WILPINJONG COAL PROJECT

APPENDIX E

Air Quality Impact Assessment

AIR QUALITY IMPACT ASSESSMENT: WILPINJONG COAL PROJECT

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Prepared for
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1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for Wilpinjong Coal Pty Ltd (WCPL). It provides an assessment of the air quality impacts of the Wilpinjong Coal Project (the Project). The Project involves the development an open-cut coal mine 40 km to the north-east of Mudgee in central New South Wales (NSW). The purpose of this report is to quantitatively assess the air quality impacts of the Project.

The Project area and nearby receptors are shown on **Figure 1**.

The assessment is based on the use of a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the mine.

To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality goals.

The assessment is based on a conventional approach following the procedures outlined in the NSW Department of Environment and Conservation's (DEC, formerly Environment Protection Authority) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (**NSW EPA, 2001**).

In summary, the report provides information on the following:

- the way in which mining is to be undertaken with a focus on describing those aspects that will assist in understanding how the mine will affect air quality;
- air quality goals that need to be met to protect the air quality environment;
- meteorological and climatic conditions in the area;
- a discussion as to the likely existing air quality conditions in the area;
- the methods used to estimate dust emissions and the way in which dust emissions from the proposal would disperse and fallout;
- the expected dispersion and dust fallout patterns due to emissions from the mine and a comparison between the predicted dust concentration and fallout levels and the relevant air quality criteria;
- control methods which can be used to reduce dust impacts;
- the emissions of greenhouse gases from the Project;
- the emissions of odour from the Project;
- the likely impacts of construction; and
- potential cumulative impacts.

2. LOCAL SETTING AND PROJECT DESCRIPTION

The Project is located 40 km to the northeast of Mudgee and approximately 11 km to the south-east of Ulan in central NSW. **Figure 1** shows the Project location including the mining lease application (MLA 1) boundary, mine facilities and nearest receptors.

Figure 2 shows the topography of the area. It can be seen from **Figure 2** that the Project is located within a valley running generally west to east. A ridge of high ground, running north-south crosses the valley at the eastern edge of the eastern most proposed open cut (Pit 3). Landforms are characterised by the narrow flood plains associated with the tributaries of the Goulburn River, the undulating foothills, ridges and escarpments of the Great Dividing Range and the dissected landforms of the Goulburn River National Park.

Local elevations range from approximately 350 m Australian Height Datum (AHD) on Wilpinjong Creek just to the east of the confluence with Cumbo Creek, to approximately 745 m AHD at a series of peaks to the south of the Project along the Great Dividing Range. Elevations in the Goulburn River National Park to the north of the Project are generally less than 600 m AHD.

Within the Project area, elevations generally range from approximately 350 m to 440 m AHD, while the escarpment areas and narrow ridges adjoining the Munghorn Gap Nature Reserve rise to above 510 m AHD in places.

Land use in the vicinity of the Project consists of a combination of coal mining operations (Ulan Coal Mines), agricultural land uses (primarily grazing), national park/nature reserve (Goulburn River National Park and Munghorn Gap Nature Reserve) and the rural residential developments of Wollar and Ulan.

The Wilpinjong resource is contained within the Ulan coal seam. The Project will include:

- development and operation of an open cut mine within the MLA 1 area to produce coal for domestic electricity generation and export markets;
- selective highwall mining of the Ulan Seam within the MLA 1 area;
- a Coal Handling and Preparation Plant (CHPP) and mine facilities area;
- water management infrastructure including the relocation of Cumbo Creek;
- water supply bores and associated pump and pipeline system;
- placement of mine waste rock (i.e. overburden, interburden/partings and coarse rejects) predominantly within mined-out voids;
- placement of tailings within a combination of out-of-pit and in-pit tailings storages;

- development and rehabilitation of final mine landforms and establishment of woodland vegetation in areas adjacent to the Project;
- a mine access road, temporary construction camp access road, internal access roads and haul roads;
- closure of Wilpinjong Road and Bungulla Road;
- realignment of two sections of Ulan-Wollar Road (including the relocation of two road-rail crossings);
- relocation of the existing 11 kilovolt electricity transmission line;
- an on-site temporary construction camp to accommodate up to 100 people during the construction phase;
- a rail spur and rail loop;
- coal handling and train loading infrastructure;
- transportation of product coal to market via train; and
- Enhancement and Conservation Areas.

A 21 year mine plan has been developed with a maximum mining rate of up to 13 Mtpa of ROM coal. It is estimated that the operations would require excavation of 330 million bank cubic metres (Mbcm) of waste rock. As mining progress the waste rock will be deposited in the mined out voids.

Six pits have been have been marked out within MLA 1 (refer **Figure 1**) and at any one time there would be mining in up to three of these pits. Mining will commence in Pit 1 and generally progress towards Pits 2, 4 and 3. Pits 5 and 6 will be mined in the later years of the 21 year mine schedule.

Figure 3 shows the mine plan for the years chosen for the air quality assessment. These figures include the active mining areas, the active mine waste rock emplacement areas and proposed haul routes. Also shown on these figures are the location of dust sources used for the dispersion modelling. These are discussed later in this report (see **Section 6**).

The 21 year proposed mine schedule is presented below in **Table 1**.

Table 1 : Wilpinjong Coal Project Proposed Mine Schedule

Year	Open cut waste rock (Mbcm)	Open cut ROM coal (Mtpa)	CHPP rejects (Mtpa)	Product coal (Mtpa)
1	1	1.5	0.4	1.1
2	5.5	9.5	2.7	6.8
3	7.7	13	3.4	9.6
4	11	13	3.4	9.6
5	11.2	13	3.4	9.6
6	9.3	13	3.5	9.5
7	13.8	13	3.3	9.7
8	12.9	13	3.3	9.7
9	19.5	13	3.6	9.4
10	14.3	13	3.6	9.4
11	19.1	13	3.5	9.5
12	18.5	13	4	9
13	17.1	13	4	9
14	15.6	13	4.1	8.9
15	19.2	13	3.7	9.3
16	22.7	13	3.6	9.4
17	26.5	13	3.7	9.3
18	23.8	13	4	9
19	25	13	4.2	8.8
20	26.4	13	4	9
21*	9.8	5.6	1.8	3.8
Total	**329.9**	**250.6**	**71.2**	**179.4**

The highlighted years indicate the years selected for the assessment

* *To conservatively assess impacts during Year 21, the material quantities presented in Table 1 for Year 20 were used in dispersion modeling instead of Year 21 material quantities.*

The mining method is described below:

- Vegetation clearing and topsoil/subsoil stripping. Stripped topsoil and subsoil would be used directly in progressive rehabilitation or placed in temporary stockpiles.
- Drilling and blasting of overburden, with some waste rock “throw blast” into the adjacent mined-out strip.
- Dozer pushing of blasted overburden into the adjacent mined-out strip to expose the upper ply of the Ulan Seam. Exposed coal would then be selectively mined and hauled by trucks to the ROM coal stockpiles.

- Interburden/parting material would then be ripped, pushed or excavated and hauled to expose the underlying working sections of the Ulan Seam.
- Progressive rehabilitation of the mine waste rock emplacements.

The mining would commence at one end of a strip and continue to the end of the strip before starting on a new strip. Re-profiled waste rock emplacements would be progressively rehabilitated.

Table 2 shows the active pits for each year of assessment. Also included in this table is the estimated allocation of ROM coal and waste rock movements.

Table 2 : Mining Activity Distribution for Selected Project Years

Project Year	Active Pits	Allocation of ROM coal and waste rock movements (% of total for that Year)
Year 3	Pit 1	67
	Pit 2	33
Year 9	Pit 2	33
	Pit 3	25
	Pit 4	42
Year 13	Pit 3	16
	Pit 4	16
	Pit 5	68
Year 14	Pit 5	42
	Pit 6	58
Year 21	Pit 5 (south)	50
	Pit 5 (west)	25
	Pit 6	25

In all stages of the Project, mining is proposed for 24 hours per day, seven days per week. Construction activities would be carried out during the day, up to seven days per week.

3. AIR QUALITY ASSESSMENT CRITERIA

Table 3 and **Table 4** summarise the air quality assessment criteria that are relevant to this study. The air quality criteria or goals relate to the total dust burden in the air and not just the dust from the Project. In other words, some consideration of background levels needs to be made when using these goals to assess impacts. This will be discussed in **Section 7.2**.

Table 3 : Air Quality Assessment Criteria for Particulate Matter Concentrations

Pollutant	Standard/Goal	Averaging Period	Agency
Total suspended particulate matter (TSP)	90 µg/m³	Annual mean	NHMRC
Particulate matter < 10 µm (PM_{10})	50 µg/m³ #	24-hour maximum	DEC
	30 µg/m³	Annual mean	DEC long-term reporting goal
	50 µg/m³	(24-hour average, 5 exceedances permitted per year)	NEPM

 # Non cumulative for purposes of impact assessment (refer Section 7.2)

Epidemiological studies (**Dockery *et al.*, 1993** for example) indicate that it is the finer particles, that is those below 2.5 µm in equivalent aerodynamic diameter[1] and referred to as $PM_{2.5}$, that cause health impacts as they can be taken deeper into the lung. As yet, Australia has no ambient goal for $PM_{2.5}$ applied on a project basis.

The National Environmental Protection Council (NEPC) has developed an advisory National Environmental Protection Measure (NEPM) for $PM_{2.5}$. The numerical values for the NEPM are:

- An annual average $PM_{2.5}$ concentration of 8 µg/m³; and
- A maximum 24-hour average $PM_{2.5}$ concentration of 25 µg/m³.

At this stage, the advisory $PM_{2.5}$ standard is not part of the NSW DEC assessment criteria. Predictions as to the likely contribution that emissions from the Project will make to ambient $PM_{2.5}$ concentrations have been undertaken, however, these predictions have not been used to assess impacts against the proposed advisory standard. Predictions of $PM_{2.5}$ concentrations are provided in **Appendix A**.

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 4** shows the maximum acceptable increase in dust deposition over the existing dust levels. These criteria for dust fallout levels are set to protect against nuisance impacts (**NSW EPA, 2001**).

1 A particle is said to have an equivalent aerodynamic diameter of 2.5 µm if it behaves in the same way as a sphere of density 1 g/cm³ and diameter 2.5 µm regardless of its shape and physical size.

Table 4 : NSW DEC Criteria for Dust Fallout

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

The sulfur content of Australian diesel is too low and mining equipment is too widely dispersed over mine sites to cause sulfur dioxide goals to be exceeded even in mines that use large quantities of diesel. For this reason no detailed study of SO_2 emissions from the mine has been undertaken. For the same reason, NO_x and CO emissions have not undergone a detailed modelling assessment.

Thus the main focus of the study is on the potential effects of particulate matter (PM) emissions. Particulate matter has the capacity to affect human health and to cause nuisance effects. The potential harmful effects of particulate matter depend on both the particulate matter size and/or on the chemical composition.

The human respiratory system has in-built defensive systems that prevent particles larger than approximately 10 µm from reaching the more sensitive parts of the respiratory system. Particles with an equivalent aerodynamic diameter less than 10 µm are referred to as PM_{10}. Particles larger than 10 µm, while generally not associated with health effects, can deposit on materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air. This is referred to as Total Suspended Particulate matter (TSP). In practice particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 µm. TSP includes PM_{10}.

4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[2] and mixing height[3].

A meteorological station was installed on the Project site in May 2004. The location of the meteorological monitoring station and other monitoring sites are shown in **Figure 4**. Data collected from the meteorological station include 10-minute records of temperature, wind speed, wind direction and sigma-theta. The data have been processed into a form suitable for use in the ISCST3 dispersion model. At the time of writing, one full year of data had not been collected with the meteorological data file containing 6,456 hours of data (74% of one year). Data are continuing to be collected from this site.

Meteorological data has also been generated for the Project by CSIRO's model (The Air Pollution Model, TAPM). TAPM is a prognostic model which has the ability to generate meteorological data for any location in Australia (from 1997 onwards) based on synoptic information determined from the six hourly Limited Area Prediction System (LAPS) (**Puri *et al.,* 1997**). The model is discussed further in the accompanying user manual (see **Hurley, 2002**).

The on-site data and TAPM generated data have been prepared into meteorological data files suitable for use in dispersion modelling. Windroses generated from these two datasets are presented in **Figures 5** and **6**. It can be seen from **Figure 5** that the winds measured at the site are well defined and are predominantly from either the east or west. In summer the most common winds are from the east while in winter this pattern is reversed, with westerly winds dominant. Spring exhibits an almost equal distribution of easterly and westerly winds.

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

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

Figure 6 shows the wind patterns determined for the site from TAPM. There are some clear similarities between these data and the on-site data however the wind speeds from TAPM are higher than those measured on-site. The average wind speed from TAPM was 4 m/s while the on-site weather station measured an average wind speed of 2.5 m/s. The annual percentage of calm conditions (that is, winds less than or equal to 0.5 m/s) was much higher for the on-site data than for the TAPM data (9.6% compared with 0.4%).

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. For the on-site data, a stability class was assigned to each hour of the meteorological data using sigma-theta according to the method recommended by the US EPA (**US EPA, 1986**). Stability class for each hour of the data from TAPM was determined within the model from estimates of temperature profiles and other meteorological parameters. **Table 5** shows the frequency of occurrence of the stability categories expected in the area from the two datasets.

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

Table 5 : Frequency of Occurrence of Stability Classes in the Study Area

Stability Class	On-site data (1-Jun-04 to 28-Feb-05) (%)	Wilpinjong by TAPM (%)
A	12.9	3.3
B	5.6	9.8
C	12.6	14.6
D	34.8	38.4
E	8.4	15.9
F	25.7	18.0
Total	100	100

For months of the year where no on-site data are available, these data have been supplemented with data from TAPM. That is, the data generated by TAPM for months from March to May have been added to the on-site data for use in the dispersion modelling. Joint wind speed, wind direction and stability class frequency tables for the on-site and TAPM generated data can be provided in electronic form on request.

4.2 Local Climatic Conditions

The Bureau of Meteorology also collects climatic information in the vicinity of the study area. A range of climatic information collected from Gulgong Post Office (located approximately 30 km from the Project) are presented in **Table 6** (**Bureau of Meteorology, 2005**). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures experienced at Gulgong are 22.8°C and 9.4°C respectively. On average January is the hottest month with an average maximum temperature of 30.8°C. July is the coldest month, with average minimum temperature of 2.5°C.

The annual average relative humidity reading collected at 9 am from the Gulgong site is 72% and at 3 pm the annual average is 45%. The month with the highest relative humidity on average is June with a 9 am average of 84%. The month with the lowest relative humidity is December with a 3 pm average of 36%.

Rainfall data collected at Gulgong shows that January is the wettest month with an average rainfall of 71.2 mm over 6 days. The average annual rainfall is 648.6 mm with an average of 73 raindays.

Table 6 : Climate Information for the Study Area

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean 9 am dry-bulb temperature (deg C)	21.5	20.6	19.1	15.8	11.4	7.6	6.6	8.5	12.5	16.3	18.1	20.8	14.9
Mean 9 am wet-bulb temperature (deg C)	17.2	17.2	15.6	12.9	9.8	6.4	5.4	6.8	9.7	12.4	14.2	16.2	11.9
Mean 9 am humidity (%)	65	70	69	71	80	84	83	77	70	63	63	61	72
Mean 3 pm dry-bulb temperature (deg C)	29.1	28.3	26.1	22	17.7	14.2	13.6	15.3	18.4	21.8	24.7	28	21.7
Mean 3 pm wet-bulb temperature (deg C)	19.4	19.6	17.8	15	12.6	10.1	9.2	10.1	12.1	14.2	16.3	18.1	14.6
Mean 3 pm relative humidity (%)	38	42	43	46	52	57	53	48	46	42	39	36	45
Mean daily maximum temperature (deg C)	30.8	29.8	27.3	23.3	18.9	15.4	14.6	16.3	19.3	23.2	26.3	29.7	22.8
Mean daily minimum temperature (deg C)	16.5	16.3	13.6	9.8	6.5	3.4	2.5	3.4	6.1	9.1	11.9	14.9	9.4
Mean rainfall (mm)	71.2	60.7	54.8	45.2	45.9	50	48.5	47.2	46.3	57	57.9	63.9	648.6
Median rainfall (mm)	63.7	43.2	37.8	33.4	35.8	43.8	43.4	42.6	39.1	49.7	51	51.2	635
Mean number of rain days	5.9	5.1	5	4.5	5.6	7.1	7.3	6.8	6.6	6.6	6.1	6	72.5

Climate averages for Station: 062013; Commenced: 1881, Last record: 2004; Latitude (deg S): -32.3634; Longitude (deg E): 149.5329. Source : ***Bureau of Meteorology (2005)***

4.3 Existing Air Quality

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

A monitoring program has been established in the area as part of the Project which includes the measurement of dust deposition and dust concentration (as PM_{10}). **Figure 4** shows the location of the monitoring sites. Monitoring commenced in June 2004.

4.3.1 Dust Deposition

Dust deposition is monitored using dust deposition gauges at six locations in the area (refer to **Figure 4** for the locations). Dust deposition gauges use a simple device consisting of a funnel and bottle to estimate the rate at which dust settles onto the surface over periods approximating one month.

Data collected from the six gauges in the study area are summarised in **Table 7**. Eight months of data are available for this study. These measurements include all background sources relevant to the location.

Table 7 : Dust Deposition Data for the Wilpinjong Project

Sample Date	Insoluble solids ($g/m^2/month$)					
	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**
Jun-04	2.1	1.8	2.0	1.7	-	2.4
Jul-04	1.0	1.1	1.2	0.8	2.9	0.8
Aug-04	0.6	0.6	0.7	0.4	0.4	1.7
Sep-04	1.5	1.0	3.9	0.5	0.7	2.4
Oct-04	0.5	0.7	0.2	0.2	0.5	3.6
Nov-04	0.1	0.3	5.4	0.1	0.2	1.8
Dec-04	2.3	5.5	0.7	0.3	0.3	1.2
Jan-05	1.7	1.8	3.6	1.2	1.4	2.9
Feb-05	1.0	1.4	1.5	1.1	1.2	1.7
Mar-05	1.7	2.5	3.7	2.9	1.1	1.9
Average	**1.2**	**1.7**	**2.3**	**0.9**	**1.0**	**2.0**
Maximum	**2.3**	**5.5**	**5.4**	**2.9**	**2.9**	**3.6**
Minimum	**0.1**	**0.3**	**0.2**	**0.1**	**0.2**	**0.8**

The data in **Table 7** shows that none of the monitoring locations have reported an average level above the DEC 4 $g/m^2/month$ dust fallout criteria. The average of data from all sites was 1.5 $g/m^2/month$.

4.3.2 Dust Concentration

Long term measurements of PM_{10} concentrations commenced in the area in June 2004. The Project area is predominantly grassland although the surrounding hills are well vegetated. Sources of particulate matter in the area would include traffic on unsealed roads, local building and construction activities, animal grazing activities and to a lesser extent traffic from the other local roads.

Data collected from the high volume air sampler installed for the Project are shown below in **Table 8**. The highest 24-hour average PM_{10} concentration since monitoring began was 45.2 µg/m³ on 21 January 2005. This is below the 50 µg/m³ DEC goal. The average PM_{10} concentration for this period was 11.0 µg/m³.

Table 8 : Dust Concentration Data for the Wilpinjong Project

Date sampled	Measured PM_{10} concentration (µg/m³)
19-Jun-04	3.4
25-Jun-04	5.5
01-Jul-04	8.8
07-Jul-04	7.3
13-Jul-04	4.1
19-Jul-04	10.2
27-Jul-04	3.7
31-Jul-04	10.5
06-Aug-04	1.2
12-Aug-04	6.7
18-Aug-04	2.4
24-Aug-04	11.5
30-Aug-04	4.7
06-Sep-04	6.5
11-Sep-04	5.4
17-Sep-04	6
23-Sep-04	12.3
29-Sep-04	21.5
05-Oct-04	4.8
11-Oct-04	18.8
17-Oct-04	11.7
23-Oct-04	5.8
29-Oct-04	12
04-Nov-04	9.7
10-Nov-04	10.1
16-Nov-04	10.8
22-Nov-04	10.1
28-Nov-04	25.2
04-Dec-04	13.6
10-Dec-04	4
16-Dec-04	13.5
22-Dec-04	17.3
28-Dec-04	21.7
3-Jan-2005	18.7
9-Jan-2005	8.4
15-Jan-2005	28.3
21-Jan-2005	45.2
27-Jan-2005	4.3
2-Feb-2005	0.5
8-Feb-2005	12.2
15-Feb-2005	17.1
20-Feb-2005	5.9
Average	**11.0**

For the purposes of establishing the existing air quality, a value of 11 µg/m³ has been taken to be the annual average PM_{10} background level to apply over the entire study area. Monitoring data from areas in the Hunter Valley where co-located TSP and PM_{10} monitors have been operated for reasonably long periods of time indicate that long term average PM_{10} concentrations are approximately 40% of the corresponding long-term TSP concentration (NSW Minerals Council, 2000). Assuming that PM_{10} constitutes 40% of the TSP, an annual average background TSP level would be 28 µg/m³.

