Appendix E
Air Quality Assessment

FINAL REPORT

Reavill Farm Pty Ltd
and Tucki Hills Pty Ltd

Champions Quarry
1586 Wyrallah Road
Tuckurimba NSW

Air Quality Assessment

November 2009

Environmental Resources Management Australia
Level 3, Yarra Tower (WTC)
18-38 Siddeley Street, DOCKLANDS VIC 3005
AUSTRALIA
Telephone +61 3 9696 8011
Facsimile +61 3 9696 8022
www.erm.com

FINAL REPORT

Reavill Farm Pty Ltd
and Tucki Hills Pty Ltd

Champions Quarry
1586 Wyrallah Road
Tuckurimba NSW

November 2009

Reference: 0098287RP1_AQ

For and on behalf of
Environmental Resources Management
Australia

Approved by: Murray Curtis

Signed:

Position: Managing Partner

Date: 10 November 2009

This report has been prepared in accordance with the scope of services described in the contract or agreement between Environmental Resources Management Australia Pty Ltd ACN 002 773 248 (ERM) and Reavill Farm Pty Ltd and Tucki Hills Pty Ltd. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Reavill Farm Pty Ltd and Tucki Hills Pty Ltd. Furthermore, the report has been prepared solely for use by the Reavill Farm Pty Ltd and Tucki Hills Pty Ltd and ERM accepts no responsibility for its use by other parties.

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia (ERM) was commissioned by Reavill Farm Pty Ltd and Tucki Hills Pty Ltd to prepare an Air Quality Assessment for the proposed expansion of the sandstone quarry (Champions Quarry located at 1586 Wyrallah Rd, Tuckurimba NSW approximately 16km south of Lismore.

This assessment is performed as part of a Part 3A major project application for the expansion with annual output of 250,000 tonnes per annum, for a total of 6.25 million tonnes extraction of sandstone resource.

1.2 SCOPE OF WORK

The scope of works for the air quality assessment is as follows:

- evaluate the existing conditions at the Project Site including existing air quality, sensitive receptors in the area, local meteorology and topography. This is based on information made available by Champions Quarry, on-site visits conducted by ERM staff and information available in the public domain;

- detail the legislative and regulatory framework relevant to the assessment of air quality for the proposed operation;

- review the potential emissions to atmosphere and develop an air emissions inventory for the development;

- assess the air quality impacts from operation of the facility at sensitive receptors;

- identify possible site-specific ameliorative measures to be considered as part of the proposal based on the outcomes of the air quality assessment; and

- consultation with Champions Quarry throughout the assessment.

1.3 GENERAL APPROACH TO THE ASSESSMENT

A *Level 2 air quality impact assessment*, as described by the NSW Department of Environment, Climate Change and Water (DECCW 2005) was carried out to determine potential impacts from the quarry expansion, this is a realistic and comprehensive assessment based on site specific input data.

A typical *Level 2 air quality impact assessment* for a large scale development involves the gathering, processing and presentation of information on:

- emission source details such as types, locations, dimensions, flow characteristics and rates of contaminant release to the atmosphere. Identification of significant or potentially significant contaminants is required, based on their expected rates of release and inherent properties to potentially cause environmental harm;
- meteorological conditions, which affect the dispersion of contaminant plumes released into the atmosphere;
- local geographical details such as topography and surface characteristics including land use and vegetation types;
- the existing levels of selected contaminants in the receiving environment;
- predicted future ambient concentrations, taking into account the existing baseline conditions. The prediction of ambient (usually ground-level) concentrations requires the use of mathematical models that simulate the release and dispersion of contaminant plumes;
- a basis for determining whether predicted contaminant concentrations are acceptable. This generally involves the use of air quality guidelines prepared by the relevant regulatory authorities; and
- measures incorporated into the design and/or management of the proposed development to mitigate air quality impacts, and in particular to mitigate the risks of adverse impacts under abnormal operating conditions.

The key contaminants considered in this assessment are:

- total suspended particulates (TSP);
- particulate matter less than 10 microns (PM_{10}); and
- deposited dust.

It is noted that the sandstone material at Champions Quarry is expected to contain only a small percentage of fines (i.e. less than 10 microns) as is discussed further in *Section 6.2.8*.

2 *SITE AND PROCESS DESCRIPTION*

2.1 *SITE DESCRIPTION*

The quarry is located off Wyrallah Rd, Tuckurimba approximately 16 kilometres south of Lismore, NSW.

The Project Site and operational Project Area are shown in *Figure 2.1.*

Proposed permanent quarry infrastructure includes a quarry office and staff amenities, weighbridge plant and general storage sheds and sand screening and washing plant. Mobile crushing will be used on-site on a required basis.

The Project Area will have a partially covered temporary holding stockpile and service area, comprising 100m x 40m concrete slab with six product and aggregate bays. Access to the Project Area will be on a sealed road from Wyrallah Road.

The Project Area layout is shown in *Figure 2.2*.

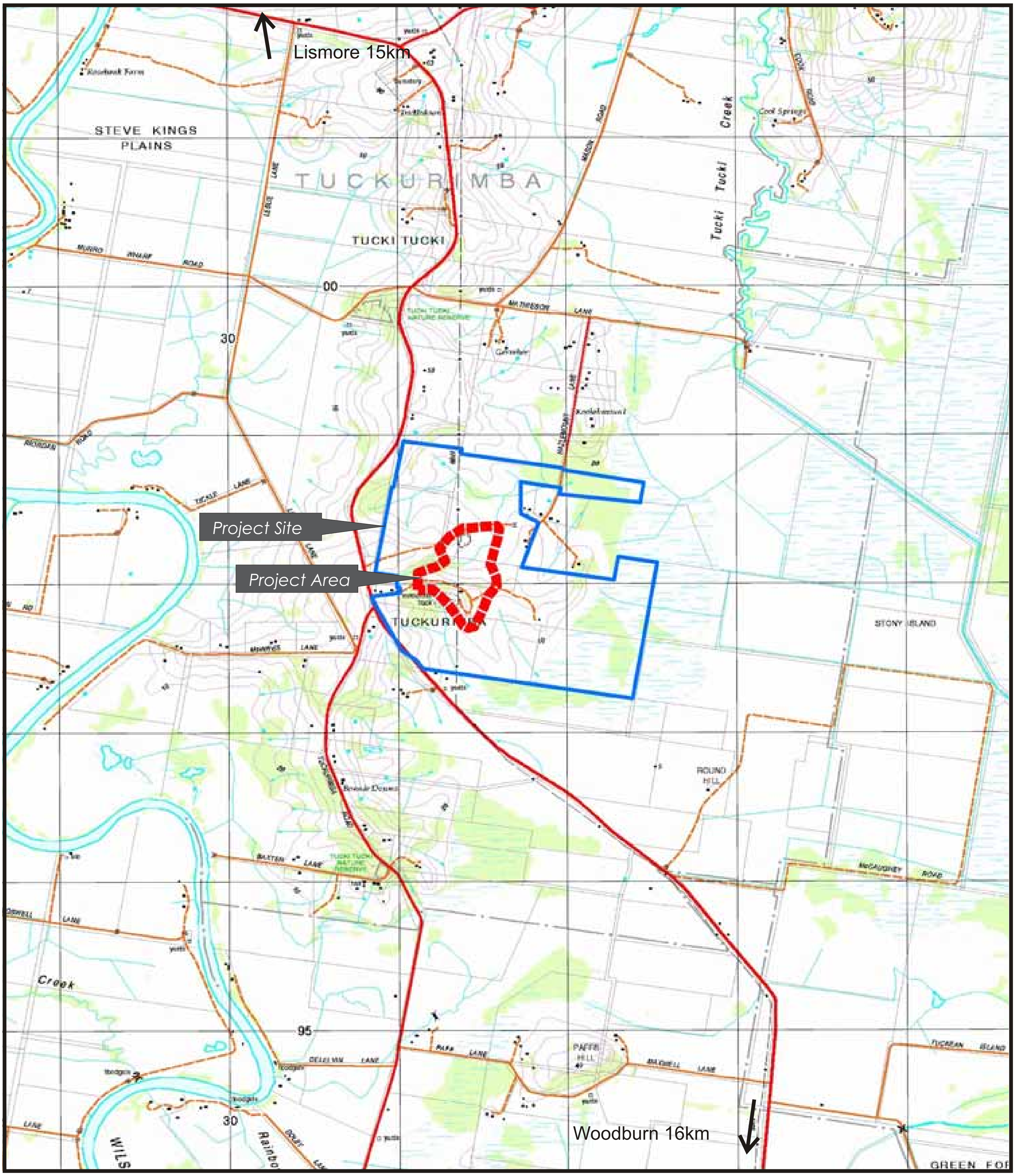


Figure 2.1

Project Locality Plan

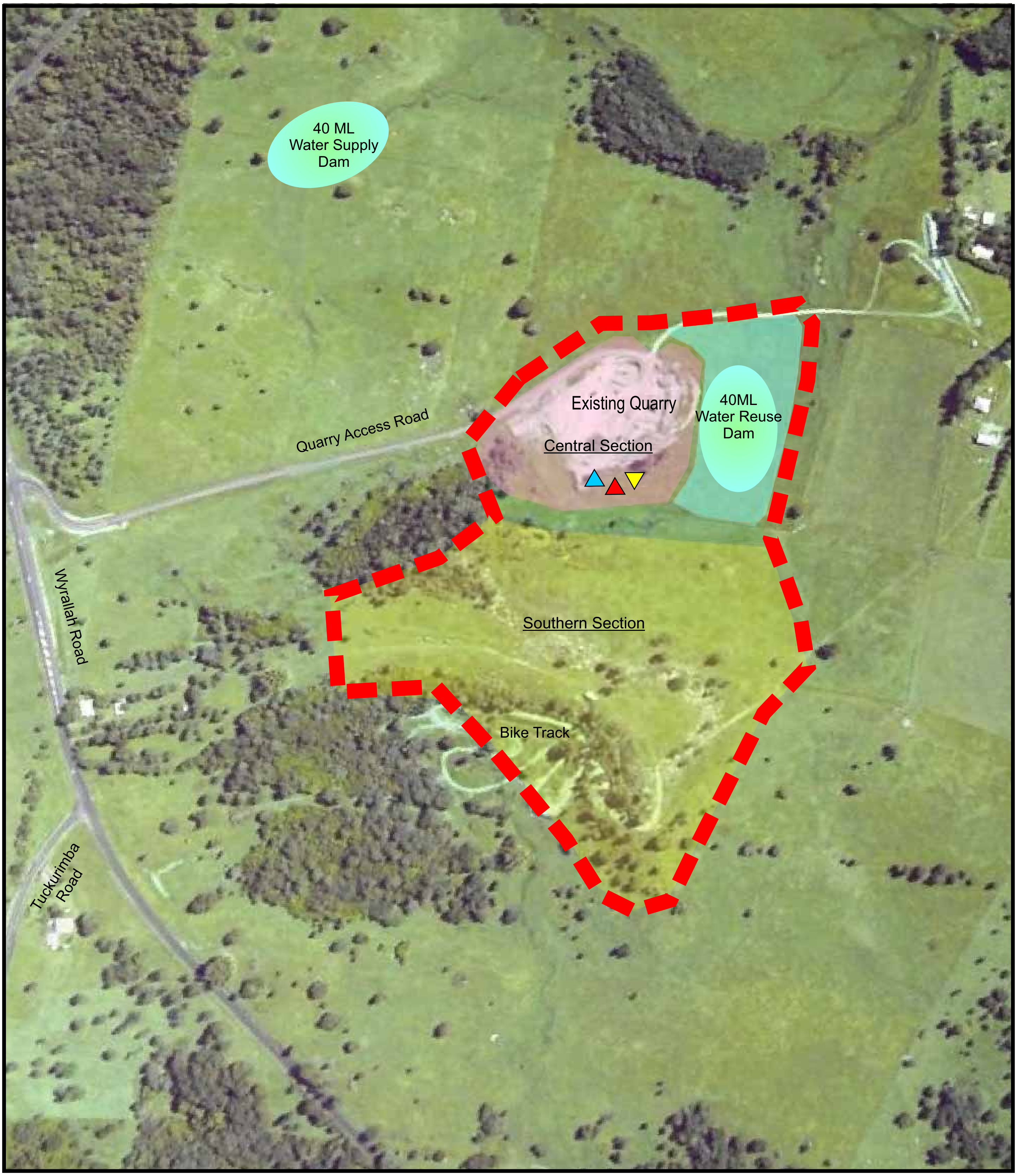
Client:	Champions Quarry		
Project:	Champions Quarry Expansion		
Drawing No:	0098287pm_01		
Date:	12/08/09	Drawing size:	A4
Drawn by:	AM	Reviewed by:	WW
Source:	Department of Lands		
Scale:	Refer to Scale Bar		

N

0 0.5 1km

Environmental Resources Management Australia Pty Ltd
PO Box 5711 3/146 Gordon Street
Port Macquarie NSW 2444
Telephone +61 2 6584 7155

ERM



Legend

- Extent of Quarry Extraction and Operations (Project Area)
- Washing Plant
- Processing Plant
- Service Area and Temporary Stockpile Holding Area
- Water Management Dam
- Central Section
- Southern Section
- Water Management (Non-quarrying area)

Client:	Champions Quarry		
Project:	Champions Quarry Expansion		
Drawing No:	0098287pm_03	Suffix No:	V4
Date:	12/08/09	Drawing size:	A4
Drawn by:	AM	Reviewed by:	WW
Source:	-		
Scale:	Refer to Scale Bar		

N 0 50 100 150 200 m

Figure 2.2

Proposed Project Area Layout

Environmental Resources Management Australia Pty Ltd
PO Box 5711 3/146 Gordon Street
Port Macquarie NSW 2444
Telephone +61 2 6584 7155

ERM

2.2 *PROCESS DESCRIPTION*

Material extraction will occur in the *Central* and *Southern* quarry sections (refer *Figure 2.2* above). The existing quarry is located within the *Central* section. The majority of the land that is required to be cleared of vegetation has been cleared. Preparation for new cells will commence with up to 3 hectares of top soil removed by a bulldozer to an average depth of 0.5 metres, and up to 3 hectares of overburden to an average depth of 1.0 meters will be removed.

