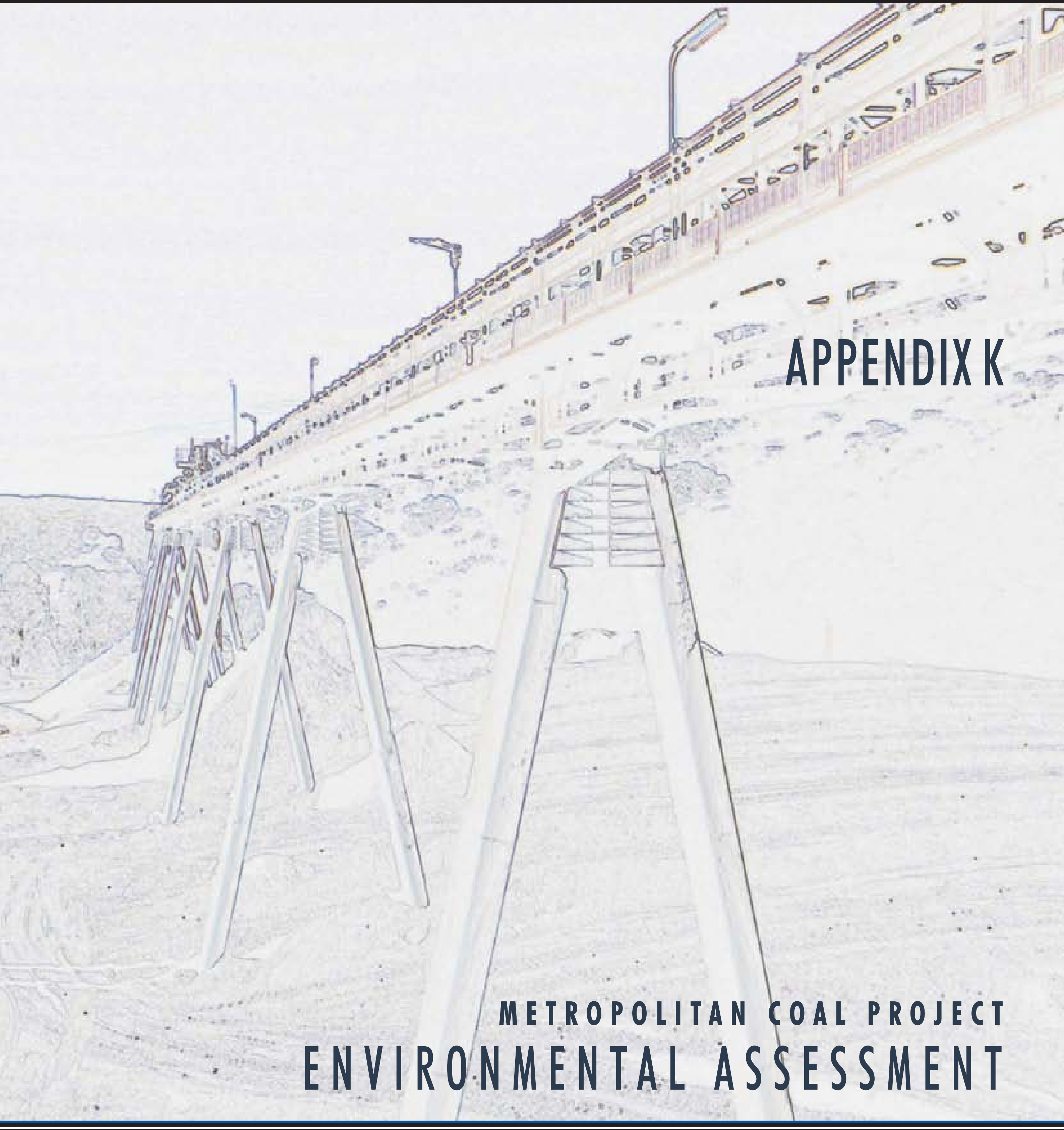

APPENDIX K

METROPOLITAN COAL PROJECT

ENVIRONMENTAL ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT: METROPOLITAN COAL PROJECT

3 June 2008

Prepared for
Helensburgh Coal Pty Ltd

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CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

(Figures are located at the end of this report)

1. INTRODUCTION

Helensburgh Coal Pty Ltd (HCPL) own and operate the Metropolitan Colliery, located approximately 30 kilometres (km) north of Wollongong in New South Wales (NSW). The Metropolitan Colliery produces approximately 1.8 million tonnes (Mt) of run-of-mine (ROM) coal and some 1.5 Mt of saleable coking and semi-hard coking coal annually. HPCL are proposing an increase in production, as well as other modifications and new facilities, to extend the life of the Metropolitan Colliery by approximately 25 years. The proposed changes to the mining operations are referred to as the Metropolitan Coal Project (the Project). An approval for the Project will be sought under Part 3A of the *Environmental Planning and Assessment Act, 1979*.

This report has been prepared by Holmes Air Sciences for HCPL. It provides an assessment of air quality impacts associated with the Project. Resource Strategies Pty Ltd is preparing the Environmental Assessment, for which this report will be a supporting appendix.

The assessment follows the procedures outlined by the NSW Department of Environment and Climate Change (DECC, formerly the Department of Environment and Conservation [DEC]) in their guidance document titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**DEC, 2005**). Consideration was also given to the requirements of the *Protection of the Environment (Clean Air) Regulation , 2002*, however the requirements of this regulation are only of limited applicability to the Project, as it is a mine, not a major chemical or industrial facility that would emit pollutants in sufficient quantities that require licensing under this regulation.

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

In summary, the report provides information on the following:

- An overview of existing air quality, including a review of the emissions from the existing Metropolitan Colliery;
- Proposed mining operations;
- Air quality criteria relevant for the Project;
- Meteorological and climatic conditions in the area;
- Methods used to estimate dust emissions from the Project;
- Expected dispersion and dust fallout patterns due to emissions from the Project;
- Comparisons of model predictions with relevant air quality assessment criteria, including the consideration of cumulative effects; and
- Greenhouse gas emissions.

Odour from the mine ventilation system is also addressed.

2. PROJECT DESCRIPTION

The Metropolitan Colliery is an underground coal mining operation located near Helensburgh and approximately 30 km to the north of Wollongong. **Figure 1** shows the location of the Metropolitan Colliery major surface facilities area, the coal lease boundary and the existing and proposed underground mining areas.

Helensburgh is a town in the Wollongong Local Government Area, bounded by the Garawarra State Conservation Area and Royal National Park to the north and east and the F6 Southern Freeway to the west. Helensburgh is approximately 5 km from the east coast, although the typical elevation is around 250 metres (m) above mean sea level. To the eastern side of Helensburgh, the terrain falls sharply via Helensburgh Gully and Camp Gully, which lead to the Metropolitan Colliery major surface facilities area. The complex terrain around the major surface facilities area is shown by **Figure 2**.

Under the existing Metropolitan Colliery operations, coal is extracted from the underground mining operations and transferred by conveyor to the coal handling and preparation plant (CHPP) or the ROM coal stockpile at the major surface facilities area. The ROM coal is then crushed, screened and washed at the CHPP before being transferred by conveyor to the product stockpiles. The majority of the product coal (approximately 90%) is loaded (by front-end-loader) to trains for transport to the Port Kembla Coal Terminal. Approximately 10% of product coal is transported by truck to the Corrimal and Coalcliff Coke Works. Coal reject from the CHPP is transported by truck to the Glenlee Washery (approximately 25 km from the Metropolitan Colliery) for disposal. Existing underground mining operations produce up to 1.5 million tonnes per annum (Mtpa) of product coal.

It is proposed to continue the underground mining operations to the north of the current longwall mining areas. These operations would extend the life of the Metropolitan Colliery by approximately 25 years. The Project would use existing surface and underground facilities at the Metropolitan Colliery, however some new facilities (for example, an additional ventilation shaft) and modifications to the major surface facilities area would be developed. **Figure 3** shows the layout of the major surface facilities area.

Some of the key components of the Project include the following:

- Ongoing surface and underground exploration activities in the Project underground mining area and surrounds;
- Continued development of underground mining operations within existing HCPL mining and coal leases and two new Mining Lease Application areas;
- Increasing production from 1.8 to 3.2 Mtpa of ROM coal;
- Increasing CHPP throughput from approximately 400 to 600 tonnes per hour (tph);
- Continued transport of coal reject to the Glenlee Washery;
- Continued transport of product coal by road to the Corrimal and Coalcliff coking plants (loaded by front end loader);
- Construction of a coal reject paste backfill plant and associated coal reject stockpile and underground delivery systems; and
- Transporting of product coal by train 24 hours per day and seven days per week.

Underground mining operations would continue to be conducted up to 24 hours per day, seven days per week.

A provisional materials schedule for Project operations is provided in **Table 1**. Two air quality modelling scenarios have been developed (highlighted cells), based on the provisional schedule (**Table 1**). Year 3 includes the operation of a short-term surface stockpile for coal rejects, with haulage from the CHPP to a location east of the current product stockpile (refer **Figure 3**). Production in Year 3 would have increased marginally to approximately 2.1 Mtpa ROM coal.

Year 15 represents the anticipated peak year for Project production and materials handling. There would be continued road transport of coking coal at 120,000 tpa and rail transport at a maximum (approximately 2.6 Mtpa). An additional upcast ventilation shaft would have been installed to complement the existing upcast ventilation shaft by Year 15.

Table 1 : Provisional materials schedule for the Project

Year	Total ROM coal (Mtpa)	Total coking coal (Mtpa)	Total thermal coal (Mtpa)	Total coal reject (Mtpa)
1	1.80	1.53	0.03	0.24
2	1.91	1.62	0.03	0.26
3	2.13	1.81	0.03	0.29
4	2.50	2.12	0.04	0.34
5	2.45	2.08	0.04	0.33
6	2.60	2.21	0.04	0.35
7	2.61	2.22	0.04	0.35
8	2.61	2.22	0.04	0.35
9	2.72	2.31	0.04	0.37
10	2.86	2.43	0.04	0.39
11	2.91	2.48	0.04	0.39
12	3.06	2.60	0.05	0.41
13	3.10	2.63	0.05	0.42
14	2.99	2.54	0.05	0.40
15	3.19	2.71	0.05	0.43
16	3.02	2.56	0.05	0.41
17	3.03	2.58	0.04	0.41
18	2.86	2.43	0.04	0.39
19	2.97	2.53	0.04	0.40
20	3.03	2.58	0.04	0.41
21	3.15	2.68	0.04	0.43
22	2.80	2.38	0.04	0.38
23	2.60	2.21	0.04	0.35
Total	**62.90**	**53.46**	**0.94**	**8.50**

3. AIR QUALITY CRITERIA

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

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

Table 2 : DECC assessment criteria for particulate matter concentrations

Pollutant	Criterion	Averaging period
Total suspended particulate matter (TSP)	90 µg/m³	Annual mean
Particulate matter less than 10 microns in size (PM_{10})	50 µg/m³	24-hour maximum*
	30 µg/m³	Annual mean

* *This goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best-practice dust control measures.*
µg/m³ = micrograms per cubic metre

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

Table 3 : DECC criteria for dust fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

g/m²/month = grams per square metre per month

4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing air quality in the area. The existing air quality conditions will be influenced to some degree by the existing operations of the Metropolitan Colliery.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[1] and mixing height[2]. There are no weather stations near the major surface facilities area that measure the meteorological parameters necessary for air dispersion modelling. Notwithstanding, the Bureau of Meteorology station located at Lucas Heights, some 15 km to the north, provides general climatic conditions (see **Section 4.2**). Data for the dispersion model have been generated using the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) prognostic model known as The Air Pollution Model (TAPM) (Version 3.0).

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**). TAPM uses information such as terrain and landuse data to predict meteorological data on a smaller scale. The model is discussed further in the accompanying user manual (see **Hurley, 2002**). TAPM is able to generate all meteorological parameters required by the air dispersion model.

TAPM was used to generate meteorological parameters at the Metropolitan Colliery site for the 2007 calendar year. The centre of the TAPM grid was at 34.18 degrees south and 151.00 east, which approximately corresponds with the centre of the largest coal stockpile on the Metropolitan Colliery site.

Due to the highly variable topography and its effect on wind direction and speed, use of TAPM generated data sets at 10 m above ground-level is considered to be more representative than relying on regional weather station data or short term on-site data.

As noted above, the wind speed and wind direction data required for modelling have been taken from the TAPM model simulation for 2007. Annual and seasonal wind roses have been prepared from the TAPM generated data for levels at 10 and 100 m above local ground-level for a point located approximately on the product stockpile.

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

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

The wind roses for 10 and 100 m are shown in **Figure 4** and **Figure 5** respectively. Both levels show a similar distribution of wind directions, but the winds at 100 m elevation are (as expected) significantly stronger than those at 10 m elevation. Also, there are some important and interesting differences in the distribution of winds with direction.

Over the year, at 10 m above ground, the most common winds are from the west, followed by a significant occurrence of winds from the south-southeast. In summer the most common winds are from the northeast, north-northwest and southeast. In winter, the dominant winds are from the west while in autumn and spring, winds from the west or south to south-southeast prevail (**Figure 4**).

The annual average wind speed at 10 m elevation was 3.5 metres per second (m/s) and at 100 m elevation it was 6.6 m/s.

The main difference between the 10 and 100 m elevation winds is in the wind speed, but interestingly, the north-northeast winds that are present at 100 m elevation are much reduced at 10 m elevation. This is almost certainly a consequence of the shielding afforded by the valley in which the major surface facilities area is located. The valley shape would block winds that would otherwise be observed at the 100 m elevation. Thus the TAPM generated data may provide a more realistic representation of wind patterns in the valley than weather stations located outside the valley at further distances from the main sources of dust at the major surface facilities area.

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. TAPM estimates atmospheric stability from the synoptic analyses and land-use data it is provided in order to run. **Table 4** shows the frequency of occurrence of the stability categories expected in the area.

The most common stability class in the area of the major surface facilities was determined to be D class at 33.7%. It is under these conditions that pollutant emissions will disperse rapidly.

Table 4 : Frequency of occurrence of stability classes in the study area

Stability Class	Metropolitan Colliery major surface facilities area (2007 by TAPM)
A	5.3
B	14.0
C	9.8
D	33.7
E	16.2
F	21.0
Total	100

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

4.2 Local Climatic Conditions

The Bureau of Meteorology collects climatic information at Lucas Heights, approximately 15 km to the north of Helensburgh. A range of climatic information collected from the Lucas Heights site are presented in **Table 5** (**Bureau of Meteorology, 2008**).

Table 5 : Climate information for Lucas Heights

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (Degrees C)	25.9	26	24.7	22.3	18.9	16.2	15.8	17.2	19.5	21.6	23.4	25.7	21.4	21
Mean minimum temperature (Degrees C)	17.4	17.6	16.1	13.3	10.1	8.2	6.6	7.4	9.4	11.9	13.7	15.9	12.3	21
Mean rainfall (mm)	96.2	104.6	112.2	91.4	81.1	100.8	59.7	73.3	52.6	72.9	92.5	81.5	1018.2	50
Mean number of days of rain	11.1	11.2	12	9.5	9.7	9.6	7.6	8	8.2	10	11	10.3	118.2	49
Mean number of clear days	5.4	4.8	5.8	10.5	9.9	8.8	12.6	11.9	10	6.7	6.9	6.2	99.5	20
Mean number of cloudy days	16.4	12.2	13.6	9.4	10.9	10.7	6.6	8.2	9.2	13.2	12.3	13.6	136.3	20
Mean 9am temperature (Degrees C)	21.3	21.4	20.3	17.8	14.1	11.6	10.5	12	14.6	17.2	18.8	20.6	16.7	20
Mean 9am relative humidity (%)	72	74	73	70	72	73	68	65	63	64	66	67	69	20
Mean 3pm temperature (Degrees C)	24.2	24.3	23.1	21	17.7	15.2	14.8	16	18	19.6	21.5	23.7	19.9	20
Mean 3pm relative humidity (%)	62	63	63	58	58	61	52	51	52	57	57	57	57	20

Climate averages for Station: 066078 Lucas Heights ANSTO, Commenced: 1958; Last record: 2008; Latitude (deg S): -34.051; Longitude (deg E): 150.9800; State: NSW. Source: ***Bureau of Meteorology (2008)*** *website.*

Temperature data from **Table 5** indicate that the warmest month is February and the coolest is July with the mean daily maximum temperatures of 26.0 and 15.8°C respectively. The mean daily minimum temperature follows the same pattern with the warmest month being February and the coolest being July with mean daily minimum temperatures of 17.6 and 6.6°C respectively.

Humidity data indicate that the mean of the 9 am relative humidity observations are highest in February and lowest September, with values of 74% and 63% respectively. The mean of the 3 pm observations are highest in February and March (63%) and lowest in August (51%).

Over the year, rain falls on an average of 118 days and the month with the highest and lowest monthly average rainfalls are March (112.2 mm) and September (52.6 mm).

Other statistical measures of climate are also shown in **Table 5**.