The measured dust deposition and suspended particulate levels in the Project area are considered typical of a rural area remote from industrial emission sources. Air quality in the area is largely determined by emissions from natural sources, road traffic and community and agricultural activities. From time to time particulate matter levels would be expected to be affected by smoke from bushfires and dust from regional dust storms.

From the monitoring data available it has been assumed that the following background concentrations apply at the nearest receptors:

- Annual average TSP of 28 µg/m³
- Annual average PM_{10} of 11 µg/m³
- Annual average dust deposition of 1.5 g/m²/month

In addition, the DEC guidelines require an assessment against 24-hour PM_{10} concentrations. This assessment adopts the approach that the predicted 24-hour average PM_{10} concentration from the development should be less than 50 µg/m³ at the nearest receptors.

5. ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at open-cut coal mines. Total dust emissions due to the mine have been estimated by analysing the activities taking place at the site during selected years of operation.

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

The assessment has considered five selected years during the proposed mining. These cover impacts arising for a range of product coal and overburden quantities. The selected years also cover mining activities in various locations of the Project area . The operational description for the project has been used to determine haul road distances and routes, stockpile and pit areas, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions for each year of assessment.

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

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

It was found from an initial analysis of dispersion modelling results that there may be adverse air quality impacts at several receptors in the area. In order to reduce the number of adversely affected receptors a higher level of dust control has been proposed for haul roads from pits to emplacement areas from Year 14. In Year 21 it was necessary to further intensify dust control measures and the model predictions assume that haul roads are chemically treated to achieve a higher level of dust control. These control measures are discussed further in **Section 7**. The emission estimates presented in **Table 9** reflect these proposed control measures.

Table 9 : Estimated Dust Emissions Due to the Proposed Mining Operations

Activity	*TSP emission rate (kg/year)*				
	Year 3	*Year 9*	*Year 13*	*Year 14*	*Year 21*
OB - Stripping in first pit	2555	4258	5962	5962	9368
OB - Stripping in second pit	2555	4258	5962	5962	9368
OB - Stripping in third pit	0	4258	5962	0	9368
OB - Drilling in first pit	11306	5568	11474	9787	4219
OB - Drilling in second pit	5568	7087	2700	7087	4219
OB - Drilling in third pit	0	4219	2700	0	8437
OB - Blasting in first pit	38606	19015	39183	33420	14405
OB - Blasting in second pit	19015	24201	9219	24201	14405
OB - Blasting in third pit	0	14405	9219	0	28811
OB - Sh/Ex/FELs loading in first pit	20610	25707	46453	36146	26367
OB - Sh/Ex/FELs loading in second pit	10151	32719	10930	26175	26367
OB - Sh/Ex/FELs loading in third pit	0	19475	10930	0	52733
OB - Hauling to emplace from first pit	316419	394680	891480	332966	161920
OB - Hauling to emplace from second pit	155848	502320	167808	241114	242880
OB - Hauling to emplace from third pit	0	299000	167808	0	485760
OB - Emplacing at dumps in first pit	20610	25707	46453	36146	26367
OB - Emplacing at dumps in second pit	10151	32719	10930	26175	26367
OB - Emplacing at dumps in third pit	0	19475	10930	0	52733
OB - Dozers on O/B in first pit	383775	127925	383775	383775	127925
OB - Dozers on O/B in second pit	255850	383775	127925	255850	127925
OB - Dozers on O/B in third pit	0	127925	127925	0	383775
CL - Dozers ripping in first pit	305600	152800	152800	305600	152800
CL - Dozers ripping in second pit	152800	152800	152800	152800	152800
CL - Dozers ripping in third pit	0	152800	152800	0	152800
CL - Loading ROM to trucks in first pit	588389	289804	597171	509352	219548
CL - Loading ROM to trucks in second pit	289804	368841	140511	368841	219548
CL - Loading ROM to trucks in third pit	0	219548	140511	0	439096
CL - Hauling ROM coal to dump hopper from first pit	290333	102960	459680	502667	78000
CL - Hauling ROM coal to dump hopper from second pit	154440	189280	97067	291200	78000
CL - Hauling ROM coal to dump hopper from third pit	0	216667	130347	0	180267
CL - unloading ROM coal at pile/hopper all pits	130000	130000	130000	130000	130000
CL - ROM rehandle pile to hopper (FEL)	39000	39000	39000	39000	39000
CL - Handling coal at CHPP	24251	24251	24251	24251	24251
CL - FEL pushing ROM coal	305600	305600	305600	305600	305600
CL - Dozers pushing product coal	57180	57180	57180	57180	57180
CL - Loading product coal stockpile	1752	1715	1642	1624	1642
WE - OB dumps at first pit	79789	27535	117649	36609	34106
WE - OB dumps at second pit	102630	51315	28474	121091	143463
WE - OB dumps at third pit	0	30351	25345	0	143463
WE - first pit	38486	12516	37548	34419	25970
WE - second pit	27535	39738	33480	51941	26596
WE - third pit	0	62579	9700	0	45683
WE - ROM stockpiles	3520	3520	3520	3520	3520
WE - Product stockpiles	4756	4756	4756	4756	4756
Loading coal to trains	1752	1715	1642	1624	1642
Grading roads	36928	36928	36928	36928	36928
TOTAL ANNUAL DUST (kg)	**3887562**	**4752895**	**4976127**	**4403766**	**4540377**
Annual production (t)	**9600000**	**9400000**	**9000000**	**8900000**	**9000000**
Ratio of dust to production (kg/t)	**0.40**	**0.51**	**0.55**	**0.49**	**0.50**

Key:
First pit = Pit 1, 2, 5, 6 and 6 for Years 3, 9, 13, 14 and 21 respectively
Second pit = Pit 2, 4, 4, 5 and 5(west) for Years 3, 9, 13, 14 and 21 respectively
Third pit = Pit 3, 3, and 5(south) for Years 9, 13 and 21 respectively
OB: Operations on overburden, CL: Operations on coal, WE: Wind erosion

6. APPROACH TO ASSESSMENT

In August 2001 the DEC published new guidelines for the assessment of air pollution sources using dispersion models (**NSW EPA, 2001**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The approach taken in this assessment follows as closely as possible the approaches suggested by the guidelines.

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

The model used was the US EPA ISCST3 model. The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as $PM_{2.5}$, 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as the Rest). Mass emission rates in each of these size ranges have been determined using the factors derived from the **SPCC (1986)** study and TSP emission rates calculated using emission factors derived from **US EPA (1985)** and **NERDDC (1988)** work (see **Appendix B**).

The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 0.0468 of the TSP;
- $PM_{2.5-10}$ (CM) is 0.3440 of TSP; and
- PM_{10-30} (Rest) is 0.6090 of TSP.

Modelling was done using three ISC source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 µm. The predicted concentration in the three plot output files for each group were then combined according to the weightings 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 or quarry operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, the operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. **Figure 3** shows the location of the modelled sources for each year of assessment. 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) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted over an area 14.3 km (east to west) by 9.6 km (north to south). Local terrain for each year of mining was provided by Thiess Pty Ltd (Thiess) and has been included in the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. It has been assumed that each activity will occur for 24-hours per day as indicated in the operational description provided by Thiess. Dust emissions from wind erosion sources have been modelled for 24 hours per day in all modelling scenarios. Model predictions have been made at 415 discrete receptors located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearby receptors.

The ISCST3 model input files will be provided in electronic form on request.

The model ISCST3 was used in this instance as it has been the most widely used model in NSW for assessing the dust impacts of extractive industries. AUSPLUME is the DEC's model of first choice but it has had limited use in dust modelling applications.

Dust impacts and model predictions using ISCST3 are presented as contour plots in **Figures 7** to **11**.

Comparisons between ISCST3 and AUSPLUME (see **Holmes Air Sciences, 2003** for example) have also suggested that a correction factor is appropriate for short term ISCST3 predictions. Although the comparison between AUSPLUME and ISCST3 shows varying differences AUSPLUME has consistently predicted almost 50% lower than uncorrected ISCST3 predictions. Thus AUSPLUME may have some advantages over ISCST3 in that it more accurately predicts 24-hour average concentrations of PM_{10}, which are known to be consistently overestimated by ISCST3. However, AUSPLUME was not able to accept the large number of sources that have been used to represent the Project.

A calibration study was undertaken as part of the EIS for the Warkworth mine in the Hunter Valley (**Holmes Air Sciences, 2002**). The calibration was done by comparing the predicted maximum 24-hour average PM_{10} concentrations in the period 1 November 2000 to 31 October 2001 at the several mine operated monitors. The maximum measured PM_{10} concentration and TSP concentrations at four sites over the same period were then determined by inspection of the monitoring data records. The TSP concentrations have been converted to equivalent PM_{10} concentrations assuming that PM_{10} constitutes 40% of the TSP in this area. The results are shown below in **Table 10**.

Table 10 : Comparison of Measured and Predicted Maximum 24-hour PM_{10} Concentrations

Monitoring site	Maximum predicted 24-hour PM_{10}	Maximum measured or inferred 24-hour PM_{10}	Ratio of predicted to measured concentration
HV1	100	170 x 0.4 = 68	1.5
HV2	140	140 x 0.4 = 56	2.5
Bulga PM_{10}	160	44 (direct measurement)	3.6
Bulga TSP	160	102 x 0.4 = 41	3.9
Lot 543	95	138 x 0.4 = 55	1.7
Average			2.6

** Note, PM_{10} concentrations are only measured at the Bulga monitoring site, the other sites measure TSP only*

The average extent of over prediction was a factor of 2.6; that is unadjusted model predictions appear to over predict 24-hour PM_{10} concentrations by 260%. This factor was used to adjust the model predictions for the Warkworth EIS downwards to obtain a calibrated prediction of the worst-case 24-hour PM_{10} concentrations for all scenarios that were assessed. This same factor has been used for the 24-hour PM_{10} predictions in the current assessment. This matter is discussed in further detail in **Section 7.4**.

The 2.6 calibration factor was discussed in the Commission of Inquiry for the Mt Owen Open Cut Coal Mine in the Hunter Valley. The Commissioner's report concluded that it would be inconsistent with the evidence not to apply a calibration factor but recommended that a verification of the magnitude of the calibration factor be undertaken within 18 months (Cleland, 2004). The Mt Owen Open Cut Coal Mine development consent, Condition 28 of Schedule 4 of DA 14-1-2004 (approved on 8th December 2004), requires that *"within 18 months of this consent, the Applicant shall validate the calibration factor applied to the 24-hour average PM_{10} predictions in the EIS, and if necessary, revise the 24-hour average PM_{10} predictions for the development, in consultation with DEC, and to the satisfaction of the Director-General"*. To date, data from this study are not available, however, it is envisaged that a similar verification process would be undertaken for the Wilpinjong Coal Project or the results of the Mt Owen Open Cut Coal Mine verification process will be used to validate the calibration factor in this case.

7. ASSESSMENT OF IMPACTS

7.1 Introduction

This section provides an interpretation of the predicted dust concentrations and deposition levels.

Dust concentrations and deposition rates due to the selected years of assessment have been presented as isopleth diagrams showing the following:

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

The maximum 24-hour average contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that occurred at each location. The maxima are used to show concentrations which can possibly be reached under the modelled conditions. It should be noted that the contour plots show predicted concentrations and deposition levels due only to modelled dust sources for the mine. That is, the predictions do not include contributions from existing non mine sources.

Model predictions for each year of assessment have also been presented in tabular form for the nearest receptors that are not on Project related land (**Table 11**). **Figure 1** shows the identification label given to each receptor. Predicted concentrations and deposition levels above the relevant air quality criteria have been highlighted. Interpretation and analysis of the model predictions for each year of assessment is provided below.

7.2 Assessment Criteria

The air quality criteria used for deciding which properties are likely to experience air quality impacts are those specified in the DEC's modelling guidelines (refer to **Table 3** and **Table 4**). Recent conditions of consent for mines in the Hunter Valley have assisted with the interpretation of these air quality criteria.

The air quality criteria are:

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

7.3 Physical and Chemical Properties of the Material Handled

The materials to be handled are coal and overburden. The overburden comprises claystone, carbonaceous/claystone and siltstone. These are common materials found in overburden and interburden on NSW coalmines. The air quality standards referred to above used in this report as the basis for assessment would be appropriate for assessing the impacts of the TSP and PM_{10} fractions of the dust.

7.4 Assessment of Impacts

Dispersion model predictions for the proposed Year 3, 9, 13, 14 and 21 mining operations are shown in **Figures 7** to **11** respectively. It can be seen from these figures that the highest concentrations and deposition levels are centered around the activities taking place during that year.

To further assist in assessing the air quality impacts at places of special interest the dispersion model results have been presented in tabular form showing the predictions at each of the nearest receptors. **Table 11** shows this information. The predictions can be compared with the relevant air quality criteria to determine the most affected receptors.

The modeling assessment has been undertaken in several stages. The first stage assumes that normal controls, as would be applied routinely on coal mines in NSW, are applied. If the assessment identifies that a property or properties might be impacted by dust levels above the assessment criteria then the feasibility of further mitigation has been explored.

Further mitigation was in the form of achieving a higher level of control over the dust emissions from haul roads. Normal practice, as implemented in the Hunter Valley is estimated to achieve 75% control of dust emissions from haul roads. According to (**Kinsey and Cowherd, 1992**) this requires a moisture content of 3.5% in the haul road surface. The control can be increased to 80% by applying water at a rate that will maintain the surface moisture at 4%.

This is relevant for Years 14 and 21. In Year 14, by improving the controls on haul roads used to haul overburden from the pit to the emplacement area it was possible to reduce the predicted 24-hour average PM_{10} concentrations at receptor 32C from 52.1 µg/m³, which is above the assessment criterion of 50 µg/m³, to 46.5 µg/m³, which is below the assessment criterion. The Year 14 predictions assume that overburden haul roads would be watered and/or chemical dust suppressants used to maintain the surface moisture level at 4% and all other roads at 3.5%.

In Year 21, normal controls resulted in the annual average predicted PM_{10} concentration at receptor 44 being 33.4 µg/m³, which is above the assessment criterion of 30 µg/m³. Controlling all haul roads to a level of 90% control by additional watering and the use of chemical dust suppressants allowed the predicted annual average PM_{10} level to be reduced to 27.7 µg/m³.

Table 11 : Predicted Concentrations at Nearest Receptors

Receptor ID#,	Location	Year 3	Year 9	Year 13	Year 14 Special controls (see text above)	Year 21 Special controls (see text above)
Predicted maximum 24-hour average PM_{10} concentrations (µg/m³), Goal = 50 µg/m³						
54	766993, 6414339	6.4	19.5	9.2	8.1	13.4
3	767624, 6414780	8.0	23.3	10.5	8.1	17.7
29	769640, 6414422	9.3	27.3	9.0	7.7	15.3
6	769665, 6414771	10.7	41.4	10.6	8.4	14.7
4	771946, 6415997	20.2	30.0	22.8	23.3	26.5
49	772628, 6414436	11.4	14.4	12.0	16.0	15.3
60B	777370, 6414439	11.6	11.9	7.6	7.4	11.0
150A St Luke's Anglican Church	777644, 6415367	14.1	21.4	12.2	12.4	8.2
900 St Laurence O'Toole Catholic Church	777322, 6415742	16.3	25.7	14.4	14.2	10.0
901 Wollar Primary School	777539, 6416180	14.2	22.8	14.1	12.2	8.0
128	777913, 6418126	9.2	12.8	17.1	8.5	7.4
28A	777749, 6417918	10.7	15.1	18.4	9.7	7.3
28B	777798, 6417801	10.8	15.9	19.0	9.8	7.4
125	777788, 6418297	9.1	15.2	18.2	8.4	7.8
123A	777632, 6418797	13.4	21.7	17.6	8.4	7.5
123B	777639, 6418893	14.4	19.9	17.2	8.5	7.4
26	777426, 6419160	15.0	18.8	18.8	9.2	8.0
25	777263, 6418737	13.3	23.9	21.3	8.8	8.5
23A	776368, 6419288	21.4	36.9	27.6	11.6	14.0
23B	776843, 6418715	13.8	27.3	24.1	9.8	10.3
31A	776467, 6418378	14.5	31.4	27.0	11.9	11.0
31B	776715, 6418357	13.5	28.6	25.8	11.3	10.2
53	775868, 6418368	17.8	37.0	21.1	13.1	15.4
52A	775953, 6417825	18.4	37.7	21.7	15.1	10.8
52B	776049, 6417999	17.5	38.8	21.5	13.6	10.0
51	775652, 6417715	20.6	37.7	21.6	15.7	13.3
55	775645, 6418421	18.5	39.7	21.9	13.5	16.6
56	775885, 6418762	17.1	42.4	34.0	12.6	14.2

Receptor ID#,	Location	Year 3	Year 9	Year 13	Year 14 Special controls (see text above)	Year 21 Special controls (see text above)
45	775480, 6420806	20.0	37.6	38.3	12.0	7.2
WB	776524, 6420802	20.9	19.2	37.4	9.8	5.6
14	768693, 6421882	35.3	19.1	**108.0**	**237.7**	30.0
32C	766144, 6423788	13.8	12.1	19.8	36.5	16.6
44	765808, 6421028	22.4	12.5	32.7	40.7	38.8
20	764298, 6419757	21.5	10.3	20.4	19.5	26.9
43	765320, 6418044	19.2	19.9	16.9	11.3	29.1
WA	768057, 6420989	49.9	-	-	-	-
WC	768543, 6421676	36.5	-	-	-	-
Predicted annual average PM_{10} concentrations (µg/m^3), Goal = 30 µg/m^3 (Predictions with background are shown in parentheses)						
54	766993, 6414339	1.6 (12.6)	3.5 (14.5)	1.6 (12.6)	1.2 (12.2)	2 (13)
3	767624, 6414780	1.9 (12.9)	4.5 (15.5)	1.8 (12.8)	1.4 (12.4)	2.3 (13.3)
29	769640, 6414422	1.2 (12.2)	3.8 (14.8)	1.5 (12.5)	1 (12)	2.1 (13.1)
6	769665, 6414771	1.5 (12.5)	5 (16)	1.7 (12.7)	1.2 (12.2)	2.6 (13.6)
4	771946, 6415997	3.2 (14.2)	14.2 (25.2)	3.1 (14.1)	3 (14)	6.1 (17.1)
49	772628, 6414436	1.3 (12.3)	4.1 (15.1)	1.3 (12.3)	1.2 (12.2)	3.1 (14.1)
60B	777370, 6414439	2 (13)	3 (14)	1.9 (12.9)	1.6 (12.6)	1.8 (12.8)
150A St Luke's Anglican Church	777644, 6415367	2.3 (13.3)	4.3 (15.3)	2.4 (13.4)	1.9 (12.9)	1.7 (12.7)
900 St Laurence O'Toole Catholic Church	777322, 6415742	2.7 (13.7)	5.3 (16.3)	2.7 (13.7)	2.1 (13.1)	1.9 (12.9)
901 Wollar Primary School	777539, 6416180	2.8 (13.8)	5.5 (16.5)	3 (14)	2.2 (13.2)	2 (13)
128	777913, 6418126	2.9 (13.9)	5.3 (16.3)	4.2 (15.2)	2.2 (13.2)	1.9 (12.9)
28A	777749, 6417918	3.1 (14.1)	6.1 (17.1)	4.4 (15.4)	2.3 (13.3)	2.1 (13.1)
28B	777798, 6417801	3 (14)	6.1 (17.1)	4.4 (15.4)	2.3 (13.3)	2 (13)
125	777788, 6418297	3.1 (14.1)	6.1 (17.1)	4.5 (15.5)	2.4 (13.4)	2.2 (13.2)
123A	777632, 6418797	3.4 (14.4)	6.4 (17.4)	5 (16)	2.4 (13.4)	2.1 (13.1)
123B	777639, 6418893	3.4 (14.4)	6.2 (17.2)	5.1 (16.1)	2.4 (13.4)	2 (13)
26	777426, 6419160	3.8 (14.8)	6.9 (17.9)	5.8 (16.8)	2.6 (13.6)	2.2 (13.2)
25	777263, 6418737	3.7 (14.7)	7.6 (18.6)	5.6 (16.6)	2.7 (13.7)	2.4 (13.4)
23A	776368, 6419288	5.8 (16.8)	12.8 (23.8)	9.1 (20.1)	3.7 (14.7)	3.5 (14.5)
23B	776843, 6418715	4.3 (15.3)	9.3 (20.3)	6.5 (17.5)	3 (14)	2.8 (13.8)
31A	776467, 6418378	5 (16)	11.7 (22.7)	7.2 (18.2)	3.5 (14.5)	3.5 (14.5)
31B	776715, 6418357	4.6 (15.6)	10.6 (21.6)	6.7 (17.7)	3.3 (14.3)	3.3 (14.3)
53	775868, 6418368	6 (17)	15.6 (26.6)	7.7 (18.7)	4.1 (15.1)	4 (15)
52A	775953, 6417825	5.2 (16.2)	14.6 (25.6)	6 (17)	3.7 (14.7)	3.8 (14.8)
52B	776049, 6417999	5.2 (16.2)	14.3 (25.3)	6.5 (17.5)	3.8 (14.8)	3.8 (14.8)
51	775652, 6417715	5.5 (16.5)	16.8 (27.8)	6.1 (17.1)	4 (15)	3.9 (14.9)
55	775645, 6418421	6.3 (17.3)	17 (28)	8.1 (19.1)	4.2 (15.2)	4 (15)
56	775885, 6418762	5.9 (16.9)	15.1 (26.1)	9.3 (20.3)	3.9 (14.9)	3.7 (14.7)
45	775480, 6420806	5.8 (16.8)	9.9 (20.9)	15.3 (26.3)	4.1 (15.1)	2.7 (13.7)
WB	776524, 6420802	4.6 (15.6)	7.9 (18.9)	9.3 (20.3)	3.4 (14.4)	2.3 (13.3)
14	768693, 6421882	11 (22)	6.5 (17.5)	**40.3 (51.3)**	**160.7 (171.7)**	15.2 (26.2)
32C	766144, 6423788	4.1 (15.1)	3.4 (14.4)	7.1 (18.1)	10.5 (21.5)	5.8 (16.8)
44	765808, 6421028	6.8 (17.8)	4.9 (15.9)	10.9 (21.9)	14.3 (25.3)	16.7 (27.7)
20	764298, 6419757	4.8 (15.8)	4.3 (15.3)	5.8 (16.8)	5.7 (16.7)	10.3 (21.3)
43	765320, 6418044	4.4 (15.4)	5.6 (16.6)	5 (16)	4.6 (15.6)	15 (26)

