WHITEHAVEN COAL

Narrabri Coal Operations Pty Ltd

ABN: 15 129 850 139

Narrabri Coal Mine
Stage 2 Longwall Project

Air Quality Assessment

Prepared by:

Heggies Pty Ltd

November 2009

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Air Quality Assessment

Prepared for: R.W. Corkery & Co. Pty. Limited
Level 1, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Fax: (02) 9985 8208
Email: brooklyn@rwcorkery.com

On behalf of: Narrabri Coal Operations Pty Ltd
Level 9, 1 York Street
PO Box R1113
SYDNEY NSW 1225

Tel: (02) 8507 9700
Fax: (02) 8507 9701
Email: thaggarty@whitehaven.net.au

Prepared by: Heggies Pty Ltd
PO Box 176
LANE COVE NSW 2066

Tel: (02) 9427 8100
Fax: (02) 9427 8200
Email: sydney@heggies.com

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EXECUTIVE SUMMARY

Heggies Pty Ltd has been commissioned by R.W. Corkery and Co. Pty. Limited on behalf of Narrabri Coal Operations Pty Limited to conduct an air quality impact assessment of the proposed Stage 2 operations at the Narrabri Coal Project.

Narrabri Coal Operations Pty Limited proposes to convert the approved Narrabri Coal Mine from a continuous miner operation with an approved annual production rate of 2.5Mtpa to a longwall mining operation with a maximum annual production rate of 8Mtpa.

Scenarios were modelled for site construction and underground longwall mining operations, assessing the impact of fugitive dust emissions from surface operations and the mine ventilation system. Odour emissions from the ventilation system are also assessed.

Atmospheric dispersion modelling predictions of fugitive emissions from the Mine Site were undertaken using the CALPUFF dispersion model in screening mode.

Further modelling of fugitive coal dust emissions from uncovered rail carriages leaving the Mine Site was conducted using the US EPA line source model CAL3QHCR.

Local meteorological conditions obtained from a weather station operated on the Mine Site and air quality monitoring data from local and regional sources were integrated into the dispersion model.

The results of the dispersion modelling conducted indicated that for all modelling scenarios, compliance with all relevant DECC air quality goals would be likely. Some exceedances of the 24-hour PM_{10} criterion of 50µg/m^3 were predicted for the closest two receptors during the operational modelling scenario. However, given the highly conservative nature of the modelling scenario, the reduced frequency of the meteorological conditions conducive to these exceedances and the periodic nature of the primary PM_{10} emitting activities on the Mine Site, it is considered that compliance with the 24-hour PM_{10} criterion is likely. Furthermore, it was concluded that emissions from the rail transportation of coal to Port Newcastle would be unlikely to adversely impact upon potential receptors situated in close proximity to the rail corridor.

Emissions of Greenhouse Gas (CO_2 and CH_4) are considered separately – see Part 8 of the Specialist Consultant Studies Compendium.

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1 INTRODUCTION

Narrabri Coal Operations Pty Limited (the Proponent) proposes to convert the approved Narrabri Coal Mine from a continuous miner operation with an approved annual production rate of 2.5Mtpa to a longwall mining operation with a maximum annual production rate of 8Mtpa.

Heggies Pty Ltd (Heggies) has been commissioned by R.W. Corkery & Co. Pty. Limited (RWC) on behalf of the Proponent to conduct an air quality impact assessment to identify potential impacts of the proposed Stage 2 operations at the Narrabri Coal Mine (the "Mine Site").

The air quality impact assessment is prepared in accordance with the NSW Department of Planning (DoP) Director General's Requirements (DGRs) for assessment, specifically those required by the NSW Department of Environment and Climate Change (DECC), as follows:

