles that relate greenhouse gases (GHG) to the global warming effect and estimates emissions of GHGs associated with all coal operations at the Mt Arthur Coal complex, including the proposed increase in ROM production from the Project. It is demonstrated that when all categories (that is, Scopes 1, 2 and 3) of GHG emissions from the Project are taken into account, the Project will comply with the principles of ESD.

Scope 1 and Scope 2 are emissions due to the actual operation of Mt Arthur Coal and Scope 3 are emissions that would result from the off-site transport and burning of the coal produced by Mt Arthur Coal .

Mt Arthur Coal already has approval to extract and process 28 Mtpa ROM (20 Mtpa from the existing open cut operations and 8 Mtpa from MAU). The Project include in this assessment is seeking an increase in open cut ROM production of 8 Mtpa. Greenhouse gas assessments were completed for the existing approved projects at the time approval was sought (**SEE Sustainability Consulting, 2006 and 2007**). For this assessment, the greenhouse calculations have been based on all operations at the Mt Arthur complex, not just the proposed increase.

12.2 Science of global warming

It is considered that the most authoritative and comprehensive documents dealing with the science of global warming are the technical assessment reports produced approximately every five years by the Intergovernmental Panel on Climate Change (IPCC). To date, the IPCC has published four technical assessment reports, the most recent being in 2007 (**IPCC, 2007**). These documents are essentially the scientific community's consensus view on climate change. The reports also provide a useful database that is necessary to understand the significance of various human activities in the context of climate change. In summary, the IPCC reports provide well written information critical to understanding the science of global warming. They include quantitative information on the production and fate of greenhouse gases and estimates of the expected increases in global temperatures for a range of scenarios intended to cover a range of possible futures.

These scenarios are chosen to illustrate the range of uncertainty in the predictions of temperature increases. The Garnaut Climate Change Review, commissioned by Australia's Commonwealth, State and Territory governments, released a final report in September 2008 which suggests that emissions are tracking at the upper bounds of the scenarios modelled by the IPCC (**Garnaut, 2008**).

The temperature of the earth's atmosphere is determined almost entirely[a] by the balance in radiation received from the sun and that re-radiated to outer space (see for example **IPCC, 2001**).

The parts of the radiation spectrum through which the earth can re-radiate and lose energy to outer space depends on the composition of the atmosphere. Certain gases including water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and a range of other gases absorb electromagnetic energy in the infrared spectrum. Solar radiation from the sun contains most of its energy in the infrared, visible and ultraviolet parts of the spectrum.

Sunlight passes through the atmosphere and warms both the atmosphere and the earth's surface. Clouds and the earth's surface directly reflect some of the sun's radiation back to space, but much of the sun's radiation is absorbed by the earth's surface and some by the atmosphere, which are warmed. The warmed earth and its atmosphere then reradiate this energy back to space. For the average global temperature to remain constant, the incoming radiation from the sun must be balanced by the outgoing energy radiated from the earth and atmosphere.

Global warming (and the associated climate change) occurs because of the changing composition of the atmosphere, namely the increasing concentrations of GHGs, in particular CO_2, CH_4 and N_2O. These gases reduce the parts of the electromagnetic spectrum through which energy can be re-radiated from the earth. In response, the earth's temperature must increase to allow the rate of energy loss from the earth to increase and thereby allow the incoming and outgoing radiation to be brought back into balance.

In summary, GHGs absorb electromagnetic energy and change the radiation balance of the earth causing the temperature to increase so that the radiation balance is restored.

Without the presence of any GHGs, the earth's average temperature would be extremely cold (-18 ^oC) (**Seinfeld and Pandis, 1998**) and most of the planet would be uninhabitable. However, the effect of increasing greenhouse gases is to change existing climates and this will place stresses on current ecological systems that have adapted to current climate regimes.

Increasing concentrations of CO_2, CH_4 and other GHGs will cause the temperature of the atmosphere to increase but, because the earth transports heat from the equator towards the poles in a complicated way via ocean currents and winds, the precise effect of increasing concentrations is difficult to estimate for any particular location.

The cause of the increasing concentrations of CO_2 and CH_4 is largely attributable to the increase in the worldwide use of fossil fuels to provide energy for increasing populations, which also have increasing per capita consumptions of energy. However, land clearing on a global scale is also an important cause in the change in the concentrations of CO_2.

[a] The words "almost entirely" are used because the residual heat from the earth's formation and from the decay of radioactive elements in the earth have some effect on the earth's temperature.

12.3 Quantifying greenhouse effects

Scientific publications sometimes refer to the quantity of carbon stored in the atmosphere or may refer to the equivalent quantity of carbon dioxide. In this context, 1.0 tonne (t) of carbon is the same as 3.67 t of CO_2. Most of the analysis in this report will refer to CO_2 rather than carbon, as this appears to be the most common approach used in Australia.

The estimated quantity of carbon dioxide stored in the atmosphere now is approximately 3,000 Gigatonnes (Gt). The International Energy Agency (**IEA, 2006**) estimates that in 2004, the global emissions of CO_2 from burning fossil fuels were 26,583.3 Mt per year, of which Australia's emissions of CO_2 from burning fossil fuels were 354.4 Mt CO_2 (i.e. 1.4% of the global anthropogenic, or human-related, total).

Because the relationship between global warming and greenhouse gas concentrations is not linear[a] there is no accepted method to determine the contribution that a given emission of greenhouse gases might make to global warming.

To understand this point it is useful to consider the following discussion from Section 1.3.1 of the Second Scientific Assessment Report prepared by the IPCC (**IPCC, 1996**).

> *"The amount of carbon dioxide in the atmosphere has increased by more than 25% in the past century and since the beginning of the industrial revolution, an increase which is known to be in large part due to the combustion of fossil fuels and the removal of forests (Chapter 2 [*of the report*]). In the absence of controls, projections are that the future rate of increase in carbon dioxide amount may accelerate and concentrations could double from pre-industrial values within the next 50 to 100 years (**IPCC, 1994**).*
>
> *The increased amount of carbon dioxide is leading to climate change and will produce, on average, a global warming of the Earth's surface because of its enhanced greenhouse effect – although the magnitude and significance of the effects are not yet fully resolved. If, for instance, the amount of carbon dioxide in the atmosphere were suddenly doubled, but with other things remaining the same, the outgoing long-wave radiation would be reduced by about 4 Wm^{-2}. To restore the radiative balance, the atmosphere must warm up and, in the absence of other changes, the warming at the surface and throughout the troposphere would be about 1.2 ^oC. However, many other factors will change, and various feedbacks come into play (see Section 1.4.1* [of the report]*), so the best estimate of the average global warming for doubled carbon dioxide is 2.5 ^oC (**IPCC, 1990**). Such a change is very large by historical standards and would be associated with major climate changes around the world.*
>
> *Note if carbon dioxide were removed from the atmosphere altogether, the change in out going radiation would be about 30 Wm^{-2} – 7 to 8 times as big as the change for doubling – and the magnitude of the temperature change would be similarly enhanced. The reason is that the carbon dioxide absorption is saturated over part of the spectral region where it absorbs, so the amount of absorption changes at a much smaller rate than the concentration of the gas (Chapter 2* [of the report]*). If the concentrations of carbon dioxide are more than doubled, then the relationship between radiative forcing and concentration is such that each further doubling provides a further radiative forcing of about 4 Wm^{-2}."*

[a] The warming effect of a given quantity of greenhouse gases to the atmosphere is less and less as the concentration become higher and higher.

12.4 Greenhouse gas inventories

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

The protocol nominates the following GHGs:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs); and
- Perfluorocarbons (PFCs).

From the point of view of Mt Arthur Coal , only CO_2, CH_4 and N_2O are relevant.

CO_2 and N_2O are formed and released during the combustion of gaseous, liquid and solid fuels. They are liberated when fuels are burnt in diesel powered equipment and in the generation of the electrical energy that will be used by Mt Arthur Coal . CH_4 is released as a fugitive emission during the extraction of the coal.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The global warming potentials assumed in the Department of Climate Change (**DCC, 2008a**) emission factors are as follows.

- CO_2 – 1.
- CH_4 – 21.
- N_2O – 310.
- NO_2 – not included.

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred to in terms of CO_2-equivalent emissions.

12.5 Emission factors

The National Greenhouse Accounts (NGA) Factors published by the DCC (**DCC, 2008a and DCC, 2008b**) have been used to convert fuel usage and electricity consumption into CO_2-equivalent emissions. The relevant emission factors are summarised in **Table 12.1**.

Table 12.1: Summary of greenhouse gas emission factors

Type of Fuel and Electricity		Emission factor		Scope	Source
		Mining and extraction			
Diesel - on-site transport activities[a]		2.7	t CO_2-e/kL	1	Table 4 (**DCC, 2008b**)
		0.2	t CO_2-e/kL	3	Table 38 (**DCC, 2008b**)
Biodiesel – on-site transport activities		0.1	t CO_2-e/kL	1	Table 4 (**DCC, 2008b**)
Explosives use[b]	ANFO	0.17	t CO_2-e/tonne	1	Table 4 (**DCC, 2008a**)
	Heavy ANFO	0.18	t CO_2-e/tonne	1	Table 4 (**DCC, 2008a**)
Electricity[c]		0.89	kg CO_2-e/kWh	2	Table 39 (**DCC, 2008b**)
		0.17	kg CO_2-e/kWh	3	
Extraction of coal		45.5	kg CO_2-e/tonne ROM	1	Table 6 (**DCC 2008b**
		Transport of product coal			
Rail transport		12.3	g CO_2-e/t-km	3	**QR Network Access (2002)**
Fuel oil (ship transport)		73.1	kg CO_2-e/GJ	3[d]	Table 4 (**DCC, 2008b**)
		5.3	kg CO_2-e/GJ	3	Table 38 (**DCC, 2008b**)
		Burning of coal			
Burning coal		3.00	kg CO_2-e/tonne	1	Table 1 (**DCC, 2008b**)

Notes:

(a) The emission factors for diesel usage include Scope 1 emissions which are associated with burning the fuel and Scope 3 emissions which are associated with producing the diesel.

(b) As the calculation of emissions from explosives use are no longer required under the NGER reporting requirements, the GHG emissions factor for explosives use has been removed from NGA Factors published November 2008 (**DCC, 2008b**). Therefore the factors published in February 2008 (**DCC, 2008a**) have been used.

(c) The emission factors for electrical energy include Scope 2 emissions (i.e. those associated with generating the electricity) and Scope 3 emissions (those associated with producing the fuel for the power station and the distribution losses involved in delivering electricity to the mine).

(d) The emission factor provided is for Scope 1 fuel usage, but as this is being applied to the shipment of coal, it is being used as Scope 3 emission factor.

12.6 Mt Arthur Coal greenhouse emissions

CO_2-equivalent (CO_2-e) emissions from Mt Arthur Coal will result from the following sources:

1. The extraction and processing of the coal due to the combustion of diesel fuel (used in diesel-powered equipment, in blasting and to power the diesel generators).
2. The transport of the product coal to The Port of Newcastle and the transport of the product coal overseas.
3. The combustion of the product coal in power generating facilities.

The following sections estimate the CO_2 emissions from each of these sources.

12.6.1 Emissions from extraction and processing

As discussed in **Section 12.5**, to estimate CO_2-e emissions from extraction of the coal, the following assumptions have been made.

- Each kilowatt-hour (kWh) of electrical energy used results in the release of 1.06 kg of CO_2.
- Each litre of diesel fuel burnt is assumed to result in the release of 2.9 kg of CO_2.
- Each tonne of explosive used is assumed to result in the release of 0.17 t of CO_2.
- Each tonne of ROM coal mined results in the release of 2.17 kg of methane and that methane has a greenhouse warming potential of 21 (This means that each kilogram of methane, because of its lifetime in the atmosphere and its spectral absorption characteristics, is equivalent to 21 kg of CO_2). Therefore, the CO_2-e emissions released for each tonne of ROM coal mined is equal to 45.5 (see Table 6, **DCC, 2008a**).
- No carbon capture technology used.

Information was provided by Mt Arthur Coal on the historic usage of electrical energy, usage of explosives and diesel fuel. These data were pro-rated to the conceptual mine plan's ROM coal production rates for Mt Arthur Coal. **Table 12.2** presents a summary of the ROM coal production rates.

Table 12.2: ROM coal production rates

Year	Open Cut ROM coal production (Mtpa)	Underground ROM Coal Production (Mtpa)	Mt Arthur Complex Total ROM Coal Production (Mtpa)
2010	13.85	8.00	21.85
2011	16.66	8.00	24.66
2012	21.00	8.00	29.00
2013	26.00	8.00	34.00
2014	32.00	4.00	36.00
2015	32.00	4.00	36.00
2016	32.00	4.00	36.00
2017	32.00	4.00	36.00
2018	30.00	6.00	36.00
2019	30.00	6.00	36.00
2020	30.00	6.00	36.00
2021	28.00	8.00	36.00
2022	28.00	8.00	36.00

Table 12.3 summarises the fuel and energy usage for the extraction and processing of the coal, **Table 12.4** summarises the estimated annual average CO_2 emissions from Mt Arthur Coal due to extraction and processing using the emissions factors presented in **Table 12.1**.

Table 12.3: Fuel, energy and explosives usage from mining processing

Year	Total ROM coal (kt ROM coal/y)	Electrical energy used (processing) (kWh)	Diesel used in extraction total (Litres/y)	Biodiesel used in extraction total (Litres/y)	ANFO used in blasting (kt/y)[(a)]	Heavy ANFO used in blasting (kt/y) [(a)]
2010	21,850	104,026	108,524	9,317	14	14
2011	24,660	117,405	122,481	10,515	17	17
2012	29,000	138,067	144,037	12,366	21	21
2013	34,000	161,872	168,871	14,498	26	26
2014	36,000	171,394	178,804	15,351	32	32
2015	36,000	171,394	178,804	15,351	32	32
2016	36,000	171,394	178,804	15,351	32	32
2017	36,000	171,394	178,804	15,351	32	32
2018	36,000	171,394	178,804	15,351	30	30
2019	36,000	171,394	178,804	15,351	30	30
2020	36,000	171,394	178,804	15,351	30	30
2021	36,000	171,394	178,804	15,351	28	28
2022	36,000	171,394	178,804	15,351	28	28
Total	**433,510**	**2,063,912**	**2,153,151**	**184,856**	**350**	**352**

Notes:

a) The explosives usage only applies to material extracted from the open cut operations.

Table 12.4: Summary of estimated CO_2-e emissions from mining and processing of coal from Mt Arthur Coal

Year	CO_2-e from electrical energy (processing) (kt/y)		CO_2-e from mining (diesel usage) (kt/y)		CO_2-e from mining (biodiesel usage) (kt/y)	CO_2-e from blasting (kt/y) [a]	CO_2-e from CH_4 released during mining (kt/y) [b]	Total (kt/y)	
	Scope 2	Scope 3	Scope 1	Scope 3	Scope 1	Scope 1	Scope 1	Scope 1 & 2	Scope 3
2010	93	18	293	22	1.10	2.35	2.49	630	1,022
2011	104	20	330	25	1.24	2.82	3.00	758	1,200
2012	123	23	389	29	1.45	3.56	3.78	956	1,476
2013	144	28	456	35	1.71	4.41	4.68	1,183	1,793
2014	153	29	482	37	1.81	5.42	5.76	1,456	2,104
2015	153	29	482	37	1.81	5.42	5.76	1,456	2,104
2016	153	29	482	37	1.81	5.42	5.76	1,456	2,104
2017	153	29	482	37	1.81	5.42	5.76	1,456	2,104
2018	153	29	482	37	1.81	5.08	5.40	1,365	2,012
2019	153	29	482	37	1.81	5.08	5.40	1,365	2,012
2020	153	29	482	37	1.81	5.08	5.40	1,365	2,012
2021	153	29	482	37	1.81	4.75	5.04	1,274	1,921
2022	153	29	482	37	1.81	4.75	5.04	1,274	1,921
TOTAL	**1,837**	**351**	**5,810**	**440**	**21.75**	**60**	**63**	**15,994**	**23,785**

Notes:

a) The blasting emissions only apply to material extracted from the open cut operations.

b) The CH_4 released during mining only applies to the open cut operations.

12.7 Emissions from export and burning of the product coal

12.7.1 Introduction

Product coal is either transported via conveyor to Macquarie Generation's Bayswater Power Station or transported via rail to the Port of Newcastle for shipment overseas. The total product coal transferred to the Port of Newcastle will not exceed 27 Mtpa. **Table 12.5** presents a summary of the quantity of product coal assumed for each destination.

Table 12.5: Summary of product coal destinations

Year	Total product coal (t)	Product coal to Bayswater Power (t)[a]	Product coal to Port of Newcastle (t)
2010	12,195,040	3,506,932	8,688,108
2011	14,667,840	3,506,932	11,160,908
2012	18,487,040	3,506,932	14,980,108
2013	22,887,040	3,506,932	19,380,108
2014	28,163,520	1,163,520	27,000,000
2015	28,163,520	1,163,520	27,000,000
2016	28,163,520	1,163,520	27,000,000
2017	28,163,520	1,163,520	27,000,000
2018	26,405,280	0	26,405,280
2019	26,405,280	0	26,405,280
2020	26,405,280	0	26,405,280
2021	24,647,040	0	24,647,040
2022	24,647,040	0	24,647,040
TOTAL	**309,400,960**	**18,681,808**	**290,719,152**

Note:

a) It has been assumed that the quantity of coal supplied to Bayswater Power Station remains at the 2008 level for the period 2010 to 2013 (i.e. 3,506,932 tpa). For the period 2014 to 2017 (when it is anticipated the maximum transfer of coal to the Port of Newcastle would occur) it has been assumed that the balance of the product coal is supplied to Bayswater Power Station. After 2017 it is assumed all coal is transported to the Port of Newcastle.

12.7.2 Emissions from off-site transport of product coal via rail

For the purpose of this analysis, it has been assumed that the coal for shipment overseas is carried by rail to the Port of Newcastle a distance of approximately 120 km (one way). According to a study commissioned by **QR Network Access (2002)** the Australian average CO_2-e emission rate for rail transport is 12.3 g/net tonne-km for a loaded train. In the absence of a specific emission factor for unloaded trains, it has conservatively been assumed that the same emission factor applies for the return trip.

Using this information, **Table 12.6** presents a summary of the CO_2 emissions from transporting the product coal from Mt Arthur Coal to the Port of Newcastle.

It has conservatively been assumed that the product coal is 88% of ROM coal. Actual recovery rate as provided by Mt Arthur Coal is between 70 and 75%.

Table 12.6 summarises the estimated CO_2 emissions for each year of operation due to transport of the product via rail.

Table 12.6: Estimated CO_2-e emissions from rail transport of product coal (t/y)

Year	Product coal to Port of Newcastle (t)	Total CO_2-e from rail transport (t)
		Scope 3
2010	8,688,108	12,824
2011	11,160,908	16,474
2012	14,980,108	22,111
2013	19,380,108	28,605
2014	27,000,000	39,852
2015	27,000,000	39,852
2016	27,000,000	39,852
2017	27,000,000	39,852
2018	26,405,280	38,974
2019	26,405,280	38,974
2020	26,405,280	38,974
2021	24,647,040	36,379
2022	24,647,040	36,379
Total Mt Arthur Coal	**290,719,152**	**429,101**

12.7.3 Emissions from shipping of product coal overseas

There will also be emissions associated with the shipping of the product overseas. **Table 12.7** presents a summary of coal destination and shipping distances from the Port of Newcastle.

Table 12.7: Port of Newcastle coal destinations and distances

Location	Country	% of coal	Return distance (km)
Osaka	Japan	59	16130
Kaohsiung	Taiwan	14	15642
Busan	Korea	11	16760
Mazatlan	Mexico	7	24906
Penang	Malaysia	4	16976
Shanghai	China	3	16938
Rotterdam	Netherlands	2	43060

Source: **Umwelt (2008)**

Based on information provided by Mt Arthur Coal, **Table 12.8** presents a summary of the assumptions used to calculative the emissions from transport of the product coal by sea.

Table 12.8: Summary of assumptions

Parameter	Assumption	
Average size of Cape vessels	120,000	tonnes
Average size of Panamax vessels	80,000	tonnes
Average size of Handy Size vessels	60,000	tonnes
Proportion shipped on Cape vessels	35%	
Proportion shipped on Panamax vessels	60%	
Proportion shipped on Handy vessels	5%	
Average Cape vessel speed	14.5	knots
Average Panamax vessel speed	14.5	knots
Average Handy vessel speed	13.5	knots
Average Cape vessel fuel consumption	57.0	tonnes per day
Average Panamax vessel fuel consumption	36.0	tonnes per day
Average Handy vessel fuel consumption	33.0	tonnes per day
Density of fuel oil	1010.0	kg/m^3
Energy content fuel oil	39.7	GJ/kL
Total Scope 3 emission factor	78.6	kg CO_2-e/GJ

Source: **Mt Arthur Coal (2009)**

Estimated GHG emissions from the sea transportation of the coal are provided in **Table 12.9**.

Table 12.9: Estimated CO_2-e emissions from sea transport of product coal (Mt/y)

Year	Product coal exported (t)	Total CO_2-e from sea transport (t) Scope 3
2010	8,688,108	360,588
2011	11,160,908	449,768
2012	14,980,108	585,696
2013	19,380,108	746,078
2014	27,000,000	1,032,678
2015	27,000,000	1,032,678
2016	27,000,000	1,032,678
2017	27,000,000	1,032,678
2018	26,405,280	992,463
2019	26,405,280	992,463
2020	26,405,280	992,463
2021	24,647,040	938,928
2022	24,647,040	938,928
Total	**290,719,152**	**11,128,088**

12.7.4 Emissions from use of coal

The Proponent's customers will make use of the coal, and there will inevitably be GHG emissions associated with the end use. The emissions from burning the product coal will be much larger than those associated with the extraction and processing of the coal. The adopted convention is that these emissions are attributed to the user of the coal not the producer, however, to address the judgement of her Honour Pain J in the matter of *Gray v The Minister for Planning*, estimates of the GHG emissions associated with the use of the coal have been made.

The convention of not including these emissions avoids double counting of the emissions: leaving the accounting of the emissions from the use of the coal to the end user is also desirable as emissions due to the end use depend on the method by which the coal is used to produce energy and any control measures that might be in place. Various methods of burning will be used by different customers. As most coal from Mt Arthur Coal is to be exported, any assessment of greenhouse emissions by its use in those other jurisdictions will be speculative and potentially unreliable. However, it is assumed that the remainder of the coal is burnt in a power station.

The quantity of CO_2 emitted can be estimated with a reasonable degree of reliability if the carbon content of the coal is known. It is reasonable to assume that all the carbon will be converted to CO_2 and that minor emissions of CO will be converted to CO_2 reasonable rapidly (in 1 to 4 months) (**Seinfeld and Pandis, 1998**). There will, however, be some uncertainty as to the production of N_2O, which depends not only on the nitrogen content in the fuel but the temperature of the combustion process. Some small quantity of carbon will also be retained in the ash from combustion in power stations.

It is assumed that the coal will be used in a power station and that the power station will have similar emissions to a power station in NSW burning black coal. The emissions can then be estimated using the NGA emission factor of 88.43 kg CO_2-e/GJ (Table 1, Scope 1 of **DCC, 2008a**).

Based on Mt Arthur Coal data (**BHP Billiton, 2009**), the coal has a dry-ash-free specific energy of approximately 33.94 GJ/t.

Table 12.10 summarises the estimated CO_2 emissions for each year of Mt Arthur Coal due to usage of the product.

Table 12.10: Estimated CO_2-e emissions from usage of coal (Mt/y)

Year	Total product coal (t/y)	Total CO_2-e from usage (t)
2010	12,195,040	36,601,147
2011	14,667,840	44,022,796
2012	18,487,040	55,485,416
2013	22,887,040	68,691,198
2014	28,163,520	84,527,572
2015	28,163,520	84,527,572
2016	28,163,520	84,527,572
2017	28,163,520	84,527,572
2018	26,405,280	79,250,542
2019	26,405,280	79,250,542
2020	26,405,280	79,250,542
2021	24,647,040	73,973,511
2022	24,647,040	73,973,511
Total	**309,400,960**	**928,609,495**

12.8 Total CO_2-equivalent emissions

Table 12.11 summarises the total emissions from all sources.

Table 12.11: Summary of total estimated CO_2-e emissions all sources (Mt/y)

Year	Product coal (Mt)	CO_2-e Mining and extraction (Mt)		CO_2-e Transport of product coal - rail (Mt)	CO_2-e Transport of product coal - sea (Mt)	CO_2-e Usage of product coal (Mt)	CO_2-e Total (Mt)	
		Scope 1	Scope 2	Scope 3	Scope 3	Scope 3	Scope 1 & 2	Scope 3
2010	12.20	1.02	0.04	0.01	0.36	36.60	1.02	37.03
2011	14.67	1.20	0.05	0.02	0.45	44.02	1.20	44.55
2012	18.49	1.48	0.05	0.02	0.59	55.49	1.48	56.17
2013	22.89	1.79	0.06	0.03	0.75	68.69	1.79	69.56
2014	28.16	2.10	0.07	0.04	1.03	84.53	2.10	85.71
2015	28.16	2.10	0.07	0.04	1.03	84.53	2.10	85.71
2016	28.16	2.10	0.07	0.04	1.03	84.53	2.10	85.71
2017	28.16	2.10	0.07	0.04	1.03	84.53	2.10	85.71
2018	26.41	2.01	0.07	0.04	0.99	79.25	2.01	80.39
2019	26.41	2.01	0.07	0.04	0.99	79.25	2.01	80.39
2020	26.41	2.01	0.07	0.04	0.99	79.25	2.01	80.39
2021	24.65	1.92	0.07	0.04	0.94	73.97	1.92	75.05
2022	24.65	1.92	0.07	0.04	0.94	73.97	1.92	75.05
TOTAL	**309.40**	**23.78**	**0.79**	**0.43**	**11.13**	**928.61**	**23.78**	**941.39**
						Total (Mt)	**965.17**	
						Annual average (Mt/y)	**74.24**	

12.9 Important additional considerations

While it is possible to assess the significance of these emissions by comparing them with other sources of greenhouse gases, it is also important to note that the efficiency with which the coal is used is also very important. All other things being equal[a], global CO_2-e emissions could be halved if power station efficiencies were doubled, or halved if the efficiency by which end users' consumed electricity was doubled or waste was reduced and so on.