Receptor ID#	Location	Year 3	Year 9	Year 13	Year 14 Special controls (see text above)	Year 21 Special controls (see text above)
WA	768057, 6420989	13.8 (24.8)	-	-	-	-
WC	768543, 6421676	12.3 (23.3)	-	-	-	-
Predicted annual average TSP concentrations (µg/m³), Goal = 90 µg/m³ (Predictions with background are shown in parentheses)						
54	766993, 6414339	1.7 (29.7)	3.6 (31.6)	1.7 (29.7)	1.2 (29.2)	2.1 (30.1)
3	767624, 6414780	2 (30)	4.8 (32.8)	1.9 (29.9)	1.5 (29.5)	2.5 (30.5)
29	769640, 6414422	1.3 (29.3)	4 (32)	1.6 (29.6)	1.1 (29.1)	2.2 (30.2)
6	769665, 6414771	1.5 (29.5)	5.2 (33.2)	1.8 (29.8)	1.3 (29.3)	2.8 (30.8)
4	771946, 6415997	3.4 (31.4)	15.9 (43.9)	3.3 (31.3)	3.2 (31.2)	6.5 (34.5)
49	772628, 6414436	1.3 (29.3)	4.4 (32.4)	1.4 (29.4)	1.3 (29.3)	3.3 (31.3)
60B	777370, 6414439	2.1 (30.1)	3.2 (31.2)	1.9 (29.9)	1.6 (29.6)	1.8 (29.8)
150A St Luke's Anglican Church	777644, 6415367	2.4 (30.4)	4.6 (32.6)	2.5 (30.5)	2 (30)	1.8 (29.8)
900 St Laurence O'Toole Catholic Church	777322, 6415742	2.8 (30.8)	5.6 (33.6)	2.8 (30.8)	2.2 (30.2)	2 (30)
901 Wollar Primary School	777539, 6416180	2.9 (30.9)	5.8 (33.8)	3.1 (31.1)	2.3 (30.3)	2.1 (30.1)
128	777913, 6418126	3.1 (31.1)	5.6 (33.6)	4.4 (32.4)	2.3 (30.3)	2 (30)
28A	777749, 6417918	3.3 (31.3)	6.5 (34.5)	4.7 (32.7)	2.4 (30.4)	2.2 (30.2)
28B	777798, 6417801	3.2 (31.2)	6.4 (34.4)	4.6 (32.6)	2.4 (30.4)	2.1 (30.1)
125	777788, 6418297	3.3 (31.3)	6.4 (34.4)	4.7 (32.7)	2.5 (30.5)	2.2 (30.2)
123A	777632, 6418797	3.5 (31.5)	6.7 (34.7)	5.3 (33.3)	2.5 (30.5)	2.2 (30.2)
123B	777639, 6418893	3.6 (31.6)	6.5 (34.5)	5.3 (33.3)	2.5 (30.5)	2.1 (30.1)
26	777426, 6419160	4 (32)	7.2 (35.2)	6.1 (34.1)	2.7 (30.7)	2.3 (30.3)
25	777263, 6418737	3.9 (31.9)	8 (36)	5.9 (33.9)	2.8 (30.8)	2.5 (30.5)
23A	776368, 6419288	6 (34)	13.2 (41.2)	9.7 (37.7)	3.9 (31.9)	3.6 (31.6)
23B	776843, 6418715	4.5 (32.5)	9.8 (37.8)	6.9 (34.9)	3.2 (31.2)	2.9 (30.9)
31A	776467, 6418378	5.2 (33.2)	12.3 (40.3)	7.6 (35.6)	3.7 (31.7)	3.6 (31.6)
31B	776715, 6418357	4.9 (32.9)	11.1 (39.1)	7.1 (35.1)	3.4 (31.4)	3.5 (31.5)
53	775868, 6418368	6.3 (34.3)	16.4 (44.4)	8.1 (36.1)	4.2 (32.2)	4.2 (32.2)
52A	775953, 6417825	5.4 (33.4)	15.4 (43.4)	6.3 (34.3)	3.9 (31.9)	3.9 (31.9)
52B	776049, 6417999	5.5 (33.5)	15.1 (43.1)	6.8 (34.8)	3.9 (31.9)	4 (32)
51	775652, 6417715	5.8 (33.8)	17.8 (45.8)	6.4 (34.4)	4.1 (32.1)	4.1 (32.1)
55	775645, 6418421	6.6 (34.6)	18 (46)	8.6 (36.6)	4.4 (32.4)	4.2 (32.2)
56	775885, 6418762	6.2 (34.2)	15.9 (43.9)	9.9 (37.9)	4.1 (32.1)	3.8 (31.8)
45	775480, 6420806	6.1 (34.1)	10.2 (38.2)	16.2 (44.2)	4.3 (32.3)	2.8 (30.8)
1B	776524, 6420802	4.8 (32.8)	8.1 (36.1)	9.7 (37.7)	3.5 (31.5)	2.4 (30.4)
14	768693, 6421882	11.3 (39.3)	6.7 (34.7)	42.2 (70.2)	**176.3 (204.3)**	15.7 (43.7)
32C	766144, 6423788	4.2 (32.2)	3.5 (31.5)	7.3 (35.3)	10.9 (38.9)	5.9 (33.9)
44	765808, 6421028	7 (35)	5.1 (33.1)	11.5 (39.5)	15.3 (43.3)	17.7 (45.7)
20	764298, 6419757	5 (33)	4.5 (32.5)	6.1 (34.1)	6 (34)	10.8 (38.8)
43	765320, 6418044	4.7 (32.7)	5.8 (33.8)	5.2 (33.2)	4.8 (32.8)	16.2 (44.2)
WA	768057, 6420989	14.4 (42.4)	-	-	-	-
WC	768543, 6421676	12.8 (40.8)	-	-	-	-
Predicted annual average dust deposition (g/m²/month), Goal = 4 g/m²/month (Predictions with background are shown in parentheses)						
54	766993, 6414339	0 (1.5)	0.1 (1.6)	0 (1.5)	0 (1.5)	0 (1.5)
3	767624, 6414780	0 (1.5)	0.1 (1.6)	0 (1.5)	0 (1.5)	0 (1.5)
29	769640, 6414422	0 (1.5)	0.1 (1.6)	0 (1.5)	0 (1.5)	0.1 (1.6)
6	769665, 6414771	0 (1.5)	0.1 (1.6)	0 (1.5)	0 (1.5)	0.1 (1.6)

Receptor ID#	Location	Year 3	Year 9	Year 13	Year 14 Special controls (see text above)	Year 21 Special controls (see text above)
4	771946, 6415997	0.1 (1.6)	1 (2.5)	0.1 (1.6)	0.1 (1.6)	0.3 (1.8)
49	772628, 6414436	0 (1.5)	0.1 (1.6)	0 (1.5)	0 (1.5)	0.1 (1.6)
60B	777370, 6414439	0.1 (1.6)	0.1 (1.6)	0 (1.5)	0 (1.5)	0.1 (1.6)
150A St Luke's Anglican Church	777644, 6415367	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)	0 (1.5)	0.1 (1.6)
900 St Laurence O'Toole Catholic Church	777322, 6415742	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)	0.1 (1.6)
901 Wollar Primary School	777539, 6416180	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)	0.1 (1.6)
128	777913, 6418126	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)	0.1 (1.6)
28A	777749, 6417918	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)	0.1 (1.6)
28B	777798, 6417801	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)	0.1 (1.6)
125	777788, 6418297	0.1 (1.6)	0.2 (1.7)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
123A	777632, 6418797	0.1 (1.6)	0.2 (1.7)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
123B	777639, 6418893	0.1 (1.6)	0.2 (1.7)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
26	777426, 6419160	0.1 (1.6)	0.2 (1.7)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
25	777263, 6418737	0.1 (1.6)	0.3 (1.8)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
23A	776368, 6419288	0.2 (1.7)	0.3 (1.8)	0.4 (1.9)	0.1 (1.6)	0.1 (1.6)
23B	776843, 6418715	0.2 (1.7)	0.3 (1.8)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
31A	776467, 6418378	0.2 (1.7)	0.4 (1.9)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
31B	776715, 6418357	0.2 (1.7)	0.4 (1.9)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
53	775868, 6418368	0.2 (1.7)	0.6 (2.1)	0.3 (1.8)	0.1 (1.6)	0.1 (1.6)
52A	775953, 6417825	0.2 (1.7)	0.6 (2.1)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
52B	776049, 6417999	0.2 (1.7)	0.5 (2)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
51	775652, 6417715	0.2 (1.7)	0.7 (2.2)	0.2 (1.7)	0.1 (1.6)	0.1 (1.6)
55	775645, 6418421	0.2 (1.7)	0.7 (2.2)	0.3 (1.8)	0.1 (1.6)	0.1 (1.6)
56	775885, 6418762	0.2 (1.7)	0.6 (2.1)	0.4 (1.9)	0.1 (1.6)	0.1 (1.6)
45	775480, 6420806	0.2 (1.7)	0.2 (1.7)	0.6 (2.1)	0.1 (1.6)	0.1 (1.6)
WB	776524, 6420802	0.1 (1.6)	0.2 (1.7)	0.3 (1.8)	0.1 (1.6)	0.1 (1.6)
14	768693, 6421882	0.2 (1.7)	0.1 (1.6)	1 (2.5)	**6.8 (8.3)**	0.3 (1.8)
32C	766144, 6423788	0.1 (1.6)	0.1 (1.6)	0.1 (1.6)	0.2 (1.7)	0.1 (1.6)
44	765808, 6421028	0.2 (1.7)	0.1 (1.6)	0.5 (2)	0.7 (2.2)	0.7 (2.2)
20	764298, 6419757	0.2 (1.7)	0.1 (1.6)	0.2 (1.7)	0.2 (1.7)	0.4 (1.9)
43	765320, 6418044	0.2 (1.7)	0.2 (1.7)	0.2 (1.7)	0.1 (1.6)	0.8 (2.3)
WA	768057, 6420989	0.4 (1.9)	-	-	-	-
WC	768543, 6421676	0.3 (1.8)	-	-	-	-

Receptors WA and WC are mine-owned dwellings that would not be tenanted after Year 3.

Receptors WD and WE (**Figure 1**) are owned by WCPL and will not be tenanted after Year 1 of the Project and therefore have not been assessed. WA and WC are also owned by WCPL and will not be tenanted beyond Year 3. For this reason predictions for WA and WC are not provided after Year 3.

Comparing the model predictions with air quality goals, the following conclusions can be made as to air quality at receptors:

- In Year 3: Predicted concentrations and deposition levels are predicted to be below the relevant air quality criteria for all receptors.
- In Year 9: Predicted concentrations and deposition levels are predicted to be below the relevant air quality criteria for all receptors.
- In Year 13: Predicted maximum 24-hour average PM_{10} concentrations and annual average PM_{10} are above the air quality criteria for receptor 14.
- In Year 14: Predicted maximum 24-hour average PM_{10} concentrations are above the air quality criteria for receptor 14. Predicted annual average PM_{10}, TSP and dust deposition levels are also above the air quality criteria for receptor 14.
- In Year 21: Predicted concentrations and deposition levels are predicted to be below the relevant air quality criteria for all receptors.

It was noted in **Section 6** that a calibration factor of 1/2.6 was applied to the predicted 24-hour concentrations of PM_{10}. During Year 3, receptor WA is predicted to experience a maximum 24-hour PM_{10} concentration of 49.9 $\mu g/m^3$, but this receptor is owned by WCPL and will not be tenanted beyond Year 3. Receptor 56 is not owned by the Project and is the location with the next highest predicted 24-hour PM_{10} concentration. The predicted concentration is 42.4 $\mu g/m^3$. This provides a margin of 7.6 $\mu g/m^3$ before the 50 $\mu g/m^3$ criterion would be reached.

7.5 Properties without Residences

In some development consents, property has been considered to be affected by a proposal if any of the DEC's assessment criteria are exceeded on more than 25% of the land regardless of whether a residence exists on the property. The contours presented in **Figures 7** to **11** have been reviewed against the land tenure information provided in **Appendix C**. The review showed that excluding land already owned by mining interests, there was one privately owned parcel of land without a residence, where one or more of the DEC's assessment criteria were predicted to be exceeded over 25% or more of the land.

In Year 21 approximately 50% of property 5 is predicted to experience maximum 24-hour average PM_{10} concentrations, due to emissions from the Project, greater than 50 $\mu g/m^3$. In addition, approximately 80% of property 5 is predicted to experience annual average PM_{10} concentrations, due to emissions from the Project plus background, greater than 30 $\mu g/m^3$.

8. CONSTRUCTION

A number of construction activities are proposed as part of the Project. These would include construction of the temporary construction camp, mine access road, CHPP, mine facilities area, coal handling and train loading infrastructure and the rail spur and loop. Construction work would be expected to be completed over a six month period.

These activities would not be expected to generate significant quantities of dust and dust emissions would be readily controlled using water sprays (ie. water trucks) and standard dust control measures used on construction sites.

The construction of the rail loop will involve the clearing of vegetation and the placement of track. Earthworks will take place along a narrow corridor of varying width ranging from 100 m to 25 m, within which the track will be laid. The construction work is expected to be completed over a 6 month period, however, construction of the Project spur and loop would only take a few months. Clearly dust emissions from works of this type have the capacity to cause nuisance impacts if not properly managed. In practice, it is not possible to realistically quantify impacts using dispersion modelling. To do so would require knowledge of weather conditions for the few weeks that work will be taking place in each location along the track.

Proper dust management will require the use of water carts, the defining of trafficked areas, the imposition of site vehicle speed limits and constraints on work under extreme unfavourable weather conditions.

9. CUMULATIVE IMPACTS

The Ulan Coal Mines are operated by Ulan Coal Mines Limited (UCML), approximately 11 km to the northwest of the Project area. The effect of existing emissions from the Ulan Coal Mines has been captured by the existing dust monitoring program operated for the Project. UCML has approval to produce up to 10 Mtpa of coal. The effect of emissions from Ulan Coal Mines operating at a production level of 10 Mtpa has been assessed by **Holmes Air Sciences (2005)**. The modelling results indicate that dispersion would have reduced the concentration of the annual average PM_{10} and TSP emission contribution from the Ulan Coal Mines to less than 1 $\mu g/m^3$ by the time these emissions have been carried to the receptors assessed for the Wilpinjong Coal Project. Similarly annual dust deposition contributions from the Ulan Coal Mines are predicted to have reduced to below 0.2 g/m^2/month at these receptors.

The predicted annual average PM_{10} and TSP concentrations at nearby receptors due to the Project plus background concentrations are shown in parentheses in **Table 11**. When 1 $\mu g/m^3$ is added to these predicted concentrations, the resultant predicted annual average PM_{10} and TSP concentrations are below the relevant criteria at all receptors with the exception of receptor 14 for annual average TSP concentrations in Year 14 and annual average PM_{10} in Years 13 and 14. These criteria are also exceeded for receptor 14 for the non-cumulative assessment **(Section 7.4)**.

Similarly, when 0.2 g/m^2/month is added to the predicted Project plus background rates for annual average dust deposition (shown in parentheses in **Table 11**), the resultant predicted annual average dust deposition rates are below the relevant criteria at all nearby receptors with the exception of receptor 14 in Year 14. This criterion is also exceeded for receptor 14 for the non-cumulative assessment **(Section 7.4)**.

Based on the above, the cumulative effects of emissions from the Ulan Coal Mines in the Project area are considered to be small. The cumulative assessment presented above is conservative in that the dust emissions from the existing Ulan Coal Mines operations would have been captured by the monitoring program undertaken for the Wilpinjong Coal Project to date and are already included in the background concentrations referred to above.

In addition, it is noted that a 2Mtpa underground mining operation comprising Underground Mine No. 4, a new CHPP, rail loop and train loading facility was approved in October 1985 as part of Stage 2 of the Ulan Coal Mines (hereafter referred to as Ulan Stage 2). The Underground Mine No. 4 and associated surface facilities that form part of Ulan Stage 2 were not developed at that time [**Kinhill, 1998**]. The EIS prepared for the Ulan Stage 2 development [**Kinhill Stearns Engineers, 1983**] concluded that a relatively small increase in the rate of dust deposition at nearby privately owned residences in Ulan would result from the Ulan Stage 2 development.

Dust deposition modelling results presented in the Ulan Stage 2 EIS indicate that dust deposition from the Ulan Stage 2 development would reduce to less than 0.05 g/m^2/month by the time it has traveled 2 km from the operation. This increment is significantly less than that predicted in **Holmes Air Science (2005)** for the Ulan Coal Mines operating at a production level of 10 Mtpa (see above). Based on this the increase in cumulative impacts (i.e. in addition to those discussed above for the Ulan Coal Mines) resulting from the Ulan Stage 2 development would be negligible.

10. ODOUR

Self-heating of coal occurs at different rates depending on the composition of the coal and how it is managed. Emissions of odours from coal mines can occur if self-heating of the coal is allowed to occur without proper control. Self-heating that gives rise to smoldering fires in stockpiles, or the coal seam, can lead to significant emissions of smoke and odour, but these are usually brought under control rapidly. However coal disposed of as waste in partings and with overburden can be difficult to control if allowed to begin to burn.

The propensity for spontaneous combustion at the Ulan Coal Mines was previously assessed (**Kinhill, 1998**). The testing indicated a moderate susceptibility to spontaneous combustion. This is considered an indication of the spontaneous combustion susceptibility at the Project.

Most modern mines are able to control emissions of odour through the implementation of simple control measures which involve careful mining[4] to ensure that combustible material disposed of with overburden is kept to a minimum and that any material that contains a significant fraction of combustible material is disposed of in structures that minimize the ingress of fresh air. Coal at Wilpinjong will need to be managed to control self-heating.

A Spontaneous Combustion Management Plan would be developed for the Project. The Spontaneous Combustion Management Plan would include the following:

- coal stockpile and emplacement management measures;
- commitments to monitor potential causes of spontaneous combustion events; and
- corrective action in the event of spontaneous combustion.

[4] In practice careful mining means using appropriately sized equipment for mining seams so that accidental incorporation of coal into overburden is minimized.

11. GREENHOUSE ISSUES

Coal mining results in the emissions of CO_2 during the combustion of diesel fuel (used in diesel-powered equipment and in blasting). In addition, emissions occur indirectly, from the use of electricity to power mining equipment and to operate the coal handling and preparation plant and conveyors. Mining can also result in fugitive emissions of methane (CH_4) and carbon dioxide (CO_2) trapped in the coal matrix and released as the coal is mined.

To estimate emissions from these sources, the electrical and fuel requirements for each year in the life of the mine have been estimated. This has been done using data supplied by **Thiess (2005)**. In summary, these data state that:

1. Consumption of electrical energy to operate the ROM coal handling equipment, the CHPP and train load-out when the mine is producing 13 Mtpa of ROM coal is 52,000 MWh/y, and

2. Consumption of diesel fuel for diesel powered equipment and explosives for production of 13 Mtpa of ROM coal is 13 ML.

The data indicate that the production of each tonne of ROM coal would require 4 kWh of electrical energy and 1 L of diesel. These figures have been used to calculate the quantity of electrical energy and diesel required by the mine per year. Note in Year 1 an allowance has been made for diesel used for construction activities as well as mining.