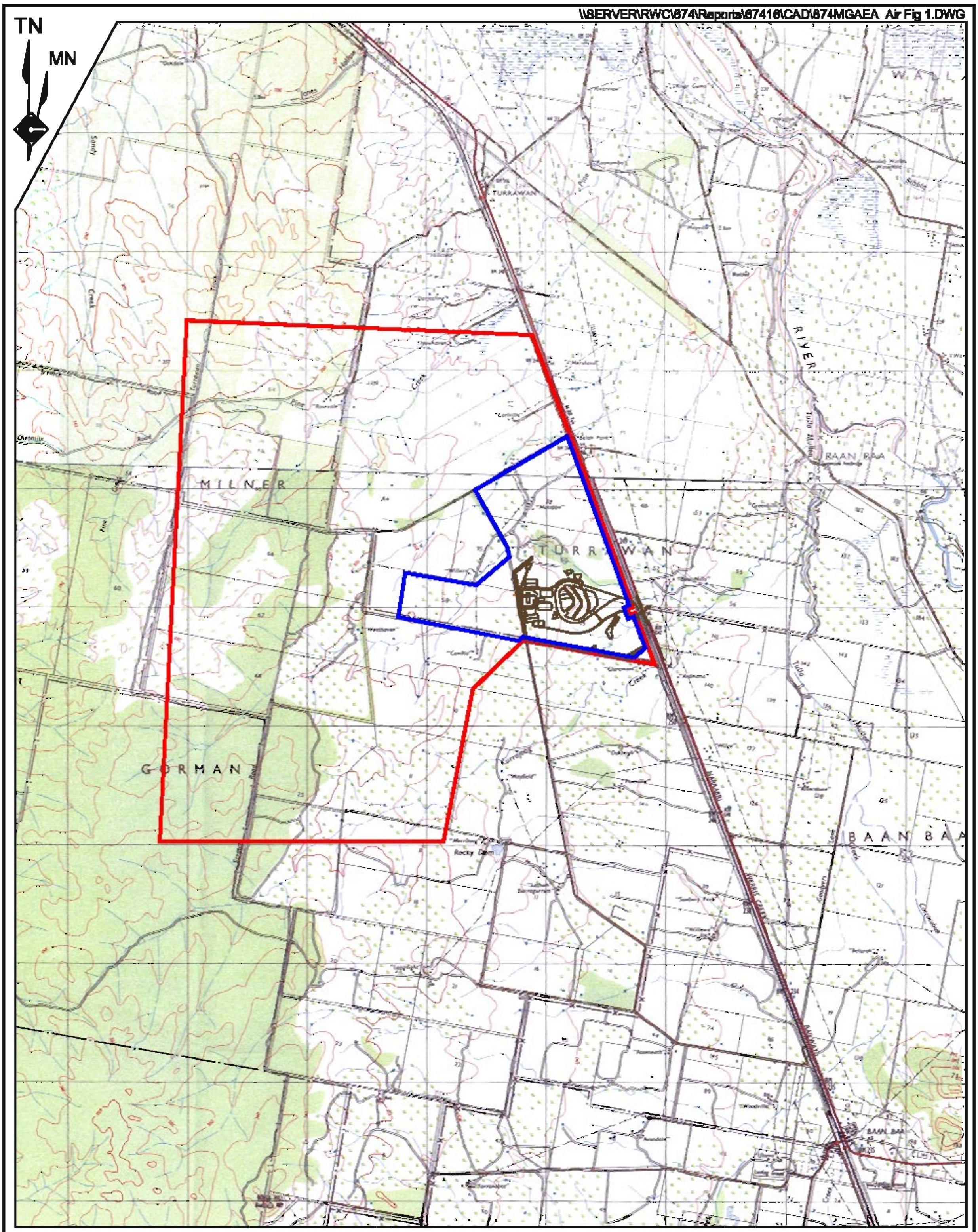
> "*The goal is to maintain existing rural air quality and protect sensitive receptors, both on and off site, from adverse impacts of dust and odour.*
>
> *Dust is the primary concern with potential emissions from conveyors, transfer points, loading facilities and from coal stacks. Coal particles can be also disperse in water spray drift when using recycled water. There is potential for odour from the exhaust fan due to engine emissions.*
>
> *DECC expects that models used at existing premises in conjunction with analysis of local meteorological and terrain data would be sufficient to inform decisions about design and management options.*
>
> *Another key aspect that will need to be investigated, impacts defined and mitigation measures proposed is impact of coal dust from rail transportation. This will required liaison with the Australian Rail Track Corporation (ARTC) who hold the environmental protection licence (EPL 3142) for the rail network. Note during the PFM reference was provided to DECC to a study undertaken by Queensland Rail on fugitive coal dust emissions.*"

A separate report addressing the DGRs for Greenhouse Gas emissions of CO_2 and CH_4 has been prepared separately by Heggies (Heggies report "10-7193R2") – see Part 8 of the Specialist Consultant Studies Compendium.

2 PROJECT SETTING AND OVERVIEW

The land on which the Mine Site would be developed and operated is located immediately to the west of the Kamilaroi Highway and North Western Branch Railway Line, approximately 10km north-northwest from Baan Baa (see **Figure 1**). The Mine Site lies within Mining Lease 1609 which covers an area of approximately 5 210ha. The Mine Site is primarily cleared grazing land, with native vegetation in the western part. The proposed Pit Top Area covers an area of approximately 76ha.

Figure 1 illustrates the local setting of the Mine Site.



REFERENCE

- Mine Site Boundary
- Pit Top Area Boundary
- Approved Disturbance within the Pit Top Area

SCALE 1:100 000

1 0 1 2 3 4 5 km

Base Map Source: Narrabri (1973) and Baan Baa (1985) 1:50 000 Topographic Maps

Figure 1

LOCAL SETTING OF THE MINE SITE

Note: A colour version of this figure is available on the Project CD

2.1 Sensitive Receptors

A number of non-project related residential dwellings are situated in the area surrounding the Mine Site. These dwellings were identified as sensitive receptor locations and are taken into account during the assessment of potential air quality impacts associated with the Longwall Project.

A list of existing sensitive receptor points (R1 to R18) identified in the immediate vicinity of the Mine Site, and respective distances of these receptor points to the Coal Preparation Plant (CPP), situated in the eastern half of the Pit Top Area, are listed in **Table 1**. A number of receptors are situated within the Mine Site boundary but outside the Pit Top Area. Properties R8, R9, R12, and R14 have been excluded from Table 1 as they are owned by the proponent and hence project-related.

