Air Quality Assessment of Proposed Mine for Central West Coal Project

Prepared for

URS

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Glossary

Term	Definition
%	percent
$\mu g/m^3$	micrograms per cubic metre
<	less than
>	greater than
°C	degrees Celsius
AGD	Australian Geodetic Datum
AMG	Australian Map Grid coordinates
AWS	Automatic weather station
BOM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	digital elevation model terrain data
e.g.	for example
EPP(Kwinana)	Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999
i.e.	that is,
g	grams
GHD	Gutteridge, Haskins and Davey Pty Ltd
g/m^2/month	grams per square metre per month
g/s	grams per second
g/VKT	grams per vehicle kilometres travelled
ha	hectare
kg	kilogram
km	kilometre
km/hr	kilometre per hour
km^2	square kilometre
L/m^2/hour	Litres per square metre per hour
m	metre
M	million
m^2	square metres
m^3	cubic metres
mg	milligram
Mg	megagram
MGA94	Map Grid of Australia 1994
Mg/hectare/yr	megagrams per hectare per year
m/s	metres per second
Mt	million tonnes
Mtpa	million tonnes per annum
NEPM(Air)	National Environment Protection (Ambient Air Quality) Measure
NPI	National Pollutant Inventory
NSW	New South Wales
NSW DECC	New South Wales Department of the Environment and Climate Change

PM	Particulate matter (fine dust)
$PM_{2.5}$ and PM_{10}	Particulate matter less than 2.5 or 10 microns, respectively
project	Central West Coal Project
ROM	run of mine
TAPM	The Air Pollution Model
TEOM	tapered element oscillating microbalance
TSP	total suspended particles
URS	URS Corporation
US EPA	United States Environmental Protection Agency
WA DEC	Western Australia Department of Environment and Conservation

1. Introduction

URS has commissioned Katestone Environmental to undertake an air quality impact assessment study for a proposed coal mine as part of the Central West Coal Project (the project). The purpose of this assessment is to:

- Describe the regulatory requirements for protecting environmental values for air, such as achieving relevant air quality goals
- Describe the meteorology and existing air quality that may be affected by the project
- Evaluate the air quality impacts of the project on the existing environment
- Detail proposed impact management techniques

1.1 Project background

The project involves open-cut strip mining of a 75 Mt sub-bituminus coal deposit (the Central West Coal Deposit) as a fuel source for the proposed Coolimba Power Station. This project is related to a proposal by Coolimba Power Pty. Ltd. (a wholly owned subsidiary of Aviva Corporation Limited) known as the Coolimba Power Project. The Coolimba Power Project is currently undergoing a separate environmental assessment.

The project site is located approximately eight kilometres southwest of the Town of Eneabba, as shown in Figure 1. The coal reserves are covered by Mining Lease M267SA, M70/492 and M70/1039 (Figure 2).

1.2 Activities on site

The air quality impact assessment takes into account dust generating activities from mining operations and disturbed surfaces within the mine lease application area. The project consists of an open-cut strip coal mine with a production rate of approximately 2 to 2.5 million tonnes per annum (Mtpa). The mining method will involve the removal of overburden by bulldozer and the use of conveyors to transport the overburden into a previously mined area of the coal pit. The coal will be removed by the use of continuous miners with a primary crusher and sizer located within the pit. The sized coal will be transported by conveyor out of the pit and then transported by truck to the run of mine (ROM) hopper or ROM stockpile. The coal is then conveyed to the crushing plant where again it is crushed and sized, then conveyed to the product stockpile. The coal is conveyed to the Coolimba Power Station as a fuel source and no coal rejects are expected. Ash from the power station will be hauled on site and disposed of alongside the overburden.

1.3 Dust generating activities

Dust generating activities have been assessed for their potential impact on sensitive receptor locations outside the mining lease boundaries. Maximum 24 hour and annual average emissions were modelled to ascertain the activities which posed the greatest potential for dust impacts. Dust emissions are calculated by employing emission factors provided in the US EPA's AP-42 document for various open cut mining activities.

The extraction of coal from an open cut mine is a dust generating activity with the potential to impact on human health and amenity. Key activities that contribute to dust generation include:

- Vehicle traffic on haul roads
- Overburden removal
- Extraction activities within the pit itself
- Wind erosion from stockpiles
- Exposed surfaces

Under normal conditions a human respiratory tract in good health is able to deal with inhaled particles without undue stress or long-term effects. In sensitive individuals, or when high levels of particles are present, particulate matter may contribute to increased rates of respiratory illnesses and symptoms.

Studies indicate that such adverse effects are dependent on a number of factors (Neale 2005), including:

- particle size (whether particles can penetrate the lower airways)
- the intensity of the exposure
- the chemical nature of the particles and their interaction with human tissue
- the presence or absence of pre-existing conditions (especially diseases of the respiratory tract)
- meteorological factors such as winds, humidity, a temperature inversion, rain or thunderstorms

The vast majority of dust from mining activities consists of coarse particles (around 40 per cent) and particles larger than PM_{10}, generated from natural activities such as mechanical disturbance of rock and soil materials by dragline or shovel, bulldozing and vehicles on dirt roads. Particles are also generated when wind blows over bare ground and different types of stockpiles (NSW Department of Health 2007).

2. Methodology of assessment

2.1 Relevant legislation and guidelines

2.1.1 Air quality criteria

The National Environmental Protection Council defines national ambient air quality standards and goals in consultation with, and agreement from, all state governments. These were first published in 1997 in the National Environment Protection (Ambient Air Quality) Measure (NEPM(Air)).

Air quality in Western Australia is assessed according to standards specified by the NEPM(Air) through the National Environment Protection Council (Western Australia) Act 1996 (WA DEC, 1996). Compliance with the NEPM(Air) standards is determined via ambient air quality monitoring undertaken at locations prescribed by the NEPM(Air) and that are representative of large urban populations. The NEPM(Air) standard for particulate matter with an aerodynamic diameter less than 10 µm (PM_{10}) is based on international studies and guidelines published by the World Health Organisation (WHO).

The WHO suggests that PM_{10} be used as an indicator of the level of particulate matter in the atmosphere because there is more extensive PM_{10} measurement data throughout the world than any other indicator of particulate matter. However, the WHO guideline for PM_{10} is actually based on epidemiological studies in conjunction with $PM_{2.5}$ measurements. WHO has used a generic $PM_{2.5}/PM_{10}$ ratio of 0.5 to calculate its recommended PM_{10} guideline of 50 µg/m³ from the $PM_{2.5}$ guideline of 25 µg/m³. This ratio of 0.5 is close to that observed typically in the urban areas of developing countries and at the bottom of the range (0.5 – 0.8) found in the urban areas of developed countries. WHO indicates that if justified by local conditions, the $PM_{2.5}/PM_{10}$ ratio may be changed based on the local data when the local standards are set.

In the recent US EPA Emissions inventory a $PM_{2.5}/PM_{10}$ ratio of 0.2 was used to estimate the $PM_{2.5}$ emissions associated with fugitive dust from mining and quarrying. This suggests that a very different ratio should be applied to particulate matter that is associated with mining and quarry activities than what may be relevant in urban areas.

For this project the ratio of $PM_{2.5}/PM_{10}$ varied between 0.04 to 0.36 depending on the source of dust; with an average of all dust sources of 0.1. This would suggest a relevant PM_{10} guideline value of 125 - 250 µg/m³ based on the WHO methodology and a ratio of $PM_{2.5}/PM_{10}$ of between 0.2 and 0.1.

Notwithstanding this we have conservatively applied the NEPM standard of 50 µg/m^3 to coarse particulate matter from coal stockpiles and mining activities which is likely to overstate the potential for adverse impacts.

The NEPM(Air) is presented in Table 1.

Table 1 National Environment Protection (Ambient Air Quality) Measure standard

Pollutant	Averaging period	NEPM (Air) standard ($\mu g/m^3$)	NEPM (Air) goal – maximum allowable exceedances
PM_{10}	24-hour	50	5 days per year

For other significant air pollutants not covered by the NEPM(Air), the Western Australia Department of Environmental Protection adopts the World Health Organisation's Guidelines for Air Quality or air quality guidelines from other jurisdictions where appropriate. Air quality guidelines for the most significant air pollutants that may arise from this project are summarised in Table 2. Western Australia reports a 24-hour average TSP guideline in the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999. In the Kwinana area, a 24-hour average standard of 90 $\mu g/m^3$ (limit of 150 $\mu g/m^3$) applies for an isolated residential dwelling.

Table 2 Relevant air quality guidelines

Pollutant	Averaging period	Air quality guidelines	Units	Source
PM_{10}	24-hour	50	$\mu g/m^3$	NEPM
	Annual	30	$\mu g/m^3$	NSW DECC
TSP	24-hour	90	$\mu g/m^3$	Kwinana
	Annual	90	$\mu g/m^3$	NSW DECC
Dust deposition rate	Annual	2 [a]	g/m^2/month	NSW DECC
		4 [b]		
Note: [a] Maximum increase in deposited dust level [b] Maximum total deposited dust level				

2.2 Study description

2.2.1 Scope of works

The air quality impact assessment for the project will be based on potential impacts of dust due to mine operations for the following pit locations:

- Mining operations when mining occurs at the southern end of the coal pit
- Mining operations when mining occurs towards the north of the coal pit
- Mining operations when mining occurs at the northern end of the coal pit

These three scenarios will represent impacts of dust on sensitive receptors over the life of the mine.

2.2.2 Methodology

The air quality assessment was conducted in accordance with recognised techniques for dispersion modelling and emission estimation.

The prognostic model TAPM (developed by CSIRO, version 3) and the diagnostic meteorological model CALMET (developed by EarthTec, version 6) were used in conjunction with site specific meteorological data to develop a three-dimensional wind field representing wind flows in the region. Refer to Appendix A for model details.

The dispersion model CALPUFF (developed by EarthTec, version 6) was used in the assessment of ground-level concentrations of pollutants due to the mine.

Emission factors for dust emissions from the mine were calculated based on emission factors published by the United States Environmental Protection Agency (USEPA) in their AP-42 documents and by the National Pollutant Inventory (NPI) in their emission factor handbooks.

Mining activities, such as extraction rates of coal and overburden, location of equipment and mining schedules were based on information supplied by Aviva Corporation Limited, as detailed in Appendix B.

3. Existing environment

The existing environment in the region surrounding the project is discussed here in terms of the meteorological conditions that are likely to influence the dispersion of air pollutants from the mining operations, other existing sources of air pollution in the region and the location of sensitive receptors.

3.1 Climate

The climate data used in this analysis has been sourced from the Bureau of Meteorology (BOM) meteorological station at Eneabba and from the automatic weather station (AWS) owned and operated by Iluka Resources. The Iluka Resources AWS is located less than three kilometres to the east of the town of Eneabba, and is illustrated in Figure 3.

The BOM meteorological data used for this analysis includes average monthly:

- Maximum and minimum daily temperature
- Highest, mean and lowest rainfall
- 9am and 3pm relative humidity
- Solar radiation exposure

The BOM meteorological station does not record hourly average wind speed and direction information, which is used in both climate analysis and assimilation with meteorological and dispersion modelling. Consequently, hourly average wind speed and direction data has been obtained from the Iluka Resources AWS for use in this study.

3.1.1 Wind Speed and Direction

The annual distribution of winds recorded at the Iluka Resources AWS near Eneabba is illustrated in a wind rose diagram in Figure 5, with a frequency distribution for the wind speed presented in Figure 6. Seasonal and diurnal distributions for wind speed and direction are presented in wind rose diagrams in Figure 7 and Figure 8 respectively.

The annual distribution of wind direction indicates that winds are fairly evenly distributed between the east-northeast through to the west-southwest, with 79.4% of winds blowing from this broad sector. The seasonal analysis indicates that summer winds tend to blow predominantly from the south-western quadrant, while winter winds tend to be more north-easterly and easterly. The diurnal analysis shows the impact of the sea breeze with strong westerlies and south-westerlies developing during the afternoon (midday to 6pm) and continuing into the evening (6pm to midnight). During the night, winds tend to blow predominantly from the northeast, east and southeast and strengthen in the morning, becoming more easterly and north-easterly.

The distribution of wind speeds at Eneabba shows 36.3% of winds are greater than 5 m/s. Light winds less than 2 m/s account for 20% of the winds.

3.1.2 Temperature and Solar Radiation

The annual mean maximum daily temperature recorded at the BOM meteorological station at Eneabba for the period 1972-2008 was 27.6°C, with a mean minimum daily temperature of 13.6°C. The warmest month is February with an average maximum daily temperature of 36.1°C, while December, January and March also average above 33°C. In contrast, the coolest month is July with an average maximum daily temperature of 19.6°C, while the mean minimum daily temperature is 9.1°C.

The average monthly distribution of maximum and minimum temperatures is illustrated in Figure 9.

Figure 12 presents the hourly averaged distribution of solar radiation recorded at the Iluka Resources meteorological station near Eneabba, while Figure 13 shows the average daily solar exposure by month at the BOM meteorological station at Eneabba. These figures illustrate the typical daily and monthly pattern of solar exposure, with the mean daily maximum solar radiation peaking around 12pm and annual solar exposure 2.5 to 3 times greater during the summer than the winter.

3.1.3 Rainfall

Rainfall information has been analysed from data provided by the BOM (Figure 10) and indicates that the annual average is 505.1 mm. The wettest period in the Eneabba region is during the winter months from May to August when, on average, 68.4% of the annual rainfall occurs. Only 6.1% of the annual average rainfall occurs during the summer months (December to January).

3.1.4 Relative Humidity

The monthly averaged distribution of relative humidity at 9am and 3pm at the Eneabba BOM meteorological station is presented in Figure 11.

The distribution indicates that the summer months (December to February) tend to be relatively dry with mean daily maximum relative humidity below 50%, while in the winter months the daily maximum relative humidity ranges from 74% to 78%. The data also shows that, on average, the relative humidity is 17% higher at 9am than at 3pm.

3.1.5 Development of meteorological wind field for dispersion modelling

Whilst there is meteorological data available for a site located at Eneabba, a three-dimensional wind field was required for inclusion in the dispersion modelling of potential impacts from the project. A coupled approach using the meteorological models TAPM (CSIRO, version 3) and CALMET (EarthTech, version 6) in conjunction with the on-site measurements has been used. Details of this modelling approach are provided in Appendix A.

3.2 Location of sensitive receptors and surrounding landuse

The locations of the nearest sensitive receptors are presented in Table 3 and Figure 3.

Table 3 Location of sensitive receptors

Receptor	Easting AGD (m)	Northing AGD (m)	Distance from mine
R1	327337	6698388	5.1 km north
R2	324051	6690326	3.3 km north
R3	322465	6689554	5.0 km west
R4	341480	6681401	10.0 km east
R5	325159	6681369	3.9 km west
R6	327062	6682264	1.8 km west
R7	327019	6683467	1.4 km west
R8	326287	6678839	4.9 km southwest
R9	327783	6676991	5.8 km southwest
R10	328760	6673579	9.1 km south
Eneabba	332559	6700166	8.2 km northeast

The project site is located on the border of the shires of Carnamah and Coorow (and thus the mine is located in both shires) on an elevated flat plateau approximately 100 metres above sea level and 30 km from the coastline. The area surrounding the site contains a number of mining leases for deposits of heavy mineral sands and coal, with the mining town of Eneabba located approximately 8 km north-east of the site. The closest existing industrial activity to the site is the Iluka South, North and West sand mines located approximately 3 km east, 7 km north and immediately north of the project site, respectively.

3.3 Ambient air quality

The closest existing industrial activity to the proposed project is the Iluka South, North and West sand mines located approximately 3 km east, 7 km north and to the immediate north of the proposed project, respectively. Iluka Resources undertakes dust monitoring of PM_{10} and total suspended particulates. Monitoring of PM_{10} is undertaken at Eneabba and at Depot Hill on the eastern boundary of the Iluka North Mine using a TEOM. Monthly dust deposition rates are recorded at six locations, four at the Iluka South Mine operating to the east of the proposed project and two at the Iluka North Mine operations, more than 7 km from the proposed project.

3.3.1 PM_{10}

Iluka Resources Midwest Annual Environment report 2007 (the report) reported that the 24-hour average ground-level concentrations of PM_{10} exceeded the NEPM(Air) standard of 50 µg/m^3 on three occasions in the town of Eneabba, whilst background levels (recorded at Depot Hill) exceeded 50 µg/m^3 on four occasions. It was noted that *"these exceedances occurred during periods of high regional winds where elevated dust levels were noted on a regional basis and were not specifically associated with mine activities…"* For 2007, PM_{10} levels at Eneabba were generally lower than 30 µg/m^3 (24-hour average).

3.3.2 Dust deposition rate

Total particulate matter was recorded at six sites from July 2007 and January 2008. Four of the dust gauges (known as ENE 1, ENE 2, ENE 4 and ENE 5) are located at the Iluka South Mine operations. These are the nearest set of measurements of dust to the Central West Mine Project.

Monitoring results reported in the 2007 Midwest Annual Environmental report are presented below. The report states that the '*high regional winds in November were reflected in results from all depositional dust gauges, however, the high reading from ENE 5 in December may be an anomaly*'.

Table 4 Monthly dust deposition rates from Iluka Resources monitoring

Monthly depositional Dust values (g/m^2/month)						
Month	**ENE 1**	**ENE 2**	**ENE 3**	**ENE 4**	**ENE 5**	**ENE 6**
July-Aug	4.1	0.7	1.2	0.9	1.2	
Aug-Sep	2.3	1.4	1.5	1.4	2.0	1.3
Sep-Oct	4.5	2.2	1.8	2.0	2.2	4.0
Oct-Nov	0.3	0.7	1.1	1.2	1.0	0.7
Nov-Dec	4.0	7.5	4.0	2.9	5.3	4.7
Dec-Jan	4.6	2.6	0.8	1.2	9.6	0.8

3.3.3 Background dust level for assessment

The available baseline dust monitoring information for the Eneabba region is not suitable to add as a constant background to the modelled impacts from the proposed Central West Mine. This is because the separation of the sensitive receptors identified (see Table 3) from the proposed Central West Mine and the fact that they are even further away from the existing Iluka sand mines, it is unlikely that cumulative impact of dust from both sources will be significant on ground-level concentrations of dust.

Notwithstanding this, we have included a cumulative assessment for completeness, assuming a background level of 30 µg/m³ and 15 µg/m³ for 24-hour and annual average ground-level concentrations of PM_{10}. Background level of TSP have been assumed to be 60 µg/m³ and 30 µg/m³ for a 24-hour and annual average (Assuming PM_{10} is 50% of TSP levels). These values are based on the monitoring data collected by Iluka resources and documented in their 2007 Midwest Annual Environmental Report.

A cumulative assessment has also been undertaken to account for the particulate emissions generated by the power station boilers and emitted through the main stack. The fugitive emissions for coal handling, storage and processing associated with the operation of the power station have also been considered as part of this assessment.

4. Dust from mining operations

4.1 Description

Three scenarios have been assessed in terms of potential impacts of dust due to the sensitive receptors.

- Scenario 1: Mining operations when mining occurs at the southern end of the coal pit, approximately 3 kilometres south-east of the crushing plant
- Scenario 2: Mining operations when mining occurs towards the north of the coal pit, approximately 5 kilometres north of the crushing plant
- Scenario 3: Mining operations when mining occurs at the northern end of the coal pit, approximately 7.5 kilometres north-northeast of the crushing plant

Figure 4 indicates the location of the mining for each of these scenarios.

4.2 Emission estimation

Activities for this project that are expected to be the most significant sources of dust emissions are the truck operations and wheel generated dust on haul roads. Wind-blown dust will also occur due to wind erosion of stockpiles, crushing of coal and coal movement by bulldozer and conveyor.

Three dust emission scenarios have been chosen to represent the mining activities with the highest potential for causing off-site impacts. Dust emission rates have been calculated using coal mining emission factors and detailed information on mining activities for each of these scenarios and are provided in Appendix B. Details of the overburden and coal extraction for the project, the locations of coal and overburden dumping and equipment operation were provided by URS Corporation.

Dust emission rates from the mine have been calculated using emission factors published by the USEPA and the NPI (USEPA, 1998; USEPA, 2004; USEPA, 2006a; USEPA, 2006b; NPI, 2001). For the majority of dust-producing activities, the dust emission rate is dependent upon the wind speed with little or no dust emissions occurring for some activities below a threshold wind speed. For some dust sources such as coal conveyors, the frequency of utilisation and coal throughput are also important determinants of the dust emission rate. For conveyors, an emission factor has been derived from studies by GHD and Oceanics Australia (GHD-Oceanics, 1975). Table 5 summarises the emissions of TSP, PM_{10} and $PM_{2.5}$ from the all fugitive dust activities associated with the extraction, transportation, handling, storage and processing of coal, overburden and ash due to operation of the mine and power station.

Other factors that determine the dust emission rate are the coal type, coal moisture content, coal particle size distribution, rainfall and the mitigation measures that may be employed. These key factors have been accounted for in estimating the dust emissions for the project. Details of the methodology and the emission factors used for estimating dust emissions are included in Appendix B.