In converting the information to estimates of CO_2-e (CO_2 equivalent) emissions, it has been assumed that each kWh of electrical energy used results in the release of 0.968 kg of CO_2–e (**Australian Greenhouse Office, 2003** – figure for NSW generators) and that each litre of diesel fuel burnt (either in mobile plant or explosives[5]) results in the release of 2.7 kg of CO_2–e (**Australian Greenhouse Office, 2003**).

Tests have been undertaken to estimate the quantity of fugitive CH_4 and CO_2 likely to be released from the coal seams as they are mined. The test results were provided in a report by **GeoGAS Systems Pty Ltd (2005)**. Five samples from two boreholes were analysed. The quantity of gas liberated ranged from 0.41[6] m^3/t (from the WL-03 samples at a depth of approximately 32 m) to 0.60 m^3/t (from the WL-04 sample at a depth of approximately 16 m). The average value was 0.51 m^3/t.

[5] Note the Australian Greenhouse Office workbook does not include information on emissions from blasting and the assumption that the emissions would be similar to that for diesel-powered engines is based on the fact, that in both cases, the majority of the greenhouse gas emission arises from the combustion of carbon in the diesel.

[6] Measurements refer to 20 ^{o}C and 101.3 kPa

Three of the samples were useful in providing data on the percentage of CH_4, CO_2 and nitrogen in gas. The range in composition and average values were:

- Methane – 0 to 14% with average of 4.8%, and
- Carbon dioxide – 75% to 100% with average of 92%.

Based on these values, 0.024 m^3 (0.016 kg) of CH_4 and 0.469 m^3 (0.86 kg) of CO_2 would be released per tonne of ROM coal mined. Methane has a greenhouse warming potential of 21. (This means that each kilogram of methane, because of its lifetime in the atmosphere and it spectral absorption characteristics, is equivalent to 21 kg of CO_2). Thus, the effective emission is 1.2 kg of CO_2-e per tonne of ROM coal mined. Thus, in addition to emissions from electricity and diesel fuel use, it has been assumed that each tonne of ROM coal mined results in the release of 1.2 kg of CO_2-e as result of fugitive emissions of CH_4 and CO_2.

It is relevant to note that the Australian Greenhouse Gas Office workbook (**Australian Greenhouse Office, 2003** – see Table 6) estimates that open cut coal mines in NSW produce approximate 2.17 kg of CH_4 per tonne of ROM coal (or 45.6 kg of CO_2-e per tonne of ROM coal mined) as a fugitive emission from the coal seam as coal is uncovered and processed. This is significantly more than the 1.2 kg CO_2-e per tonne of ROM estimated for the Project. It should also be noted that the Australian Greenhouse Office workbook estimate is for CH_4 alone and does not include CO_2 emissions so the difference is larger than it appears to be. A likely explanation for this difference is that the Wilpinjong seams are significantly shallower than the average open cut mine in NSW and therefore have lost much of their gaseous components.

The estimated emissions of greenhouse gases due to mining for each year is shown in **Table 12**. The total lifetime emission is estimated to be 1,948,473[7] t CO_2-e, which is an average of 92,784 t CO_2-e per year over 21 years. (Note in Year 1 an allowance has been made for diesel used in construction as well as mining.)

The estimated emission of 92,784 t of CO_2-e (0.092 Mt of CO_2-e), the annual average greenhouse gas emissions over the life of the mine due to mining, can be compared with the following estimates for the 1990 provided by the **Australian Greenhouse Office (2002)**:

- current estimate of Australia's 1990 emissions – 532.1 Mt CO_2-e,
- current estimate of Australia's 1990 emissions for the energy sector – 286.2 Mt CO_2-e, and
- current estimate of Australia's 1990 emissions for the industrial processes sector – 26.1 Mt CO_2-e.

[7] Note the large number of significant figures in these estimates are retained here for the purpose of verifying calculations not to imply that the estimate has the precision of +/- 1 t.

It should be noted that mitigation of greenhouse gas emissions is inherent in the development of the mine plan. For example, reducing fuel usage by mobile plant is an objective of mine planning. Hence, significant savings of greenhouse gas emissions are attributable to appropriate mine planning. Additional management/minimisation of greenhouse gas emissions associated with the Project operation via:

- regular maintenance of plant and equipment to minimise fuel consumption and associated emissions;
- consideration of energy efficiency in plant and equipment selection/purchase; and
- establishment of significant areas of woodland vegetation over the Project life (refer Section 5 of Volume 1 of the EIS).

Table 12 : Summary of Estimated CO2-e Emissions

Year	ROM (Mtpa)	Electrical energy required by CHPP (kWh/y)	Diesel consumed (L/y)	CO_2 from consumption of electrical energy (t/y)	CO_2 from diesel use (t/y)	CO_2-e from release of CH4 and CO2 from mined coal (t/y)	Total CO_2-e emission (t/y)
1	1.5	6,000,000	1,800,000	5,808	4,860	1,800	12,468
2	9.5	38,000,000	9,500,000	36,784	25,650	11,400	73,834
3	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
4	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
5	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
6	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
7	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
8	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
9	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
10	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
11	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
12	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
13	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
14	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
15	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
16	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
17	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
18	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
19	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
20	13	52,000,000	13,000,000	50,336	35,100	15,600	101,036
21	5.6	22,400,000	5,600,000	21,683	15,120	6,720	43,523
Total	250.6	1,002,400,000	250,900,000	970,323	677,430	300,720	1,948,473

12. MONITORING AND MITIGATION MEASURES

The modelling results are based on the assumption that the Project applies dust control measures that are standard practice on NSW mines and that the additional measures required for Years 14 to 21 are also applied. This section outlines procedures proposed for the management and control of dust emissions.

The aim of the procedures is to minimise the emission of dust. Dust can be generated from two primary sources as follows:

- wind blown dust from exposed areas and from locations where there is no vegetation cover, and
- dust generated by mining activities.

Table 13 and **Table 14** list the different sources of wind blown and mining generated dust respectively, and their recommended control procedures.

A monitoring program would be undertaken to verify environmental performance. The monitoring program would be developed in consultation with the DEC but would be expected to incorporate the following:

- One meteorological station within the Project area.
- High volume PM_{10}; monitors at three locations. The monitor at the existing location in Wollar would be retained at or near its current location. In addition a high volume PM_{10} monitor would be installed close to receptor 45 and an additional monitor would be located to the west of the Project.
- Deposition gauges would be added to the existing locations to provide adequate coverage for the operational phase of mining.

Table 13 : Control Procedures for Wind Blown Dust

Source	Control Procedures
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 tipping.
Coal handling areas	Maintain coal-handling areas in a moist condition using water carts to minimise wind blown and traffic generated dust.
Coal Product Stockpiles	Maintain water sprays on product coal stockpiles and use sprays to reduce the risk of airborne dust.

Table 14 : Mine Generated Dust and Controls

Source	Control procedures
Haul Road Dust	All active roads and traffic areas will be watered using water carts to minimise the generation of dust. To further minimise dust generation in Years 14 to 21 chemical dust suppressants, increased utilisation of water carts and/or fixed irrigation will be used on select haul roads to maintain high moisture levels. Active haul roads will be minimised and clearly defined. Obsolete roads will be rehabilitated.
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 constructed so as to minimise dust generation (well compacted select material) and watered as required. Obsolete roads will be rehabilitated.
Topsoil Stripping	Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.
Topsoil Stockpiling	Establishment of a cover crop over topsoil stockpiles that are not to be used in less than 6 months. This would minimise the potential for dust emissions due to wind erosion.
Drilling	Dust aprons will be lowered during drilling. Drill rigs will be equipped with dust suppression equipment and it will be operated whenever the potential for high levels of dust generation is identified.
Blasting	Stemming will be designed to provide optimum confinement of the blast charge.
Raw Coal Bins	Automatic sprays or other dust control mechanisms will be used when tipping raw coal generates excessive dust quantities.
Coal Preparation Plant	Spillage of material will be cleaned up to prevent dust. Dust suppression systems will be fitted at transfer points to prevent high dust levels where necessary.

13. CONCLUSIONS

This report has assessed the air quality impacts associated with the operation of the proposed Wilpinjong Coal Project in central NSW. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities associated with the mine. The dispersion modelling took account of the local meteorology and terrain information and used dust emission estimates to predict the air quality impacts for five periods over the life of the mine. The periods were selected to cover a range of mine production quantities and active pit location combinations. The outcomes of the modeling are summarised below:

- In Year 3: Predicted concentrations and deposition levels are predicted to be below the relevant air quality criteria for all receptors.
- In Year 9: Predicted concentrations and deposition levels are predicted to be below the relevant air quality criteria for all receptors.
- In Year 13: Predicted maximum 24-hour average PM_{10} concentrations and annual average PM_{10} are above the air quality criteria for receptor 14.
- In Year 14: Predicted maximum 24-hour average PM_{10} and annual average PM_{10}, TSP and dust deposition concentrations are above the air quality criteria for receptor 14.
- In Year 21: Predicted concentrations and deposition levels are predicted to be below the relevant air quality criteria for all receptors.
- In Year 21: Predicted maximum 24 hour average PM_{10} and annual average PM_{10} are above the air quality criteria for one parcel of private vacant land (property 5).

The cumulative effects of dust emissions from the Ulan Coal Mines (including Ulan Stage 2) in the Project area are considered be small and do not change the conclusions presented above for the non-cumulative assessment.

The assessment has also examined the potential for odours to impact the community and concludes that proper management of waste coal would allow the mine to operate without causing odour impacts.

Finally, greenhouse gas emissions have been estimated. On average, over the life of the mine, it is estimated that mining will result in the release of approximately 93 kt of CO_2-e per year. The estimate includes emissions of fugitive CH_4, and CO_2 from the coal seam and emissions of greenhouse gases from the use of electrical and diesel energy required for the mining and processing of the coal and for construction.

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FIGURES

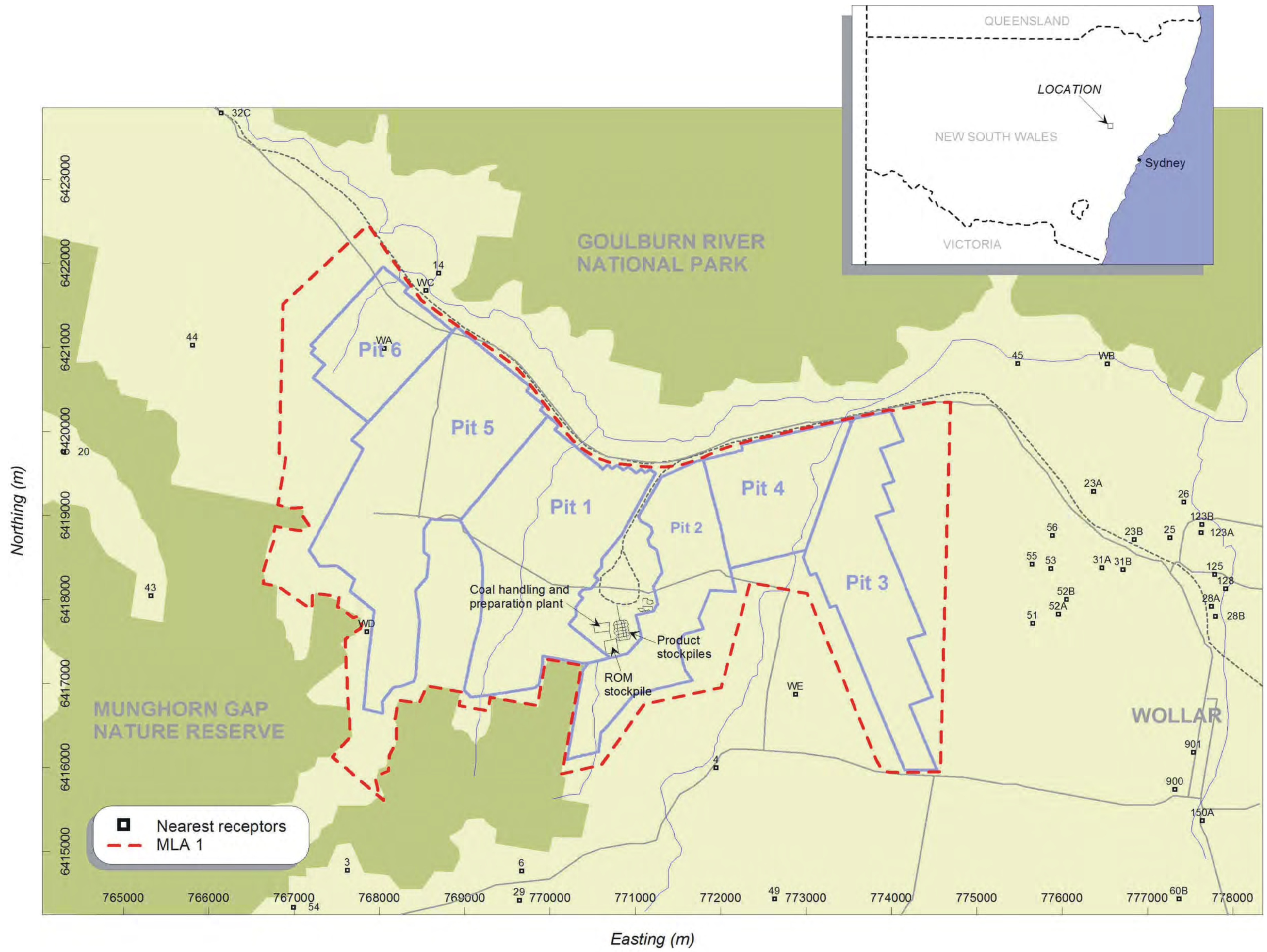


FIGURE 1

Location of study area

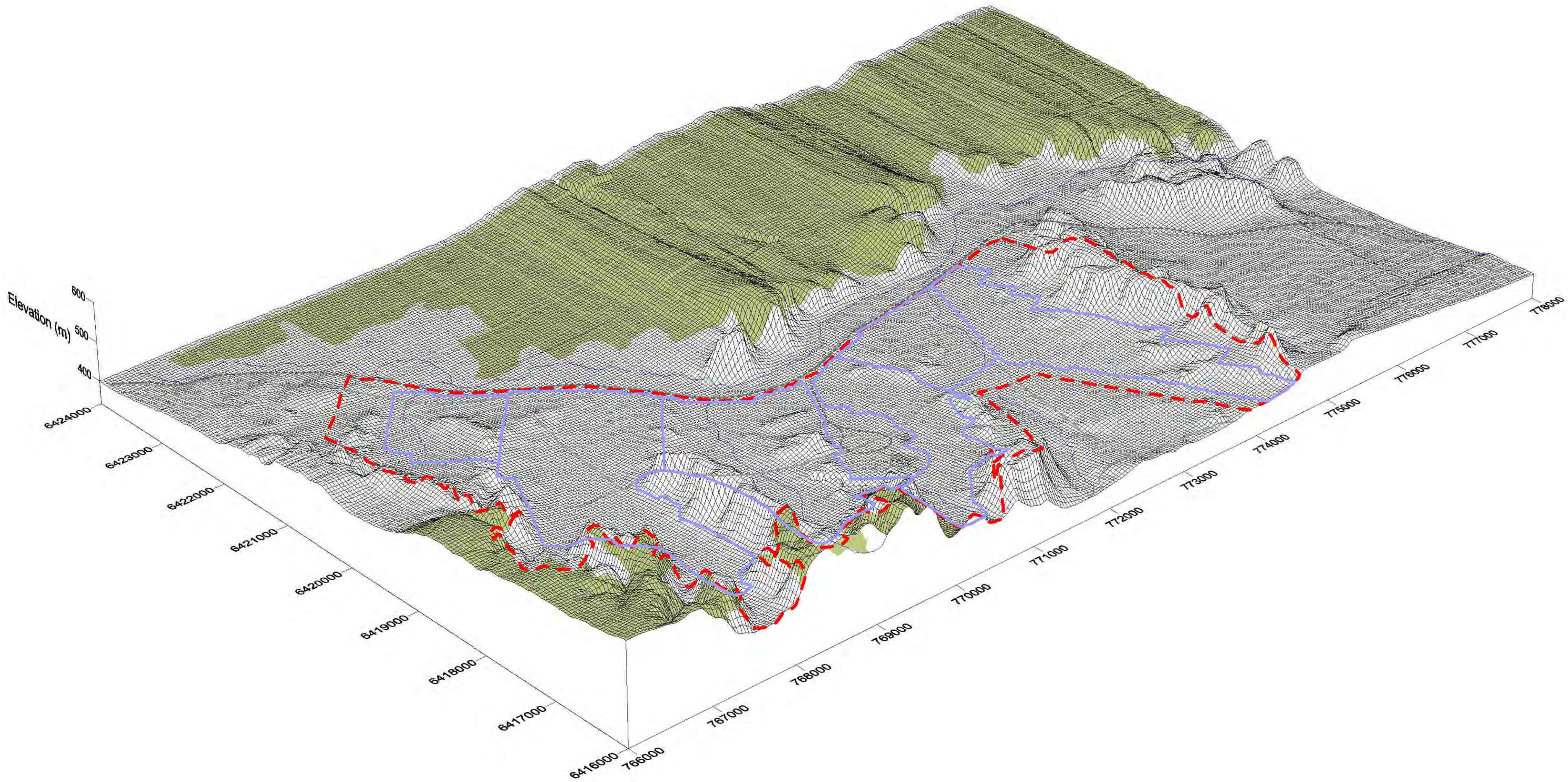
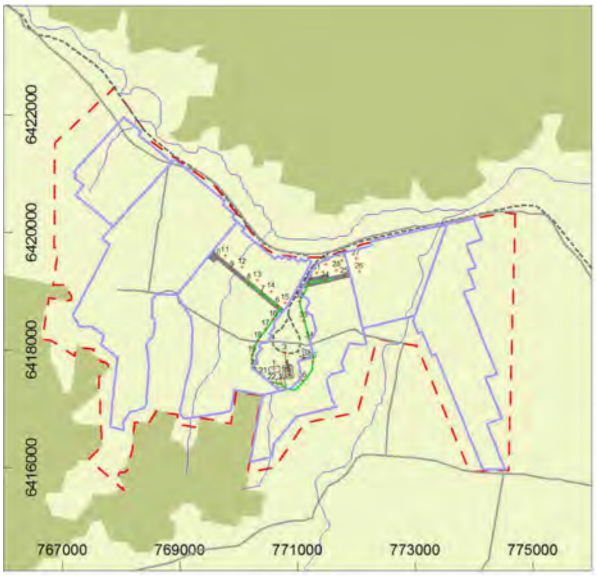
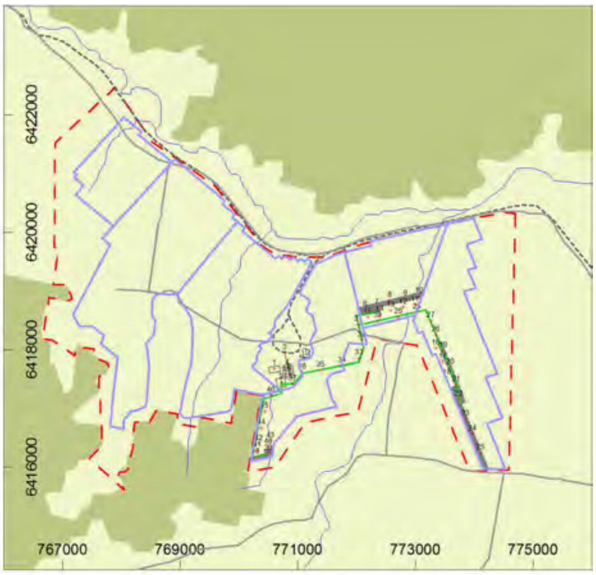


FIGURE 2

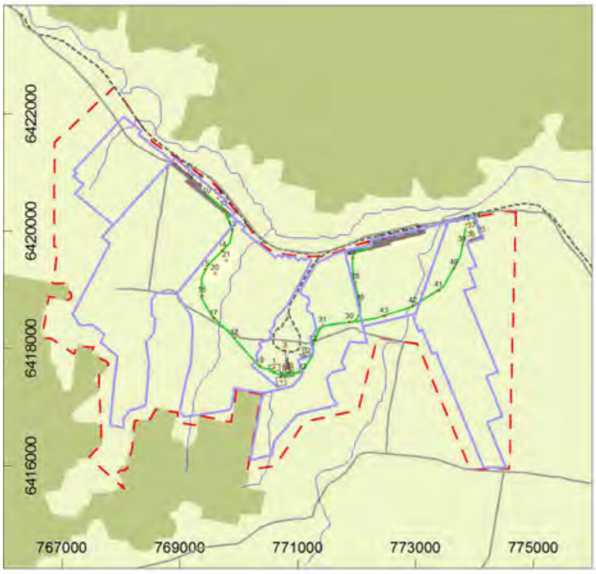
Pseudo 3-dimensional topographical representation of the study area