4.3 Existing Air Quality

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

Dust deposition and dust concentration (PM_{10}) is monitored in the study area. The locations of the monitoring sites are shown in **Figure 6**. There is one high volume air sampler, measuring PM_{10}, and six dust deposition gauges.

4.3.1 Dust Concentration

Table 6 shows the results of PM_{10} monitoring by the high volume air sampler (HV1) at Helensburgh. The monitor is located close to the Metropolitan Colliery and within the residential area of Helensburgh (refer **Figure 6**) and would measure the contribution from a range of particulate matter sources, including local traffic, lawn mowing activities, as well as local industry and the dust sources associated with the existing Metropolitan Colliery operations. Data have been collected on every sixth day since 5 May 2007.

Table 6 : Measured 24-hour average PM_{10} concentrations at Helensburgh

Date	Measured 24-hour average PM_{10} by high volume air sampler (µg/m^3) DECC criterion = 50 µg/m^3
05-May-07	28
11-May-07	15
17-May-07	20
23-May-07	10
29-May-07	19
04-Jun-07	12
10-Jun-07	13
16-Jun-07	8
22-Jun-07	12
28-Jun-07	11
04-Jul-07	12
10-Jul-07	7

Table 6: Measured 24-hour average PM_{10} concentrations at Helensburgh (Continued)

Date	Measured 24-hour average PM_{10} by high volume air sampler ($\mu g/m^3$) DECC criterion = 50 $\mu g/m^3$
16-Jul-07	9
22-Jul-07	14
28-Jul-07	5
03-Aug-07	12
09-Aug-07	16
15-Aug-07	10
21-Aug-07	14
27-Aug-07	10
02-Sep-07	20
08-Sep-07	8
14-Sep-07	16
20-Sep-07	16
26-Sep-07	16
2-Oct-07	20
8-Oct-07	13
14-Oct-07	15
20-Oct-07	36
26-Oct-07	10
1-Nov-07	21
7-Nov-07	7
13-Nov-07	14
19-Nov-07	19
25-Nov-07	11
Average (5-May-07 to 25-Nov-07)	**14**[1]

[1] *Following completion of this report, additional measured 24-hour PM_{10} data was received from HCPL's high volume air sampler. Analysis of a complete 12 months of data (i.e. May 2007 to May 2008) gave a measured 24-hour average PM_{10} of 14 (i.e. no material change to that presented in Table 6).*

The PM_{10} monitoring shows that 24-hour average concentrations have generally been well below the DECC's 24-hour assessment criterion of 50 $\mu g/m^3$. The highest 24-hour PM_{10} concentration recorded to date was 36 $\mu g/m^3$, measured on 20 October 2007.

From the six months of monitoring data that are available the average PM_{10} concentration is 14 $\mu g/m^3$. This is well below the DECC's annual average criterion of 30 $\mu g/m^3$

Annual average TSP concentrations can be estimated from the PM_{10} measurements by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**). Use of this relationship indicates that annual average TSP concentrations are around 35 $\mu g/m^3$ which is below the DECC assessment criterion of 90 $\mu g/m^3$.

In NSW, it is quite common to measure 24-hour average concentrations above the DECC criterion of 50 $\mu g/m^3$ on occasions. Events such as bushfires or dust storms are often the cause of elevated PM_{10} concentrations, which can be observed over large geographical areas.

4.3.2 Dust Deposition

Monthly dust deposition rates have been measured at four sites (DG1, DG2, DG3 and DG4) (see **Figure 6** for locations) since December 2002. DG1 is located at 15 Old Station Road on the side of a driveway. DG2 is located at 28 Station Road, at the rear of a private house. DG3 is located at the Mine Manager's residence adjacent to a garage and DG4 is at 355 Princess Highway Helensburgh (at the Helensburgh Golf Course). DG4 is sufficiently remote from the Metropolitan Colliery to provide information representative of areas that are not affected by emissions from the existing major surface facilities area. Two additional sites (DG5 and DG6) were added around November 2006 and are located to the west and north-west of the major surface facilities area, on Parkes Street.

Data collected from the dust deposition gauges from 2003 to 2007 are presented in **Table 7**. Annual average dust deposition (insoluble solids) rates for all sites have been in the range of 1.1 to 2.9 g/m^2/month. Although there is some variability in the data, there is no clear evidence that any of the sites that are potentially affected by emissions from the Metropolitan Colliery have recorded deposition levels that are significantly higher than the dust deposition levels recorded at the background station (DG4 – Golf Course). All sites have measured annual average dust deposition below the 4 g/m^2/month (all sources) criterion advocated by the DECC.

Table 7 : Measured dust deposition around Helensburgh

Year	Annual average dust deposition (insoluble solids) (g/m^2/month) DECC criterion = 4 g/m^2/month					
	DG1 15 Old Station Road - EPA ID No 1	DG2 28 Old Station Road - EPA ID No 2	DG3 Mine Entrance - EPA ID No 3	DG4 Helensburgh Golf - EPA ID No 4	DG5 83 Parkes St. - EPA ID No. 5	DG6 55 Parkes St.
2003	2.4	1.4	2.1	2.1	-	-
2004	2.6	1.1	2.2	2.5	-	-
2005	1.9	1.6	2.1	2.4	-	-
2006	2.9	1.7	2.2	2.0	-	-
2007	2.8	1.3	1.2	2.6	1.3	1.4

In 2007 the average deposition from all gauges was 1.8 g/m^2/month.

4.3.3 Complaint Data

In accordance with the requirements of the Metropolitan Colliery Environment Protection Licence (EPL), a log of complaints has been kept by HCPL and a summary of the dust complaints from 2003 to 2007 is shown below in **Table 8**. Complaints can provide a useful insight into the nature of nuisance from a facility. In addition to air quality monitoring, complaints can also act as a performance indicator and zero or very few complaints from residences nearby would typically suggest very little nuisance impacts. Another performance indicator is air dispersion modelling, the results of which are discussed in **Sections** 7 and **8**.

Table 8 : Dust related complaints since 2003

Year	Number of dust related complaints
2003	11
2004	6
2005	3
2006	3
2007	4

Based on the monitoring data presented above, the PM_{10} concentrations in the residential areas are below air quality assessment criteria, suggesting that human health is not compromised in the residential areas. Measured dust deposition levels are also below the assessment amenity criteria.

However, the ongoing register of some dust related complaints suggest that there are still some occasional nuisance impacts observed by residents that may be attributable to activities associated with the Metropolitan Colliery. From review of the information since 2003, dust related complaints can be at any time of day. It is likely that dry windy conditions would be most conducive to causing off-site impacts.

Most of the complaints relating to air quality suggested that dust or coal dust was settling on a residents property. One explanation may be that there is an accumulation of dust over long periods of time which may be visible but still complies with the DECC's assessment criteria for dust deposition. It is noted from **Table 8** that there has been a marked decrease in the number of dust related complaints since 2003.

4.3.4 Ventilation Shaft Measurements

HLA-Envirosciences (HLA-ENSR) measured emissions from the existing upcast ventilation shaft (No. 3) at the Metropolitan Colliery in March 2007. The testing was carried out in accordance with the procedures identified in the NSW DECC document "Approved Methods for the Sampling and Analysis of Air Pollutants in NSW" (**DECC, 2007**).

Results from the ventilation shaft testing are summarised in **Table 9** (**HLA-ENSR, 2008**).

Table 9 : Summary of measurement results for existing ventilation shaft

Parameter	Result
Odour measurement: sample 1	197 odour units (ou)
Odour measurement: sample 2	152 ou
Average of 2 odour samples	175 ou
TSP concentration	0.42 milligrams per normal cubic metre (mg/Nm^3)
CO_2	0.32%
Flow rate*	107.4 Am^3/s (90.2 Nm^3/s)
Temperature	36.5 deg C
Diameter	2.87 m

Notes: Am^3/s = Actual cubic metres per second
Nm^3/s = Normal cubic metres per second
** Lower than the operational flow rate of 238 Am^3/s, due a "change in diameter" disturbance at the sampling location (**HLA-ENSR, 2008**). For conservatism, the higher flow rate of 238 Am^3/s was used for calculation of TSP mass emission rate and dust modelling. For the odour modelling, the exit velocity was calculated from the lower flow rate, as measured.*

The measurement data shown in **Table 9** have been used to determine dust and odour emissions from the existing and proposed additional vent shaft.

5. ESTIMATED PROJECT DUST EMISSIONS

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

The operations which apply in each case have been combined with emission factors developed, both locally and by the **US EPA (1985 and updates)**, to estimate the amount of dust produced by each activity. This study draws on US EPA emission factors for mining operations that were subject to significant revisions in 2003. The emission factors applied are considered to be the most up to date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The assessment has considered two key Project scenarios; namely, Year 3 and Year 15. The operational description for the Project has been used to determine haul road distances and routes, stockpile areas and locations, activity operating hours, truck sizes and other details necessary to estimate dust emissions for each year.

The most significant dust generating activities from the Project operations have been identified and the dust emission estimates during the two operational years selected (Years 3 and 15) are presented below in **Table 10**.

Details of the dust emission calculations are presented in **Appendix B**. The estimated emissions take account of existing and proposed air pollution controls including passive controls such as sealed lengths of applicable internal haul roads. Active controls such as the intensity of dust suppression watering are also considered in the emission calculations.

Table 10 : Estimated dust emissions due to proposed mining operations

ACTIVITY	Annual TSP emission rate (kg/year)	
	Year 3	Year 15
Loadout to ROM coal stockpile/bin	51	76
Dozer working on ROM coal stockpile	4,400	5,720
FEL loading ROM coal from stockpile to crusher	51	76
Transfer from underground to crusher (enclosed, 70% reduction)	138	206
Primary and secondary coal crushing (enclosed, 70% reduction)	153	229
Transfer from crusher to CHPP (enclosed, 70% reduction)	153	229
Handling of coal at CHPP (enclosed, 70% reduction)	459	687
Loading to product coal stockpiles	690	1,036
Dozer working on product coal stockpiles	47,523	61,780
FEL loading product coal to trucks	45	45
Loading product coal to trains (FEL)	645	991
Hauling coal reject to temporary stockpile (y3) / backfill plant (y15)	1,544	16,212
Hauling product coal off-site (unsealed road)	4,444	4,444
Hauling product/coal reject off-site (sealed road)	4,385	1,541
Wind erosion from ROM stockpile	130	130
Wind erosion from product coal stockpiles	1,955	1,955
Ventilation shaft emissions	3,152	7,192
Total dust (kg)	**69,918**	**102,549**
Annual ROM production (t)	**2,130,000**	**3,190,000**
Ratio of dust to production (kg/t)	**0.03**	**0.03**

6. APPROACH TO ASSESSMENT

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

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

The model used was a modified version of the US EPA ISCST3 model, referred to as ISCMOD (see discussion later in this section). The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995**).

The modelling has been based on the use of three particle-size categories; namely $PM_{2.5}$ (particles in size range 0 to 2.5 µm), $PM_{2.5-10}$ (particles in size range 2.5 to 10 µm) and PM_{10-30} (particles in size range 10 to 30 µm). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA (see **Appendix B**).

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

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

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

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

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

Mining operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. **Figure 7** shows the location of the modelled sources, where each of the dust generating activities listed in **Table 10** is assigned to one or more of these source locations (**refer Appendix B**).

Dust concentrations and deposition rates have been predicted over the extent of **Figure 1** with the Metropolitan Colliery major surface facilities located approximately in the centre. Model predictions have been made at 287 discrete receptors, including residential locations, located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearest sensitive areas whilst still maintaining acceptable model run times.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. Local terrain has been included in the modelling. Emissions associated with loading trucks and road haulage of product coal and coal reject by truck have been modelled between the hours of 7 am and 5 pm. All other activities have been modelled for 24 hours per day. **Appendix B** provides a summary of dust emissions, hours of emission and allocation of sources for each activity.

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

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

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

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

In addition, the cumulative impacts of the Project have been assessed by adding model predictions made at locations representative of nearest privately-owned residences (see **Figure 7**) to levels measured by the air quality monitors (refer **Section 4.3**). Predictions were then compared with the current DECC assessment criteria.

7. ASSESSMENT OF DUST IMPACTS

Dust concentrations and deposition rates for the selected years of assessment (Years 3 and 15) have been presented as isopleth diagrams in **Figure 8** and **Figure 9**. These figures include the following:

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

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

The contour plots show predicted concentrations and deposition levels due only to modelled dust sources associated with the Project. That is, the predictions do not include contributions from other sources.

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

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

Figure 8 shows model predictions for Year 3. As expected, the highest levels are predicted to be centred around the surface activities. A contribution to ground-level concentrations and deposition levels is also evident from the ventilation outlet to the south-west of the Metropolitan Colliery major surface facilities area.

For Year 3, maximum 24-hour average PM_{10} concentrations are predicted to be less than 50 $\mu g/m^3$ at the nearest residential areas (marked by the yellow squares) to the north and west of the major surface facilities area. Annual average PM_{10} concentrations for Year 3 are predicted to be less than 5 $\mu g/m^3$ or less, at nearest residential areas and TSP concentrations are predicted to be less than 10 $\mu g/m^3$. Note that background concentrations need to be considered for annual average PM_{10} and TSP when comparing the model predictions with the air quality criteria (refer **Section 3**).

Dust deposition at the nearest residential areas is predicted to be 1 g/m^2/month or less for Year 3 operations. This is below the 2 g/m^2/month criterion for the Project considered alone.

Model results for Year 15 (see **Figure 9**) show a similar pattern of dispersion to Year 3 predictions but are slightly higher. This increase reflects the increase in coal handling from 1.8 to 3.2 Mtpa. By Year 15, an additional ventilation outlet would be located to the north-west of the Colliery. At the nearest privately owned residences, the model predictions still suggest compliance with air quality criteria. For maximum 24-hour average PM_{10} the predicted contribution from the mine is less than 50 µg/m^3. For annual average PM_{10} and TSP, model predictions are of the order of 10 and 15 µg/m^3 respectively at the nearest privately owned residences. Annual average dust deposition predictions are 1 g/m^2/month or less.

The model predictions for the nearest residences are summarised in **Table 11**. This table shows the contribution from the mining operations only and does not include background concentrations. **Figure 7** shows the locations of the modelling points selected to be representative of the nearest residences listed in **Table 11**.

It can be seen from **Table 11** that no adverse air quality impacts are expected from Year 3 or Year 15 operations, although maximum 24-hour average PM_{10} concentrations approach the 50 µg/m^3 for "P50" (49 µg/m^3) in Year 15. As discussed in **Section 2**, Year 15 represents the anticipated peak year for mine production and materials handling. Dust emissions would be expected to be highest in Year 15.

Table 11 : Project only predictions at locations representative of nearest residences

Location	Prediction due to Year 3	Prediction due to Year 15	Project only criteria
Maximum 24-hour average PM_{10} concentrations (µg/m^3)			
O2	15	19	50
O18	13	15	50
P86	13	16	50
P59	14	19	50
P53	16	22	50
P50	33	49	50
P46	29	40	50
F17	28	37	50
F19	28	38	50
Annual average PM_{10} concentrations (µg/m^3)			
O2	1	1	-
O18	1	1	-
P86	1	1	-
P59	1	1	-
P53	1	1	-
P50	3	4	-
P46	2	3	-
F17	3	4	-
F19	2	3	-
Annual average TSP concentrations (µg/m^3)			
O2	2	2	-
O18	2	2	-
P86	1	1	-
P59	1	2	-
P53	2	2	-
P50	5	7	-
P46	4	5	-
F17	5	7	-
F19	4	6	-

Table 11 : Project only predictions at locations representative of nearest residences (Continued)

Location	Prediction due to Year 3	Prediction due to Year 15	Project only criteria
Annual average dust deposition (g/m²/month)			
O2	0.3	0.2	2
O18	0.3	0.2	2
P86	0.1	0.1	2
P59	0.1	0.2	2
P53	0.2	0.2	2
P50	0.6	0.9	2
P46	0.5	0.8	2
F17	0.9	1.2	2
F19	0.6	0.9	2

To assess cumulative air quality impacts the background PM_{10}, TSP and deposition levels have been added to the model predictions and the results are shown in **Table 12**. The results can be compared with the relevant cumulative air quality criteria to assess compliance.

From **Table 12** it can be seen that none of the nearest sensitive receptor locations are predicted to experience cumulative concentration or deposition levels above the DECC assessment criteria. Note that the measured levels would be expected to already include some contribution from the existing Metropolitan Colliery operations, so the approach of added measured levels to predicted Project levels involves some element of double-counting and is conservative.