Table 5 Estimated total TSP, PM_{10}, $PM_{2.5}$ (g/s) for all fugitive dust activities associated with the mine and power station operations

Activity	TSP	PM_{10}	$PM_{2.5}$
Haul road (coal)	32.1	9.2	0.9
Material handling – transfer	1.7	0.7	0.06
Conveyor emissions	0.3	0.1	0.005
wind erosion stockpiles	1.9	0.9	0.04
wind erosion exposed areas	5.3	2.5	0.4
Bulldozing	1.7	0.5	0.04
crushing/screening	1.4	0.5	0.01
pit activities (coal extraction, overburden dumping)	1.0	0.3	0.09
Haul, dumping and wind erosion (ash)	3.8	1.3	0.1
Haul road (initial waste)	30.5	8.7	0.9
Total	79.7	24.7	2.5

4.3 Model configuration

Dust dispersion modelling was carried out for each of the three scenarios detailed in Section 4.1. The modelling considered a 24-hour average and annual average simulation for PM_{10}, TSP and dust deposition. Twelve months of modelled meteorological data was used as input for the dispersion model. This encompasses all weather conditions likely to be experienced in the region during a typical year. Results are presented below without ambient background levels to assess the potential impacts that mining activities may have on the town of Eneabba and surrounding areas. CALPUFF version 6.0 was used to calculate the dispersion potential of dust generated by mining activities. Meteorological input for CALPUFF was derived from a coupled TAPM/CALMET approach to generate a three-dimensional wind field including observational data assimilation. Details of the modelling are provided in Appendix A.

For dust deposition modelling, a particle size distribution for each activity was included based on size fractions of TSP, PM_{10} and $PM_{2.5}$ reported for the various mine sources in the USEPA AP-42 documents (USEPA, 1998).

5. Construction impacts

5.1 Construction activities

Construction phase activities can be broadly described as:

- Site clearance of areas for construction activities, including vegetation clearance
- Topsoil removal and storage, and earthworks
- Civil works including temporary and permanent drainage works
- Structure and plant erection and installation
- Commissioning and testing of plant and equipment
- Construction site demobilisation

Infrastructure that will be constructed during the construction phase or at some time during mine operation includes:

- Haul roads
- Light and heavy vehicle internal roads
- Main gate and security building
- Mine Infrastructure Area
- Telecommunications
- Water supply and management facilities, including raw water supply and storage and initial tailings dam
- Blast magazine

5.2 Management

Dust management should include regular watering of roads and exposed areas to reduce wheel-generated dust and restricting vehicle speeds to below 30 km per hour. During high wind conditions, dust-generating activities such as earthworks that could potentially affect residents should not be carried out. The loads of haul vehicles should be covered when moving outside of the construction site and any spillages should be cleaned up. Stockpiled material should be vegetated or kept in appropriate enclosures to prevent wind erosion from the prevailing easterly wind direction.

Regular cleaning of machinery and vehicle tyres will prevent track-out of dust to public roads. Burning or incineration of cleared vegetation or other materials should not be carried out on site at any time.

Before construction commences, a dust management plan (DMP) should be developed to assist in minimising nuisance dust. Dust measures to be included are:

- Management of the earth moving
- Minimising speed of on-site traffic, where applicable, to minimise wheel generated dust
- Ensuring all vehicles are suitably fitted with exhaust systems that minimise gaseous and particulate emissions to meet vehicle design standards
- Watering of bunds and stockpiles to minimise dust lift-off
- Watering unsealed roads to minimise dust lift-off from the road surface
- Limiting vegetation and soil clearing, so as to minimise the area of exposed soil that may generate dust
- Compaction of soil and stabilisation of vegetation to minimise dust lift off due to wind erosion within the construction area

If on-site concrete batching plants, bitumen or asphalt plants are required; these may be a source of dust, odour and other air pollutants. Site-specific air quality assessments should be undertaken if these activities are to be located within close proximity of sensitive land-uses.

Construction of pipelines for water should be undertaken with a DMP in place to ensure minimal dust nuisance.

6. Mining activities

Mining activities include the excavation, loading, reworking, transporting and dumping of overburden and coal. The impact of wind erosion has been accounted for in relation to disturbed areas prior to rehabilitation and those areas that are undergoing rehabilitation. All relevant sources of fugitive dust emissions associated with the mine and power station operations have been accounted for in the development of the dispersion model results. Appendix B details some of the sources used in this assessment. Three mine operation scenarios have been modelled in this assessment as detailed in section 4.1.

The following sections present the potential impacts due to dust for the three modelling scenarios.

6.1 Scenario 1

In this scenario, mining occurs at the southern end of the coal reserve. The maximum 24-hour average and annual average ground-level concentrations of PM_{10} that are predicted to occur at the location of the sensitive receptors are presented in Table 6. The results show:

- The maximum 24-hour average ground-level concentrations of PM_{10} due to the mine operations are below the NEPM standard of 50 µg/m³. The highest 24-hour average ground-level concentration of PM_{10} is predicted to occur at R6, located 1.8 km southwest of the ROM pad.
- At Eneabba, the maximum 24-hour average ground-level concentration of PM_{10} due to the mine (including a background value of 30 µg/m^3) is predicted to be 37.6 µg/m^3, well below the NEPM standard.
- The annual average ground-level concentrations of PM_{10} are well below the NSW DECC goal of 30 µg/m^3. The highest concentration predicted at a receptor is 19.6 µg/m^3, less than 66% of the goal.
- At Eneabba, the annual average ground-level concentration of PM_{10} due to the mine plus a conservative background level is predicted to be 15.3 µg/m^3, approximately 50% of the DECC goal for annual average PM_{10}.

Figure 14 and Figure 15 show the maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted due to the mine in isolation. The figures indicate that the impacts decrease rapidly with distance from the mine operations, with slightly higher concentrations predicted to the south and southwest.

Table 6 Predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} - Scenario 1

Receptor	Maximum 24-hour average PM_{10} (µg/m^3)		Annual average PM_{10} (µg/m^3)	
	Mine in isolation	Mine with background	Mine in isolation	Mine with background
R1 - 5.1 km north	7.2	37.2	0.6	15.6
R2 - 3.3 km north	7.5	37.5	0.5	15.5
R3 - 5.0 km west	5.5	35.5	0.6	15.6
R4 - 10.0 km east	8.5	38.5	0.3	15.3
R5 - 3.9 km west	27.4	57.4	2.2	17.2
R6 - 1.8 km west	44.6	74.6	4.6	19.6
R7 - 1.4 km west	29.8	59.8	4.1	19.1
R8 - 4.9 km southwest	36.6	66.6	1.1	16.1
R9 - 5.8 km southwest	27.5	57.5	0.7	15.7
R10 - 9.1 km south	7.9	37.9	0.2	15.2
Eneabba - 8.2 km northeast	7.6	37.6	0.3	15.3
Standard/goal	50		30	

The ground-level concentrations of TSP and dust deposition rate predicted at the location of the sensitive receptors are presented in Table 7. The results show:

- Compliance with the 24-hour average EPP(Kwinana) goal of 90 µg/m^3 (limit of 150 µg/m^3) for TSP. The highest 24-hour average (115 µg/m^3, including a background of 60 µg/m^3) is predicted to occur at R6 (1.8 km from the mine).
- Compliance with the annual average NSW DECC goal of 90 µg/m^3 for TSP. The annual average ground-level concentration of TSP predicted at Eneabba is 30.4 µg/m^3. The highest annual average ground-level concentration of TSP predicted at a sensitive receptor is 37.2 µg/m^3 at two receptors located within 2 km of the mine, which is 42 % of the goal.
- Compliance with the NSW DECC criteria of 2 g/m^2/month (annual average) as an incremental dust deposition rate is achieved. The annual average dust deposition rate predicted at Eneabba is 0.02 g/m^2/month. The highest annual average dust deposition rate due to the mine operations predicted at a sensitive receptor is 0.4 g/m^2/month at R7.

The maximum 24-hour and annual average ground-level concentrations of TSP are presented in Figure 16 and Figure 17, due to the mine in isolation. The annual average dust deposition rate is presented in Figure 18.

Table 7 Predicted 24-hour average and annual average ground-level concentrations of TSP and dust deposition rate - Scenario 1

Receptor	Maximum 24-hour average TSP (µg/m^3)		Annual average TSP (µg/m^3)		Annual average dust deposition rate (g/m^2/month)
	Mine in isolation	Mine with background	Mine in isolation	Mine with background	
R1 - 5.1 km north	8.9	68.9	0.8	30.8	0.03
R2 - 3.3 km north	12.0	72.0	1.4	31.4	0.09
R3 - 5.0 km west	8.2	68.2	0.9	30.9	0.07
R4 - 10.0 km east	9.1	69.1	0.3	30.3	0.01
R5 - 3.9 km west	33.4	93.4	3.1	33.1	0.16
R6 - 1.8 km west	55.0	115.0	7.2	37.2	0.30
R7 - 1.4 km west	36.2	96.2	7.2	37.2	0.37
R8 - 4.9 km southwest	37.8	97.8	1.3	31.3	0.04
R9 - 5.8 km southwest	29.4	89.4	0.8	30.8	0.02
R10 - 9.1 km south	8.0	68.0	0.3	30.3	0.01
Eneabba - 8.2 km northeast	8.5	68.5	0.4	30.4	0.02
Standard/guideline	90 (150 limit)		90		2

6.2 Scenario 2

In this scenario, mining occurs towards the north of the coal reserve. The maximum 24-hour average and annual average ground-level concentrations of PM_{10} that are predicted to occur at the location of the sensitive receptors are presented in Table 8. The results show:

- At Eneabba, the maximum 24-hour average ground-level concentration of PM_{10} is predicted to be 40.8 µg/m^3, below the NEPM standard even with the inclusion of a background value of 30 µg/m^3.
- The maximum 24-hour average ground-level concentrations of PM_{10} due to the mine operations are below the NEPM standard of 50 µg/m^3 at all but one of the sensitive receptors.
- The maximum 24-hour average ground-level concentrations of PM_{10} predicted at a sensitive receptor, due to the mine in isolation, is at R7 located 1.4 km west of the ROM pad, where 53.6 µg/m^3 is predicted. The 24-hour average ground-level concentrations of $PM_{10,}$ due to the mine in isolation is predicted to be above 50 µg/m^3 on one occasion at this receptor with ground-level concentrations generally less than 30 µg/m^3 for all other days of the year (Figure 20).
- The annual average ground-level concentrations of PM_{10} are well below the NSW DECC criteria of 30 µg/m^3. The highest concentration is predicted to be 18.1 µg/m^3 at R7. This is less than 37% of the goal.

Figure 19 and Figure 21 present the maximum 24-hour average and annual average ground-level concentrations of PM_{10}, due to the mine in isolation.

Table 8 Predicted 24-hour average and annual average ground-level concentrations of PM_{10} - Scenario 2

Receptor	Maximum 24-hour average PM_{10} (µg/m^3)		Annual average PM_{10} (µg/m^3)	
	Mine in isolation	Mine with background	Mine in isolation	Mine with background
R1 - 5.1 km north	11.8	41.8	1.2	16.2
R2 - 3.3 km north	21.4	51.4	2.1	17.1
R3 - 5.0 km west	8.8	38.8	1.2	16.2
R4 - 10.0 km east	2.9	32.9	0.1	15.1
R5 - 3.9 km west	23.2	53.2	1.1	16.1
R6 - 1.8 km west	38.7	68.7	2.2	17.2
R7 - 1.4 km west	53.1	83.1	3.1	18.1
R8 - 4.9 km southwest	9.3	39.3	0.4	15.4
R9 - 5.8 km southwest	8.8	38.8	0.3	15.3
R10 - 9.1 km south	5.5	35.5	0.1	15.1
Eneabba - 8.2 km northeast	10.8	40.8	0.4	15.4
Standard/goal	50		30	

The ground-level concentrations of TSP and dust deposition rate predicted at the location of the sensitive receptors are presented in Table 9. The results show:

- Compliance with the 24-hour average EPP(Kwinana) goal of 90 µg/m^3 (limit of 150 µg/m^3) for TSP. The highest 24-hour ground-level-concentration is 118.6 µg/m^3 at R7.
- Compliance with the annual average TSP NSW DECC goal of 90 µg/m^3. The annual average ground-level concentration of TSP predicted at Eneabba is 30.5 µg/m^3. The highest annual average ground-level concentration of TSP predicted at a sensitive receptor is 33.9 µg/m^3 at R7, which is 38% of the standard.
- Compliance with the NSW DECC criteria of 2 g/m^2/month (annual average) for the dust deposition rate is achieved. The annual average dust deposition rate predicted at Eneabba is 0.02 g/m^2/month. The highest annual average dust deposition rate due to the mine operations predicted at a sensitive receptor is 0.2 g/m^2/month at R2.

The maximum 24-hour average and annual average ground-level concentrations of TSP due to the mine in isolation are presented in Figure 23 and Figure 24. The annual average dust deposition rate is presented in Figure 25.

Table 9 Predicted 24-hour average and annual average ground-level concentrations of TSP and dust deposition rate - Scenario 2

Receptor	Maximum 24-hour average TSP ($\mu g/m^3$)		Annual average TSP ($\mu g/m^3$)		Annual average dust deposition rate (g/m^2/month)
	Mine in isolation	Mine with background	Mine in isolation	Mine with background	
R1 - 5.1 km north	13.5	73.5	1.5	31.5	0.05
R2 - 3.3 km north	22.4	82.4	2.9	32.9	0.2
R3 - 5.0 km west	10.2	70.2	1.6	31.6	0.1
R4 - 10.0 km east	2.9	62.9	0.2	30.2	0.01
R5 - 3.9 km west	23.4	83.4	1.2	31.2	0.03
R6 - 1.8 km west	39.8	99.8	2.5	32.5	0.05
R7 - 1.4 km west	58.6	118.6	3.9	33.9	0.1
R8 - 4.9 km southwest	9.4	69.4	0.5	30.5	0.01
R9 - 5.8 km southwest	9.0	69.0	0.3	30.3	0.01
R10 - 9.1 km south	5.5	65.5	0.1	30.1	0.003
Eneabba - 8.2 km northeast	10.9	70.9	0.5	30.5	0.02
Standard/goal	90 (150 limit)		90		2

6.3 Scenario 3

In this scenario, mining occurs at the extreme northern end of the coal reserve, the closest point to the township of Eneabba. The maximum 24-hour average and annual average ground-level concentrations of PM_{10} that are predicted to occur at the location of the sensitive receptors are presented in Table 10. The results show:

- At Eneabba, the maximum 24-hour average ground-level concentration of PM_{10} is predicted to be 40 $\mu g/m^3$, well below the NEPM standard even with the inclusion of a background value of 30 $\mu g/m^3$.
- The predicted maximum 24-hour average ground-level concentrations of PM_{10} due to the mine operations are below the NEPM standard of 50 $\mu g/m^3$ at all but one of the sensitive receptors.
- The maximum 24-hour average ground-level concentrations of PM_{10}, due to the mine in isolation, predicted at a sensitive receptor is 53.2 $\mu g/m^3$ (at R7). The 24-hour average ground-level concentrations of PM_{10} is predicted to be above 50 $\mu g/m^3$ on one occasion at this receptor with ground-level concentrations generally less than 30 $\mu g/m^3$ for all other days of the year (Figure 26).

Figure 25 and Figure 27 show the maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted due to the mine in isolation.

Table 10 Predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} due to mine operations in Scenario 3

Receptor	Maximum 24-hour average PM_{10} ($\mu g/m^3$)		Annual average PM_{10} ($\mu g/m^3$)	
	Mine in isolation	Mine with background	Mine in isolation	Mine with background
R1 - 5.1 km north	15.1	45.1	1.9	16.9
R2 - 3.3 km north	23.0	53.0	3.0	18.0
R3 - 5.0 km west	15.0	45.0	1.6	16.6
R4 - 10.0 km east	2.9	32.9	0.2	15.2
R5 - 3.9 km west	23.2	53.2	1.1	18.1
R6 - 1.8 km west	38.7	68.7	2.2	17.2
R7 - 1.4 km west	53.2	83.2	3.2	18.2
R8 - 4.9 km southwest	9.7	39.7	0.5	15.5
R9 - 5.8 km southwest	8.8	38.8	0.3	15.3
R10 - 9.1 km south	5.5	35.5	0.1	15.1
Eneabba - 8.2 km northeast	10.0	40.0	0.6	15.6
Standard/goal	50		30	

The ground-level concentrations of TSP and dust deposition rate predicted at the location of the sensitive receptors are presented in Table 11. The results show:

- Compliance with the 24-hour average EPP(Kwinana) goal of 90 $\mu g/m^3$ (limit of 150 $\mu g/m^3$) for TSP. The highest 24-hour ground-level concentration is 118.8 $\mu g/m^3$ at R7.
- Compliance with the annual average TSP NSW DECC goal of 90 $\mu g/m^3$. The annual average ground-level concentration of TSP predicted at Eneabba is 30.7 $\mu g/m^3$. The highest annual average ground-level concentration of TSP at a sensitive receptor is 34.4 $\mu g/m^3$ at R2, which is 39% of the goal.
- Compliance with NSW DECC criteria of 2 g/m^2/month (annual average) for the dust deposition rate. The annual average dust deposition rate predicted at Eneabba is 0.03 g/m^2/month. The highest annual average dust deposition rate due to the mine operations predicted at a sensitive receptor is 0.30 g/m^2/month at R2.

Table 11 Predicted 24-hour average and annual average ground-level concentrations of TSP and dust deposition rate due to mine operations in Scenario 3

Receptor	Maximum 24-hour average TSP (µg/m³)		Annual average TSP (µg/m³)		Annual average dust deposition rate (g/m²/month)
	Mine in isolation	Mine with background	Mine in isolation	Mine with background	
R1 - 5.1 km north	21.1	81.1	2.4	32.4	0.08
R2 - 3.3 km north	27.3	87.3	4.4	34.4	0.3
R3 - 5.0 km west	16.9	76.9	2.3	32.3	0.16
R4 - 10.0 km east	2.9	62.9	0.2	30.2	0.01
R5 - 3.9 km west	23.5	83.5	1.3	31.3	0.03
R6 - 1.8 km west	39.9	99.9	2.6	32.6	0.05
R7 - 1.4 km west	58.8	118.8	3.9	33.9	0.1
R8 - 4.9 km southwest	9.8	69.8	0.5	30.5	0.01
R9 - 5.8 km southwest	9.0	69.0	0.3	30.3	0.01
R10 - 9.1 km south	5.5	65.5	0.1	30.1	0.003
Eneabba - 8.2 km northeast	10.6	70.6	0.7	30.7	0.03
Standard/guideline	90 (limit 150)		90		2

The maximum 24-hour annual average ground-level concentrations of TSP, due to the mine in isolation are presented in Figure 28 and Figure 29. The annual average dust deposition rate is presented in Figure 30.

6.4 Cumulative impacts with proposed Coolimba Power Station (stack emissions)

Potential air quality impacts due to the proposed Coolimba Power Station boiler emissions emitted from the stacks have been assessed in a separate study by Katestone Environmental (March 2009). Particulate matter is the only common air pollutant that is likely to have a cumulative impact with the mine. The power station will use particulate controls that will result in all particulate matter that is emitted being less than 10 µm in diameter. Ground-level concentrations of PM_{10} due to the coal fired power station were quantified assuming the plant was operating at 100% capacity.

Figure 31 presents the maximum 24-hour average ground-level concentrations of PM_{10}, presented in the study. The results show that the maximum 24-hour average ground-level concentration of PM_{10} predicted to occur in the modelling domain is 4 µg/m³. The maximum at a receptor is 1.8 µg/m³. The highest annual average ground-level concentration of PM_{10} predicted to occur in the modelling domain is 0.2 µg/m³.

The ground-level concentrations of PM_{10} due to the power station are very small compared to the ground-level concentrations of PM_{10} due to the proposed mine. Using the maximum concentrations predicted from both facilities the increase in maximum concentrations of PM_{10} presented in Sections 6.1 to 6.3 would be at most 2-4 µg/m³ for a 24-hour average.

6.5 Summary

Open cut mining operations are transient in nature, where activities migrate throughout the MDL on a daily basis as required by mine operations at the time. The inability of the modelling to characterise the intricacies of the inherent changes to operational schedules means that an idealised worst case scenario must be assumed to assess the potential impacts of the operation. As such the modelling results are a conservative estimate of the potential impacts an activity could have assuming a constant emission rate.

The modelling indicated that wheel generated dust from the haulage trucks are a major source of dust. Emissions from haulage can be controlled using a variety of management techniques. Sealing the haul roads or watering the haul roads at a rate of greater than 2 $L/m^2/hour$ will reduce emissions by a further 25%. Using vehicles with a greater payload will decrease emissions due to a decrease in vehicle kilometres travelled. For example, switching from a truck with a payload of 100 tonnes to 150 tonnes reduces emissions by 30%.

For the 24-hour average ground-level concentration of dust, impacts are highest at R6 and R7 during August. This is due to winds predominantly being northeasterly to easterly, transporting dust towards these receptors. The annual average concentrations are very low indicating that the potential for dust impacts at these receptors only occurs for a short period of time.

Overall, the modelling demonstrates that the mine is unlikely to cause adverse impacts at the nearest sensitive receptors. Compliance with the NEPM standard of 50 $\mu g/m^3$ is achieved at all but one of the sensitive receptors due to emissions from the mine operation. At receptor to the west of the mine area the 24-hour average PM_{10} levels are predicted above 50 $\mu g/m^3$ on one day for two of the mine scenarios assessed. Considering the low frequency of impact, the stringent application of an urban standard to crustal matter, conservative nature of the emission rates and ability to manage dust generating activities, the impact on local air quality due to the proposed Central West Coal Project are low.