Different customers will use the coal in power plants of different thermal efficiencies. The Australian Coal Association provides some typical statistics for power station efficiencies on their web site (**ACA, 2006**).

The web site notes the following:

> "*Industry has continuously striven to increase efficiencies of conventional plant; for example, the average thermal efficiency of US power stations has increased from 5% in 1900, to around 35% currently. In China, most power plants are relatively small, average efficiency is about 28% compared to an OECD average of 38%. New conventional* [pulverised fuel] *PF power plants achieve above 40% efficiency.*
>
> *Advanced modern plants use specially developed high strength alloy steels, which enable the use of supercritical and ultra-supercritical steam (pressures >248 bar and temperatures >566°C) and can achieve, depending on location, close to 45% efficiency.*

[a] Population remaining fixed and the per capita consumption of energy being fixed.

> *Application of new advanced materials to PF power plant should enable efficiencies of 55% to be achieved in the future. This results in corresponding reductions in CO_2 emissions as less fuel is used per unit of electricity generated".*

The Proponent does not propose, nor does its application for approval, seek approval to burn any of the coal produced.

12.10 Contribution to global warming and conclusions

Finally, it is useful to consider the contribution that might be made to global warning from:

- emissions from mining;
- emissions from burning Mt Arthur Coal -related product coal; and
- the combined emissions from both mining and burning Mt Arthur Coal -related product coal.

Because the relationship between global warming and greenhouse gas concentrations is not linear[a] there is no accepted method to determine the contribution that a given emission of greenhouse gases might make to global warming.

To understand this point, it is useful to consider the discussion from Section 1.3.1 of the Second Scientific Assessment Report prepared by the IPCC (**IPCC, 1996**), which was provided earlier in **Section 12.3**.

At any point in time, it would be reasonably simple to compare the estimated emission of CO_2-equivalent from the various activities with the estimated equivalent global CO_2 emissions of 3,000 Gt. On this basis, average annual emissions over the lifetime of Mt Arthur Coal from the mining and burning of coal (including mining, transporting the coal to the Port of Newcastle and overseas, and usage of the coal) are estimated to be 0.0024% of the current global CO_2 load. Thus, Mt Arthur Coal could be considered to contribute 0.0024% to the increase in global temperatures caused by the increase in greenhouse gas emissions as they are currently. This invites the question as to what temperature rise might be attributed to the GHG emissions from Mt Arthur Coal.

Based on the IPPC estimate that a doubling of the CO_2-equivalent concentration in the atmosphere would lead to a 2.5°C increase in global average temperature (see **Section 12.3**), and that the current global CO_2 load is approximately 3,000 Gt, we can estimate that the annual average emissions during the life of Mt Arthur Coal (including mining, transporting the coal to the Port of Newcastle and overseas, and usage of the coal) are predicted to lead to an increase in global temperature of 0.00006 °C [$(7.42 \times 10^7/3{,}000 \times 10^9) \times 2.5$°C].

There will clearly be no measurable environmental effect due to the emissions of GHGs from Mt Arthur Coal, even when the customer's use of the coal is taken into account. Any environmental assessment would conclude that the effects of the emissions from Mt Arthur Coal are unable to be measured. Given this, it is clear that Mt Arthur Coal will comply with the principles of ESD.

[a] The warming effect of a given quantity of greenhouse gases to the atmosphere is less and less as the concentration become higher and higher (see **Section 12.3**).

In practice, of course, the effects of global warming and associated climate change are the cumulative effect of many thousands of such sources and it is the cumulative effects that pose a threat to ESD principles.

This analysis highlights the problem of dealing with climate change on a mine-by-mine, or project-by-project basis. Indeed, if this approach is adopted, it is likely to be ineffective since the coal will simply be sourced from some other place.

Ultimately, the control of greenhouse gas emissions is likely to occur via economic instruments such as the Carbon Pollution Reduction Scheme, as outlined in the Australian Government green paper released in July 2008 (**DCC, 2008c**), and subsequent white Paper released in December 2008 (**DCC, 2008d**), which detail the design of a national emissions trading scheme.

The scheme will require businesses and industry to buy a 'pollution permit' for each tonne of carbon they contribute to the atmosphere, giving them a strong incentive to reduce pollution, encourage the development of carbon capture and sequestration, encourage the development of renewable forms of energy generation and improve the efficiency with which electricity is used. At the time of writing the emissions trading scheme had been delayed to July 2011, and the legislation has yet to be passed through Parliament.

13 BLAST FUMES

The explosive used in blasting will be primarily ammonium nitrate fuel oil (ANFO), detonation of which produces gases. The principal gases are nitrogen, water vapour and carbon dioxide together with smaller amounts of carbon monoxide and oxides of nitrogen.

Samples of blasting dust taken at the Ravensworth Open Cut Mine in 1992 measured a maximum nitrogen dioxide (NO_2) concentration of 3 parts per million (ppm) over an exposure period of six minutes.

Scientific literature suggests that no adverse health effects would be expected due to this exposure although a noticeable odour would be present. Given that the concentration at the nearby residences will be significantly lower than the 3 ppm measured on-site at Ravensworth, it is unlikely that there will be any adverse impacts due to NO_2 emissions from the blasting.

14 MITIGATION MEASURES AND COMMITMENTS

14.1 Introduction

The modelling results presented above are based on the assumption that the Proponent applies the control measures discussed in **Section 14.2** to minimise dust emissions. The locations of the nearby rural/residential areas to the northwest of the Project are in the prevailing wind direction for part of the year. Because of this, it will be necessary to ensure that dust emissions are kept to the minimum practicable level and that cumulative impacts with other mining projects are kept to acceptable levels. This section outlines procedures proposed for the management and control of dust emissions.

14.2 Proposed dust management and control procedures

The term "best practice" is frequently used in pollution control and pollution management. However, what constitutes "best practice" is difficult to define in practical situations. Environment Australia has published a series of booklets to assist the mining industry with incorporating best practice environmental management through all phases of mineral production from exploration through construction and eventual closure. In the booklet for Dust Control (**Environment Australia, 1998**[a]) "best practice" is defined as follows:

"'Best Practice' can be defined as the most practical and effective methodology that is currently in use or otherwise available. Best practice dust management can be achieved by appropriate planning in the case of new or expanding mining operations, and by indentifying and controlling dust sources during the active phases of all mining operations."

The following procedures are proposed for the management of dust emissions from the Open Cut Project. The aim of these is to minimise the emission of dust in a cost effective manner. The effects of these controls are included in the model simulations. Dust can be generated from two primary sources:

- wind blown dust from exposed areas; and
- dust generated by mining activities.

The proposed controls have been considered against those determined to be best practice in the Environment Australia booklet for Dust Control.

Table 14.1 and **Table 14.2** list the different sources of wind-blown and mining-generated dust respectively, the proposed controls, and identify those considered to be best-practice.

[a] Note that this document is currently under review but has not yet been released.

Table 14.1: Best practice control procedures for wind blown dust

Source	Control Procedures	Applied at Mt Arthur Coal
Areas disturbed by mining	Disturb only the minimum area necessary for mining. Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden placement.	Yes
Coal handling areas	Maintain coal-handling areas in a moist condition using water carts to minimise wind blown and traffic generated dust.	Yes
Coal product stockpiles	Maintain water sprays on product coal stockpiles to reduce emissions of dust.	Yes

Table 14.2: Best practice control procedures for mining generated dust sources

Source	Control procedures	Applied at Mt Arthur Coal
Haul Road Dust	All roads and trafficked areas will be treated with a chemical solution or equivalent alternative to minimise the generation of dust. All haul roads will have edges clearly defined with marker posts or equivalent to control their locations, especially when crossing large overburden emplacement areas. Obsolete roads will be ripped and re-vegetated.	Yes
Minor roads	Development of minor roads will be limited and the locations of these will be clearly defined. Minor roads used regularly for access etc will be watered. Obsolete roads will be ripped and re-vegetated.	Yes
Topsoil Stripping	Access tracks used by topsoil stripping scrapers during their loading and unloading cycle will be watered. Topsoil stripping will not occur in dry dusty conditions.	Yes
Topsoil Stockpiling	Long term topsoil stockpiles, not used for over 6 months will be re-vegetated.	Yes
Drilling	Dust aprons on drill rigs will be lowered during drilling. Drills will be equipped with dust extraction cyclones, or water injection systems. Water injection or dust suppression sprays will be used when high levels of dust are being generated.	Yes
Blasting	Adequate angular rock stemming will be used at all times.	Yes
Raw Coal Bins	Automatic sprays, or other dust control mechanisms will be used when tipping raw coal that generates excessive dust quantities.	Yes
Coal Preparation Plant	All spillage of material will be cleaned up to prevent dust. Water sprays are/will be fitted at all transfer points.	Yes

Mt Arthur Coal's existing air quality monitoring program will reviewed to take into account the impacts of the Project. The program will be regularly reviewed to ensure it remains effective.

14.3 Proposed GHG emissions management and control procedures

Scope 1 greenhouse gas emissions are under the control of the Project. Mt Arthur Coal will continue to review and monitor emissions and the activities that lead to emissions, to ensure that emissions are kept to the minimum practicable level and will attempt to keep the ratio of greenhouse gas emissions per tonne of coal produced as low as possible. In order to facilitate the control of GHG emissions, Mt Arthur Coal have developed an Energy Excellence Working Group. The working group has held workshops across the site to identify potential energy efficiency opportunities.

Ongoing review will include:

- Reviewing equipment purchases with a view to keeping fuel efficiency levels high;
- Maintaining equipment to ensure that diesel and electrically powered equipment are operated efficiently;
- Reviewing mining practices to minimise double handling of materials and ensuring that coal and overburden haulage is undertaken using the most efficient routes;
- Ensuring that lighting and heating are only used when required;
- Use of alternative fuels (e.g. bio-diesel, solar panels and solar hot water systems) where feasible, and;
- Managing spontaneous combustion to minimise emissions of all gases including greenhouse gases (see **Section 14.4**).

14.4 Proposed Spontaneous Combustion management and control procedures

Mt Arthur Coal will continue to monitor and manage spontaneous combustion throughout the life of the Project. These techniques will be consistent with techniques currently employed at Mt Arthur Coal (discussed in detail in **Section 11.2.3** and include:

- Managing spontaneous combustion in accordance with the spontaneous documented procedures and processes;
- Capping of all areas of spontaneous combustion with inert material; and
- Monitoring and placement of coal stockpiles and their temperature.

15 CONCLUSIONS

This report has developed dust emissions inventories for the proposed operations at Mt Arthur Coal for three stages of operation. These stages have been selected to represent the potential worst-case air quality impacts that the Project will have on different areas around the EA Boundary throughout its lifetime.

The emissions inventories developed for each of the stages have been used with local meteorological data and a modified version of the US EPA's ISCST3 model to predict the maximum 24-hour PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition (insoluble solids) over an area extending approximately 30 km (east-west) and 27 km (north-south). The modelling has been undertaken to show both the effects of the Project only and the cumulative effects of the Project with neighbouring mines and other sources of dust.

It is concluded that eight private residences, owned by five landowners, (Residences 206, 207, 208, 209, 210, 211, 212[a] and 226) will be impacted by dust levels exceeding the 24-hour average PM_{10} assessment criterion (at the 98.6th percentile, that is more than five days per year) of 50 $\mu g/m^3$. Six private residences (Residences 9[b], 28, 29, 210, 212[a], and 264) and one recreational facility (10[c]) will be impacted by dust levels exceeding the annual average PM_{10} assessment criterion of 30 $\mu g/m^3$ for the Project and other sources. No private residences will be impacted by dust levels exceeding the TSP assessment criterion of 90 $\mu g/m^3$ for the Project and other sources. Five private residences, owned by three landowners, (Residences 208, 209, 210, 211, and 212[a]) will be impacted by dust levels exceeding the annual average 2 g/m^2/month (insoluble solids) deposition level assessment criteria from the Project alone. One private residence (Residence 212 [a]) will be impacted by dust levels exceeding the annual average 4 g/m^2/month (insoluble solids) deposition level assessment criteria from the Project and other sources.

Residence 9 is located within Mt Arthur Coal's existing zone of affectation and resident 212 is located within Bengalla's zone of affectation.

Construction activities associated with the Project will have negligible emissions.

Spontaneous combustion events will continue to be managed and monitored to ensure minimal impact.

The CO_2 emissions released during the mining operations are small compared to the CO_2 emissions released during the combustion of the coal proposed for extraction. Mt Arthur Coal is committed to reviewing and monitoring GHG emissions and the activities that lead to GHG emissions, to ensure that these emissions are kept to the minimum practicable level and will attempt to keep the ratio of greenhouse gas emissions per tonne of coal produced as low as possible.

Based on scientific literature, and sampling undertaken at similar operations, it is unlikely that there will be any issues from blasting emissions.

[a] Residence 212 is located in the Bengalla ZOA.
[b] Residence 9 is located in the existing Mt Arthur Coal ZOA.
[c] 'Residence' 10 is Muswellbrook Race Club Limited, therefore not strictly a residence.

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Appendix A: Residence ownership details

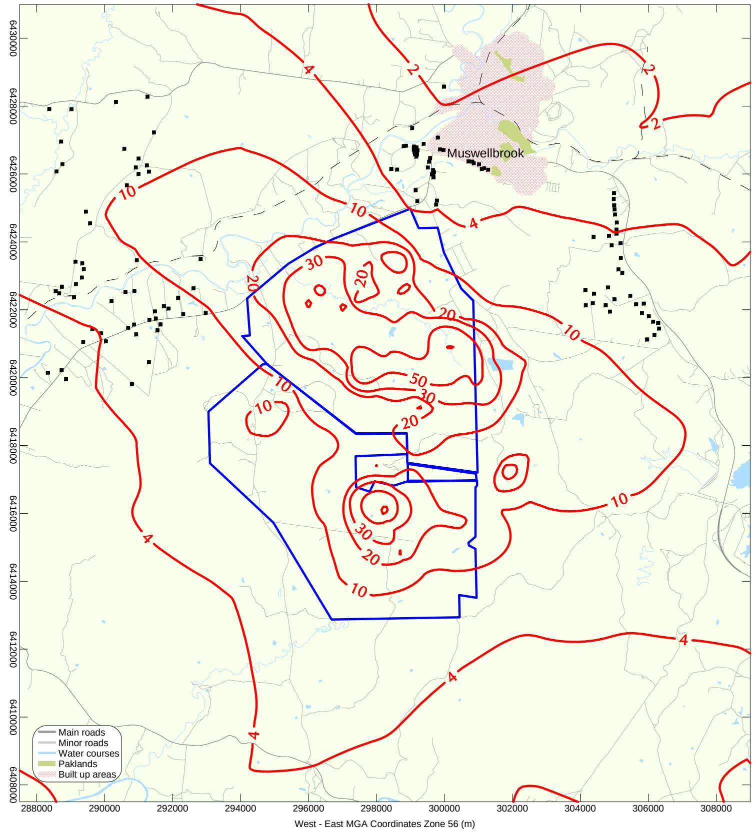
Table A.1: Residence ownership details

Residence ID	Ownership details	Existing ZOA	MGA coordinates Zone 56 Easting (m)	Northing (m)
6	Scriven		299201	6425202
8	Drake		299156	6425525
9	Englebrecht	Mt Arthur Coal	298437	6426150
10	Muswellbrook Race Club Ltd		298607	6426131
11	Drake		299512	6426192
12	Tubb		299551	6426363
13	Upper Hunter Developers Pty Ltd & Turner		299580	6426467
14	Robinson		299098	6426730
15	Dobie		299125	6426723
16	Sweeney		299153	6426716
17	Gleeson & Cranfield		299206	6426702
18	Bredden		299197	6426672
20	Good		299189	6426608
21	Cridland		299193	6426582
22	Englebrecht Racing Stables Pty Ltd		299174	6426549
23	Englebrecht		299175	6426512
24	Reid		299136	6426584
25	Andrews		299138	6426622
26	Byrnes & Moller		299122	6426655
27	Barron		299111	6426698
28	McGoldrick		298804	6426824
29	Barnett		298868	6426831
30	Englebrecht		299103	6426810
31	Jabetin Pty Ltd		299051	6427356
32	Almond & Hume		299178	6426785
33	Barkley		299391	6426889
34	Hardes		299807	6427071
36	Horne		299985	6428573
37	The Council of the Municipality of Muswellbrook		299972	6426709
37	The Council of the Municipality of Muswellbrook		299872	6426725
39	Buckley		299669	6426114
40	Buckley		299693	6426053
41	Ray		299629	6425993
42	Hallett & Campbell		299671	6425952
43	Hallett & Campbell		299680	6425898
49	Webber		299780	6425216
49	Webber		299759	6425096
56	Bancroft		300708	6426373
57	Mayer		300823	6426365
58	Masters		300866	6426319
59	Osborn		301020	6426283
60	Osborn		301102	6426149
61	Burton		301171	6426174
62	Burke & Talbot		301288	6426127
69	Wells		304991	6425439
70	Folpp		304984	6425266
71	Hunt		304996	6425080
72	Budden		305009	6424957
73	Hogan		305023	6424805
75	Harris		305073	6424570
76	Merlaust Pty Ltd		305066	6424362
77	Perram		304844	6424178
77	Perram		305067	6424239
78	Yarramolong Stud Pty Ltd		304392	6424149
79	Jackson		305185	6423962

Residence ID	Ownership details	Existing ZOA	MGA coordinates Zone 56	
			Easting (m)	Northing (m)
79	Jackson		304925	6423902
82	Newton		305122	6423190
83	Newton		305192	6423531
85	Collins		305235	6423088
86	Baxter		305468	6422411
87	Halloran		305005	6422307
88	Reynolds		304813	6422657
89	Page		304403	6422473
90	Page		304148	6422584
91	Doherty		304161	6422132
92	Duck		304367	6422195
93	Osborn		304746	6422136
94	Skinner		304872	6421947
95	De Boer		305641	6422163
96	Bird		305867	6422181
97	Clifton		305812	6421905
98	Jones		306016	6421813
99	Hunter		306291	6421613
99	Hunter		306144	6421650
100	Sharman		306317	6421445
101	Horder		306182	6421257
102	Robertson	Mt Arthur Underground	305966	6421123
182	Paulsen		288865	6419960
183	Beringer Blass Wine		290804	6419806
184	Fosters Wine		291646	6421567
184	Fosters Wine		291553	6421392
184	Fosters Wine		291305	6420460
186	Turner		290039	6421068
187	Duncan		290930	6421274
190	Phillips		288331	6420146
191	Wilks		288736	6420223
195	MacPherson		289371	6421057
196	Eglington, Fuller & Goodchild		289638	6421433
197	Eglington, Fuller & Goodchild		289898	6421304
198	Duncan		290692	6421470
200	Walsh		290612	6422527
201	Denton		290865	6421565
203	Latham		291319	6421705
204	Latham		291481	6421952
205	Lambkin		291506	6421741
206	Wild		291745	6422110
207	Zahra		291881	6422035
208	Zahra		292164	6422353
209	Rankin		292313	6421874
210	Rankin		292613	6422632
211	Rankin		292977	6421911
212	Chudyk	Bengalla	292824	6423499
213	Lawson		288662	6422483
213	Lawson		288744	6422679
213	Lawson		288562	6422551
216	Meyer		289099	6422365
218	Markham		289332	6422951
218	Markham		289390	6423199
218	Markham		289157	6422757
226	Roots		290946	6423464
231	Brown		289144	6423418

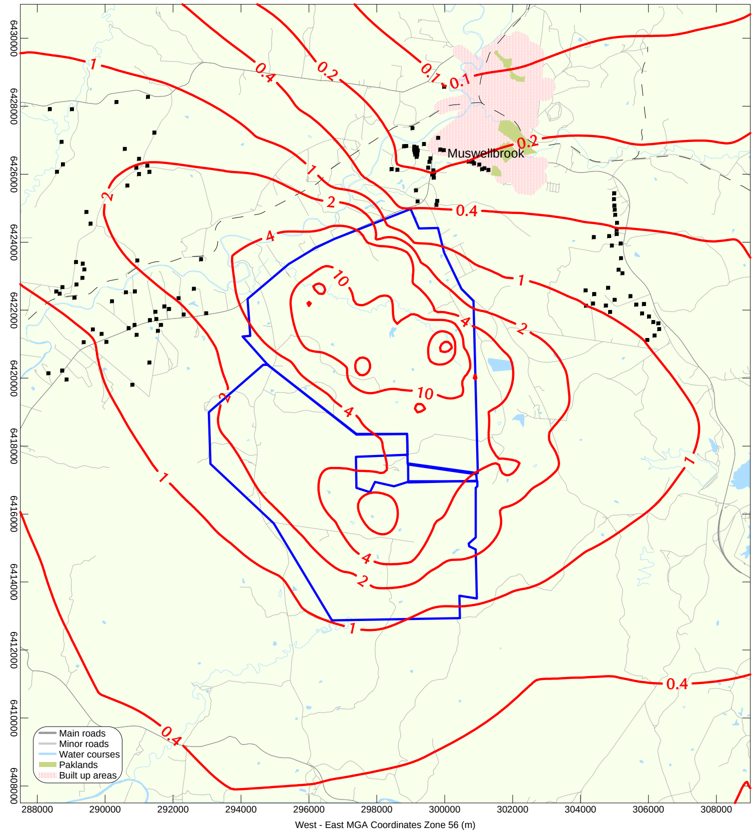
Residence ID	Ownership details	Existing ZOA	MGA coordinates Zone 56	
			Easting (m)	Northing (m)
232	Brown		289343	6423367
233	Merrick		289450	6424892
233	Merrick		289573	6424545
235	Thompson		288582	6426073
236	Thompson		288759	6426291
238	Peel		290918	6426190
239	Ellis		290654	6425667
240	Murray		290998	6426004
241	Lane		291304	6426070
242	Ellis		290998	6426453
242	Ellis		290581	6426744
242	Ellis		291242	6426252
243	McNeill		288720	6426954
250	Hamilton		291451	6427224
252	Strachan		291263	6428276
254	Hughes		290335	6428124
257	Parkinson		289023	6427912
259	Googe		288371	6427916
264	Moore		292314	6429010

Appendix B: Predicted $PM_{2.5}$ emissions from mining sources



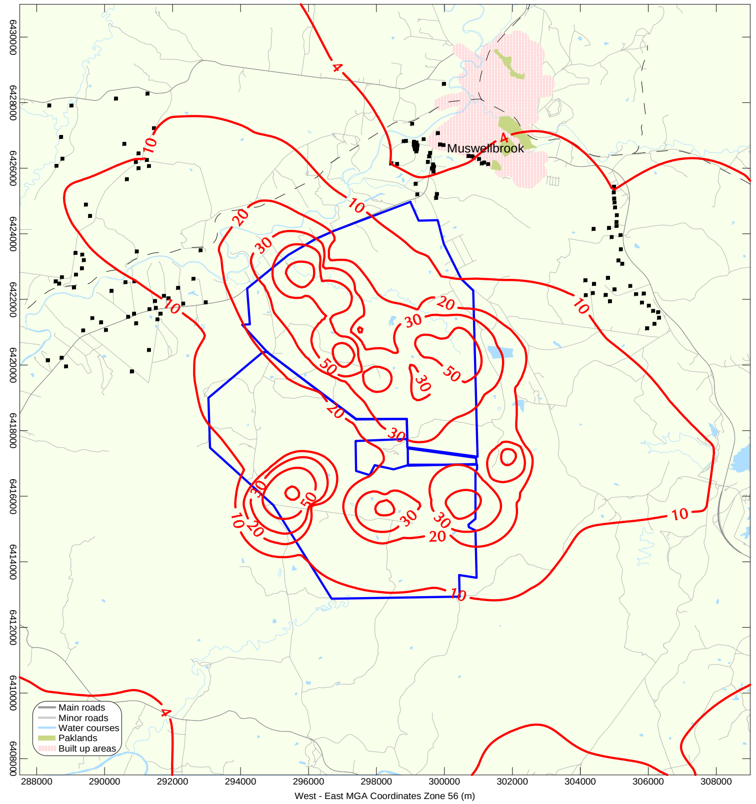
Species:	Averaging Time:	Percentile:	Scenario:	Location:
$PM_{2.5}$	24-hour	Maximum	2011 Project only	Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria :** N/A	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure B.1: Predicted maximum 24-hour average $PM_{2.5}$ concentration due to emissions from the Proposal alone – 2011



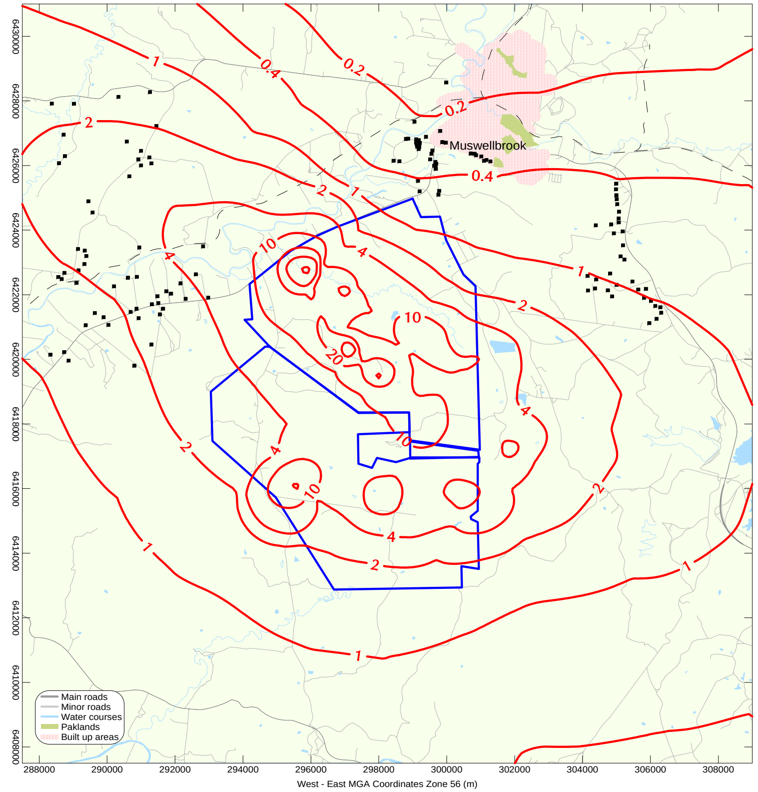
Species:	Averaging Time:	Percentile:	Scenario:	Location:
$PM_{2.5}$	Annual	Maximum	2011 Project only	Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria :** N/A	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure B.2: Predicted annual average $PM_{2.5}$ concentration due to emissions from the Proposal alone – 2011