Table 12 : Cumulative predictions at locations representative of nearest residences

Location	Measured (or inferred) background level (from **Section 4.3**)	Prediction due to Year 3 including background	Prediction due to Year 15 including background	Cumulative criteria
Annual average PM_{10} concentrations (µg/m³)				
O2	14	15	15	30
O18	14	15	15	30
P86	14	15	15	30
P59	14	15	15	30
P53	14	15	15	30
P50	14	17	18	30
P46	14	16	17	30
F17	14	17	18	30
F19	14	16	17	30
Annual average TSP concentrations (µg/m³)				
O2	35	37	37	90
O18	35	37	37	90
P86	35	36	36	90
P59	35	36	37	90
P53	35	37	37	90
P50	35	40	42	90
P46	35	39	40	90
F17	35	40	42	90
F19	35	39	41	90
Annual average dust deposition (g/m²/month)				
O2	1.8	2.1	2.0	4
O18	1.8	2.1	2.0	4
P86	1.8	1.9	1.9	4
P59	1.8	1.9	2.0	4
P53	1.8	2.0	2.0	4
P50	1.8	2.4	2.7	4
P46	1.8	2.3	2.6	4
F17	1.8	2.7	3.0	4
F19	1.8	2.4	2.7	4

In terms of the cumulative air quality impacts of 24-hour average PM_{10} concentrations, the DECC's criterion of 50 µg/m³ has been interpreted as a Project-specific goal. This carries the assumption that the Project operates with best practice dust control measures. The measures which are already employed at the Metropolitan Colliery major surface facilities area are generally regarded as best practice measures for minimising emissions from the dust generating activities and these measures would continue to be implemented for the Project.

These measures include (**HCPL, 2008**):

- Watering of unsealed haul roads and hardstand areas;
- Enclosure of crushing and screening processes;
- Enclosure of transfer conveyors;
- Fixed water sprays located on conveyors and stockpiles (sprays can be operated manually or automatically by wind speed and direction sensor);
- Truck wash for all heavy vehicles travelling off-site;
- Progressive sealing of car parks and yard areas; and
- Fixed speed limits for all roads around the surface facilities.

It is also understood that HCPL is also currently trialling the use of dust suppressant products on haul road surfaces at the Metropolitan Colliery major surface facilities area. While this has not been included in the modelling, if implemented this could potentially further reduce dust emissions from related activities.

In practice, the dust emissions are likely to be controlled beyond the level assumed in the modelling, however given that the air dispersion modelling has predicted 24-hour average PM_{10} concentrations that approach the 50 µg/m³ criterion (49 µg/m³ at P50 in Year 15), it would be useful to extend the dust mitigation measures to include a real-time dust monitoring system.

A real-time dust monitoring system would potentially help to identify activities that may lead to off-site air quality impacts. The monitoring can be used to assess compliance with the DECC's ambient air quality criteria and access to the data in real-time may enable site operators to modify activities, as required, to minimise dust emissions and off-site impacts.

Dust management measures at the Metropolitan Colliery are detailed in an existing Dust Management Plan, which would be updated for the Project. The operation of the real-time dust monitoring system and operational controls at the major surface facilities area that could be implemented during adverse conditions based on the real-time monitoring results would be detailed in the updated Project Dust Management Plan.

This would include review of daily weather forecasts to anticipate dry windy weather so as to facilitate appropriate management measures for stockpiles and other potential dust generating areas (e.g. such that these areas are sufficiently wetted for dry windy conditions).

Real time will involve identifying the most affected receptor and the installation of a PM_{10} monitor at this location. Data would be available in real-time to the environmental officer who would investigate the causes of dust levels exceeding a pre-set limit and take appropriate corrective action should the investigation reveal that emissions from the colliery are the cause of the alert.

The dispersion modelling also cannot exclude the possibility that 24-hour average PM_{10} concentrations exceed 50 $\mu g/m^3$ in Helensburgh from time to time. The measurement data (refer **Section 4.3.1**) have shown that there have been no exceedances of 50 $\mu g/m^3$ although it is quite common for many parts of NSW to experience 24-hour average PM_{10} concentrations above 50 $\mu g/m^3$ on a number of occasions each year. The exceedances are most often due to widespread naturally occurring events such as dust storms or bushfires.

Clearly, if the background levels on a given day approach 50 $\mu g/m^3$, the potential for Project related dust emissions to contribute to exceedances at nearest sensitive receptor locations also increases.

8. ASSESSMENT OF ODOUR IMPACTS

Odour measurements were made by HLA-ENSR on the air in the existing upcast ventilation shaft (No. 3) at Metropolitan Colliery (refer **Section 4.3.4**). The measurements showed that the odour concentration in the air was very low at an average of 175 odour units (ou). Nevertheless, odour dispersion modelling (using AUSPLUME Version 6.0) has been carried out to predict the resultant ground-level odour concentrations in the vicinity of the existing and proposed vent shafts.

The modelling took into account the local topography and meteorology. **Table 13** provides information on the source location and emissions characteristics. The modelling was carried out in accordance with DECC guidelines for the modelling and assessment of air pollutants (**DEC, 2005**).

Table 13 : Information used for modelling odour from ventilation shaft

Location (MGA easting and northing, m) and base elevation (m)	Existing (No. 3): 312446, 6213601, 306 Proposed (No. 4): 313526, 6216637, 288
Height (m)	5
Diameter (m)	2.87
Flow rate (m^3/s)	107.4^+
Velocity (m/s)	16.6
Temperature (deg C)	36.5
Odour concentration (odour units)	175
Odour emission rate (ou.m^3/s)	18795
Nose-response odour emission rate (ou.m^3/s) (peak-to-mean* of 2.3)	43229

** This is as measured (see Table 9) and lower than existing and proposed operational conditions. The lower flow rate has been used for the odour modelling which is consistent with the odour sample conditions. The assumed lower flow rate also results in a lower and more conservative exit velocity for the modelling.*
** Ratio of peak 1-second average concentrations to mean 1-hour average concentrations*

Predicted odour levels at the 99th percentile have been compiled from the model results, for consistency with DECC odour criteria, and contour plots are shown in **Figure 10**. The DECC odour criteria is 2 ou at the 99th percentile, for populations of 2,000 or more. The model results demonstrate compliance with the DECC criteria by a large margin. As such, no adverse odour impacts are predicted for the vent shaft in its existing location or with the additional vent shaft.

9. GREENHOUSE GAS EMISSIONS AND ASSESSMENT

9.1 Introduction

A number of conventions on the determination, assessment and the reporting of greenhouse gas (GHG) emissions from human activity have been developed. These are discussed in the Commonwealth Department of Climate Change (DCC) document titled *National Greenhouse Accounts Factors* (the NGA Factors) (**DCC, 2008**). The NGA Factors define two types of greenhouse gas emissions, as follows:

> ***Direct emissions*** *are produced from sources within the boundary of an organisation and as a result of the organisation's activities.*
>
> …
>
> ***Indirect emissions*** *are emissions generated in the wider community as a consequence of an organisation's activities (particularly from its demand of goods and services, but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity…*

To help delineate direct and indirect emissions, the NGA Factors defines "scopes" of emissions for emission accounting purposes. The scope that emissions are reported under in the NGA Factors is determined by whether the activity is within the organisation's boundary (that is direct-scope 1) or outside it (for example, indirect-scope 2), with an "emission factor" relevant to each activity (**DCC, 2008**). The NGA Factors adopts the emission factors listed in the *Technical Guidelines from the Estimation of Greenhouse Emissions and Energy at Facility-Level* (**DCC, 2007**), as follows:

- ***Direct (or point source) emission factors*** *give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate* ***scope 1 emissions.***

- ***Indirect emission factors*** *are used to calculate* ***scope 2 emissions*** *from the generation of electricity (or steam or heating/cooling)* ***purchased and consumed*** *by the reporting organisation as Kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fossil fuels (coal, natural gas, etc) at the power station or facility.*

In addition, Scope 3 emissions include all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation.

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

The Kyoto Protocol identifies GHGs as follows:

- Carbon dioxide (CO_2);
- Methane (CH_4);

- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulfur hexafluoride (SF_6).

CO_2 and N_2O are formed and released during the combustion of gaseous, liquid and solid fuels. The most significant gases for the Project are CO_2 and CH_4, which would be liberated when fuel is burnt in diesel engines, through electricity consumption and from the coal seam gas flaring or venting.

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

The global warming potentials assumed by the **DCC (2008)** for emission factors are as follows:

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

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

The emission factors published by the **DCC** (**2008**) have been used to convert fuel usage, gas flaring and gas venting emissions into CO_2-e emissions. **Table 14** below outlines the key CO_2-e emission sources and respective scope of emissions.

Table 14 : Summary of Project CO_2-e emission sources

Project Component	Direct Emissions (Scope 1)	Indirect Emissions (Scope 2)	Indirect Emissions (Scope 3)
Consumption of diesel fuel to power on-site equipment	Emissions from the combustion of diesel during operations	N/A	Emissions attributable to the extraction of diesel fuel
Electricity consumption	N/A	Emissions from the generation of the electricity consumed during operations	Emissions attributable to the extraction of fuel used in electricity generators
Coal extraction (Gas flaring and ventilation)	Emissions resulting from venting or burning CH_4 and venting CO_2	N/A	N/A
LPG consumption	Emissions from LPG consumption in the methane flare unit generator		Emissions attributable to the extraction and production of LPG
Transporting product and reject coal by truck	N/A	N/A	Emissions from the combustion of diesel from third-party truck operators
Transporting product coal by train	N/A	N/A	Emissions from the combustion of diesel from third-party train operators
Steelmaking	N/A	N/A	Emissions generated from off-site coke usage for steel and iron production

Sections 9.2 to **9.6** provide an overview of emission factors and assumptions for each activity while **Section 9.7** provides a summary of all annual CO_2-e emission estimates. In determining these emissions construction and decommissioning activities have also been included. For the purposes of the calculations, it has been assumed that in the first five years there would be a an additional fuel and electricity consumption of 20%. At the end of the Project life a decommission stage assumes one extra year of average fuel and electricity consumption.

9.2 Diesel Use

The Project would consume diesel fuel to power on-site equipment. The relevant emission factors for diesel use are provided in Table 3 of **DCC (2008)** and are listed below:

- Scope 1: 2.7 kg CO_2-e/litre for diesel usage; and
- Scope 3: 0.3 kg CO_2-e/litre required to produce the fuel.

Diesel usage per year has been estimated on a pro-rata basis from the ROM coal production. Historical data shows that for 1.8 Mtpa ROM coal production the diesel usage is estimated at 705 kilolitres (kL) per year and for 3.2 Mtpa ROM coal production it is estimated at 1,410 kL per year. A linear fit to these two points has been used to estimate the diesel required to mine other quantities of ROM.

9.3 Electricity Consumption

In the year ending June 2006, the Metropolitan Colliery produced 1.7 Mt of ROM coal and consumed 33.86 gigawatt hours (GWh) of electricity. It is estimated that at peak production (3.2 Mtpa of ROM) power requirements will be 175.2 GWh/y. Electricity consumption for future years of operation has been estimated assuming a linear increase in the annual energy needed based on straight line of best-fit joining these two points. This is 94.2 GWh for each million tonnes of ROM above 1.7 Mt. Thus annual electricity consumption has been estimated to be:

33.86 GWh + ([Annual ROM Coal Production] Mtpa – 1.7 Mtpa) x 94.2 GWh.

The relevant emission factors for electricity use are as follows (see Table 1 in DCC [2008]):

- Scope 2: 0.89 kg CO_2-e/kilowatt hours (kWh) of electrical energy used in NSW; and
- Scope 3: 0.17 kg CO_2-e/kWh for the provision of the fuel used in the power station and losses in the distribution system that delivers the power to the Metropolitan Colliery.

9.4 Coal Extraction (Gas Flaring and Venting)

Coal seam gas would be flared when appropriate and possible. This would result in emissions of CO_2 and CH_4. Current volumes of gas are estimated at 1,960 L/s, consisting of 735 L/s of CH_4 and 1,225 L/s of CO_2. The percentage of CH_4 in the gas is expected to decrease over time and it has been assumed for the purposes of the calculations that there would be no methane present by Year 23. The total gas volume expelled from mining activities has been assumed to be in proportion to the ROM coal produced. A total of 1,960 L/s is produced for mining of 1.8 Mtpa ROM coal. Flaring is assumed to occur when the CH_4 concentration is 15% or more. This converts the CH_4 (warming potential 21) into CO_2 (warming potential 1).

Table 15 provides an example of how the greenhouse gas emissions from venting have been estimated. It shows the calculation steps for only Year 1, but all other years have been treated in the same way. The calculations assume that all CH_4 flared is converted to CO_2. Also, the greenhouse warming potential of CH_4 is taken to be 21 times that of CO_2.

Table 15 : Estimated current gas volumes by flaring and venting

Parameter	Value	Comments
Mining Year	Year 1	Calculations for Year 1 are provided below as an example
Estimated total gas produced (L/s)	1960	Assumed to be constant for all Project years
Estimated CH_4 emission (L/s)	735	Assumed to reduce from 735 to 0 between Years 1 and 23
Estimated CO_2 emission (L/s)	1225	That is, total gas minus CH_4
Gas volumes		
Volume of CH_4 to be flared (L/year)	2.32E+10	Assumes flaring if CH_4 is more than 15% of the total gas volume which is the case for Year 1
Volume of CH_4 to be vented (L/year)	0.00E+00	Venting of CH_4 only occurs when the concentration is less than 15% of the total gas volume
Volume CO_2 to be vented (L/year)	3.86E+10	
CH_4 mass from flaring (t/y)	14,906	Year 1. Flared only if 15% or more of gas is CH_4.
Calculated emissions		
CH_4 emission from venting (t/y)	-	Venting when CH_4 is less than 15% of the total gas volume
CO_2 emissions from venting (t/y)	68,320	
CO_2-equivalent emissions from CH_4 and CO_2 flaring and venting		
CO_2-e emissions (t/y)	109,311	Molecular weight of CH_4 = 16 g Molecular weight of CO_2 = 44 g CH_4 warming potential = 21 1 mole of gas has a volume of 24.88 L at 30 °C

9.5 LPG Generator Use

A 150 kVA Liquefied Petroleum Gas (LPG) generator is assumed to be required for the methane flare unit for the first five years of the Project. LPG consumption is estimated to be approximately 13 cubic metres/hour (m^3/h), at atmospheric pressure.

The DCC emission factors for LPG combustion are as follows (see Table 1 in **DCC [2008]**):

- Scope 1: 59.9 kg CO_2-e/Gigajoule (GJ) of LPG consumed; and
- Scope 3: 5.3 kg CO_2-e/GJ of LPG consumed.

The LPG consumption, as a gas at atmospheric pressure, has been converted to an annual energy consumption rate by taking the volume of vaporised gas to liquefied gas to be 250 to 1 and assuming the energy content in 25.5 gigajoules per kilolitre (GJ/kL) (**DCC, 2008**). It has been assumed that the LPG Generator operates continuously.

9.6 Export and End Use of Coal

Export and end use of coal can be separated into the following categories, with associated emissions factors. All activities in this category fall under Scope 3 emissions, as defined by the GHG Protocol. The Scope 3 emissions for the Project are discussed below and summarised in **Section 9.7**.

Diesel usage for road transport of coal reject to Glenlee Washery and coal to Coalcliff and Corrimal:

There would be truck transportation of coal reject to Glenlee and product coal to Coalcliff and Corrimal. This transportation would consume diesel fuel and the relevant emission factor for diesel use is provided in Table 3 of **DCC (2008)** and is listed below:

- Scope 3 (full fuel cycle): 2.9 kg CO_2-e/litre for diesel usage.

Diesel usage per year has been estimated from the travel distances and a fuel consumption rate of 0.546 L/km (Table 4 of **AGO (2006)**). The travel distances from Metropolitan Colliery have been taken to be 70 km to Glenlee and 20 km on average to either Coalcliff of Corrimal. These data have been used to estimate diesel usage for the road transport.

Diesel usage for rail transport of coal to Port Kembla (QR Network Access, 2002):
The majority of coal produced by the Project would be loaded to trains and transported to Port Kembla. Emissions associated with the transport of product coal are based on:

- Scope 1 as Scope 3: 0.0123 kg CO_2-e/t-km travelled (**QR Network Access, 2002**).

For the purposes of the calculations, it has been assumed that the distance by rail to Port Kembla is approximately 40 km (one way).

Emissions from sea transport of the Project's export product coal have not been included in the inventory as the exact destination, shipping route and distance is not yet known. At this time, these emissions are highly speculative and for this reason have not been included in the calculations below.

Burning of coal in domestic and international power stations:
The burning of thermal coal in domestic and international power stations would result in CO_2-e emissions. The AGO provide (Table 1 of **DCC [2008]**) a coal combustion emission factor as follows:

- Scope 1 as Scope 3: 89.3 kg CO_2-e/gigajoule (GJ) (similar to black coal in NSW power stations).

A default AGO specific energy content of 27 GJ/t of black coal has been used for the calculations.

Domestic and international steelmaking:
The use of coal for off-site coke and subsequent steel and iron production would result in CO_2-e emissions. It order to provide CO_2-e emission estimates it has been assumed all coking coal is transformed into coke and used in steel production. Resulting emission estimates are regarded as indicative only.