Table 1
Surrounding Sensitive Receptor Locations

Receptor ID Property Name	Location (m, MGA, Zone 55)		Distance (km) / Direction From CHPP	Elevation (m, AHD)
	Easting	Northing		
R1 - "Bow Hills"	780236	6620670	2.2 / ENE	240
R2 - "Ardmona"	780357	6618921	2.7 / ESE	245
R3 - "Naroo"	779679	6619147	2.0 / ESE	245
R4 - "Oakleigh"	779679	6617759	3.0 / SSE	260
R5 - "Pineview"	779412	6617194	3.4 / SSE	265
R6 - "Matilda"	777859	6616978	3.3 / S	275
R7 - "Haylin View"	777448	6617297	3.1 / SSW	275
R10 - "Merrilong"	777099	6616248	4.2 / SSW	280
R11 - "Kurrajong"	776161	6618325	2.7 / SW	320
R13 - "Newhaven"	776497	6624586	4.6 / NNW	260
R15 - "Greylands"	777570	6622705	2.5 / NNW	265
R16 - "Belah Park"	778783	6622924	2.7 / NNE	260
R17 – "Bungaree"	777500	6624315	4.1 / NNW	255
R18 – "Merulana"	778510	6624110	3.8 / NNE	255

Note: [1] Project related residence
Note: [2] Identified as residences where the negotiations are currently in place for the acquiring of these properties.

Figure 2 illustrates the location of the surrounding receptors in relation to the Mine Site.

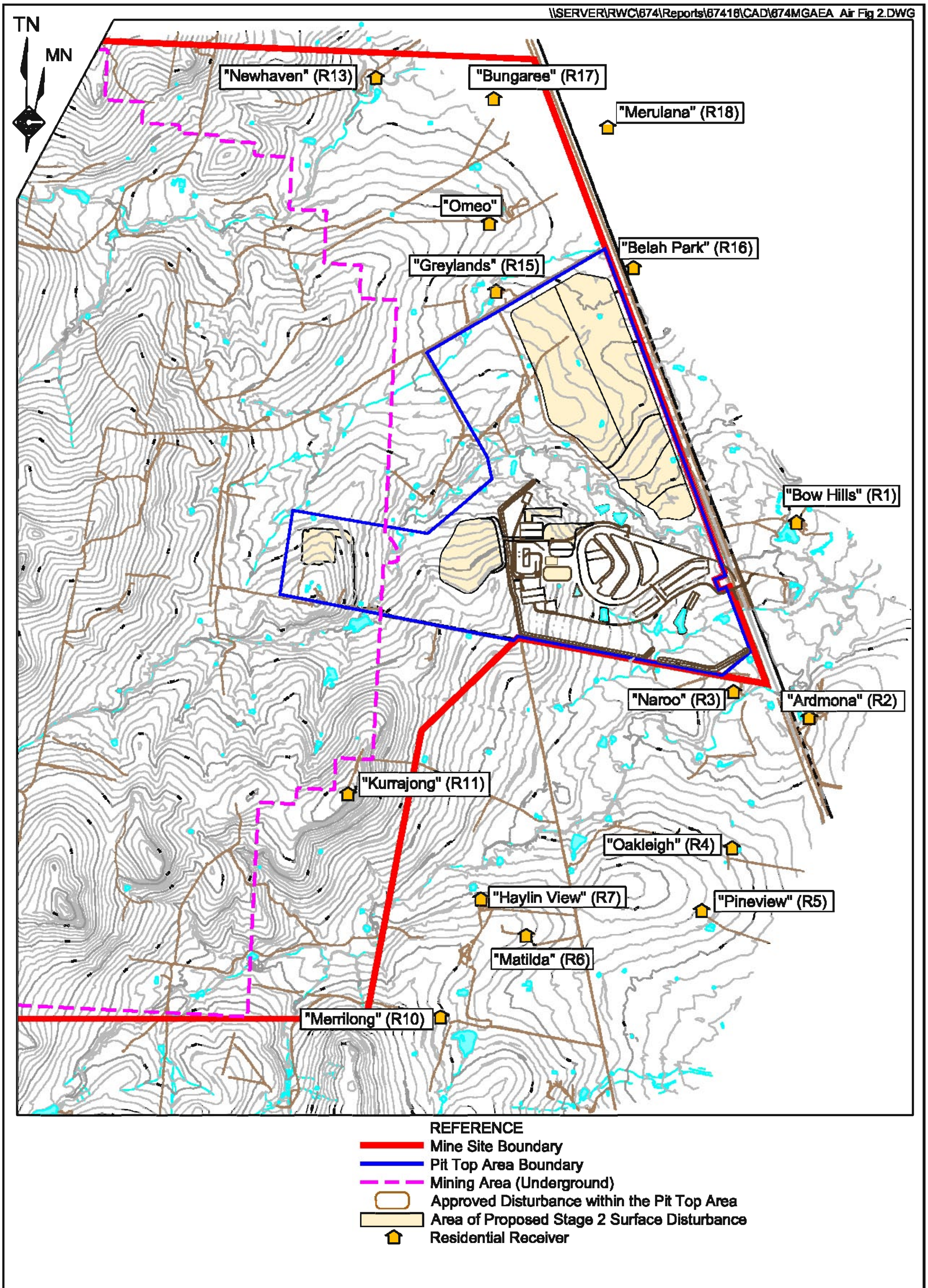
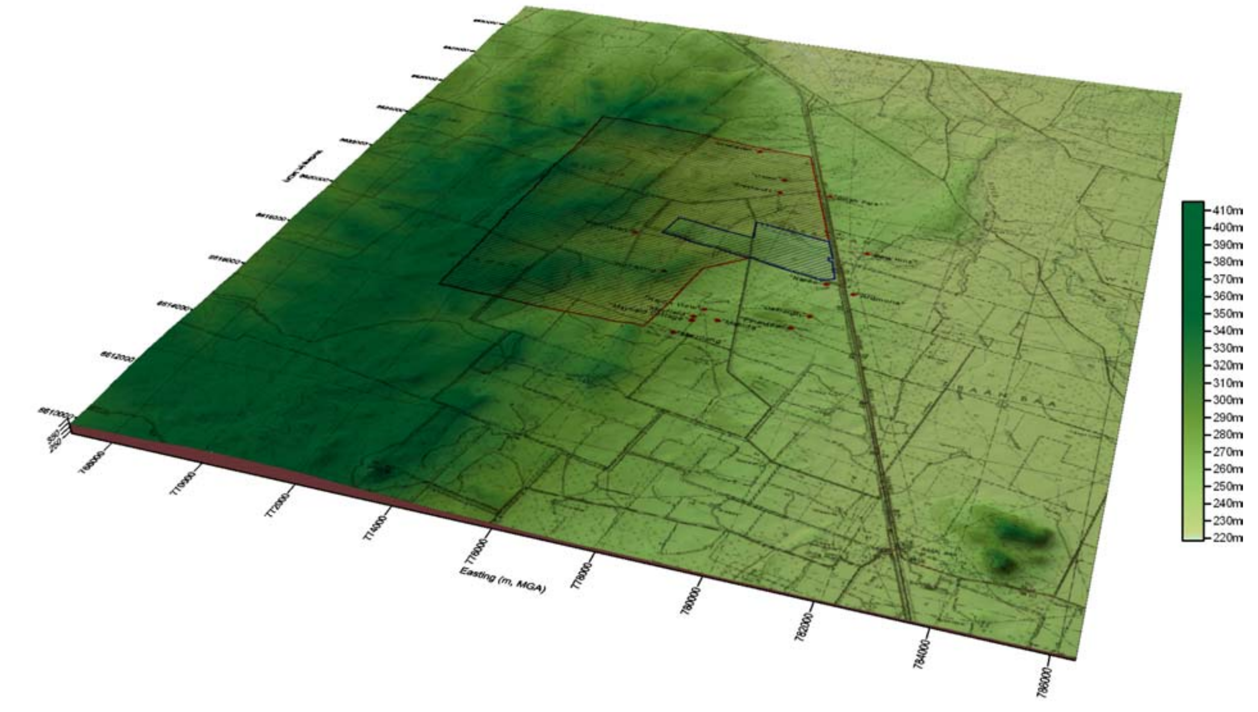