Approximately 20% of the total top soil and overburden material will be put aside for rehabilitation. These stockpiles will be vegetated. Top soil and overburden will also be used to form noise and visual amenity screening bunds around the extraction cells. The overburden used to create bunds will be vegetated to minimise dust emissions and will be retained for future rehabilitation of the Project Area.

Remaining topsoil and overburden will be sold-on, or used for rehabilitation as required.

Following removal of overburden, a bulldozer will be used to 'rip and push' sandstone material to form stockpiles of unprocessed material at the base of the extraction cell.

The bulldozer is estimated to be able to 'rip and push' up to 3,000 tonnes per day of material and is therefore likely to operate in 'campaigns' totalling approximately 80 days per year.

Front end loader(s) and/or excavator(s) will be used on-site to transfer material from the unprocessed stockpiles at the base of the extraction cells for direct transportation off-site and transportation to the processing area.

It is anticipated that approximately 70% of the material will be transported directly off-site, whilst approximately 30% would be transported to the sand screening and washing plant. The washing plant is to be located in the in the *Central* section located in the existing quarry.

The processing area will have a small stockpile of unprocessed material ready to be washed. Some of the harder material may require crushing with a secondary crusher. This is anticipated to be less than 10% (25,000 t) of the total annual output of the quarry (250,000 t). A mobile crusher will be brought to the Project Area as required to be used on a campaign basis only.

Front end loader(s) or excavator(s) will load unprocessed material to the sand screening and washing plant. This plant will be a 'screw and bucket wheel' system, washing the unprocessed sandstone material to produce separate fine and coarse grading stockpiles. Six partially covered storage bays will store processed material and aggregate in the processing area. There will be approximately 8,000 t of washed sand in stockpiles in the processing area that is not likely to be stored in the processing storage bays.

A front end loader(s) or excavator(s) will load processed material to trucks for transportation off-site.

3 AIR QUALITY LEGISLATION AND GUIDELINES

3.1 AIR QUALITY ISSUES

The principle pollutants of concern with respect to emissions of atmosphere from the proposed quarry expansion are:

- total suspended particulates (TSP);
- particulate matter less than 10 microns (PM_{10}); and
- deposited dust.

3.2 RELEVANT NSW REGULATORY FRAMEWORK

The air quality assessment was carried out in accordance with the following NSW DECCW policy:

- *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales*, NSW DEC, August 2005.

3.3 NATIONAL ENVIRONMENT PROTECTION MEASURES

The National Environment Protection Measure (Ambient Air Quality) 1998 (NEPM) is a Commonwealth Government initiative which aims to achieve nominated standards of air quality within ten years. Air quality standards for six major air pollutants (carbon monoxide, nitrogen dioxide, photochemical oxidants, sulfur dioxide, lead and small airborne particles) have been set.

All states and territories including NSW have adopted the NEPM air quality goals for pollutants. The criteria relating to potential emissions from the Champions Quarry facility are outlined in *Table 3.1* below. These standards are legally binding on all levels of government. Measurement and concentration averaging periods are based on critical exposure times for health impacts and are thus different for various pollutants. The NEPM criteria have been incorporated into the NSW DECCW impact assessment criteria.

Table 3.1 *NEPM (Ambient Air Quality) Standards*

Pollutant	Averaging Period	Maximum Concentration	Maximum Allowable Exceedences
Particles as PM_{10}	24 hour	50 μg/m3	5 days in a year.

3.4 NSW DECCW IMPACT ASSESSMENT CRITERIA

The NSW DECCW publish Impact Assessment Criteria for air pollutants in their document *"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales" (2005).* This document is referred to in *Part 4: Emission of Air Impurities from Activities and Plant in the Protection of the Environment Operations (Clean Air) Regulation* (2002). Industry has an obligation to ensure compliance with the requirements specified in this Regulation.

The impact assessment criteria relevant to the proposed mining operation are presented in *Table 3.2*. These are the criteria which the predicted ground level concentrations will be compared against.

Table 3.2 *NSW DECCW Impact Assessment Criteria*

Pollutant[1]	Averaging Period	Concentration
PM_{10}	24 hours	50 µg/m^3
	Annual	30 µg/m^3
Total Suspended Particulates	Annual	90 µg/m^3
Deposited Dust	Annual	2 g/m^2/month

1. Source: *"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (NSW DEC, 2005)*
2. Source: "*National Environment Protection Measure (Ambient Air)" (Amendment 2003)*

3.5 NSW DECCW ACTION FOR AIR

Action for Air is the NSW Government's 25 year air quality management plan. It primarily targets smog and particle pollution in the Greater Metropolitan Region (GMR) of NSW. There are no specific requirements in the document that relate to the proposed facility.

4 EXISTING ENVIRONMENT

4.1 METEOROLOGICAL CONDITIONS

Meteorology plays a major role in determining the location and the degree of off-site impacts of activities proposed to be carried out at the quarry. Air dispersion modelling requires information about the dispersion characteristics of the area. In particular, data is required on wind direction, wind speed, temperature, atmospheric stability and mixing height.

A meteorological file covering the period January 1st 2004 – December 31st 2004 suitable for modelling using AUSPLUME have been prepared for ERM by PDS Consulting. The files utilise data on wind speed, wind direction and ambient temperature from an Automatic Weather Station (AWS) at Casino, located approximately 20 km west of the Project Site.

Information as to the development of the meteorological file is included in *Annex A*.

4.2 CLIMATE

Long-term climate data is available from a Bureau of Meteorology (BoM) weather station located in Lismore, approximately 16 km northwest of the project Area.

Table 4.1 presents temperature, humidity and rainfall data from this weather station, which consists of monthly average 9am and 3pm readings. Monthly averages of maximum and minimum temperatures are also presented. Rainfall data consists of mean monthly rainfall and the average number of rain days per month.

Temperature

On average, January is the warmest month in Lismore with a mean daily maximum of 29.9ºC. The coolest month is July with a mean daily minimum temperature of 6.5ºC.

Rainfall

The mean annual rainfall at Lismore is 1343.1 mm. The mean number of rain days annually over this period is 104.4 days. On average, March is the wettest month with a mean monthly rainfall of 188.4 mm, while September is the driest month with an average of 50.4 mm.

Table 4.1 Climate Data for Lismore Station (1884 – 2003)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature													
Mean (°C)	29.9	29.1	27.9	25.7	22.6	20.2	19.9	21.5	24.4	26.6	28.2	29.7	25.5
Daily Minimum Temperature													
Mean (°C)	18.8	18.8	17.4	14.2	10.9	8.2	6.5	7.2	9.9	13.2	15.8	17.8	13.2
9 am Mean													
Temperature (°C)	24.4	23.6	22.2	19.5	15.8	12.9	11.8	13.7	17.7	27.1	22.8	24.4	19.2
Humidity (%)	74	79	80	80	81	81	79	73	68	65	67	69	75
3 pm Mean													
Temperature (°C)	28.5	27.9	26.8	24.5	21.6	19.4	19.1	20.5	23.1	24.8	26.8	28.2	24.3
Humidity (%)	58	61	60	58	59	56	51	46	45	50	52	54	54
Rainfall													
Mean (mm)	155.4	183.6	188.4	129.2	115.3	97.0	80.3	54.9	50.4	73.2	94.1	121.3	1343.1
Raindays													
Mean (Number)	10.4	11.7	13.0	10.0	9.3	7.4	6.4	5.8	5.7	7.1	8.2	9.4	104.4

1. Station number 058037; Latitude 28.81 S; Longitude 153.26 E
2. Source - Bureau of Meteorology, Commonwealth of Australia.

4.3 *WINDROSE SUMMARY*

Wind speed and direction information is available from long term average data collected at the BoM Casino Airport AWS, located approximately 20 km west of the Project Site.

On an annual basis, winds are predominantly from the southeast, east and northwest, with smaller contributions from the south and west. Calm conditions are evident approximately 2% of the time. Windrose diagrams are presented in *Annex B*.

- during summer, predominant winds are from the east, with smaller contributions from the southeast and south;
- during autumn, predominant winds are from the south, with smaller contributions from the west and southeast;
- during winter, predominant winds are from the northwest and west, with smaller contributions from the south; and
- during spring, predominant winds are from the east and northwest, with smaller contributions from the south.

4.4 *STABILITY CLASS*

Stability class is used to determine the rate at which a plume disperses by turbulent mixing. Each stability class is associated with a dispersion curve, which is used by a dispersion model to calculate plume dimensions and odour concentrations downwind of the source.

Stability classes are categorised from A to F. Stability class A refers to highly unstable conditions while class D refers to neutral conditions. Stability class F refers to stable conditions. The intermediate classes not mentioned refer to conditions between those described above.

Table 4.2 shows the frequency of occurrence of the different stability categories expected in the area.

Table 4.2 Frequency of Stability Classes

Stability Class	Frequency (%)
A	2
B	10
C	14
D	32
E	15
F	27

1. Source: PDS Consulting

It can be seen that due to the large percentage of D-F stability classes (74%), poor dispersion conditions may be evident in the Lismore area.

4.5 *BACKGROUND CONCENTRATIONS*

Background air quality is a measure of the existing air quality in the absence of the project activity. The background air quality is due to sources (natural or man made) other than the Project Area. It is important to consider background air quality when considering cumulative impacts on sensitive receptors in the area.

A review of the State of the Environment Report (SOE) for the Lismore City Council (2004) indicated that the Council did not undertake any air monitoring within the reporting period (July 2003/June 2004) and therefore definitive statements based on monitoring data within the region cannot be made.

A desktop review of the National Pollutant Inventory (NPI) of reported emissions from fixed and mobile sources in the vicinity of the Project Area was also undertaken to obtain an indication of existing industries in the project area. No facilities within the Lismore region are reporting emissions of particulate matter under the NPI reporting scheme.

4.5.1 *Particulate Matter*

The NSW DECCW does not monitor particulate matter in Lismore or the surrounding region. In the absence of site specific background data, particular in the form of PM_{10} recorded through a TEOM in Tamworth approximately 300km southwest of the Project Site, has been used as a 'worst case'.

The Tamworth monitoring data, in the absence of data recorded at Lismore, is anticipated to represent elevated concentrations of particulate matter due to the proximity of rural, industrial and transport sources. The use of this data is therefore considered a 'high' background PM_{10} concentration.

The Tamworth station records 24-hour concentrations of PM_{10}; daily data for 2004 has been provided by the NSW DECCW in order to undertake a contemporaneous assessment of 24 hour PM_{10} cumulative concentrations, in accordance with the NSW DECCW Approved Methods (2005).

To undertake a cumulative assessment of annual PM_{10} ground level concentrations, the annual average of the 24 hour Tamworth records has been used. This gives a background concentration of 20.7µg/m^3.

A background concentration for TSP has been estimated at 52.9 µg/m^3, based on a particle size distribution with PM_{10} being approximately 39.1% of TSP (see *Section 6.2.8*).

4.5.2 *Dust Deposition*

There is no dust deposition monitoring program currently undertaken in the vicinity of the Project Site. No public information regarding background dust deposition levels in the Lismore region. The Project Area is located in a well vegetated agricultural area, as such it is anticipated that background dust deposition levels will be low, and a cumulative assessment of dust deposition has not been undertaken.