7. Mitigation measures

7.1 Measures to minimise dust emissions

Measures to minimise the potential impact of fugitive dust emissions must recognise all potential sources of dust emissions and have strategies in place to mitigate any unnecessary emissions and adverse impacts that the proposed activities may have on the health and amenity of the surrounding community. A sound management plan will have both proactive and reactive measures.

A proactive management plan should include:

- Watering and grading haul roads and use of surface treatments where necessary
- Covers on conveyors
- Progressive revegetation of disturbed areas as mining operations develop
- Minimisation of the drop height for dragline operations
- Dust suppression of stockpiles and rejects emplacement
- Implementation of continuous real time monitoring at identified sensitive sites
- Implementation a forecasting system to assist in anticipating adverse meteorological conditions that give rise to dust generation
- Implementation of operational changes and improved mitigation to avoid adverse impacts
- Development of a Trigger Action Response Plan (TARP) that will initiate the reactive management plan when a threshold concentration is reached

A reactive management plan includes but is not limited to:

- Implementation of additional mitigation measures when wind conditions become adverse
- Adaptive management strategies such as reduction in extraction rates of operation when meteorological monitoring suggests adverse wind conditions or dust monitoring at sensitive receptors indicates levels are near exceeding air quality criteria

7.2 Triggers for management

Given the scattered spatial distribution of receptors and the long time period that the Project is proposed to operate for, it is best to have a combined approach to air quality management. This should include the management of activities on site along with the use of a real time monitoring and forecasting system.

The results of the dispersion modelling presented in Section 6 indicate that the highest 24-hour average PM_{10} concentrations are predicted to occur at sensitive receptors to the west of the mine. These concentrations are due to the proximity of the receptors to the ROM pad, ash dam and waste dump. Those receptors located within 2 km of the mine are at the greatest risk of adverse impacts. Measurements at these locations can be used to benchmark the performance of any mitigation and management strategies. Good performance at these sites will demonstrate acceptable 24-hour average PM_{10} levels at other sites further afield. Section 7.3 details the recommended monitoring strategy.

To achieve this, a minimum criteria level for the implementation of a trigger action response plan (TARP) should be set to an appropriate level on a 1-hour averaging period to ensure the 24-hour average PM_{10} standard is no exceeded. Where once ambient levels of PM_{10} exceed a yet to be determined concentration level the TARP is activated, the source is identified and appropriate mitigation and management steps are taken until levels return to below the trigger criteria.

To further the Projects ability to manage these challenges a weather forecasting system can be developed to determine the likelihood of an exceedance occurring based on meteorological conditions. Such that adverse meteorological conditions can be identified prior to its onset and mitigation measures implemented prior to an exceedance being recorded.

7.3 Monitoring

The following monitoring should be established and linked to mine operations management as it will provide the basis for the development of the TARP:

- Continuous monitoring of PM_{10} at R7
- Meteorological monitoring located within the mine area

The monitoring strategy should take a holistic view of the operations and its potential impacts on the community. Where operations and mitigation measures are implemented in an effort to avoid adverse impacts before an exceedance occurs.

The system will allow management to make informed and accurate decisions on mine operations, equipment locations and extraction rates to mitigate any adverse impact on the surrounding sensitive receptors, before any impact actually occurs.

8. Conclusions

An air quality assessment was undertaken to assess the potential dust impacts for the proposed Central West Coal project. Modelling was undertaken for three scenarios:

- Scenario 1: Mining operations when mining occurs at the southern end of the coal pit, approximately 3 kilometres south-east of the crushing plant
- Scenario 2: Mining operations when mining occurs towards the north of the coal pit, approximately 5 kilometres north of the crushing plant
- Scenario 3: Mining operations when mining occurs at the northern end of the coal pit, approximately 7.5 kilometres north-northeast of the crushing plant

Dispersion modelling has been undertaken to assess the potential impact of the Project on ground-level concentrations of PM_{10} and TSP as well as dust deposition rate at the Eneabba township and surrounding sensitive receptors. The findings of the air quality assessment are as follows:

- The modelling indicates compliance with the annual average NSW DECC goal of 30 $\mu g/m^3$ for PM_{10} for the three mine scenarios.
- The modelling indicates compliance with the 24-hour average EPP(Kwinana) goal of 90 $\mu g/m^3$ (limit of 150 $\mu g/m^3$) for TSP for the three mine scenarios.
- The modelling indicates compliance with the annual average NSW DECC goal of 90 $\mu g/m^3$ for TSP for the three mine scenarios.
- The modelling indicates compliance with the annual average NSW DECC goal of 2 g/m^2/month for dust deposition rate for the three mine scenarios.
- The modelling indicates the 24-hour average NEPM standard of 50 $\mu g/m^3$ for PM_{10} is exceeded on one day for the two mine scenarios at a single sensitive receptor due to operation of the mine in isolation.
- At Eneabba Township all air quality criteria are achieved.
- The highest levels of dust are predicted to occur at R7 in August when the winds are predominately from the northeast to east.
- Wheel generated dust due to haulage of the coal is one of the main sources of dust for scenario 2 and scenario 3. The emissions can be reduced through management techniques such as additional watering of haul roads (above 2 L/m^2/hour), paving the haul roads, or by using trucks with larger payloads to reduce the number of vehicle kilometres travelled.

It is recommended that a proactive management plan should include, where necessary:

- Watering and grading haul roads and use of surface treatments
- Partial covers on conveyors
- Progressive revegetation of disturbed areas as mining operations develop
- Implementation windbreaks i.e. tree planting around stockpiles
- Progressive rehabilitation and revegetation of mined surfaces
- Continuous monitoring of dust concentrations at sensitive receptors
- Continuous monitoring of meteorological conditions
- Dust suppression of stockpiles and rejects emplacement

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Figure 1 Project location		
Location Western Australia	**Data source** Aviva	**Units** Australian Map Grid coordinates – MGA94 1994 AMG Zone 50.
Type Map		**Date** October 2008

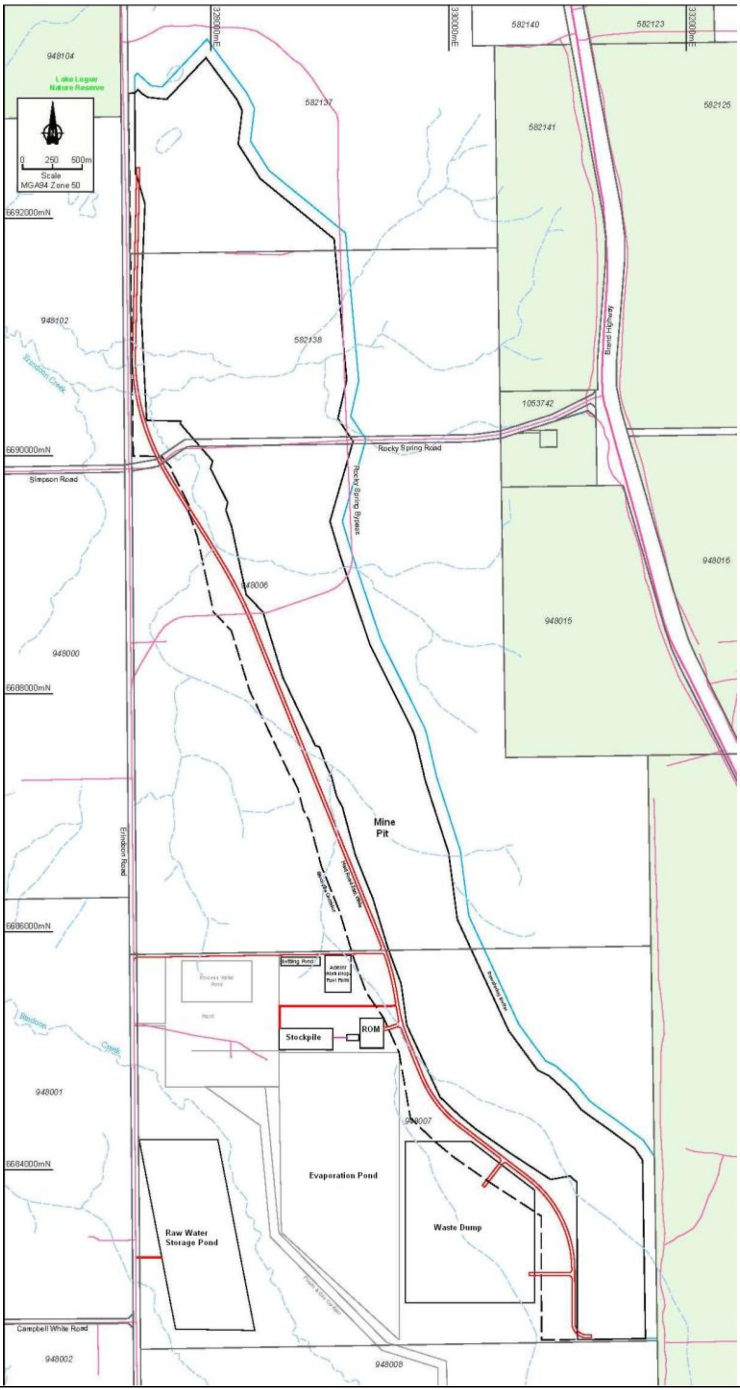


Figure 2 Mine layout

Location Central West Coal mine	**Data source** Aviva
Type Aerial map	**Date** October 2008

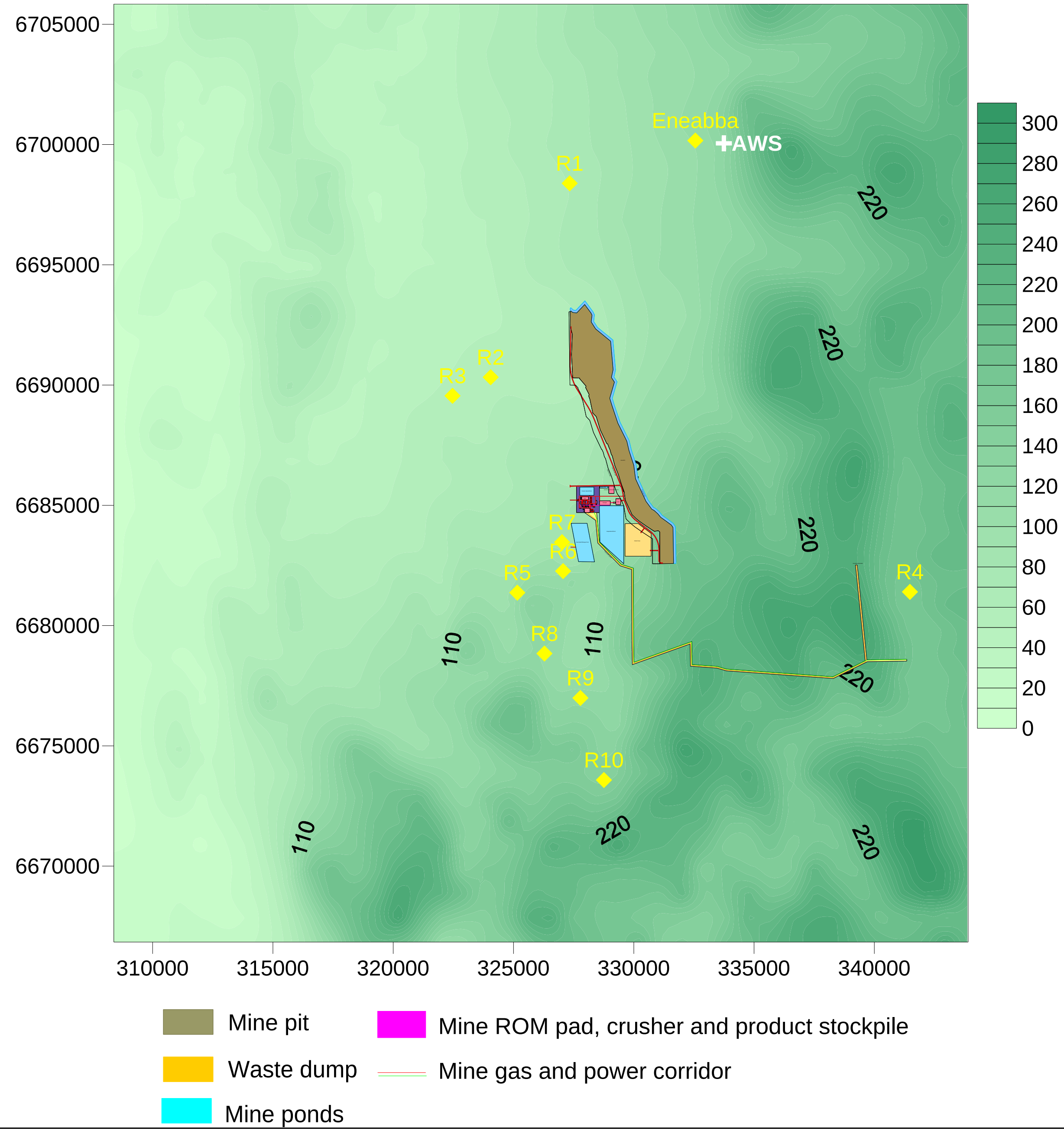


Figure 3 Terrain

Location	**Data source**	**Units**
Eneabba and surrounds	Aviva	Metres above sea level
Type	**Prepared by**	**Date**
Contour map	Natalie Shaw	October

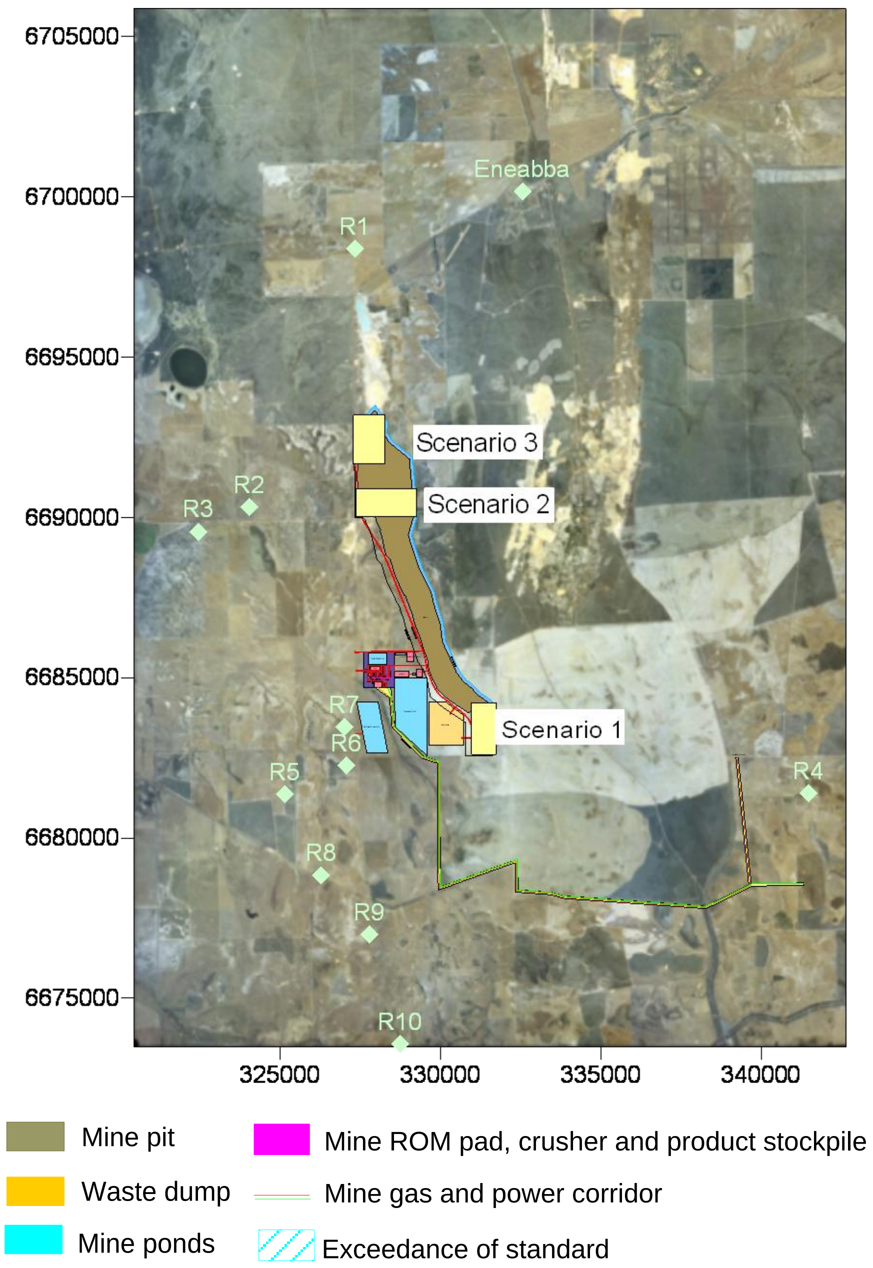


Figure 4 Study area

Location	**Data source**	**Units**
Eneabba and surrounds	Surfer	Australian Map Grid coordinates – GDA94 AMG Zone 50.
Type	**Prepared by**	**Date**
Aerial map	Kim Henville	October 2008

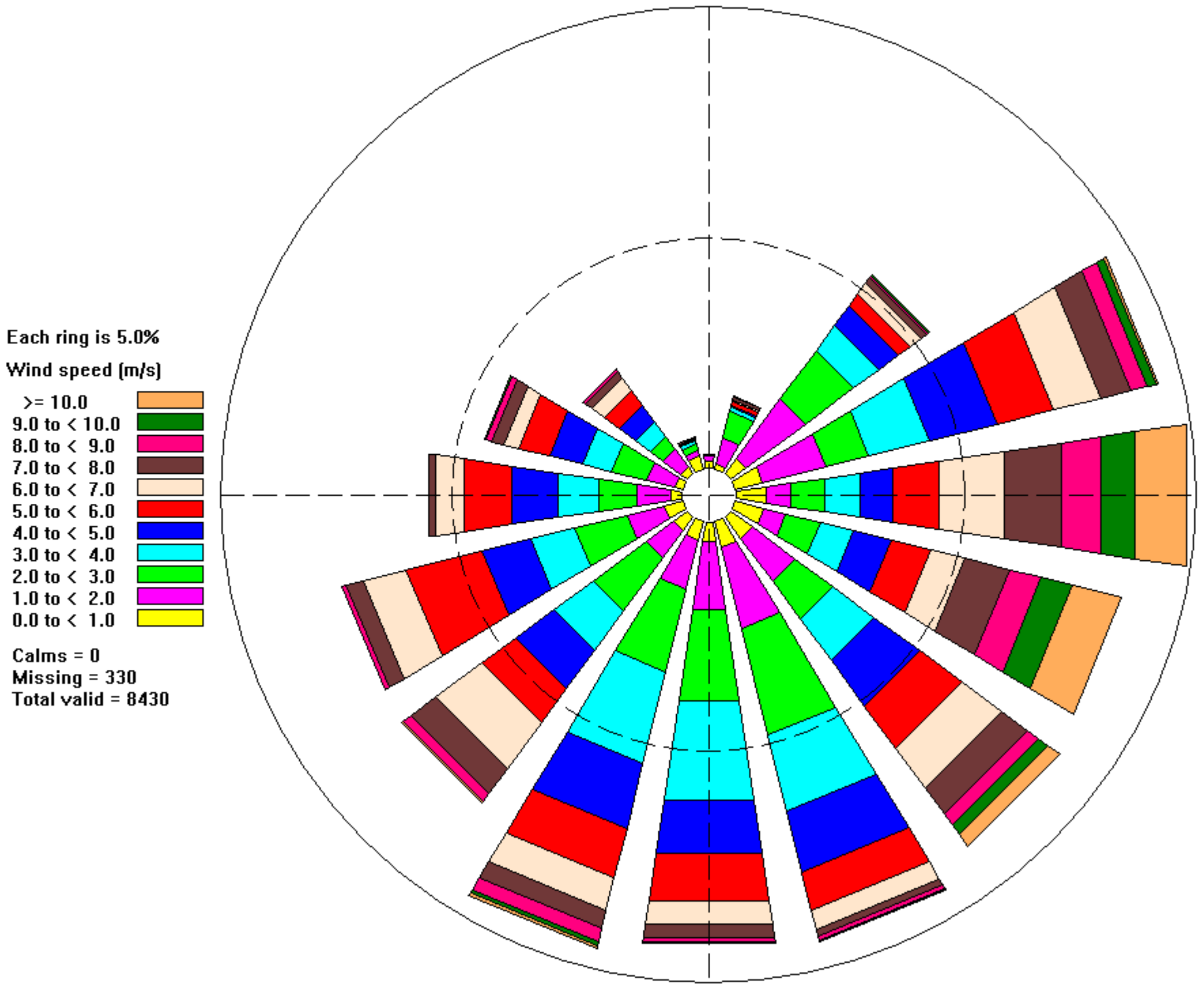


Figure 5 **Annual distribution of wind speed and direction for the Iluka Resources meteorological station near Eneabba**