Figure 2
SENSITIVE RECEPTOR LOCATIONS

2.2 Local Topography

The topography of the area surrounding the Mine Site increases gradually from east to west. A defined region of elevated terrain begins to the west of the Pit Top Area, while the topography to the east is predominantly uniform. A three dimensional representation of the topographical features described above is presented in **Figure 3**.



Note: Topography shown with vertical exaggeration of x2 to emphasise terrain features

Figure 3
3-Dimensional Topography Surrounding the Mine Site

The Mine Site itself is located at an approximate elevation of between 240m and 360m AHD, with the highest topography occurring between the Pit Top Area and the western boundary (as shown in **Figure 3**). All selected sensitive receptor locations (see **Table 1**) are located at an elevation similar to that found within the Mine Site.

Given the relatively uncomplicated nature of the surrounding topography, particularly between the Pit Top operations and surrounding sensitive receptors, there is unlikely to be a significant influence on the dispersion. Consequently, topography will not be included in the atmospheric dispersion modelling to be conducted within this assessment (see **Section 6**).

2.3 Project Overview

Longwall mining would involve the sequential development of heading gate roads approximately 305m apart oriented north-south from the main headings ("West Mains") and developed for the full distance to the northern and southern boundaries of ML 1609 (up to 4.115km). Once each set of roadways are fully developed, the longwall equipment would be installed and the coal recovered as the longwall unit retreats back towards the West Mains between the two roadways. All coal would be conveyed back to the Pit Bottom Area for transfer to the surface via the approved conveyor drift.

A conceptual mine ventilation system has been developed to manage seam gas generated within the mine and to provide a safe working environment for the mine's workforce. Gas composition within the mine varies considerably but the dominant gas is CO_2 with significant concentrations of CH_4 and N_2 present.

The proposed ventilation system would incorporate:

- A number of concrete-lined upcast ventilation shafts up to 6m in internal diameter. The initial shaft would be located approximately 200m in bye of the Pit Bottom.
- A total of twelve 2.1m smooth lined return shafts located at the end of every third gate road to draw fresh air from the surface to ventilate the active main gate roads.

Transportation of the mined coal to the ROM stockpile would continue to be via the conveyor drift from the Pit Bottom Area to the box cut of the Pit Top Area. From the box cut excavation, the ROM coal would be transported to the ROM coal stockpile area by conveyor from where it would be sent to the Coal Preparation Plant (CPP).

The ROM coal would be drawn from the ROM coal stockpiles via one of two reclaim valve and tunnels from where it would be fed to a rotary breaker for size reduction. The broken coal would then be transferred to a dry screen with the <16mm coal transferred directly to the product coal stockpile area and the remainder transferred to a jig washery for removal of fine material and screening of the coarse reject. The <50mm coal would be transferred to the product coal stockpile area with the coarse reject and dewatered and thickened fine reject sent to a reject emplacement area for storage.