5 EMISSIONS INVENTORY

5.1 OVERVIEW

Particulate emissions are anticipated to arise from the following activities at the quarry:

- bulldozers working on topsoil, overburden, and sandstone material;
- loading unprocessed sandstone to haul and road trucks;
- transfer of unprocessed material to the washing and screening plant;
- wheel generated dust from road trucks, and on-site haul trucks; and
- wind generated dust from exposed areas and stockpiles.

Emissions have been estimated using published emission factors from the Australian National Pollutant Inventory (NPI) emission estimation technique manual for Mining and Processing of Non-metallic Materials (2000), and the US EPA AP 42 document 'Compilation of Air Pollutant Emission Factors'.

Emission estimates have been based on a maximum annual output of 250,000 tonnes and an operating schedule of 6 days per week (which for modelling purposes equates to 312 working days a year) and dust generation activities assumed to be undertaken for 10.5 hours per day.

It is noted that actual quarry operation hours will be Monday through Friday (7am-5:30pm), and 6.5 hours on Saturday (7:30 am -3pm) and the quarry would only operate for an anticipated maximum of 280 days per year. Hence, the emissions estimates used for the modelling are considered to be conservative.

As previously discussed some of the harder material may require crushing with a secondary crusher, which is anticipated will occur for less than 10% (25,000 t) of the total annual output of the quarry (250,000 t). Water and/or chemical suppression is proposed for the campaign based mobile crushing equipment. Crushing is therefore not anticipated to be a significant source of emissions to the atmosphere and has not been included as an activity in the dispersion model.

Wind erosion has been modelled occurring at wind speeds over 5.14 metres per second.

The following sections provide an outline of activities on-site which are expected to generate particulate emissions.

5.2 *QUARRY PIT OPERATIONS*

5.2.1 *Preparation of the Extraction Cells*

The extraction of the sandstone resource will take place within an '*operational project area*' of approximately 16 hectares, which is divided into two separate extraction areas (referred to as the Central and Southern *section areas*) and includes water management area (i.e. non-extraction areas). The sequential extraction and rehabilitation within 'section areas' will take place in up to three '*work cells*' that will have a maximum area of three hectares each.

Preparation for the new cells will commence with removal by a bulldozer of up to 3 hectares of top soil to an average depth of 0.5 metres, and up to 3 hectares of overburden to an average depth of 1.0 meters will be removed. It has been conservatively assumed that up to 9 hectares will be exposed at any one time. The cells will however will be progressively worked and/or rehabilitated to ensure that at any one time a minimum area is exposed, in addition to the existing cell and processing area which will be active. The activity of a bulldozer working on topsoil and overburden has been identified as a source of emissions and therefore has been included in the dispersion model.

5.2.2 *'Ripping and Pushing' the Sandstone Material*

Following removal of overburden, a bulldozer will be used to 'rip and push' sandstone material to form stockpiles of unprocessed material at the base of the extraction cell(s).

The bulldozer is estimated to be able to 'rip and push' up to 3,000 tonnes per day of material and is therefore likely to operate in 'campaigns' totalling approximately 80 days per year. The activity of the bulldozer working on unprocessed material has been identified as a source of emissions and therefore has been included in the dispersion model.

5.2.3 *Loading Unprocessed Material to Haul Trucks*

Emissions of particulate matter are generated as a result of transferring unprocessed material into trucks using an excavator or loader. It has been assumed that all unprocessed material will be loaded to haul truck(s) for transportation either off-site or to the process area. Loading of trucks has been included as a source of emissions in the dispersion model.

5.3 *ON-SITE HAULAGE*

The main quarry access road is to be sealed and is not anticipated to be a source of dust emissions. Haulage along unsealed roads around the project Area will generate dust emissions. Vehicle movements on unpaved roads have been included as a source of emissions in the dispersion model. It is noted that the proposed haul road between the main access road and the *Southern Section* pit will be progressively sealed within 12 months of accessing this section, allowing for material removal and settlement. This will further reduce the potential for dust emissions. Therefore, the dispersion modelling is considered conservative with regard to long-term quarry operations.

5.4 *PROCESSING AREA*

5.4.1 *Dumping to Stockpile*

Haul trucks will transport approximately 30% of material from the *Southern Section* to the *Central Section* processing area. The unprocessed material will be 'dumped' to the unprocessed material stockpile. This activity has been identified as a source of potential emissions and therefore has been included in the dispersion model.

5.4.2 *Loading the Washing and Processing Plant*

A front end loader will be used to load unprocessed material to the washing and processing plant. This activity has been identified as a source of emissions and therefore has been included in the dispersion model.

5.4.3 *Screening and Washing Plant*

The washing plant will be a 'screw and bucket wheel' system, washing the screened sand material to produce separate fine and coarse grading stockpiles. The material is washed directly and input into the screening and washing plant. The US EPA emission factor database, AP-42 provides the following commentary with respect to emissions from sand and gravel processing:

'Generally, these materials are wet or moist when handled, and process emissions are often negligible. A substantial portion of these emissions may consist of heavy particles that settle out within the plant.'

Given the nature of the material and the process, emissions from the screening and washing plant are not expected to be significant and have therefore not been included in the dispersion model.

A screening plant may also be used to screen topsoil. Screening topsoil has a greater dust generation potential than screening sandstone material due to the nature of the materials. It is anticipated up to 5,000 tonnes of topsoil may be screened in a year, and that this activity would occur for approximately 6 days per year. If topsoil is screened, then the total amount of sandstone screened in a year will be reduced so that an estimated 70,000 tonnes of material (sandstone and topsoil) would be screened in a given year.

The primary water spray would still be in operation during topsoil screening, and this activity would only be undertaken during calm days. Given the proposed frequency (maximum of 6 days per year) topsoil screening has not been included as an activity in the dispersion model.

5.4.4 Loading Processed Material to Haul Trucks

Emissions of particulate matter are generated as a result of transferring processed material into trucks using a front end loader(s) or excavator(s). Processed material will be loaded from the processed material stockpiles directly into trucks for transport off-site. Loading of trucks has been included as a source of emissions in the dispersion model.

5.4.5 Wind Erosion

Wind erosion is expected to generate particulate matter emissions from exposed areas and unprocessed stockpiles.

Wind erosion of exposed areas, consisting of the *Southern* pit up to a maximum of 9 hectares in area and the existing processing area (up to 1.5 hectares) represent a source of emissions. Emissions from wind erosion of exposed areas have therefore been included as a source in the dispersion model.

Wind erosion of stockpiles of unprocessed material represents a potential emission source. The moisture content of the material is approximately 8% and the silt content of the deposit has been determined as 1%. The properties of the material therefore result in a reduced potential to generate emissions from wind erosion. Nonetheless, wind erosion of unprocessed stockpiles has been included as an emission source in the dispersion model. Unprocessed stockpiles have been estimated at a maximum of 35,000 tonnes (total) across the two stockpiles within the extraction cells, and a 5,000 tonne stockpile at the processing area.

Overburden and topsoil will be used to develop bunds around the cells and placed in stockpiles for rehabilitation. The overburden used to create bunds will be vegetated to minimise dust emissions and will be retained for future rehabilitation of the Project Area. As these stockpiles will be vegetated emissions from wind erosion are not expected to be significant and have therefore not been included in the dispersion model. Remaining excess topsoil and overburden will be sold.

The processed or 'washed' sand retains moisture and has had all dust and silt removed. It is anticipated that two washed sand stockpiles, of up to 8,000 t, will not be stored in processing bays. Given the nature of the material and the process, emissions from wind erosion of exposed processed stockpiles are not expected to be significant and have therefore not been included in the dispersion model.

5.4.6 Storage Areas

Six partially covered storage bays will store processed material and aggregate in the processing area. Emissions due to wind erosion of material in storage areas are not expected to be significant and have therefore not been included in the dispersion model.

5.5 EMISSIONS SUMMARY

Estimates have been based on the implementation of controls such as watering of unsealed surfaces and water suppression on crushing equipment.

A control factor of 50% has been applied to unsealed roads, based on the assumption that a low level of watering (between 1-2 L/m^2/hr) will occur (National Pollutant Inventory, 2001). It is noted that the main access road will be sealed prior to the commencement of the expanded quarrying activities and the haul road between the main access road and the *Southern Section* will be sealed within 12 months of access this section, allowing for road construction and settlement.

Particulate exhaust emissions from mobile equipment are expected to be a minor contributor of overall particulate emissions from the Project Area, due to the small fleet on-site. Additionally, emission factors for activities have been derived from measurements that cover all PM_{10} emissions associated with a unit operation, including exhaust emissions. Therefore, adding exhaust emissions to the fugitive emissions would involve some double counting and over estimation of emissions (NSW Minerals Council, 2000).

A detailed breakdown of emission estimates used in this assessment is provided in *Annex C.*

6 *DISPERSION MODELLING ASSESSMENT*

6.1 *MODELLING METHODOLOGY*

In this assessment the dispersion model AUSPLUME v6.0 has been used to model emissions from the proposed operations.

The AUSPLUME model is described in Environment Protection Authority of Victoria Publication No. 264 of 1986 *"The AUSPLUME Gaussian Plume Dispersion Model"*. AUSPLUME's mathematical basis was derived from a modified version of the US Environmental Protection Agency ISC model. It is described in the Victorian EPA "*State Environment Protection Policy (Air Quality Management)*".

The NSW DECC approve this model in their guidance document *"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW"*, 2005.

The AUSPLUME configuration files employed for the modelling have been provided for this report in electronic format.

6.2 *MODELLING PARAMETERS*

6.2.1 *Roughness Height*

The surface roughness of the area over which the plume is dispersing will affect the surface-generated turbulence and hence the vertical and, to a lesser extent, the horizontal dimensions of the plume.

Surface roughness is characterised by the term 'roughness height' and varies from zero metres over ice to one metre in pine forests or cities. The roughness height selected for the purpose of the modelling is 'rolling rural'. AUSPLUME allows the user to simulate this by the choice of 0.4 metres.

6.2.2 *Meteorological Data*

A meteorological data file suitable for modelling using AUSPLUME was complied by PDS Consultancy using data from an Automatic Weather Station (AWS) at Casino. This station is located approximately 20km west of the quarry and is considered representative of the meteorological conditions in the area.

A further discussion of local meteorology is presented in *Chapter 4.*

6.2.3 *Terrain*

The terrain in the modelling domain is flat to slightly undulating. Accordingly, it is not considered that terrain will influence the dispersion of pollutants from the Project Area, and as such, terrain effects have not been included in the model.

In addition, AUSPLUME cannot account for terrain effects from area and volume sources.

6.2.4 *Wind Profile Exponents*

Irwin Rural wind profile exponents were utilised in the modelling. This profile is for rural regions such as Lismore.

6.2.5 *Model Receptors*

A Cartesian grid was set-up with the south west corner positioned at 530300E, 6797300N and grid receptors at regularly spaced intervals of 50m, covering an area of 2 km by 2 km.

The discrete receptors were chosen to represent nearby residences. A detailed list of discrete representative receptors is presented in *Table 6.1*. The locations of these receptors are shown in *Figure 6.1*.

Table 6.1 Sensitive Receptor Locations

Receptor Number	Description	AMG[1] Coordinates	Distance from existing quarry (m)	Distance from proposed Project Area boundary (m)
1	Residence	531089, 6799150	810	810
2	Residence	531738, 6798473	330	200[2]
3	Residence	532043, 6798156	630	510
4	Residence	530867, 6797990	530	220

Notes:

1. AMG Australian Map Coordinates
2. Distance to Water Reuse Area (note: distance to operational quarry unchanged at 330m)

6.2.6 *Background Concentrations*

A discussion of background concentrations included in this assessment is presented in *Section 4.5.*

6.2.7 *Building Wakes*

Building wake effects are flow lines that cause the plume to be forced downwards much sooner than it would have had the building not been there.

This can result in higher ground level concentrations on the leeward side of obstructions. AUSPLUME contains algorithms to determine the effects of building downwash on plume dispersion.

Building wake effects cannot be included when assessing the impacts of area and volume sources. As such, building wakes have not been included in this model.

6.2.8 *Particle Size Distribution*

Particle size distribution data was presented in a report completed by Holmes Air Science[1]. This size distribution is presented in *Table 6.2* and has been used in the modelling assessment for deposited dust.

Table 6.2 Mean Particle Size Distribution

Range (micron)	Mass Fraction
0-2.5	0.047
2.6-10	0.344
10-30	0.609

It is noted that the sandstone material at Champions Quarry is not expected to contain significant fines (i.e. less than 10 microns) as demonstrated by the laboratory reports provided in the Coffee Geosciences *(2008) Champions Quarry - material Assessment of Proposed Expansion Area* report (as provided in *Appendix B* of EA report) . Laboratory reports provided in the *material assessment* report indicated that generally less than 20% of material passed the 75 micron sieve, hence the above size distribution is considered conservative for modelling purposes.