Location Iluka Resources meteorological station near Eneabba	**Period** 1/05/06 – 1/05/07	**Data source** Iluka Resources	**Units** Metres per second for and Degrees
Type Annual wind rose	8760 hourly average records	**Prepared by** Kim Henville	**Date** 10/10/08

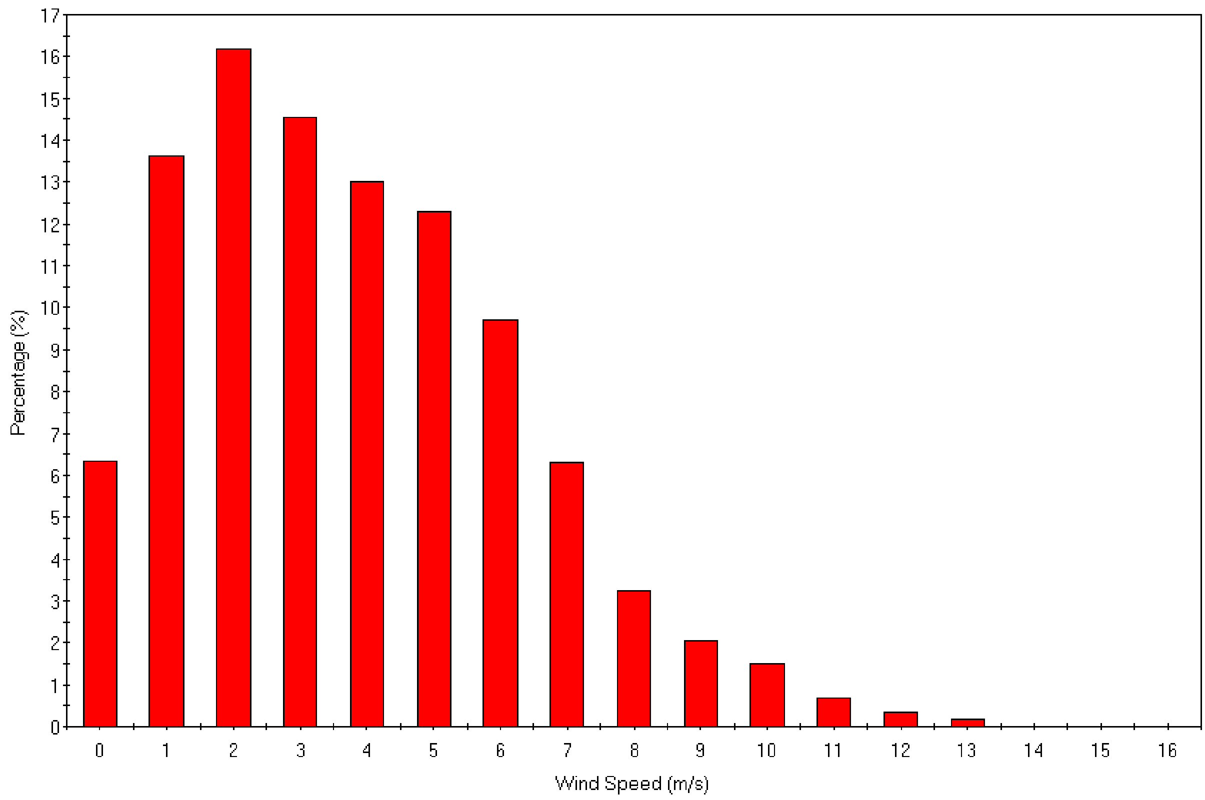


Figure 6 **Frequency distribution of annual wind speed Iluka Resources meteorological station near Eneabba**

Location Iluka Resources meteorological station near Eneabba	**Period** 1/05/06 – 1/05/07	**Data source** Iluka Resources	**Units** Metres per second
Type Frequency distribution of annual wind speed	8760 hourly average records	**Prepared by** Kim Henville	**Date** 10/10/08

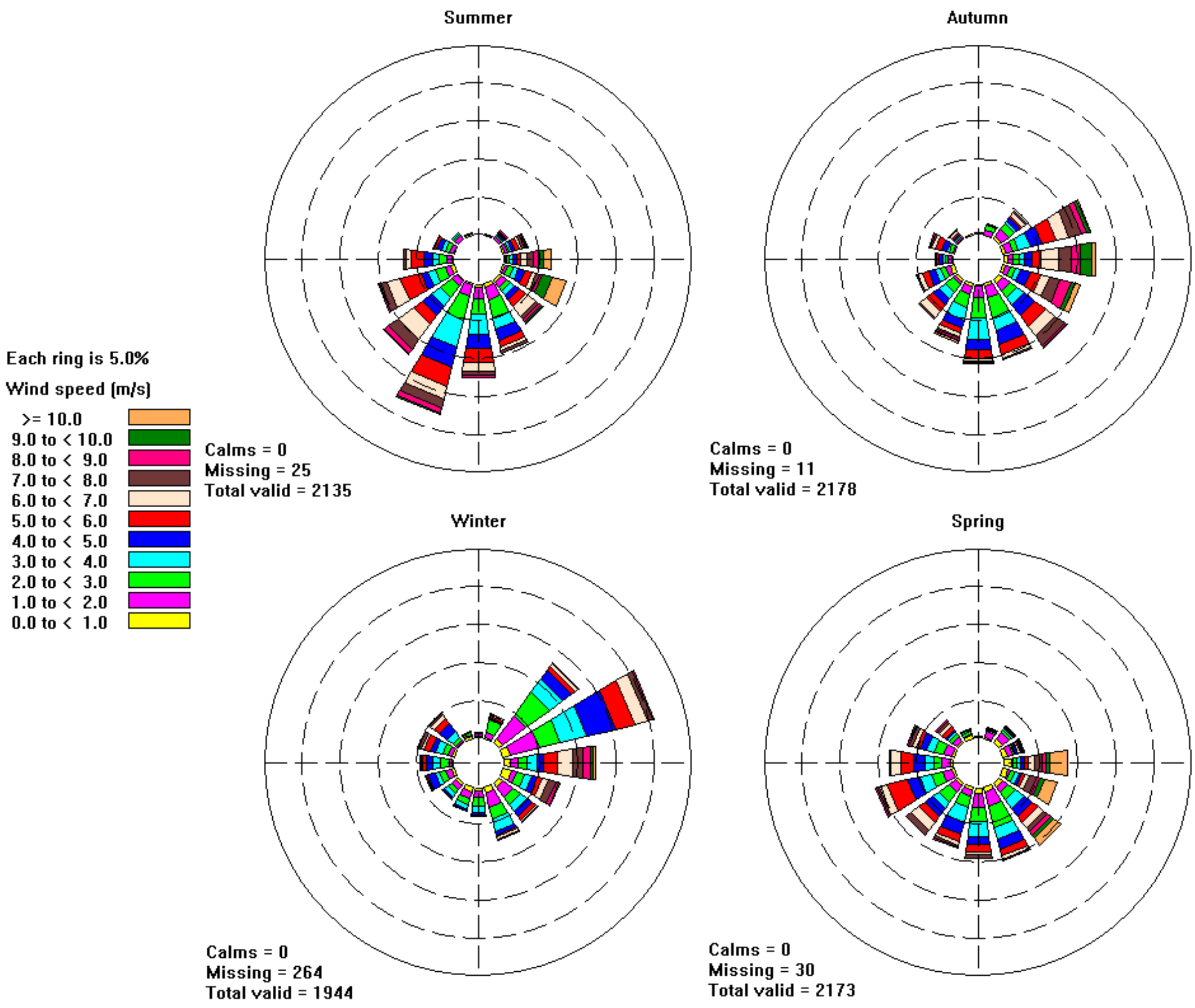


Figure 7 Seasonal distribution of wind speed and direction for the Iluka Resources meteorological station near Eneabba

Location Iluka Resources meteorological station near Eneabba	**Period** 1/05/06 – 1/05/07	**Data source** Iluka Resources	**Units** Metres per second
Type Seasonal wind rose	8760 hourly average records	**Prepared by** Kim Henville	**Date** 10/10/08

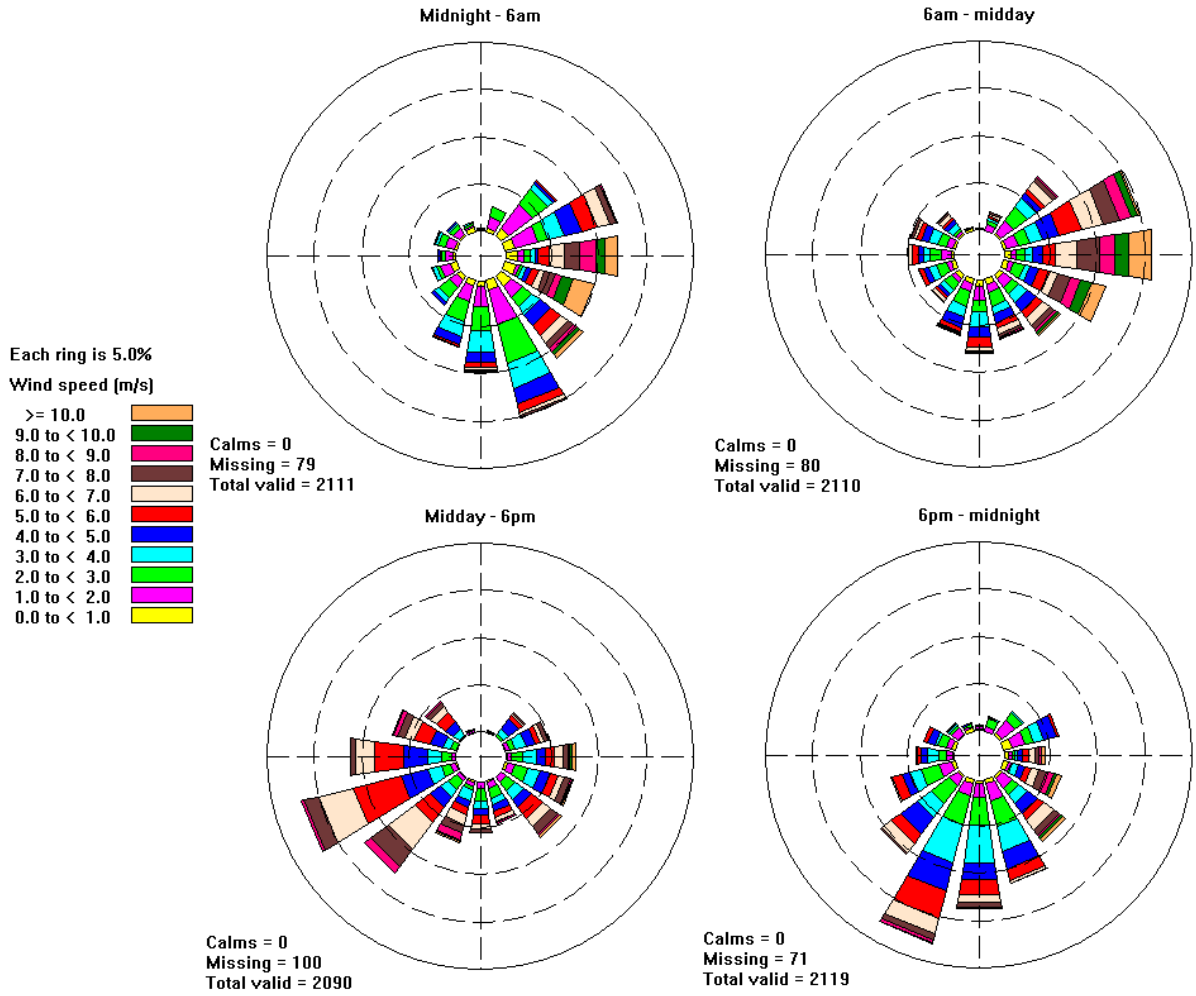


Figure 8 **Diurnal distribution of wind speed and direction for the Iluka Resources meteorological station near Eneabba**

Location	**Period**	**Data source**	**Units**
Iluka Resources meteorological station near Eneabba	1/05/06 – 1/05/07	Iluka Resources	Metres per second
Type Diurnal wind rose	8760 hourly average records	**Prepared by** Kim Henville	**Date** 10/10/08

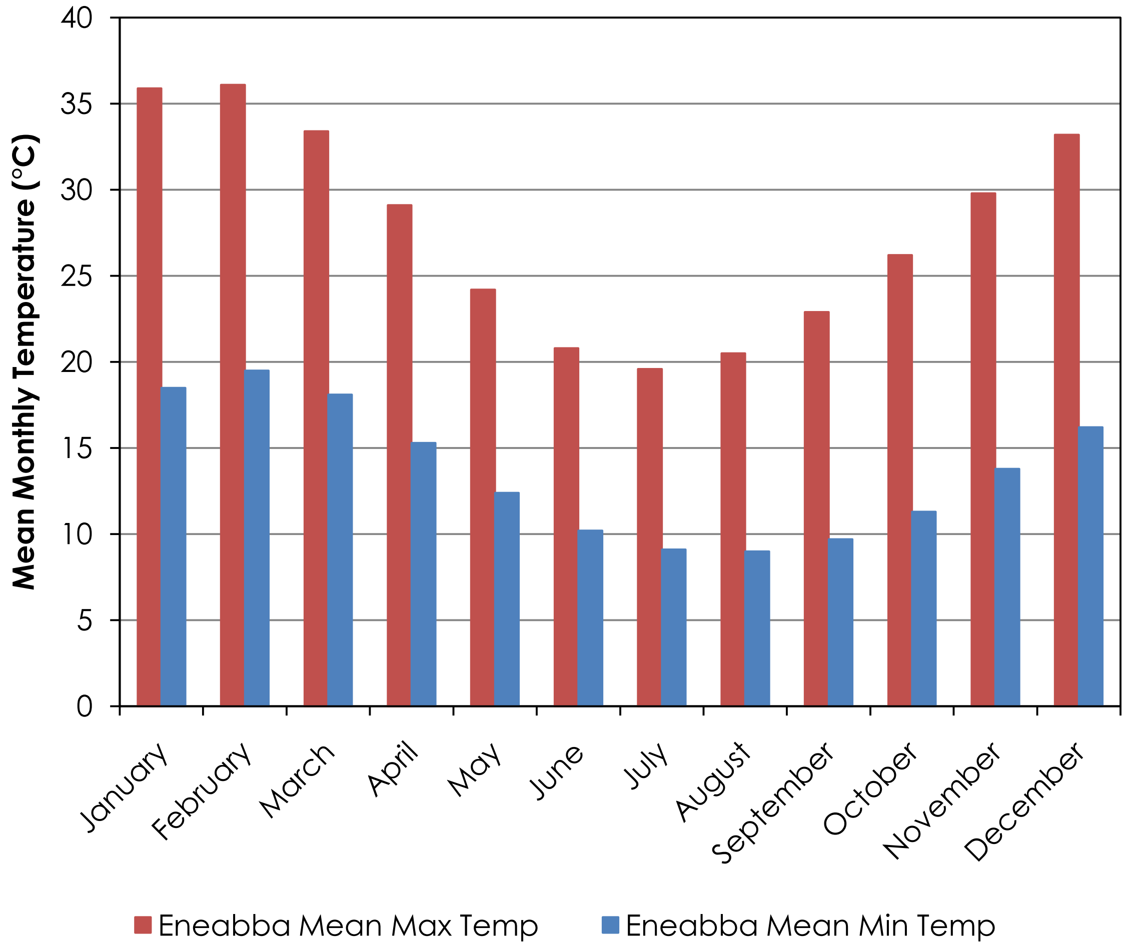


Figure 9 Mean maximum and minimum temperatures for Eneabba

Location	**Period**	**Data source**	**Units**
Eneabba	1972 - 2008	Bureau of Meteorology	Celsius
Type		**Prepared by**	**Date**
Histogram		Kim Henville	24/09/2008

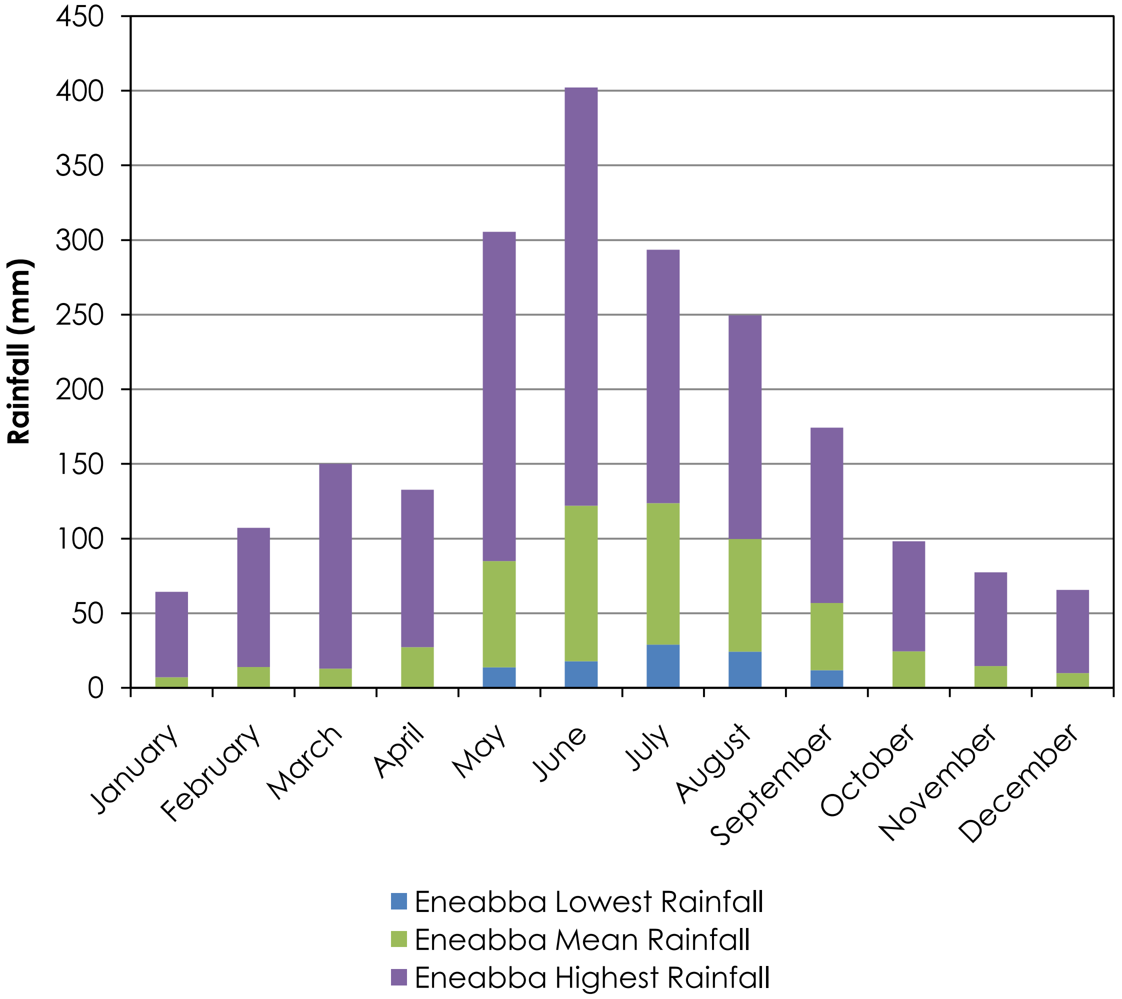


Figure 10 Range of lowest, average and highest monthly rainfall for Eneabba

Location	**Period**	**Data source**	**Units**
Eneabba	1964 - 2008	Bureau of Meteorology	Millimetres
Type Stacked Histogram		**Prepared by** Alex Schloss	**Date** 24/09/2008