The product coal would be drawn from stockpiles via three reclaim valves and tunnels and conveyed to the train load-out bin. The loading of product coal via the drawdown valves and trains load-out bin would be fully automated with batches of 5 400t to 6300t drawn from the stockpiles and loaded to trains on the Narrabri Coal Rail Siding.

2.4 Scope

The scope of the assessment is limited to an assessment of:

- Particulate emissions site construction and preparation.
- Particulate emissions from surface operations and ventilation system.
- Fugitive particulate emissions from rail transportation.
- Odour emissions from the ventilation exhaust.

Greenhouse Gas emissions of CO_2 and CH_4 are considered separately (Heggies report "10-7193R2" dated 29/05/2009) – see part 8 of the Specialist Consultant Compendium.

3 AIR QUALITY CRITERIA

3.1 Criteria Applicable to Particulate Matter

The term *"particulate matter"* refers to a category of airborne particles typically less than 50 microns (µm) in diameter and ranging down to 0.1 µm in size. Particles less than 10 µm are referred to in this report as PM_{10}.

Emissions of PM_{10} are considered important pollutants in terms of impact due to their ability to penetrate into the respiratory system. Potential adverse health impacts associated with exposure to PM_{10} include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NSW Department of Environment and Climate Change (DECC) detail PM_{10} impact assessment criteria within the 2005 document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods"), which are presented in **Table 2**.

Table 2
DECC Goals for PM_{10} – 24-hour and Annual

Averaging Period	Maximum Concentration
24-hour	50 µg/m^3
Annual	30 µg/m^3
Source: Approved Methods, DECC 2005	

The 24-hour PM_{10} reporting standard of 50 µg/m^3 is numerically identical to the equivalent National Environment Protection Measure (NEPM) reporting standard except that the NEPM reporting standard allows for five exceedances per year. These NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998 to be achieved within 10 years of commencement.

3.2 Criterion Applicable to Total Suspended Particulates (TSP)

The annual goal for Total Suspended Particulates (or TSP) is given as 90µg/m^3 within the Approved Methods.

It is noted that the PM_{10} sub-set is typically approximately 50% of TSP in the ambient air in regions where road traffic is not the dominant particulate source, such as rural areas (USEPA, 2001). Consequently, the annual average TSP criterion of 90 µg/m^3 is consistent with an annual average PM_{10} criterion of approximately 45µg/m^3.

On this basis, it is concluded that the annual TSP goal would be achieved if the DECC annual PM_{10} criterion of 30 µg/m^3 is satisfied. TSP has therefore not been considered further in this report.

3.3 Nuisance Impacts of Fugitive Emissions

The preceding sections are concerned in large part with the health impacts of particulate matter. Nuisance impacts need also to be considered, mainly in relation to dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 g/m^2/month.

Table 3 presents the DECC impact assessment goals for dust fallout, showing the allowable increase in dust deposition level over the ambient (background) level which would be acceptable so that dust nuisance could be avoided.

Table 3
DECC Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m^2/month	4g/m^2/month
Source: Approved Methods, DECC 2005		

3.4 Goals Applicable to Odour Emissions

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance criteria guide decisions on odour management, but are not specifically intended to achieve "no odour". The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit per cubic metre (OU). Therefore, an odour criterion of less than 1OU would theoretically result in no odour impact being experienced.

In practice, the character of a particular odour can only be judged by the receiver's reaction to it, and preferably only compared to another odour under similar social and regional conditions. Based on the literature available, the level at which an odour is perceived to be a nuisance can range from 2OU to 10OU.

Odour performance criteria need to be designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours, using a statistical approach which depends on the size of the affected population. A summary of odour performance criteria for various population densities is shown in **Table 4**.

Table 4
DECC Odour Performance Criteria vs. Population Density

Population of Affected Community	Odour Performance Criteria OU
Urban area (≥ 2000)	2.0
500 - 2000	3.0
125 - 500	4.0
30 - 125	5.0
10 - 30	6.0
Single residence (≤ 2)	7.0
Source: Technical Notes: Assessment and Management of Odours from Stationary Sources in New South Wales, DECC 2006	

The area surrounding the Mine Site is primarily rural. It is assumed that the population that may potentially be affected by odour emissions associated with coal seam gases is of the order of 10 and 30 people. Consequently, the project odour performance goal adopted for this assessment is:

- A maximum of 6.0 odour units (OU) expressed as a nose response average (1-second) value.

3.5 Project Air Quality Goals

In view of the foregoing, the air quality goals adopted for this assessment, which conform to current DECC air quality criteria, are summarised in **Table 5**.

Table 5
Project Air Quality Goals

Pollutant	Averaging Time	Goal
PM_{10}	24 hours Annual	50µg/m^3 30µg/m^3
Dust Deposition	Annual	Maximum Increase of 2g/m^2/month Maximum Total of 4g/m^2/month
Odour	1-second Nose Response Average	6OU

4 EXISTING AIR QUALITY ENVIRONMENT

4.1 Air Quality Monitoring at the Mine Site

An air quality monitoring network of two high volume air samplers (HVAS), for PM_{10} monitoring, and eight dust deposition gauges has been established progressively since December 2005 in the vicinity of the Mine Site. Monitoring data for PM_{10} and dust deposition data has been provided by the Proponent for use in this assessment to provide an indication of the existing air quality environment. The Proponent-owned monitoring locations are presented in **Figure 4**[1].