[1] Holmes Air Sciences (2006) – Air Quality Impact Assessment – Maroota Sand Quarry

Legend

Sensitive Receptor Location

Extent of Quarry Extraction and Operations (Project Area)

Client:	Champions Quarry
Project:	Champions Quarry Expansion
Drawing No:	0098287pm_GIS_AQ_6.1
Date:	13/08/2009 Drawing size: A4
Drawn by:	AM Reviewed by: WW
Source:	-
Scale:	Refer to Scale Bar

N

0 100 200 300m

Figure 6.1
Sensitive Receptor Locations

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

6.3 *MODEL INPUT DATA*

The following information was collected for area and volume sources:

- source location coordinates;
- source length, width and height; and
- emission rates.

These are presented in *Table 6.3* and *Table 6.4* below.

Table 6.3 Model Input Data – Area Sources

Area Source	X length (m)	Y length (m)	Initial Vertical Spread (m)	Source Coordinates (SW corner)	Emission Rate ($g/s/m^2$)	
					TSP	PM_{10}
HAULAGE						
Haulage (internal from Cells to processing area and off-site)	Access and internal haul road have been modelled in sections				0.0018	0.00048
QUARRY CELL						
Bulldozer working on overburden	5	5	0	531433, 6797935	0.186	0.046
Excavator loading trucks	5	5	0	531342, 6798049	0.0008	0.00036
Excavator working on material	5	5	0	531462, 6798038	0.0008	0.00036
Wind erosion exposed surfaces	Quarry cell has been modelled as a polygon, initial vertical spread of 2 metres.				0.000011	0.000006
PROCESSING AREA						
Dumping to unprocessed stockpile	2	2	0	531379, 6798240	0.0682	0.0244
Front end loader loading to washing plant	2	2	0	531383, 6798274	0.0051	0.0023
Front end loader loading processed sand to trucks for haulage off-site	2	2	0	531418, 6798286	0.0051	0.0023
Wind erosion – processing area exposed surfaces	Processing area has been modelled as a polygon, initial vertical spread of 2 metres.				0.000011	0.000006

Table 6.4 Model Input Data – Volume Sources

Volume Source	Initial Horizontal Spread (m)	Initial Vertical Spread (m)	Height (m)	Source Coordinates (SW corner)	Emission Rate (g/s)	
					TSP	PM_{10}
Wind erosion – Processing area stockpile	7.5	1	4	531351, 6798242	0.009	0.005
Wind erosion – Cell 1 stockpile	12.5	1.25	5	531510, 6798052	0.026	0.013
Wind erosion – Cell 2 stockpile	12.5	1.25	5	531340, 6798067	0.026	0.013

7 RESULTS

Predicted ground level concentration resulting from the quarry operations are presented in the following sections.

7.1 SHORT TERM (24 HOUR) IMPACTS - PM_{10}

The dispersion modelling assessment uses 'contemporaneous' meteorological and monitoring data – they both cover the period January-December 2004. This allows the (incremental) ground level concentrations predicted by the dispersion model on a given day to be added to the background data recorded at Tamworth on the same day for a cumulative assessment.

The Tamworth monitoring data has two recorded concentrations (50.7 and 55.7µg/m^3) in excess of the NSW assessment criterion of 50µg/m^3. These data have therefore been excluded from this assessment in accordance with NSW DECCW guidelines. The maximum 24 hour PM_{10} concentration (below the NSW criterion) recorded at Tamworth between the January and December 2004 was 42.5 µg/m^3, on the 3rd of November 2004.

The following table (*Table 7.1)* details the predicted ground level concentrations of PM_{10} at each sensitive receptor for the 3rd of November 2004.

Table 7.1 Predicted 100th Percentile Ground Level Concentrations for PM_{10} (24 hour average)

Receptor	Date	Incremental Concentration (µg/m^3)	Background Concentration (µg/m^3)	Cumulative Concentration (µg/m^3)	Criterion (µg/m^3)
1	03/11/04	0.00	42.5	42.5	50
2	03/11/04	0.023	42.5	42.5	50
3	03/11/04	1.39	42.5	43.9	50
4	03/11/04	0.31	42.5	42.8	50

1. Background is recorded at the Tamworth DECCW monitoring station
2. Incremental – ground level concentration from the development in isolation
3. Cumulative – ground level concentrations from the development including background concentrations

Table 7.2 details the highest predicted 24 hour incremental ground level concentrations of PM_{10} for each sensitive receptor with the corresponding background concentration recorded at the Tamworth monitoring station on that day.

Table 7.2 ***Maximum predicted incremental 100th Percentile Ground Level Concentrations for PM_{10} (24 hour average)***

Receptor	Date	Incremental Concentration	Background Concentration	Cumulative Concentration	Criterion
1	14/03/04	4.1	NR	4.1	50 µg/m³
2	30/07/04	23.8	24.9	48.7	50 µg/m³
3	15/03/04	10.3	15.2	25.5	50 µg/m³
4	06/12/04	9.2	9.5	18.7	50 µg/m³

1. Background is recorded at the Tamworth DECCW monitoring station
2. Incremental – ground level concentration from the development in isolation
3. Cumulative – ground level concentrations from the development including background concentrations
4. NR – No background result was recorded on this day

Annex D provides a summary of the cumulative PM_{10} predicted ground level concentrations for the ten highest days of recorded background concentrations, and, in a separate table, the ten highest incremental concentrations for each sensitive receptor.

7.2 *LONG TERM (ANNUAL) IMPACTS – PM_{10} AND TSP*

Table 7.3 below shows the incremental (Project Area only) and cumulative (Project Area + background) concentrations for pollutants which are assessed against an annual averaging period in accordance with the NSW DECCW guidelines.

Table 7.3 Annual Average Dispersion Modelling Pollutant Concentration and Deposition Rates, at Sensitive Receptors

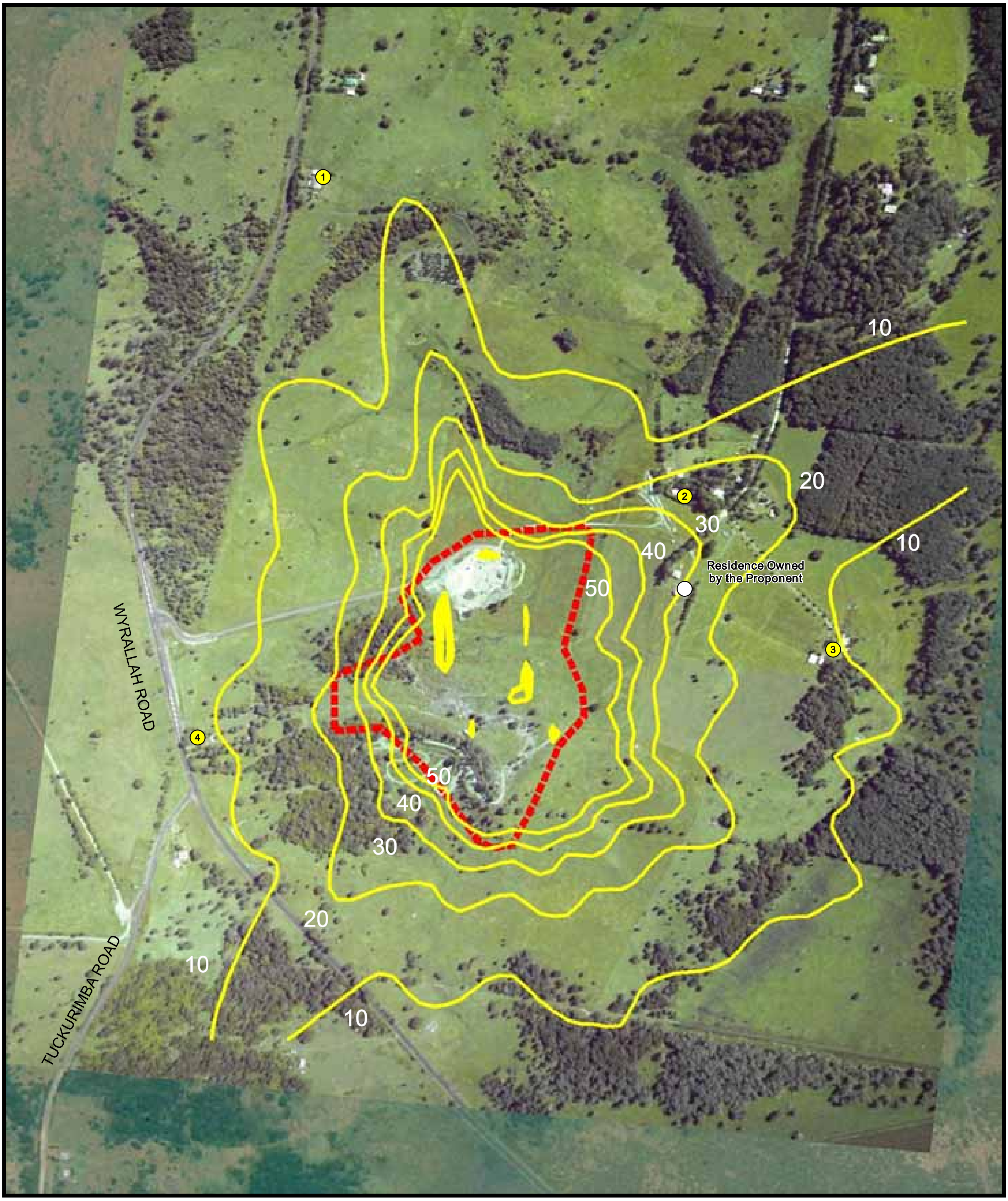
Receptor	**PM_{10} Incremental**	**PM_{10} Cumulative (incremental +background – 20.7)**	**TSP Incremental**	**TSP Cumulative (incremental + background – 52.9)**	**Dust Deposition Incremental**
	µg/m³	**µg/m³**	**µg/m³**	**µg/m³**	**g/m²/month**
Receptor 1	0.36	21.06	1.53	54.43	0.029
Receptor 2	1.55	22.25	7.69	60.59	0.128
Receptor 3	1.75	22.45	8.88	61.78	0.126
Receptor 4	1.20	21.90	4.74	57.64	0.128
Criteria	**-**	**30**	**-**	**90**	**2.0**

1. Increment – Concentration resulting from quarry activities at a modelled sensitive receptors
2. Cumulative – Concentration resulting from quarry activities plus ambient background concentration

7.3 *RESULTS SUMMARY*

The results presented in *Table 7.1 - Table 7.3* show that the predicted impact of increased throughput at the proposed development are below the NSW DECCW nominated criteria.

In addition, the concentration contours presented in *Figure 7.1 - Figure 7.3* below show that the predicted concentrations are localised around the Project Area and decrease rapidly with distance from the Project Area.



Legend

- Sensitive Receptor Location
- PM10 24hour contours
- Extent of Quarry Extraction and Operations (Project Area)

Client:	Champions Quarry
Project:	Champions Quarry Expansion
Drawing No:	0098287pm_GIS_AQ_7.1
Date:	13/08/2009 — Drawing size: A4
Drawn by:	AM — Reviewed by: WW
Source:	Dept of Lands
Scale:	Refer to Scale Bar