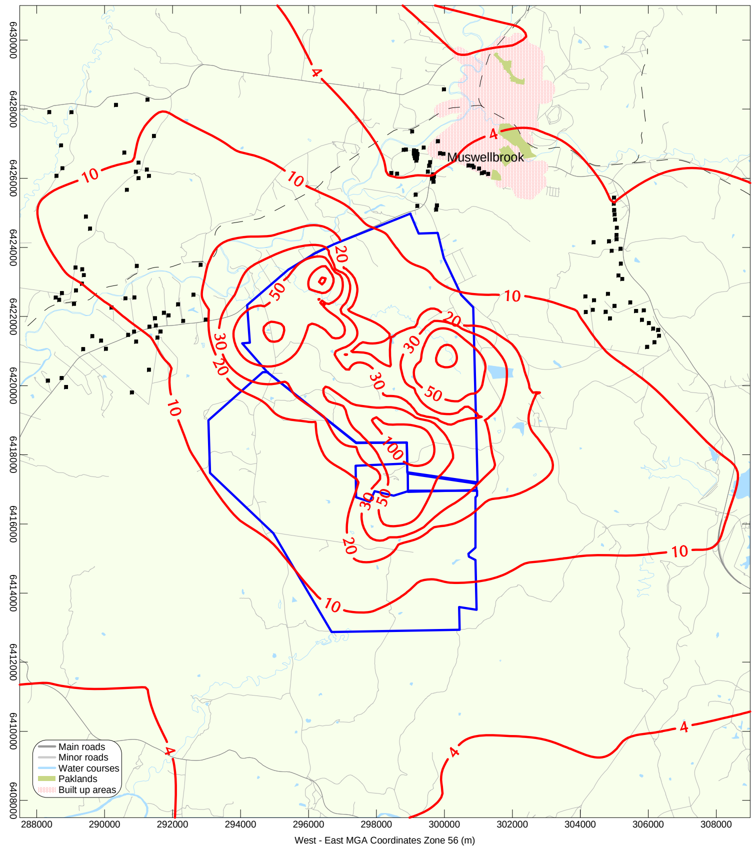
Species:	Averaging Time:	Percentile:	Scenario:	Location:
$PM_{2.5}$	24-hour	Maximum	2016 Project only	Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria :** N/A	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure B.3: Predicted maximum 24-hour average $PM_{2.5}$ concentration due to emissions from the Proposal alone – 2016



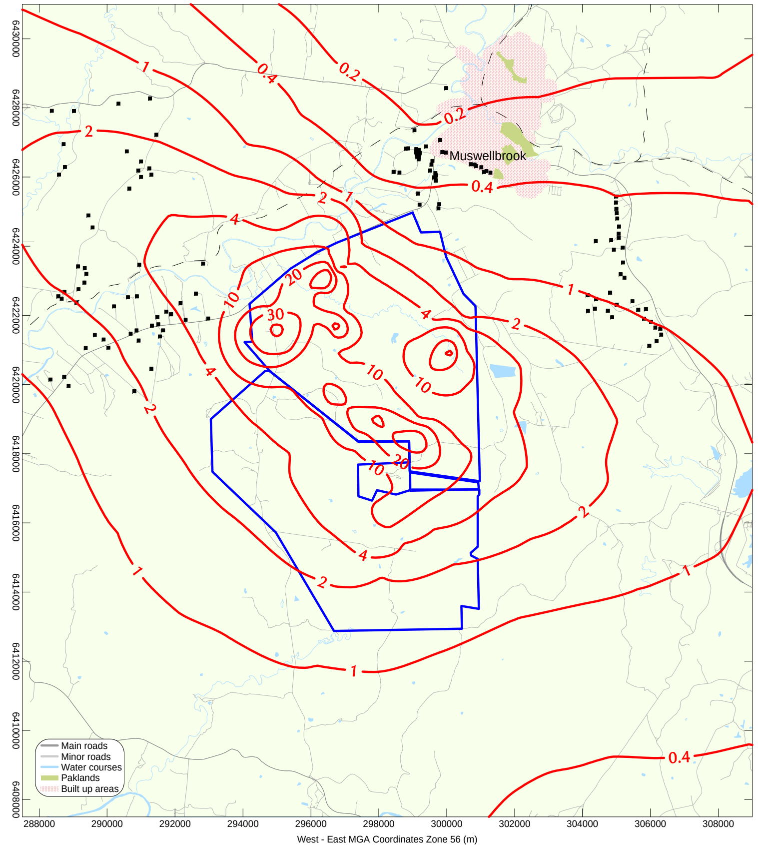
Species:	Averaging Time:	Percentile:	Scenario:	Location:
$PM_{2.5}$	Annual	Maximum	2016 Project only	Mt Arthur Coal
Model Used: ISCMOD	**Units:** µg/m^3	**Assessment criteria :** N/A	**Met Data:** Macleans Hill 2007-2008	**Plot:** J Cox

Figure B.4: Predicted annual average $PM_{2.5}$ concentration due to emissions from the Proposal alone – 2016



Species:	Averaging Time:	Percentile:	Scenario:	Location:
$PM_{2.5}$	24-hour	Maximum	2022 Project only	Mt Arthur Coal
Model Used:	**Units:**	**Assessment criteria :**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	N/A	Macleans Hill 2007-2008	J Cox

Figure B.5: Predicted maximum 24-hour average $PM_{2.5}$ concentration due to emissions from the Proposal alone – 2022



Species:	Averaging Time:	Percentile:	Scenario:	Location:
$PM_{2.5}$	Annual	Maximum	2022 Project only	Mt Arthur Coal
Model Used:	**Units:**	**Assessment criteria :**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	N/A	Macleans Hill 2007-2008	J Cox

Figure B.6: Predicted annual average $PM_{2.5}$ concentration due to emissions from the Proposal alone – 2022

Appendix C: Dust deposition and HVAS PM_{10} monitoring data

Table C.1: Dust deposition monitoring data (g/m²/month)

		Deposition gauge ID																				
	Month	DD1	DD2	DD3	DD4	DD5	DD6	DD7	DD8	DD9	DD10	DD11	DD12	DD13	DD14	DD15	DD16	DD17	DD18	DD19	DD20	DD21
2003	January	4.1	ND	5.3	2.5	2.9	4.7	2.6	2.4	2.8	2.4	6.2	2.7	2.3	2.7	5.3	5.8	4.1	5.5	3.5	7.6	3.8
	February	4.4	4.8	5.2	2.2	4.2	2.8	3	1.8	2.6	1.8	2.5	4.6	1.6	1.8	2.3	3.7	2.6	2.6	2.7	3.3	2.7
	March	5	6	ND	1.7	3.1	2.6	6.1	1.8	1.9	3.2	2.9	3.8	1.8	2.5	2.8	3.7	4.6	3.1	1.6	3.8	2.9
	April	4.6	3.5	4.5	0.8	1.7	1	1.9	0.9	1.4	2.2	1	3.3	1.3	1.4	1.4	2.1	2.2	2.2	2.1	2.2	1.4
	May	3	8.4	ND	1.6	1.9	1	1.2	0.4	0.6	1.3	0.9	0.8	0.7	1	1.1	3.4	3.4	2.2	2.9	2.7	1.6
	June	1.5	2.1	ND	0.9	1.6	0.8	2.8	0.5	0.3	1.1	ND	2.4	0.7	0.6	0.8	5.8	2	1.9	1.4	1.5	1.5
	July	0.9	1.5	1	0.8	1.8	0.8	ND	0.4	4	0.8	ND	7	0.6	0.5	0.4	1.6	3.4	0.9	4.3	1.1	1
	August	3.3	3.4	1.9	0.9	3	0.8	6.9	0.6	0.5	1.2	2.6	1.3	0.7	0.8	1	3.8	3.8	1.5	2	1.4	1.9
	September	ND	2.1	1.9	1.3	2.7	0.7	0.8	0.6	0.6	0.8	1.3	0.8	0.9	0.7	1.1	4.5	2.7	1.7	3.1	1.4	1.8
	October	1.6	3.8	2.5	1.4	1.4	7.3	1.2	0.9	1.5	1.7	7.5	1.9	1.2	1.7	1.8	4.3	5.3	2.8	3.3	2.5	2.3
	November	5.5	4.4	5.4	1.6	4.2	1.3	4.7	1	1.1	2.8	ND	1.5	4.1	1.2	1.9	6.5	4.2	3.2	3.2	3.3	1.7
	December	3.2	7.8	5.2	6.2	4.4	1.7	ND	1.1	1.5	2	ND	3.6	4.2	1.7	2.4	5.3	4.1	4.3	2.5	3.5	ND
	Average	**3.4**	**4.3**	**3.7**	**1.8**	**2.7**	**2.1**	**3.1**	**1.0**	**1.6**	**1.8**	**3.1**	**2.8**	**1.7**	**1.4**	**1.9**	**4.2**	**3.5**	**2.7**	**2.7**	**2.9**	**2.1**
2004	January	2.4	3.3	4.2	1.8	2	1.5	ND	1.2	2	2.7	ND	ND	4.1	1.6	C	C	9.3	2.5	C	2.4	ND
	February	2.3	5.1	2.5	1.2	ND	1.6	ND	1.2	1	1.9	ND	C	2.4	1	1.5	3.9	3.9	2.9	3	3.6	2.1
	March	2	5.6	2.9	6.3	ND	1.1	ND	1.7	2.8	2	ND	1.4	1.5	1	1.8	5	3.1	2.2	2.1	2.3	ND
	April	2.2	4	2.6	1.4	5.3	1.2	8.8	1.3	1.1	3.2	ND	1.3	2.2	1.2	2	C	5.2	3.5	2.8	2.1	2.6
	May	1.8	3.5	1.9	1.2	ND	0.9	1.4	0.9	0.9	1.6	2.7	0.9	1.2	0.9	1.6	5.1	5.7	4.2	3.5	2.5	2.5
	June	1	1.9	1.4	0.7	5.1	0.5	ND	0.6	0.4	1.5	ND	0.7	0.3	1.9	5.4	5.3	ND	2.1	2.2	1.6	1.4
	July	2.3	3	ND	1.4	ND	0.4	6.5	2.7	0.6	1.1	ND	1.1	0.8	0.6	1.1	2.2	3	1.9	2.4	1.7	3.6
	August	1.8	3.4	C	1.1	1.5	1.1	C	0.9	1	1.6	ND	1.1	1.3	0.9	1.3	3.4	3	2.2	2.7	2.5	ND
	September	2.6	2.3	ND	1.4	C	1.6	1.3	0.7	0.9	C	C	5	0.9	1	C	2.1	2.1	1.9	2.5	2	2.3
	October	2.3	6.9	ND	1.9	1.7	1.7	ND	1.1	1	ND	ND	2.9	2.4	1.9	1.5	ND	2.6	2.8	2.9	3	1.7
	November	4	2.3	C	1.1	2.8	1.9	ND	1.1	1.1	1.3	C	3.1	0.9	0.8	1.3	2.5	4.4	3.3	1.4	2.1	1.4
	December	1.6	2.7	C	1.4	C	1.4	1.8	1.5	2.3	1.6	C	1.8	3.3	1.6	1.7	C	3.1	2	0.9	2.3	2.5
	Average	**2.2**	**3.7**	**2.6**	**1.7**	**3.1**	**1.2**	**4.0**	**1.2**	**1.3**	**1.9**	**2.7**	**1.9**	**1.8**	**1.2**	**1.9**	**3.7**	**4.1**	**2.6**	**2.4**	**2.3**	**2.2**
2005	January	2	2.3	C	1.4	3.3	2.1	1.6	1.1	1.5	ND	C	0.6	1.3	1	2.1	C	1.9	1.8	1.7	1.8	1.7
	February	2.7	C	2.7	2.3	1.4	1.9	1.9	2	1.9	1.6	C	6.6	2.2	1.9	2.5	C	3	3.1	2.9	2.3	2.7
	March	2.7	C	3.7	2.4	2.9	1.9	1.6	1.3	1	2.1	C	1.6	1.4	1.1	2.4	3.9	2.7	1.5	1.3	3.4	3.2
	April	3.6	C	C	2	7.3	3.8	2.2	1.5	1.3	2.3	3.1	2.1	1.5	1.3	2.2	2	2.5	1.8	2.4	5.3	2.4
	May	1.6	2.4	2.1	1.3	2.1	1.3	3.4	1.2	0.5	3	3.5	2.2	1.4	0.9	1.8	4.4	2.5	1.8	2.3	3.2	1.7
	June	1.5	C	2.6	1.3	1.7	0.7	1	1.3	0.9	2.3	2.5	1.4	1.2	0.8	1.2	3.6	1.2	1.8	1.4	8.5	2.4
	July	1.8	3.8	2.8	1.6	1.5	1.2	1.2	0.7	1.1	2.4	C	1.3	0.8	0.7	C	2.6	2.8	2.4	2.4	2.2	2.4
	August	2	2	2.7	1.7	3	1.6	1.1	1.1	0.8	2.3	C	1.5	1.4	0.5	C	C	2.7	3	3.2	ND	2.3
	September	2	C	4.1	1.3	2.4	2.3	2.3	2	1	1.1	C	1.2	1	0.6	0.6	2.2	1.7	2	2.3	1.8	1.6
	October	1.7	C	2.8	1.1	2.3	1.4	1.8	0.8	0.8	0.6	ND	2	0.8	0.8	3.8	2	1.8	1.8	2.4	2.3	1.3
	November	ND	C	4.8	1.8	3.6	1.9	ND	1.9	1.1	ND	C	3	3.2	1.2	3.2	4.5	2.2	2.8	2.6	3.6	2.1
	December	ND	3.7	3.7	2.2	4.2	1.5	1.5	1	1.1	1.3	C	1.6	1.1	0.8	3.9	4.2	2.3	1.9	2.9	2.6	1.7
	Average	**2.2**	**2.8**	**3.2**	**1.7**	**3.0**	**1.8**	**1.8**	**1.3**	**1.1**	**1.9**	**3.0**	**2.1**	**1.4**	**1.0**	**2.4**	**3.3**	**2.3**	**2.1**	**2.3**	**3.4**	**2.1**

		Deposition gauge ID																				
	Month	**DD1**	**DD2**	**DD3**	**DD4**	**DD5**	**DD6**	**DD7**	**DD8**	**DD9**	**DD10**	**DD11**	**DD12**	**DD13**	**DD14**	**DD15**	**DD16**	**DD17**	**DD18**	**DD19**	**DD20**	**DD21**
2006	January	2.7	7	5.5	1.8	2.9	1.8	2.2	1.5	1.5	3.4	8	7	1.6	1.4	3.4	2	1.7	3.5	2.1	3.3	1.8
	February	2.6	4.6	3.2	1.6	2.1	2.9	2.9	1.4	1.3	2.2	3.2	1.5	1.1	0.9	4.5	7	3.6	3	2.3	3.7	2.3
	March	1.7	5.6	3.1	1.4	1.9	1.6	0.9	2.3	0.8	1.3	ND	4.6	1	0.9	2.5	3.7	1.3	1.6	1.6	1.8	1.6
	April	2.3	6	3.8	2.1	2	1	1.9	1.2	0.8	1.7	4.6	2.3	1.1	1.1	3	3.4	2.4	2.5	3.2	2.9	2.9
	May	2.1	4.6	3	1.7	2.4	1.2	3	1.3	0.8	1.9	5.1	5.3	2.9	1.4	2.3	5.7	2.6	2.7	4.3	5.3	4.5
	June	2	3.7	2.9	2.5	2.8	1.4	6.9	1	0.9	2.7	2.6	1.7	1.5	1.2	2.3	5	2.4	2.3	2.3	3.2	2.9
	July	6.6	3	2	1.4	2	0.8	0.6	0.6	0.4	1.5	4.7	0.9	0.9	0.7	1.7	2.4	2.8	1.7	1.7	2.5	1.1
	August	2	2.9	ND	1.6	2.6	1.3	1.5	1	1	1.6	2.1	1.5	1.6	0.8	1.9	3.6	2.5	2.8	2.8	2.9	3
	September	2.5	2.9	3.2	1.5	1.6	1	1.1	0.9	0.9	1.2	2	1.6	1.4	0.9	1.6	2.8	2.2	2	2.1	3.4	2.2
	October	2.8	2.9	2.3	2.2	1	1.6	0.9	1.4	1.7	2.6	2.7	1.9	1.9	1.4	3.2	6.3	2.2	2.9	3	4	3.9
	November	3	4.1	5.2	3	3	1.9	1.8	0.9	0.7	3.3	1	1.4	1.6	1	1.3	3.7	2	8.8	4.4	ND	4.3
	December	3.3	4.7	4.9	2.4	2	2.7	ND	1.1	1.2	1.6	2.7	2.9	2.7	1.3	1.3	5.4	2.1	2.6	2.2	6.1	3
	Average	**2.8**	**4.3**	**3.6**	**1.9**	**2.2**	**1.6**	**2.2**	**1.2**	**1.0**	**2.1**	**3.5**	**2.7**	**1.6**	**1.1**	**2.4**	**4.3**	**2.3**	**3.0**	**2.7**	**3.6**	**2.8**
2007	January	1.7	ND	ND	2.4	1.4	1.9	2.1	1.3	0.9	1.7	ND	0.6	1.4	ND	5.3	ND	1.6	1.1	2.2	1.8	1.0
	February	3.2	ND	6.3	1.9	6.1	1.2	ND	0.7	1.1	4.2	3.0	1.9	1.9	1.5	1.8	ND	3.3	3.1	4.3	5.5	2.1
	March	1.6	4.3	3.5	1.7	2.2	1.2	1.1	1.5	1.0	2.4	2.3	1.1	1.8	0.7	2.4	ND	1.9	3.3	ND	3.2	2.5
	April	2.8	ND	ND	1.8	1.5	1.1	0.8	0.7	0.6	1.5	2.9	2.0	1.8	ND	4.4	ND	2.2	2.1	1.9	2.9	1.9
	May	2.1	ND	ND	1.2	3.0	1.3	0.8	1.0	0.7	1.4	ND	1.0	1.0	0.7	1.4	2.6	1.7	2.1	1.8	ND	1.8
	June	ND	ND	2.5	1.1	1.3	ND	1.3	1.4	1.1	2.5	2.3	1.5	0.8	0.6	0.6	2.7	1.3	1.5	1.6	0.8	1.0
	July	1.0	2.0	2.1	1.0	0.9	0.3	0.2	0.6	0.3	0.8	ND	0.9	0.5	0.1	0.6	2.1	2.1	ND	1.4	0.9	1.0
	August	0.9	2.7	2.2	0.9	1.7	1.0	0.6	0.4	0.6	1.2	0.2	4.2	0.4	0.3	0.8	1.8	1.4	1.7	2.8	2.5	2.1
	September	0.8	ND	ND	1.1	1.9	1.3	0.5	1.0	1.7	1.1	ND	1.2	1.2	0.4	1.5	2.4	1.3	2.2	1.4	1.5	2.1
	October	ND	ND	ND	3.4	ND	ND	2.7	1.8	3.0	ND	ND	ND	ND	ND	5.3	ND	4.0	ND	4.2	4.1	3.2
	November	3.0	ND	5.5	2.7	3.1	8.1	2.2	1.8	1.6	3.2	3.9	2.8	2.5	1.5	3.8	4.8	3.4	5.2	2.6	5.2	1.4
	December	2.9	4.7	5.6	1.9	5.5	1.6	0.9	0.8	0.8	1.6	2.1	1.8	1.2	1.2	2.5	5.6	2.1	2.5	2.2	3.2	1.8
	Average	**2.0**	**3.4**	**4.0**	**1.8**	**2.6**	**1.9**	**1.2**	**1.1**	**1.1**	**2.0**	**2.4**	**1.7**	**1.3**	**0.8**	**2.5**	**3.1**	**2.2**	**2.5**	**2.4**	**2.9**	**1.8**
2008	January	2	ND	ND	1.9	1	2	0.8	N	0.5	1	2.1	2.6	1	0.9	1.5	3.4	1.6	2	1.5	2.9	1.9
	February	2.5	ND	3.5	2.2	2.6	3.1	2.2	5.9	1	2.1	1.8	2.3	1.5	1.3	2.7	5.8	ND	3.3	2.8	3.9	2.7
	March	3.2	ND	5.4	N	1.9	2.2	0.7	0.6	1	2.8	1.2	3.5	1.7	1.4	1.9	5.3	1.8	2.4	2.6	4	1.6
	April	ND	ND	ND	1.9	1.5	1.5	1	0.8	0.7	1.5	2.1	1.2	1	1	1.9	4.2	2.7	2.8	3.1	3.9	2.4
	May	ND	ND	ND	N	ND	1.4	0.9	1.3	1	2.5	ND	ND	1.6	1	1.8	3.6	1.9	2	3	2	2.3
	June	1.4	ND	3.1	1.1	1.2	1.3	0.3	1.7	1.7	0.6	2.3	0.5	0.4	0.5	ND	1.5	1.8	1.3	1.7	2.6	0.9
	July	1.2	2.1	ND	1.6	3.1	1.1	ND	2.1	2	2.6	ND	2.4	2.2	1.3	1.7	2.7	1.5	2	3.3	2.5	1.5
	August	1.5	ND	1.9	1.1	ND	2.2	2.6	1.5	0.8	1.4	ND	0.8	0.9	0.7	0.7	1.6	1.2	1.3	2.2	1.7	2.4
	September	2.2	3.5	3	1.8	3.7	1.8	0.9	0.8	0.9	1.3	1.4	1.2	1.1	0.9	1.3	3.3	1.6	1.2	1.4	2.4	1
	October	1.7	3.7	3.2	1.3	2.2	2.7	2.1	1	1.3	2.8	ND	2	1.4	0.7	1.4	0.5	2.2	1.4	2.3	2.3	0.9
	November	3.2	ND	2	1.6	ND	ND	1.3	2	1.1	1.8	3	2.1	2.7	1.2	3	3.9	3.8	2.4	1.5	4.4	3.6
	December	2.2	ND	1.7	3.9	ND	2.1	1.1	N	1.2	2.6	3.3	1.8	ND	1.8	2.2	3.5	3.3	1.6	1.4	3.7	1.2
	Average	**2.1**	**3.1**	**3.0**	**1.8**	**2.2**	**1.9**	**1.3**	**1.8**	**1.1**	**1.9**	**2.2**	**1.9**	**1.4**	**1.1**	**1.8**	**3.3**	**2.1**	**2.0**	**2.2**	**3.0**	**1.9**

Notes:
ND – no data
C – sample contaminated

Table C.2: HVAS 24-hour average PM_{10} monitoring data ($\mu g/m^3$)

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
1/01/2002	23	14	13					12	13		16
7/01/2002	45	45	49					16	48	12	44
13/01/2002	38	26	23					27	30	13	36
19/01/2002	50	34	33					32	26	8	33
25/01/2002	15	14	19					15	13	2	31
31/01/2002	33	19	22					16	15	6	33
6/02/2002	27	26	30					26	26	18	20
12/02/2002	44	43	51					36	33	27	46
18/02/2002	13	43	9					4	5	7	14
24/02/2002	18	15	15	15				13	10	9	18
2/03/2002	35	43	31	30				33	30	8	33
8/03/2002	39	19	19	17				16	15	14	33
14/03/2002	30	23	22	20				22	22	19	25
20/03/2002	56	33	26	27				26	29	5	38
26/03/2002	40	25	23	22				25	20	8	26
1/04/2002	21	23	20	18				18	21		25
7/04/2002	18	23	21	21				20	17	17	23
13/04/2002	27	25	25	23				30	26	8	38
19/04/2002	14	6	8	8				6	8	2	8
25/04/2002	29	20	17	20				16	42	7	21
1/05/2002	16	19	16	15				16	11	9	22
7/05/2002	39	21	17	24				19	17		20
13/05/2002	45	23	23	25				20	20	3	
19/05/2002	16	12	10	12				10	10	8	13
25/05/2002	7	7	3	4				4	3	3	6
31/05/2002	9	7	6	6				5	4	6	16
6/06/2002	12	13	9	12				8	8	10	16
12/06/2002	8	5	4	7				5	4	4	5
18/06/2002	3	1	2	2				1	1	2	5
24/06/2002	12	3	5	5				4	3	4	6
30/06/2002	19	6	8	9				4	5	6	4
6/07/2002	28	3	3	5				5	5	6	6
12/07/2002	36	11	15	14				10	10	9	10
18/07/2002	42	10		11	105			8	9	6	18
24/07/2002	17	9		15	26			11	13	7	11
30/07/2002	33	17		25	39			20	10	13	21
5/08/2002	17	13		12	29			12	13	10	27
11/08/2002	24	16		15	18			15	12	8	14
17/08/2002	23	21		16	26			18	18	14	18
23/08/2002	19	15		15	18			13	11	10	22
29/08/2002	21	22		16	78			15	12	8	12