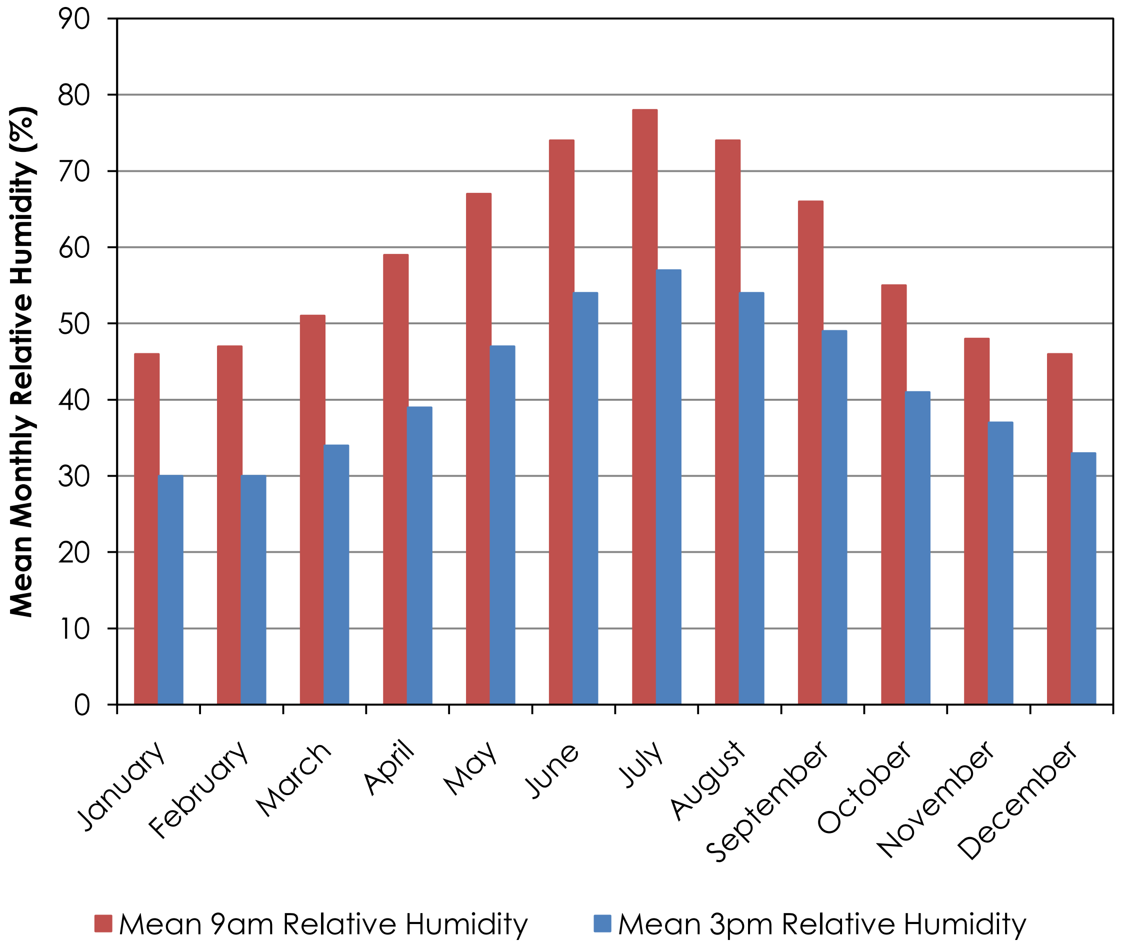


Figure 11 Mean 9am and 3pm relative humidity for Eneabba

Location	Period	Data source	Units
Eneabba	1976 - 2008	Bureau of Meteorology	Millimetres
Type Stacked Histogram		**Prepared by** Alex Schloss	**Date** 24/09/2008

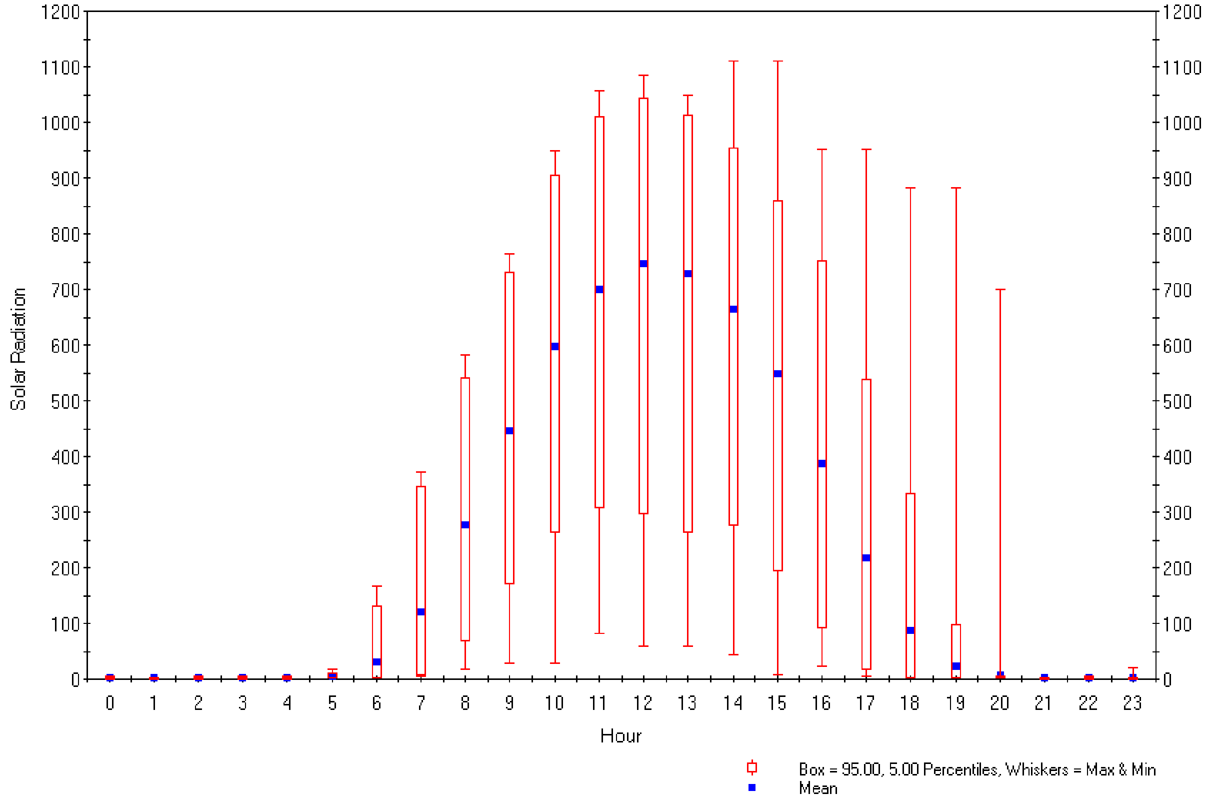


Figure 12 Mean daily solar exposure for Eneabba

Location	**Period**	**Data source**	**Units**
Eneabba	1/05/06 – 1/05/07	Iluka Resources	Watts per square metre
Type		**Prepared by**	**Date**
Box and whisker plot		Andrew Balch	10/10/2008

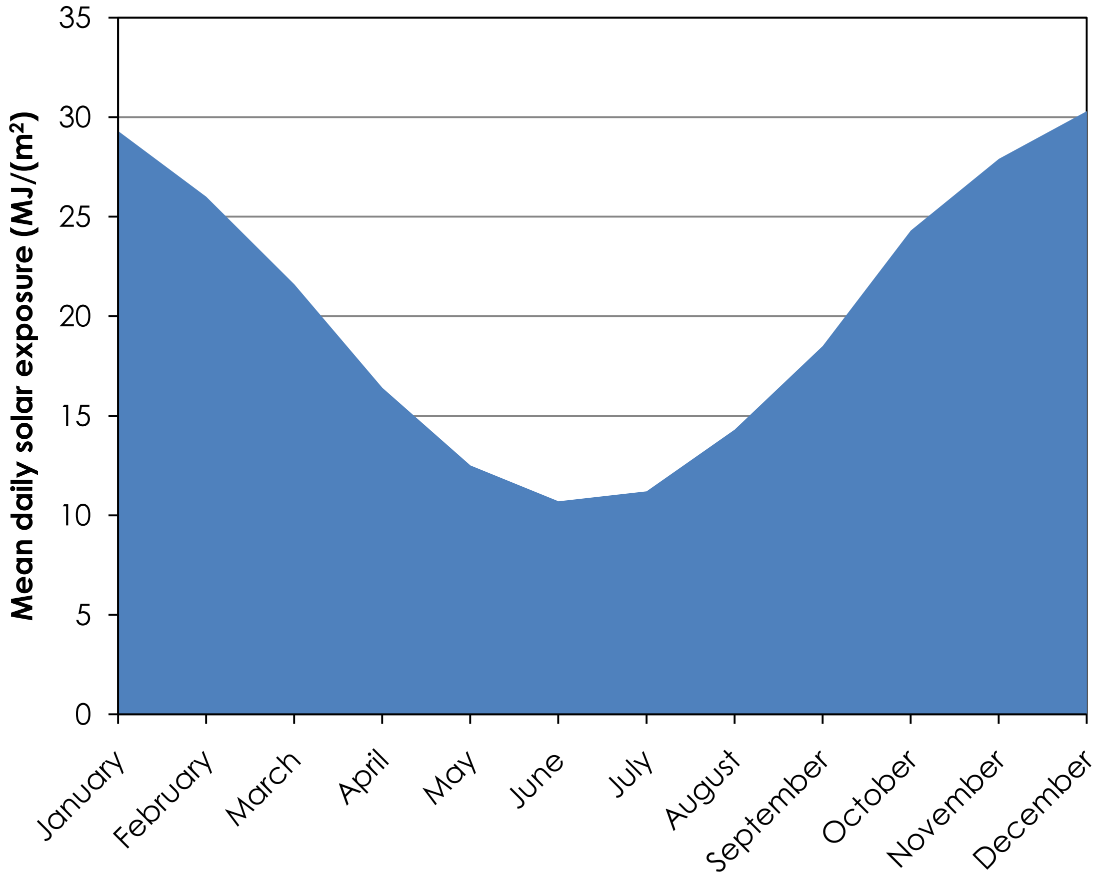


Figure 13 Mean daily solar exposure for Eneabba

Location Eneabba	**Period** 1990 - 2008	**Data source** Bureau of Meteorology	**Units** Megajoules per square metre
Type Line graph		**Prepared by** Alex Schloss	**Date** 24/09/2008

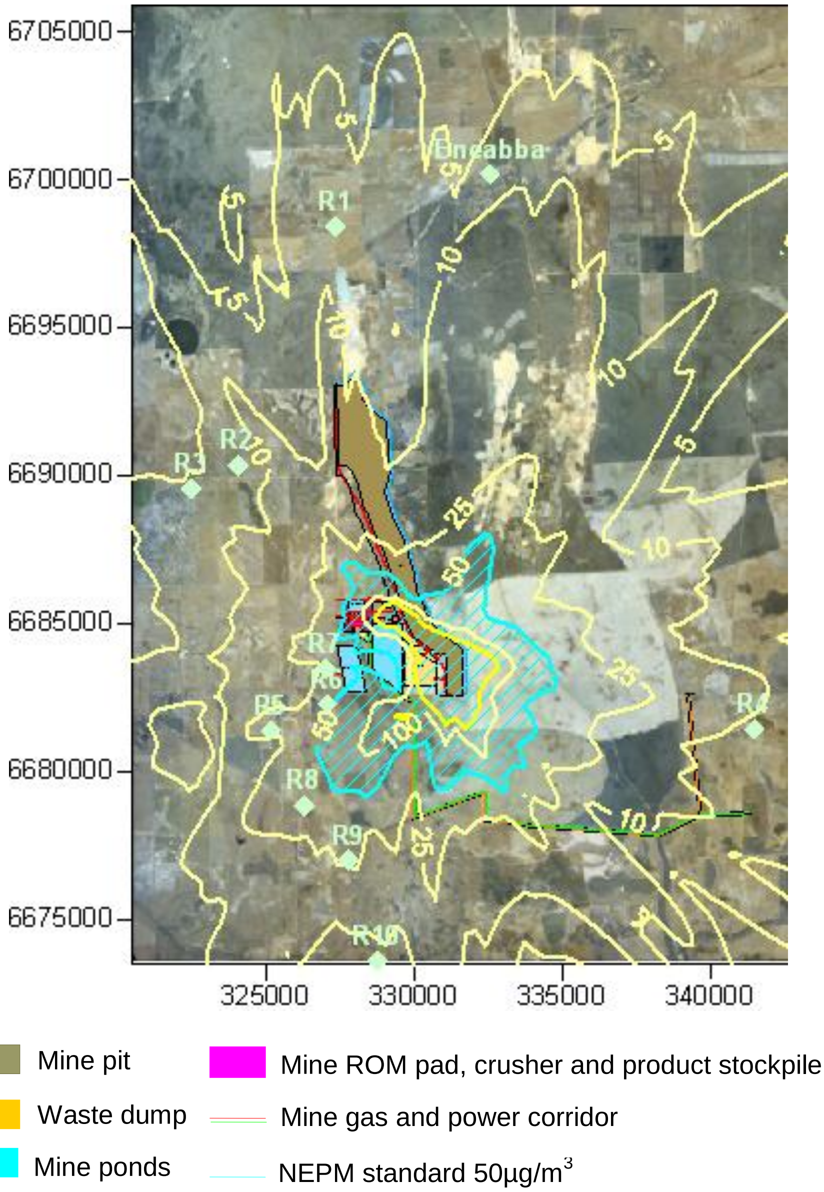


Figure 14 Predicted maximum 24-hour average ground-level concentrations of PM_{10} - Scenario 1

Location	Averaging period	Data source	Units
Eneabba and surrounds	24-hour	Calpuff	µg/m³
Type	**Standard**	**Prepared by**	**Date**
Maximum contours No background	NEPM 50 µg/m³	Natalie Shaw	28/10/08

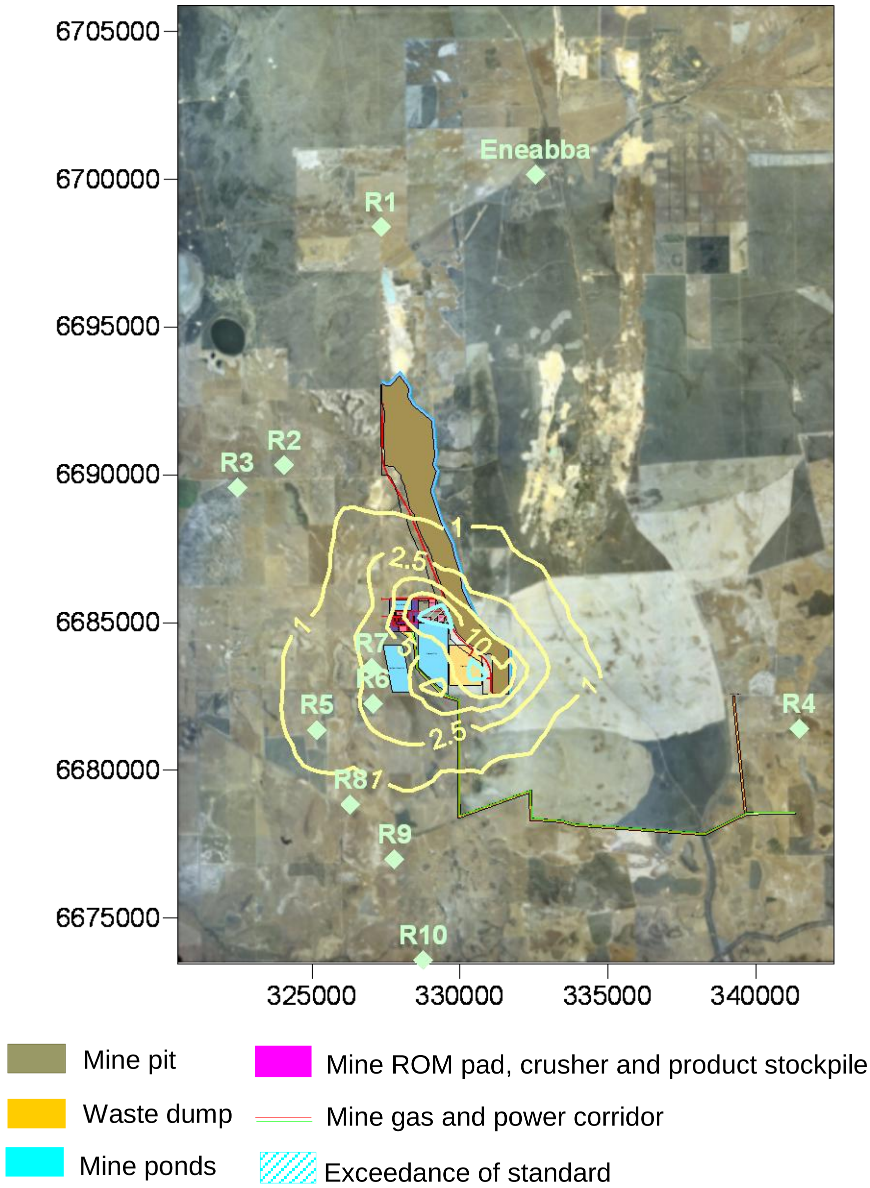
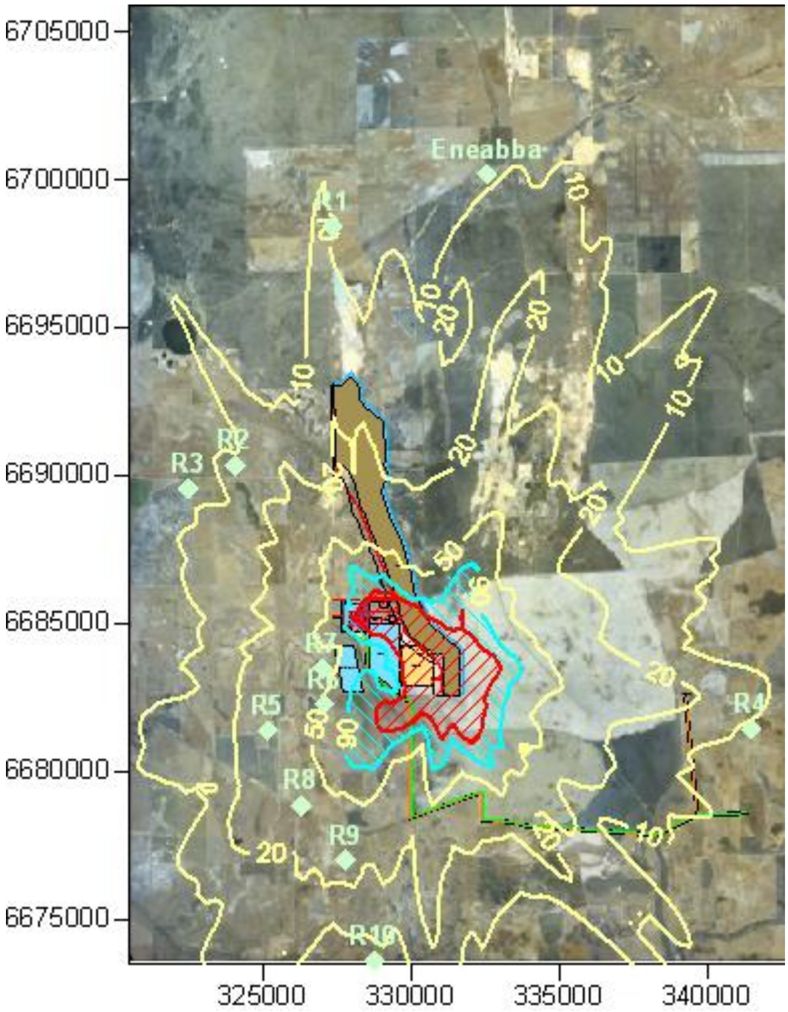


Figure 15 Predicted annual average ground-level concentrations of PM_{10} – Scenario 1

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	Annual	Calpuff	µg/m³
Type	**Standard**	**Prepared by**	**Date**
Annual contours No background	NSW DECC 30 µg/m³	Natalie Shaw	28/10/08



Mine pit		Mine ROM pad, crusher and product stockpile	
Waste dump		Mine gas and power corridor	
Mine ponds		EPP standard 90µg/m^3	
		Limit 150µg/m^3	

Figure 16 Predicted maximum 24-hour average ground-level concentrations of TSP - Scenario 1

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	24-hour	Calpuff	µg/m³
Type Maximum contours No background	**Goal** EPP(Kwinana) Standard 90 µg/m³ (limit 150 µg/m³)	**Prepared by** Natalie Shaw	**Date** 28/10/08

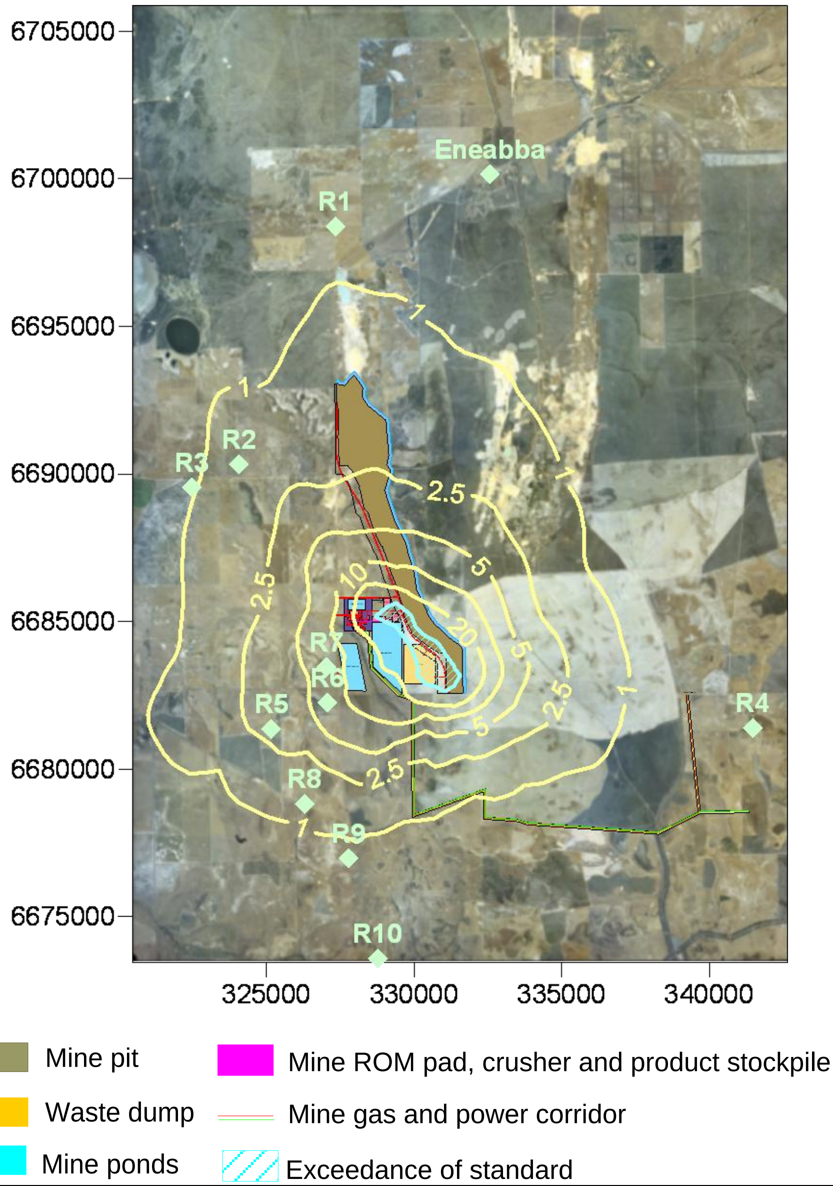


Figure 17 Predicted annual average ground-level concentrations of TSP - Scenario 1