N

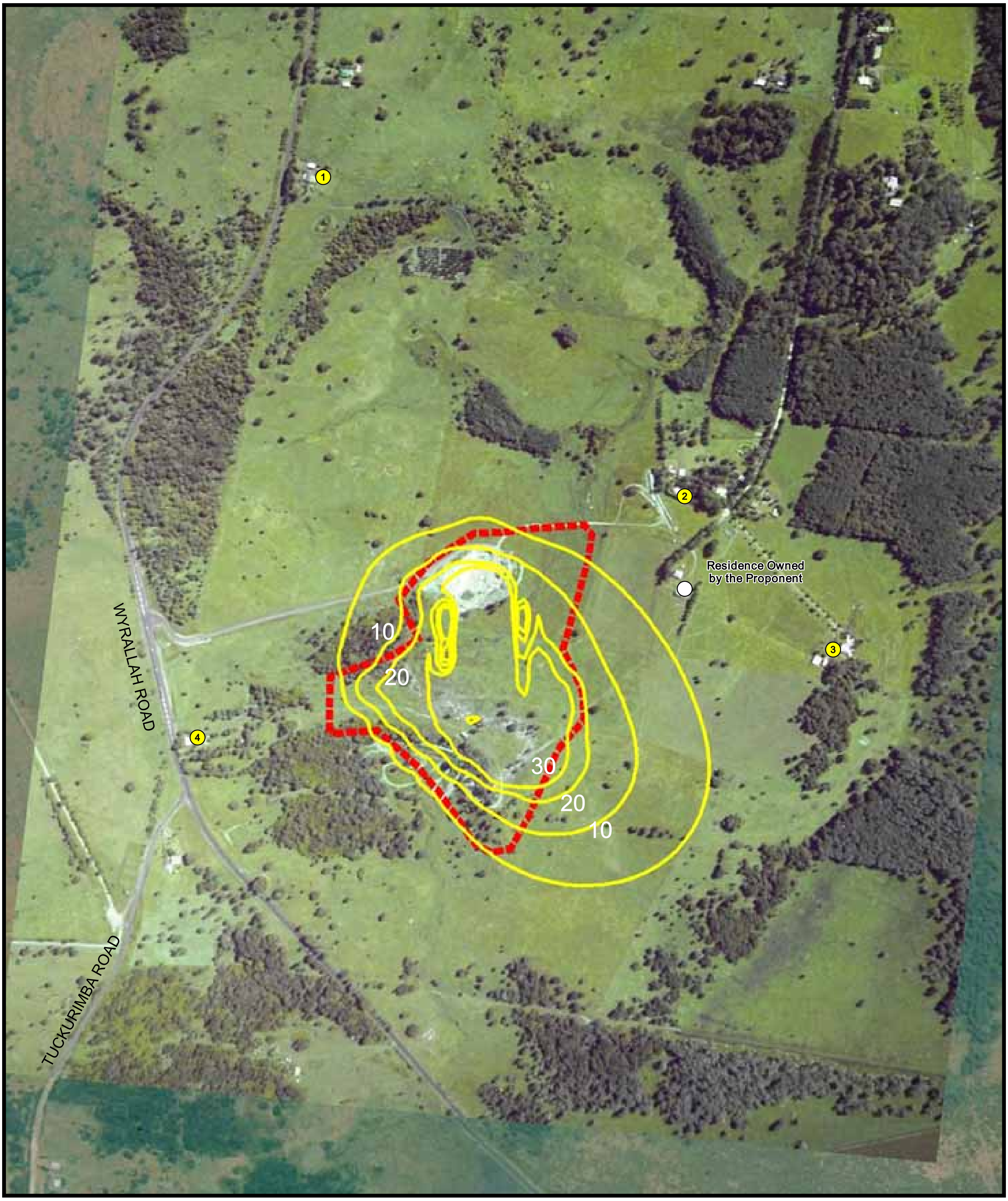
0 100 200 300m

Figure 7.1

PM10 24 hour average incremental concentrations

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM



Legend

Sensitive Receptor Location

PM10 annual contours

Extent of Quarry Extraction and Operations (Project Area)

Client:	Champions Quarry
Project:	Champions Quarry Expansion
Drawing No:	0098287pm_GIS_AQ_7.2
Date:	13/08/2009 — Drawing size: A4
Drawn by:	AM — Reviewed by: WW
Source:	-
Scale:	Refer to Scale Bar

N

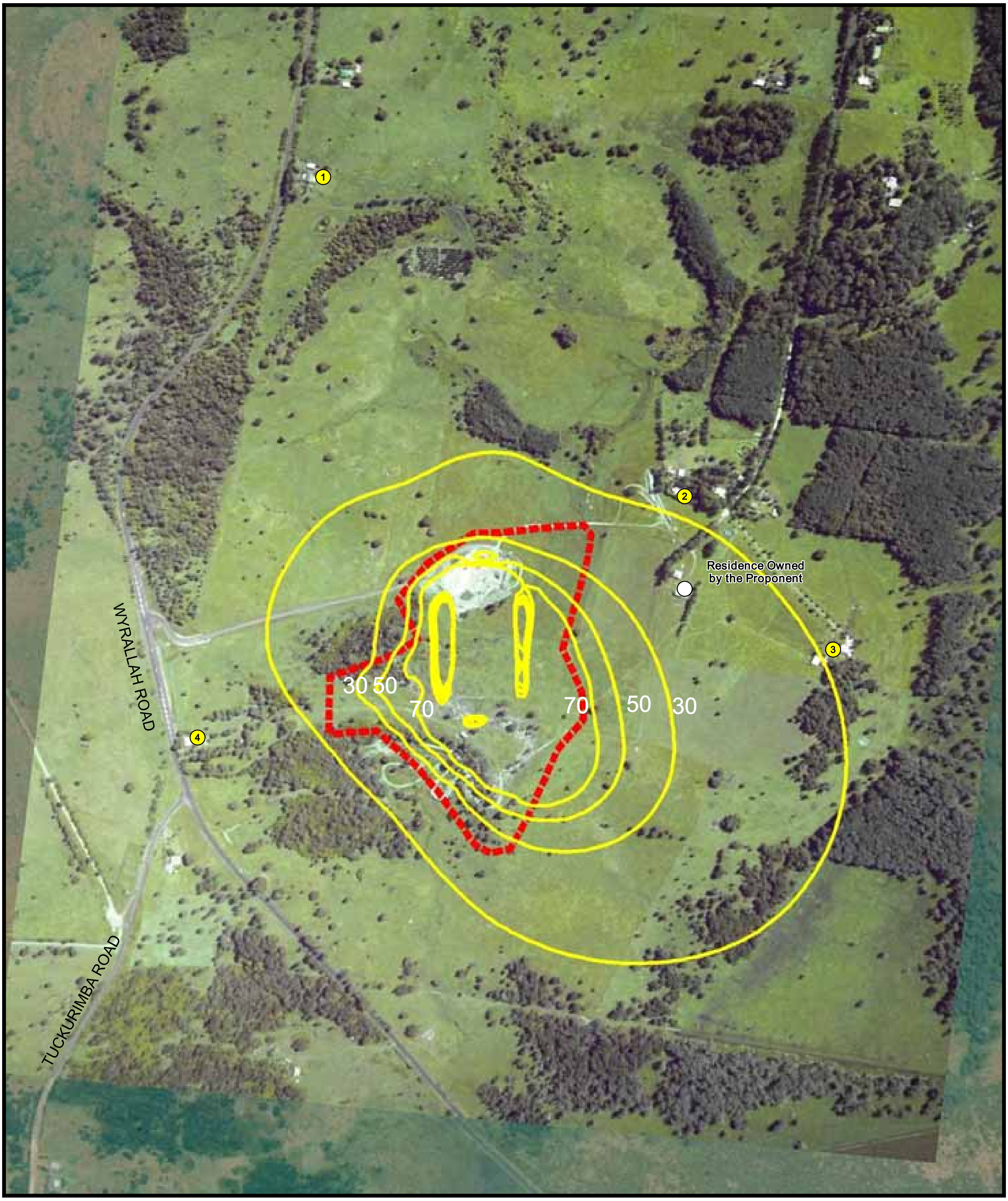
0 100 200 300m

Figure 7.2

PM10 annual average incremental concentrations

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM



Legend

Sensitive Receptor Location

TSP annual contours

Extent of Quarry Extraction and Operations (Project Area)

Client:	Champions Quarry		
Project:	Champions Quarry Expansion		
Drawing No:	0098287pm_GIS_AQ_7.3		
Date:	13/08/2009	Drawing size:	A4
Drawn by:	AM	Reviewed by:	WW
Source:	-		
Scale:	Refer to Scale Bar		

N

0 100 200 300m

Figure 7.3

TSP annual average incremental concentrations

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

8 DISCUSSION & CONCLUSIONS

8.1 SUMMARY OF RESULTS

8.1.1 Overview

Table 8.1 presents a summary of the maximum predicted incremental ground level concentrations for the modelled receptor where highest concentrations were recorded.

Table 8.1 Maximum Incremental Ground Level Concentrations

Pollutant[2]	Maximum Increment[1]	Background[4]	Cumulative	Criteria[3]	% of Criteria
PM_{10} – 24 hour ($\mu g/m^3$)	23.8	24.9	48.7	50	97.4%
PM_{10} – 24 hour ($\mu g/m^3$)[5]	1.39	42.5	43.9	50	87.8%
PM_{10} – Annual ($\mu g/m^3$)	1.75	20.7	22.45	30	74.8%
TSP – Annual ($\mu g/m^3$)	8.88	52.9	61.78	90	68.6%
Dust Deposition – Annual ($g/m^2/month$)	0.128	N/A	N/A	2	6.4%

1. Maximum increment has been estimated based on dispersion modelling.
2. Modelling results are presented for the receptors identified as experiencing the highest levels of each contaminant.
3. Criteria are sourced from DECCW (2005) *"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW"*
4. Background data derived from the DECCW Tamworth TEOM monitoring data
5. Predicted concentration on day of maximum background (contemporaneous data presented in *Table 7.1)*

8.1.2 Results Summary

Total Suspended Particulates (TSP) – Long term (annual) average

The predicted ground level concentrations of TSP (annual average) comply with the NSW assessment criterion of 90 $\mu g/m^3$ at existing sensitive receptors.

The maximum predicted incremental TSP concentration was 8.88 $\mu g/m^3$. The background level derived from monitoring data at Tamworth for 2004 was 52.9 $\mu g/m^3$, and the cumulative impact of 61.78 $\mu g/m^3$ represents 68.6% of the criteria.

Particulate Matter less than 10 micron (PM_{10}) – Short term (24 hour) average

The predicted ground level concentrations of PM_{10} (24 hour average) comply with the NSW assessment criterion of 50 $\mu g/m^3$ at existing sensitive receptors.

The PM_{10} cumulative assessment uses monitoring data from Tamworth which is contemporaneous with the meteorological data used in the dispersion modelling. The Tamworth monitoring data has two recorded concentrations (50.7 and 55.7µg/m^3) in excess of the NSW assessment criterion of 50µg/m^3. These data have therefore been excluded from this assessment in accordance with NSW DECCW guidelines.

The Tamworth monitoring data, in the absence of data recorded at Lismore, is anticipated to represent elevated concentrations of particulate matter due to the proximity of rural, industrial and transport sources. The use of this data is therefore considered a 'high' background PM_{10} concentration.

The highest background recorded at Tamworth was 42.5 µg/m^3, and the increment predicted by the modelling on that day was 1.39 µg/m^3 (at *Receptor 3*), giving a cumulative impact of 43.9 µg/m^3, representing 87.8% of the criteria.

The highest predicted incremental concentration was 23.8 µg/m^3 predicted at *Receptor 2*. The background data recorded at Tamworth on that day was 24.9 µg/m^3, and the cumulative impact of 48.7 µg/m^3 represents 97.4% of the criteria.

The highest incremental concentration predicted by the model was based on inclusion of the following activities all occurring simultaneously:

- bulldozer working on overburden – 8 hours/day;
- excavator working on material – 900 tonnes/day;
- excavator loading haul trucks – 900 tonnes/day;
- dumping to stockpile (processing area) – 900 tonnes/day;
- loading the washing plant – 900 tonnes/day;
- FEL loading to trucks – 900 tonnes/day;
- wind erosion from:
    - exposed areas;
    - product stockpiles; and
- On-site haulage.

It is unlikely that these activities will all occur simultaneously; as such the results presented represent a worst case scenario. It is also noted that the above activities list assume that all materials are to be processed before leaving the Project Area. As previously discussed only approximately 30% is to be processed, hence the modelling is considered conservative.

In addition, the second highest predicted concentration at *Receptor 2* was 9.82 μg/m³, the background data recorded on that day was 30.3 μg/m³ and the cumulative impact of 40.1 μg/m³ represents 80.2% of the criteria.

Particulate Matter Less Than 10 Micron (PM_{10}) – Long term (annual) average

The maximum predicted incremental PM_{10} (annual average) concentration was 1.75 μg/m³ at *Receptor 2*. The average background recorded at Tamworth for 2004 was 20.7 μg/m³, and the cumulative impact of 22.45 μg/m³ represents 74.8% of the criteria.

Dust Deposition

The predicted incremental ground level dust deposition rates comply with the NSW assessment criterion of an increment of 2g/m²/month at modelled sensitive receptors. The maximum predicted increment was 0.13 g/m²/month, which represents 6.4% of the incremental criteria. Dispersion modelling of dust deposition has included atmospheric dry depletion.

A cumulative assessment was not undertaken for dust deposition due to lack of available background levels of dust deposition. However, the Project Area contributions are low in comparison to the incremental deposition criterion of 2 g/m²/month, and hence would not be anticipated to exceed the cumulative criterion of 4 g/m²/month if background levels were included in this assessment.

8.2 MANAGEMENT AND MITIGATION

A number of management measures are already in place and proposed as part of the expansion of operations to reduce the generation of particulate emissions. These measures are outlined below:

Nature of the Material

The sandstone being extracted is 'soft sandstone' and therefore its inherent properties reduce potential for dust emissions to atmosphere compared to other extracted materials. It is high in moisture (estimated at 8%), and low in silt (1%).