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
4/09/2002	14	14		13	13			13	13	9	12
10/09/2002		13		13	20			10	10	9	17
16/09/2002		19		19	27	49		17	17	12	17
22/09/2002		39		17	21	24		19	18	1	19
28/09/2002		30		26	21	48		19	21	14	28
4/10/2002		36		30	35	57		40	38	7	41
10/10/2002		23		22	34	63		20	16	14	25
16/10/2002				20	18	60		14	13	4	14
22/10/2002		38		42	43	75		37	44	17	
28/10/2002		23		29	31	120		25	18	9	30
3/11/2002		57		58	51	135		58	57	11	52
9/11/2002		52			58	225		54	46	13	57
15/11/2002		35		31	34	85		33	29	24	33
21/11/2002		19		20	27	130		20	19	12	37
27/11/2002		81		81	74	135		72	73	17	85
3/12/2002		38		39	36	47		39	34	7	49
9/12/2002		46		54	61	63		44	38	8	47
15/12/2002		25		23	20	28		24	18	5	23
21/12/2002		41		32	39	43		32	28	2	35
27/12/2002		13		13	12	17		12	9	4	17
2/01/2003		22		19	23	28		21	24	3	27
8/01/2003		26		26	24	40		28	25	2	24
14/01/2003		29		26	29	43		29	24	10	30
20/01/2003		60		53	58	61		56	46		61
26/01/2003		33		41	29	48		36	31		33
1/02/2003		50		51	55	50		53	39	24	60
7/02/2003		39		12	34	39		40	25		33
13/02/2003		35		34	44	49		37	28		41
19/02/2003		25		24	24	26		21	20	20	28
25/02/2003		24		29	22	26		23	21	33	23
3/03/2003		32		30	31	34		33	33	37	40
9/03/2003		22		18	20	18		18	21	20	21
15/03/2003		21		19	26	27		21	21	25	28
21/03/2003		60		66	96	64		60	74	71	84
27/03/2003		27		22	31	31		20	17	20	28
2/04/2003		16		15	13	19		14	13	13	17
8/04/2003		23		24	41	25		21	25	26	30
14/04/2003		9		9	5	8		9	11	12	9
20/04/2003		12		10	12	7		7	11	11	13
26/04/2003		10		9	12	9		9	8	11	8
2/05/2003		26		20	24	30		19	18		26
8/05/2003		6		9	11	11		8	9	15	5
14/05/2003		8		9	8	12		7	3	9	11

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
20/05/2003		14		17	12	33		12	12	18	12
26/05/2003		6		8	28	8		12	12	8	29
1/06/2003		7		10	13	12		6	4	9	3
7/06/2003		10		9		24			9	10	9
13/06/2003		9		9	7	17		7	9	9	8
19/06/2003		11		14	79	22		8	14	18	12
25/06/2003		19		18	29	21		16	13	20	21
1/07/2003		5		3	13	17		2	2	3	12
7/07/2003		9		9	20	18		4	3	6	9
13/07/2003		9		7	23	10		4	7	9	10
19/07/2003		15		10	12			8	5	9	10
25/07/2003		4		10	4		6	2	2	2	2
31/07/2003		4		3			13	3	3	3	5
6/08/2003		34		13	17		38	13	12	14	14
12/08/2003		12		11	16		15	9	7	10	14
18/08/2003		12		3	7		5	2	2	3	7
24/08/2003		8		9	8		14	7	7	8	8
30/08/2003		15		10	19		16	8	8	8	11
5/09/2003		21		14	24		36	12	19	18	20
11/09/2003				20	17		37	11	9	17	14
17/09/2003				5	7		35	3	1	3	6
23/09/2003		25		31	31		91	29	21	26	43
29/09/2003		11		18	16		32	15	10	14	14
5/10/2003		9		11	15		11	8	7	10	16
11/10/2003		11		15	24		15	10	13	9	17
17/10/2003		20		22	22		22	19	17	18	23
23/10/2003		17		17	41		22	17	17	19	20
29/10/2003		96		83	106		119	91	81	92	144
4/11/2003		28		26	26		42	24	27	27	32
10/11/2003		26		25	25		47	21	16	20	32
16/11/2003		29		26	18		62	31	26	26	38
22/11/2003		7		8	6		7	7	4	7	6
28/11/2003		22		18	21		14	17		15	22
4/12/2003		14		13	16		15	13	13	13	19
10/12/2003		28		31	27		31	27	22	27	
16/12/2003		27		20	20		25	25	15	17	24
22/12/2003		18		14	26		45	16	9	15	31
28/12/2003		27		21			23	28	21	17	23
3/01/2004		33		30	27		33	30	28	29	29
9/01/2004		38		40	35		49	45	40	49	47
15/01/2004		28		29	27		30	26	26	24	35
21/01/2004		14		15	16		30	17	22	16	16
27/01/2004		26		28	25		26	26	25	24	26

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
2/02/2004		17		16	18		38	17	20	19	17
8/02/2004		43		43	43		60	43	35	38	43
14/02/2004		31		29	36		30	33		27	37
20/02/2004		29		30	43		63	32	29	30	43
26/02/2004		9		10	18		19	10	10	9	18
3/03/2004		17		16	19		23	18	11	12	24
9/03/2004		18		18	22		46	20	20	20	23
15/03/2004		21		24	29		38	23		21	43
21/03/2004		20		20	36		34	20	18	18	30
27/03/2004		59		48	61		58	58		49	58
2/04/2004		47		43	42		51	50	12	50	53
8/04/2004		28		30	35		29	22	18	19	29
14/04/2004		30		29	25		33	32	27	26	24
20/04/2004		31		29	36		45	32	22	25	39
26/04/2004		24		25	29		38	24	24	31	26
2/05/2004		3		4	8		21	6	5	4	5
8/05/2004		27		29	66		44	29	32	28	110
14/05/2004		29		32	71		63	37	27	32	33
20/05/2004		9		25	22		53	18	11	21	11
26/05/2004		7		7	11		16	7	6	7	9
1/06/2004		10		14	16		17	11	11	17	9
7/06/2004		13		10	28		17	9	7	6	22
13/06/2004		6		9	14		12	6	6	7	8
19/06/2004		7		4	7		21	4	6	4	7
25/06/2004		5		4	8		11	3	3	3	5
1/07/2004		59		8	27		27	12	6	12	13
7/07/2004		7		7	18		30	6	4	7	10
13/07/2004		2		4	18		11	2	3	3	4
19/07/2004		3		4	12		10	3	3	3	27
25/07/2004		2		3	5		6		4	2	3
31/07/2004		16		14	169		25	14	12	14	16
6/08/2004		1		2	8		17	1	2	2	4
12/08/2004		5		8	29		20	5	5	5	6
18/08/2004		1		1	6		3	2	1	2	13
24/08/2004		25		17	25		27	17	17	23	17
30/08/2004		20		15	18		22	15	13	14	19
5/09/2004		3		2	10		9	2	3	3	6
11/09/2004		4		5	5		11	3	3	4	6
17/09/2004		7		7	14		19	6	5	9	10
23/09/2004		16		4	155		40	23	13	15	22
29/09/2004		36		29	51		47	33	27	32	44
5/10/2004		11		7	12		10	7	8	12	12
11/10/2004		28		30	32		42	32	27	31	32

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
17/10/2004		20		17	24		20	21	15	14	20
23/10/2004		8		8	11		13	9	8	7	15
29/10/2004		24		20	23		18	20	15	15	22
4/11/2004		28		30	21.1		20.7	30	20.8	19.7	29.4
10/11/2004		12.4		11.8	11.4		7.9	10.5	8.4	7.9	17.6
16/11/2004		19.6		25.3	23		23.8	18.8	14.4	16.4	27
22/11/2004		15.9		19.3	20		19.3	15.4	14.8	15.5	16.9
28/11/2004		20.9		26	20.3		40.5	23.8	22.1	27.5	21.9
4/12/2004		14.8		14.8	15.7		15.4	11.8	10.7	11.2	13.4
10/12/2004		8.7		9	7.9		10.2	7.3	8.6	7.4	13.3
16/12/2004		16.8		18	19		19.8	16.8	16.8	17.4	25
22/12/2004		23.7		24.3	20.5		24.3	25	22.7	23.7	22.9
28/12/2004		13		13.3	14.9		22	13.5	11.2	12.3	16.9
3/01/2005		30.4		32	28.4		27.3	30.5	27.9	27.7	29.7
9/01/2005		20.6		20.1	18		15.3	19.2	15.4	16.5	21.2
15/01/2005		49.2		47.3	55.6		46.7	43	42.8	42.4	57.3
21/01/2005		29.4		29.7	31.7		30.2	31.1	30.6	29.5	29.7
27/01/2005		13.6		14.4	13.3		11.4	14.7	9.9	12.3	14.5
2/02/2005		23.2		27.2	17.3		19.2	25.6	25.7	24	22.3
8/02/2005		10.9		19.9	17.3		14.3	18.1	16	17.6	13.6
14/02/2005		27.1		26.5	23		20.9	26.5	22.3	27	27.4
20/02/2005		9.7		10.9	8.1		8.8	8.5	8.2	9.3	9
26/02/2005		33.9		35.8	37.4		37.2	32.7	30.4	32.7	40.6
4/03/2005		13.5		15.3	13.8		19.4	14	12.9	14.4	14.4
10/03/2005		22.3		26.4	33.1		18.7	20.4	18.1	18.8	26.7
16/03/2005		27.3		34.2	59.3		34.9	30.7	29	30.6	34.8
22/03/2005		6.3		6.9	15.4		10.8	5.9	5.7	6.1	17.3
28/03/2005		10.8		15.8	16.4		13	13.8	13.9	18.5	10.2
3/04/2005		12.6		84.5	18.6		47.4	21.9	16.6	23.9	14.9
9/04/2005		17.4		15.5	47.6		20.6	15.7	11.6	16.1	13.6
15/04/2005		21.5		24.2	24.2		28.6	21.7	14.2	19.8	17.1
21/04/2005		18.3		15.5	26.1		19.3	14.8	14.3	15.2	22.4
27/04/2005		18.3		21.8	23.1		29.8	24.9	15.2	19.9	28.9
3/05/2005		15.9		14.4	41.2		27.6	19.6	11.3	13.9	12.7
9/05/2005		13.2		9.9	9.5		12.8	11.8	11.2	12.4	11
15/05/2005		10.4		8.9	20.1		12.8	10.4	9.6	11.1	19
21/05/2005		9.5		12	15.3		16.4	10.4	10.4	11.2	10.6
27/05/2005		13.1		14.3	18.1		30	14	12.9	16.7	15.9
2/06/2005		24.1		22.9	35.2		28.5	20.4	17.3	21.6	21.9
8/06/2005		29.9		29.1	35		37.3	27.8	19.5	26.9	26.2
14/06/2005		1.8		2.6	4.5		4.2	2.4	0.4	0.5	1.9
20/06/2005		1.8		2.3	4.2		4.2	2.3	2	3.2	3.3
26/06/2005		8.3		8.2	8.2		6.8	6.4	6.7	6.7	11.8

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
2/07/2005		3		3	7.3		4.2	3	3	3	3.5
8/07/2005		13.9		14.5	22.2		21.1	15.1	12.2	16	19.4
14/07/2005		2.3		1.8	4.5		8.6	1.5	1.8	1.2	3.2
20/07/2005		22.4		20.6	24.2		16.2	15.2	12.5	16.2	22.6
26/07/2005		3.9		3.4	18.8		20.2	3.4	3.1	4.5	6.7
1/08/2005		22.9			28.9		26.5	18.3	14.9	21.1	25.7
7/08/2005		7.6		6.4	13.9		12.7	2.6	3.3	4.4	5.8
13/08/2005		6.2		31.4			23.7	8.4	4.6	12.2	11.2
19/08/2005		17.4		33	16.7		36.6	20.6	14.9	20	16.8
25/08/2005		22.6		25.1	38.4		33.4	18.7	15.5	19.1	24.5
31/08/2005		20		18.5	60.9		43.1	18.7	13.9	19.6	26.1
6/09/2005		9.8		7.5	12.6		9.6	6.9	8	9.7	14.9
12/09/2005		2.3		2.3	3.6		8.7	2.4	2.1	3	5.5
18/09/2005		3.6		5	10.6		11.4	2.6	4.3	5.1	17
24/09/2005		20.5		22.3	25.9		32.6	18.4	17.6	18	
30/09/2005		5.8		6.7	16.7		14.2	6.9	4.7	9.4	24.5
6/10/2005		12.4		13.6	26.1		35.8	15.3	16.8	15.6	31.7
12/10/2005		17.5		16.8	18.1		19.8	16.4	13.3	14.4	18.6
18/10/2005		18.9		15.4	36.2		17.8	13	3.3	13.3	22.1
24/10/2005		11.6		12.2	14.6		19.3	12.4	12	12	34
30/10/2005		13.9		11.5	12.8		12.6	20.2	11	11.5	1
5/11/2005		13.3		14	13.8		13.1	12.6	1	11.3	12.3
11/11/2005		14.3		15.1	20.1		30.1	13.9	14.4	12.9	27.6
17/11/2005		26.8		22.1	20.2		20.8	18.1	17.3	17.4	22.4
23/11/2005		7.6		8.3	12.5		13.6	9.1	8.6	8.4	13.3
29/11/2005		5.6		6.5	7.1		6.7	7.2	10.8	7.4	8.2
5/12/2005		10.9		11.8	16.2		37.3	12.6	14.1	15	21.5
11/12/2005		29.3		26.8	35.7		29.9	22.7	24.3	21	30.6
17/12/2005		10.1		10.1	17.3		15.3	9	10.7	13.9	16.8
23/12/2005		31.6		28.9	30.6		32.4	30.6	1	30.5	35.1
29/12/2005		62.7		71.7	41.1		45.3	59.6	43.4	26.4	42.3
4/01/2006		45.6		42.5	41.2		38.5	36.7	45.2	34.9	48
10/01/2006		19.9		17	21		18.4	18	0.5	14.6	18.6
16/01/2006		17.6		13.5	14.9		14.6	12.9	0.5	10.8	16.2
22/01/2006		29.6		20.8	14.6		12.6	16.2		16.5	15.9
28/01/2006		20.4		16.8	21.4		28.3	15.2	21.5	15.8	18.2
3/02/2006		22.2		16.2	17.1		29.5	15	20.4	13.8	23.3
9/02/2006		23.6		25.9	32.3		95.7	24.5		21.2	30.1
15/02/2006					20.6		37.2				22.4
21/02/2006		17.8		14.4	17.7		25.2	12.4	14.2		16.4
27/02/2006		13.8		12.8	13.2		20.5	12.4			16.1
5/03/2006		12.1		12.3	14.6		12.7	9.5		9.7	11.5
11/03/2006		27.9		30.5	32.1		36.5	24.8		25.5	25.6

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
17/03/2006		22.3		23.6	44		62.3	23	25.3	18.7	34.1
23/03/2006		16.2		27.3	39.1		18.8	20.5		16.2	20.8
29/03/2006		18.6		26.6	36.6		30.8	15.9	15.5	16.3	16.8
4/04/2006		11.9		20.2	15.1		89.2	14.9	13.1	18.3	14.7
10/04/2006		28.7		44.3	28.6		38.3	29.3	28.7	32.8	27.1
16/04/2006				18	11.6		13.2	9.6	9.5	12.5	15.7
22/04/2006		17.6		22	36.1		16.5	9.8	13.1	15.1	14.6
28/04/2006		19.3		25.5	27.3		15.8	15	15.8	18.3	21.5
4/05/2006		8.1		22.3	13.3		20.6	10.9	14.7	17	9.1
10/05/2006		11.6		28.1	15.7		31.1	11.6	11.1	12.1	15.5
16/05/2006		17		20.9	30.3		19.3	11.9	13.3	13.5	15.3
22/05/2006		15.4		21.8	22.1		23.4	13.3	11.1	15	18.1
28/05/2006					34.3		18.7				
3/06/2006		5.6		17.7	66.2		19.9	9.5	4.9	8.7	8.9
9/06/2006		16.2		11.9	10.1		10.8	9.5	9.9	9.6	10.4
15/06/2006		5.8		11.7	14.5		22.9	7	6.8	8.7	9
21/06/2006		11.7		13.6	13.5		14.1	7.7	9.2	8.1	15.6
27/06/2006		9		6	25.2		24.3	6.6	9.1	11.5	9.2
3/07/2006		2.6		2.3	9.8		7.3	2.7	2.7	3.3	20.7
9/07/2006		6.1		5.3	10.9		9.8	9.2	3.6	7.7	7.2
15/07/2006		12.4		7.6	8.9		7	6.5	6.1	6.1	8.8
21/07/2006		13.3		7.2	13.4		11.7	9.3	7.4	9.2	14.2
27/07/2006		22.6		10.5	17.9		10.5	8	7.4	7.8	9.9
2/08/2006		7		10.5	17.1		11.4	8.1	4.1	13.8	7.8
8/08/2006		13.7		17.7	22.6		19	16.5	15.8	28.4	17
14/08/2006		14.5		17.3	20.6		20.1	13.1	12.4	15.9	16.3
20/08/2006		18.6		17.9	30.9		23.9	18.4	13.6	22.3	10.1
26/08/2006		9.7		9.7	12.1		9.9	8.8	6.5	8.7	9.5
1/09/2006		9.8		7.6	20.2		18.7	5.7	5.2	8	11.2
7/09/2006		1.9		2.3			4.7	2.2	2.6	2.2	8.6
13/09/2006		9.9		8.3	12		9	7.7	6.7		13.6
19/09/2006		11.5		15.1	15.5		16.4	14.2	17.7		26.1
25/09/2006		27.4		23.3	25.8		29	23.1	20	20.1	29.3
1/10/2006		27.4		17.3	25.1		56.1		24.2		21.3
7/10/2006		34.5		22.9	23.7		40.6	24.5	27.4	26.3	23.3
13/10/2006		17.7		28.7	20.6		50.8	25.1	31.4	32	15.6
19/10/2006		27.4		25.2	31.2		58.7	33.8	24.3	26.8	32.4
25/10/2006										32.5	
31/10/2006		19.8		19.9	17.6		41.2	24.3	16.7	27.4	17.1
6/11/2006		10.6		9.7	9		11.8	7.6	7.9	7.9	15.8
12/11/2006		19.5		17.6	18.9		35.7	20.7	19.1	21.3	25.2
18/11/2006		23.6		29.3	20		32.5	22.7	21.9	22.7	22.1
24/11/2006		33.9		20.6	36.1		42.7	33.4	28.6	31.5	30.9

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
30/11/2006		36.4		29.6	38		49.5	34.2	26.8	30.3	
6/12/2006		24.2		24.2	27.1		42.5		50.5	20.9	31.5
12/12/2006		17.3		15.3	21.4		39.2	17.6	13.3	15.8	21.9
18/12/2006		32.8		34.5	24.7		35.3	27.2	21.1	24.6	31
24/12/2006		14.2		15.8			17.1	15.2	14.2	14.2	13.7
30/12/2006		16.3		13.3	14.5		16.7	11.5	10.6	11.8	14.3
5/01/2007		26.2		20.4	18.9		30	20.6	18.7	22.9	18.2
11/01/2007		37.3		39.5	43.3		71.1	34.9	31.3	35	36.9
17/01/2007		35.4		45.2	28.5		44.3	32.3	26.1	32.1	34
23/01/2007		32.9		40.6	47.2		45.4	31.5	31.5	30.4	40.2
29/01/2007		27.7		32.6	46.9		41.4	25.2	31.6	22.9	35
4/02/2007		30.5		33.3	45.4		31.4	25.6	22.5	23.5	43.7
10/02/2007		16.7		18.3	30.7		21.3	15.8	15.2	15.6	17.4
16/02/2007		16.9			19.7		27.8	19.9	16.2	18.3	21.8
22/02/2007		19.3			29		38.3	19.6	17.7	21.7	28.3
28/02/2007		13.8			17		19.4	13.4	10.8	11.6	23.7
6/03/2007		12.6		14.6	14.3		12.3	13.1	11.8	15.4	19.2
12/03/2007		29.3		29.9	43.4		27.5	27.2	24.9	37.2	39.4
18/03/2007		8.4		8.8	9.8		12	8.1	8.4	8.6	9.5
24/03/2007		18.3			18.1		27.6	15.4	16.2	18.4	15.6
30/03/2007		9.9		12.3	20.2		27.1	9	9.9	11.2	17.7
5/04/2007		15.8		15.3	25.1		29.4	14.3	15.2	18.5	29.5
11/04/2007		22.9		30.4	27.3		26.1	21.3	19.2	22.1	20.8
17/04/2007		37		43	31.4		43.4	30.2	28.1	28.7	
23/04/2007		15.2		16.9	27.6		34.8	14.9	11.4	14	27.7
29/04/2007		9.2		11.1	10.4		20.9	9.2	8	10.2	12.4
5/05/2007		40.8		38.3	43.9		67	32.8	41.7	43.3	38.6
11/05/2007		18.7		19.5	17.9		29.2	16.9	17.7	20.5	17.9
17/05/2007		13.4		20	16.1		24.6	13	14.1	14.8	14.9
23/05/2007		7.2		9.1	15.6		18.7	5.2	6.4	7.2	7
29/05/2007		11.7		25	24.7		57.7	14	15.8	16.4	30.2
4/06/2007											
10/06/2007											
16/06/2007		2.1		2.9	4.5		8.3	2.7	2.9	2.5	4.9
22/06/2007		8.8		4.6	16.1		9.7	4.2	5.4	5.5	
28/06/2007		2.8		3.2	3.6		10.6	1.3	2.1	2	3.1
4/07/2007		5.1		5.4	10.4		14.8	3.5	4.8	4.3	9.4
10/07/2007		6.5		5.2	15.3		13.9	5.1	5.3	3.5	20.8
16/07/2007		5.6		10.4	15.5		15.1	9.9	6.1	12.8	9.3
22/07/2007		6.1		5.5	23.3		24.1	4	4.4	4.1	7.4
28/07/2007		16		13.1	16.9		15.9	11.1	10.2	13.3	14.6
3/08/2007		3		3.4	7.7		17	2.7	2.5	3.5	7.8
9/08/2007		6.7		11.2	14.5		25	7.1	6.5	11.1	10.5

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
15/08/2007		18.6		22.1	21.4		21.8	15.4	14.3	15.2	20.6
21/08/2007		7.7		8	9		10.3		7.9	7.5	9.1
27/08/2007		4.6		7.9	11.2		11.8	16.1	10	10.9	13.4
2/09/2007		17		17.7	16.3		21.5	16.7	20.3	19.5	15.5
8/09/2007		6.9		6.8	9.4		8.6	5.3	5	5.8	9
14/09/2007		18.9		20.1	31.5		47.3		20.5	21.4	29.6
20/09/2007		12.5		18.7	40.3		30.5	13.9	18.7	16.5	35.2
26/09/2007		29.9		33.7	34		27	23.8	23.7	27.5	31.3
2/10/2007		26.7		45.9	35.1		97.2	26.2	29.9	30.2	41.1
8/10/2007		17.9		20.8	28.5		31.5	13.7	19.6	18.5	33
14/10/2007		21.2		16.6	15.6		54.5	15.1	17.1	14.2	16.6
20/10/2007		49.3		52.7	64.6		51	43	54	48	54.1
26/10/2007		4.2		12.6	11.5		15.3	8.7	9.8	9.9	13
1/11/2007				32.4	41.2		40.6	26.4	32.4	31.1	38.5
7/11/2007		10.9		10.2	11.6		13.4	8.2	9.8	10.4	15.5
13/11/2007		25.7		27.4	18.2		19.2	22.3	22.3	26.8	22.7
19/11/2007		31.2		34.8	28.6		28.7	30	33.7	37.5	32.6
25/11/2007		19.6		21.4	14.6		15.4	16.1	19.2	16.2	15.8
1/12/2007		14.9		16.8	15.9		13	15.5	16.1	14.8	15.3
7/12/2007		19.5		22	21.4		19.2	20.8	21.7	23.6	20.8
13/12/2007		17.6		16.9	19.6		11.6	13	15.5	14.6	18.2
19/12/2007		27.1		25.7	25		24.6	20.3	22.6	19.9	24.5
25/12/2007		15.2		17	18.9		15.6	12.8	15.4	15.2	17.5
31/12/2007		23.5		25.9	28.9		23.1	19.5	22.4	21.2	26.7
6/01/2008		7.3		8.4	10.5		12.9	9.2	10.6	10.7	13.3
12/01/2008		41.4		34.1	36.6		45.5		34.4	35	41.5
18/01/2008		8.7		9.6	8.8		11		8.7	7.6	9.3
24/01/2008		21.9		23.5	26.4		23.9	18.3	21.2		41.9
30/01/2008		28.7		32.3	29.5		63.4	32.6	29.4		31.2
5/02/2008		7.4		7.6	8.4		9.4	6.7	7		8.1
11/02/2008		13.1		14.1	12.4		16.1	12.2	11.4		14.8
17/02/2008		14.2		14.9	16.2		10.1		10.7		18
23/02/2008		45.9		47.3	84.3		78.9	34.2	37.5		57.6
29/02/2008		13.3		18.8	15.1		9.2	10.5	11	11.5	15.2
6/03/2008		20.6		25.7	27.1		30.2	20.4	28.4	29.9	23.4
12/03/2008		25.9		28.9	25.6		23	16.7	15.1	19.9	22.3
18/03/2008		28.9		31.1	31.1		28.3	22.7	22	25.9	36.8
24/03/2008		20.7		26.7	20.5		19.8	15.8	13.7	17	19.1
30/03/2008		11.9		19.6	20.2		31.5	7.9	10.3	13.5	18
5/04/2008		27		29.9	33.9		25.5	16.1	17.4	20.6	24.7
11/04/2008		17.9		19	13.9		14.5	12.3	12.4	13.3	16.4
17/04/2008		12.4		13.6	18.3		24.5	7.8	9.2	10.1	25.4
23/04/2008		5.2		5.7	5.8		7.7			4	7.2