The **DCC (2006)** provide an emission factor as follows:

- $E_{ISR} = AD_{coke} \times OF \times CO_2EF_{coke} - CO_{sequ} \times 44/12$

Where,

AD_{coke} is the quantity of coke consumed as reductant (GJ)
OF is the oxidation factor (taken to be 0.98)
CO_{sequ} is the quantity of carbon sequestered in the product (conservatively assumed to be zero)
CO_2EF_{coke} is the CO_2 emission factor for coke as the fuel (119.5 Gg/PJ from DCC, 2006).

One tonne of coal equivalent has been taken to be 29.3076 GJ/t.

9.7 *Summary of GHG Emissions*

Table 16 and **Table 17** summarise the annual GHG emissions in tonnes of CO_2-e, for each year of operations, including all of the above emission sources and scopes.

The total lifetime direct (Scope 1) emissions from the Project is estimated to be approximately 6,310,336 tonnes (t) CO_2-e, which is an average of approximately 262,931 t CO_2-e per year over the life of the Project (refer **Table 16**). This includes additional activities associated with an anticipated five year construction period and a one year decommissioning stage. This equates to lifetime average Scope 1 emissions of 0.1 t CO_2-e /t ROM coal.

Indirect (Scope 2 and 3) emissions would be released in the process of mining coal and through the export and end use of the coal. The total lifetime indirect emissions (Scope 2 and 3) from mining coal (**Table 16**) are estimated to be 3,546,039 t CO_2-e, which is an average of approximately 147,752 t CO_2-e, or 0.056 t CO_2-e/t ROM coal.

The GHG emission estimates can be compared with the following 2005 estimates provided by the Australian Greenhouse Office (AGO) in the latest Australian National Greenhouse Gas Inventory report (**AGO, 2007**) and *State and Territory Greenhouse Gas Inventories 2005* (**AGO, 2005**):

- Current estimate of Australia's 2005 net emissions, 559.1 Mt CO_2-e;
- Current estimate of NSW's net 2005 emissions, 158.2 Mt CO_2-e;
- Current estimate of Australia's 2005 net emissions for the energy sector, the major contributor to carbon-dioxide emissions, 391 Mt CO_2-e; and
- Current estimate of Australia's 2005 net emissions for the industrial sector, 29.5 Mt CO_2-e.

Total indirect emissions (Scope 3) from the export and end use of the coal are estimated to be 185,838,567 t CO_2-e, which is an average of 8,079,938 t CO_2-e per annum (**Table 17**). By convention, HCPL would only report the GHG emissions due to mining the coal (**Table 16**). The end user would account for emissions caused when the coal is used.

An *Energy Savings Action Plan* (**Energetics, 2007**) has been prepared for the Metropolitan Colliery, which identifies opportunities to reduce energy use and greenhouse intensities on-site. As a result, HCPL have already implemented the following measures to address energy use issues at the Metropolitan Colliery including:

- the introduction of energy savings targets;
- the implementation of operating procedures for energy intensive processes/ equipment;
- documenting energy use;
- maintaining a register of energy savings opportunities;
- incorporating regular reviews of the energy cost-saving program; and
- increasing staff awareness of site energy issues.

Table 16 : Estimated annual greenhouse gas emissions from mining coal

Mining year (years 1 to 5 include construction)	ROM coal (t)	Diesel use (l)	Electricity use (kWh)	Estimated annual CO_2-e emissions (t/y)								
				Diesel use		Electricity consumption		Coal extract.	LPG generator		Total (direct- Scope 1)	Total (indirect- Scope 2 and 3)
				Scope 1	Scope 3	Scope 2	Scope 3	Scope 1	Scope 1	Scope 3		
1	1,800,000	845,995	51,936,000	2,284	169	46,223	8,829	109,311	257,317	22,768	368,912	77,989
2	1,910,000	912,466	64,370,400	2,464	182	57,290	10,943	115,991	257,317	22,768	375,772	91,183
3	2,130,000	1,045,409	89,239,200	2,823	209	79,423	15,171	129,352	257,317	22,768	389,491	117,570
4	2,500,000	1,268,994	131,064,000	3,426	254	116,647	22,281	151,821	257,317	22,768	412,564	161,949
5	2,450,000	1,238,780	125,412,000	3,345	248	111,617	21,320	148,785	257,317	22,768	409,446	155,952
6	2,600,000	1,107,852	118,640,000	2,991	222	105,590	20,169	157,894	-	-	160,885	125,980
7	2,610,000	1,112,888	119,582,000	3,005	223	106,428	20,329	158,501	-	-	161,506	126,979
8	2,610,000	1,112,888	119,582,000	3,005	223	106,428	20,329	158,501	-	-	161,506	126,979
9	2,720,000	1,168,280	129,944,000	3,154	234	115,650	22,090	165,181	-	-	168,336	137,974
10	2,860,000	1,238,780	143,132,000	3,345	248	127,387	24,332	334,433	-	-	337,777	151,968
11	2,910,000	1,263,959	147,842,000	3,413	253	131,579	25,133	325,104	-	-	328,517	156,965
12	3,060,000	1,339,494	161,972,000	3,617	268	144,155	27,535	321,848	-	-	325,465	171,958
13	3,100,000	1,359,637	165,740,000	3,671	272	147,509	28,176	311,912	-	-	315,583	175,956
14	2,990,000	1,304,244	155,378,000	3,521	261	138,286	26,414	292,866	-	-	296,388	164,962
15	3,190,000	1,404,958	174,218,000	3,793	281	155,054	29,617	292,647	-	-	296,440	184,952
16	3,020,000	1,319,351	158,204,000	3,562	264	140,802	26,895	269,958	-	-	273,520	167,960
17	3,030,000	1,324,387	159,146,000	3,576	265	141,640	27,055	258,200	-	-	261,776	168,960
18	2,860,000	1,238,780	143,132,000	3,345	248	127,387	24,332	235,511	-	-	238,855	151,968
19	2,970,000	1,294,173	153,494,000	3,494	259	136,610	26,094	229,826	-	-	233,320	162,962
20	3,030,000	1,324,387	159,146,000	3,576	265	141,640	27,055	221,104	-	-	224,680	168,960
21	3,150,000	1,384,816	170,450,000	3,739	277	151,701	28,977	216,026	-	-	219,765	180,954
22	2,800,000	1,208,566	137,480,000	3,263	242	122,357	23,372	182,406	-	-	185,669	145,971
23	2,600,000	1,107,852	118,640,000	2,991	222	105,590	20,169	157,894	-	-	160,885	125,980
decom.	-	1,214,215	134,684,504	3,278	243	119,869	22,896	-	-	-	3,278	143,008
Total(t)	62,900,000	29,141,151	3,232,428,104	78,681	5,832	2,876,862	549,513	4,945,072	1,286,585	113,840	6,310,336	3,546,039
Average(t)	2,734,783	1,214,215	134,684,504	3,278	243	119,869	22,896	215,003	53,938	4,950	262,931	147,752
Lifetime average t CO_2-e/t ROM coal											0.100	0.056

Table 17 : Estimated annual greenhouse gas emissions from export and end use activities

Mining year	Coal reject by truck (t)	Product coal by truck (t)	Coal by train (t)	Estimated annual CO_2-e emissions (t/y) (indirect emissions – Scope 3)					
				Coal reject by truck	Product coal by truck	Rail transport	Steelmaking	Burning coal	Total (indirect-Scope 3)
1	240,000	120,000	1,440,000	1,970	281	1,417	5,251,286	72,333	5,327,288
2	250,000	120,000	1,530,000	2,053	281	1,506	5,560,185	72,333	5,636,358
3	250,000	120,000	1,720,000	2,053	281	1,692	6,212,306	72,333	6,288,665
4	320,000	120,000	2,040,000	2,627	281	2,007	7,276,292	96,444	7,377,652
5	320,000	120,000	2,000,000	2,627	281	1,968	7,139,003	96,444	7,240,324
6	320,000	120,000	2,130,000	2,627	281	2,096	7,585,191	96,444	7,686,639
7	300,000	120,000	2,140,000	2,463	281	2,106	7,619,513	96,444	7,720,807
8	300,000	120,000	2,140,000	2,463	281	2,106	7,619,513	96,444	7,720,807
9	300,000	120,000	2,230,000	2,463	281	2,194	7,928,412	96,444	8,029,795
10	300,000	120,000	2,350,000	2,463	281	2,312	8,340,278	96,444	8,441,779
11	300,000	120,000	2,400,000	2,463	281	2,362	8,511,888	96,444	8,613,438
12	300,000	120,000	2,530,000	2,463	281	2,490	8,923,754	120,555	9,049,543
13	-	120,000	2,560,000	-	281	2,519	9,026,720	120,555	9,150,076
14	-	120,000	2,470,000	-	281	2,430	8,717,821	120,555	8,841,088
15	-	120,000	2,640,000	-	281	2,598	9,301,297	120,555	9,424,732
16	-	120,000	2,490,000	-	281	2,450	8,786,465	120,555	8,909,752
17	-	120,000	2,500,000	-	281	2,460	8,855,110	96,444	8,954,295
18	-	120,000	2,350,000	-	281	2,312	8,340,278	96,444	8,439,316
19	-	120,000	2,450,000	-	281	2,411	8,683,499	96,444	8,782,635
20	-	120,000	2,500,000	-	281	2,460	8,855,110	96,444	8,954,295
21	-	120,000	2,600,000	-	281	2,558	9,198,331	96,444	9,297,615
22	-	120,000	2,300,000	-	281	2,263	8,168,667	96,444	8,267,656
23	-	120,000	2,130,000	-	281	2,096	7,585,191	96,444	7,684,012
Total(t)	3,500,000	2,760,000	51,640,000	28,735	6,463	50,813	183,486,110	2,266,434	185,838,567
								Lifetime average t CO_2-e/t ROM coal	2.955

HCPL would prepare and implement an Energy Plan for the Project to further improve energy performance and management systems at the Metropolitan Colliery.

Minimising fuel and electricity usage is an integral objective of mine planning and cost control systems. Additional controls on greenhouse gas emissions associated with the Project would include:

- regular on-site energy audits to optimise energy efficiency;
- consideration of energy efficiency in plant and equipment selection/purchase;
- regular maintenance of plant and equipment to minimise fuel consumption and associated emissions; and
- installation of solar-powered monitoring equipment and other instrumentation where practicable.

As stated in **Section 9.4**, methane levels in coal seam gas are low in the Project underground mining area, however, when methane levels in coal seam gas are sufficient to viably flare, methane flaring would be undertaken.

10. CONCLUSIONS

This report has assessed the air quality impacts of the Metropolitan Coal Project. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities associated with the proposal. The dispersion modelling took account of meteorological conditions and terrain information and used dust emission estimates to predict the air quality impacts for two future mining scenarios.

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

No exceedances of the DECC's 24-hour average PM_{10} criterion have been measured from the seven months of data. It is possible however that widespread events, such as bushfires and regional dust storms, may cause elevated background levels in the future. In these circumstances, the potential for the mine related dust emissions to cause exceedances of 50 $\mu g/m^3$ also increases. A real-time dust monitoring system may help to more accurately identify whether dust emissions from the Project activities are contributing to exceedances of the 50 $\mu g/m^3$ criteria at off-site receptors.

Results from the dispersion modelling suggested that the Project-specific and cumulative dust concentrations and deposition levels would be in compliance with the DECC's air quality assessment criteria at sensitive receptor locations. Best practice dust mitigation measures should ensure that off-site air quality impacts are minimised.

Odour levels in the vent shaft outlet are very low. Consequently, no odour impacts are predicted by dispersion modelling of emissions from the vent shaft in its present or proposed locations.

There would be GHG emissions from the mining activities as a result of diesel use, electricity consumption and coal seam gas extraction. These emissions have been quantified.

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

STATISTICS FOR FILE: C:\Jobs\MetroCol\metdata\metro07.aus
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000342	0.002055	0.001370	0.000000	0.000000	0.000000	0.000000	0.000000	0.003767
NE	0.000457	0.001142	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.002740
ENE	0.000114	0.001484	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.001941
E	0.000457	0.002283	0.001941	0.000000	0.000000	0.000000	0.000000	0.000000	0.004680
ESE	0.000457	0.005023	0.001598	0.000000	0.000000	0.000000	0.000000	0.000000	0.007078
SE	0.000571	0.006849	0.001598	0.000000	0.000000	0.000000	0.000000	0.000000	0.009018
SSE	0.000114	0.003995	0.002511	0.000000	0.000000	0.000000	0.000000	0.000000	0.006621
S	0.000457	0.000457	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
SSW	0.000799	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001256
SW	0.000114	0.000685	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
WSW	0.000114	0.000342	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000571
W	0.000114	0.000228	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000457
WNW	0.000228	0.000571	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
NW	0.000000	0.001484	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.002169
NNW	0.000342	0.002511	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.003995
N	0.000228	0.004110	0.001256	0.000000	0.000000	0.000000	0.000000	0.000000	0.005594
CALM									0.000342
TOTAL	0.004909	0.033676	0.014384	0.000000	0.000000	0.000000	0.000000	0.000000	0.053311

MEAN WIND SPEED (m/s) = 2.54
NUMBER OF OBSERVATIONS = 467

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000457	0.003196	0.005708	0.000342	0.000000	0.000000	0.000000	0.000000	0.009703
NE	0.000000	0.003311	0.013470	0.005023	0.000000	0.000000	0.000000	0.000000	0.021804
ENE	0.000114	0.002397	0.007648	0.000685	0.000000	0.000000	0.000000	0.000000	0.010845
E	0.000571	0.003767	0.003653	0.000000	0.000000	0.000000	0.000000	0.000000	0.007991
ESE	0.000457	0.003881	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.005479
SE	0.000913	0.004566	0.003881	0.001712	0.000000	0.000000	0.000000	0.000000	0.011073
SSE	0.000571	0.005365	0.006735	0.001370	0.000000	0.000000	0.000000	0.000000	0.014041
S	0.000114	0.002626	0.004795	0.001370	0.000000	0.000000	0.000000	0.000000	0.008904
SSW	0.000114	0.001256	0.001027	0.000114	0.000000	0.000000	0.000000	0.000000	0.002511
SW	0.000114	0.001370	0.001027	0.000228	0.000000	0.000000	0.000000	0.000000	0.002740
WSW	0.000228	0.001256	0.002283	0.000342	0.000000	0.000000	0.000000	0.000000	0.004110
W	0.000114	0.001370	0.004566	0.001256	0.000000	0.000000	0.000000	0.000000	0.007306
WNW	0.000228	0.003995	0.004224	0.001256	0.000000	0.000000	0.000000	0.000000	0.009703
NW	0.000571	0.003311	0.004224	0.000799	0.000000	0.000000	0.000000	0.000000	0.008904
NNW	0.000342	0.004224	0.002169	0.000342	0.000000	0.000000	0.000000	0.000000	0.007078
N	0.000342	0.003425	0.002854	0.000000	0.000000	0.000000	0.000000	0.000000	0.006621
CALM									0.000913
TOTAL	0.005251	0.049315	0.069406	0.014840	0.000000	0.000000	0.000000	0.000000	0.139726

MEAN WIND SPEED (m/s) = 3.27
NUMBER OF OBSERVATIONS = 1224

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000457	0.001256	0.004566	0.001027	0.000000	0.000000	0.000000	0.000000	0.007306
NE	0.000228	0.002169	0.006050	0.002968	0.000000	0.000000	0.000000	0.000000	0.011416
ENE	0.000342	0.002055	0.001941	0.000000	0.000000	0.000000	0.000000	0.000000	0.004338
E	0.000685	0.001598	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.002397
ESE	0.001370	0.002055	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.003653
SE	0.001027	0.001598	0.001142	0.001256	0.000000	0.000000	0.000000	0.000000	0.005023
SSE	0.000685	0.002626	0.001712	0.003425	0.000685	0.000114	0.000000	0.000000	0.009247
S	0.000457	0.001826	0.001826	0.001598	0.001941	0.000000	0.000000	0.000000	0.007648
SSW	0.000571	0.000342	0.000685	0.000685	0.000114	0.000000	0.000000	0.000000	0.002397
SW	0.000000	0.000799	0.000571	0.000114	0.000000	0.000000	0.000000	0.000000	0.001484
WSW	0.000114	0.000571	0.001826	0.001941	0.001484	0.000228	0.000000	0.000000	0.006164
W	0.000342	0.001370	0.002626	0.005023	0.003539	0.000342	0.000000	0.000000	0.013242
WNW	0.000228	0.001826	0.003425	0.003082	0.001027	0.000457	0.000000	0.000000	0.010046
NW	0.000342	0.001598	0.002169	0.001027	0.000913	0.000000	0.000000	0.000000	0.006050
NNW	0.000342	0.001826	0.000685	0.000457	0.000114	0.000000	0.000000	0.000000	0.003425
N	0.000114	0.001256	0.001484	0.000342	0.000000	0.000000	0.000000	0.000000	0.003196
CALM									0.000571
TOTAL	0.007306	0.024772	0.031050	0.022945	0.009817	0.001142	0.000000	0.000000	0.097603