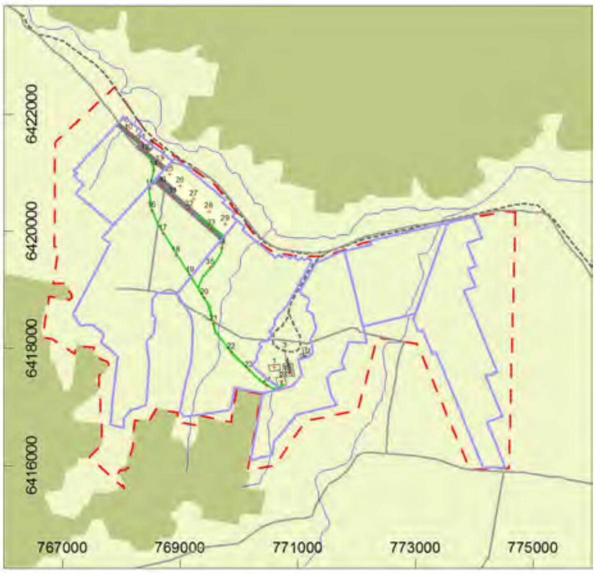
Year 3



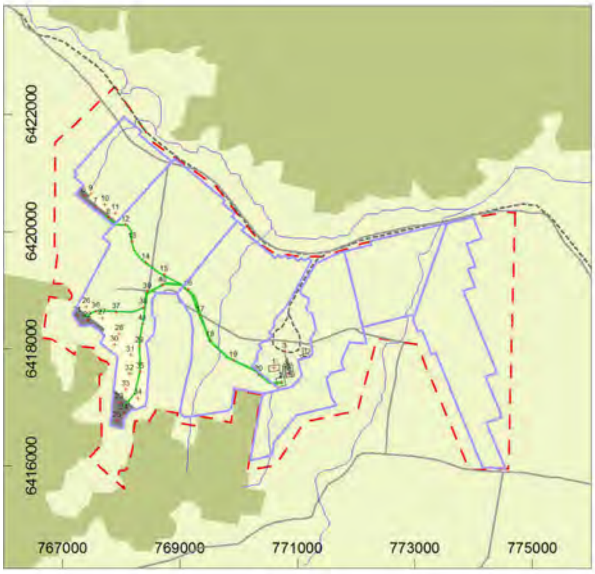
Year 9



Year 13



Year 14



Year 21

Mine plan and location of modelled dust sources

FIGURE 3

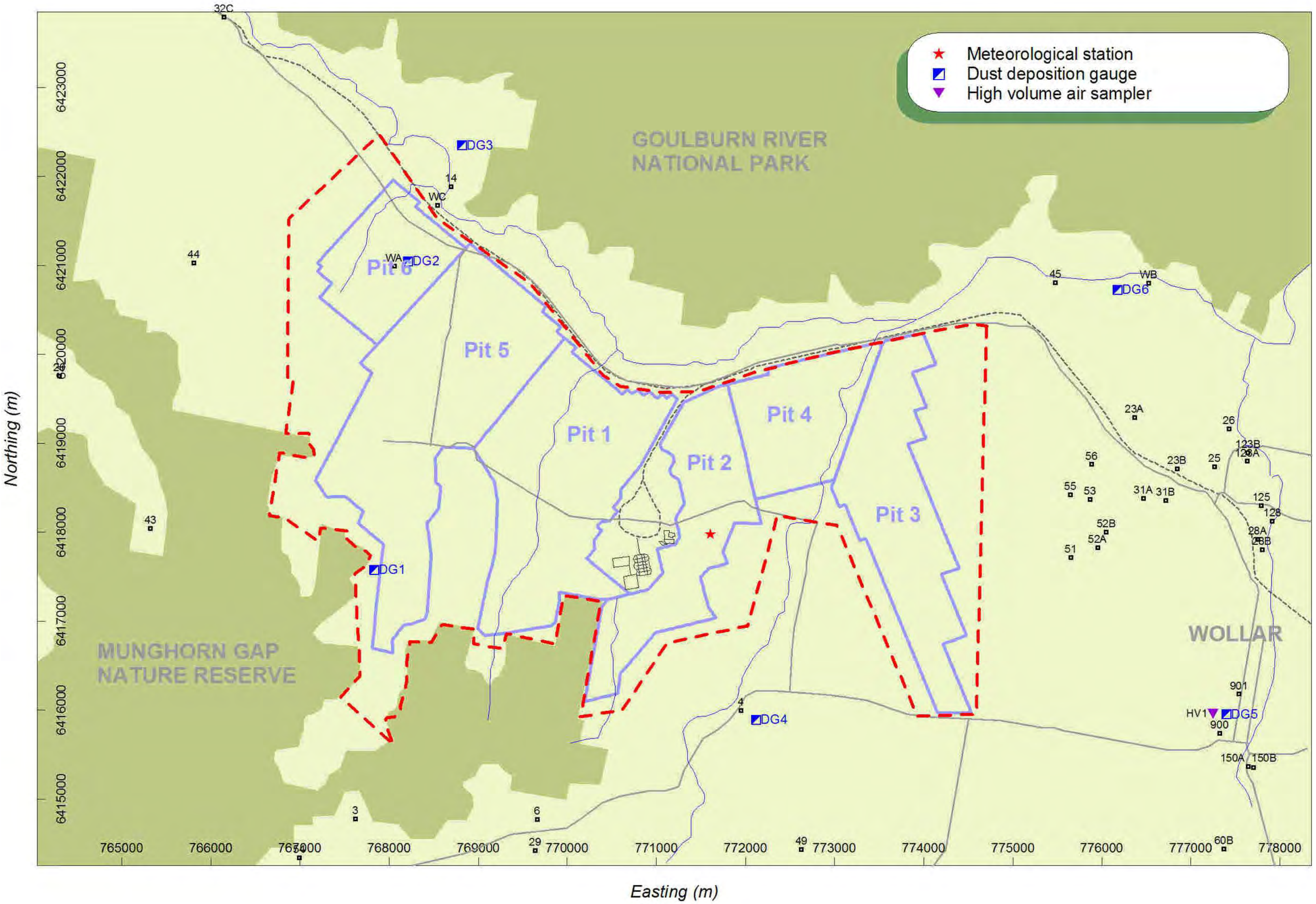
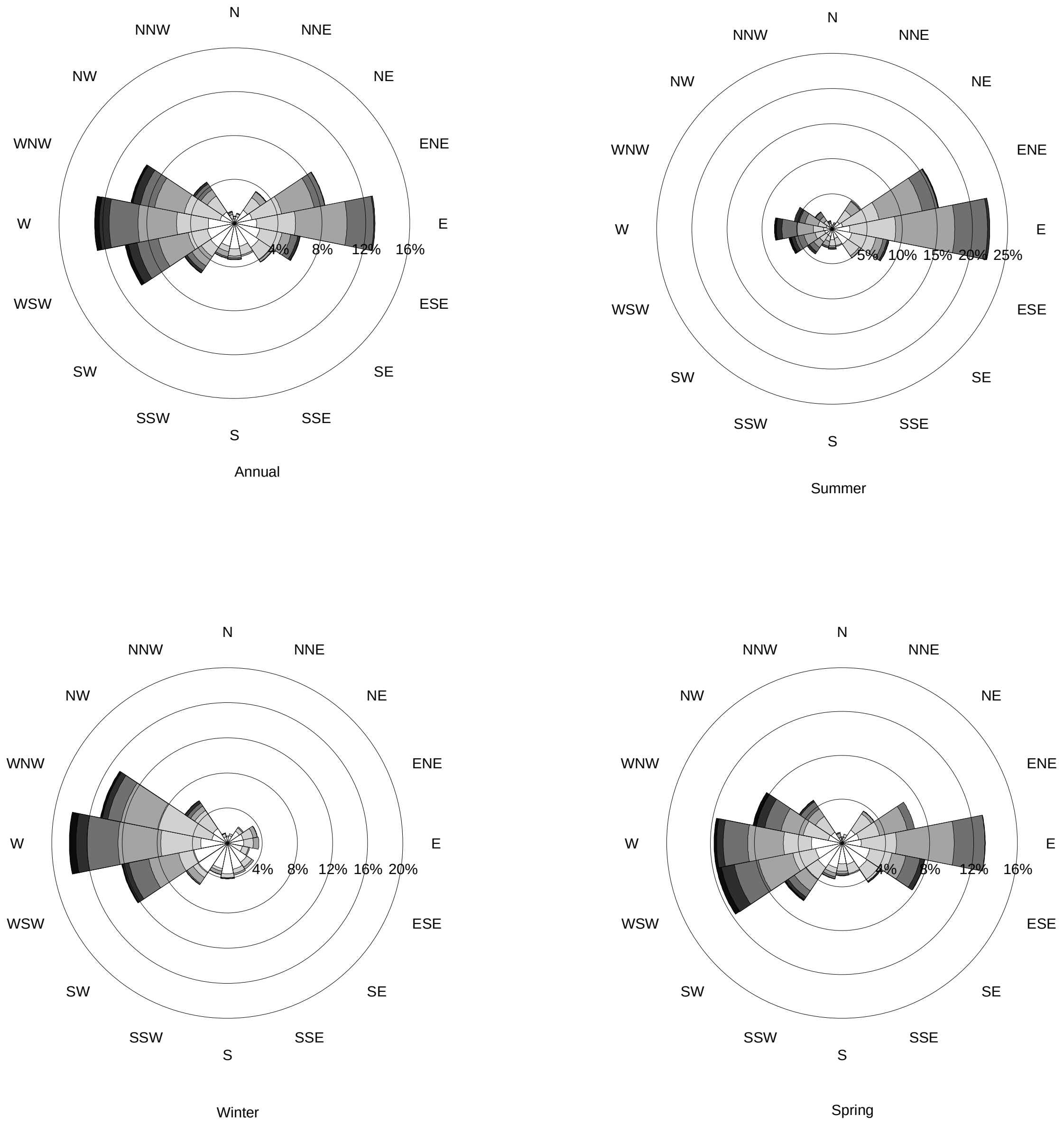
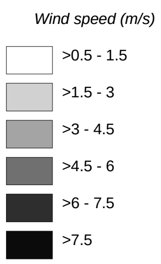


FIGURE 4

Monitoring for the Wilpinjong Project



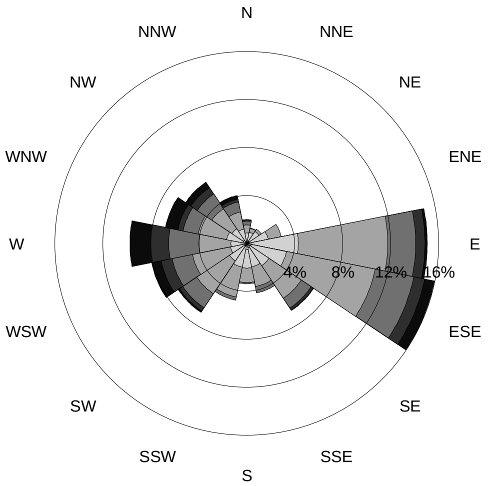


Annual and seasonal windroses for Wilpinjong (1June 2004 to 28 February 2005)

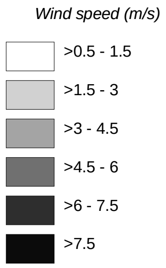
(Note: insufficient data for Autumn wind rose)

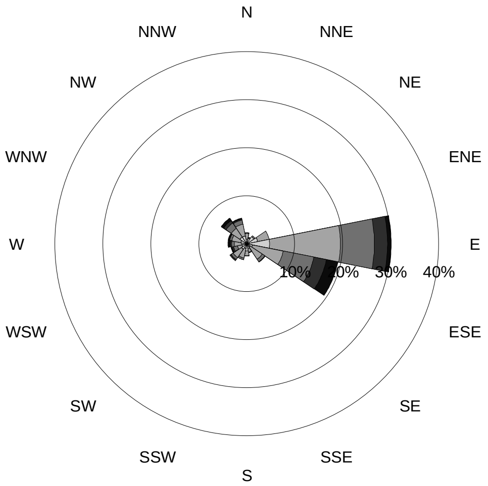
FIGURE 5

Annual and seasonal windroses for Wilpinjong (2003, TAPM)