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	Annual	Calpuff	µg/m³
Type	**Goal**	**Prepared by**	**Date**
Annual contours No background	NSW DECC 90 µg/m³	Natalie Shaw	28/10/08

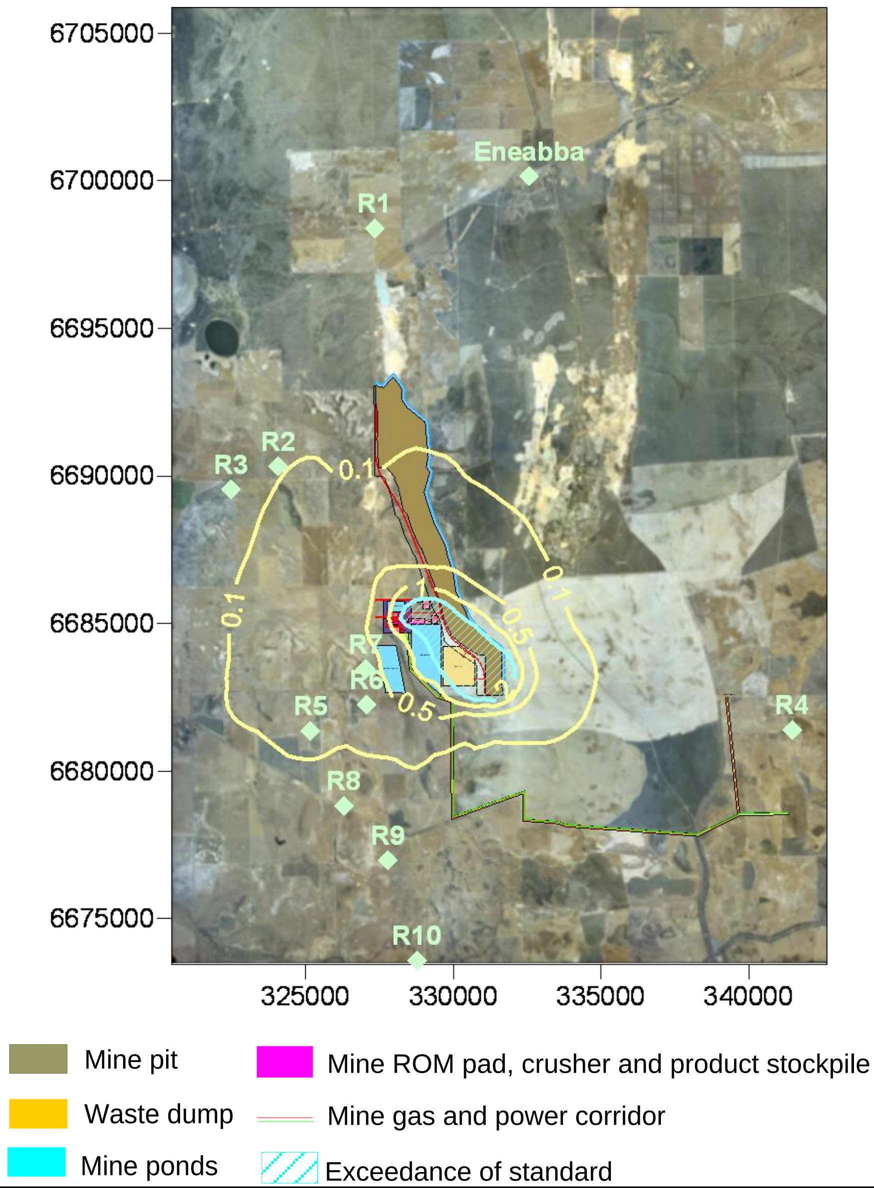


Figure 18 Predicted annual average dust deposition rate - Scenario 1

Location Eneabba and surrounds	**Averaging period** Annual	**Data source** Calpuff	**Units** g/m²/month
Type Annual contours No background	**Guideline** NSW DECC 2 g/m²/month	**Prepared by** Natalie Shaw	**Date** 28/10/08

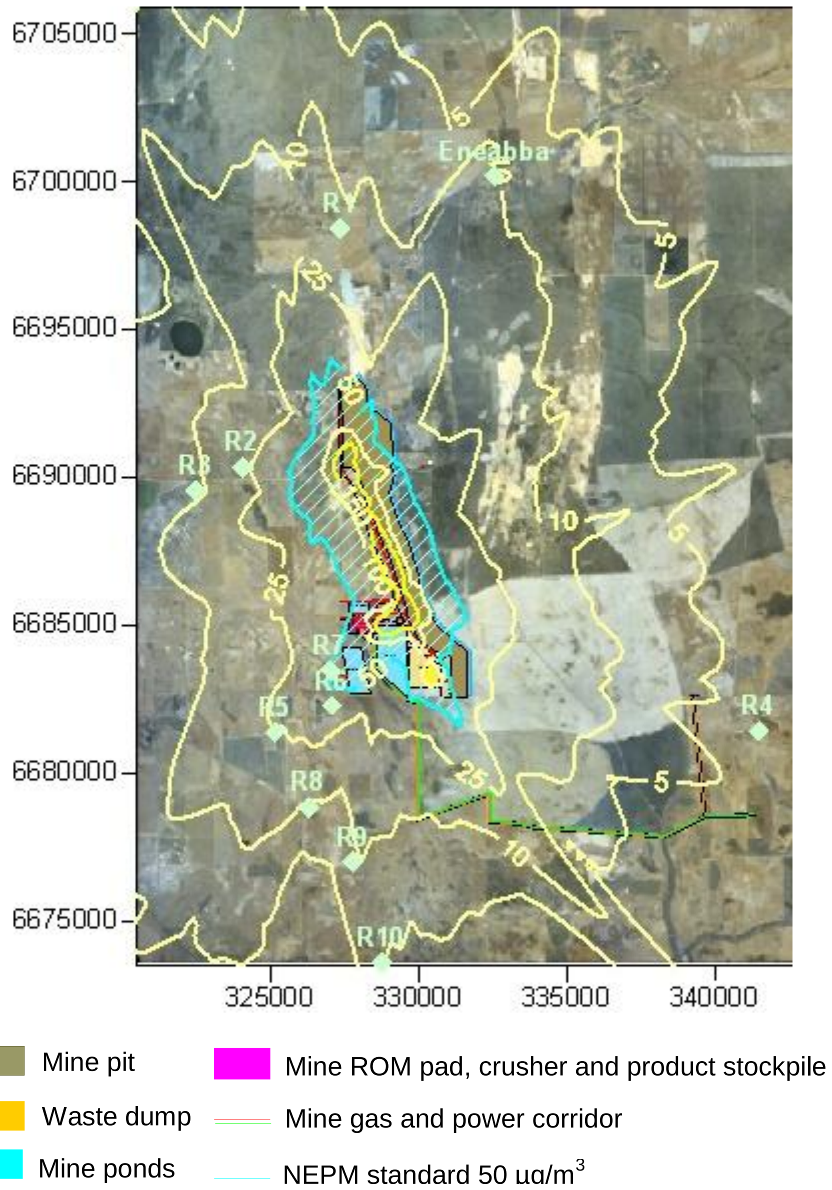


Figure 19 Predicted maximum 24-hour average ground-level concentrations of PM_{10}– Scenario 2

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	24-hour	CALPUFF	µg/m³
Type Maximum contours No background	**Standard** NEPM 50 µg/m³	**Prepared by** Natalie Shaw	**Date** 28/10/08

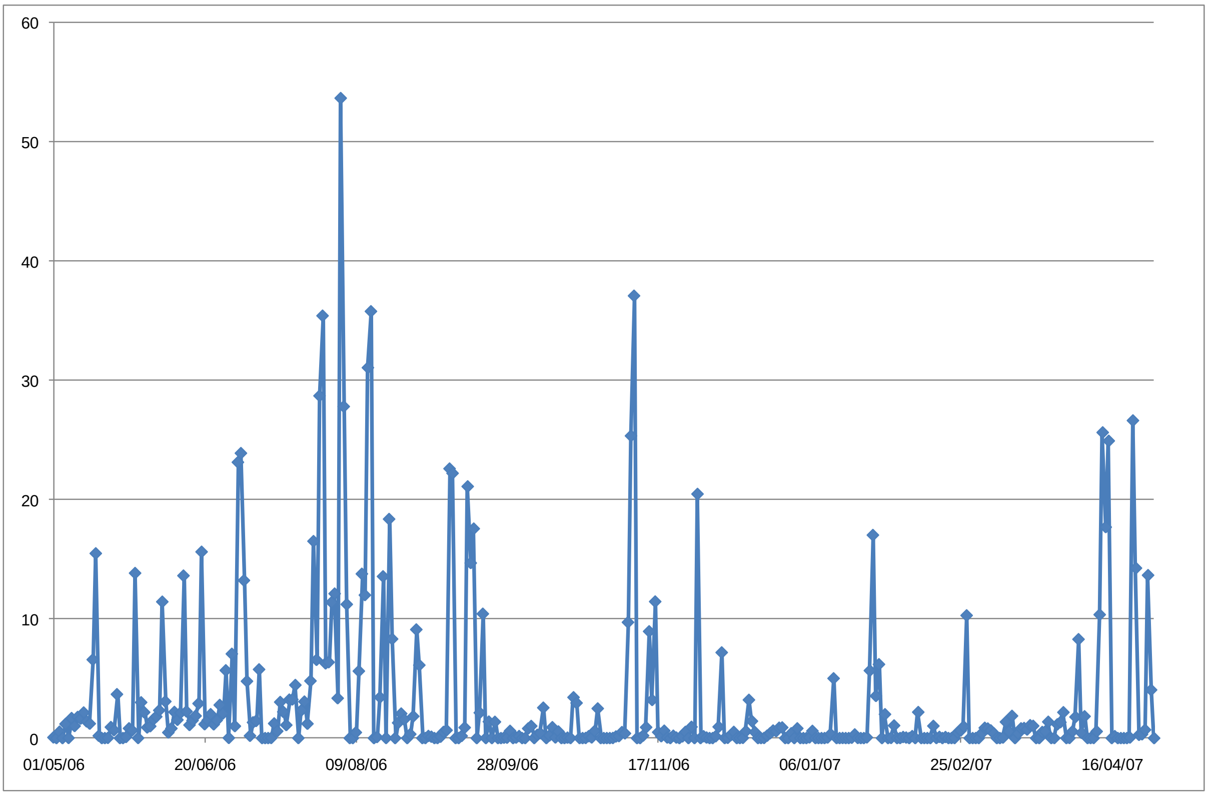


Figure 20 Predicted 24-hour average ground-level concentrations of PM_{10} – Scenario 2, at Receptor 7

Location	**Averaging period**	**Data source**	**Units**
Receptor 7	24-hour	CALPUFF	µg/m³
Type	**Standard**	**Prepared by**	**Date**
Timeseries	NEPM 50 µg/m³	Natalie Shaw	28/10/08

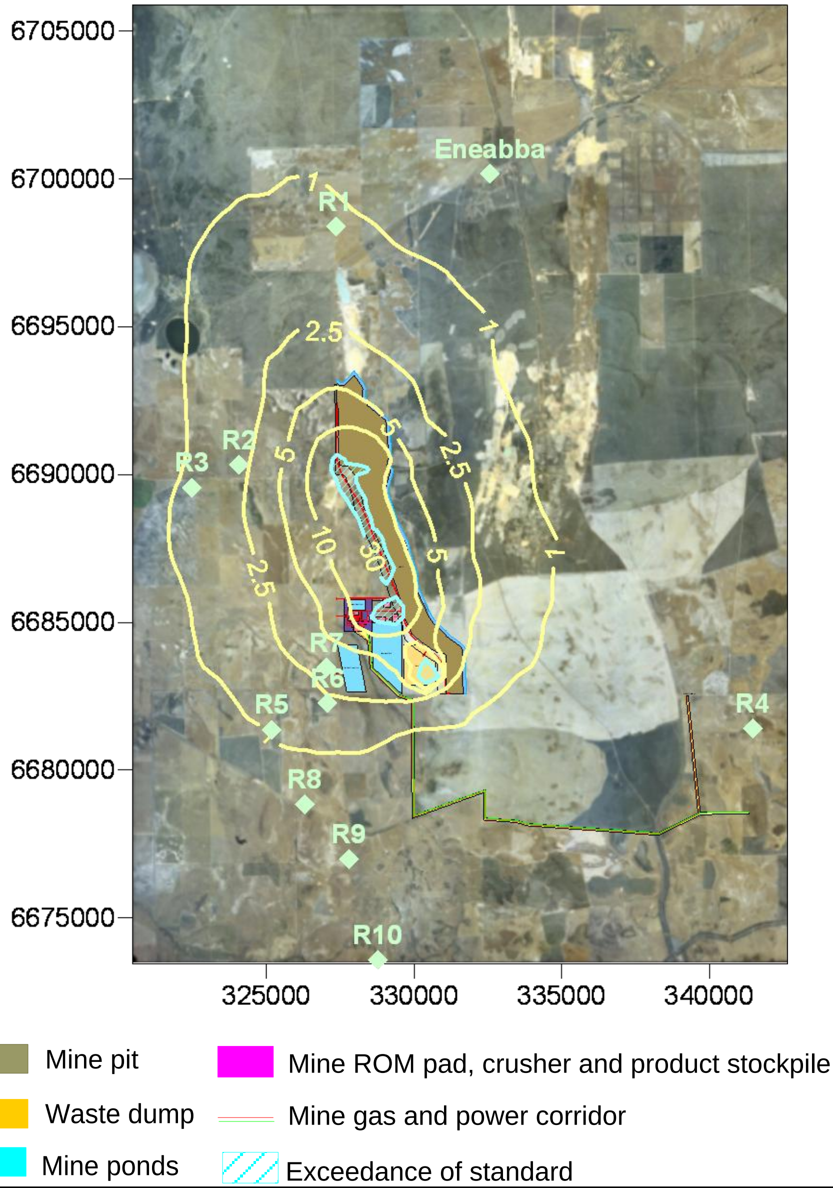


Figure 21 Predicted annual average ground-level concentrations of PM_{10} - Scenario 2

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	Annual	CALPUFF	µg/m³
Type	**Standard**	**Prepared by**	**Date**
Annual contours No background	NSW DECC 30 µg/m³	Natalie Shaw	28/10/08

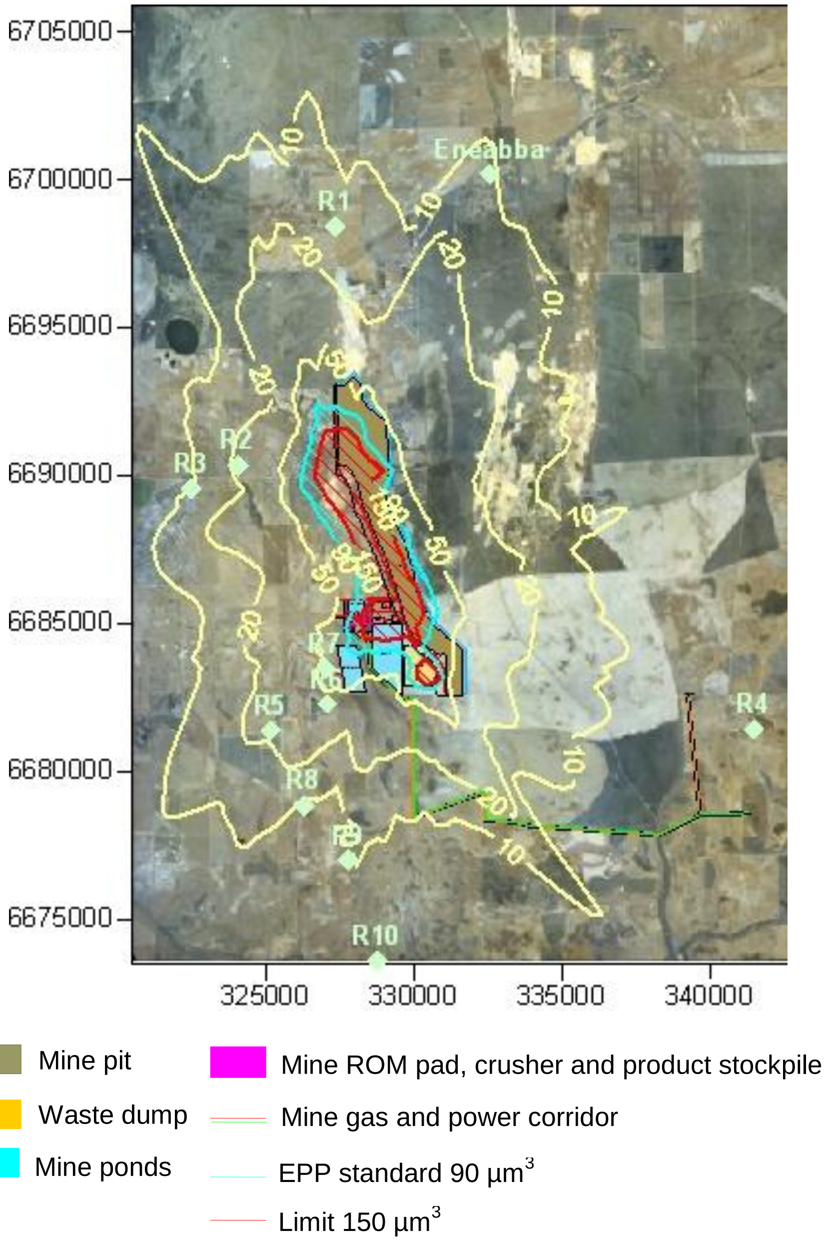


Figure 22 Predicted maximum 24-hour average ground-level concentrations of TSP - Scenario 2

Location Eneabba and surrounds	**Averaging period** 24-hour	**Data source** Calpuff	**Units** µg/m³
Type Maximum contours No background	**Goal** EPP(Kwinana) Standard 90 µg/m³ (limit 150 µg/m³)	**Prepared by** Natalie Shaw	**Date** 28/10/08

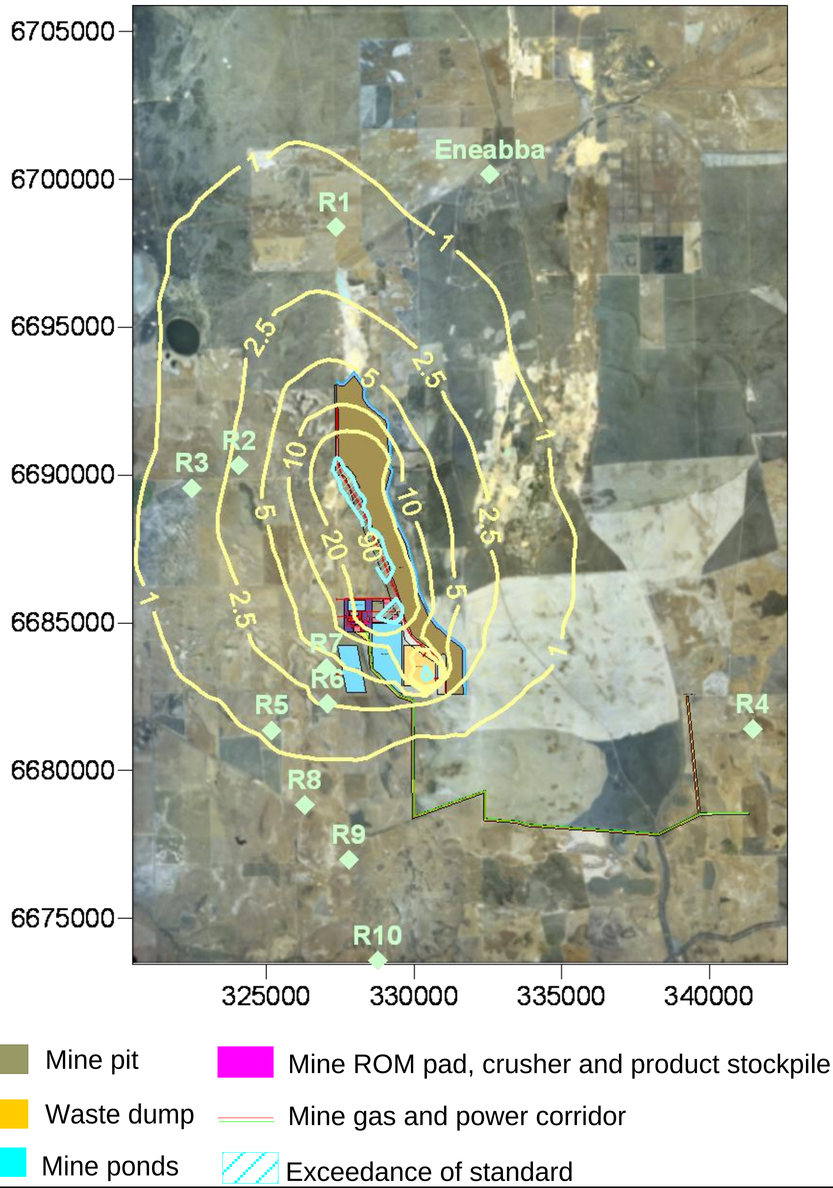


Figure 23 Predicted annual average ground-level concentrations of TSP – Scenario 2