Date	Monitoring location ID										
	Boyle	Constable	Whites Creek	Denman Rd West	South Muswellbrook	Chalmers/Yarak Lodge	Sheppard Ave	Windmill	Edderton	Roxburgh Sth	Wire Lane
29/04/2008		11		6.3	12.8		9.3	5.5	8.5	14.7	
5/05/2008		9.5		11.1	25.8		23.3	10.2	10.5	23.5	17
11/05/2008		24.2		21.1	23.8		18.3	18.6	17	24.8	21.6
17/05/2008		13.2			28.3		19	12.6	14.5	27.6	19.9
23/05/2008		20.1		17	18		23.1	13.9	13.7	22.3	24.8
29/05/2008		16.1		16.2	19.9		22.9	12.5	11.4	23.5	19
4/06/2008											
10/06/2008		10.4		11.4	13.8		7.5	9.2	8.3	21.3	14.1
16/06/2008		2.7		4	11.7		10.1	2.4	2.7	4	17.5
22/06/2008		4.9		3.4	12.7		4.6	2.4	4.7	7.6	10.6
28/06/2008		17.2		13.3	19.8		15.1	9.2	10.8	19	14.5
4/07/2008		12.1		13.9	19		17.9	11.8	11.1	24.4	15.6
10/07/2008		1		1	2		3	1	2	3	3
16/07/2008		1		2	8		4	1	6	5	1
22/07/2008		13		9	13		11	6	5	8	10
28/07/2008		3		1	3		3	2	2	1	2
3/08/2008		8		10	14		12	7	8	10	9
9/08/2008		8		6	13		9	3	5	6	7
15/08/2008		7		9	14		22	7	6	7	11
21/08/2008		22		23	28		37	20	22	22	19
27/08/2008		20		19	30		27	17	14	19	24
2/09/2008		23		17	24		47	14	17	19	28
8/09/2008		8		10	16		15	8	12	17	15
14/09/2008		11		16	13		14	10	9	11	15
20/09/2008		35		50	44		47	33	33	43	42
26/09/2008		20		16	23		24	11	20	18	17
2/10/2008		25		35	27		34	24	28	39	24
8/10/2008		9		18	17		15	3	5	16	10
14/10/2008		16		12	29		17	14	24	27	24
20/10/2008		16		33	34		28	18	29	35	31
26/10/2008		15		29	19		10	15	26	29	22
1/11/2008		25		54	27		15	22	16	22	26
7/11/2008		34		56	39		33	26	28	30	41
13/11/2008		27		47	30		27	21	24	16	43
19/11/2008		11		15	6		8	5	1	5	11
25/11/2008		23		51	21		16	34	11	31	29
1/12/2008		6		16	9		23	4	6	11	8
7/12/2008		6		15	15		12	9	5	13	19
13/12/2008		11		24	6		24	11	10	16	14
19/12/2008		16		17	23		29	11	10	19	23
25/12/2008		17		34	19		15	18	18	19	15
31/12/2008		29		34	43		44	28	28	43	37

Appendix D: Joint wind speed, wind direction and stability class tables for Macleans Hill meteorological station

STATISTICS FOR FILE: C:\Jobs\MAC2008\Met\MH\MH0708.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	0.002993	0.002302	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005295
NE	0.003108	0.001151	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004259
ENE	0.002072	0.001036	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003108
E	0.001842	0.002647	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004489
ESE	0.001611	0.004029	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005640
SE	0.001496	0.003223	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004719
SSE	0.000576	0.001611	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002187
S	0.001151	0.001151	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002302
SSW	0.001381	0.000576	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001957
SW	0.001496	0.000921	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002417
WSW	0.001611	0.001727	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003338
W	0.002878	0.004029	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006906
WNW	0.002993	0.005640	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008633
NW	0.003913	0.003683	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007597
NNW	0.003223	0.002072	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005295
N	0.003453	0.002532	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005985
CALM									0.001496
TOTAL	0.035797	0.038329	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.075622

MEAN WIND SPEED (m/s) = 1.56
NUMBER OF OBSERVATIONS = 657

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	0.001381	0.000921	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002302
NE	0.001727	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001957
ENE	0.000806	0.000806	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.001842
E	0.001266	0.000921	0.000460	0.000000	0.000000	0.000000	0.000000	0.000000	0.002647
ESE	0.000460	0.001957	0.001957	0.000000	0.000000	0.000000	0.000000	0.000000	0.004374
SE	0.000000	0.001611	0.001496	0.000000	0.000000	0.000000	0.000000	0.000000	0.003108
SSE	0.000576	0.000345	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.001036
S	0.000115	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000230
SSW	0.000115	0.000115	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000345
SW	0.000230	0.000576	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000806
WSW	0.001036	0.000460	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.001727
W	0.000806	0.001496	0.000921	0.000000	0.000000	0.000000	0.000000	0.000000	0.003223
WNW	0.001842	0.002762	0.001151	0.000000	0.000000	0.000000	0.000000	0.000000	0.005755
NW	0.001496	0.002187	0.000806	0.000000	0.000000	0.000000	0.000000	0.000000	0.004489
NNW	0.000806	0.001381	0.000576	0.000000	0.000000	0.000000	0.000000	0.000000	0.002762
N	0.000691	0.002532	0.000345	0.000000	0.000000	0.000000	0.000000	0.000000	0.003568
CALM									0.000921
TOTAL	0.013352	0.018416	0.008402	0.000000	0.000000	0.000000	0.000000	0.000000	0.041091

MEAN WIND SPEED (m/s) = 2.03
NUMBER OF OBSERVATIONS = 357

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	0.002993	0.003338	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.006446
NE	0.002302	0.000691	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002993
ENE	0.001496	0.000460	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001957
E	0.000460	0.001151	0.001496	0.000115	0.000000	0.000000	0.000000	0.000000	0.003223
ESE	0.000230	0.003568	0.013812	0.006561	0.000000	0.000000	0.000000	0.000000	0.024171
SE	0.000230	0.002072	0.002878	0.000576	0.000000	0.000000	0.000000	0.000000	0.005755
SSE	0.000115	0.000691	0.000345	0.000115	0.000000	0.000000	0.000000	0.000000	0.001266
S	0.000230	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000460
SSW	0.000115	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000230
SW	0.000000	0.000115	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000345
WSW	0.001036	0.000691	0.000345	0.000230	0.000000	0.000000	0.000000	0.000000	0.002302
W	0.001381	0.002762	0.003338	0.001381	0.000000	0.000000	0.000000	0.000000	0.008863
WNW	0.001151	0.004374	0.007251	0.001842	0.000000	0.000000	0.000000	0.000000	0.014618
NW	0.000460	0.002878	0.002647	0.002993	0.000000	0.000000	0.000000	0.000000	0.008978
NNW	0.001266	0.001842	0.001381	0.000691	0.000000	0.000000	0.000000	0.000000	0.005180
N	0.001266	0.005064	0.001036	0.000460	0.000000	0.000000	0.000000	0.000000	0.007827
CALM									0.000921
TOTAL	0.014733	0.030041	0.034876	0.014963	0.000000	0.000000	0.000000	0.000000	0.095534

MEAN WIND SPEED (m/s) = 3.02
NUMBER OF OBSERVATIONS = 830

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	0.010129	0.010244	0.000460	0.000000	0.000000	0.000000	0.000000	0.000000	0.020833
NE	0.012316	0.007827	0.000115	0.000000	0.000115	0.000000	0.000000	0.000000	0.020373
ENE	0.010359	0.001842	0.000345	0.000000	0.000000	0.000000	0.000000	0.000000	0.012546
E	0.003108	0.004834	0.003338	0.003683	0.001496	0.000000	0.000000	0.000000	0.016459
ESE	0.004144	0.027624	0.049033	0.058126	0.039250	0.011050	0.003108	0.000345	0.192680
SE	0.001381	0.015078	0.032459	0.031192	0.017956	0.005755	0.000806	0.000345	0.104972
SSE	0.000691	0.001381	0.001496	0.002532	0.000921	0.000921	0.000000	0.000000	0.007942
S	0.000460	0.001266	0.001496	0.000460	0.000000	0.000000	0.000000	0.000000	0.003683
SSW	0.000230	0.000460	0.001036	0.000230	0.000000	0.000000	0.000000	0.000000	0.001957
SW	0.001381	0.001381	0.000806	0.000000	0.000115	0.000000	0.000000	0.000000	0.003683
WSW	0.001381	0.004949	0.003108	0.001381	0.000230	0.000115	0.000000	0.000230	0.011395
W	0.003108	0.007366	0.004949	0.007942	0.007251	0.005525	0.001381	0.000115	0.037638
WNW	0.002878	0.010820	0.014848	0.019452	0.011280	0.005640	0.002993	0.000000	0.067910
NW	0.002878	0.008863	0.002647	0.001611	0.001496	0.000000	0.000000	0.000000	0.017495
NNW	0.002762	0.006561	0.002417	0.000345	0.000230	0.000115	0.000000	0.000000	0.012431
N	0.005640	0.011625	0.002072	0.000230	0.000000	0.000000	0.000000	0.000000	0.019567
CALM									0.001842
TOTAL	0.062845	0.122122	0.120626	0.127187	0.080341	0.029121	0.008287	0.001036	0.553407

MEAN WIND SPEED (m/s) = 4.21
NUMBER OF OBSERVATIONS = 4808

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	0.006215	0.003453	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009669
NE	0.007136	0.002647	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009784
ENE	0.008402	0.001611	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010014
E	0.004604	0.004834	0.001727	0.000460	0.000000	0.000000	0.000000	0.000000	0.011625
ESE	0.004259	0.014618	0.008172	0.001151	0.000000	0.000000	0.000000	0.000000	0.028200
SE	0.001727	0.009899	0.008287	0.002878	0.000000	0.000000	0.000000	0.000000	0.022790
SSE	0.001036	0.003108	0.001496	0.000230	0.000000	0.000000	0.000000	0.000000	0.005870
S	0.000345	0.000345	0.000806	0.000000	0.000000	0.000000	0.000000	0.000000	0.001496
SSW	0.000115	0.000576	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000921
SW	0.000460	0.001266	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.001957
WSW	0.001611	0.004834	0.000806	0.000000	0.000000	0.000000	0.000000	0.000000	0.007251
W	0.002072	0.007827	0.007251	0.000921	0.000000	0.000000	0.000000	0.000000	0.018071
WNW	0.001496	0.008057	0.009669	0.001496	0.000000	0.000000	0.000000	0.000000	0.020718
NW	0.002878	0.002072	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004949
NNW	0.002072	0.004374	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006446
N	0.004604	0.002993	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007597
CALM									0.002762
TOTAL	0.049033	0.072514	0.038674	0.007136	0.000000	0.000000	0.000000	0.000000	0.170120

MEAN WIND SPEED (m/s) = 2.27
NUMBER OF OBSERVATIONS = 1478

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	0.001957	0.000806	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002762
NE	0.003223	0.000460	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003683
ENE	0.003338	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003453
E	0.003683	0.001611	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005295
ESE	0.004029	0.002993	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007021
SE	0.001957	0.002302	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004259
SSE	0.000806	0.000691	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001496
S	0.000691	0.000345	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001036
SSW	0.001036	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001036
SW	0.001496	0.000921	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002417
WSW	0.002762	0.002532	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005295
W	0.003453	0.002762	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006215
WNW	0.001611	0.002417	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004029
NW	0.002993	0.001036	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004029
NNW	0.002762	0.001036	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003798
N	0.002532	0.000460	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002993
CALM									0.005410
TOTAL	0.038329	0.020488	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.064227

MEAN WIND SPEED (m/s) = 1.28
NUMBER OF OBSERVATIONS = 558

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	0.025668	0.021064	0.000576	0.000000	0.000000	0.000000	0.000000	0.000000	0.047307
NE	0.029811	0.013006	0.000115	0.000000	0.000115	0.000000	0.000000	0.000000	0.043048
ENE	0.026473	0.005870	0.000576	0.000000	0.000000	0.000000	0.000000	0.000000	0.032919
E	0.014963	0.015999	0.007021	0.004259	0.001496	0.000000	0.000000	0.000000	0.043738
ESE	0.014733	0.054788	0.072974	0.065838	0.039250	0.011050	0.003108	0.000345	0.262086
SE	0.006791	0.034185	0.045120	0.034645	0.017956	0.005755	0.000806	0.000345	0.145603
SSE	0.003798	0.007827	0.003453	0.002878	0.000921	0.000921	0.000000	0.000000	0.019797
S	0.002993	0.003453	0.002302	0.000460	0.000000	0.000000	0.000000	0.000000	0.009208
SSW	0.002993	0.001842	0.001381	0.000230	0.000000	0.000000	0.000000	0.000000	0.006446
SW	0.005064	0.005180	0.001266	0.000000	0.000115	0.000000	0.000000	0.000000	0.011625
WSW	0.009438	0.015193	0.004489	0.001611	0.000230	0.000115	0.000000	0.000230	0.031308
W	0.013697	0.026243	0.016459	0.010244	0.007251	0.005525	0.001381	0.000115	0.080916
WNW	0.011971	0.034070	0.032919	0.022790	0.011280	0.005640	0.002993	0.000000	0.121662
NW	0.014618	0.020718	0.006100	0.004604	0.001496	0.000000	0.000000	0.000000	0.047537
NNW	0.012891	0.017265	0.004374	0.001036	0.000230	0.000115	0.000000	0.000000	0.035912
N	0.018186	0.025207	0.003453	0.000691	0.000000	0.000000	0.000000	0.000000	0.047537
CALM									0.013352
TOTAL	0.214088	0.301911	0.202578	0.149286	0.080341	0.029121	0.008287	0.001036	1.000000

MEAN WIND SPEED (m/s) = 3.29
NUMBER OF OBSERVATIONS = 8688

FREQUENCY OF OCCURRENCE OF STABILITY CLASSES

A : 7.6%
B : 4.1%
C : 9.6%
D : 55.3%
E : 17.0%
F : 6.4%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0203	0110	0049
02	0000	0000	0000	0194	0114	0054
03	0000	0000	0000	0187	0122	0053
04	0000	0000	0000	0199	0110	0053
05	0000	0000	0000	0198	0111	0053
06	0003	0002	0007	0214	0086	0050
07	0011	0016	0038	0209	0064	0024
08	0036	0036	0078	0205	0005	0002
09	0062	0049	0092	0159	0000	0000
10	0090	0046	0082	0144	0000	0000
11	0095	0039	0096	0132	0000	0000
12	0103	0036	0087	0136	0000	0000
13	0088	0038	0092	0144	0000	0000
14	0076	0037	0084	0165	0000	0000
15	0055	0032	0087	0188	0000	0000
16	0025	0021	0065	0237	0007	0007
17	0013	0005	0022	0274	0039	0009
18	0000	0000	0000	0242	0107	0013
19	0000	0000	0000	0233	0107	0022
20	0000	0000	0000	0228	0103	0031
21	0000	0000	0000	0241	0093	0028
22	0000	0000	0000	0241	0089	0032
23	0000	0000	0000	0210	0111	0041
24	0000	0000	0000	0225	0100	0037

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0056	0063	0167	0932	1424	0538
<=1000 m	0326	0168	0305	1407	0015	0008
<=1500 m	0275	0126	0358	1553	0039	0012
<=2000 m	0000	0000	0000	0516	0000	0000
<=3000 m	0000	0000	0000	0378	0000	0000
>3000 m	0000	0000	0000	0022	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	0046	0087	0041	0056	0091	0041	0000
02	0055	0085	0047	0060	0072	0043	0000
03	0050	0106	0039	0059	0068	0040	0000
04	0056	0090	0038	0074	0070	0034	0000
05	0099	0080	0039	0062	0061	0021	0000
06	0081	0108	0091	0042	0028	0012	0000
07	0115	0063	0115	0067	0001	0001	0000
08	0000	0062	0134	0166	0000	0000	0000
09	0000	0000	0096	0192	0074	0000	0000
10	0000	0000	0000	0237	0125	0000	0000
11	0000	0000	0000	0138	0224	0000	0000
12	0000	0000	0000	0092	0270	0000	0000
13	0000	0000	0000	0000	0362	0000	0000
14	0000	0000	0000	0000	0362	0000	0000
15	0000	0000	0000	0000	0362	0000	0000
16	0000	0000	0000	0000	0362	0000	0000
17	0003	0008	0008	0004	0324	0015	0000
18	0005	0034	0057	0014	0200	0051	0001
19	0010	0055	0072	0039	0054	0129	0003
20	0021	0062	0056	0036	0061	0123	0003
21	0019	0056	0049	0037	0085	0113	0003
22	0027	0047	0054	0056	0094	0083	0001
23	0033	0079	0048	0045	0104	0053	0000
24	0032	0082	0039	0057	0110	0042	0000