Watering Of Haul Roads

The main quarry access road is to be sealed prior to commencement of expanded quarry operations and is not anticipated to be a significant source of dust emissions. Within the Project Area there is a haulage road which connects the *Southern Section* with the *Central Section*, and with the main quarry access road. This haul route will be initially laid with gravel on top of a sandstone roadbase during Project start-up. This road base will have a higher moisture content and a lower silt content than a standard dirt road. In addition a water tanker will be used to maintain a watering rate of 1-2 $l/m^2/minute$. The section of road between the *Southern Section* and the main quarry access is to ultimately be sealed (within 12 months of start-up).

Management of Exposed Areas

Exposed areas will consist of a quarry area up to an assumed maximum of 8 hectares in area (allowing for staged rehabilitation and stabilisation for the 9 hectares of 'work cells'), and the *Central* processing area (~1.5 hectares). These constitute a absolute maximum – and this has formed the basis of the modelling assessment. Quarry operations will aim to minimise and stabilise exposed areas.

In addition overburden and top soil will be used to develop bunds around the cells providing a 'wind shield' for parts of the exposed cell.

The overburden used to create bunds will be vegetated to minimise dust emissions and will be retained for future rehabilitation of the Project Area. Remaining excess topsoil and overburden will be sold.

Storage Areas

Storage bays in the processing area will be used to store processed material and aggregate.

Off-site Transport

Current practice requires all road trucks to have covers in place prior to leaving the Project Area.

8.3 *CONCLUSIONS*

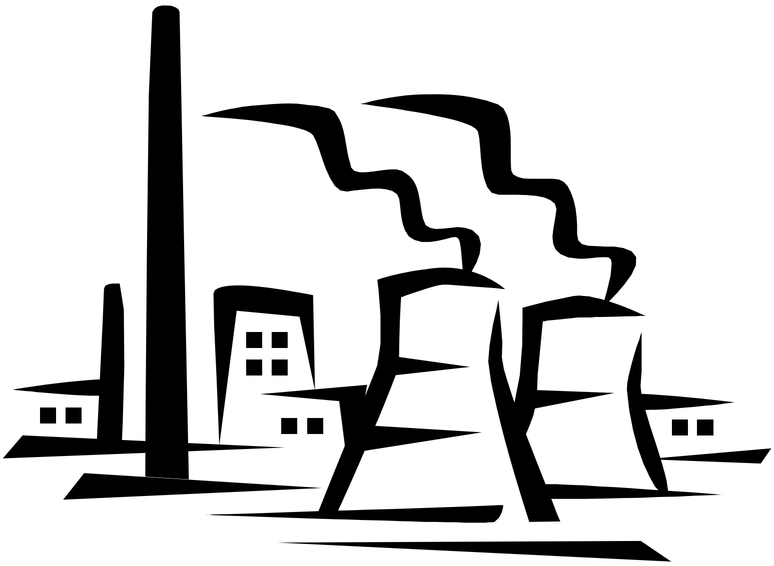
This air quality assessment of the proposed expansion of the sandstone quarry highlights that the proposed operations as conservatively modelled would meet the NSW DECCW air quality impact criteria for PM_{10} and TSP short and long term averages and dust deposition.

Annex A

Meteorological File Development

Report
On

AUSPLUME
input Meteorological data file



Exclusively Prepared for

ERM Australia Pty Ltd

By

pDs MultiMedia and Consultancy service

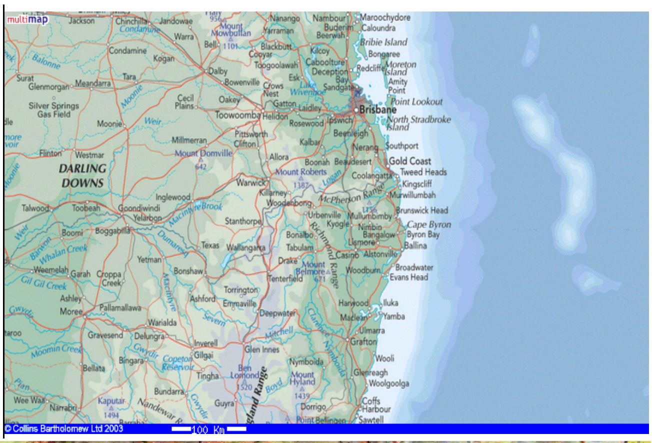
metfile@tpg.com.au

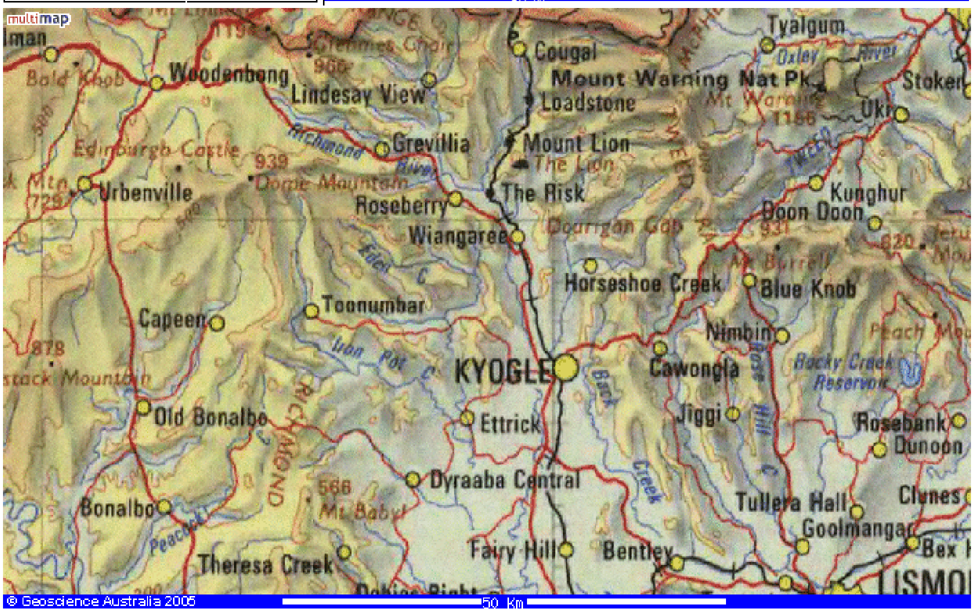
AUSPLUME input Meteorological Data File for AUSPLUME

(Victoria, Regulatory Pollution Dispersion Model)

Casino (for Kyogle)-New South Wales

STATE:	NSW
LATITUDE:	-28.88º
LONGITUDE:	153.05º
EASTING:	505000
NORTHING:	6805000





pDs Consultancy

metfile@tpg.com.au

Data Source

1. Casino AWS Data- Bureau of Meteorology New South Walses Regional Office.
2. Brisbane Cloud data and Vertical temperature Profiles –National Climate Centre-Bureau of Meteorology, Melbourne.

Land use category: mixed **Urban**
Surface Roughness: **0.3 m**
Anemometer Height **:10m**

Input Information

- Onsite (**Casino**) parameters

  a. Wind speed (m/s)
  b. Wind direction
  c. Ambient Temperature (C)
  d. Dew point
  e. Surface Pressure

  Wind was measured at 10m (Anemometer Height)

Offsite (**Brisbane**)

  f. Cloud cover (Total amount)
  a. Vertical temperature profiles; Temperature, Dewpoint (2 profiles per day)

DATA HANDLING

QA/QC on Bureau of Meteorology Raw data

Casino AWS

- Incomplete days removed
- Suspected wind stalls (both wind direction and speed) removed
- Small gaps filled with previous or following data
- Wind direction found to be stored to the nearest 10 degrees
    - Last digit of Wind Direction randomised (± 5)
- Wind Speed converted to m/s from km/hr.
- Temperature, Surface Pressure and Dewpoint were checked for unusual values

Brisbane Vertical Temperature Profiles

- Gaps in vertical temperature profiles (twice daily) were filled with previous or following day data for the completeness.

100% data recovered for 2004.

Important Notes:

1. Sensitivity of Anemometers (not known) may not be up to air quality standard.
2. Zero wind speed is allowed, which may not be acceptable to older versions of *AUSPLUME.*

Standard Analysis

Data Coverage

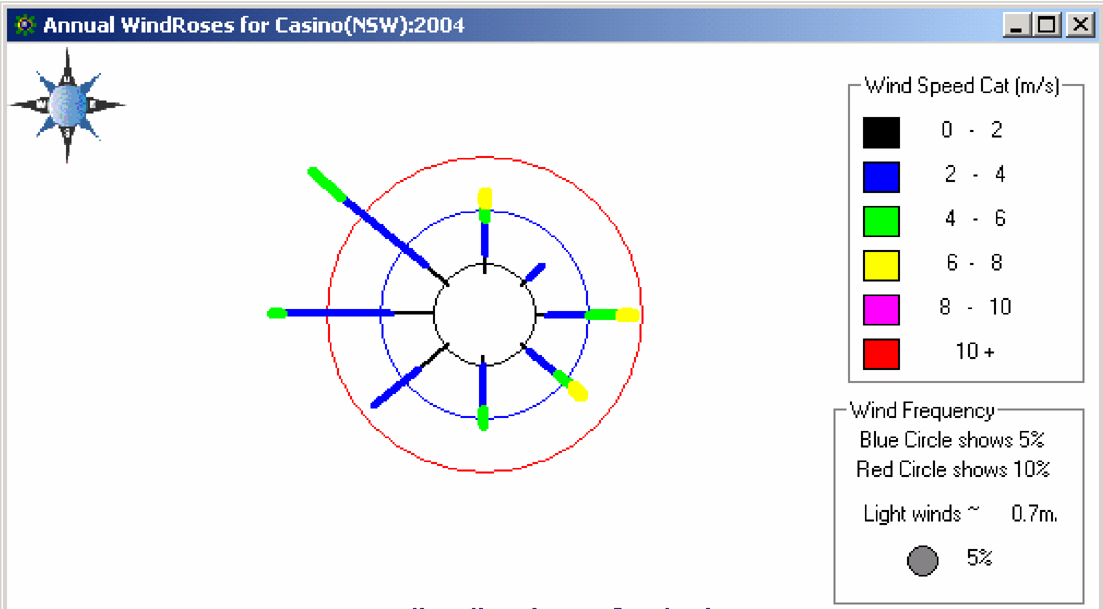
Summer	:90	days
Autumn	:92	
Winter	:92	
Spring	:91	
Number of days covered :365	% Coverage :99.7%	

All 4 seasons are well represented.

Stability Distribution

Stability Category	% Distribution	Avg Wind Speed	Avg Temperature	Avg Mixing Height
A	2 %	1.7	24.9	1060
B	10 %	2.9	23.7	1169
C	14 %	3.7	22.8	1179
D	32 %	4.3	20.5	1137
E	15 %	3.1	17.5	811
F	27 %	1.7	14.5	476

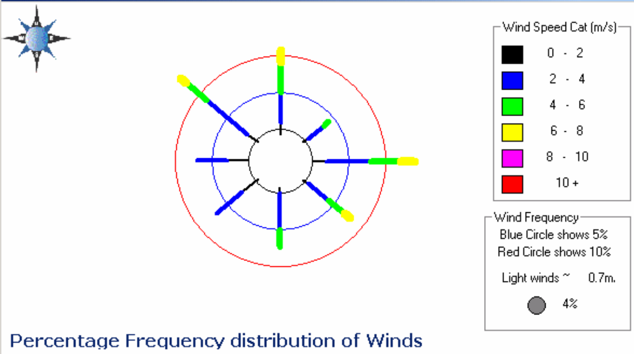
Annual Wind Roses for Casino



Percentage Frequency distribution of Winds

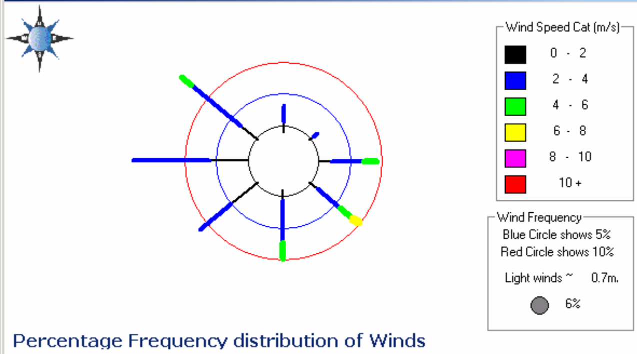
Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.2	1.7	1.7	1.9	4.4	4.8	3.9	2.3	22%
2 - 4	2.8	4.7	4.3	5.9	6.4	10.9	11.2	4.7	51%
4 - 6	0.8	3.0	2.7	2.6	0.7	1.5	4.6	2.9	19%
6 - 8	0.3	1.5	1.2	0.3	0.2	0.8	1.0	1.1	6%
8 - 10	0.0	0.2	0.3	0.0	0.1	0.5	0.1	0.3	2%
10 +	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	%
Total Dir Freq	5%	11%	10%	11%	12%	19%	21%	11%	