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	Annual	CALPUFF	µg/m³
Type	**Goal**	**Prepared by**	**Date**
Annual contours No background	EPP(Kwinana) 90 µg/m³	Natalie Shaw	28/10/08

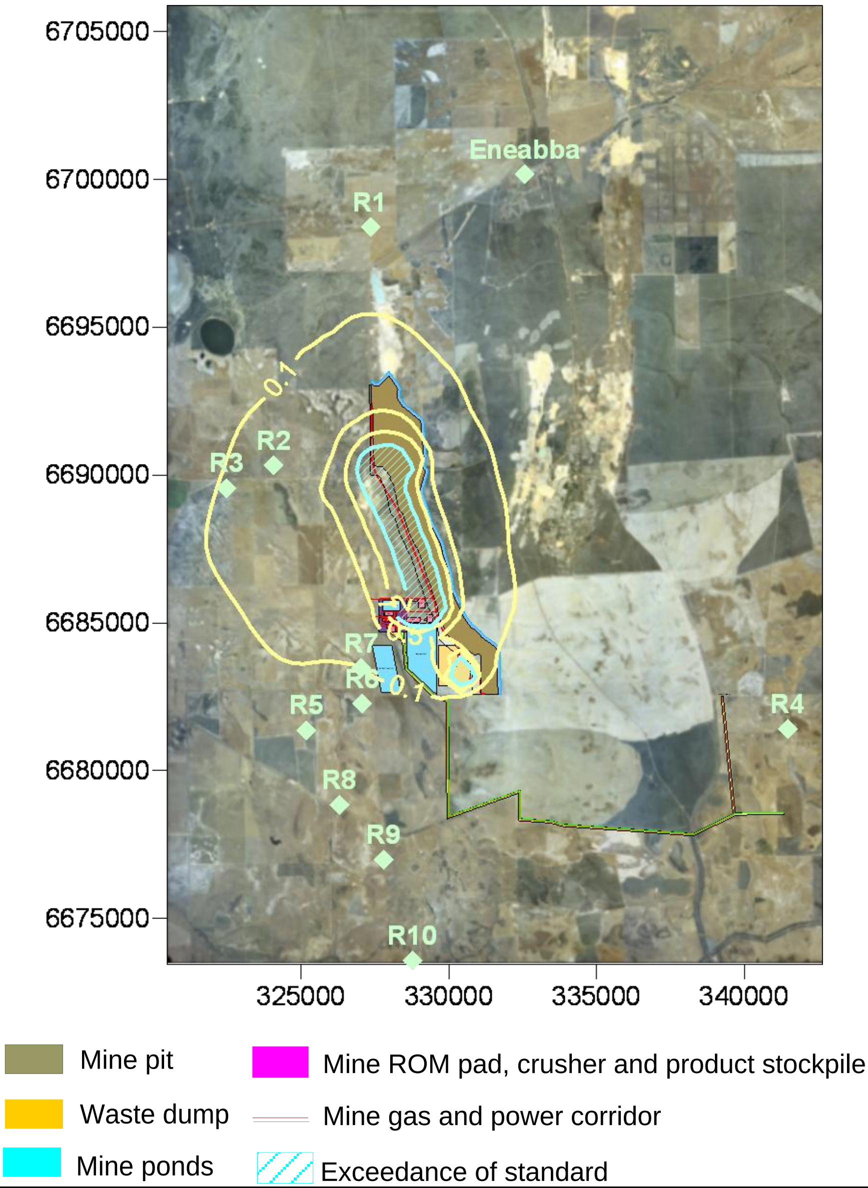


Figure 24 Predicted annual average dust deposition rate – Scenario 2

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	Annual	CALPUFF	g/m²/month
Type	**Guideline**	**Prepared by**	**Date**
Annual contours No background	NSW DECC 2 g/m²/month	Natalie Shaw	28/10/08

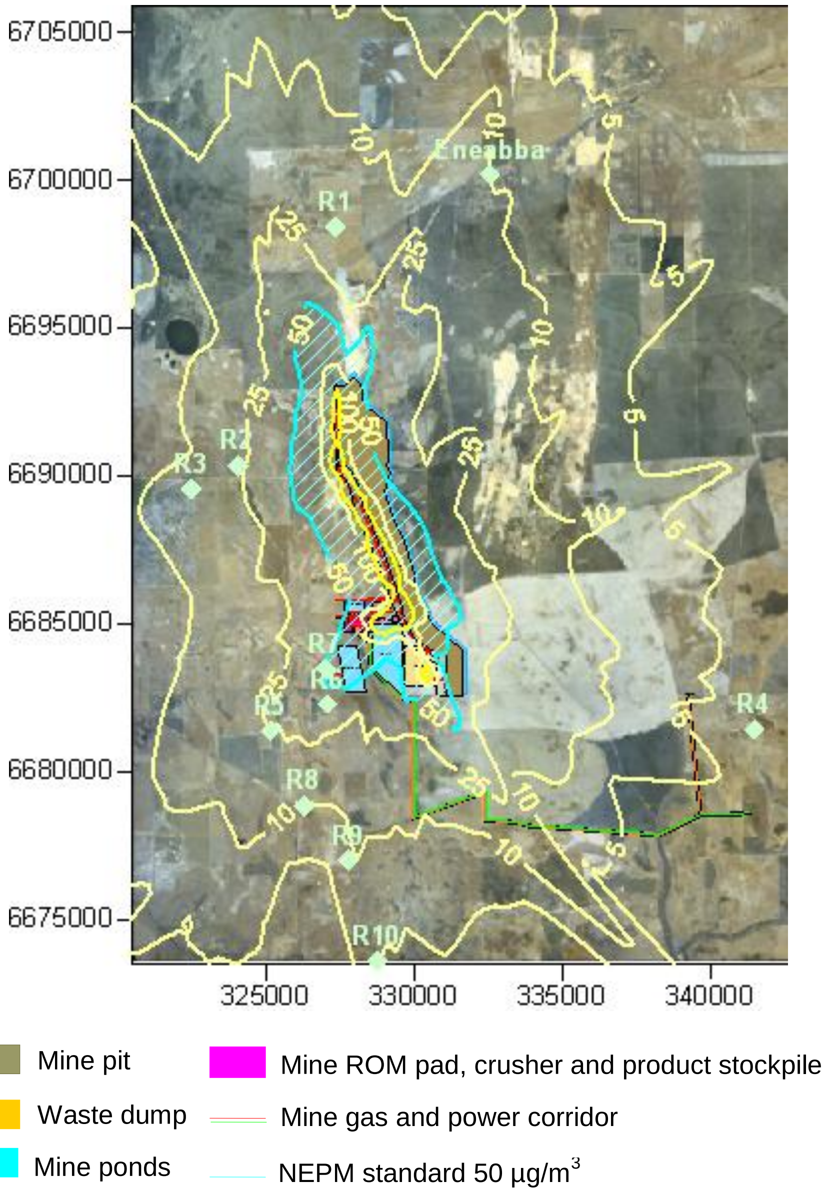


Figure 25 Predicted maximum 24-hour average ground-level concentrations of PM_{10} – Scenario 3

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	24-hour	CALPUFF	µg/m³
Type	**Standard**	**Prepared by**	**Date**
Maximum contours No background	NEPM 50 µg/m³	Natalie Shaw	28/10/08

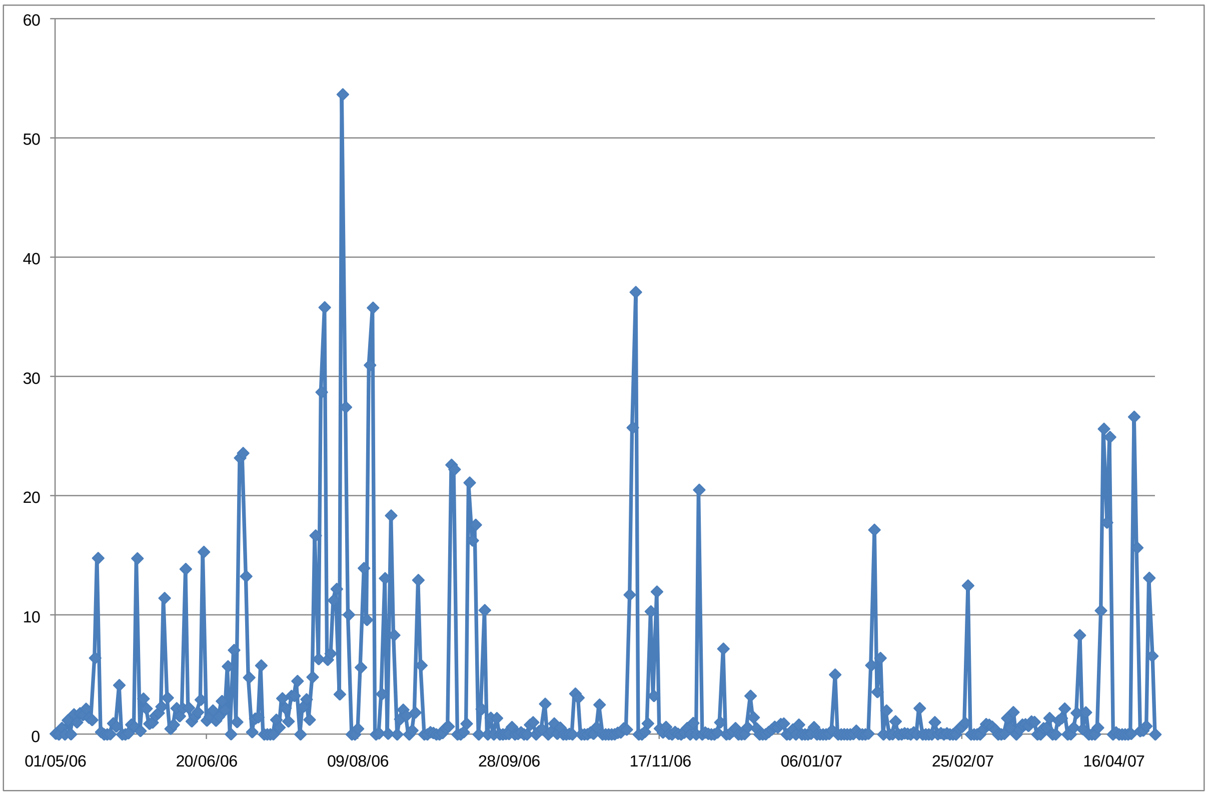


Figure 26 Predicted 24-hour average ground-level concentrations of PM_{10} due to the mine – Scenario 3, at Receptor 7

Location Receptor 7	**Averaging period** 24-hour	**Data source** CALPUFF	**Units** µg/m³
Type Timeseries	**Standard** NEPM 50 µg/m³	**Prepared by** Natalie Shaw	**Date** 28/10/08

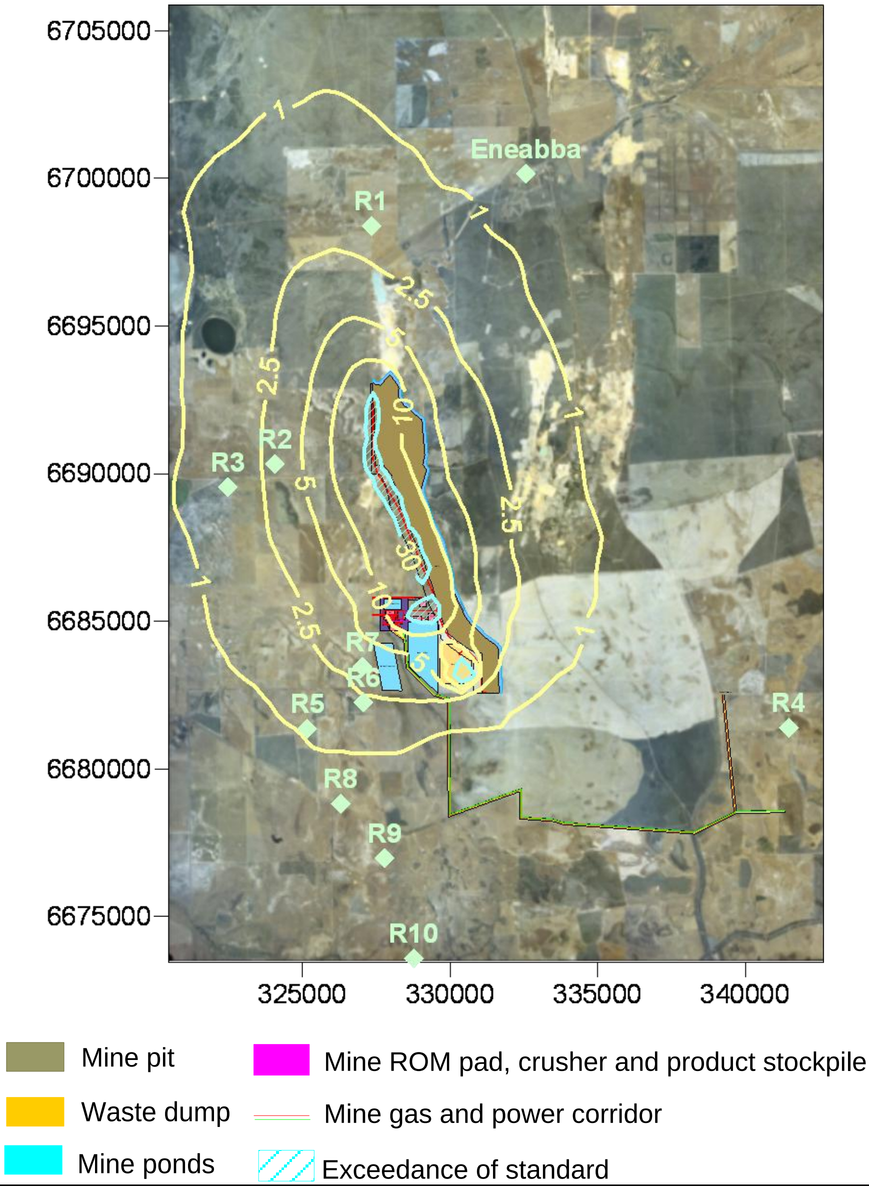


Figure 27 Predicted annual average ground-level concentrations of PM_{10}– Scenario 3

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	Annual	CALPUFF	µg/m³
Type	**Standard**	**Prepared by**	**Date**
Annual contours No background	NSW DECC 30 µg/m³	Natalie Shaw	28/10/08

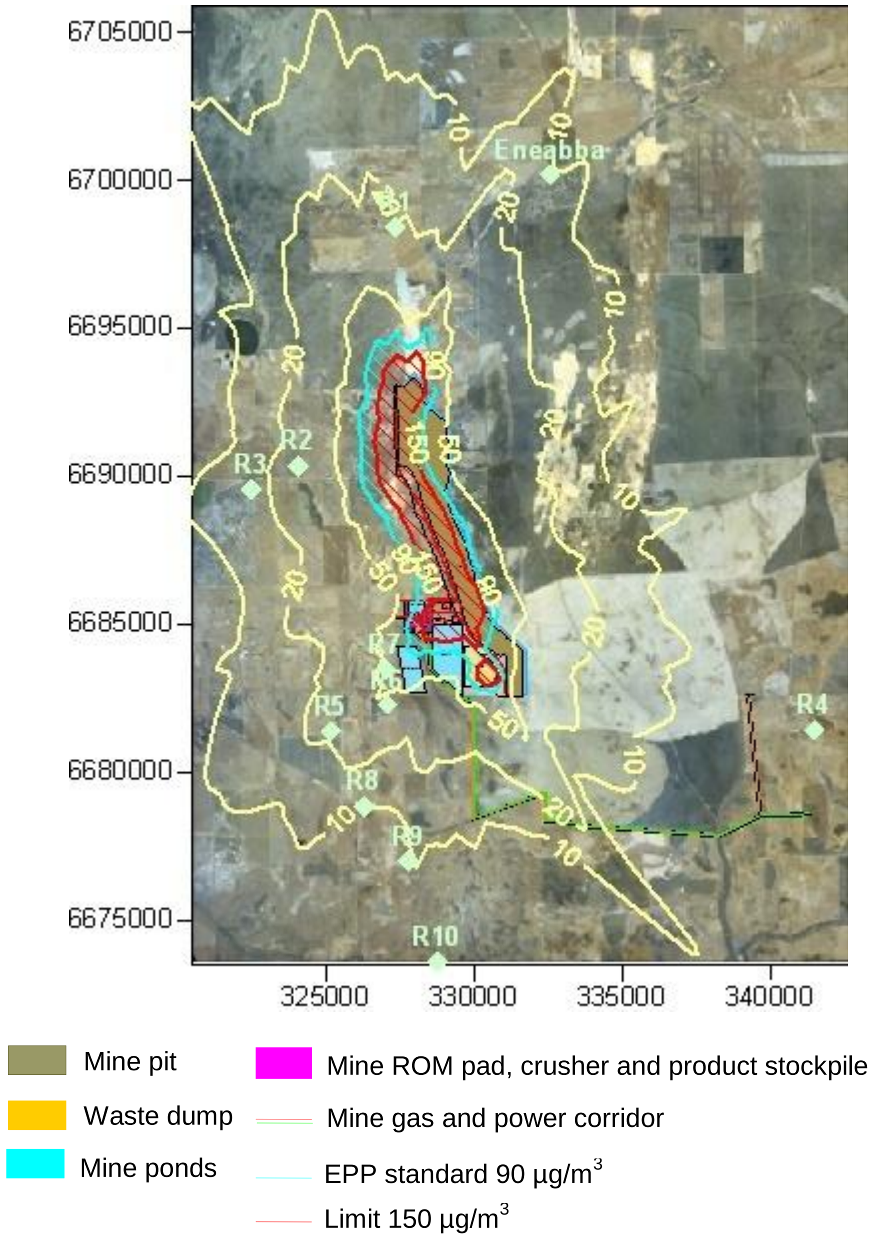


Figure 28 Predicted maximum 24-hour ground-level concentrations of TSP – Scenario 3

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	24-hour	CALPUFF	µg/m³
Type	**Goal**	**Prepared by**	**Date**
Maximum contours No background	EPP(Kwinana) Standard 90 µg/m³ (limit 150 µg/m³)	Natalie Shaw	28/10/08

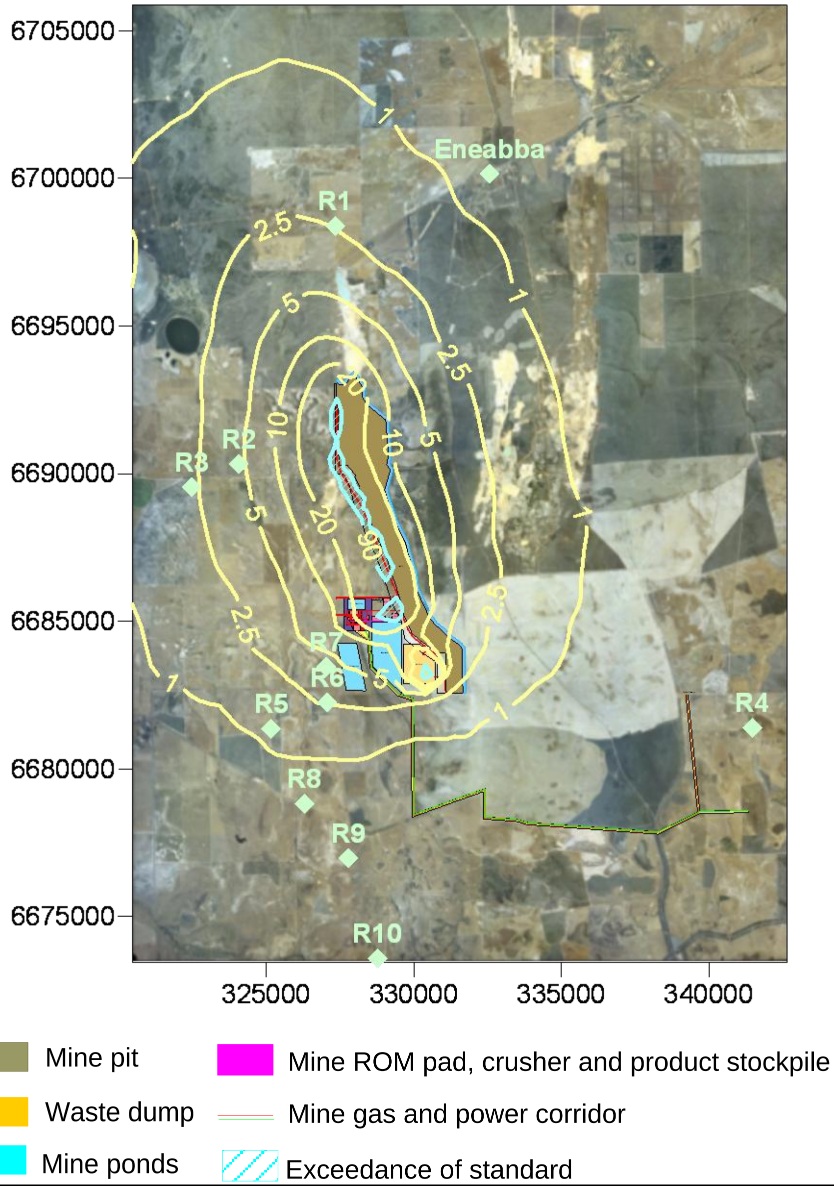


Figure 29 Predicted annual average ground-level concentrations of TSP – Scenario 3