Appendix E: Example ISCMOD input file

```
**  ISCST3 model input runstream : Dust - rehab areas revised per email from Mel 9/3/09
CO STARTING
   TITLEONE ISCST3 Dust Model Run
   MODELOPT RURAL CONC DDEP DRYDPLT HE>ZI
   SAVEFILE C:\JOBS\MAC2008\ISC\2011\SAVE2011.FIL
   AVERTIME 24 PERIOD
   POLLUTID TSP
   ERRORFIL c:\JOBS\MAC2008\ISC\2011\error.log
   TERRHGTS ELEV
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  POINT1  VOLUME  297862 6423726 171.2
   LOCATION  POINT2  VOLUME  297958 6423391 180.3
   LOCATION  POINT3  VOLUME  298149 6423151 200.0
   LOCATION  POINT4  VOLUME  298580 6423056 234.4
   LOCATION  POINT5  VOLUME  298509 6423415 230.8
   LOCATION  POINT6  VOLUME  297766 6423128 180.0
   LOCATION  POINT7  VOLUME  297838 6422936 201.2
   LOCATION  POINT8  VOLUME  297694 6422672 200.0
   LOCATION  POINT9  VOLUME  298101 6422505 201.6
   LOCATION  POINT10  VOLUME  298461 6422385 218.0
   LOCATION  POINT11  VOLUME  298748 6422073 205.5
   LOCATION  POINT12  VOLUME  299131 6421786 203.4
   LOCATION  POINT13  VOLUME  299491 6421546 203.8
   LOCATION  POINT14  VOLUME  299826 6421187 201.1
   LOCATION  POINT15  VOLUME  300042 6420900 202.1
   LOCATION  POINT16  VOLUME  300162 6420564 211.8
   LOCATION  POINT17  VOLUME  300353 6420684 207.3
   LOCATION  POINT18  VOLUME  296400 6423487 125.0
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   LOCATION  POINT20  VOLUME  296089 6422313 103.8
   LOCATION  POINT21  VOLUME  296185 6421642 117.7
   LOCATION  POINT22  VOLUME  296520 6421139 124.0
   LOCATION  POINT23  VOLUME  296904 6420636 176.0
   LOCATION  POINT24  VOLUME  297526 6420253 161.7
   LOCATION  POINT25  VOLUME  298197 6419846 147.6
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   LOCATION  POINT39  VOLUME  296904 6422169 161.1
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   LOCATION  POINT350  VOLUME  298461 6421355 308.3
   LOCATION  POINT351  VOLUME  299754 6419223 178.1
   LOCATION  POINT352  VOLUME  300257 6418360 236.8
   LOCATION  POINT353  VOLUME  300305 6417618 217.7
   LOCATION  POINT354  VOLUME  300353 6416061 154.2
   LOCATION  POINT355  VOLUME  300281 6416683 162.6
   LOCATION  POINT356  VOLUME  299107 6415845 249.3
   LOCATION  POINT357  VOLUME  299084 6416444 246.5
   LOCATION  POINT358  VOLUME  298461 6416540 217.8
   LOCATION  POINT359  VOLUME  298844 6415054 209.0
   LOCATION  POINT360  VOLUME  299467 6414480 194.0
   LOCATION  POINT361  VOLUME  294149 6418696 175.0
   LOCATION  POINT362  VOLUME  293933 6418911 181.8
   LOCATION  POINT363  VOLUME  301647 6417306 230.2
   LOCATION  POINT364  VOLUME  302054 6417522 238.0
   LOCATION  POINT365  VOLUME  302557 6417618 247.7
   LOCATION  POINT366  VOLUME  300976 6417067 205.0
   LOCATION  POINT367  VOLUME  301407 6417354 225.8
   LOCATION  POINT368  VOLUME  301838 6417618 237.3
   LOCATION  POINT369  VOLUME  297113 6421313 62.7
   LOCATION  POINT370  VOLUME  297091 6421595 58.3
   LOCATION  POINT371  VOLUME  297214 6421500 78.4
   LOCATION  POINT372  VOLUME  297377 6421227 111.8
   LOCATION  POINT373  VOLUME  297414 6421413 122.7
   LOCATION  POINT374  VOLUME  297395 6421700 139.1
   LOCATION  POINT375  VOLUME  297969 6421791 292.0
   LOCATION  POINT376  VOLUME  296777 6421504 47.7
   LOCATION  POINT377  VOLUME  297914 6420713 129.5
   LOCATION  POINT378  VOLUME  298091 6420522 92.9
   LOCATION  POINT379  VOLUME  297646 6420627 72.6
   LOCATION  POINT380  VOLUME  298301 6421050 250.0
   LOCATION  POINT381  VOLUME  298160 6421423 291.7
   LOCATION  POINT382  VOLUME  298774 6420927 296.1
   LOCATION  POINT383  VOLUME  300020 6419344 254.5
   LOCATION  POINT384  VOLUME  299783 6419831 294.6
   LOCATION  POINT385  VOLUME  300653 6419876 197.0
   LOCATION  POINT386  VOLUME  300653 6420319 200.0
   LOCATION  POINT387  VOLUME  302342 6420492 212.9
** Point Source       QS   RH  IL   IV
** Parameters        ----  --- ---  ---
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SRCPARAM  POINT340  1.0 2.0 10.0 2.0
SRCPARAM  POINT341  1.0 2.0 10.0 2.0
SRCPARAM  POINT342  1.0 2.0 10.0 2.0
SRCPARAM  POINT343  1.0 2.0 10.0 2.0
SRCPARAM  POINT344  1.0 2.0 10.0 2.0
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   SRCPARAM  POINT345  1.0 2.0 10.0 2.0
   SRCPARAM  POINT346  1.0 2.0 10.0 2.0
   SRCPARAM  POINT347  1.0 2.0 10.0 2.0
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   SRCPARAM  POINT356  1.0 2.0 10.0 2.0
   SRCPARAM  POINT357  1.0 2.0 10.0 2.0
   SRCPARAM  POINT358  1.0 2.0 10.0 2.0
   SRCPARAM  POINT359  1.0 2.0 10.0 2.0
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   SRCPARAM  POINT385  1.0 2.0 10.0 2.0
   SRCPARAM  POINT386  1.0 2.0 10.0 2.0
   SRCPARAM  POINT387  1.0 2.0 10.0 2.0
   PARTDIAM  POINT1-POINT129  1.0
   PARTDIAM  POINT130-POINT258  5.0
   PARTDIAM  POINT259-POINT387  17.3
   MASSFRAX  POINT1-POINT387  1.0
   PARTDENS  POINT1-POINT387  2.5
   SRCGROUP  FP  POINT1-POINT129
   SRCGROUP  CM  POINT130-POINT258
   SRCGROUP  REST  POINT259-POINT387
SO FINISHED

RE STARTING
RE DISCCART 297956.7614 6419037.437 266.3525683
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NB: The full set of receptors has not been included to save on space. A complete set is available on disk if required

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RE FINISHED


ME STARTING
   INPUTFIL  C:\Jobs\MAC2008\Met\MH\MH0708.isc
   ANEMHGHT  10  METERS
   SURFDATA  99999 2007
   UAIRDATA  99999 2007
ME FINISHED

OU STARTING
   RECTABLE  ALLAVE  FIRST-SECOND
   MAXTABLE  ALLAVE  50
   PLOTFILE  24 FP FIRST  C:\Jobs\MAC2008\ISC\2011\FP1D_inc_v2.PLO
   PLOTFILE  24 CM FIRST  C:\Jobs\MAC2008\ISC\2011\CM1D_inc_v2.PLO
   PLOTFILE  24 REST FIRST  C:\Jobs\MAC2008\ISC\2011\RE1D_inc_v2.PLO
   PLOTFILE  PERIOD  FP  C:\Jobs\MAC2008\ISC\2011\FP1Y_inc_v2.PLO
   PLOTFILE  PERIOD  CM C:\Jobs\MAC2008\ISC\2011\CM1Y_inc_v2.PLO
   PLOTFILE  PERIOD  REST  C:\Jobs\MAC2008\ISC\2011\RE1Y_inc_v2.PLO
OU FINISHED
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Appendix F: Emission calculations

Mt Arthur Coal Emissions Inventory

Description of operations

The dust emission inventories have been prepared using the operational description of the proposed mining activities provided by Mt Arthur Coal.

Topsoil would be removed using a scraper followed by blasting would be required to fragment the waste rock prior to excavation using loaders and trucks with an average capacity of 298 t. Following removal of the waste rock, the exposed coal would be cleaned using a dozer and/or grader. The coal seam would then be ripping, loaded into haul trucks with an average capacity of 150 t using an excavator or front-end-loader (FEL) and transported either directly or via a temporary ROM stockpile to the existing Coal Handling Preparation Plant (CHPP).

The waste rock would be hauled for placement in-pit or out-of-pit, as required.

Emission estimates

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

Extraction and processing activities are assumed to occur 24 hours a day, 7 days a week. Dust from wind erosion is assumed to occur over 24 hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This will mean that most wind erosion occurs in the day when wind speeds are highest.

Removal of topsoil
The TSP emission factor for removal of topsoil is 14 kg/h (**SPCC, 1983**) was applied.

Drilling overburden
The emission factor used for drilling has been taken to be 0.59 kg/hole (**US EPA, 1985 and updates**).

The number of holes per year were calculated based on information provided by Mt Arthur Coal.

Blasting overburden
TSP emissions from blasting were estimated using the **US EPA (1985 and updates)** emission factor equation given in **Equation 1**.

Equation 1

$$E_{TSP} = 0.00022 \times A^{1.5} \quad \text{kg/blast}$$

where,

A = area to be blasted in m^2

The area to be blasted per blast and number of blasts per year were calculated based on information provided by Mt Arthur Coal.

Loading material / dumping overburden using shovels/excavators/FELs
Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables.

Equation 2

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

where,

$E_{TSP} = TSP\ emissions$

$k = 0.74$

$U = wind\ speed\ (m/s)$

$M = moisture\ content\ (\%)$

$[where\ 0.25 \le M \le 4.8]$

The wind speed value was taken from the Macleans Hill 2007/2008 meteorological dataset. The moisture content for overburden was assumed to be 2%.

Hauling material / product on unsealed surfaces
After the use of agglomeration agents, the emission factor used for trucks hauling waste rock or ROM coal on unsealed surfaces is 0.6 kg per vehicle kilometre travelled (kg/VKT).

The return trip for each year was provided by Mt Arthur Coal. It was assumed haul trucks with an average capacity of 298 t was used for the hauling of overburden, for ROM coal the average truck capacity was assumed to be 150 t.

Dozers on overburden
Emissions from dozers on overburden have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**), per **Equation 3**.

Equation 3

$$\mathrm{E_{TSP}} = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \qquad \text{kg/hour}$$

where,

$\mathrm{E_{TSP}} = TSP\ \ emissions$

$\mathrm{s = silt\ content\ (\%), and}$

$\mathrm{M = moisture\ (\%)}$

The silt content in the overburden was assumed to be 10%, and the moisture content 2%. This results in a emission factor of 16.7 kg/h.

Dozers ripping coal and handling ROM coal at CHPP
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in **Equation 4**.

Equation 4

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

Where,
s = silt content (%), and
M = moisture (%)

The silt content in the coal whilst ripping was assumed to be 5%, and the moisture content 6%, resulting in an emission factor of 20 kg/h.

For dozers handling coal at the CHPP, the coal was assumed to have a silt content of 4%, and a moisture content of 6%, resulting in an emission factor of 15.3 kg/h.

Loading / unloading coal
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in **Equation 5**.

Equation 5

$$E_{TSP} = \frac{0.580}{M^{1.2}} \qquad \text{kg/t}$$

where,

$E_{TSP} = TSP \ \ emissions$

M = moisture (%)

The moisture content was assumed to be 6%.

Reloading coal from stockpiles to trains
Equation 2 was used and the moisture content was assumed to be 10%.

Wind erosion
The emission factor for wind erosion is given in **Equation 6** below.

Equation 6

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

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

It was assumed that silt content is 10%, the number of raindays was taken as 101 days.

This is the average of the raindays from the Bureau of Meteorology sites at Scone Airport and Scone SCS. The percentage of winds above 5.4 m/s was calculated to be 17.4%, based on the Macleans Hill 2007/2008 dataset.

Grading roads

Estimations of TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (**Equation 7**).

Equation 7

$$E_{TSP} = 0.0034 \times S^{2.5} \quad \text{kg/VKT}$$

where,

S = speed of the grader in km/h (taken to be 8 km/h)

The following tables present the calculated emissions for each year of operations modelled and the allocation of the sources as represented in **Figure 8.1** to **Figure 8.3**.

The abbreviations used in the tables are as follows:

- O/B - overburden
- CL - coal
- WE - wind erosion emissions
- WI - wind insensitive emissions
- WS - wind sensitive emissions
- MC - Macleans Hill pit
- WM - Windmill pit
- HU - Huon pit
- CA - Calool pit
- RX - Roxburgh pit
- AY - Ayredale pit
- SN, SC, SS- Saddler's pit (north, central, south)

Table F.1: 2011 – detailed emission calculations

ACTIVITY	TSP emission/year for 2011 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping topsoil - MC	4,402	314	h/y	14.0	kg/h						
OB - Stripping topsoil - WM	11,227	802	h/y	14.0	kg/h						
OB - Stripping topsoil - HU	3,188	228	h/y	14.0	kg/h						
OB - Stripping topsoil - CA	-	0	h/y	14.0	kg/h						
OB - Stripping topsoil - RX	3,442	246	h/y	14.0	kg/h						
OB - Stripping topsoil - AY	699	50	h/y	14.0	kg/h						
OB - Stripping topsoil - SN, SC, SS	2,352	168	h/y	14.0	kg/h						
OB - Drilling - MC	9,362	15,867	holes/y	0.59	kg/hole						
OB - Drilling - WM	16,490	27,950	holes/y	0.59	kg/hole						
OB - Drilling - HU	12,619	21,389	holes/y	0.59	kg/hole						
OB - Drilling - CA	3,309	5,608	holes/y	0.59	kg/hole						
OB - Drilling - RX	16,789	28,456	holes/y	0.59	kg/hole						
OB - Drilling - AY	2,568	4,353	holes/y	0.59	kg/hole						
OB - Drilling - SN, SC, SS	7,994	13,550	holes/y	0.59	kg/hole						
OB - Blasting - MC	33,290	31	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - WM	58,639	54	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - HU	44,874	41	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - CA	11,766	11	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - RX	59,700	55	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - AY	9,132	8	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - SN, SC, SS	28,428	26	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Sh/Ex/FELs loading - MC	66,886	31,988,435	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - WM	117,817	56,346,499	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - HU	90,162	43,120,060	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - CA	23,640	11,305,795	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - RX	119,950	57,366,495	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - AY	18,349	8,775,316	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - SN, SC, SS	57,117	27,316,252	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Hauling to emplacement - MC	204,044	31,988,435	t/y	0.00638	kg/t	298	t/truck load	3.166	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - WM	691,701	56,346,499	t/y	0.01228	kg/t	298	t/truck load	6.093	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - HU	427,777	43,120,060	t/y	0.00992	kg/t	298	t/truck load	4.924	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - CA	96,831	11,305,795	t/y	0.00856	kg/t	298	t/truck load	4.251	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - RX	666,890	57,366,495	t/y	0.01163	kg/t	298	t/truck load	5.77	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - AY	121,373	8,775,316	t/y	0.01383	kg/t	298	t/truck load	6.865	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - SN, SC, SS	156,080	27,316,252	t/y	0.00571	kg/t	298	t/truck load	2.836	km/return trip	0.6	kg/VKT
OB - Emplacing at dumps - MC	66,886	31,988,435	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - WM	117,817	56,346,499	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - HU	90,162	43,120,060	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - CA	23,640	11,305,795	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - RX	119,950	57,366,495	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - AY	18,349	8,775,316	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - SN, SC, SS	57,117	27,316,252	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Dozers on O/B - MC	77,916	4,656	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B - WM	137,246	8,201	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B - HU	105,029	6,276	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B - CA	27,538	1,646	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B - RX	139,730	8,349	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B - AY	21,374	1,277	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B - SN, SC, SS	66,535	3,976	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on Rehabilitation - total	304,607	18,201	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		

ACTIVITY	TSP emission/year for 2011 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
CL - Dozers ripping - MC	6,105	873	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - WM	13,727	1,962	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - HU	10,759	1,538	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - CA	5,824	832	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - RX	13,124	1,876	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - AY	245	35	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - SN, SC, SS	4,913	702	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks - MC	125,613	1,859,461	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - WM	282,440	4,181,003	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - HU	221,387	3,277,219	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - CA	119,840	1,774,013	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - RX	270,040	3,997,437	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - AY	5,031	74,473	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - SN, SC, SS	101,086	1,496,384	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper - MC	69,455	1,859,461	t/y	0.03735	kg/t	150	t/load	9.338	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - WM	194,484	4,181,003	t/y	0.04652	kg/t	150	t/load	11.629	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - HU	153,426	3,277,219	t/y	0.04682	kg/t	150	t/load	11.704	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - CA	70,655	1,774,013	t/y	0.03983	kg/t	150	t/load	9.957	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - RX	129,549	3,997,437	t/y	0.03241	kg/t	150	t/load	8.102	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - AY	3,361	74,473	t/y	0.04513	kg/t	150	t/load	11.283	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - SN, SC,SS	96,583	1,496,384	t/y	0.06454	kg/t	150	t/load	16.136	km/return trip	0.6	kg/VKT
CL - unloading ROM coal at stockpile/hopper - MC	87,929	1,301,623	t/y	0.06755	kg/t						
CL - unloading ROM coal at stockpile/hopper - WM	197,708	2,926,702	t/y	0.06755	kg/t						
CL - unloading ROM coal at stockpile/hopper - HU	154,971	2,294,053	t/y	0.06755	kg/t						
CL - unloading ROM coal at stockpile/hopper - CA	83,888	1,241,809	t/y	0.06755	kg/t						
CL - unloading ROM coal at stockpile/hopper - RX	189,028	2,798,206	t/y	0.06755	kg/t						
CL - unloading ROM coal at stockpile/hopper - AY	3,522	52,131	t/y	0.06755	kg/t						
CL - unloading ROM coal at stockpile/hopper - SN, SC,	70,760	1,047,469	t/y	0.06755	kg/t						
CL - Rehandle ROM coal at stockpilepile/hopper	86,659	1,282,819	t/y	0.06755	kg/t						
CL - Handling coal at CHPP	7,483	16,659,989	t/y	0.00045	kg/t	1.766	average of (wind speed/2.2)^1.3 in	6	moisture content of coal in %		
CL - Dozers at CHPP	234,451	15,330	h/y	15.3	kg/h	4	silt content in %	6	moisture content in %		
CL - Transporting rejects back to CA	39,812	999,599	t/y	0.03983	kg/t	150	t/load	9.957	km/return trip	0.6	kg/VKT
CL - Transporting rejects back to RX	32,395	999,599	t/y	0.03241	kg/t	150	t/load	8.102	km/return trip	0.6	kg/VKT
CL - Loading product coal stockpile	2,254	10,262,553	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in	10	moisture content of coal in %		
CL - Loading coal to trains	2,254	10,262,553	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in	10	moisture content of coal in %		
WE - OB spoil area - All pits	8,301,909	1,621	ha	6024.9	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - Open pit - All pits	2,505,150	416	ha	6024.9	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - ROM stockpiles	36,149	12	ha	3012.4	kg/ha/y	101	Average number of raindays	5	silt content in %	17.4	% of winds above 5.4 m
WE - Product stockpiles	11,086	5	ha	2410.0	kg/ha/y	101	Average number of raindays	4	silt content in %	17.4	% of winds above 5.4 m
Grading roads	73,856	120,000	km	0.61547	kg/VKT	8	speed of graders in km/h				
Underground_ROM/crushing stockpile area	720,000	8,000,000	t/y	0.09	kg/t						
Underground_CHPP area	720,000	8,000,000	t/y	0.09	kg/t						
TOTAL (O/C)	18,591,695										

Table F.2: 2011 – source allocation

Activity	Source ID																		
OB - Stripping topsoil - MC	1																		
OB - Stripping topsoil - WM	18	19	20																
OB - Stripping topsoil - HU	21	22																	
OB - Stripping topsoil - CA	23	24	25																
OB - Stripping topsoil - RX	26	27	28																
OB - Stripping topsoil - AY	96	97																	
OB - Stripping topsoil - SN, SC, SS	70	71	72	76	77	78													
OB - Drilling - MC	1																		
OB - Drilling - WM	18	19	20																
OB - Drilling - HU	21	22																	
OB - Drilling - CA	23	24	25																
OB - Drilling - RX	26	27	28																
OB - Drilling - AY	96	97																	
OB - Drilling - SN, SC, SS	70	71	72	76	77	78													
OB - Blasting - MC	1																		
OB - Blasting - WM	18	19	20																
OB - Blasting - HU	21	22																	
OB - Blasting - CA	23	24	25																
OB - Blasting - RX	26	27	28																
OB - Blasting - AY	96	97																	
OB - Blasting - SN, SC, SS	70	71	72	76	77	78													
OB - Sh/Ex/FELs loading - MC	1																		
OB - Sh/Ex/FELs loading - WM	18	19	20																
OB - Sh/Ex/FELs loading - HU	21	22																	
OB - Sh/Ex/FELs loading - CA	23	24	25																
OB - Sh/Ex/FELs loading - RX	26	27	28																
OB - Sh/Ex/FELs loading - AY	96	97																	
OB - Sh/Ex/FELs loading - SN, SC, SS	70	71	72	76	77	78													
OB - Hauling to emplacement - MC	1	2	3	4	5	6													
OB - Hauling to emplacement - WM	8	29	30	31	34	35	36	37	38	39	89								
OB - Hauling to emplacement - HU	22	40	41	42	43	44													
OB - Hauling to emplacement - CA	23	24	25	41	42	43	44	46	47	51	52								
OB - Hauling to emplacement - RX	25	26	28	46	47	51	52	53	54	55	56	57	58						
OB - Hauling to emplacement - AY	63	64	65	66	84	85	86	105	106		108	109	110						
OB - Hauling to emplacement - SN, SC, SS	72	73	74	75	76	77	78	79	80										
OB - Emplacing at dumps - MC	2	3	4	5	6														
OB - Emplacing at dumps - WM	29	30	31	32	33	34	35	36	37	38	39	87	88	89					
OB - Emplacing at dumps - HU	40	41	42	43	44	45													
OB - Emplacing at dumps - CA	46	47	51	52	119	120	121	124											
OB - Emplacing at dumps - RX	48	53	54	55	56	58	93	125	126										
OB - Emplacing at dumps - AY	63	64	65	66	67	84	85	86	95	105	106	107							
OB - Emplacing at dumps - SN, SC, SS	74	75	79	80	81	82	98	99	100	101	102								

Activity	Source ID																			
OB - Dozers on O/B - MC	2	3	4	5	6															
OB - Dozers on O/B - WM	29	30	31	32	33	34	35	36	37	38	39	87	88	89						
OB - Dozers on O/B - HU	40	41	42	43	44	45	111	112	113	114	115	116	117	118	122	123				
OB - Dozers on O/B - CA	46	47	51	52	119	120	121	124												
OB - Dozers on O/B - RX	48	53	54	55	56	58	93	125	126											
OB - Dozers on O/B - AY	63	64	65	66	67	84	85	86	95	105	106	107								
OB - Dozers on O/B - SN, SC, SS	74	75	79	80	81	82	98	99	100	101	102									
OB - Dozers on Rehabilitation - total	4	5	10	11	12	13	14	49	50	80	82	98	99	125	126					
CL - Dozers ripping - MC	1																			
CL - Dozers ripping - WM	18	19	20																	
CL - Dozers ripping - HU	21	22																		
CL - Dozers ripping - CA	23	24	25																	
CL - Dozers ripping - RX	26	27	28																	
CL - Dozers ripping - AY	96	97																		
CL - Dozers ripping - SN, SC, SS	70	71	72	76	77	78														
CL - Loading ROM to trucks - MC	1																			
CL - Loading ROM to trucks - WM	18	19	20																	
CL - Loading ROM to trucks - HU	21	22																		
CL - Loading ROM to trucks - CA	23	24	25																	
CL - Loading ROM to trucks - RX	26	27	28																	
CL - Loading ROM to trucks - AY	96	97																		