Seasonal Wind Roses



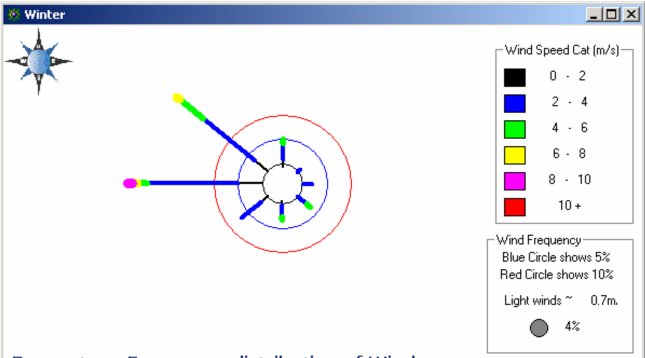
Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.5	2.1	1.9	1.6	3.2	3.7	2.5	2.1	19%
2 - 4	3.7	6.9	4.4	6.7	5.8	4.4	8.7	5.3	46%
4 - 6	1.6	4.5	3.3	3.4	0.4	0.9	4.4	5.3	24%
6 - 8	0.3	2.6	2.0	0.5	0.2	0.6	1.2	2.3	10%
8 - 10	0.0	0.4	0.4	0.0	0.0	0.3	0.2	0.5	2%
10 +	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	%
Total Dir Freq	7%	17%	12%	12%	10%	10%	17%	16%	



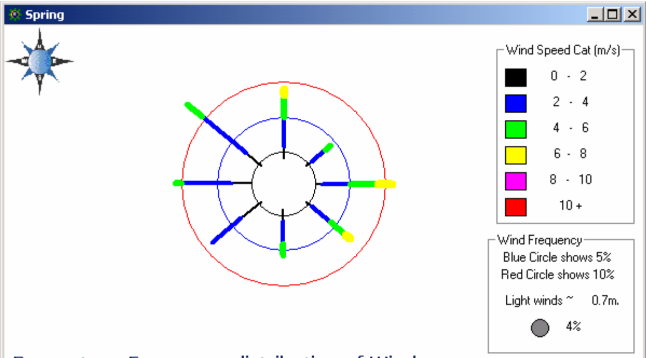
Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.0	2.1	2.1	2.4	6.4	6.6	4.8	2.5	28%
2 - 4	1.6	5.1	5.2	8.2	7.1	12.0	11.2	3.4	54%
4 - 6	0.2	2.6	3.4	3.4	0.6	0.9	2.9	0.6	14%
6 - 8	0.0	0.5	1.6	0.1	0.0	0.2	0.2	0.2	3%
8 - 10	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.1	1%
10 +	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	%
Total Dir Freq	3%	11%	13%	14%	14%	20%	19%	7%	



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.0	1.0	1.0	1.3	2.9	5.5	4.9	2.1	20%
2 - 4	2.0	2.7	3.1	3.7	6.4	19.4	15.0	4.2	56%
4 - 6	0.1	0.9	1.1	1.7	1.0	2.5	7.2	1.8	16%
6 - 8	0.0	0.1	0.0	0.2	0.5	1.5	1.6	0.6	5%
8 - 10	0.0	0.0	0.0	0.0	0.1	1.3	0.3	0.4	2%
10 +	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1%
Total Dir Freq	3%	5%	5%	7%	11%	31%	29%	9%	



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.2	1.4	2.0	2.2	4.8	3.5	3.2	2.3	21%
2 - 4	4.0	4.3	4.7	4.9	6.2	7.6	9.9	5.8	47%
4 - 6	1.5	4.2	3.1	2.1	0.8	1.6	3.8	4.2	21%
6 - 8	0.8	2.9	1.2	0.2	0.1	0.9	1.0	1.4	8%
8 - 10	0.0	0.4	0.6	0.0	0.0	0.4	0.1	0.3	2%
10 +	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	%
Total Dir Freq	7%	13%	12%	10%	12%	14%	18%	14%	

Secondary parameters

Vertical Stability

Solar Radiation for day time and Modified Pasquill Stability Class outlined in the reference, Davis and Singh, Jl of Hazardous Materials, 11 was used to determine night-time stability class. Solar radiation was theoretically calculated using off site cloud observations.

Table 1 for daytime and part of Table 2 for night-time were used.

Table 1: Stability Classification for Daytime Using Solar Radiation and Wind Speed

	Solar Radiation (W/m^2)			
Wind Speed(m/s)	≥925	≥675	≥175	< 175
< 2	A	A	B	D
< 3	A	B	C	D
< 5	B	B	C	D
< 6	C	C	D	D
≥ 6	C	D	D	D

Table 2: Modified Pasquill stability calsses

Surface Wind Speed m/s at 10m	**Daytime incoming solar radiation**				**Within 1 h before sunset or after sunrise**	**Night-time cloud amount(Oktas)**		
	Strong (>600)	Moderate (300-600)	Slight (<300)	Overcast		0-3	4-7	8
≤ 2	A	A-B	B	C	D	F	F	D
≤ 3	A-B	B	C	C	D	F	E	D
≤ 5	B	B-C	C	C	D	E	D	D
≤ 6	C	C-D	D	D	D	D	D	D
> 6	C	D	D	D	D	D	D	D

Mixing height

Definition:

The mixing height, the depth of the surface mixed layer is the height of the atmosphere above the ground, which is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable.

The mixing height was determined by using the methodology of Benkley and Schulman (Journal of Applied Meteorology, Volume 18, 1979,pp 772-780). **Brisbane** upper air observation containing temperature and moisture profiles were used to determine daytime mixing height.

Surface wind speeds and roughness are used to calculate the depth of the mechanically forced boundary layer during the night time

$MixH_m$=0.185* Ustar/Cterm

Where Ustar=.35*Usfc/Ln (Ht_{anemo}/Z_0)

Cterm = Coriolis Term =2 Ω Sin(ϕ)

Where Ω is the angular velocity of the earth
ϕ is the latitude

Ht_{anemo}= Anemometer Height, Z_0 is the roughness

Height of the convective boundary layer was determined using daytime temperature sounding (Vertical temperature and dewpoint profiles) in between sunrise and sunset. Evening or nighttime sounding for the same day is used to compensate daytime sounding to calculate convective mixing height at different daylight hours (Temperature difference at 700 hPa layer is used to allow advection). Larger value of the mechanical turbulence or convective turbulence was taken as Mixing height for the daylight hours.

Statistics of Casino (NSW) input Meteorological data file-2004

Stability	Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
A	Max of Temp	33.0	33.0	33.0	25.0	24.0		18.0	25.0	31.0	35.0	34.0	32.0	35.0
	Min of Temp	25.0	22.0	19.0	19.0	17.0		15.0	14.0	15.0	17.0	19.0	18.0	14.0
	Average of Temp	28.5	27.8	25.9	23.2	20.8		16.3	19.8	22.0	25.4	25.5	25.5	24.9
	Max of WS	2.5	2.5	2.5	1.4	1.4		1.4	1.4	2.5	2.5	2.5	2.5	2.5
	Min of WS	0.6	0.6	0.6	0.6	1.1		1.4	0.6	0.6	0.6	1.1	0.6	0.6
	Average of WS	1.8	1.7	1.7	1.3	1.3		1.4	1.2	1.7	2.0	1.9	1.9	1.7
	Max of MixH	1765	1874	1692	1886	767		1665	2582	2428	2163	2245	2009	2582
	Min of MixH	365	263	276	491	401		473	548	542	283	276	417	263
	Average of MixH	1006	1133	936	916	504		927	1239	1450	1171	1147	805	1060
B	Max of Temp	34.0	41.0	34.0	31.0	24.0	22.0	23.0	29.0	30.0	37.0	35.0	34.0	41.0
	Min of Temp	23.0	21.0	19.0	18.0	13.0	13.0	11.0	12.0	11.0	16.0	19.0	18.0	11.0
	Average of Temp	28.6	29.2	25.1	23.4	19.6	18.2	17.4	19.4	21.0	24.3	26.3	25.7	23.7
	Max of WS	4.7	4.7	4.7	4.7	4.7	4.2	4.2	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.1	0.6	0.6	0.6	1.1	0.6
	Average of WS	3.2	3.2	3.0	2.6	2.3	1.6	2.2	3.1	2.9	3.3	3.4	3.2	2.9
	Max of MixH	2117	2696	1889	2651	1189	1216	1382	2622	2691	2960	2618	2505	2960
	Min of MixH	309	223	263	210	368	401	263	579	448	315	394	309	210
	Average of MixH	1189	1371	1093	1065	720	727	806	1206	1336	1361	1384	1136	1169
C	Max of Temp	40.0	42.0	35.0	31.0	26.0	26.0	26.0	29.0	32.0	36.0	37.0	37.0	42.0
	Min of Temp	21.0	17.0	18.0	16.0	10.0	8.0	9.0	8.0	12.0	14.0	18.0	18.0	8.0
	Average of Temp	28.4	29.0	25.1	22.6	18.9	17.5	17.7	17.3	22.0	23.4	24.4	25.3	22.8
	Max of WS	9.2	7.8	8.3	5.8	5.0	5.8	5.8	5.8	9.2	11.7	7.2	10.3	11.7
	Min of WS	1.4	1.1	2.2	1.4	0.6	2.2	2.2	2.2	1.4	0.6	1.1	0.6	0.6
	Average of WS	4.3	3.7	4.0	3.2	2.8	3.1	3.4	3.6	3.6	4.2	4.2	4.2	3.7
	Max of MixH	2640	2648	1931	2215	1748	1657	2967	2343	2842	2852	2614	2446	2967
	Min of MixH	420	289	525	420	191	420	506	564	420	283	506	263	191
	Average of MixH	1348	1279	1232	1073	815	872	1026	1195	1531	1392	1343	1205	1179
D	Max of Temp	41.0	41.0	34.0	31.0	25.0	26.0	27.0	29.0	31.0	36.0	37.0	37.0	41.0
	Min of Temp	17.0	15.0	15.0	13.0	2.0	0.0	0.0	1.0	2.0	8.0	13.0	14.0	0.0
	Average of Temp	25.7	24.3	22.2	20.4	15.1	14.9	14.9	16.8	17.8	20.4	22.6	22.7	20.5
	Max of WS	9.2	9.7	12.8	7.8	7.2	9.2	9.2	14.4	10.8	11.4	12.2	9.7	14.4
	Min of WS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average of WS	4.5	4.0	4.5	3.3	2.8	3.9	4.0	5.6	4.2	4.9	4.3	4.1	4.3
	Max of MixH	2747	2356	3068	2120	1662	2280	2539	3357	2700	2662	2765	2523	3357
	Min of MixH	191	200	158	158	158	158	263	158	256	200	200	223	158
	Average of MixH	1208	1073	1163	902	728	1022	1073	1498	1173	1281	1167	1082	1137
E	Max of Temp	33.0	33.0	28.0	27.0	24.0	25.0	24.0	29.0	30.0	33.0	30.0	33.0	33.0
	Min of Temp	18.0	16.0	17.0	14.0	1.0	1.0	2.0	0.0	2.0	10.0	13.0	16.0	0.0
	Average of Temp	22.9	24.1	21.4	19.9	13.1	12.2	12.3	13.3	16.7	19.4	20.4	21.8	17.5
	Max of WS	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2

	Average of WS	2.8	3.0	2.9	3.1	2.9	3.3	3.1	3.6	3.4	3.3	3.3	3.0	3.1
	Max of MixH	1261	1327	1321	1235	1222	1458	1439	1458	1458	1366	1366	1294	1458
	Min of MixH	420	401	420	453	453	453	368	473	420	420	473	473	368
	Average of MixH	731	778	763	783	729	837	784	924	873	861	859	804	811
F	Max of Temp	31.0	39.0	30.0	30.0	24.0	23.0	22.0	27.0	25.0	29.0	28.0	30.0	39.0
	Min of Temp	14.0	15.0	15.0	12.0	3.0	-1.0	1.0	1.0	3.0	9.0	10.0	11.0	-1.0
	Average of Temp	20.5	21.8	19.7	18.2	12.9	10.0	9.2	9.7	12.1	16.0	17.0	19.1	14.5
	Max of WS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Min of WS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average of WS	1.4	1.7	1.6	1.6	1.7	1.8	1.7	2.0	1.8	1.6	1.6	1.4	1.7
	Max of MixH	966	861	802	821	913	841	1005	913	946	874	854	933	1005
	Min of MixH	158	158	158	158	158	158	158	158	158	158	158	158	158
	Average of MixH	427	488	453	431	468	511	483	555	503	469	441	403	476

Bibliography

Benkley, C.W,& Schulman L.L 1979 :Estimating Hourly Mixing Depths from Historical Meteorological Data :Jl of Applied Meteorology Vol 1 page 772-780

Dewundege, P.,2002, Comparison of Some Feasible Schemes For Atmospheric Stability Determination: A Case Study. *Proceedings of the 15th International Clean Air and Environment Conference, Christchurch, NZ, 2002*, Clean Air Society of Australia & New Zealand

Lorimer, G.S and Godfrey, J.J 1998, Plume Models: Techniques for better usage. *Proceedings of the 13th International Clean Air and Environment Conference, Adelaide, 1996*, Clean Air Society of Australia & New Zealand, pp 507-512

Mohan, M and Siddiqi, T. A. 1998, Analysis of various schemes for the estimation of atmospheric stability classification*. Atmospheric Environment **Vol 32**, No. 21, pp. 3775-3781*

Turner, D.B. 1970, Workbook of atmospheric dispersion estimates, Office of Air Program Pub. No. AP-26, EPA,USA

USEPA, 2000, *Meteorological Monitoring Guidance for Regulatory Modelling Applications*, EPA-450/R-99-005. United States Environmental Protection Agency, Washington DC, USA.