[1] It is noted that an updated Mine Site Layout base plan has subsequently been prepared the Proponent. This updated base plan is reflected in Appendices 4 to 7. It is noted, however, that the monitoring locations identified on **Figure 4** remain accurate.

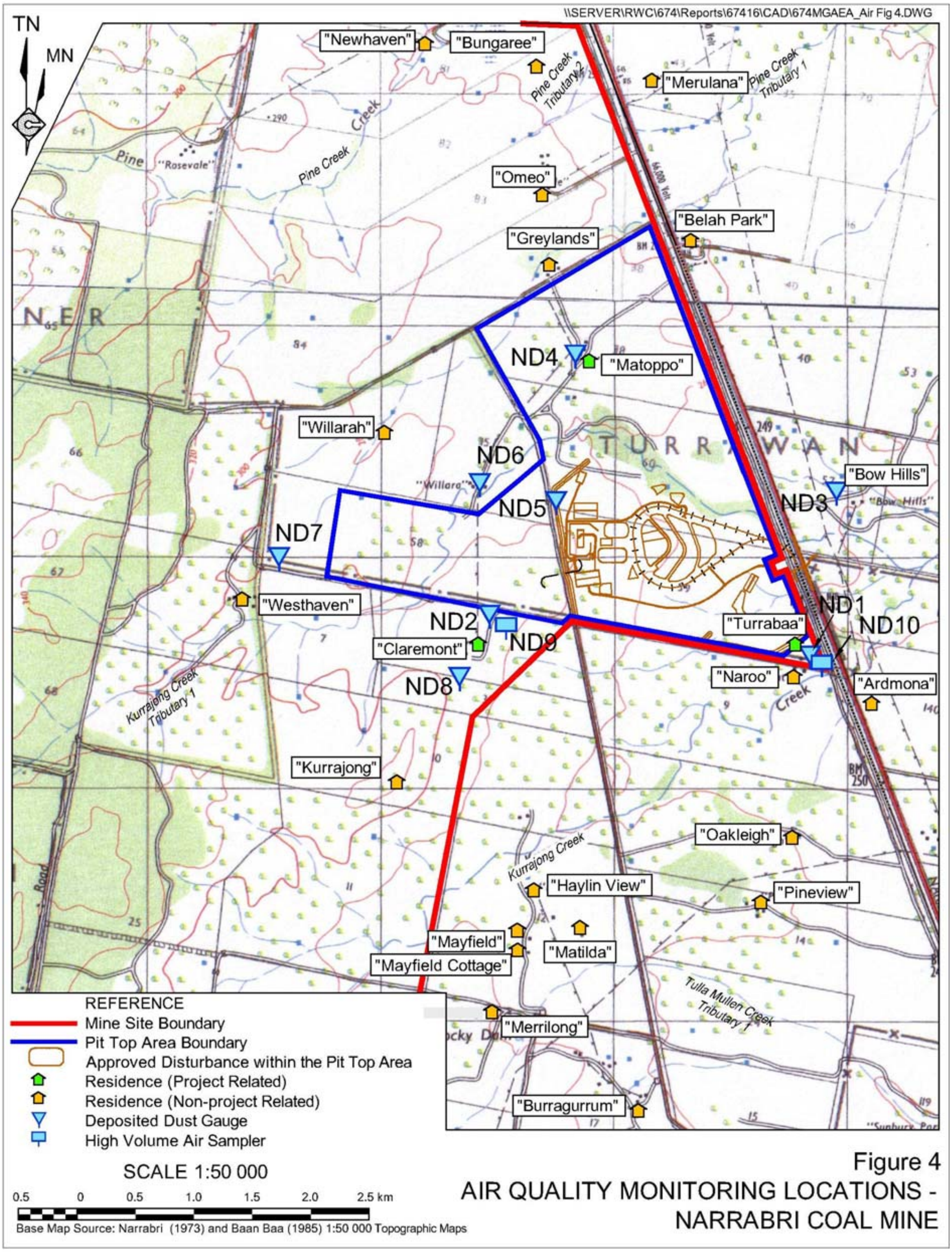


Figure 4
AIR QUALITY MONITORING LOCATIONS - NARRABRI COAL MINE

4.2 Background Dust Deposition Environment

Prior to December 2005, five dust deposition gauges were established within the vicinity of the Pit Top Area to obtain site-specific dust deposition data (see **Figure 4**). A further three dust deposition gauges were installed prior to June 2006. The dust deposition results obtained from the monitoring between December 2005 and March 2008 are listed in **Table 6**.

Table 6
Dust Deposition Monitoring Data - Mine Site - Mean Average Monthly Deposition

Site Location	Monitoring Period	Number of Samples	Total Insoluble Solids (g/m^2/month)
ND1	Dec 05 - Nov 08	36	1.5
ND2	Dec 05 - Nov 08	36	1.8
ND3	Dec 05 - Nov 08	36	0.9
ND4	Dec 05 - Nov 08	36	2.4
ND5	Dec 05 - Nov 08	36	2.7
ND6	June 06 - Nov 08	30	1.2
ND7	June 06 - Nov 08	30	1.1
ND8	June 06 - Nov 08	30	0.7
Weighted Average		**1.6**	

It is noted that after works for Stage 1 of the Narrabri Coal Project commenced in April 2008. The monitoring data obtained after this time was not included in order to avoid the derivation of an overly conservative estimation of background dust deposition levels.