CL - Loading ROM to trucks - SN, SC, SS	70	71	72		76	77	78													
CL - Hauling ROM coal to dump hopper - MC	1	2	7	8	9	10	11	12	13	14	15	16								
CL - Hauling ROM coal to dump hopper - WM	7	8	9	10	11	12	13	14	15	16	30	31	32	33	34					
CL - Hauling ROM coal to dump hopper - HU	15	16	40	41	42	43	44	45	46	47	48	49	50							
CL - Hauling ROM coal to dump hopper - CA	15	16	24	47	48	49	50	51	52											
CL - Hauling ROM coal to dump hopper - RX	16	27	28	57	58	59	60	61	62											
CL - Hauling ROM coal to dump hopper - AY	16	60	61	62	63	64	65	66	67	68	69									
CL - Hauling ROM coal to dump hopper - SN, SC,SS	16	60	61	62	66	67	68	69	70	71	72	73	81	82	83	84	85	86		
CL - unloading ROM coal at stockpile/hopper - MC	17																			
CL - unloading ROM coal at stockpile/hopper - WM	17																			
CL - unloading ROM coal at stockpile/hopper - HU	17																			
CL - unloading ROM coal at stockpile/hopper - CA	17																			
CL - unloading ROM coal at stockpile/hopper - RX	17																			
CL - unloading ROM coal at stockpile/hopper - AY	17																			
CL - unloading ROM coal at stockpile/hopper - SN, SC, SS	17																			
CL - Rehandle ROM coal at stockpile/hopper	17																			
CL - Handling coal at CHPP	17																			
CL - Dozers at CHPP	16	17	127	128																
CL - Transporting rejects back to CA	15	16	47	48	49	50	52													
CL - Transporting rejects back to RX	16	59	60	61	62	125	126													
CL - Loading product coal stockpile	127	128																		
CL - Loading coal to trains	129																			
WE - OB spoil area - All pits	2-15	29-59	63-68	73	74	75	79-95	98-126												

Activity	Source ID																			
WE - Open pit - All pits	1	18	19	20	21	22	23	24	25	26	27	28	70	71	72	76	77	78	97	98
WE - ROM stockpiles	16	17	62																	
WE - Product stockpiles	127	128																		
Grading roads	All sources																			
Underground_ROM/crushing stockpile area		70	71	72																
Underground_CHPP area		17	127	128																

Table F.3: 2016 – detailed emission calculations

ACTIVITY	TSP emission/year for 2016 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping topsoil - WM	11,227	802	h/y	14.0	kg/h						
OB - Stripping topsoil - HU	4,593	328	h/y	14.0	kg/h						
OB - Stripping topsoil - CA	2,224	159	h/y	14.0	kg/h						
OB - Stripping topsoil - RX	5,046	360	h/y	14.0	kg/h						
OB - Stripping topsoil - AY	714	51	h/y	14.0	kg/h						
OB - Stripping topsoil - SN, SC, SS	1,994	142	h/y	14.0	kg/h						
OB - Drilling - WM	40,551	68,731	holes/y	0.6	kg/hole						
OB - Drilling - HU	11,972	20,291	holes/y	0.59	kg/hole						
OB - Drilling - CA	14,008	23,743	holes/y	0.59	kg/hole						
OB - Drilling - RX	24,522	41,563	holes/y	0.59	kg/hole						
OB - Drilling - AY	22,883	38,785	holes/y	0.59	kg/hole						
OB - Drilling - SN, SC, SS	4,872	8,258	holes/y	0.59	kg/hole						
OB - Blasting - WM	144,198	133	blasts/y	1086.47	kg/blast	29000	Area of blast in square metres				
OB - Blasting - HU	42,571	39	blasts/y	1086.47	kg/blast	29000	Area of blast in square metres				
OB - Blasting - CA	49,813	46	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - RX	87,201	80	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - AY	81,371	75	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - SN, SC, SS	17,325	16	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Sh/Ex/FELs loading - WM	289,723	138,560,732	t/y	0	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - HU	85,534	40,906,895	t/y	0	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - CA	100,084	47,865,563	t/y	0	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - RX	175,204	83,791,830	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - AY	163,491	78,189,940	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - SN, SC, SS	34,810	16,647,901	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Hauling to emplacement - WM	1,688,073	138,560,732	t/y	0.01218	kg/t	295.791	t/truck load	6.006	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - HU	501,684	40,906,895	t/y	0.01226	kg/t	295.791	t/truck load	6.046	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - CA	799,563	47,865,563	t/y	0.01670	kg/t	295.791	t/truck load	8.235	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - RX	1,221,221	83,791,830	t/y	0.01457	kg/t	295.791	t/truck load	7.185	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - AY	1,231,250	78,189,940	t/y	0.01575	kg/t	296	t/truck load	7.763	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - SN, SC, SS	139,299	16,647,901	t/y	0.00837	kg/t	296	t/truck load	4.125	km/return trip	0.6	kg/VKT
OB - Emplacing at dumps - WM	289,723	138,560,732	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - HU	85,534	40,906,895	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - CA	100,084	47,865,563	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - RX	175,204	83,791,830	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - AY	163,491	78,189,940	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - SN, SC, SS	34,810	16,647,901	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Dozers on O/B - WM	245,811	14,688	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - HU	72,570	4,336	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - CA	84,915	5,074	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - RX	148,649	8,882	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - AY	138,711	8,289	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - SN, SC, SS	29,534	1,765	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on Rehabilitation - total	381,277	22,783	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		

ACTIVITY	TSP emission/year for 2016 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
CL - Dozers ripping - WM	25,528	3,649	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - HU	6,654	951	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - CA	8,105	1,158	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - RX	13,327	1,905	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - AY	12,385	1,770	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - SN, SC, SS	2,464	352	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks - WM	806,034	11,931,832	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - HU	210107.6838	3110251.026	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - CA	255,901	3,788,142	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - RX	420,810	6,229,304	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - AY	391,049	5,788,751	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - SN, SC, SS	77,803	1,151,721	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper - WM	633,437	11,931,832	t/y	0.1	kg/t	150	t/load	13.272	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - HU	165,739	3,110,251	t/y	0.1	kg/t	150	t/load	13.322	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - CA	210,515	3,788,142	t/y	0.1	kg/t	150	t/load	13.893	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - RX	230,335	6,229,304	t/y	0.03698	kg/t	150	t/load	9.244	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - AY	239,724	5,788,751	t/y	0.04141	kg/t	150	t/load	10.353	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - SN, SC,SS	82,624	1,151,721	t/y	0.07174	kg/t	150	t/load	17.935	km/return trip	0.6	kg/VKT
CL - unloading ROM coal at stockpile/hopper - WM	564,224	8,352,282	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - HU	147,075	2,177,176	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - CA	179,131	2,651,699	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - RX	294,567	4,360,513	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - AY	273,734	4,052,126	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - SN, SC,	54,462	806,204	t/y	0.06755	kg/t	70	% control				
CL - Rehandle ROM coal at stockpilepile/hopper	166,451	2,464,000	t/y	0.06755	kg/t						
CL - Handling coal at CHPP	14,372	32,000,000	t/y	0.00045	kg/t	2	average of (wind speed/2.2)^1.3 in	6	moisture content of coal in %		
CL - Dozers at CHPP	234,451	15,330	h/y	15.29362	kg/h	4	silt content in %	6	moisture content in %		
CL - Transporting rejects back to CA	106,698	1,920,000	t/y	0.05557	kg/t	150	t/load	13.893	km/return trip	0.6	kg/VKT
CL - Transporting rejects back to RX	70,994	1,920,000	t/y	0.03698	kg/t	150	t/load	9.244	km/return trip	0.6	kg/VKT
CL - Loading product coal stockpile	4,330	19,712,000	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in	10	moisture content of coal in %		
CL - Loading coal to trains	4,330	19,712,000	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in	10	moisture content of coal in %		
WE - OB spoil area - All pits	8,361,827	1,633	ha	6025	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - Open pit - All pits	2,559,374	425	ha	6025	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - ROM stockpiles	72,299	12	ha	6025	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - Product stockpiles	11,086	5	ha	2410	kg/ha/y	101	Average number of raindays	4	silt content in %	17.4	% of winds above 5.4 m
Grading roads	73,856	120,000	km	0.61547	kg/VKT	8	speed of graders in km/h				
Underground_ROM/crushing stockpile area	360,000	4,000,000	t/y	0.09000	kg/t						
Underground_CHPP area	360,000	4,000,000	t/y	0.09000	kg/t						
TOTAL (O/C)	**25,933,139**										

Table F.4: 2016 – source allocation

Activity	Source ID																			
OB - Stripping topsoil - WM	1	2	3																	
OB - Stripping topsoil - HU	4	5																		
OB - Stripping topsoil - CA	6	7	8																	
OB - Stripping topsoil - RX	9	10	11																	
OB - Stripping topsoil - AY	73	74	75																	
OB - Stripping topsoil - SN, SC, SS	69	70	71	103																
OB - Drilling - WM	1	2	3																	
OB - Drilling - HU	4	5																		
OB - Drilling - CA	6	7	8																	
OB - Drilling - RX	9	10	11																	
OB - Drilling - AY	73	74	75																	
OB - Drilling - SN, SC, SS	69	70	71	103																
OB - Blasting - WM	1	2	3																	
OB - Blasting - HU	4	5																		
OB - Blasting - CA	6	7	8																	
OB - Blasting - RX	9	10	11																	
OB - Blasting - AY	73	74	75																	
OB - Blasting - SN, SC, SS	69	70	71	103																
OB - Sh/Ex/FELs loading - WM	1	2	3	93	94															
OB - Sh/Ex/FELs loading - HU	4	5																		
OB - Sh/Ex/FELs loading - CA	6	7	8																	
OB - Sh/Ex/FELs loading - RX	9	10	11																	
OB - Sh/Ex/FELs loading - AY	73	74	75																	
OB - Sh/Ex/FELs loading - SN, SC, SS	69	70	71	103																
OB - Hauling to emplacement - WM	43	44	46	47	50	51	52	53	56											
OB - Hauling to emplacement - HU	36	37	38	43	46	47	91	92	95	96	97									
OB - Hauling to emplacement - CA	7	8	9	36	37	38	84	85	86	87	88	89	95	96		98	99			
OB - Hauling to emplacement - RX	10	21	22	23	24	25	26	27	28	29	31	32	33	57	100					
OB - Hauling to emplacement - AY	61	72	73	74	76	115	116													
OB - Hauling to emplacement - SN, SC, SS	62	66	69	70	101	102	103													
OB - Emplacing at dumps - WM	43	44	45	46	47	48	49	50	51	52	53	54	55	56						
OB - Emplacing at dumps - HU	41	42	90	91	92	97														
OB - Emplacing at dumps - CA	30	31	32	33	36	37	38	39	40	95	96	98	99	100						
OB - Emplacing at dumps - RX	21	22	23	24	25	26	27	28	29	34	35									
OB - Emplacing at dumps - AY	12	13	14	15	16	17	18	19	20	78	79	105	106	107	108	109				
OB - Emplacing at dumps - SN, SC, SS	63	64	65	66	67	68	101	102	104	105	110									
OB - Dozers on O/B - WM	43	44	45	46	47	48	49	50	51	52	53	54	55	56						
OB - Dozers on O/B - HU	41	42	90	91	92	97														
OB - Dozers on O/B - CA	30	31	32	33	36	37	38	39	40	95	96	98	99	100						
OB - Dozers on O/B - RX	21	22	23	24	25	26	27	28	29	34	35									
OB - Dozers on O/B - AY	12	13	14	15	16	17	18	19	20	78	79	105	106	107	108	109				
OB - Dozers on O/B - SN, SC, SS	63	64	65	66	67	68	101	102	104	105	110									

Activity	Source ID																			
OB - Dozers on Rehabilitation - total	28	33	39	40	42	48	55	57	64	65	66	67	105							
CL - Dozers ripping - WM	1	2	3	93	94															
CL - Dozers ripping - HU	4	5																		
CL - Dozers ripping - CA	6	7	8																	
CL - Dozers ripping - RX	9	10	11																	
CL - Dozers ripping - AY	73	74	75																	
CL - Dozers ripping - SN, SC, SS	69	70	71	103																
CL - Loading ROM to trucks - WM	1	2	3	93	94															
CL - Loading ROM to trucks - HU	4	5																		
CL - Loading ROM to trucks - CA	6	7	8																	
CL - Loading ROM to trucks - RX	9	10	11																	
CL - Loading ROM to trucks - AY	73	74	75																	
CL - Loading ROM to trucks - SN, SC, SS	69	70	71	103																
CL - Hauling ROM coal to dump hopper - WM	2	33	34	35	36	38	43	44	45	47	81	91	100							
CL - Hauling ROM coal to dump hopper - HU	2	33	34	35	36	38	43	47	81	90	91	92	100							
CL - Hauling ROM coal to dump hopper - CA	7	33	34	35	36	37	81	98	100											
CL - Hauling ROM coal to dump hopper - RX	21	22	23	26	80	81	121													
CL - Hauling ROM coal to dump hopper - AY	75	77	80	81	107	108	117	118	119	120	121									
CL - Hauling ROM coal to dump hopper - SN, SC,SS	71	72	76	80	81	104	105	106	107	108	110	111	112	113	114	117	118	119	120	
CL - unloading ROM coal at stockpile/hopper - WM	81																			
CL - unloading ROM coal at stockpile/hopper - HU	81																			
CL - unloading ROM coal at stockpile/hopper - CA	81																			
CL - unloading ROM coal at stockpile/hopper - RX	81																			
CL - unloading ROM coal at stockpile/hopper - AY	81																			
CL - unloading ROM coal at stockpile/hopper - SN, SC, SS	81																			
CL - Rehandle ROM coal at stockpile/hopper	81																			
CL - Handling coal at CHPP	81																			
CL - Dozers at CHPP	81																			
CL - Transporting rejects back to CA	7	33	34	35	36	37	81	98	100											
CL - Transporting rejects back to RX	21	22	23	26	80	81	121													
CL - Loading product coal stockpile	122	123																		
CL - Loading coal to trains	124																			
WE - OB spoil area - All pits	12-56	60	61	63-68	78	79	82	83	84	85	90	91	92	95-110						
WE - Open pit - All pits	1	2	3	4	5	6	7	8	9	10	11	69	70	71	73	74	75	93	94	103
WE - ROM stockpiles	58																			
WE - Product stockpiles	122	123																		
Grading roads	All sources																			
Underground_ROM/crushing stockpile area	70	71																		
Underground_CHPP area	81																			

Table F.5: 2022 – detailed emission calculations

ACTIVITY	TSP emission/year for 2022 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3
OB - Stripping topsoil - WM	-	0	h/y	14.0	kg/h					
OB - Stripping topsoil - HU	4,775	341	h/y	14.0	kg/h					
OB - Stripping topsoil - CA	2,380	170	h/y	14.0	kg/h					
OB - Stripping topsoil - RX	-	0	h/y	14.0	kg/h					
OB - Stripping topsoil - AY	-	0	h/y	14.0	kg/h					
OB - Stripping topsoil - SN, SC, SS	-	0	h/y	14.0	kg/h					
OB - Drilling - WM	43,839	74,303	holes/y	0.59	kg/hole					
OB - Drilling - HU	15,420	26,136	holes/y	0.59	kg/hole					
OB - Drilling - CA	12,075	20,467	holes/y	0.59	kg/hole					
OB - Drilling - RX	16,265	27,568	holes/y	0.59	kg/hole					
OB - Drilling - AY	11,769	19,948	holes/y	0.59	kg/hole					
OB - Drilling - SN, SC, SS	1,517	2,572	holes/y	0.59	kg/hole					
OB - Blasting - WM	155,888	143	blasts/y	1086	kg/blast	29000	Area of blast in square metres			
OB - Blasting - HU	54,835	50	blasts/y	1086	kg/blast	29000	Area of blast in square metres			
OB - Blasting - CA	42,940	40	blasts/y	1086	kg/blast	29000	Area of blast in square metres			
OB - Blasting - RX	57,839	53	blasts/y	1086	kg/blast	29000	Area of blast in square metres			
OB - Blasting - AY	41,851	39	blasts/y	1086	kg/blast	29000	Area of blast in square metres			
OB - Blasting - SN, SC, SS	5,395	5	blasts/y	1086	kg/blast	29000	Area of blast in square metres			
OB - Sh/Ex/FELs loading - WM	313,211	149,794,036	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Sh/Ex/FELs loading - HU	110,174	52,690,812	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Sh/Ex/FELs loading - CA	86,275	41,261,321	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Sh/Ex/FELs loading - RX	116,209	55,577,399	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Sh/Ex/FELs loading - AY	84,086	40,214,604	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Sh/Ex/FELs loading - SN, SC, SS	10,841	5,184,529	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Hauling to emplacement - WM	1,670,168	149,794,036	t/y	0.01115	kg/t	295	t/truck load	5.49	km/return trip	0.6
OB - Hauling to emplacement - HU	909,165	52,690,812	t/y	0.01725	kg/t	295	t/truck load	8.496	km/return trip	0.6
OB - Hauling to emplacement - CA	775,639	41,261,321	t/y	0.01880	kg/t	295	t/truck load	9.256	km/return trip	0.6
OB - Hauling to emplacement - RX	738,079	55,577,399	t/y	0.01328	kg/t	295	t/truck load	6.539	km/return trip	0.6
OB - Hauling to emplacement - AY	767,805	40,214,604	t/y	0.01909	kg/t	295	t/truck load	9.401	km/return trip	0.6
OB - Hauling to emplacement - SN, SC, SS	43,718	5,184,529	t/y	0.00843	kg/t	295	t/truck load	4.152	km/return trip	0.6
OB - Emplacing at dumps - WM	313,211	149,794,036	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Emplacing at dumps - HU	110,174	52,690,812	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Emplacing at dumps - CA	86,275	41,261,321	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Emplacing at dumps - RX	116,209	55,577,399	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Emplacing at dumps - AY	84,086	40,214,604	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Emplacing at dumps - SN, SC, SS	10,841	5,184,529	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %	
OB - Dozers on O/B - WM	268,061	16,018	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	
OB - Dozers on O/B - HU	94,292	5,634	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	
OB - Dozers on O/B - CA	73,838	4,412	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	
OB - Dozers on O/B - RX	99,457	5,943	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	
OB - Dozers on O/B - AY	71,965	4,300	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	
OB - Dozers on O/B - SN, SC, SS	9,278	554	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	
OB - Dozers on Rehabilitation - total	326,590	19,515	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %	

ACTIVITY	TSP emission/year for 2022 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
CL - Dozers ripping - WM	25,008	3,575	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - HU	6,721	961	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - CA	5,726	818	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - RX	11,770	1,682	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - AY	8,541	1,221	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping - SN, SC, SS	878	125	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks - WM	806,623	11,940,540	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - HU	216773.3561	3208923.829	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - CA	184,680	2,733,835	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - RX	379,629	5,619,692	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - AY	275,478	4,077,935	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks - SN, SC, SS	28,310	419,074	t/y	0.1	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper - WM	706,498	11,940,540	t/y	0.1	kg/t	150	t/load	14.792	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - HU	192,998	3,208,924	t/y	0.1	kg/t	150	t/load	15.036	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - CA	157,032	2,733,835	t/y	0.1	kg/t	150	t/load	14.36	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - RX	260,934	5,619,692	t/y	0.04643	kg/t	150	t/load	11.608	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - AY	152,009	4,077,935	t/y	0.03728	kg/t	150	t/load	9.319	km/return trip	0.6	kg/VKT
CL - Hauling ROM coal to dump hopper - SN, SC,SS	30,064	419,074	t/y	0.07174	kg/t	150	t/load	17.935	km/return trip	0.6	kg/VKT
CL - unloading ROM coal at stockpile/hopper - WM	564,636	8,358,378	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - HU	151,741	2,246,247	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - CA	129,276	1,913,685	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - RX	265,740	3,933,784	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - AY	192,835	2,854,554	t/y	0.06755	kg/t	70	% control				
CL - unloading ROM coal at stockpile/hopper - SN, SC,	19,817	293,352	t/y	0.06755	kg/t	70	% control				
CL - Rehandle ROM coal at stockpilepile/hopper	145,645	2,156,000	t/y	0.06755	kg/t						
CL - Handling coal at CHPP	12,576	28,000,000	t/y	0.00045	kg/t	2	average of (wind speed/2.2)^1.3 in	6	moisture content of coal in %		
CL - Dozers at CHPP	234,451	15,330	h/y	15.29362	kg/h	4	silt content in %	6	moisture content in %		
CL - Transporting rejects back to CA	96,499	1,680,000	t/y	0.05744	kg/t	150	t/load	14.36	km/return trip	0.6	kg/VKT
CL - Transporting rejects back to RX	78,006	1,680,000	t/y	0.04643	kg/t	150	t/load	11.608	km/return trip	0.6	kg/VKT
CL - Loading product coal stockpile	3,789	17,248,000	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in	10	moisture content of coal in %		
CL - Loading coal to trains	3,789	17,248,000	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in	10	moisture content of coal in %		
WE - OB spoil area - All pits	8,768,447	1,712	ha	6025	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - Open pit - All pits	2,553,952	424	ha	6025	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - ROM stockpiles	72,299	12	ha	6025	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m
WE - Product stockpiles	11,086	5	ha	2410	kg/ha/y	101	Average number of raindays	4	silt content in %	17.4	% of winds above 5.4 m
Grading roads	73,856	120,000	km	0.61547	kg/VKT	8	speed of graders in km/h				
Underground_ROM/crushing stockpile area	720,000	8,000,000	t/y	0.09000	kg/t						
Underground_CHPP area	720,000	8,000,000	t/y	0.09000	kg/t						
TOTAL (O/C)	**24,584,544**										

Table F.6: 2022 – source allocation

Activity	Source ID																						
OB - Stripping topsoil - HU	5	6																					
OB - Stripping topsoil - CA	7	8	9	10	101																		
OB - Drilling - WM	1	2	3	4																			
OB - Drilling - HU	5	6																					
OB - Drilling - CA	7	8	9	10																			
OB - Drilling - RX	11	12	13																				
OB - Drilling - AY	14	15	16	17																			
OB - Drilling - SN, SC, SS	18	19	20	21	22	23																	
OB - Blasting - WM	1	2	3	4																			
OB - Blasting - HU	5	6																					
OB - Blasting - CA	7	8	9	10																			
OB - Blasting - RX	11	12	13																				
OB - Blasting - AY	14	15	16	17																			
OB - Blasting - SN, SC, SS	18	19	20	21	22	23																	
OB - Sh/Ex/FELs loading - WM	1	2	3	4																			
OB - Sh/Ex/FELs loading - HU	5	6																					
OB - Sh/Ex/FELs loading - CA	7	8	9	10																			
OB - Sh/Ex/FELs loading - RX	11	12	13																				
OB - Sh/Ex/FELs loading - AY	14	15	16	17																			
OB - Sh/Ex/FELs loading - SN, SC, SS	18	19	20	21	22	23																	
OB - Hauling to emplacement - WM	1	2	3	24	25	26	27	28	29	30	31												
OB - Hauling to emplacement - HU	5	34	35	37	38	69																	