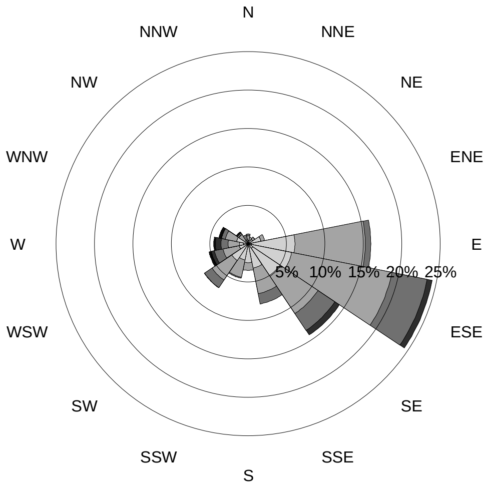


Annual
Calms = 0.4%

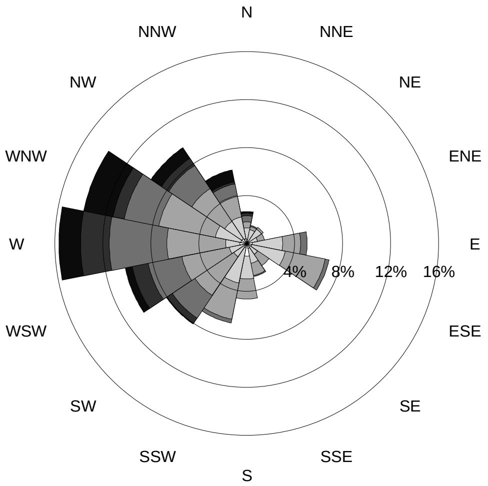




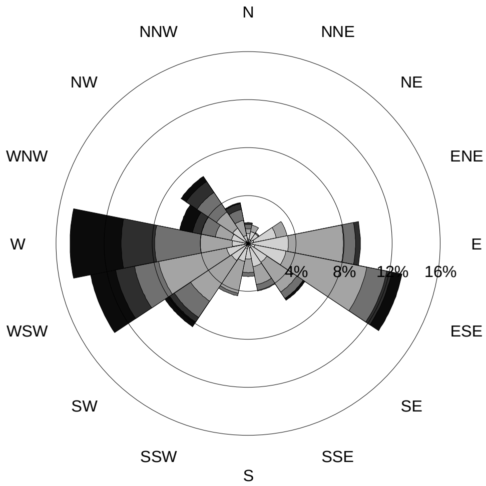
Summer
Calms = 0.3%



Autumn
Calms = 0.5%

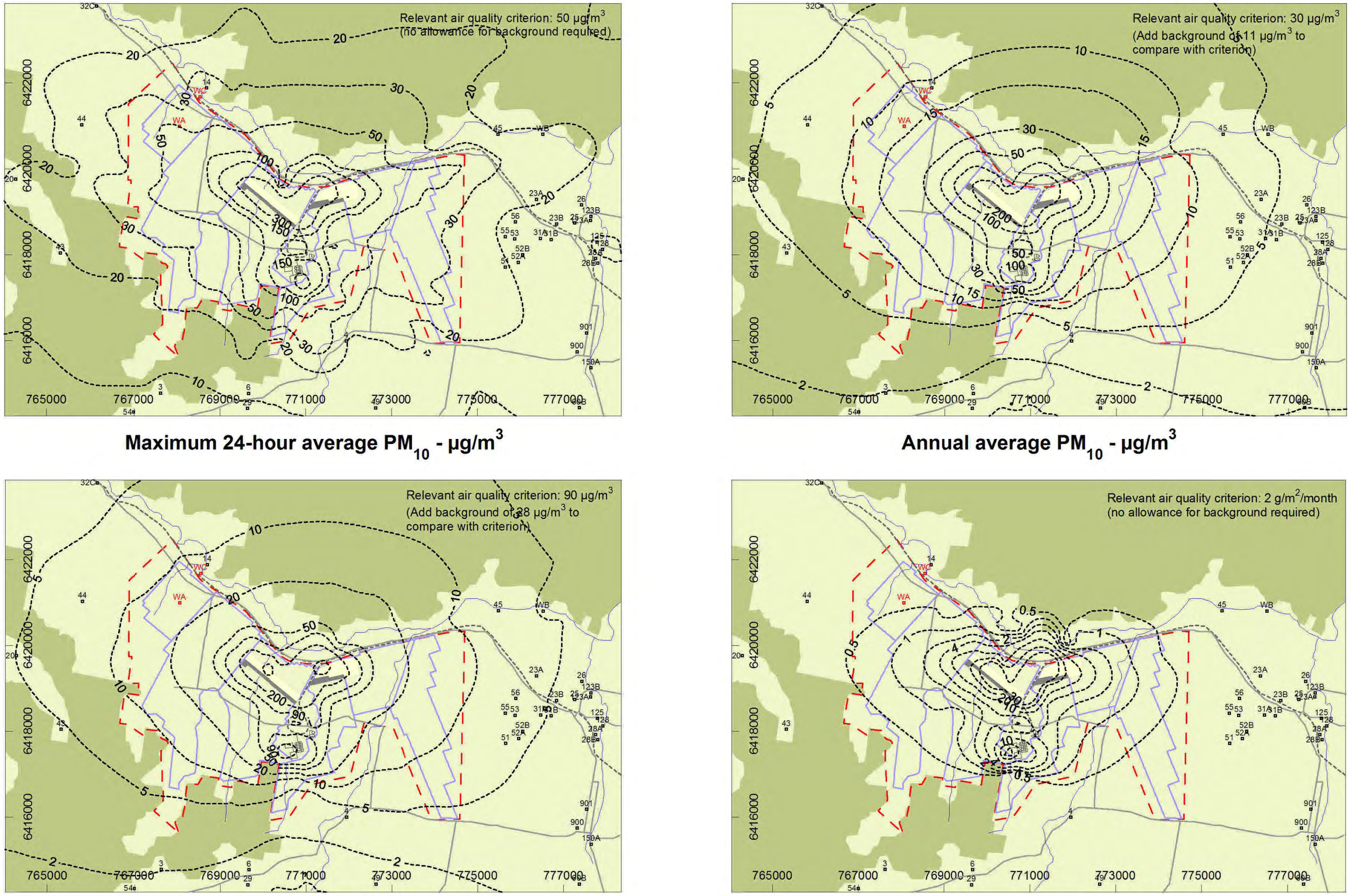


Winter
Calms = 0.5%



Spring
Calms = 0.5%

FIGURE 6



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

Annual average PM_{10} - µg/m^3

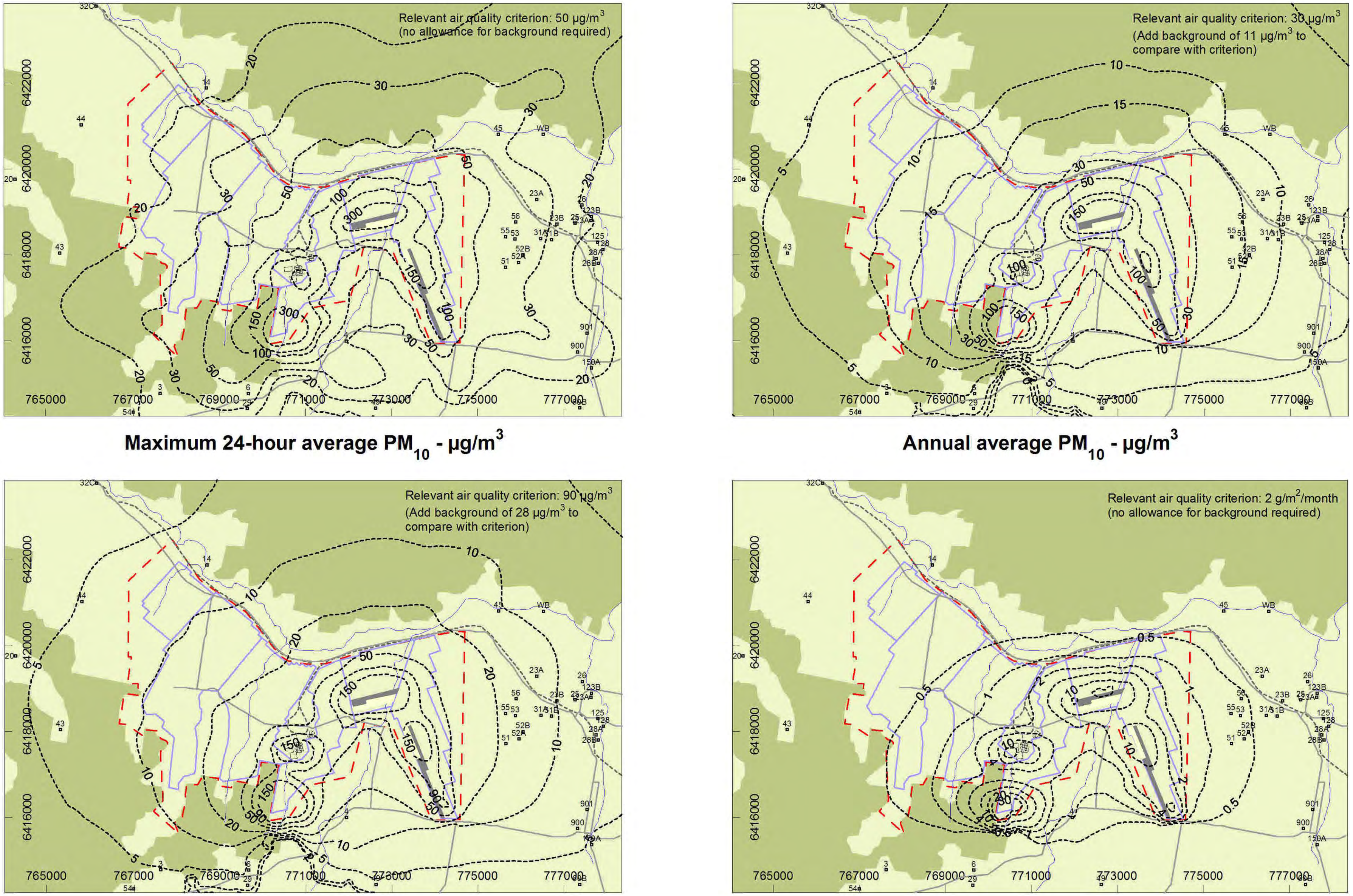
Annual average TSP - µg/m^3

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

Note: WA and WC are mine-owned residences

FIGURE 7

Dispersion model predictions due to Year 3 mining operations



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

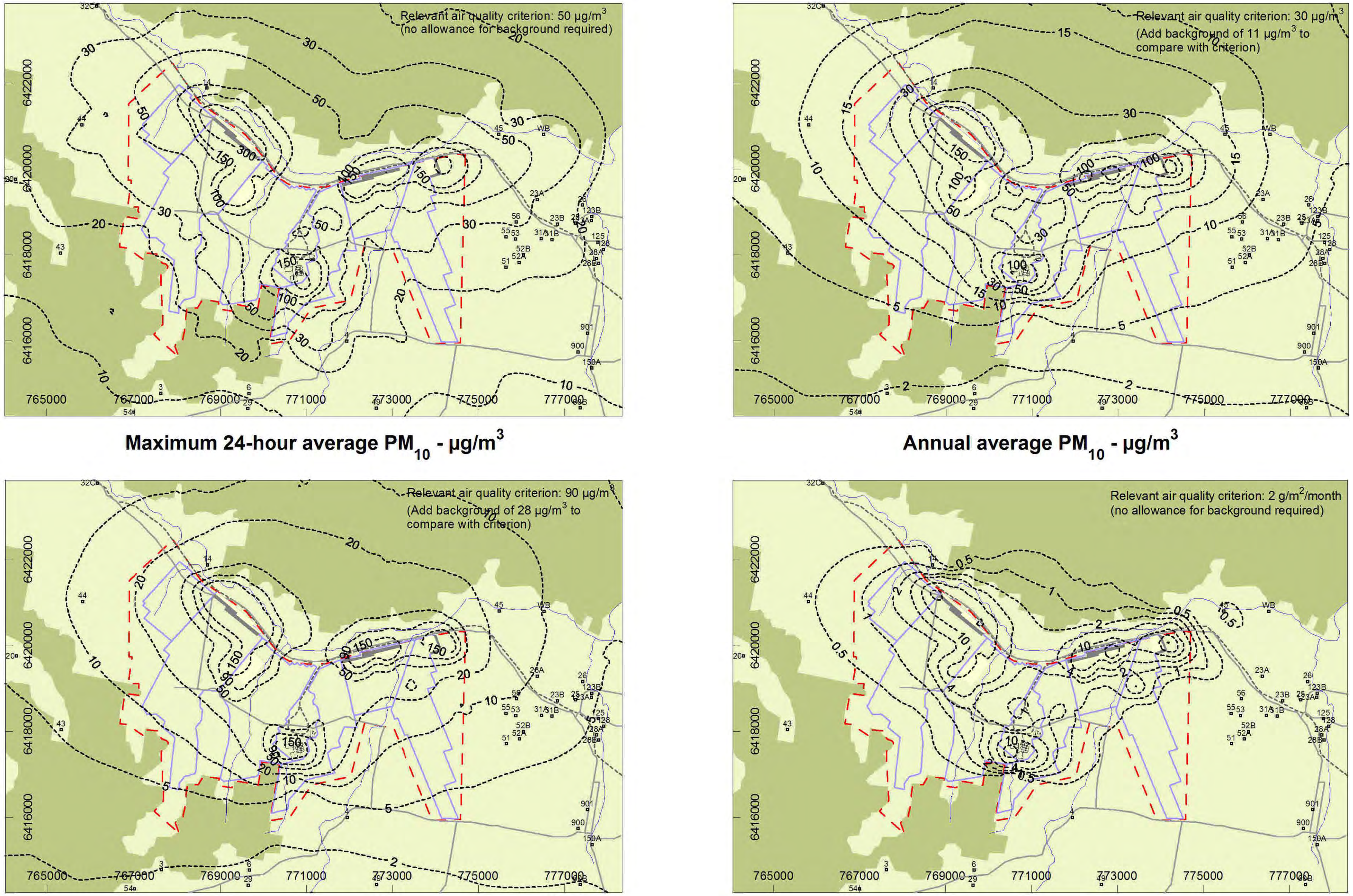
Annual average PM_{10} - µg/m^3

Annual average TSP - µg/m^3

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

FIGURE 8

Dispersion model predictions due to Year 9 mining operations



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

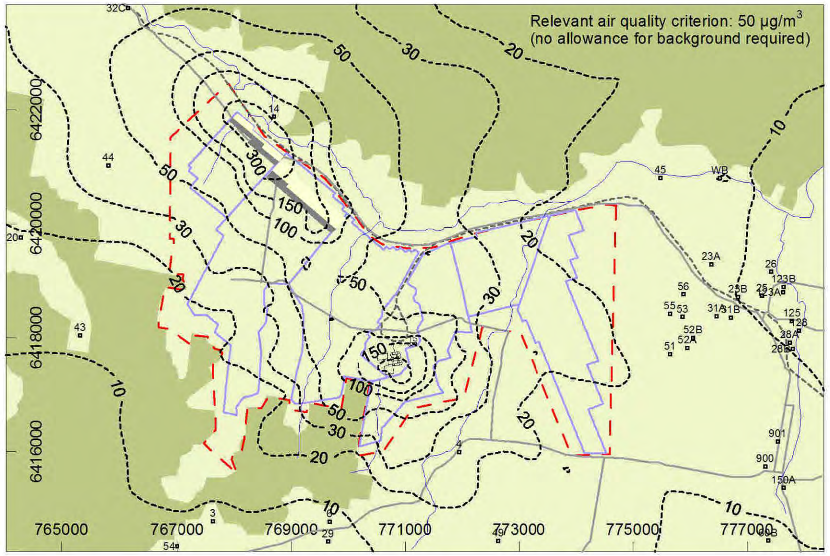
Annual average PM_{10} - µg/m^3

Annual average TSP - µg/m^3

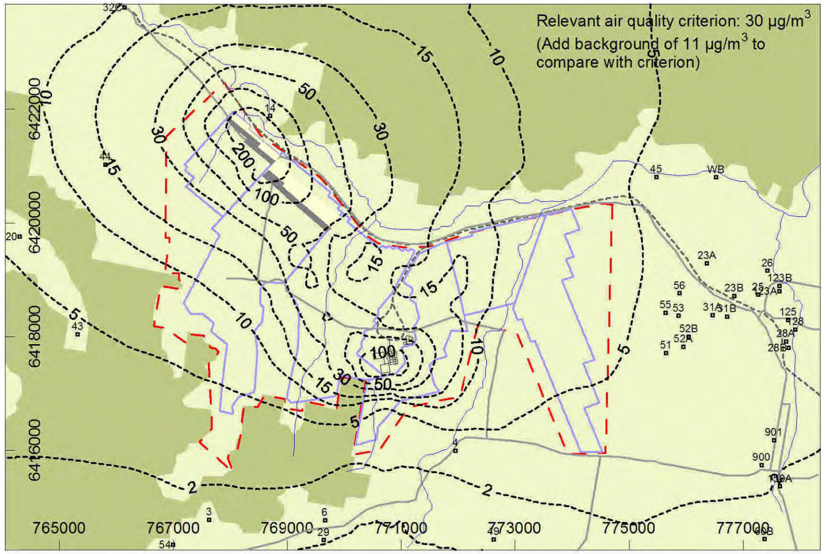
Annual average dust deposition - g/m^2/month

FIGURE 9

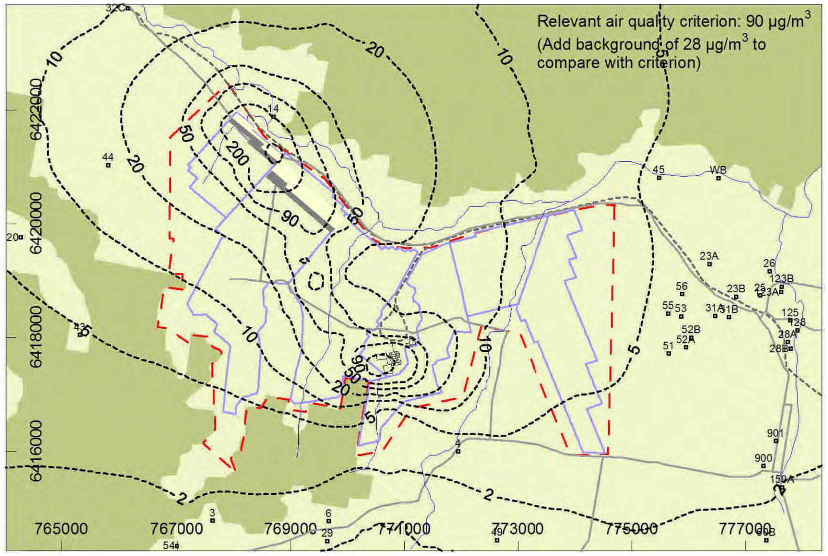
Dispersion model predictions due to Year 13 mining operations



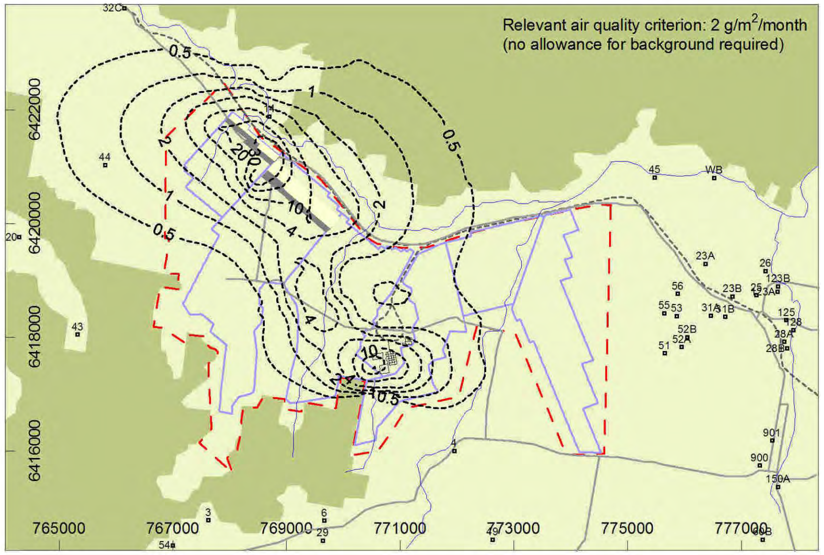
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



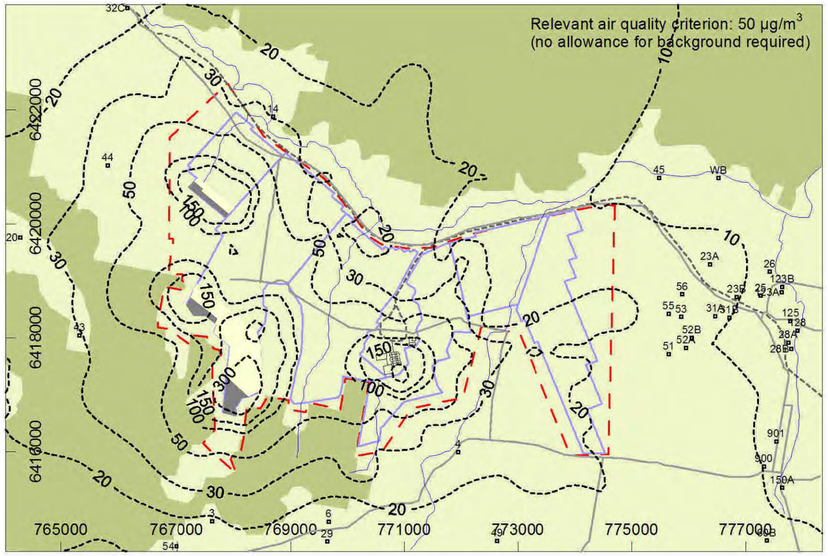
Annual average TSP - µg/m^3



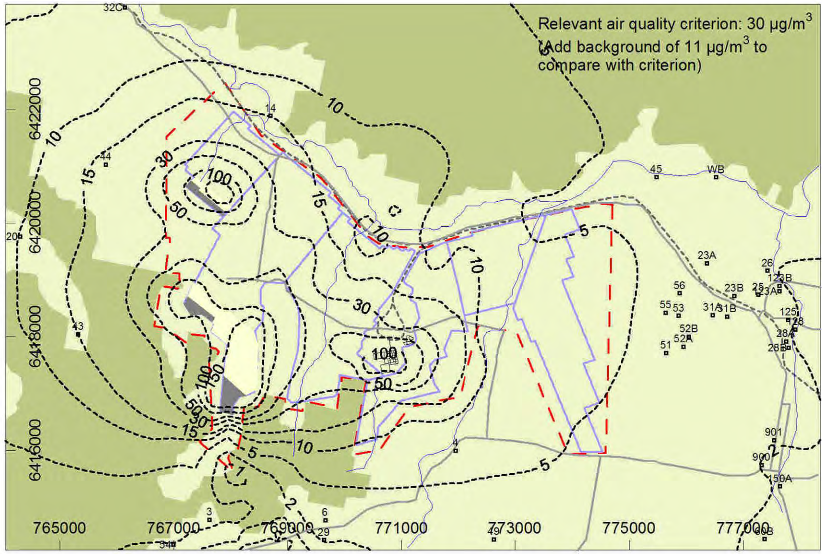
Annual average dust deposition - g/m^2/month

FIGURE 10

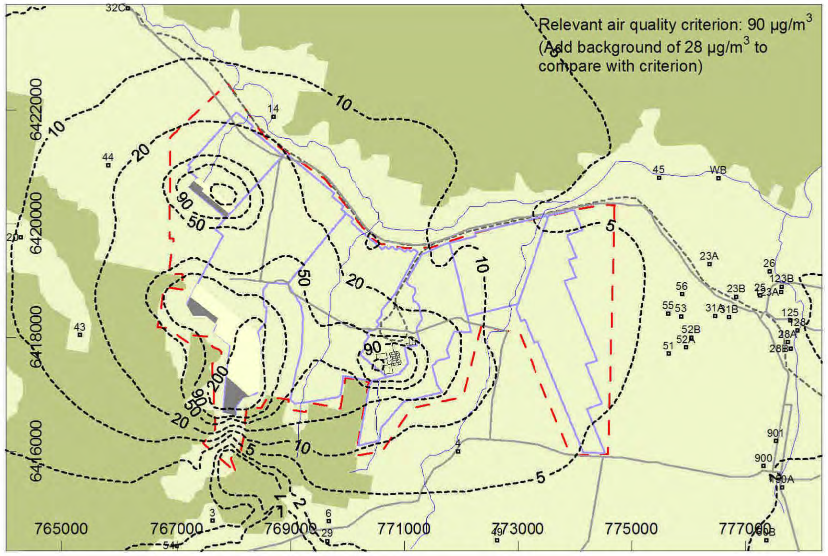
Dispersion model predictions due to Year 14 mining operations