Location	Averaging period	Data source	Units
Eneabba and surrounds	Annual	CALPUFF	µg/m³
Type	**Goal**	**Prepared by**	**Date**
Annual contours No background	NSW DECC 90 µg/m³	Natalie Shaw	28/10/08

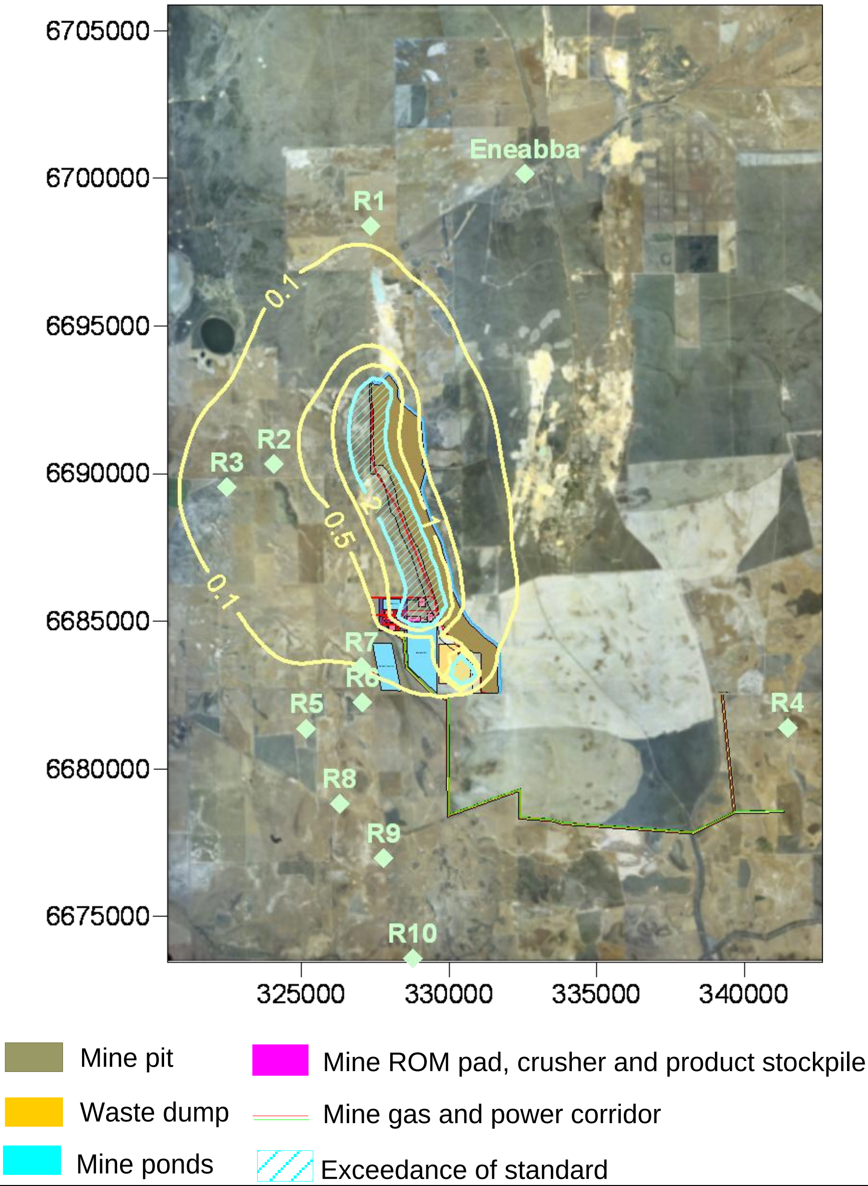


Figure 30 Predicted annual average dust deposition rate – Scenario 3

Location Eneabba and surrounds	**Averaging period** Annual	**Data source** CALPUFF	**Units** g/m²/month
Type Annual contours No background	**Guideline** NSW DECC 2 g/m²/month	**Prepared by** Natalie Shaw	**Date:** 28/10/08

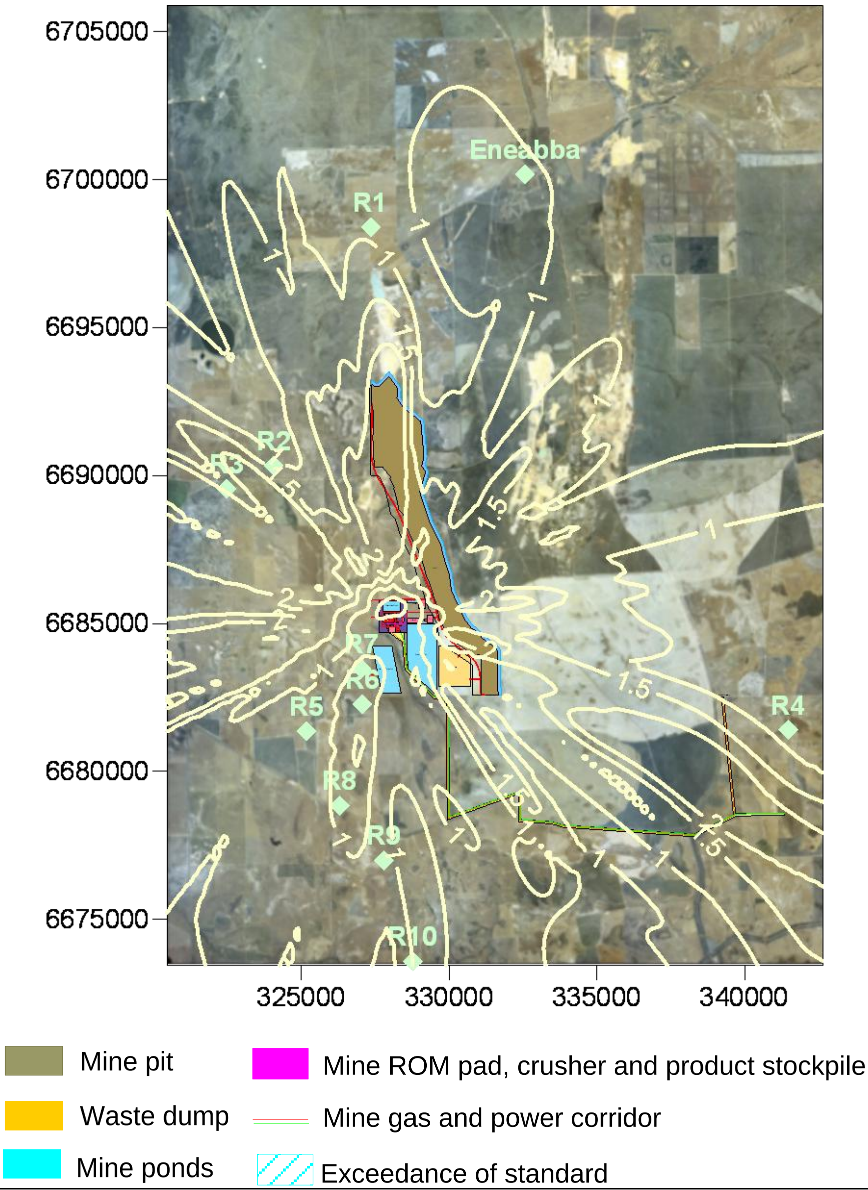


Figure 31 Predicted maximum 24-hour average ground-level concentration of PM_{10} due to the stack emissions from the proposed Coolimba Power Station

Location	**Averaging period**	**Data source**	**Units**
Eneabba and surrounds	24-hour	Katestone Environmental 2009	µg/m³
Type	**Guideline**	**Prepared by**	**Date:**
Maximum contours	NEPM(Air) 50 µg/m³	Natalie Shaw	28/10/08

Appendix A Meteorological and Dispersion Modelling Methodology

The meteorological data for this study was generated by coupling TAPM, a prognostic mesoscale model to CALMET, a diagnostic dispersion model. The coupled TAPM/CALMET modelling system was developed by Katestone Environmental to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models, such as CALPUFF. Details of the model configuration are supplied in the following sections.

TAPM meteorological simulations

The meteorological model, TAPM (The Air Pollution Model) Version 3.0.7, was developed by the CSIRO and has been validated by the CSIRO, Katestone Environmental and others for many locations in Australia, in southeast Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone Environmental has used the TAPM model throughout Australia as well as in parts of New Caledonia, Bangladesh, America and Vietnam. This model has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy and soil, and radiative fluxes.

TAPM requires synoptic meteorological information for the Eneabba region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 m to 5 km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM was configured as follows:

- 40 x 40 grid point domain with an outer grid of 30 kilometres and nesting grids of 10 kilometres, 3 kilometres and 1 kilometre
- Nested pollution grid at 250 m resolution
- Grid centred near the project site (latitude –29° 55’, longitude 115°15’)
- Geoscience Australia 9 second DEM terrain data
- Modification to the deep soil volumetric moisture content
- Synoptic data used in the simulation for the period of May 2006 to April 2007
- 30 vertical grid levels
- Data assimilation from observations at the Eneabba AWS monitoring station assimilated at the proposed southern end of the mine and at Eneabba

Meteorological observations obtained from an automatic weather station operated by Iluka Resources near Eneabba have been assimilated into TAPM. These observations have been assimilated in two locations, at the site near Eneabba and at the southern end of the mine. A radius of influence of 10 km over three vertical levels has been used for both locations in order to create an overlap between the locations and to minimise the influence of the observations in the areas of elevated terrain in the eastern region of the modelling domain.

To improve TAPM's ability to simulate the sea breeze, adjustable parameters within the TAPM model that are sensitive to the meteorological characteristics that influence the sea breeze were analysed. The sea breeze is a function of the difference in atmospheric pressure between the air above the ocean and the air above the land. To simulate the development of a sea breeze, particularly during the spring and summer months when TAPM was under-predicting winds from the southwest, adjustments were made to the monthly deep soil moisture content in TAPM.

A review of rainfall data collected by the Eneabba BOM monitoring station identified the spring and summer period of October to February as having below average rainfall, while June, July and August were the wettest months of the year. The default soil moisture content in the area in TAPM is 0.15%. This value has been adjusted to reflect variations in the annual rainfall profile based on BOM measurements. The monthly deep soil moisture content values used in TAPM are presented in Table 12.

By decreasing the soil moisture content during the spring/summer period to reflect the below average rainfall observed, the change in the Bowen ratio affected the surface heating of the air and subsequently the atmospheric pressure. This created a larger differential in air pressure between the air above the ocean and the air above the land, simulating the sea breeze.

Table 12 Deep Soil Moisture Content used in TAPM

Month	Deep Soil Moisture Volumetric Content (%)
January	0.05
February	0.05
March	0.15
April	0.15
May	0.15
June	0.25
July	0.25
August	0.25
September	0.15
October	0.05
November	0.05
December	0.05

A validation study was conducted to assess the performance of TAPM to simulate the wind speed and wind direction in the Eneabba region in Western Australia. Meteorological observations collected by Iluka Resources at Eneabba for the period 1 May 2006 to 30 April 2007 were compared with four TAPM modelling scenarios for the same period, and are summarised as follows:

- TAPM unassimilated; 1,000 m grid resolution and terrain; default settings for soil moisture content
- TAPM unassimilated; 1,000 m grid resolution and terrain; revised settings for soil moisture content based on BoM rainfall data
- TAPM unassimilated; 300 m grid resolution and terrain; revised settings for soil moisture content based on BoM rainfall data
- TAPM assimilated; 1,000 m grid resolution and terrain; revised settings for soil moisture content based on BoM rainfall data

The following conclusions can be drawn from the assessment.

In relation to the TAPM grid resolution:

- There is no significant improvement in the performance of TAPM in predicting wind speed and wind direction in the region by increasing the modelling grid resolution and the related terrain profile from 1,000 m to 300 m.

In relation to the general model performance based on statistical correlations for the 1,000 m grid resolution scenario:

- In general, the correlations between the TAPM predictions and the observations at Eneabba are good for both wind speed and directions.
- The model performed best during the night and morning periods (i.e. from midnight to midday).
- The changes in soil moisture parameters increased the performance of the model.

In relation to the prediction of wind speed for the 1,000 m grid resolution scenario:

- In general, TAPM tends to under-predict the frequency of winds below 3 m/s.
- In general, TAPM tends to over-predict the frequency of winds in the range between 3 – 6 m/s.
- In general, TAPM tends to under-predict the frequency of winds above 6 m/s.

In relation to the prediction of wind direction for the 1,000 m grid resolution scenario:

- In general, TAPM tends to over-predict the frequency of winds from the north.
- In general, TAPM tends to over-predict the frequency of winds from between the east and southeast.
- In general, TAPM tends to under-predict the frequency of winds from between the south and northwest.
- Flows from the southwest during the afternoon and particularly during the spring and summer months, are generally associated with the sea breeze.
- Flows from the southeast and east at night are generally associated with terrain induced drainage flows.
- The adjustment of the soil moisture content parameter within the TAPM configuration has not significantly improved TAPM's ability to simulate the sea breeze.

- TAPM's ability to simulate terrain induced drainage flows has not significantly changed with the adjustment of model configuration, with regard to soil moisture content parameterisation or grid resolution

In conclusion, the performance of TAPM in predicting the wind patterns in the Eneabba region was improved by the assimilation of local meteorological observations and the incorporation of soil moisture parameters based on observed rainfall data. Consequently this configuration of TAPM was used in the assessment of the air quality impacts for the Central West Coal Project.

Due to the uncertainties in the TAPM model predictions observational data were used in the estimation of emission rates for the project. Therefore the higher mean wind speed from the observations will result in higher emission rates from those sources impacted by wind speed (e.g. wind erosion from stockpiles).

CALMET meteorological simulations

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF Modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.0) was used to simulate meteorological conditions in the Eneabba region. The CALMET simulation was initialised with the gridded TAPM three dimensional wind field data from the 1 km grid. Use of the 1 km grid for input into CALMET is a sound practice and it allows CALMET to compute its own calculations for terrain. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation.

CALMET was set up with twelve vertical levels with heights at 20 m, 60 m, 100 m, 150 m, 200 m, 250 m, 350 m, 500 m, 800 m, 1600 m, 2600 m and 4600 m at each grid point. The geophysical data (land use and terrain heights) were generated from TAPM 1 km terrain. All default options and factors were selected except where noted below.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 40 by 40 at 1 km spacing
- 365 days (1 May 2006 to 30 April 2007) to match the available observational data
- Prognostic wind fields input as MM5/3D.dat for "initial guess" field only (as generated from TAPM)
- Mixing height parameters all set as default
- Temperature parameters used 1/R**2 as interpolation method, with radius of influence of 500 km
- Surface winds always extrapolated using similarity theory
- Step 1 wind field options include kinematic effects, divergence minimisation, Froude adjustment to a critical Froude number of 1 and slope flows
- Terrain radius of influence set at 2 km
- Radius of influence of observation data set at 9 km for surface and 9 km for aloft (RMAX1 and RMAX2)

- Relative weighting of step 1 wind fields versus observations set at 3 km for surface and 9 km aloft
- Data assimilation of the Eneabba meteorological monitoring station at Eneabba and at the southern end of the mine

CALPUFF dispersion modelling

The CALPUFF dispersion model utilises the three-dimensional wind fields developed using the TAPM and CALMET meteorological models to simulate the dispersion of air pollutants to predict ground-level concentrations across a gridded domain. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the three dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

CALPUFF (version 6.0) was used to simulate the dispersion characteristics and concentrations particulate matter generated by the proposed mining activities near the town of Eneabba and the wider community within the region. Hourly varying meteorological conditions were obtained from CALMET at 1 km. CALPUFF has the ability to refine the dispersion calculations via a nesting factor (of three), where the base computational grid resolutions of 1 km is reduced to 250 metres. This was employed to increase the accuracy of the simulated concentrations within the modelling domain as terrain influences and turbulence parameters are better resolved.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 120 by 120 grids at 250 m spacing
- 365 days (1 May 2006 to 30 April 2007) to match the available observational data
- Gridded 3-D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables
- Dry depletion on
- All other options set to default.

Appendix B Mine Activity Data

Table 13 List of assumptions in estimating dust emission rates

Assumption	Value	Units
Days of operation	365	days
Hours per day operation	24	hours/day
Annual coal production rate	2.5	Mtpa
Average daily coal production rate	6,849	tonnes/day
Peak daily coal production rate	20,000	tonnes/day
Average wind speed [1]	4.4	m/s
Number of days with rainfall > 0.25 mm [1]	46	days
Percentage of time that wind speed > 5.4 m/s[1]	31.3	%
Overburden moisture content	10	%
ROM coal moisture content	16.5	%
ROM coal silt content	6.2	%
Overburden silt content	7.5	%
Haul road silt content	8.4	%
Ash disposed in pit void from Coolimba Power	660,000	tonnes/annum
Initial pre-strip waste dump capacity	37.0	Mt
Initial pre-strip waste dump area	120	ha
Ash pit area	23.5	ha
Strip pit area	75	ha
Bulldozers removing overburden	2	bulldozers
Coal rehandled at ROM stockpile	10%	%
ROM stockpile surface area	0.41	ha
Product coal stockpile surface area	14.0	ha
Overburden truck average mass	208.3	tonnes
Distance to initial pre-strip waste dump	2.0	km
Coal truck average mass	60	tonnes
Scenario 1 coal haul road distance	3.3	km
Scenario 2 coal haul road distance	5.6	km
Scenario 3 coal haul road distance	7.6	km
Overburden conveyor length	10	metres
Conveyor 1 length	10	metres
Conveyor 2 length	10	metres
Conveyor 3 length	81	metres
Conveyor 4 length	81	metres
Conveyor 5 length	308	Metres
Notes: [1] Based on average for measurements from Eneabba 2006/2007 collected by Iluka Resources		

Table 14 Emission factors used to estimate $PM_{2.5}$, PM_{10} and TSP

Activity	Units	$PM_{2.5}$	PM_{10}	TSP
Bulldozing overburden	kg/hr	1.46	0.28	0.15
Overburden conveyor	g/m/s	0.00058	0.00027	0.00004
Coal conveyor	g/m/s	0.00058	0.00029	0.00001
Conveyor transfer	kg/Mg	0.00015	0.00007	0.00001
Wind erosion of overburden and ash	Mg/hectare/yr	0.85	0.40	0.06
Wind erosion of coal from exposed strip	Mg/hectare/yr	0.85	0.40	0.06
Wind erosion of coal in stockpiles	kg/hectare/yr	8114.3	4057.2	154.2
Trucks dumping coal	kg/Mg	0.0330	0.0139	0.0006
Front-end loader shifting coal	kg/Mg	0.0201	0.0036	0.0004
Coal mining and crushing coal	kg/Mg	0.00270	0.00120	0.00005
Screening coal	kg/Mg	0.01250	0.00430	0.00003
Bulldozing coal	kg/hr	6.28	1.93	0.14
Trucks dumping overburden	kg/Mg	0.00031	0.00014	0.00002
Trucks dumping ash	kg/Mg	0.0330	0.0139	0.0006
Trucks hauling coal, overburden and ash	g/VKT	4328.7	1233.9	123.4

Table 15 Annual average dust emission rates estimated for all fugitive dust generating activities associated with CWCP and Coolimba Power station (g/s)

Activity	$PM_{2.5}$	PM_{10}	TSP
Bulldozing overburden	0.09	0.15	0.81
Conveyor	0.01	0.14	0.29
Conveyor transfer	0.01	0.05	0.10
Wind erosion of overburden and ash	0.29	1.82	3.87
Wind erosion of coal	0.19	1.88	3.88
Trucks dumping coal	0.02	0.44	1.05
Front-end loader shifting coal	0.00	0.03	0.16
Coal mining	0.00	0.10	0.21
Crushing coal	0.01	0.19	0.43
Screening coal	0.00	0.34	0.99
Bulldozing coal	0.04	0.54	1.74
Trucks dumping overburden and ash - Scenario 1	0.04	0.46	1.05
Trucks dumping overburden and ash - Scenarios 2 and 3	0.01	0.29	0.69
Trucks hauling coal - Scenario 1	0.54	5.43	19.04
Trucks hauling coal - Scenario 2	0.92	9.15	32.11
Trucks hauling coal - Scenario 3	1.24	12.41	43.54
Trucks hauling overburden	0.87	8.70	30.51
Trucks hauling ash - Scenario 1	0.04	0.41	1.45
Trucks hauling ash - Scenario 2	0.07	0.70	2.44
Trucks hauling ash - Scenario 3	0.09	0.94	3.31
Note: $PM_{2.5}$ emission rates used to calculate dust depletion and deposition			