MEAN WIND SPEED (m/s) = 3.90
NUMBER OF OBSERVATIONS = 855

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002626	0.009018	0.004680	0.000114	0.000000	0.000000	0.000000	0.000000	0.016438
NE	0.001941	0.007877	0.002626	0.000000	0.000000	0.000000	0.000000	0.000000	0.012443
ENE	0.002169	0.004338	0.001712	0.000000	0.000000	0.000000	0.000000	0.000000	0.008219
E	0.002740	0.006164	0.002740	0.000000	0.000000	0.000000	0.000000	0.000000	0.011644
ESE	0.001941	0.006621	0.002055	0.000114	0.000000	0.000000	0.000000	0.000000	0.010731
SE	0.002511	0.006963	0.011530	0.011644	0.000342	0.000457	0.000000	0.000000	0.033447
SSE	0.002740	0.005365	0.012215	0.016324	0.005594	0.002055	0.000342	0.000000	0.044635
S	0.003082	0.005479	0.006050	0.012785	0.011758	0.004566	0.001598	0.000342	0.045662
SSW	0.001598	0.003995	0.003311	0.004224	0.001712	0.000000	0.000000	0.000000	0.014840
SW	0.000228	0.001142	0.002511	0.002397	0.001142	0.000000	0.000000	0.000000	0.007420
WSW	0.000457	0.002511	0.005251	0.008333	0.002055	0.000000	0.000000	0.000000	0.018607
W	0.000457	0.005365	0.006849	0.015639	0.016553	0.009247	0.001256	0.000228	0.055594
WNW	0.000457	0.005365	0.007306	0.004110	0.002283	0.002283	0.001256	0.000228	0.023288
NW	0.001027	0.004224	0.003425	0.001027	0.000228	0.000457	0.000000	0.000000	0.010388
NNW	0.002055	0.004452	0.001142	0.001027	0.000228	0.000114	0.000000	0.000000	0.009018
N	0.003425	0.005708	0.001256	0.000457	0.000000	0.000000	0.000000	0.000000	0.010845
CALM									0.003995
TOTAL	0.029452	0.084589	0.074658	0.078196	0.041895	0.019178	0.004452	0.000799	0.337215

MEAN WIND SPEED (m/s) = 4.19
NUMBER OF OBSERVATIONS = 2954

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001826	0.002169	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003995
NE	0.001712	0.001256	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002968
ENE	0.001484	0.001256	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002740
E	0.001256	0.001256	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.002854
ESE	0.000457	0.002511	0.002626	0.000228	0.000000	0.000000	0.000000	0.000000	0.005822
SE	0.000913	0.001142	0.009475	0.001142	0.000000	0.000000	0.000000	0.000000	0.012671
SSE	0.000457	0.001598	0.008676	0.004224	0.000000	0.000000	0.000000	0.000000	0.014954
S	0.000457	0.002169	0.006050	0.002626	0.000000	0.000000	0.000000	0.000000	0.011301
SSW	0.000685	0.001256	0.003196	0.001941	0.000000	0.000000	0.000000	0.000000	0.007078
SW	0.000913	0.000571	0.005822	0.001826	0.000000	0.000000	0.000000	0.000000	0.009132
WSW	0.000114	0.000228	0.016324	0.004452	0.000000	0.000000	0.000000	0.000000	0.021119
W	0.000114	0.001027	0.018836	0.006507	0.000000	0.000000	0.000000	0.000000	0.026484
WNW	0.000114	0.001142	0.012329	0.001598	0.000000	0.000000	0.000000	0.000000	0.015183
NW	0.000685	0.001370	0.005708	0.000457	0.000000	0.000000	0.000000	0.000000	0.008219
NNW	0.000457	0.003653	0.003881	0.000342	0.000000	0.000000	0.000000	0.000000	0.008333
N	0.001598	0.003196	0.002626	0.000685	0.000000	0.000000	0.000000	0.000000	0.008105
CALM									0.001370
TOTAL	0.013242	0.025799	0.095890	0.026027	0.000000	0.000000	0.000000	0.000000	0.162329

MEAN WIND SPEED (m/s) = 3.54
NUMBER OF OBSERVATIONS = 1422

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000913	0.004909	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.006279
NE	0.000913	0.001826	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
ENE	0.000342	0.002854	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.004338
E	0.000228	0.002968	0.001027	0.000000	0.000000	0.000000	0.000000	0.000000	0.004224
ESE	0.000342	0.005251	0.001598	0.000000	0.000000	0.000000	0.000000	0.000000	0.007192
SE	0.000114	0.006963	0.003196	0.000000	0.000000	0.000000	0.000000	0.000000	0.010274
SSE	0.000228	0.005251	0.002397	0.000000	0.000000	0.000000	0.000000	0.000000	0.007877
S	0.000342	0.004909	0.002968	0.000000	0.000000	0.000000	0.000000	0.000000	0.008219
SSW	0.000342	0.006050	0.001826	0.000000	0.000000	0.000000	0.000000	0.000000	0.008219
SW	0.000685	0.003995	0.004452	0.000000	0.000000	0.000000	0.000000	0.000000	0.009132
WSW	0.000342	0.006279	0.006279	0.000000	0.000000	0.000000	0.000000	0.000000	0.012900
W	0.000571	0.009361	0.009475	0.000000	0.000000	0.000000	0.000000	0.000000	0.019406
WNW	0.000114	0.009932	0.009361	0.000000	0.000000	0.000000	0.000000	0.000000	0.019406
NW	0.000342	0.016324	0.011530	0.000000	0.000000	0.000000	0.000000	0.000000	0.028196
NNW	0.001142	0.031050	0.005936	0.000000	0.000000	0.000000	0.000000	0.000000	0.038128
N	0.001027	0.019178	0.002740	0.000000	0.000000	0.000000	0.000000	0.000000	0.022945
CALM									0.000000
TOTAL	0.007991	0.137100	0.064726	0.000000	0.000000	0.000000	0.000000	0.000000	0.209817

MEAN WIND SPEED (m/s) = 2.71
NUMBER OF OBSERVATIONS = 1838

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.006621	0.022603	0.016781	0.001484	0.000000	0.000000	0.000000	0.000000	0.047489
NE	0.005251	0.017580	0.023630	0.007991	0.000000	0.000000	0.000000	0.000000	0.054452
ENE	0.004566	0.014384	0.012785	0.000685	0.000000	0.000000	0.000000	0.000000	0.032420
E	0.005936	0.018037	0.009817	0.000000	0.000000	0.000000	0.000000	0.000000	0.033790
ESE	0.005023	0.025342	0.009247	0.000342	0.000000	0.000000	0.000000	0.000000	0.039954
SE	0.006050	0.028082	0.030822	0.015753	0.000342	0.000457	0.000000	0.000000	0.081507
SSE	0.004795	0.024201	0.034247	0.025342	0.006279	0.002169	0.000342	0.000000	0.097374
S	0.004909	0.017466	0.021804	0.018379	0.013699	0.004566	0.001598	0.000342	0.082763
SSW	0.004110	0.013356	0.010046	0.006963	0.001826	0.000000	0.000000	0.000000	0.036301
SW	0.002055	0.008562	0.014612	0.004566	0.001142	0.000000	0.000000	0.000000	0.030936
WSW	0.001370	0.011187	0.032078	0.015068	0.003539	0.000228	0.000000	0.000000	0.063470
W	0.001712	0.018721	0.042466	0.028425	0.020091	0.009589	0.001256	0.000228	0.122489
WNW	0.001370	0.022831	0.036872	0.010046	0.003311	0.002740	0.001256	0.000228	0.078653
NW	0.002968	0.028311	0.027740	0.003311	0.001142	0.000457	0.000000	0.000000	0.063927
NNW	0.004680	0.047717	0.014954	0.002169	0.000342	0.000114	0.000000	0.000000	0.069977
N	0.006735	0.036872	0.012215	0.001484	0.000000	0.000000	0.000000	0.000000	0.057306
CALM									0.007192
TOTAL	0.068151	0.355251	0.350114	0.142009	0.051712	0.020320	0.004452	0.000799	1.000000

MEAN WIND SPEED (m/s) = 3.53
NUMBER OF OBSERVATIONS = 8760

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 5.3%
B : 14.0%
C : 9.8%
D : 33.7%
E : 16.2%
F : 21.0%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0078	0122	0165
02	0000	0000	0000	0075	0134	0156
03	0000	0000	0000	0084	0127	0154
04	0000	0000	0000	0086	0128	0151
05	0000	0000	0000	0120	0114	0131
06	0000	0000	0000	0227	0061	0077
07	0000	0000	0041	0285	0024	0015
08	0000	0059	0066	0240	0000	0000
09	0019	0107	0090	0149	0000	0000
10	0065	0136	0062	0102	0000	0000
11	0098	0125	0063	0079	0000	0000
12	0097	0133	0064	0071	0000	0000
13	0083	0147	0059	0076	0000	0000
14	0065	0161	0056	0083	0000	0000
15	0031	0171	0067	0096	0000	0000
16	0009	0125	0110	0121	0000	0000
17	0000	0054	0113	0198	0000	0000
18	0000	0006	0064	0239	0024	0032
19	0000	0000	0000	0205	0068	0092
20	0000	0000	0000	0062	0124	0179
21	0000	0000	0000	0060	0137	0168
22	0000	0000	0000	0067	0121	0177
23	0000	0000	0000	0073	0123	0169
24	0000	0000	0000	0078	0115	0172

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0351	0905	0648	2611	1388	1805
<=1000 m	0096	0264	0168	0312	0028	0026
<=1500 m	0019	0049	0035	0025	0003	0005
<=2000 m	0001	0006	0004	0005	0002	0002
<=3000 m	0000	0000	0000	0001	0001	0000
>3000 m	0000	0000	0000	0000	0000	0000

MIXING HEIGHT BY HOUR OF DAY

Hour	0000 to 0100	0100 to 0200	0200 to 0400	0400 to 0800	0800 to 1600	1600 to 3200	Greater than 3200
01	0169	0113	0065	0018	0000	0000	0000
02	0170	0108	0067	0019	0001	0000	0000
03	0181	0101	0066	0014	0003	0000	0000
04	0179	0095	0069	0017	0005	0000	0000
05	0186	0092	0071	0013	0003	0000	0000
06	0170	0103	0067	0023	0002	0000	0000
07	0183	0083	0064	0032	0003	0000	0000
08	0151	0111	0066	0033	0004	0000	0000
09	0146	0090	0082	0044	0003	0000	0000
10	0078	0103	0100	0079	0005	0000	0000
11	0038	0077	0127	0109	0014	0000	0000
12	0040	0049	0111	0135	0030	0000	0000
13	0035	0061	0087	0131	0051	0000	0000
14	0035	0071	0085	0110	0062	0002	0000
15	0043	0068	0097	0101	0053	0003	0000
16	0052	0079	0113	0086	0031	0004	0000
17	0083	0085	0094	0081	0021	0001	0000
18	0115	0113	0083	0047	0007	0000	0000
19	0139	0096	0107	0017	0004	0002	0000
20	0158	0114	0078	0012	0001	0002	0000
21	0163	0117	0069	0013	0002	0001	0000
22	0169	0112	0068	0014	0002	0000	0000
23	0165	0108	0075	0015	0001	0001	0000
24	0165	0115	0069	0016	0000	0000	0000

STABILITY CLASS BY HOUR OF DAY

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

STABILITY CLASS BY MIXING HEIGHT

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

MIXING HEIGHT BY HOUR OF DAY

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

APPENDIX B
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : Metropolitan Coal Project
Year 3:

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
Loadout to ROM coal stockpile/bin	51	213,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Dozer working on ROM coal stockpile	4,400	450	h/y	9.8	kg/h	5	silt content - %	10	moisture content in %		
FEL loading ROM coal from stockpile to crusher	51	213,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Transfer from underground to crusher (enclosed, 70% reduction)	138	1,917,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Primary and secondary coal crushing (enclosed, 70% reduction)	153	2,130,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Transfer from crusher to CHPP (enclosed, 70% reduction)	153	2,130,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Handling of coal at CHPP (enclosed, 70% reduction)	459	2,130,000	t/y	0.00072	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Loading to product coal stockpiles	690	1,840,000	t/y	0.00038	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	7.25	moisture content in %		
Dozer working on product coal stockpiles	47,523	4,050	h/y	11.7	kg/h	4	silt content - %	7.25	moisture content in %		
FEL loading product coal to trucks	45	120,000	t/y	0.00038	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	7.25	moisture content in %		
Loading product coal to trains (FEL)	645	1,720,000	t/y	0.00038	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	7.25	moisture content in %		
Loading reject coal to trucks (too coarse and wet for dust generation)	0										
Hauling coal reject to temporary stockpile (y3) / backfill plant (y15)	1,544	40,000	t/y	0.03860	kg/t	30	t/load	1.16	km/return trip	1.0	kg/VKT
Hauling product coal off-site (unsealed road)	4,444	120,000	t/y	0.03704	kg/t	27	t/load	1.00	km/return trip	1.0	kg/VKT
Hauling product/coal reject off-site (sealed road)	4,385	370,000	t/y	0.01185	kg/t	27	t/load	1.60	km/return trip	0.2	kg/VKT
Wind erosion from ROM stockpile	130	0.07	ha	1894.6	kg/ha/y	120	Average number of raindays	5	silt content in %	11.7922	% of winds above 5.4 m/s
Wind erosion from product coal stockpiles	1,955	2.58	ha	1515.7	kg/ha/y	120	Average number of raindays	4	silt content in %	11.7922	% of winds above 5.4 m/s
Ventilation shaft emissions	3,152	8,760	h/y	0.359856	kg/h	856800	m3/h	0.42	mg/m3		

Year 15:

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
Loadout to ROM coal stockpile/bin	76	319,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Dozer working on ROM coal stockpile	5,720	585	h/y	9.8	kg/h	5	silt content - %	10	moisture content in %		
FEL loading ROM coal from stockpile to crusher	76	319,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Transfer from underground to crusher (enclosed, 70% reduction)	206	2,871,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Primary and secondary coal crushing (enclosed, 70% reduction)	229	3,190,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Transfer from crusher to CHPP (enclosed, 70% reduction)	229	3,190,000	t/y	0.00024	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Handling of coal at CHPP (enclosed, 70% reduction)	687	3,190,000	t/y	0.00072	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %		
Loading to product coal stockpiles	1,036	2,760,000	t/y	0.00038	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	7.25	moisture content in %		
Dozer working on product coal stockpiles	61,780	5,265	h/y	11.7	kg/h	4	silt content - %	7.25	moisture content in %		
FEL loading product coal to trucks	45	120,000	t/y	0.00038	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	7.25	moisture content in %		
Loading product coal to trains (FEL)	991	2,640,000	t/y	0.00038	kg/t	1.923	average of (wind speed/2.2)^1.3 in m/s	7.25	moisture content in %		
Loading reject coal to trucks (too coarse and wet for dust generation)	0										
Hauling reject coal to temporary stockpile (y3) / backfill plant (y15)	16,212	420,000	t/y	0.03860	kg/t	30	t/load	1.16	km/return trip	1.0	kg/VKT
Hauling product coal off-site (unsealed road)	4,444	120,000	t/y	0.03704	kg/t	27	t/load	1.00	km/return trip	1.0	kg/VKT
Hauling product/reject coal off-site (sealed road)	1,541	130,000[1]	t/y	0.01185	kg/t	27	t/load	1.60	km/return trip	0.2	kg/VKT
Wind erosion from ROM stockpile	130	0.07	ha	1894.6	kg/ha/y	120	Average number of raindays	5	silt content in %	11.7922	% of winds above 5.4 m/s
Wind erosion from product coal stockpiles	1,955	2.58	ha	1515.7	kg/ha/y	120	Average number of raindays	4	silt content in %	11.7922	% of winds above 5.4 m/s
Ventilation shaft emissions	7,192	8,760	h/y	0.46116	kg/h	1954800	m3/h	0.42	mg/m3		

[1] The final Project Description (Tables 2-2 and 2-5 in the main report of the Environmental Assessment) indicate that the total material to be trucked offsite in Year 15 is 120,000t, not 130,000t. This variation is minor and the emissions inventory has not been revised as it slightly over-estimates emissions in this year (which is conservative).

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

Loading coal to stockpiles / coal transfer points / loading to trains
Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. Equation 1 shows the relationship between these variables. For enclosed transfer points it has been assumed that emissions are reduced by 70% (**National Pollutant Inventory [NPI], 2001**).

Equation 1

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

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 coal by truck
After the application of water the emission factor used for trucks hauling coal reject or product coal on unsealed surfaces was 1 kg per vehicle kilometre travelled (kg/VKT). For sealed surfaces an emission factor of 0.2 kg/VKT was assumed.

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

Equation 2

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

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

Primary and secondary coal crushing
There are currently no specific emission factors for these activities however, in practice, these will form a very small contribution of the overall dust emissions from a coal mine. In the absence of specific emission factors, TSP emissions were estimated by Equation 1. It has been assumed that emissions are reduced by 70% to reflect enclosure of this activity (**NPI, 2001**).

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

Equation 4

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

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

Dust emissions from ventilation shafts
Measurements made by **HLA-ENSR (2008)** at the Metropolitan Colliery, showed that particulate matter concentrations in ventilation outlet were 0.42 mg/Am^3.