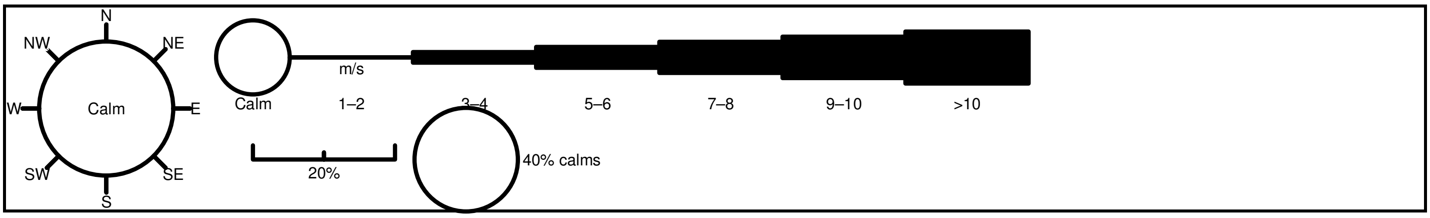
Annex B

Windroses

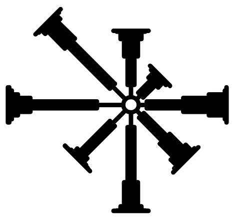
Wind Roses using data between Jan 1995 and Aug 2006 for

Casino Airport AWS

Site Number 058208 • Locality: Casino • Opened Dec 1994 • Still Open • Latitude 28°52'39"S • Longitude 153°03'07"E • Elevation 20.9m



All times 32481 observations



Australian Government
Bureau of Meteorology

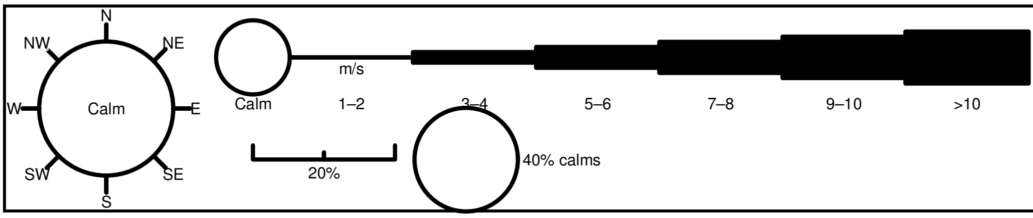
Prepared by the Bureau of Meteorology's Tasmania and Antarctica Climate Services Centre. Contact us by phone on (03) 6221 2043, by fax on (03) 6221 2045, or by email on climate.tas@bom.gov.au

 Prepared on 28 August 2006

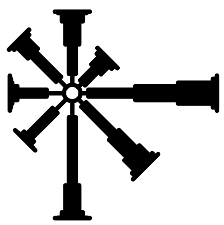
Wind Roses using data between Jan 1995 and Aug 2006 for

Casino Airport AWS

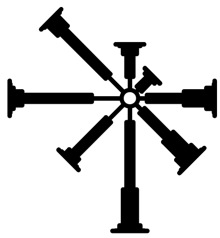
Site Number 058208 • Locality: Casino • Opened Dec 1994 • Still Open • Latitude 28°52'39"S • Longitude 153°03'07"E • Elevation 20.9m



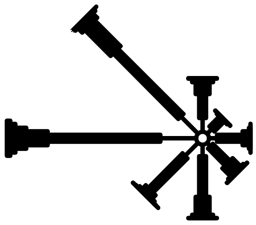
Summer 8045 observations



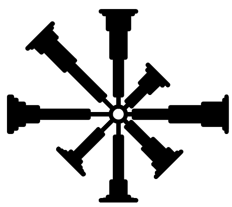
Autumn 8230 observations



Winter 8532 observations



Spring 7674 observations



Australian Government
Bureau of Meteorology

Prepared by the Bureau of Meteorology's Tasmania and Antarctica Climate Services Centre. Contact us by phone on (03) 6221 2043, by fax on (03) 6221 2045, or by email on climate.tas@bom.gov.au
 Prepared on 28 August 2006

Annex C

Emission Estimates

Table C.1 Emissions Estimation

Activity	Emissions Factor	Load	Reduction Factor	Area (m^2)	Operating Hours	Emissions		Units
						TSP	PM10	
HAULAGE								
Internal haulage from main extraction cell to the processing area and/or off-site.	Haulage (assumes unsealed roads)	**26.4 VKT/day** **Basis** – 900 tonnes/day transported, 15 tonne truck capacity, therefore 60 loads to processing area or off-site. Haulage distance (return) ~0.44km. 60 trips by 0.44km is 26.4 VKT	N/A	**1,100** 220m road approx 5m wide	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.0018	0.00048	g/sec/m^2
QUARRY CELL								
Bulldozer working on overburden	Bulldozer on overburden	8 hours /day	N/A	**25** 5 x 5m working area over an hour	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.186	0.046	g/sec/m^2
Excavator working on material	FEL / excavator	900 t/day	N/A	**25** 5 x 5m working area over an hour	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.0008	0.00036	g/sec/m^2
Excavator loader loading haul trucks	FEL / excavator	900 t/day	N/A	**25** 5 x 5m working area over an hour	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.0008	0.00036	g/sec/m^2
Wind erosion – Main extraction cell, exposed surfaces	Wind erosion	Up to a maximum of 8 hectares of exposed surface allowing for staged rehabilitation of 'work cells'	N/A	**90,000**	Hours above 5.14 m/s	0.000011	0.000006	g/sec/m^2
PROCESSING								
Dumping to unprocessed stockpile	Truck dumping	900 t/day	N/A	**4** 2 x 2m working area	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.0682	0.0244	g/sec/m^2
Front end loader loading to washing & processing plant	FEL / excavator	900 t/day	N/A	**4** 2 x 2m working area	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.0051	0.0023	g/sec/m^2
Front end loader loading processed sand to trucks	FEL / excavator	900 t/day	N/A	**4** 2 x 2m working area	11 hrs/day (Mon – Fri) & 7hrs/day (Sat)	0.0051	0.0023	g/sec/m^2

Activity	Emissions Factor	Load	Reduction Factor	Area (m^2)	Operating Hours	Emissions		Units
						TSP	PM10	
for haulage off-site								
Wind erosion – processing area exposed surfaces	Wind erosion	Approximately 1.5 hectares of exposed surface	N/A	**15,000**	Hours above 5.14 m/s	0.000011	0.000006	g/sec/m^2
STOCKPILES								
Wind erosion – Stockpile within extraction pit	Wind erosion	17,500 t unprocessed material stockpile Maximum area of 0.234 hectares and a height of 5m	N/A	**2,340**	Hours above 5.14 m/s	0.026	0.013	g/sec
Wind erosion – Stockpile within extraction pit	Wind erosion	17,500 t unprocessed material stockpile Maximum area of 0.234 hectares and a height of 5m	N/A	**2,340**	Hours above 5.14 m/s	0.026	0.013	g/sec
Wind erosion – unprocessed stockpile	Wind erosion	5,000 t unprocessed material stockpile Maximum area of 0.84 hectares and a height of 5m	N/A	**840**	Hours above 5.14 m/s	0.009	0.005	g/sec

1. VKT = vehicle kilometres travelled
2. t/yr = tonnes per year
3. Reduction factors based on recommendations in the NPI mining emissions estimation manual

Annex D

PM_{10} 24 Hour Contemporaneous Assessment

Summary of dispersion model results for PM_{10} at sensitive receptors

Top 10 Background days				Top 10 Increment days			
Date	24-hour average PM_{10} ($\mu g/m^3$)			Date	24-hour average PM_{10} ($\mu g/m^3$)		
	Background	Predicted PM_{10} increment	Total cumulative impact		Background	Predicted PM_{10} increment	Total cumulative impact
Receptor 1				*Receptor 1*			
3/11/2004	42.5	0	42.5	14/03/2004	0.0	4.07	4.1
13/10/2004	41.6	0	41.6	22/11/2004	0.0	2.91	2.9
7/01/2004	40.2	0	40.2	15/01/2004	0.0	2.9	2.9
12/10/2004	40.2	0.0174	40.2	5/04/2004	11.1	2.85	14.0
23/09/2004	40.0	0	40.0	3/12/2004	10.0	2.41	12.4
14/10/2004	38.0	0	38.0	6/04/2004	12.8	2.25	15.1
18/11/2004	37.2	0.00345	37.2	1/03/2004	19.8	2.23	22.0
11/10/2004	37.1	0	37.1	4/03/2004	12.6	2.18	14.8
4/11/2004	36.6	0.00000629	36.6	17/02/2004	15.2	2.02	17.2
26/08/2004	36.3	0.164	36.5	10/05/2004	17.2	2	19.2
Receptor 2				*Receptor 2*			
3/11/2004	42.5	0.0231	42.5	30/07/2004	24.9	23.8	48.7
13/10/2004	41.6	0.146	41.7	1/07/2004	30.3	9.82	40.1
7/01/2004	40.2	0	40.2	20/05/2004	17.4	9.17	26.6
12/10/2004	40.2	2.13	42.3	21/03/2004	19.1	9.11	28.2
23/09/2004	40.0	0.11	40.1	9/06/2004	19.8	8.8	28.6
14/10/2004	38.0	0	38.0	8/07/2004	17.4	8.07	25.5
18/11/2004	37.2	0.259	37.5	3/02/2004	16.2	7.75	24.0
11/10/2004	37.1	0.0572	37.2	16/03/2004	17.0	7.71	24.7
4/11/2004	36.6	0	36.6	5/06/2004	15.3	7.61	22.9
26/08/2004	36.3	0.623	36.9	24/02/2004	5.9	7.5	13.4
Receptor 3				*Receptor 3*			
3/11/2004	42.5	1.39	43.9	29/05/2004	15.2	10.3	25.5
13/10/2004	41.6	0.0996	41.7	20/04/2004	33.1	10	43.1
7/01/2004	40.2	0	40.2	11/06/2004	12.5	9.85	22.4
12/10/2004	40.2	0.825	41.0	25/07/2004	17.5	9.4	26.9
23/09/2004	40.0	2.64	42.6	15/03/2004	11.0	9.21	20.2
14/10/2004	38.0	0.0646	38.1	5/06/2004	15.3	9.16	24.5
18/11/2004	37.2	0.154	37.4	4/06/2004	0.0	7.82	7.8
11/10/2004	37.1	0.843	37.9	21/07/2004	0.0	7.69	7.7
4/11/2004	36.6	0.0000302	36.6	5/07/2004	24.1	7.63	31.7
26/08/2004	36.3	2.02	38.3	14/06/2004	14.8	7.59	22.4
Receptor 4				*Receptor 4*			
3/11/2004	42.5	0.31	42.8	6/12/2004	9.5	9.19	18.7
13/10/2004	41.6	1.34	42.9	9/12/2004	0.0	8.61	8.6
7/01/2004	40.2	0	40.2	5/11/2004	24.9	6.64	31.5
12/10/2004	40.2	1.3	41.5	2/01/2004	0.0	6.42	6.4
23/09/2004	40.0	0	40.0	5/01/2004	0.0	5.82	5.8
14/10/2004	38.0	0.081	38.1	18/10/2004	0.0	5.72	5.7
18/11/2004	37.2	1.35	38.6	7/12/2004	9.0	5.69	14.7
11/10/2004	37.1	1.98	39.1	10/12/2004	0.0	5.55	5.6
4/11/2004	36.6	4.63	41.2	10/07/2004	16.7	5.54	22.2
26/08/2004	36.3	2	38.3	16/12/2004	0.0	5.19	5.2