OB - Hauling to emplacement - CA	7	9	10	11	40	41	42	43	44	45	46	101	102	103									
OB - Hauling to emplacement - RX	10	11	53	54	55	57	58	59	60	61	101	102	103										
OB - Hauling to emplacement - AY	80	81	95	96	98	99	100																
OB - Hauling to emplacement - SN, SC, SS	19	21	90	91																			
OB - Emplacing at dumps - WM	26	27	28	29	30	31	32	33	36	39	70	71											
OB - Emplacing at dumps - HU	34	35	37	38	69																		
OB - Emplacing at dumps - CA	40	41	42	43	44	45	46	47	48	49	50	51	52	68									
OB - Emplacing at dumps - RX	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	72	73	74					
OB - Emplacing at dumps - AY	80	81	82	83	84	85	86	87	88														
OB - Emplacing at dumps - SN, SC, SS	89	90	91	92																			
OB - Dozers on O/B - WM	26	27	28	29	30	31	32	33	36	39	70	71											
OB - Dozers on O/B - HU	34	35	37	38	69																		
OB - Dozers on O/B - CA	40	41	42	43	44	45	46	47	48	49	50	51	52	68									
OB - Dozers on O/B - RX	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	72	73	74					
OB - Dozers on O/B - AY	80	81	82	83	84	85	86	87	88														
OB - Dozers on O/B - SN, SC, SS	89	90	91	92																			
OB - Dozers on Rehabilitation - total	39	40	41	48	67	68	71	89	90	91	92												
CL - Dozers ripping - WM	1	2	3	4																			
CL - Dozers ripping - HU	5	6																					
CL - Dozers ripping - CA	7	8	9	10																			

Activity	Source ID																					
CL - Dozers ripping - RX	11	12	13																			
CL - Dozers ripping - AY	14	15	16	17																		
CL - Dozers ripping - SN, SC, SS	18	19	20	21	22	23																
CL - Loading ROM to trucks - WM	1	2	3	4																		
CL - Loading ROM to trucks - HU	5	6																				
CL - Loading ROM to trucks - CA	7	8	9	10																		
CL - Loading ROM to trucks - RX	11	12	13																			
CL - Loading ROM to trucks - AY	14	15	16	17																		
CL - Loading ROM to trucks - SN, SC, SS	18	19	20	21	22	23																
CL - Hauling ROM coal to dump hopper - WM	2	32	34	35	36	42	47	48	72	73	74	75										
CL - Hauling ROM coal to dump hopper - HU	35	37	42	47	48	72	73	74	75													
CL - Hauling ROM coal to dump hopper - CA	10	11	12	59	60	61	65	75	97													
CL - Hauling ROM coal to dump hopper - RX	56	57	58	59	60	61	65	75	97													
CL - Hauling ROM coal to dump hopper - AY	15	65	75	97																		
CL - Hauling ROM coal to dump hopper - SN, SC,SS	19	20	90	93	95	96	97															
CL - unloading ROM coal at stockpile/hopper - WM	75																					
CL - unloading ROM coal at stockpile/hopper - HU	75																					
CL - unloading ROM coal at stockpile/hopper - CA	75																					
CL - unloading ROM coal at stockpile/hopper - RX	75																					
CL - unloading ROM coal at stockpile/hopper - AY	75																					
CL - unloading ROM coal at stockpile/hopper - SN, SC, SS	75																					
CL - Rehandle ROM coal at stockpile/hopper	75																					
CL - Handling coal at CHPP	75																					
CL - Dozers at CHPP	75																					
CL - Transporting rejects back to CA	10	11	12	59	60	61	65	75	97													
CL - Transporting rejects back to RX	56	57	58	59	60	61	65	75	97													
CL - Loading product coal stockpile	76	77																				
CL - Loading coal to trains	78																					
WE - OB spoil area - All pits	26-74	80-92																				
WE - Open pit - All pits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WE - ROM stockpiles	75	94																				
WE - Product stockpiles	76	77																				
Grading roads	All sources																					
Underground_ROM/crushing stockpile area	18	19	20																			
Underground_CHPP area	75	94																				

Appendix G: Background Emissions

Background emissions

As discussed in **Section 8.4**, in addition to emissions from nearby mines, there are also emissions from distant mines and other sources to consider.

For this assessment, a grid of annual average PM_{10} and TSP concentrations due to non-mining sources has been created to make allowance for the spatial variability that occurs in the PM_{10} and TSP concentrations due to sources that are not explicitly included in the modelling.

This approach is different from the previous practice adopted by Holmes Air Sciences (now PAEHolmes), where the effect of non-modelled source has been accounted for by assuming a constant background, and attempts to improve this methodology by accounting for the spatial variation in background.

The approach taken was to model the actual operations that took place at Mt Arthur Coal for the period July 2007 to July 2008 (see **Table G.1** for the emissions inventory) in combination with the meteorological data for the period April 2007 to March 2008 (as discussed in **Section 6**).

Annual average PM_{10} predictions were made at the monitoring sites which measure ambient PM_{10} concentration as discussed in detail in **Section 5**:

- DF01 - Roxburgh South
- DF02 - Windmill
- DF03 – Edderton Homestead
- DF04 - Antiene/Wire Lane/ Pistol Club
- DF05 - Constable
- DF06 - Racecourse Road/Sheppard Avenue
- DF07 - Highbrook Park/South Muswellbrook
- DF08 - Denman Rd West

The difference between the predicted and measured annual average concentrations was taken to be the contribution of any distant mines and other sources which were not included explicitly in the model, that is, the background emissions to add to the predicted impacts due to the operations at Mt Arthur Coal and nearby mining operations.

Table G.1: Mt Arthur Coal 2007 emissions inventory

ACTIVITY	TSP emission/year for 2022 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping topsoil - WM	-	0	h/y	14.0	kg/h						
OB - Stripping topsoil - HU	4,775	341	h/y	14.0	kg/h						
OB - Stripping topsoil - CA	2,380	170	h/y	14.0	kg/h						
OB - Stripping topsoil - RX	-	0	h/y	14.0	kg/h						
OB - Stripping topsoil - AY	-	0	h/y	14.0	kg/h						
OB - Stripping topsoil - SN, SC, SS	-	0	h/y	14.0	kg/h						
OB - Drilling - WM	43,839	74,303	holes/y	0.6	kg/hole						
OB - Drilling - HU	15,420	26,136	holes/y	0.59	kg/hole						
OB - Drilling - CA	12,075	20,467	holes/y	0.59	kg/hole						
OB - Drilling - RX	16,265	27,568	holes/y	0.59	kg/hole						
OB - Drilling - AY	11,769	19,948	holes/y	0.59	kg/hole						
OB - Drilling - SN, SC, SS	1,517	2,572	holes/y	0.59	kg/hole						
OB - Blasting - WM	155,888	143	blasts/y	1086.47	kg/blast	29000	Area of blast in square metres				
OB - Blasting - HU	54,835	50	blasts/y	1086.47	kg/blast	29000	Area of blast in square metres				
OB - Blasting - CA	42,940	40	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - RX	57,839	53	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - AY	41,851	39	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Blasting - SN, SC, SS	5,395	5	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Sh/Ex/FELs loading - WM	313,211	149,794,036	t/y	0	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - HU	110,174	52,690,812	t/y	0	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - CA	86,275	41,261,321	t/y	0	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - RX	116,209	55,577,399	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - AY	84,086	40,214,604	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Sh/Ex/FELs loading - SN, SC, SS	10,841	5,184,529	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Hauling to emplacement - WM	1,670,168	149,794,036	t/y	0.01115	kg/t	295.432	t/truck load	5.49	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - HU	909,165	52,690,812	t/y	0.01725	kg/t	295.432	t/truck load	8.496	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - CA	775,639	41,261,321	t/y	0.01880	kg/t	295.432	t/truck load	9.256	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - RX	738,079	55,577,399	t/y	0.01328	kg/t	295.432	t/truck load	6.539	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - AY	767,805	40,214,604	t/y	0.01909	kg/t	295	t/truck load	9.401	km/return trip	0.6	kg/VKT
OB - Hauling to emplacement - SN, SC, SS	43,718	5,184,529	t/y	0.00843	kg/t	295	t/truck load	4.152	km/return trip	0.6	kg/VKT
OB - Emplacing at dumps - WM	313,211	149,794,036	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - HU	110,174	52,690,812	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - CA	86,275	41,261,321	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - RX	116,209	55,577,399	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - AY	84,086	40,214,604	t/y	0.00209	kg/t	2	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Emplacing at dumps - SN, SC, SS	10,841	5,184,529	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in	2	moisture content in %		
OB - Dozers on O/B - WM	268,061	16,018	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - HU	94,292	5,634	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - CA	73,838	4,412	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - RX	99,457	5,943	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - AY	71,965	4,300	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on O/B - SN, SC, SS	9,278	554	h/y	16.73533	kg/h	10.000	silt content in %	2	moisture content in %		
OB - Dozers on Rehabilitation - total	326,590	19,515	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		

ACTIVITY	TSP emission/year for 2007 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
CL - Dozers ripping - Pit 1	1,661	237	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Dozers ripping - Pit 2	25,484	3,643	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Dozers ripping - Pit 3	7,076	1,011	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Dozers ripping - Pit 4	8,624	1,233	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Dozers ripping - Pit 5	16,633	2,377	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Dozers ripping - Pit 6	10,694	1,529	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Dozers ripping - Pit 7	2,617	374	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %	210240.0	
CL - Loading ROM to trucks -Pit 1	29,881	442,330	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks -Pit 2	374,573	5,544,845	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks -Pit 3	166,047	2,458,015	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks -Pit 4	107,722	1,594,625	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks -Pit 5	110,038	1,628,900	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks -Pit 6	83,027	1,229,060	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks -Pit 7	54,612	808,425	t/y	0.06755	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper - Pit 1	19,408	442,330	t/y	0.04388	kg/t	146	t/load	6.4	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper - Pit 2	178,835	5,544,845	t/y	0.03225	kg/t	149	t/load	4.8	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper - Pit 3	152,020	2,458,015	t/y	0.06185	kg/t	149	t/load	9.2	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper - Pit 4	87,856	1,594,625	t/y	0.05509	kg/t	149	t/load	8.2	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper - Pit 5	87,802	1,628,900	t/y	0.05390	kg/t	148	t/load	8	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper - Pit 6	57,710	1,229,060	t/y	0.04695	kg/t	149	t/load	7	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper - Pit 7	93,013	808,425	t/y	0.11505	kg/t	122	t/load	14	km/return trip	1.0	kg/VKT
CL - unloading ROM coal at stockpile/hopper Pit 1	29,881	442,330	t/y	0.0676	kg/t						
CL - unloading ROM coal at stockpile/hopper Pit 2	374,573	5,544,845	t/y	0.0676	kg/t						
CL - unloading ROM coal at stockpile/hopper Pit 3	166,047	2,458,015	t/y	0.0676	kg/t						
CL - unloading ROM coal at stockpile/hopper Pit 4	107,722	1,594,625	t/y	0.0676	kg/t						
CL - unloading ROM coal at stockpile/hopper Pit 5	110,038	1,628,900	t/y	0.0676	kg/t						
CL - unloading ROM coal at stockpile/hopper Pit 6	83,027	1,229,060	t/y	0.0676	kg/t						
CL - unloading ROM coal at stockpile/hopper Pit 7	54,612	808,425	t/y	0.0676	kg/t						
CL - Rehandle ROM coal at stockpilepile/hopper	925,899	13,706,200	t/y	0.0676	kg/t						
CL - Handling coal at CHPP	6,156	13,706,200	t/y	0.00045	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - Dozers at CHPP	100,451	6,568	h/y	15.3	kg/h	4	silt content in %	6	moisture content in %		
CL - Loading product coal stockpile	2,650	12,061,456	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
CL - Loading coal to trains	2,650	12,061,456	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB spoil area - All pits (assume 50% on 30% of area)	10,369,321	2,025	ha	6024.9	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m/s
WE - Open pit - All pits	3,049,800	506	ha	6024.9	kg/ha/y	101	Average number of raindays	10	silt content in %	17.4	% of winds above 5.4 m/s
WE - ROM stockpiles	36,149	12	ha	3012.4	kg/ha/y	101	Average number of raindays	5	silt content in %	17.4	% of winds above 5.4 m/s
WE - Product stockpiles	11,086	5	ha	2410.0	kg/ha/y	101	Average number of raindays	4	silt content in %	17.4	% of winds above 5.4 m/s
Grading roads	73,856	120,000	km	0.61547	kg/VKT	8	speed of graders in km/h				
TOTAL	21,137,333										

Table G.2 and **Table G.3** present the measured, predicted and background PM_{10} and TSP concentrations, respectively. TSP emissions are not directly measured at the monitoring locations and therefore the concentrations were calculated based on the assumption that PM_{10} concentrations are approximately 40% of TSP concentrations.

Table G.2: PM_{10} concentrations (μg/m^3)

Monitor ID	Monitor Name	Measured conc^{n}s	Predicted conc^{n}s	Background conc^{n}s (i.e. measured – predicted)
DF01	Roxburgh South	16.9	12.3	4.6
DF02	Windmill	15.2	11.9	3.3
DF03	Edderton	16.4	7.9	8.5
DF04	Wire Lane	21.3	10.9	10.3
DF05	Constable	17.1	10.5	6.6
DF06	Racecourse Rd	26.8	11.8	15.0
DF07	South Muswellbrook	22.1	6.4	15.8
DF08	Denman Rd West	19.6	17.8	1.8

Table G.3: TSP concentrations (μg/m^3)

Monitor ID	Monitor Name	Measured conc^{n}s	Predicted conc^{n}s	Background conc^{n}s (i.e. measured – predicted)
DF01	Roxburgh South	42.2	13.2	29.0
DF02	Windmill	38.1	12.8	25.3
DF03	Edderton	41.1	8.3	32.8
DF04	Wire Lane	53.2	12.2	40.9
DF05	Constable	42.8	11.4	31.5
DF06	Racecourse Rd	66.9	13.6	53.3
DF07	South Muswellbrook	55.3	7.0	48.3
DF08	Denman Rd West	49.0	19.7	29.3

The monitoring locations are sparsely located and in order to create a grid of spatially varying concentrations to sum to the predicted impacts due to operations at Mt Arthur Coal and the nearby mines, it was assumed that the annual average PM_{10} concentrations at the edges of grid are 15 μg/m^3 and that the annual average TSP concentrations are 37.5 μg/m^3.

Figure G.1 and **Figure G.2** show the grids created for PM_{10} and TSP. These demonstrate that closer to the mine the majority of the measured PM_{10} and inferred TSP concentrations are due to the operations at Mr Arthur Coal, with small contributions from other mines and non-mining sources. As you move away from Mt Arthur Coal, the contribution of other mines and non-mining sources to the total measured concentrations increases.

The exception to this would appear to be for TSP close to Muswellbrook. The inferred concentrations at Racecourse Road (DF06) and South Muswellbrook (DF07) are high compared with the predicted impacts. This suggests there is some local source of emissions close to these monitors.

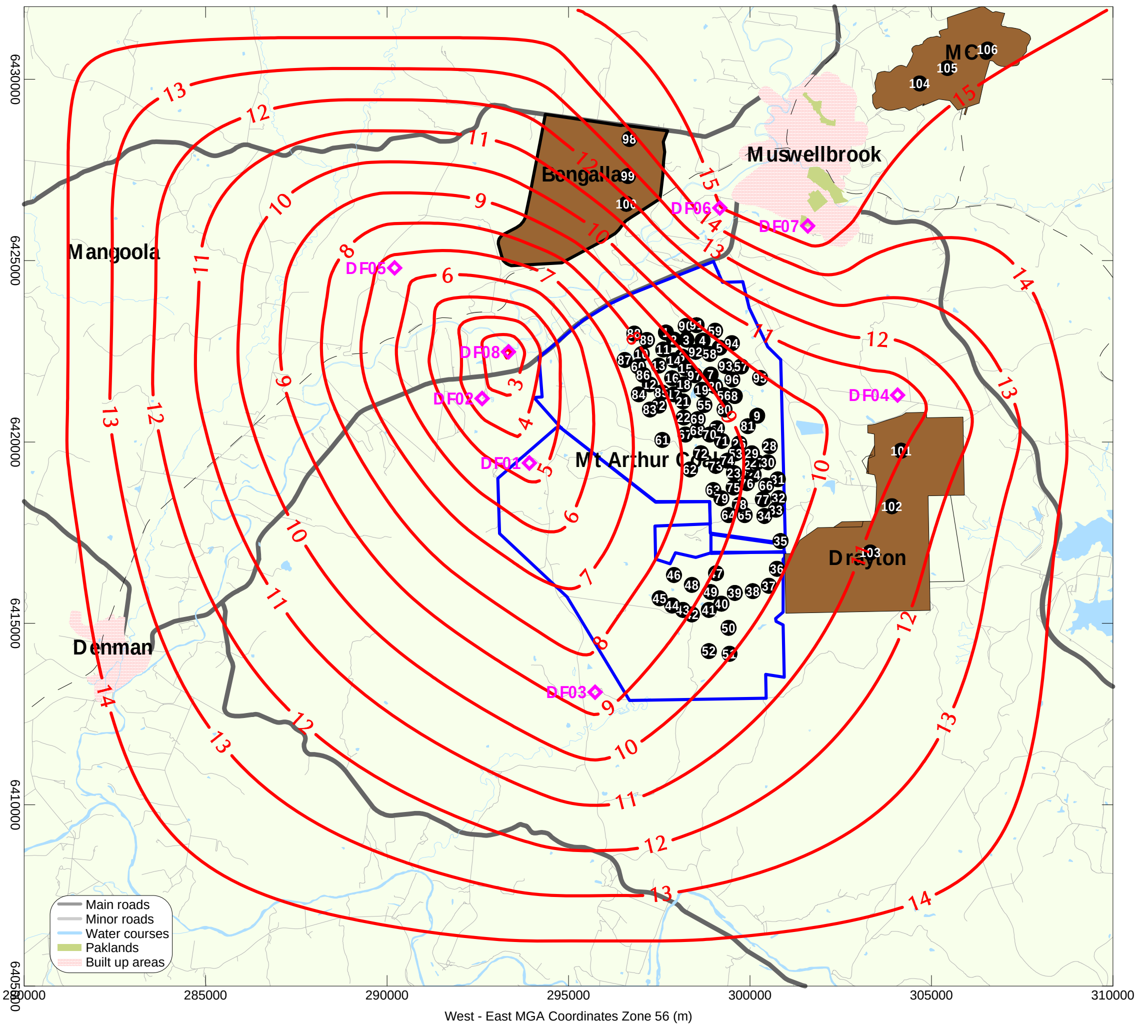

Figure G.1: Annual average PM_{10} concentrations due to distant mines and other sources

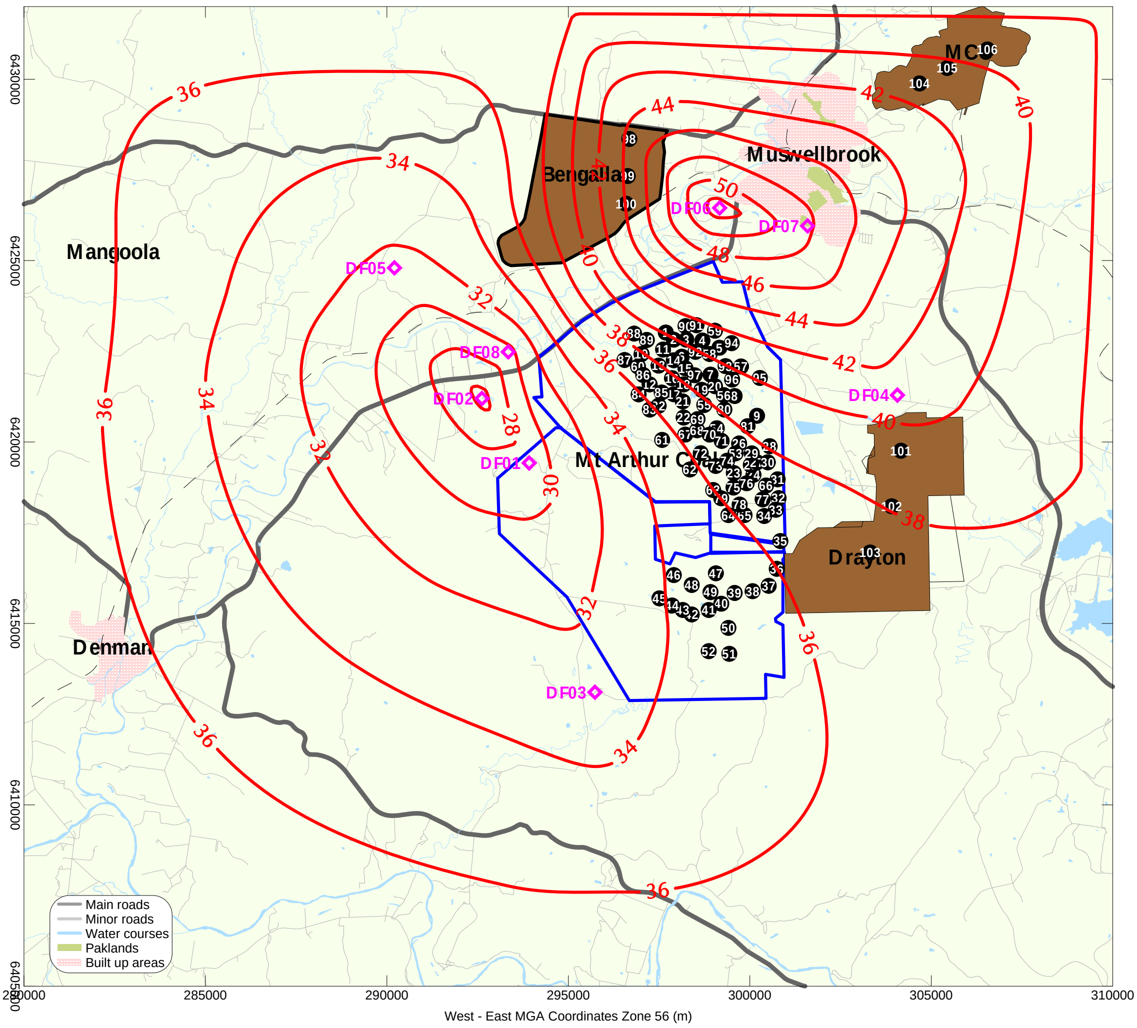

Figure G.2: Annual average TSP concentrations due to distant mines and other sources

DECC Emissions Inventory

In order to investigate the contribution to particulate emissions from sources other than mining, data for the Muswellbrook LGA were provided by the DECC from the Air Emissions Inventory for the Greater Metropolitan Region in NSW (**Agapedies, 2009**).

Figure G.3 shows Muswellbrook LGA and the modelling domain i.e. the area over which predicted impacts were modelled.

The inventory is split into seven modules:

- Biogenic (i.e. natural sources)
- Commercial business (i.e. non-EPA-licensed)
- Domestic-commercial activities
- Industrial premises (i.e. EPA licensed)
- Off-road mobile (i.e. non-registered off-road vehicles and equipment)
- On-road mobile (i.e. registered on-road vehicles)

Table G.4 presents a summary of the emissions for the Muswellbrook LGA in 2003.

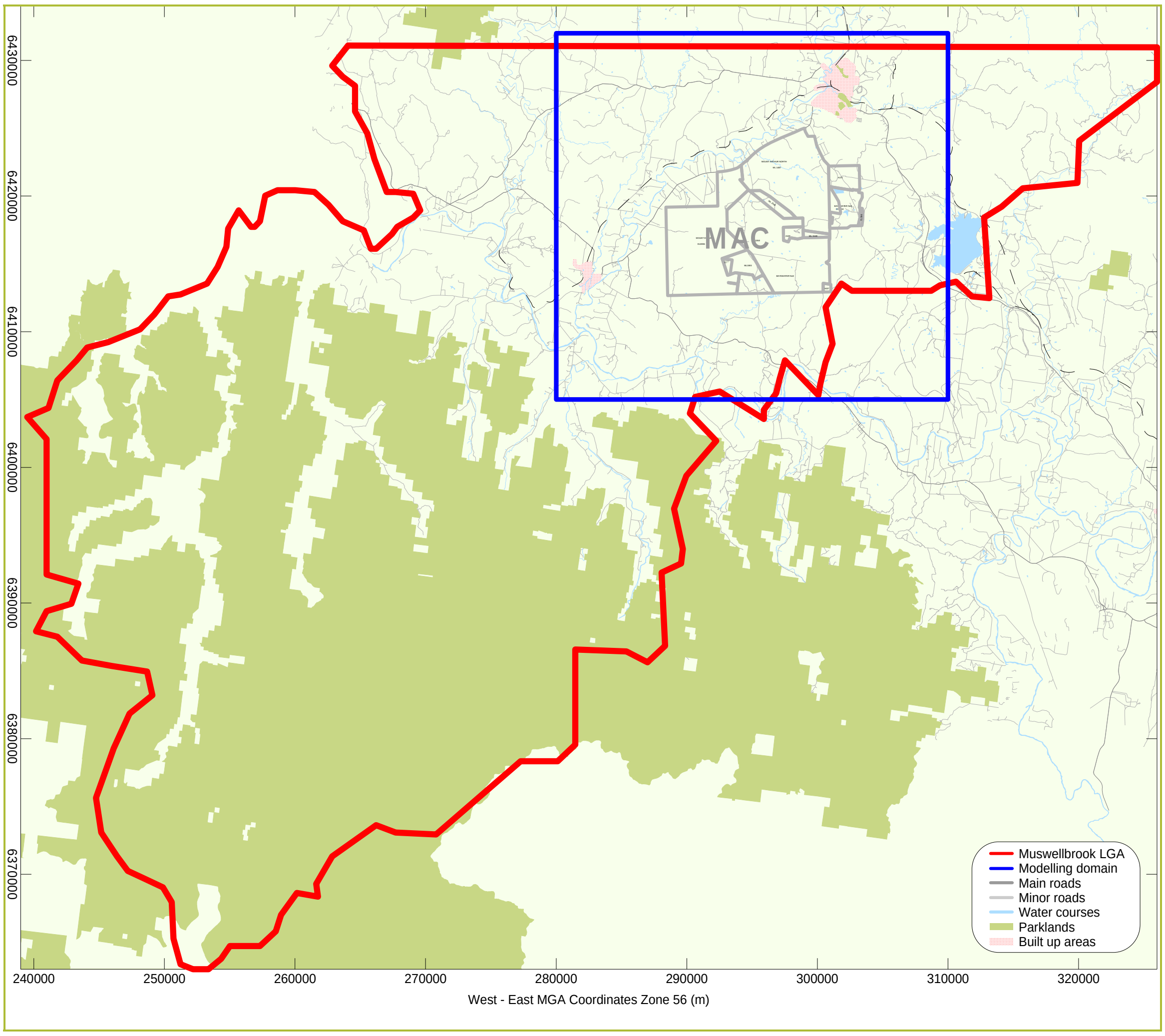

Figure G.3: Muswellbrook LGA and modelling domain

Table G.4: Muswellbrook LGA – 2003 emissions (kg)

Module	Activity	TSP	PM_{10}	$PM_{2.5}$
Biogenic	Agricultural burning	10,134	8,915	5,176
	Bushfire and prescribed burning	303,473	202,315	185,456
	Fugitive/windborne	312,552	155,666	60,901
	Biogenic Total	***626,159***	***366,896***	***251,532***
Commercial	Gravel and Sand Quarrying	421,854	88,568	22,519
	Hospitals (Except Psychiatric Hospitals)	1,618	1,617	1,617
	Commercial Total	***423,472***	***90,186***	***24,137***
Domestic-Commercial	Barbeques	37	35	20
	Gaseous Fuel Burning	410	410	410
	Lawn Mowing	893	848	780
	Lawn Mowing (Public Open Spaces)	587	558	518
	Liquid Fuel Burning (Domestic)	2	2	1
	Solid Fuel Burning (Domestic)	21,974	20,875	20,246
	Domestic-Commercial Total	***23,903***	***22,728***	***21,974***
Industrial	Coal mining	11,044,280	5,057,070	770,590
	Concrete batching	5,715	2,491	376
	Electricity Generation - Generation of electrical power from coal	2,416,709	1,143,602	360,914
	Other land-based extraction	389,339	56,615	16,408
	Solid waste landfilling	9,649	4,824	972
	Industrial Total	***13,865,692***	***6,264,602***	***1,149,260***
Off-Road Mobile	Commercial Vehicles	106,661	25,119	11,457
	Construction Vehicles	19	18	17
	Industrial Vehicles	2,184,261	471,425	194,475
	Railways	3,312	3,146	2,842
	Recreational Boating	2,950	2,802	2,580
	Off-Road Mobile Total	***2,297,202***	***502,511***	***211,371***
On-Road Mobile	On-Road Mobile	7,817	6,972	6,649
	On-Road Mobile Total	***7,817***	***6,972***	***6,649***
	Grand Total	**17,244,246**	**7,253,895**	**1,664,923**

Source: **Agapedies, 2009**

For the purposes of this assessment, the following modules and/or activities were excluded:

- Biogenic (all activities)
- Industrial (coal mining) – emissions from coal mining have been included in the background and cumulative assessment using information contained in the EIS's (see above and **Section 8**)
- Off-road mobile – more than 90% of these emissions are due to industrial vehicles and these have been assessed in detail in the EIS's for the individual mines.

The DECC inventory calculated emissions for the year 2003, and includes emission projections in yearly increments up to 2031.

Table G.5 presents a summary of the emissions used in the dispersion modelling for the year 2007, calculated by applying the relevant emission projections provided in the DECC inventory.

Table G.5: 2007 emissions as used in the modelling (kg)

Module	Activity	TSP	PM_{10}	$PM_{2.5}$
Commercial	Gravel and Sand Quarrying	384,901	74,503	19,432
	Hospitals (Except Psychiatric Hospitals)	1,669	1,669	1,669
	Commercial Total	***423,472***	***386,570***	***76,172***
Domestic-Commercial	Barbeques	39	37	21
	Gaseous Fuel Burning	442	442	442
	Lawn Mowing	938	891	820
	Lawn Mowing (Public Open Spaces)	619	589	547
	Liquid Fuel Burning (Domestic)	2	2	1
	Solid Fuel Burning (Domestic)	22,033	20,931	20,300
	Domestic-Commercial Total	***23,903***	***24,075***	***22,893***
Industrial	Concrete batching	5,934	2,586	391
	Electricity Generation - Generation of electrical power from coal	2,499,125	1,182,602	373,222
	Other land-based extraction	404,213	58,778	17,035
	Solid waste landfilling	10,017	5,009	1,009
	Industrial Total	***2,919,289***	***1,248,975***	***391,657***
On-Road Mobile	On-Road Mobile	6,176	5,509	5,253
	On-Road Mobile Total	***6,176***	***5,509***	***5,253***
	Grand Total	***3,336,111***	***1,353,549***	***440,142***

The following provides additional detail on how each source was modelled.

- Commercial sources
- Commercial sources include businesses that do not hold environment protection licences under the NSW POEO Act (Protection of the Environment Operations Act 1997).
- The sources included are:
- Three gravel and quarrying activities
- Two hospital stacks
- The emissions were allocated to the location of the activity and modelled as volume/stack sources. For the stack sources, the default stack parameters identified in **NSW DECC, 2007** were used, namely:
- Stack height 15 m
- Stack diameter 0.2 m
- Exit velocity 10 m/s
- Exit temperature 473 K
- Domestic-Commercial sources

The domestic-commercial sources were conservatively assumed to originate from Muswellbrook and Denman town centres. The emissions were pro-rated on the basis of population and modelled as a number of volume sources.

Industrial sources

The industrial source emissions for Muswellbrook LGA were calculated in the DECC inventory for the following:

- Bayswater Power Station
- Liddell Power Station
- Concrete batching plants
- Other land-based extraction
- Solid waste landfilling
- The emissions from Bayswater and Liddell were modelled as stacks, with additional fugitive emissions from Liddell modelled as a volume source. The other sources were modelled as volume sources.
- The stack parameters assumed for Bayswater and Liddell are detailed in **Table G.6**.

Table G.6: Stack parameters

Parameter	Liddell Power Station		Bayswater Power Station	
	Stack 1	Stack 2	Stack1	Stack2
Stack Height (m)	168	168	248	248
Stack Diameter (m)	9.4	9.4	12	12
Exit velocity (m/s)	19	19	13	13
Exit temp (K)	411	411	373	373

Source: **Bawden, 2009**

On-road mobile

- The total emissions were allocated on a pro-rata basis based on the Annual Average Daily Traffic (AADT) between the following highways:
- New England Highway
- Denman Road
- Wybong Road

Table G.7 presents a summary of the sources included in the dispersion. The locations of these sources are identified in **Figure G.4**.

Table G.7: Summary of DECC emissions modelling

Module	Activity	No. of activities	Modelling source type	Comments
Commercial	Gravel and Sand Quarrying	3	Volume	
	Hospitals (Except Psychiatric Hospitals)	2	Stack	
Domestic-Commercial	Barbeques	N/A	Volume	Total emissions split between Muswellbrook and Denman urban areas; pro-rated on population basis
	Gaseous Fuel Burning			
	Lawn Mowing			
	Lawn Mowing (Public Open Spaces)			
	Liquid Fuel Burning (Domestic)			
	Solid Fuel Burning (Domestic)			
Industrial	Concrete batching		Volume	
	Electricity Generation - Generation of electrical power from coal	3	Stack *2 Volume *1	
	Other land-based extraction	1	Volume	
	Solid waste landfilling	1	Volume	
On-Road Mobile	On-Road Mobile	N/A	Volume	Total emissions split between New England Highway, Denman Road and Wybong Road; pro-rated on basis of AADT

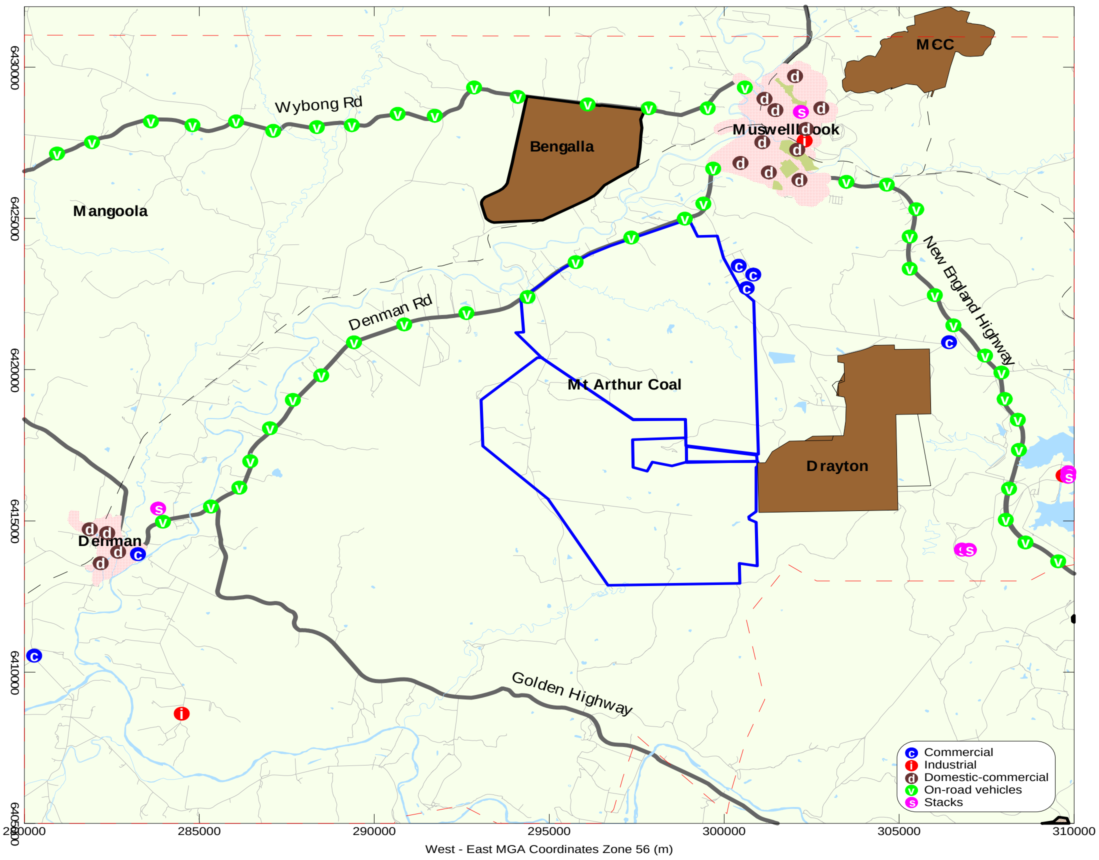

Figure G.4: Location of sources used in modelling emissions from DECC inventory

Figure G.5 presents a contour plot of the predicted annual average PM_{10} concentrations due to the sources indentified in the DECC inventory.

As the predicted impacts in the vicinity of Mt Arthur Coal are less than 0.5 $\mu g/m^3$, they have not been included in the assessment.

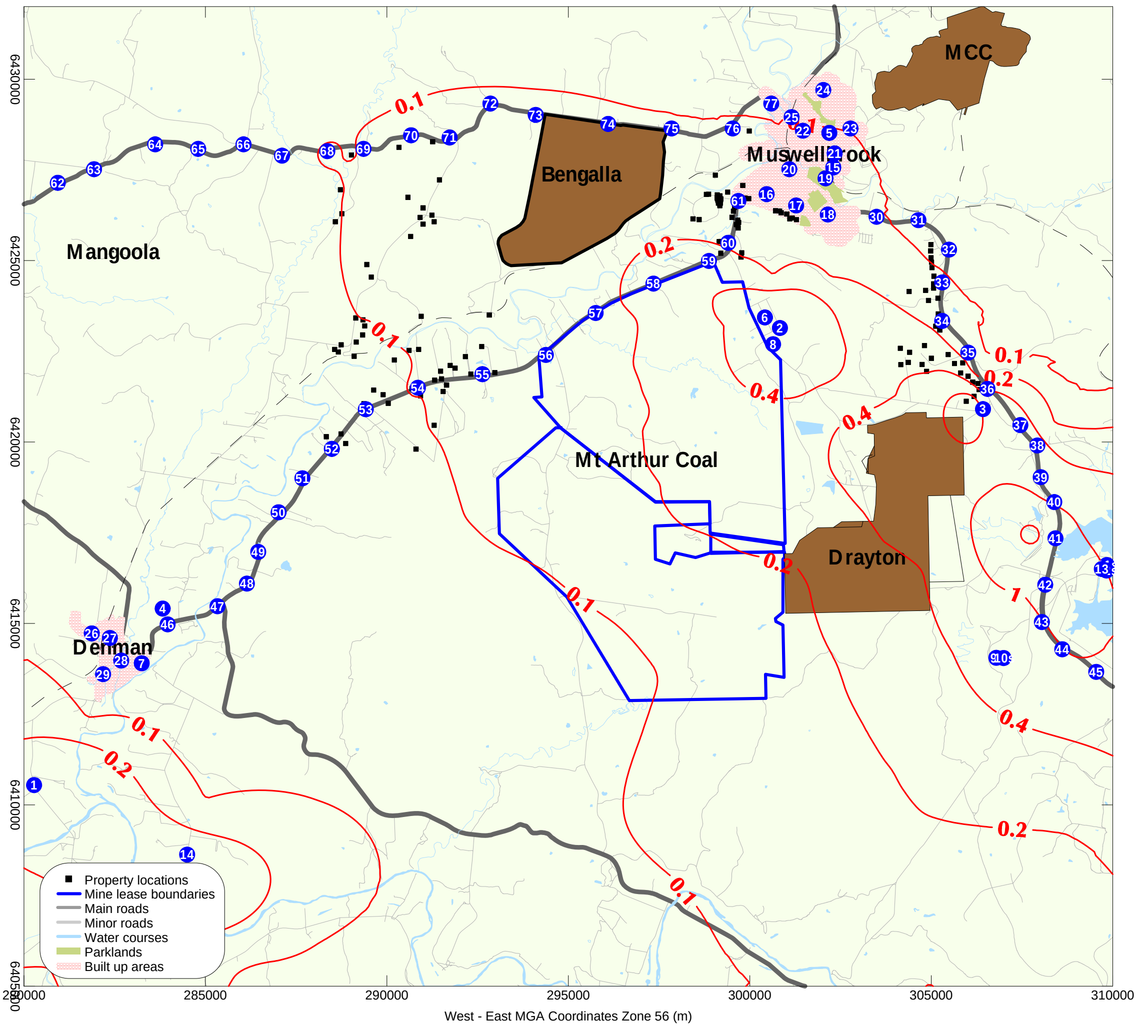

Figure G.5: Predicted annual average PM_{10} concentrations due sources other than mines