The weighted average for all sites for the monitoring period December 2005 to March 2008 is 1.6g/m^2/month. This value will be applied as the background dust deposition level in this assessment.

It is noted that a number of very high monthly dust levels were recorded across the eight dust monitoring locations. The magnitude of these values in comparison with the dataset average and general monthly trend at each location would indicate that some of these high values may be anomalous (e.g. associated with contamination of sample), however these have been retained within the dataset in order to derive a conservatively high representation of average monthly dust deposition levels at the Mine Site.

The use of a background ambient level of <2g/m^2/month means that the incremental increase in dust deposition will be the governing criterion for the Project (see **Section 3.3**).

4.3 Ambient Particulate Matter Environment

A HVAS was established at location ND9 (see **Figure 4**) in December 2007 for the purpose of PM_{10} monitoring. An additional HVAS was established at location ND10 in April 2008. 24-hour samples were collected on a one-in-six day sampling routine in accordance with Approved Methods. The results of 24-hour PM_{10} monitoring conducted at these two locations are presented in **Table 7**.

Table 7
Recorded 24-hour Average PM_{10} Concentrations – Mine Site – December 2007 to November 2009

Site Location	Number of Samples	Dataset Average (µg/m^3)	Dataset 24-hour Maximum (µg/m^3)
ND9	61	10.5	48
ND10	39	15.8	70
Weighted Average		12.6	

Figure 5 presents the recorded 24-hour average PM_{10} concentrations at the two monitoring locations between December 2007 and November 2008. From April 2008 onwards, it is evident that the PM_{10} concentrations recorded at ND10 are typically higher than the corresponding concentrations at location ND9. Daily fluctuation in recorded PM_{10} concentrations is evident at both sites. It is noted that operations as part of Stage 1 Narrabri Coal Mine commenced in April 2008.

While the PM_{10} data recorded in the vicinity of the Mine Site is useful in quantifying the likely existing PM_{10} concentrations in the local air shed, Section 5.1.1 of the Approved Methods states that for air quality assessments of this nature, ambient monitoring data for at least one year of continuous measurements should be used in dispersion modelling. Consequently, the PM_{10} data recorded on a one-in-six day cycle is not adequate for inclusion in the modelling process.

The dispersion modelling to be conducted in this assessment will focus on the 2008 calendar year, corresponding to the most recent complete period of data from the Mine Site weather station. Further discussion will be made in **Section 6**.

Data is available from the DECC's Tamworth air quality monitoring station. This air quality monitoring site is located in Hyman Park, off Robert Street and Hillvue Road, Tamworth, approximately 115 km southeast of the Mine Site.