Summary of modelled activities, emissions and locations
A summary of dust emission estimates for each activity, activity type, location of emission sources and activity hours are provided below. Information for Year 3 and Year 15 is shown below and the location of the sources can be obtained from **Figure 7**. The ISC model input files, can be provided on request.

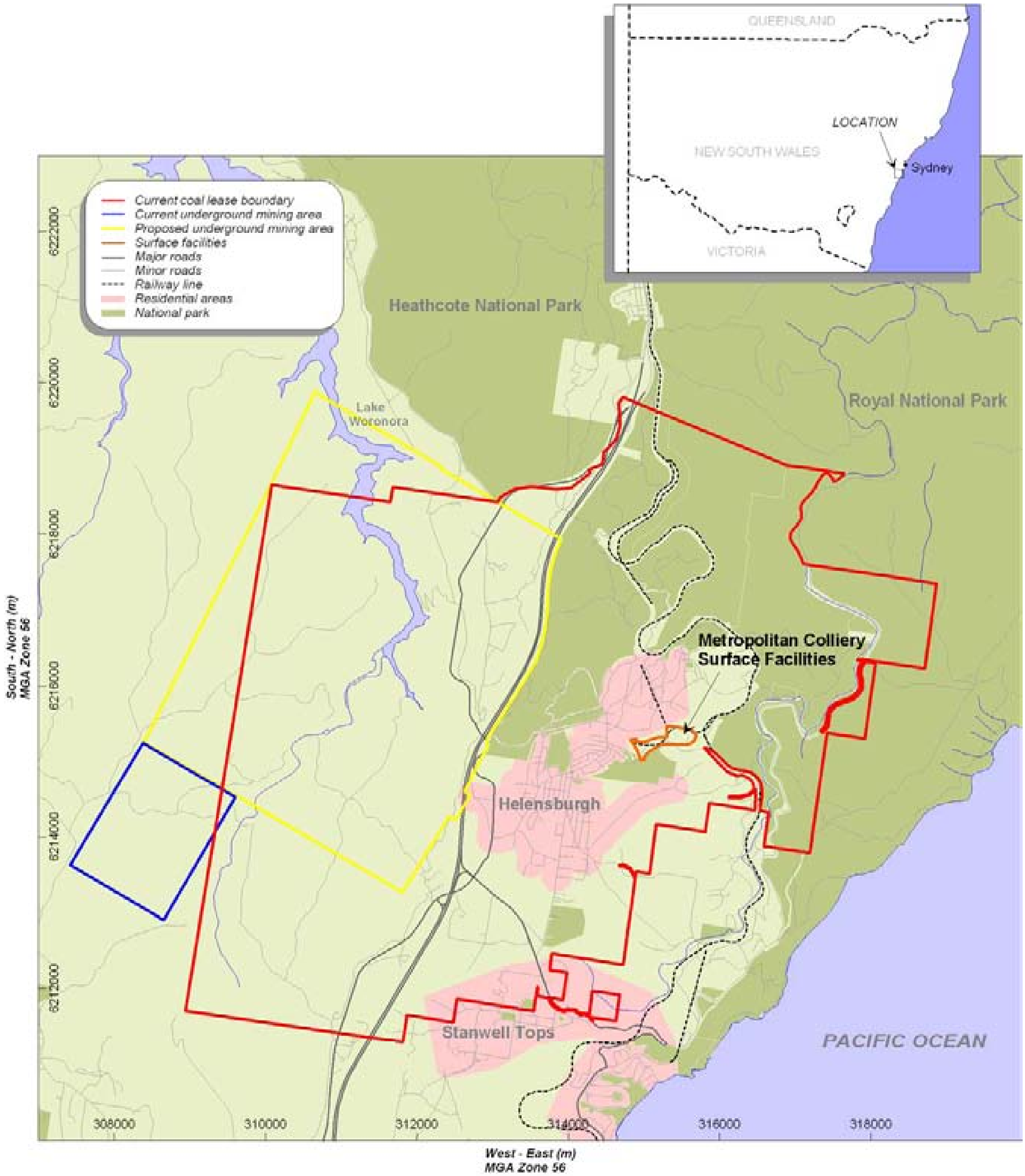
```
Year 3:
 ------------------------------      22-Apr-2008 14:16
  DUST EMISSION CALCULATIONS V2
 ------------------------------

 Output emissions file  : C:\Jobs\MetroCol\iscmod\y03\emiss.dat
 Meteorological file    : C:\Jobs\MetroCol\metdata\metro07.isc
 Number of dust sources : 26
 Number of activities   : 17
 No-blast conditions    : None
 Wind sensitive factor  : 1.923 (1.929 adjusted for activity hours)
 Wind erosion factor    : 75.573

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Loadout to ROM coal stockpile/bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 51 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer working on ROM coal stockpile
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4400 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : FEL loading ROM coal from stockpile to crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 51 kg/y
 FROM SOURCES  : 1
3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transfer from underground to crusher (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 138 kg/y
 FROM SOURCES  : 1
3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Primary and secondary coal crushing (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 153 kg/y
 FROM SOURCES  : 1
3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transfer from crusher to CHPP (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 153 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
```

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

 ACTIVITY NAME : Handling of coal at CHPP (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 459 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to product coal stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 690 kg/y
 FROM SOURCES  : 2
14 15
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer working on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 47523 kg/y
 FROM SOURCES  : 9
7 8 9 10 11 12 13 14 15
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : FEL loading product coal to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 45 kg/y
 FROM SOURCES  : 3
8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading product coal to trains (FEL)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 645 kg/y
 FROM SOURCES  : 4
10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling coal reject to temporary stockpile (y3) / backfill plant (y15)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1544 kg/y
 FROM SOURCES  : 8
5 6 7 8 9 10 16 17
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product coal off-site (unsealed road)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4444 kg/y
 FROM SOURCES  : 6
5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product/coal reject off-site (sealed road)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4385 kg/y
 FROM SOURCES  : 9
2 17 18 19 20 21 22 23 24
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Wind erosion from ROM stockpile
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 130 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1955 kg/y
 FROM SOURCES  : 11
6 7 8 9 10 11 12 13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Ventilation shaft emissions
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3152 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
Year 15:
 -------------------------------      19-May-2008 15:31
  DUST EMISSION CALCULATIONS V2
 -------------------------------

 Output emissions file  : C:\Jobs\MetroCol\iscmod\y15\emiss.dat
 Meteorological file    : C:\Jobs\MetroCol\metdata\metro07.isc
 Number of dust sources : 26
 Number of activities   : 17
 No-blast conditions    : None
 Wind sensitive factor  : 1.923 (1.929 adjusted for activity hours)
 Wind erosion factor    : 75.573

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Loadout to ROM coal stockpile/bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 76 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer working on ROM coal stockpile
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5720 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : FEL loading ROM coal from stockpile to crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 76 kg/y
 FROM SOURCES  : 1
3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transfer from underground to crusher (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 206 kg/y
 FROM SOURCES  : 1
3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Primary and secondary coal crushing (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 229 kg/y
 FROM SOURCES  : 1
3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transfer from crusher to CHPP (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 229 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling of coal at CHPP (enclosed, 70% reduction)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 687 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to product coal stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1036 kg/y
 FROM SOURCES  : 2
14 15
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer working on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 61780 kg/y
 FROM SOURCES  : 9
7 8 9 10 11 12 13 14 15
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : FEL loading product coal to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 45 kg/y
 FROM SOURCES  : 3
8 9 10
 HOURS OF DAY  :
```

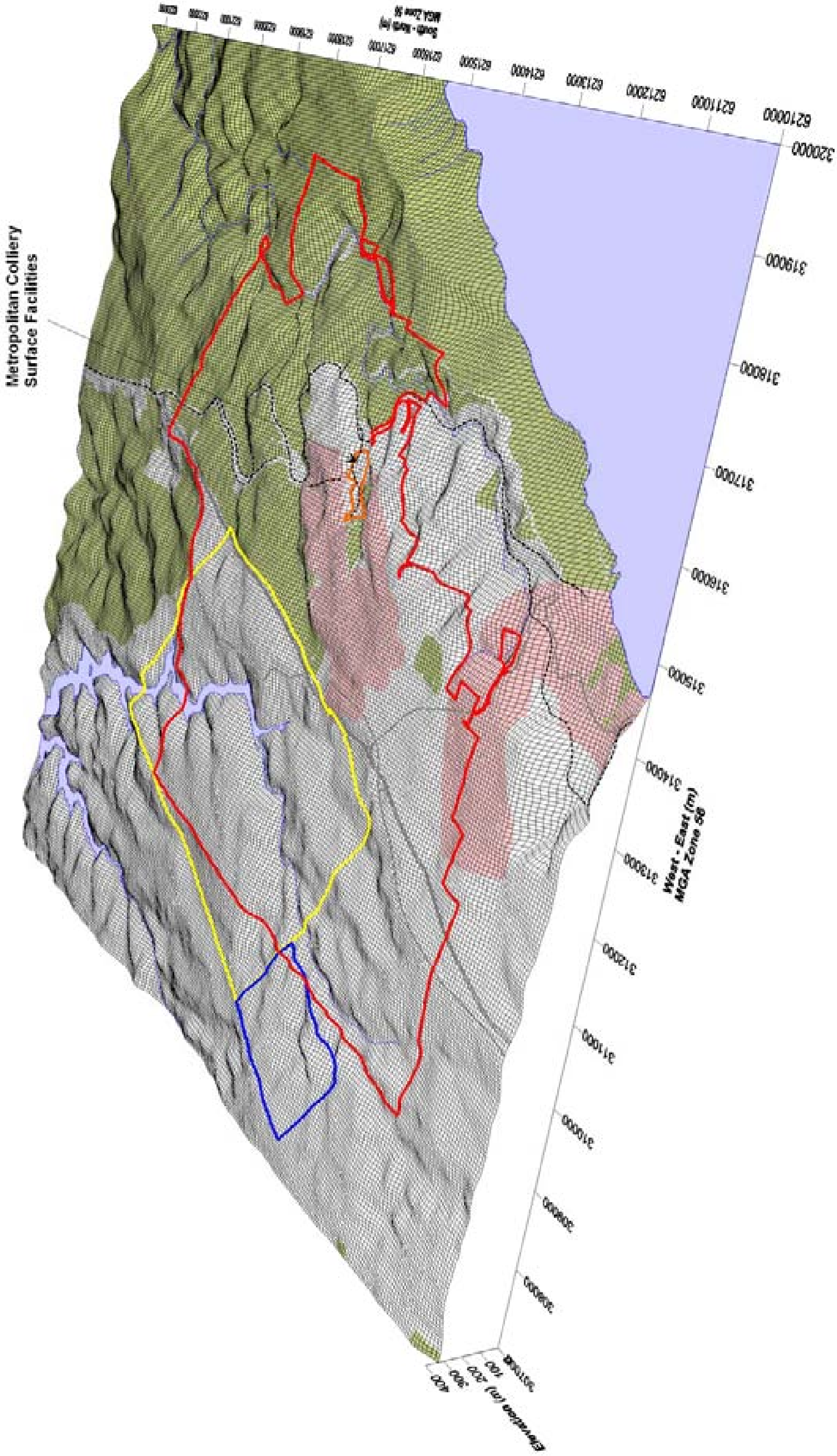
```
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading product coal to trains (FEL)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 991 kg/y
 FROM SOURCES  : 4
10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling reject coal to temporary stockpile (y3) / backfill plant (y15)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16212 kg/y
 FROM SOURCES  : 8
5 6 7 8 9 10 16 17
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product coal off-site (unsealed road)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4444 kg/y
 FROM SOURCES  : 6
5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product/reject coal off-site (sealed road)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1541 kg/y
 FROM SOURCES  : 9
2 17 18 19 20 21 22 23 24
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Wind erosion from ROM stockpile
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 130 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1955 kg/y
 FROM SOURCES  : 11
6 7 8 9 10 11 12 13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Ventilation shaft emissions
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 7192 kg/y
 FROM SOURCES  : 2
25 26
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

FIGURES



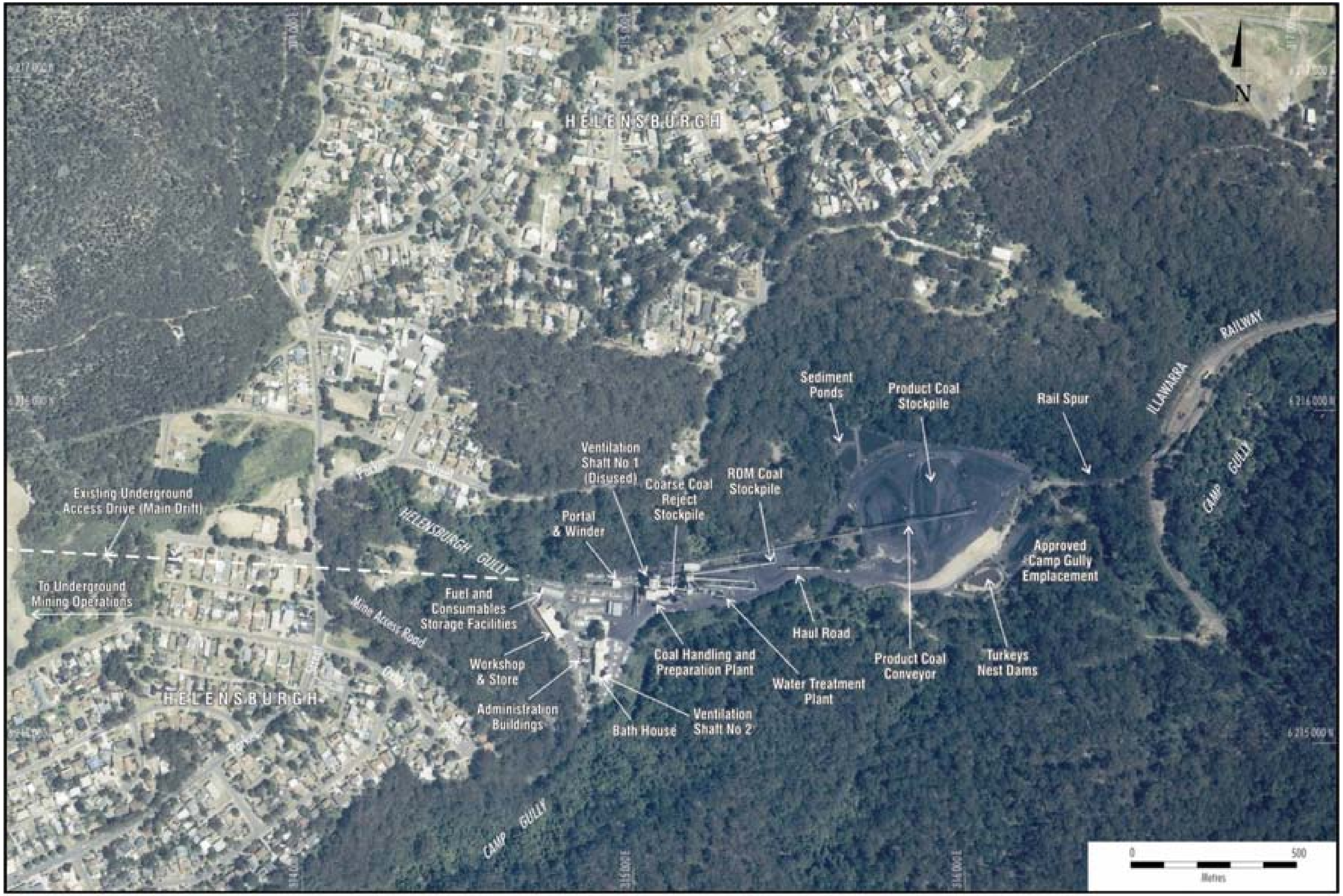
Location of study area

FIGURE 1



Pseudo three-dimensional representation of the local terrain

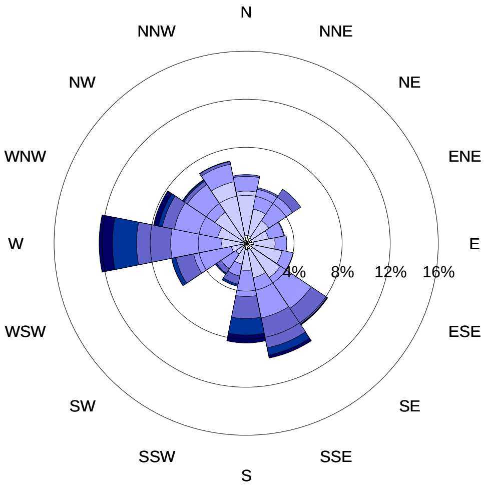
FIGURE 2



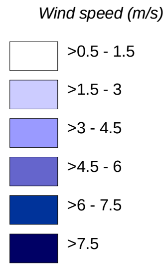
Layout of surface facilities

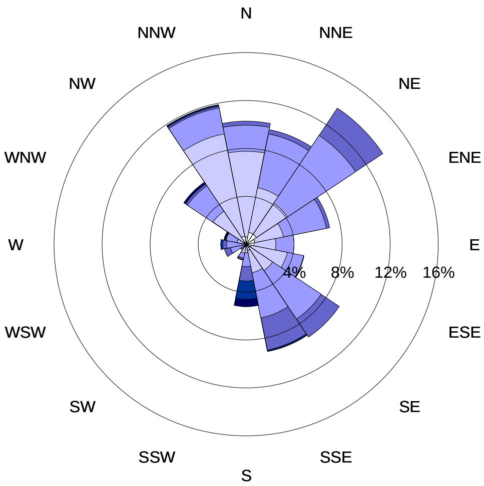
FIGURE 3

Annual and seasonal windroses for Metropolitan Colliery (2007 by TAPM at 10 m)