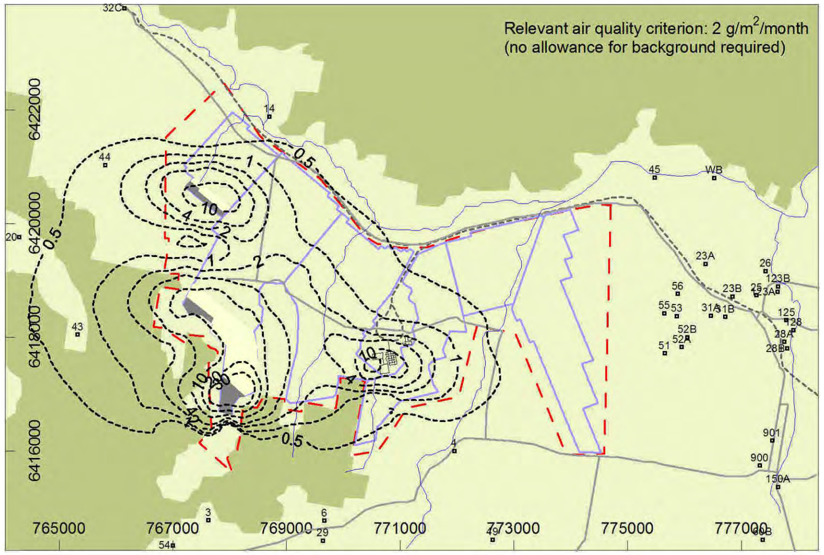
Maximum 24-hour average PM_{10} - µg/m³



Annual average PM_{10} - µg/m³



Annual average TSP - µg/m³

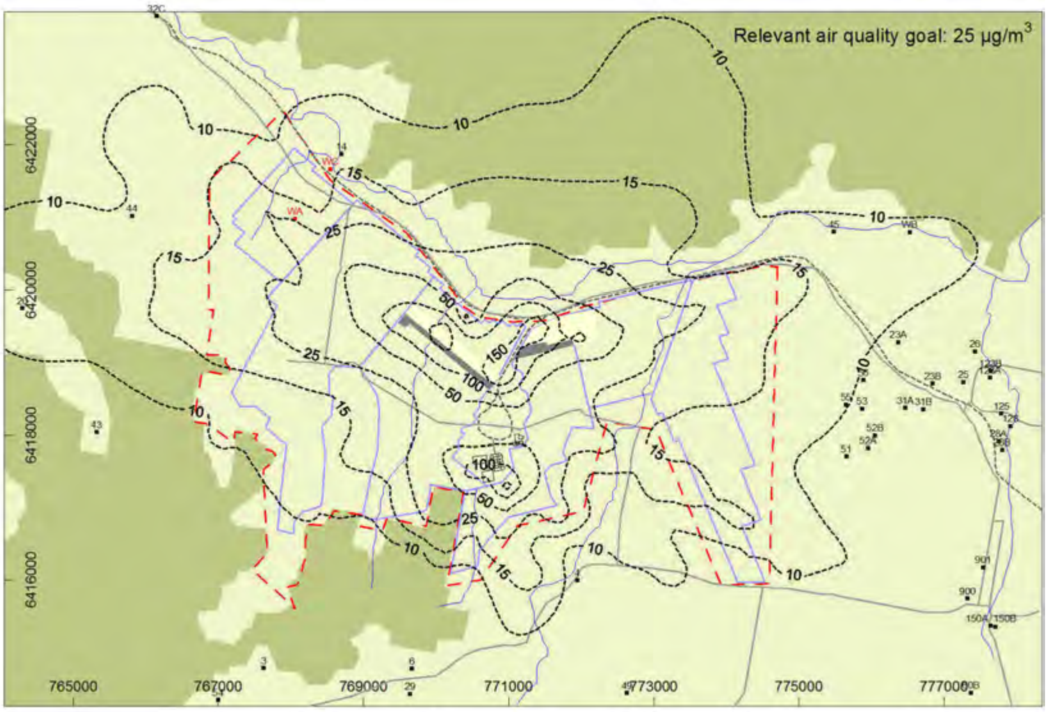


Annual average dust deposition - g/m²/month

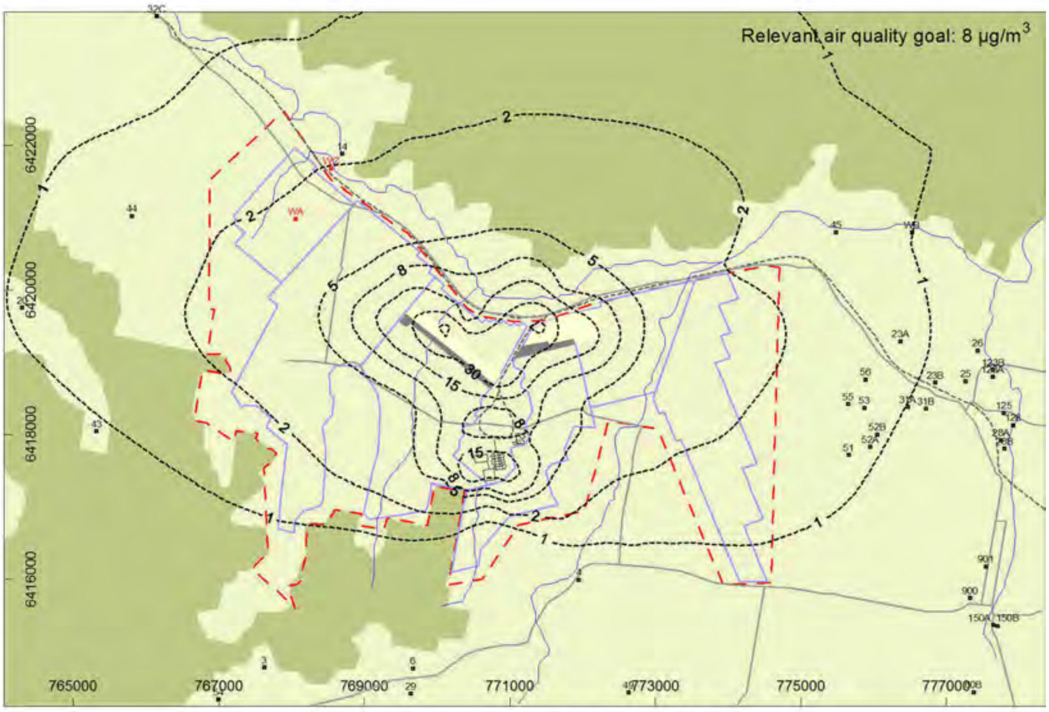
FIGURE 11

Dispersion model predictions due to Year 21 mining operations

APPENDIX A
DISPERSION MODEL PREDICTIONS OF $PM_{2.5}$



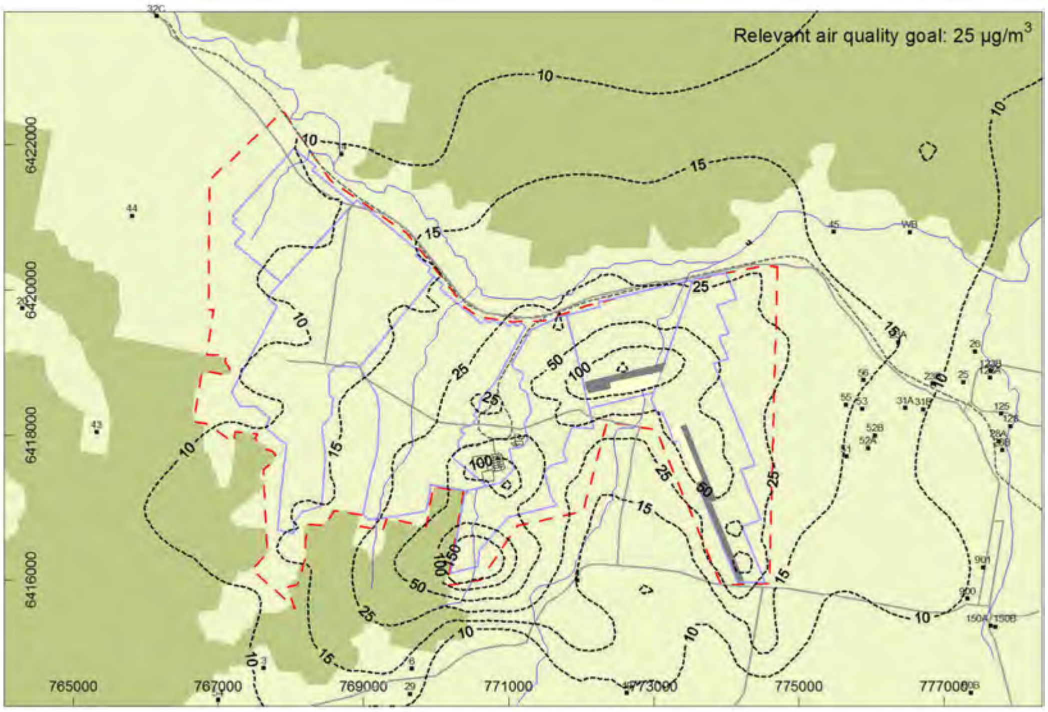
Maximum 24-hour average $PM_{2.5}$ - μg/m³



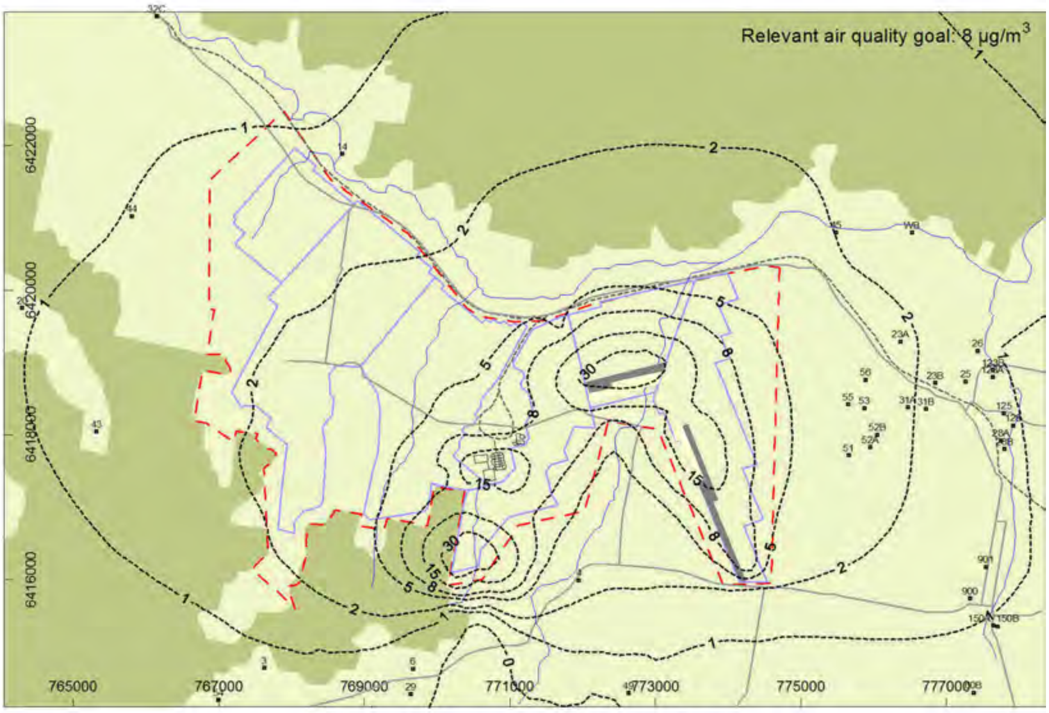
Annual average $PM_{2.5}$ - μg/m³

Note: WA and WC are mine-owned residences

$PM_{2.5}$ dispersion model predictions for Year 3 mining operations

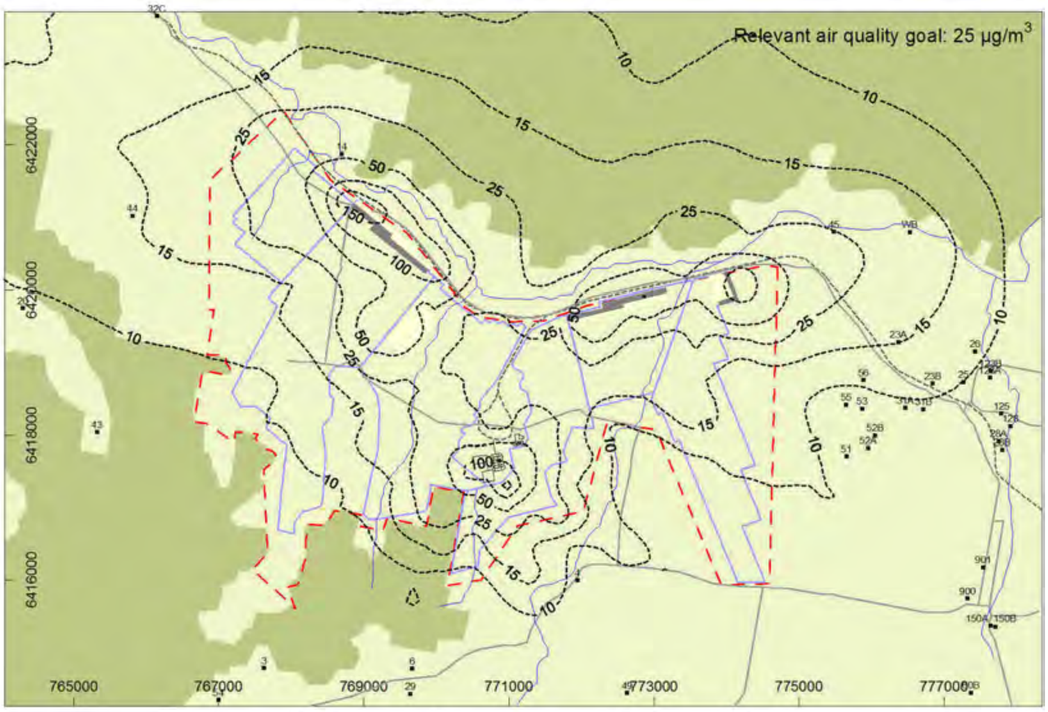


Maximum 24-hour average $PM_{2.5}$ - µg/m^3

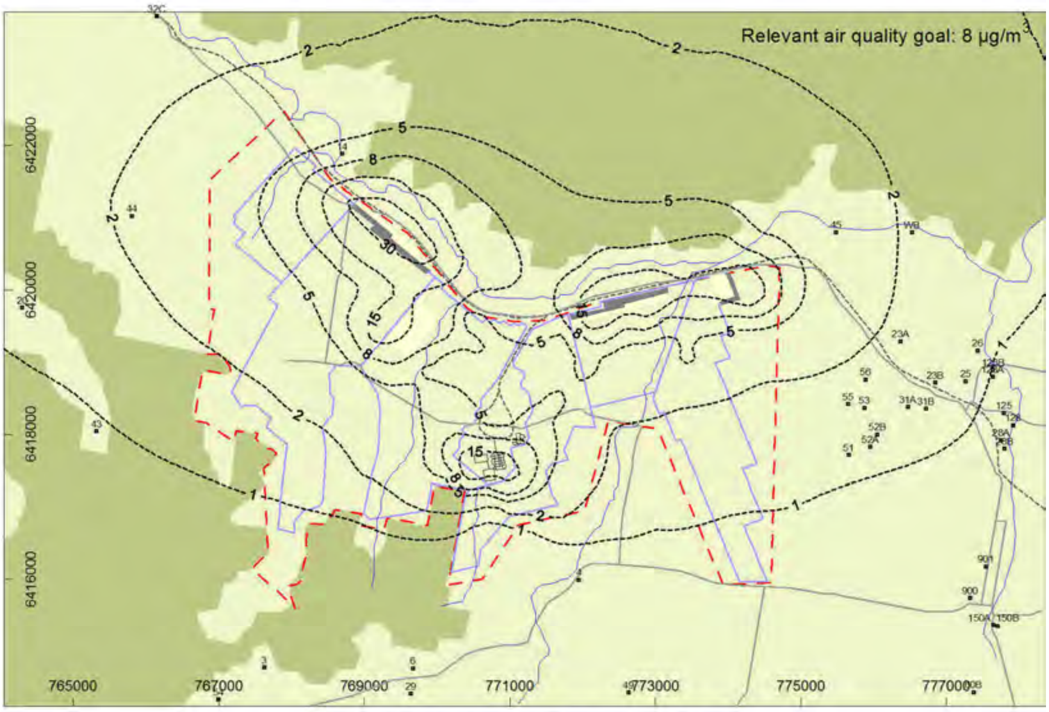


Annual average $PM_{2.5}$ - µg/m^3

$PM_{2.5}$ dispersion model predictions for Year 9 mining operations

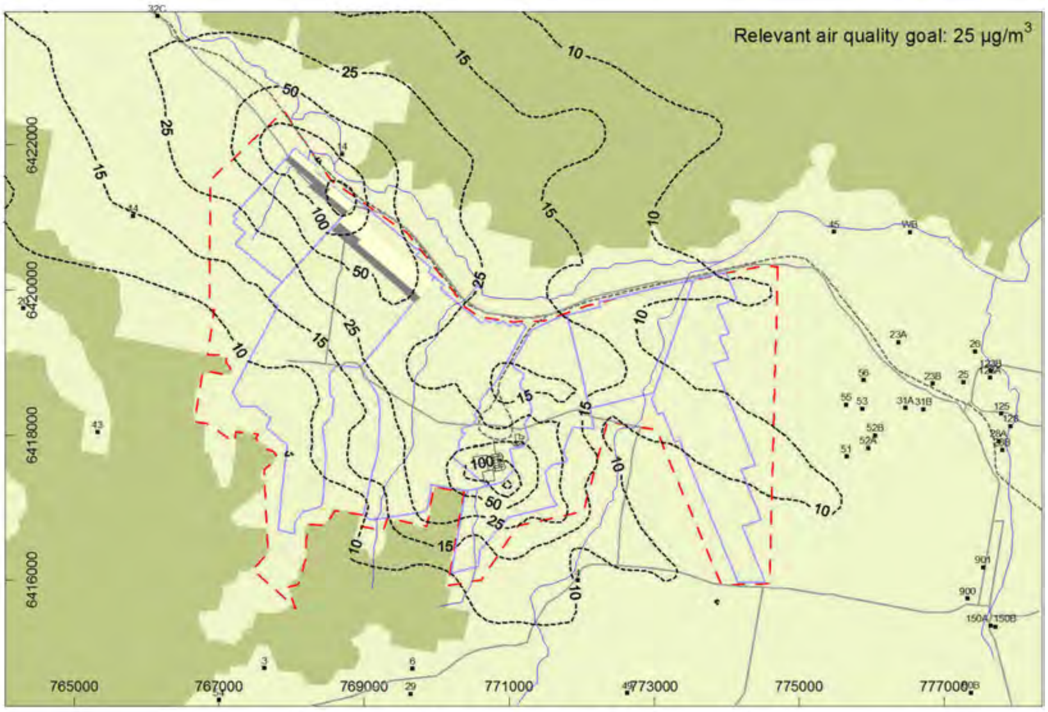


Maximum 24-hour average $PM_{2.5}$ - µg/m³

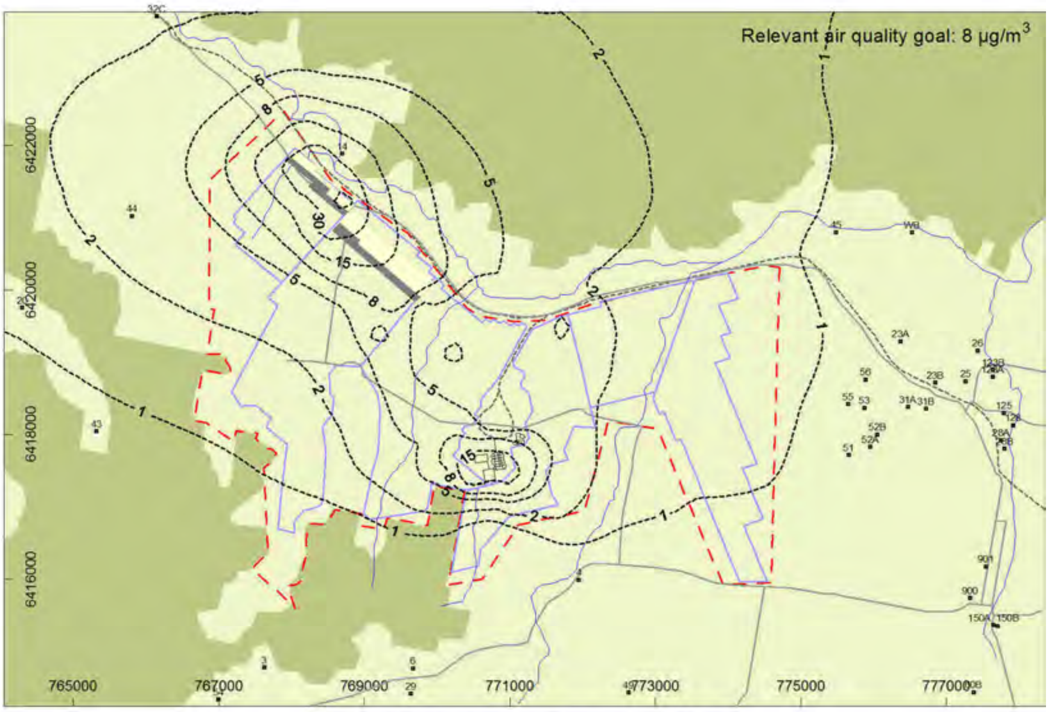


Annual average $PM_{2.5}$ - µg/m³

$PM_{2.5}$ dispersion model predictions for Year 13 mining operations

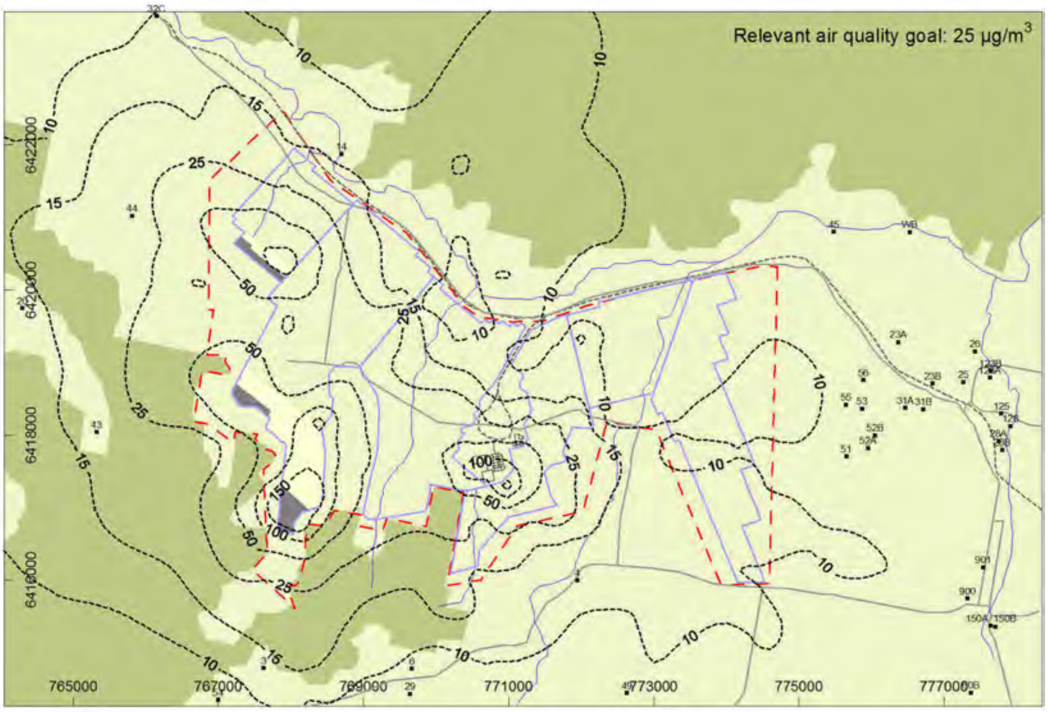


Maximum 24-hour average $PM_{2.5}$ - µg/m³

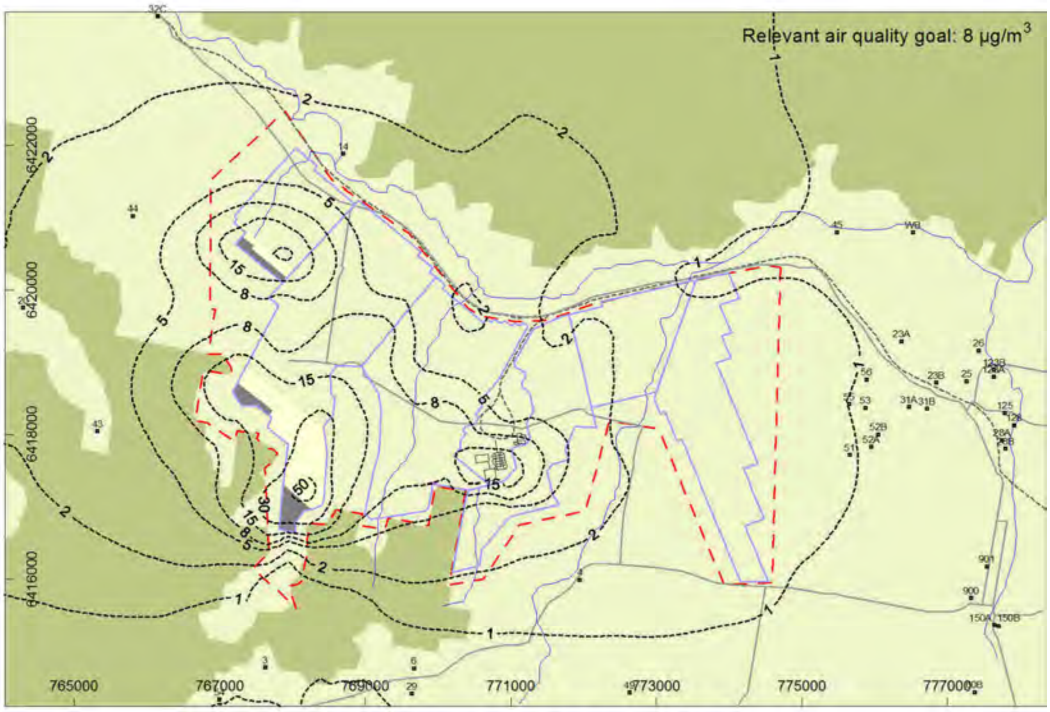


Annual average $PM_{2.5}$ - µg/m³

$PM_{2.5}$ dispersion model predictions for Year 14 mining operations



Maximum 24-hour average $PM_{2.5}$ - µg/m^3



Annual average $PM_{2.5}$ - µg/m^3

$PM_{2.5}$ dispersion model predictions for Year 21 mining operations

APPENDIX B
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : WILPINJONG COAL PROJECT OPERATIONS

Year 3

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in Pit 1	2555	182.5	h/y	14.0	kg/h						
OB - Stripping in Pit 2	2555	182.5	h/y	14.0	kg/h						
OB - Stripping in Pit -	0	0	h/y	14.0	kg/h						
OB - Drilling in Pit 1	11305.58	19162	holes/y	0.59	kg/hole						
OB - Drilling in Pit 2	5568.42	9438	holes/y	0.59	kg/hole						
OB - Drilling in Pit -	0	0	holes/y	0.59	kg/hole						
OB - Blasting in Pit 1	38606.42092	26.8	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 2	19015.10284	13.2	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit -	0	0	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in Pit 1	20610	11865700	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 2	10151	5844300	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit -	0	0	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from Pit 1	316419	11865700	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Hauling to emplace from Pit 2	155848	5844300	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Hauling to emplace from Pit -	0	0	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Emplacing at dumps in Pit 1	20610	11865700	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 2	10151	5844300	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit -	0	0	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in Pit 1	383775	22932	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 2	255850	15288	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit -	0	0	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in Pit 1	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 2	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit -	0	0	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in Pit 1	588389	8710000	t/y	0.0676	kg/t	6	moisture content of coal in %				