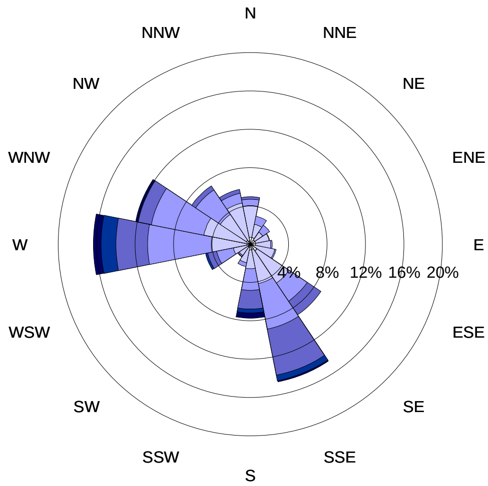


Annual
Calms = 0.7%

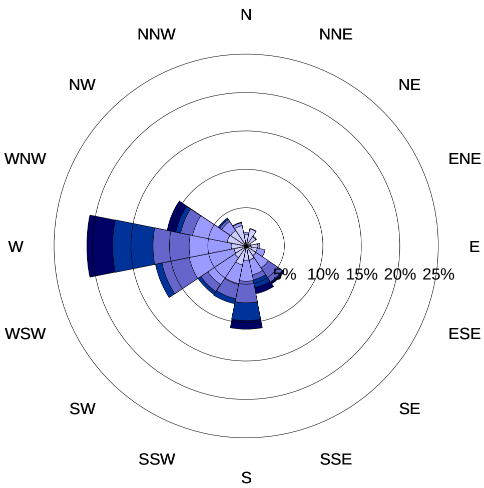




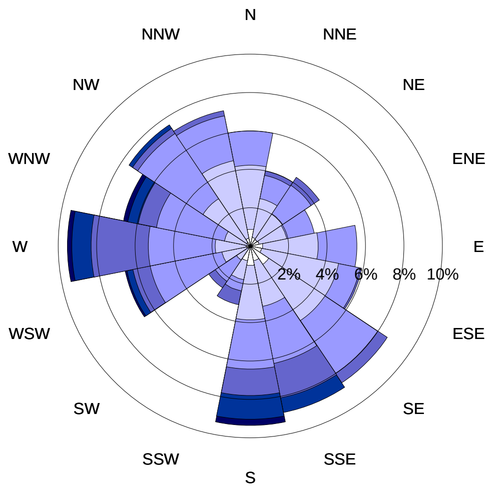
Summer
Calms = 0.8%



Autumn
Calms = 1.0%



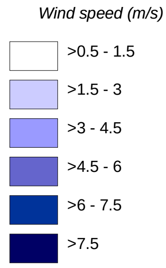
Winter
Calms = 0.3%

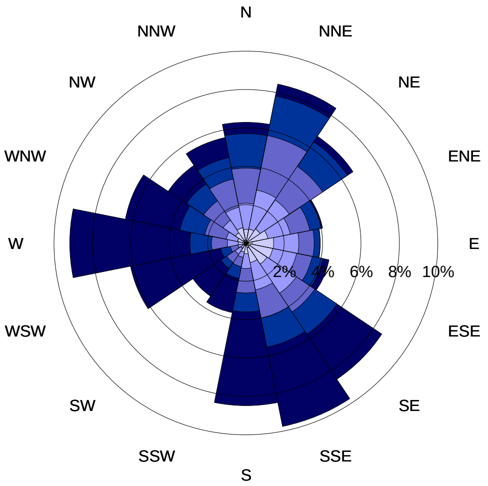


Spring
Calms = 0.7%

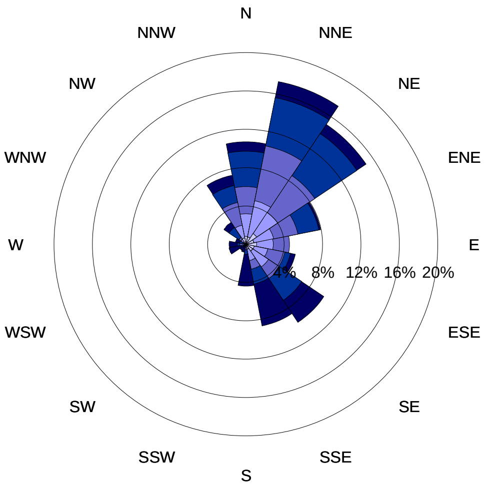
FIGURE 4

Annual and seasonal windroses for Metropolitan Colliery (2007 by TAPM at 100 m)

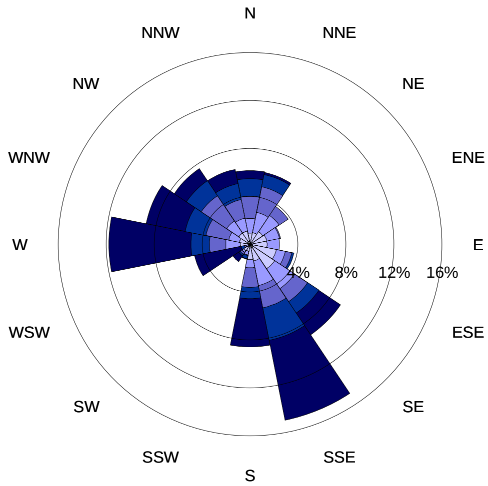




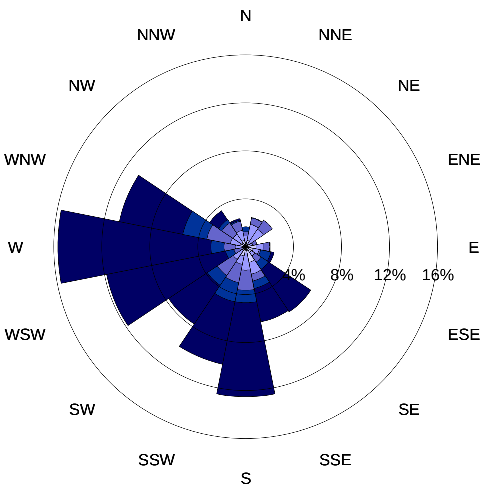
Annual
Calms = 0.3%



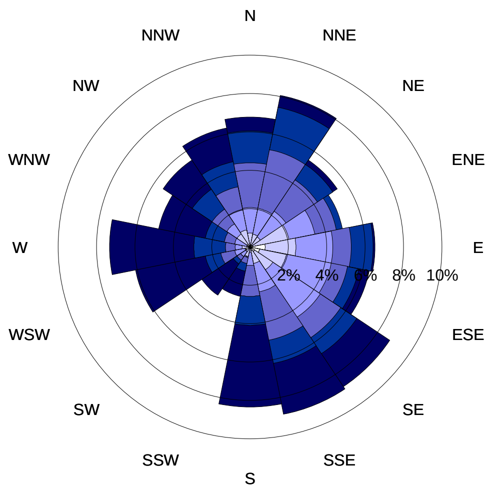
Summer
Calms = 0.1%



Autumn
Calms = 0.3%

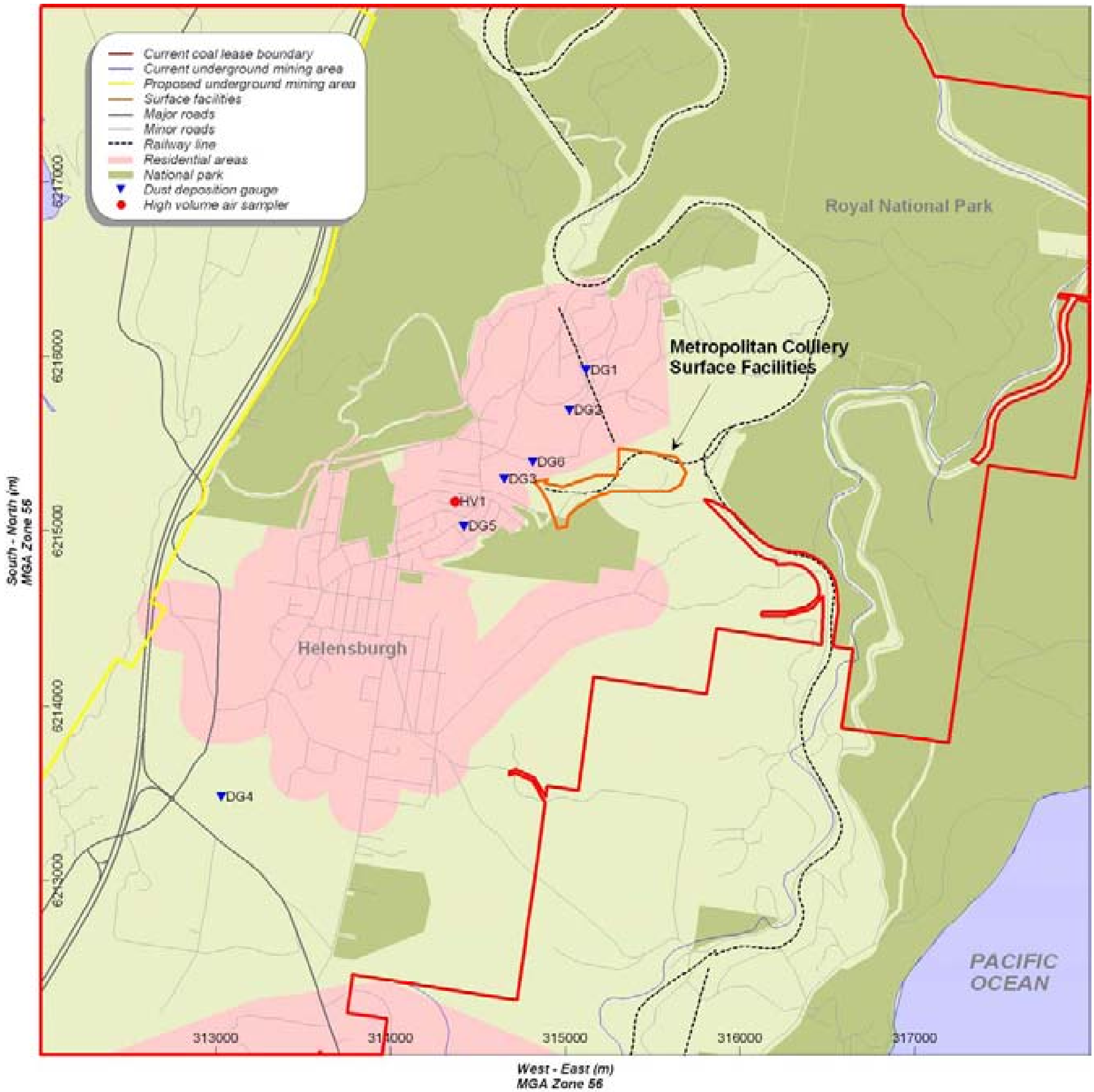


Winter
Calms = 0.4%

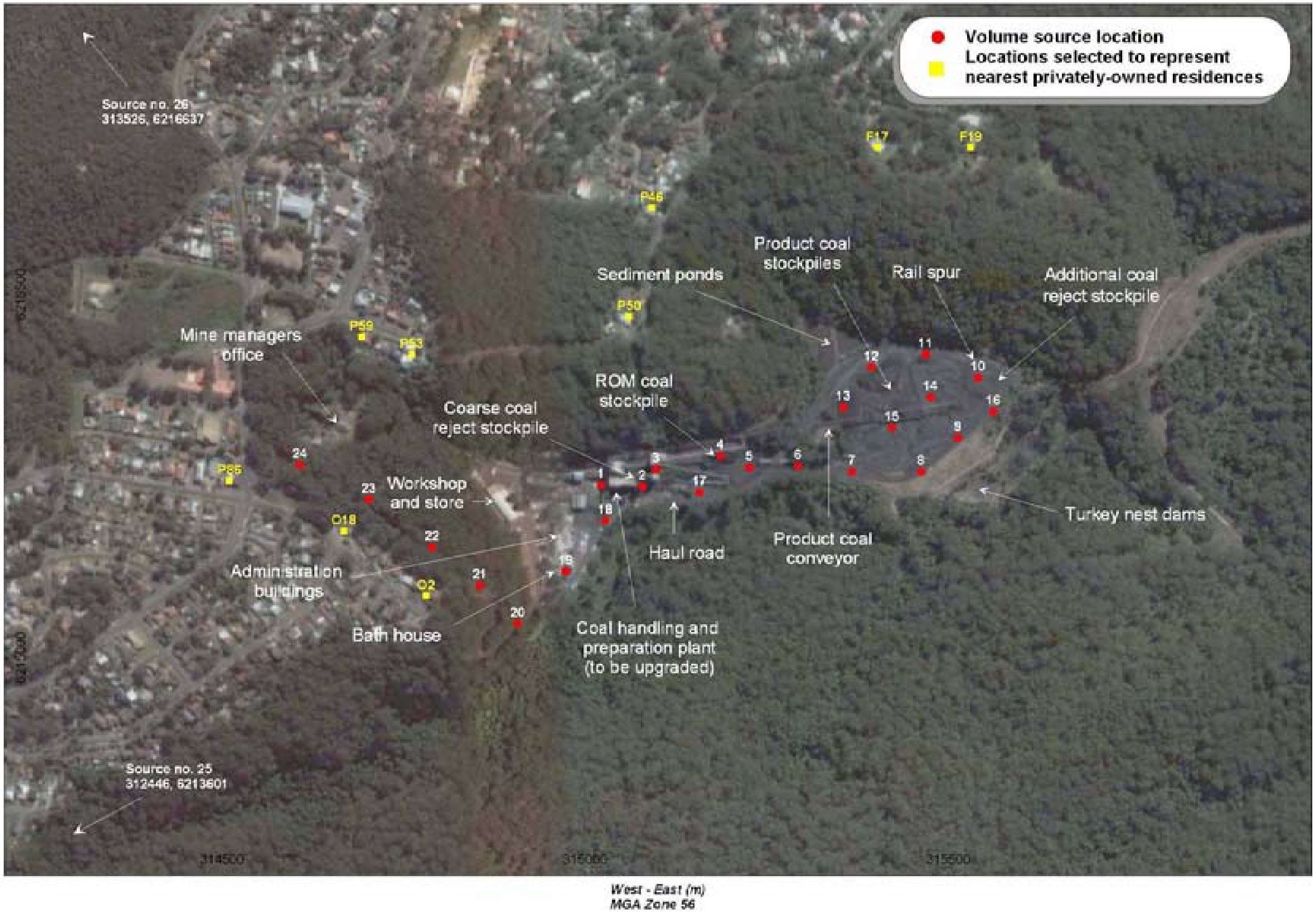


Spring
Calms = 0.4%

FIGURE 5

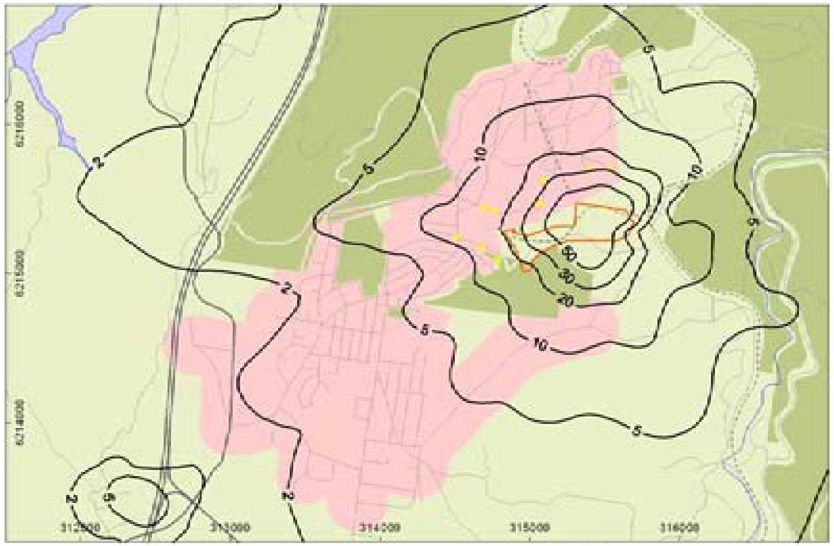


Location of ambient air quality monitoring sites

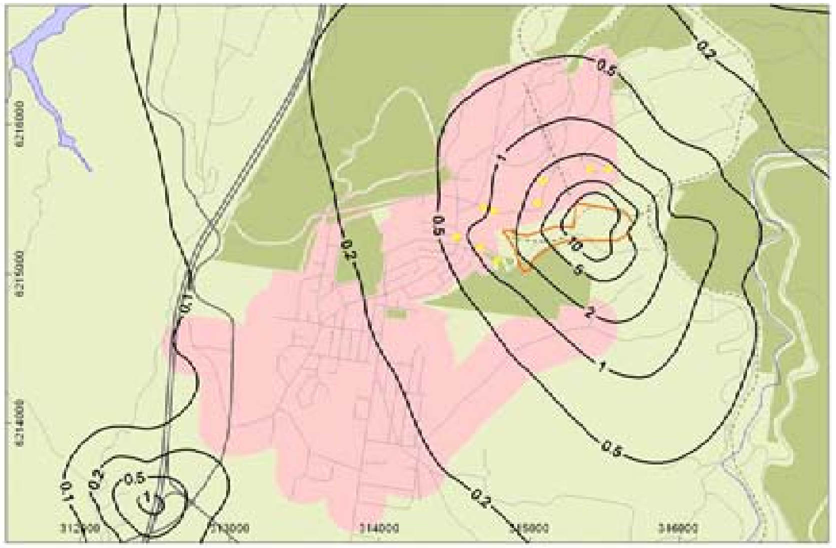


Location of modelled dust sources and nearest sensitive receptors

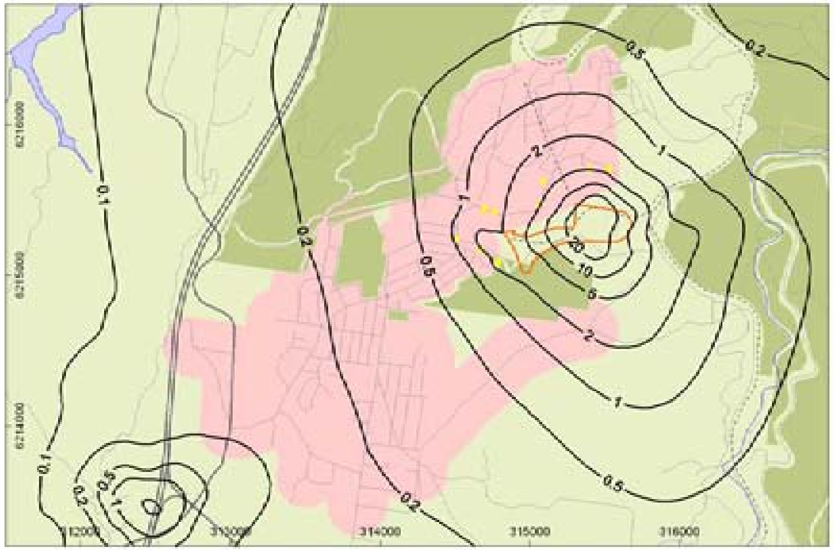
FIGURE 7



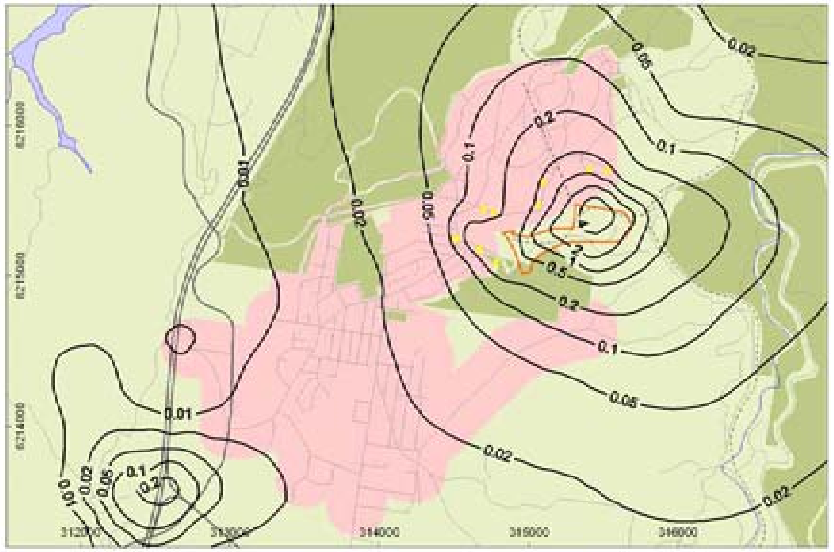
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



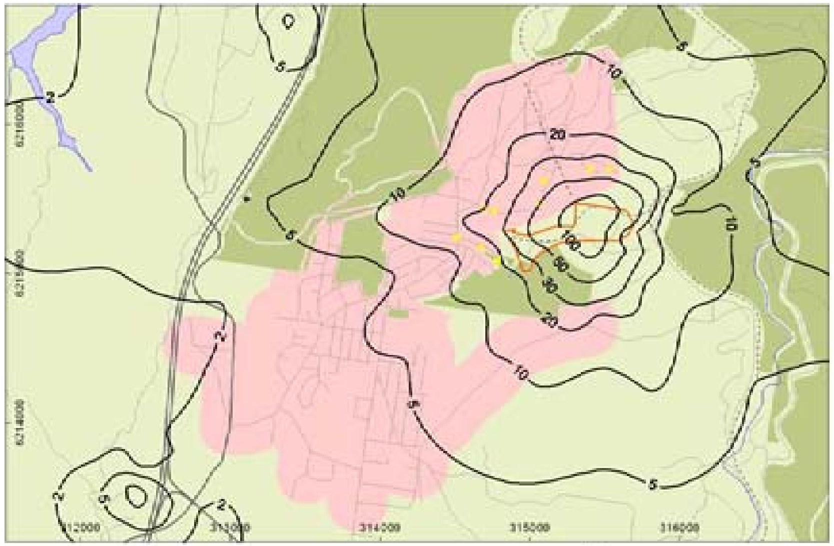
Annual average TSP - µg/m^3



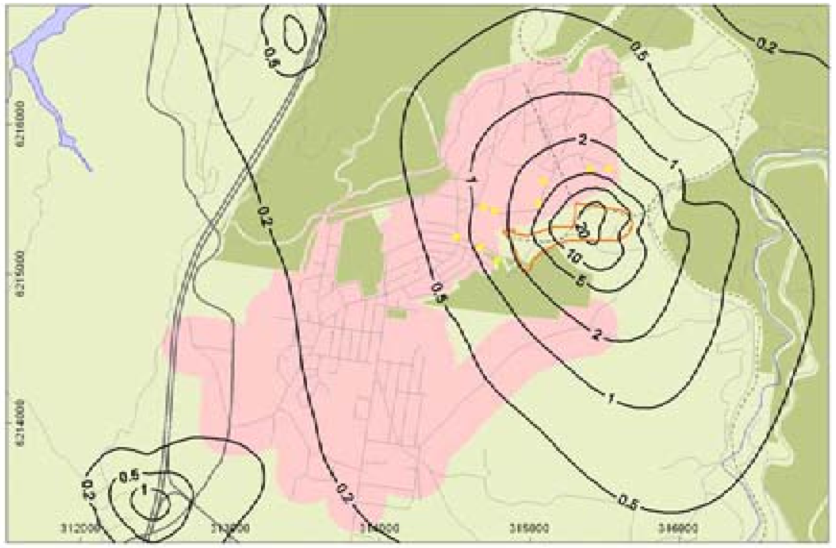
Annual average dust deposition - g/m^2/month

Predicted dust concentration and deposition levels due to Year 3 operations

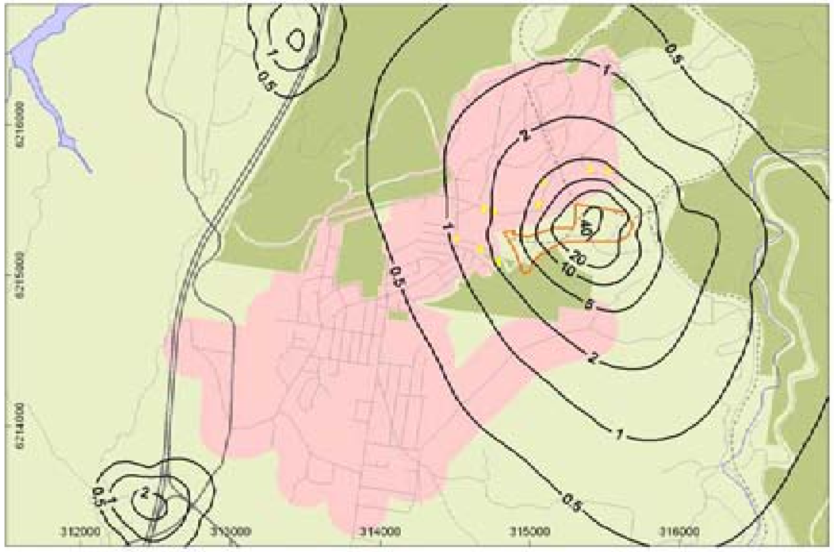
FIGURE 8



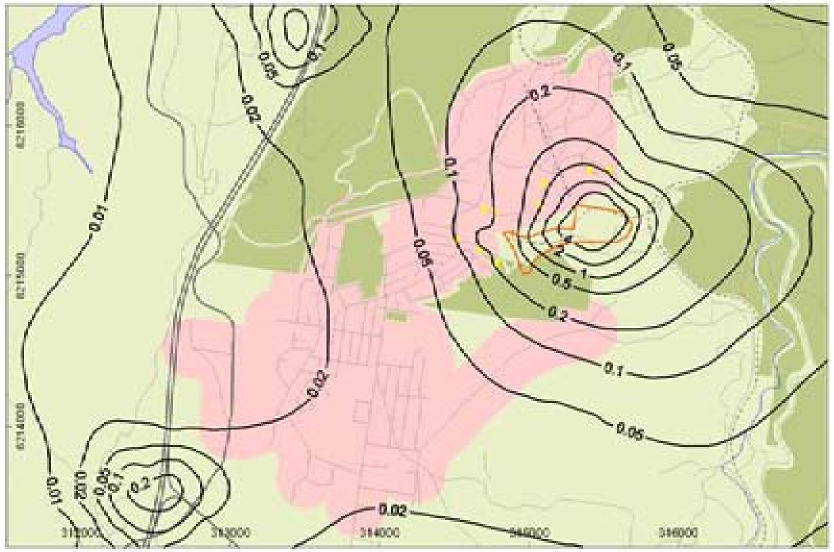
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



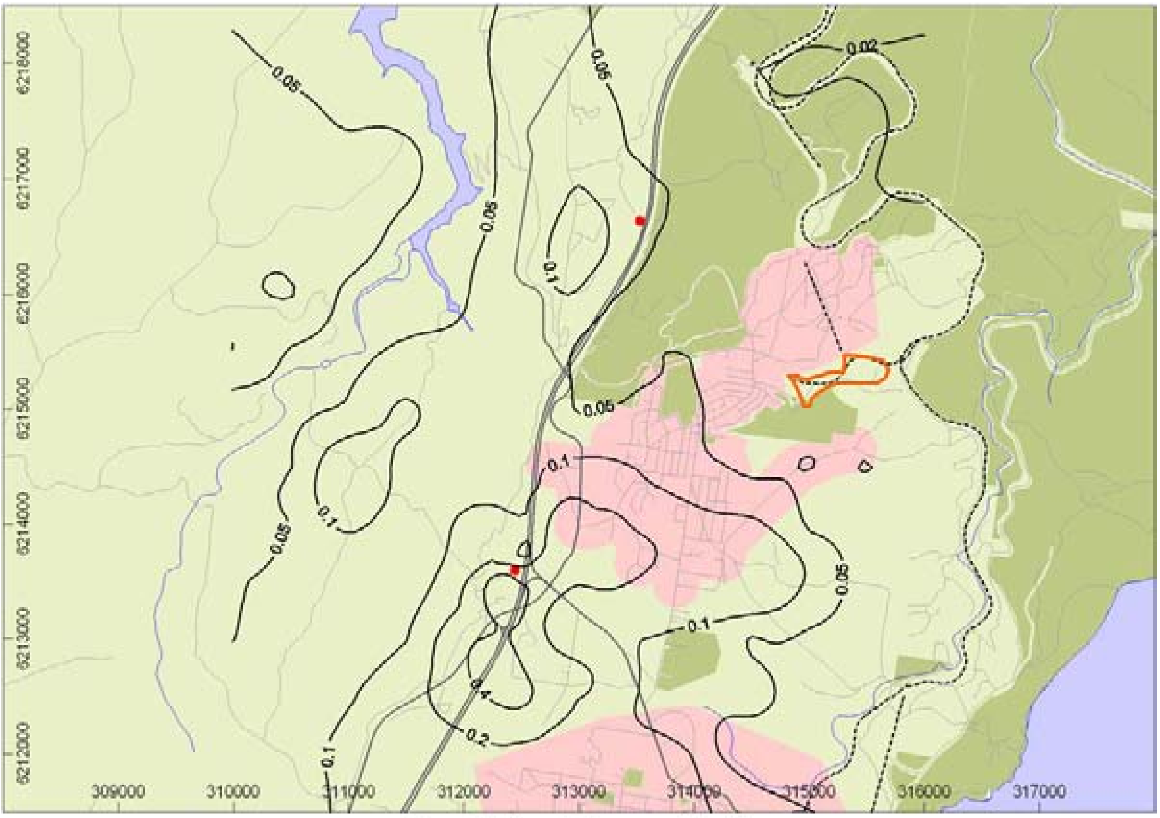
Annual average TSP - µg/m^3



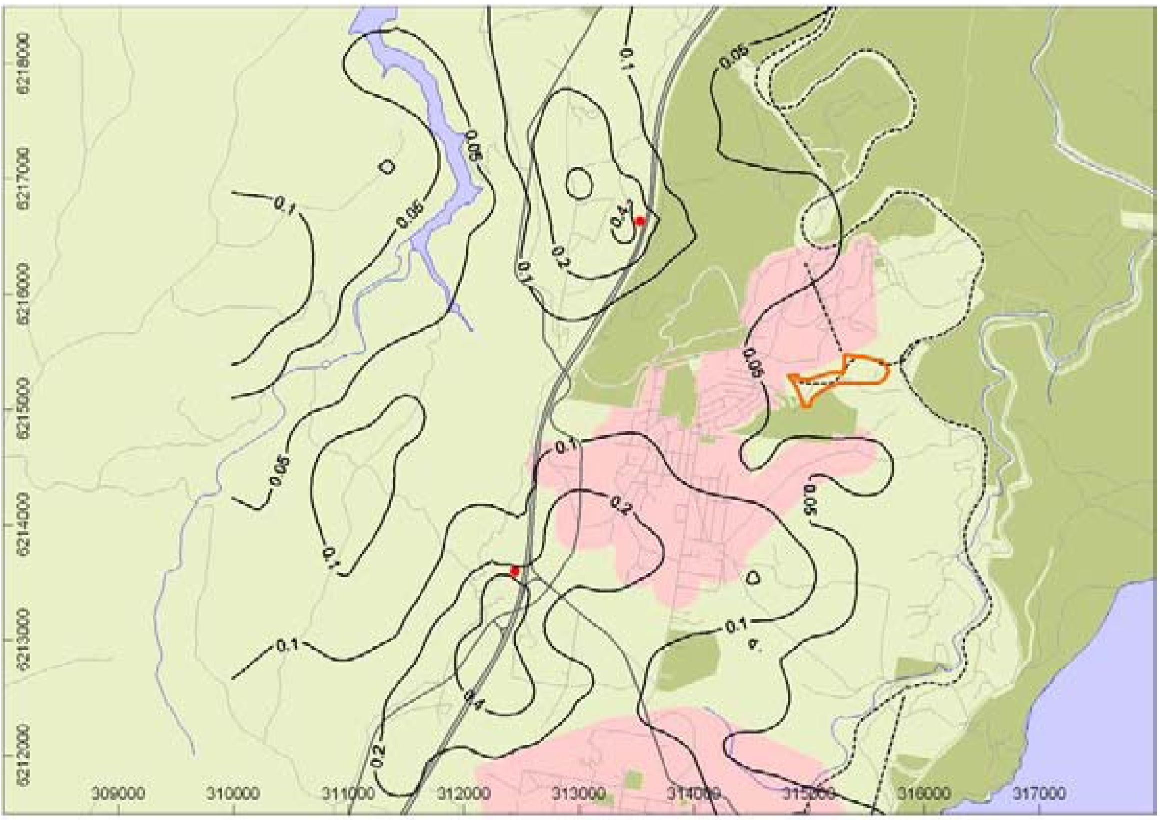
Annual average dust deposition - g/m^2/month

Predicted dust concentration and deposition levels due to Year 15 operations

FIGURE 9



Year 1 to Year 11 (one vent shaft)



Year 12 to Year 23 (two vent shafts)

Predicted odour levels at the 99th percentile due to vent shaft emissions (odour units)

FIGURE 10