CL - Loading ROM to trucks in Pit 2	289804	4290000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit -	0	0	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper from Pit 1	290333	8710000	t/y	0.0333	kg/t	150	t/load	5	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 2	154440	4290000	t/y	0.0360	kg/t	150	t/load	5.4	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit -	0	0	t/y	0.0133	kg/t	150	t/load	2	km/return trip	1.0	kg/VKT
CL - unloading ROM coal at pile/hopper all pits	130000	13000000	t	0.0100	kg/t						
CL - ROM rehandle pile to hopper (FEL)	39000	3900000	t	0.0100	kg/t						
CL - Handling coal at CHPP	24251	13000000	t	0.0019	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - FEL pushing ROM coal	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers pushing product coal	57180	7644	h/y	7.5	kg/h	4	silt content in %	10	moisture content in %		
CL - Loading product coal stockpile	1752	9600000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps at Pit 1	79789	26	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 2	102630	33	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit -	0	0	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 1	38486	12	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 2	27535	9	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit -	0	0	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - ROM stockpiles	3520	2	ha	1564	kg/ha/y	73	Average number of raindays	5	silt content in %	8.2	% of winds above 5.4 m/s
WE - Product stockpiles	4756	4	ha	1252	kg/ha/y	73	Average number of raindays	4	silt content in %	8.2	% of winds above 5.4 m/s
Loading coal to trains	1752	9600000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
Grading roads	36928	60000	km	0.6155	kg/VKT	8	speed of graders in km/h				

Year 9

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in Pit 2	4258.333333	304.1666667	h/y	14.0	kg/h						
OB - Stripping in Pit 4	4258.333333	304.1666667	h/y	14.0	kg/h						
OB - Stripping in Pit 3	4258.333333	304.1666667	h/y	14.0	kg/h						
OB - Drilling in Pit 2	5568.42	9438	holes/y	0.59	kg/hole						
OB - Drilling in Pit 4	7087.08	12012	holes/y	0.59	kg/hole						
OB - Drilling in Pit 3	4218.5	7150	holes/y	0.59	kg/hole						
OB - Blasting in Pit 2	19015.10284	13.2	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 4	24201.03998	16.8	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 3	14405.38094	10	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in Pit 2	25707	14800500	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 4	32719	18837000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 3	19475	11212500	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from Pit 2	394680	14800500	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Hauling to emplace from Pit 4	502320	18837000	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Hauling to emplace from Pit 3	299000	11212500	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Emplacing at dumps in Pit 2	25707	14800500	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 4	32719	18837000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 3	19475	11212500	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in Pit 2	127925	7644	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 4	383775	22932	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 3	127925	7644	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in Pit 2	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 4	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 3	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in Pit 2	289804	4290000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit 4	368841	5460000	t/y	0.0676	kg/t	6	moisture content of coal in %				

CL - Loading ROM to trucks in Pit 3	219548	3250000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper from Pit 2	102960	4290000	t/y	0.0240	kg/t	150	t/load	3.6	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 4	189280	5460000	t/y	0.0347	kg/t	150	t/load	5.2	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 3	216667	3250000	t/y	0.0667	kg/t	150	t/load	10	km/return trip	1.0	kg/VKT
CL - unloading ROM coal at pile/hopper all pits	130000	13000000	t	0.0100	kg/t						
CL - ROM rehandle pile to hopper (FEL)	39000	3900000	t	0.0100	kg/t						
CL - Handling coal at CHPP	24251	13000000	t	0.0019	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - FEL pushing ROM coal	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers pushing product coal	57180	7644	h/y	7.5	kg/h	4	silt content in %	10	moisture content in %		
CL - Loading product coal stockpile	1715	9400000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps at Pit 2	27535	9	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 4	51315	16	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 3	30351	10	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 2	12516	4	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 4	39738	13	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 3	62579	20	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - ROM stockpiles	3520	2	ha	1564	kg/ha/y	73	Average number of raindays	5	silt content in %	8.2	% of winds above 5.4 m/s
WE - Product stockpiles	4756	4	ha	1252	kg/ha/y	73	Average number of raindays	4	silt content in %	8.2	% of winds above 5.4 m/s
Loading coal to trains	1715	9400000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
Grading roads	36928	60000	km	0.6155	kg/VKT	8	speed of graders in km/h				

Year 13

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in Pit 5	5961.666667	425.8333333	h/y	14.0	kg/h						
OB - Stripping in Pit 4	5961.666667	425.8333333	h/y	14.0	kg/h						
OB - Stripping in Pit 3	5961.666667	425.8333333	h/y	14.0	kg/h						
OB - Drilling in Pit 5	11474.32	19448	holes/y	0.59	kg/hole						
OB - Drilling in Pit 4	2699.84	4576	holes/y	0.59	kg/hole						
OB - Drilling in Pit 3	2699.84	4576	holes/y	0.59	kg/hole						
OB - Blasting in Pit 5	39182.63615	27.2	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 4	9219.443801	6.4	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 3	9219.443801	6.4	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in Pit 5	46453	26744400	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 4	10930	6292800	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 3	10930	6292800	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from Pit 5	891480	26744400	t/y	0.0333	kg/t	150	t/truck load	5	km/return trip	1.0	kg/VKT
OB - Hauling to emplace from Pit 4	167808	6292800	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Hauling to emplace from Pit 3	167808	6292800	t/y	0.0267	kg/t	150	t/truck load	4	km/return trip	1.0	kg/VKT
OB - Emplacing at dumps in Pit 5	46453	26744400	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 4	10930	6292800	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 3	10930	6292800	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in Pit 5	383775	22932	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 4	127925	7644	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 3	127925	7644	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in Pit 5	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 4	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 3	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in Pit 5	597171	8840000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit 4	140511	2080000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit 3	140511	2080000	t/y	0.0676	kg/t	6	moisture content of coal in %				

CL - Hauling ROM coal to dump hopper from Pit 5	459680	8840000	t/y	0.0520	kg/t	150	t/load	7.8	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 4	97067	2080000	t/y	0.0467	kg/t	150	t/load	7	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 3	130347	2080000	t/y	0.0627	kg/t	150	t/load	9.4	km/return trip	1.0	kg/VKT
CL - unloading ROM coal at pile/hopper all pits	130000	13000000	t	0.0100	kg/t						
CL - ROM rehandle pile to hopper (FEL)	39000	3900000	t	0.0100	kg/t						
CL - Handling coal at CHPP	24251	13000000	t	0.0019	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - FEL pushing ROM coal	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers pushing product coal	57180	7644	h/y	7.5	kg/h	4	silt content in %	10	moisture content in %		
CL - Loading product coal stockpile	1642	9000000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps at Pit 5	117649	38	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 4	28474	9	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 3	25345	8	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 5	37548	12	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 4	33480	11	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 3	9700	3	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - ROM stockpiles	3520	2	ha	1564	kg/ha/y	73	Average number of raindays	5	silt content in %	8.2	% of winds above 5.4 m/s
WE - Product stockpiles	4756	4	ha	1252	kg/ha/y	73	Average number of raindays	4	silt content in %	8.2	% of winds above 5.4 m/s
Loading coal to trains	1642	9000000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
Grading roads	36928	60000	km	0.6155	kg/VKT	8	speed of graders in km/h				

Year 14

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in Pit 6	5961.666667	425.8333333	h/y	14.0	kg/h						
OB - Stripping in Pit 5	5961.666667	425.8333333	h/y	14.0	kg/h						
OB - Stripping in Pit -	0	0	h/y	14.0	kg/h						
OB - Drilling in Pit 6	9786.92	16588	holes/y	0.59	kg/hole						
OB - Drilling in Pit 5	7087.08	12012	holes/y	0.59	kg/hole						
OB - Drilling in Pit -	0	0	holes/y	0.59	kg/hole						
OB - Blasting in Pit 6	33420.48378	23.2	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 5	24201.03998	16.8	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit -	0	0	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in Pit 6	36146	20810400	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 5	26175	15069600	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit -	0	0	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from Pit 6	332966	20810400	t/y	0.0160	kg/t	150	t/truck load	4	km/return trip	0.6	kg/VKT
OB - Hauling to emplace from Pit 5	241114	15069600	t/y	0.0160	kg/t	150	t/truck load	4	km/return trip	0.6	kg/VKT
OB - Hauling to emplace from Pit -	0	0	t/y	0.0160	kg/t	150	t/truck load	4	km/return trip	0.6	kg/VKT
OB - Emplacing at dumps in Pit 6	36146	20810400	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 5	26175	15069600	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit -	0	0	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in Pit 6	383775	22932	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 5	255850	15288	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit -	0	0	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in Pit 6	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 5	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit -	0	0	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in Pit 6	509352	7540000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit 5	368841	5460000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit -	0	0	t/y	0.0676	kg/t	6	moisture content of coal in %				

CL - Hauling ROM coal to dump hopper from Pit 6	502667	7540000	t/y	0.0667	kg/t	150	t/load	10	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 5	291200	5460000	t/y	0.0533	kg/t	150	t/load	8	km/return trip	1.0	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit -	0	0	t/y	0.0133	kg/t	150	t/load	2	km/return trip	1.0	kg/VKT
CL - unloading ROM coal at pile/hopper all pits	130000	13000000	t	0.0100	kg/t						
CL - ROM rehandle pile to hopper (FEL)	39000	3900000	t	0.0100	kg/t						
CL - Handling coal at CHPP	24251	13000000	t	0.0019	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - FEL pushing ROM coal	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers pushing product coal	57180	7644	h/y	7.5	kg/h	4	silt content in %	10	moisture content in %		
CL - Loading product coal stockpile	1624	8900000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps at Pit 6	36609	12	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 5	121091	39	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit -	0	0	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 6	34419	11	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 5	51941	17	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit -	0	0	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - ROM stockpiles	3520	2	ha	1564	kg/ha/y	73	Average number of raindays	5	silt content in %	8.2	% of winds above 5.4 m/s
WE - Product stockpiles	4756	4	ha	1252	kg/ha/y	73	Average number of raindays	4	silt content in %	8.2	% of winds above 5.4 m/s
Loading coal to trains	1624	8900000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
Grading roads	36928	60000	km	0.6155	kg/VKT	8	speed of graders in km/h				

Year 21

ACTIVITY **Note: Year 20 waste and product quantities used here	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in Pit 6	9368	669.1666667	h/y	14.0	kg/h						
OB - Stripping in Pit 5w	9368	669.1666667	h/y	14.0	kg/h						
OB - Stripping in Pit 5s	9368	669.1666667	h/y	14.0	kg/h						
OB - Drilling in Pit 6	4219	7150	holes/y	0.59	kg/hole						
OB - Drilling in Pit 5w	4219	7150	holes/y	0.59	kg/hole						
OB - Drilling in Pit 5s	8437	14300	holes/y	0.59	kg/hole						
OB - Blasting in Pit 6	14405	10	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 5w	14405	10	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Blasting in Pit 5s	28811	20	blasts/y	1441	kg/blast	35000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in Pit 6	26367	15180000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 5w	26367	15180000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Sh/Ex/FELs loading in Pit 5s	52733	30360000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from Pit 6	161920	15180000	t/y	0.0160	kg/t	150	t/truck load	4	km/return trip	0.4	kg/VKT
OB - Hauling to emplace from Pit 5w	242880	15180000	t/y	0.0240	kg/t	150	t/truck load	6	km/return trip	0.4	kg/VKT
OB - Hauling to emplace from Pit 5s	485760	30360000	t/y	0.0240	kg/t	150	t/truck load	6	km/return trip	0.4	kg/VKT
OB - Emplacing at dumps in Pit 6	26367	15180000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 5w	26367	15180000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Emplacing at dumps in Pit 5s	52733	30360000	t/y	0.0017	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in Pit 6	127925	7644	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 5w	127925	7644	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
OB - Dozers on O/B in Pit 5s	383775	22932	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in Pit 6	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 5w	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers ripping in Pit 5s	152800	7644	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in Pit 6	219548	3250000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit 5w	219548	3250000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Loading ROM to trucks in Pit 5s	439096	6500000	t/y	0.0676	kg/t	6	moisture content of coal in %				

CL - Hauling ROM coal to dump hopper from Pit 6	78000	3250000	t/y	0.0600	kg/t	150	t/load	9	km/return trip	0.4	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 5w	78000	3250000	t/y	0.0600	kg/t	150	t/load	9	km/return trip	0.4	kg/VKT
CL - Hauling ROM coal to dump hopper from Pit 5s	180267	6500000	t/y	0.0693	kg/t	150	t/load	10.4	km/return trip	0.4	kg/VKT
CL - unloading ROM coal at pile/hopper all pits	130000	13000000	t	0.0100	kg/t						
CL - ROM rehandle pile to hopper (FEL)	39000	3900000	t	0.0100	kg/t						
CL - Handling coal at CHPP	24251	13000000	t	0.0019	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - FEL pushing ROM coal	305600	15288	h/y	20.0	kg/h	5	silt content in %	6	moisture content in %		
CL - Dozers pushing product coal	57180	7644	h/y	7.5	kg/h	4	silt content in %	10	moisture content in %		
CL - Loading product coal stockpile	1642	9000000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps at Pit 6	34106	11	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 5w	143463	46	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - OB dumps at Pit 5s	143463	46	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 6	25970	8	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 5w	26596	9	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - Pit 5s	45683	15	ha	3129	kg/ha/y	73	Average number of raindays	10	silt content in %	8.2	% of winds above 5.4 m/s
WE - ROM stockpiles	3520	2	ha	1564	kg/ha/y	73	Average number of raindays	5	silt content in %	8.2	% of winds above 5.4 m/s
WE - Product stockpiles	4756	4	ha	1252	kg/ha/y	73	Average number of raindays	4	silt content in %	8.2	% of winds above 5.4 m/s
Loading coal to trains	1642	9000000	t	0.0002	kg/t	1.467	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
Grading roads	36928	60000	km	0.6155	kg/VKT	8	speed of graders in km/h				

The dust emission inventories have been formulated from the operational description of the proposed mining activities provided by Thiess. 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.

Dozers stripping topsoil
An emission rate of 14 kg/h has been used for dozers stripping topsoil and shaping overburden dumps (SPCC, 1983).

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

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

Equation 1

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

where,
A = area to be blasted in m^2

Loading material / dumping overburden
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 $0.25 \le M \le 4.8$*]*

Hauling material / product on unsealed surfaces
After the application of water the emission factor used for trucks hauling overburden or ROM coal on unsealed surfaces was 1 kg per vehicle kilometre travelled (kg/VKT). A higher level of control has been proposed for hauling from pits to emplacement areas in Years 14 and 21. The emission factor was reduced to 0.6 kg/VKT.

Dozers on overburden
Emissions from dozers on overburden have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**). The equation is as follows:

Equation 3

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

where,

$E_{TSP} = TSP\ emissions$

s = silt content (%), and

M = moisture (%)

Dozers on coal

The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in Equation 4.

Equation 4

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

where,

$E_{TSP} = TSP\ emissions$

s = silt content (%), and

M = moisture (%)

Loading 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 (%)

Unloading ROM coal and re-handling

The emission factor has been taken to be 0.01 kg/t.

Loading coal to stockpiles

See equation 2.

Loading coal to trains

See equation 2.

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

Grading roads

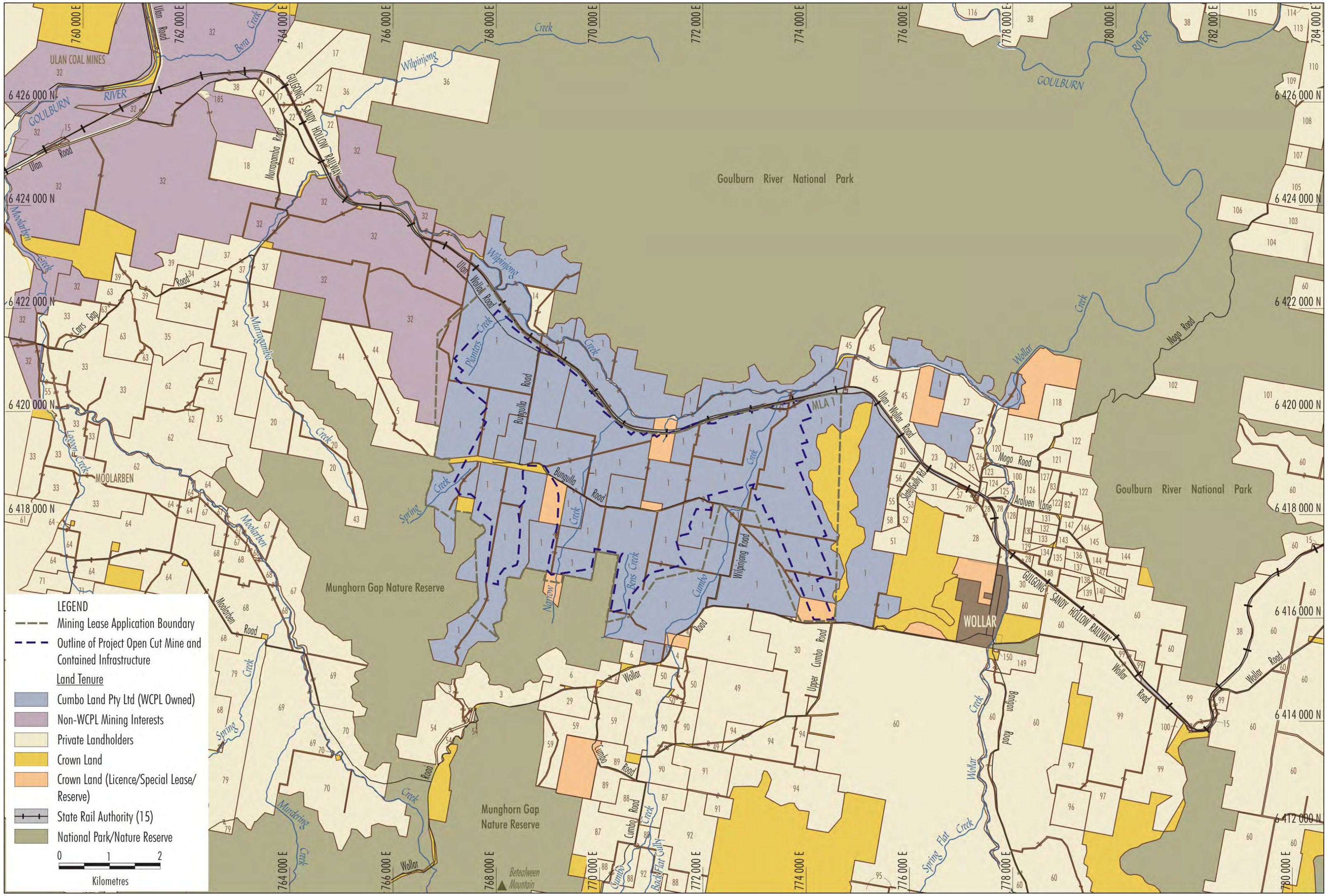
Estimated of TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (Equation 7).

Equation 7

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

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

APPENDIX C
CADASTRAL INFORMATION



Cadastral information

Figure C1