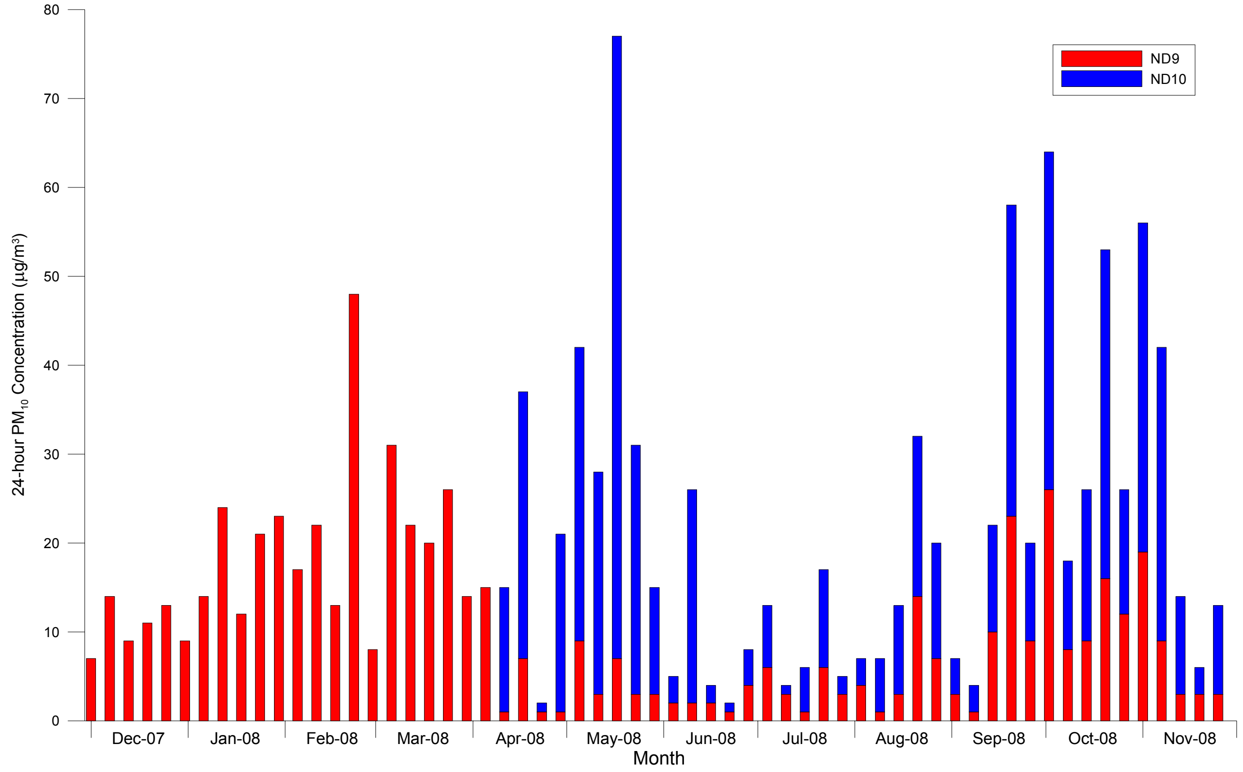


Figure 5
24-hour Average PM_{10} Concentrations – December 2007 – November 2008

The 24-hour average PM_{10} concentrations recorded at the Tamworth monitoring station during 2008, concurrent with the meteorological input dataset, are presented in **Figure 6**.

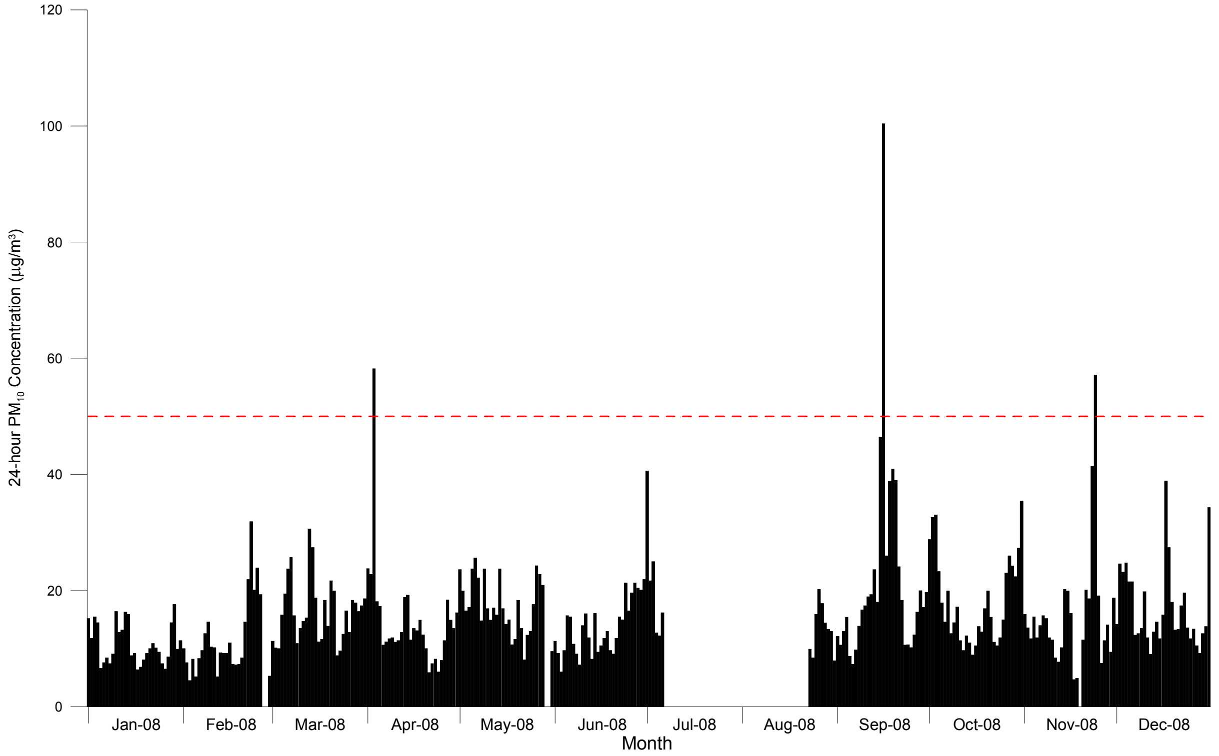


Figure 6
NSW DECC PM_{10} (24-Hour Average) Monitoring Results for Tamworth, 2008

The results indicate that the highest 24-hour average PM_{10} concentration recorded at the DECC's Tamworth monitoring site was 100.4µg/m^3 recorded on 16 September 2008. This concentration is in exceedance of the DECC's 24-hour average PM_{10} criterion. It is likely that this recorded exceedance was attributable to an anomalous regional natural event, such as a bushfire or dust storm.

Two further exceedances of the criterion were recorded during 2008, namely 58.2µg/m^3 recorded on 3 April 2008 and 57.1µg/m^3, recorded on 24 November 2008. In accordance with the Approved Methods, it is appropriate to demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity. Therefore, while above the DECC criterion, these recorded exceedances have not been discounted from the assessment.

The highest non-exceedance PM_{10} concentration recorded during 2008 at Tamworth was 46.4µg/m^3, recorded on 15 September 2008. Given that this concentration was recorded one day before the maximum as discussed above, it is also highly likely attributable to an anomalous natural event and may be considered as elevated for the region. The annual average PM_{10} concentration for the Tamworth dataset was 15.8µg/m^3. It is noted that for periods of missing data, particularly between July and August, the annual average PM_{10} concentration was inserted.

To provide a comparison between the two datasets, concurrent concentrations recorded at the DECC Tamworth monitoring station and the one-in-six day concentrations recorded about the Mine Site (ND9 and ND10) during the modelling period are presented in **Figure 7**.

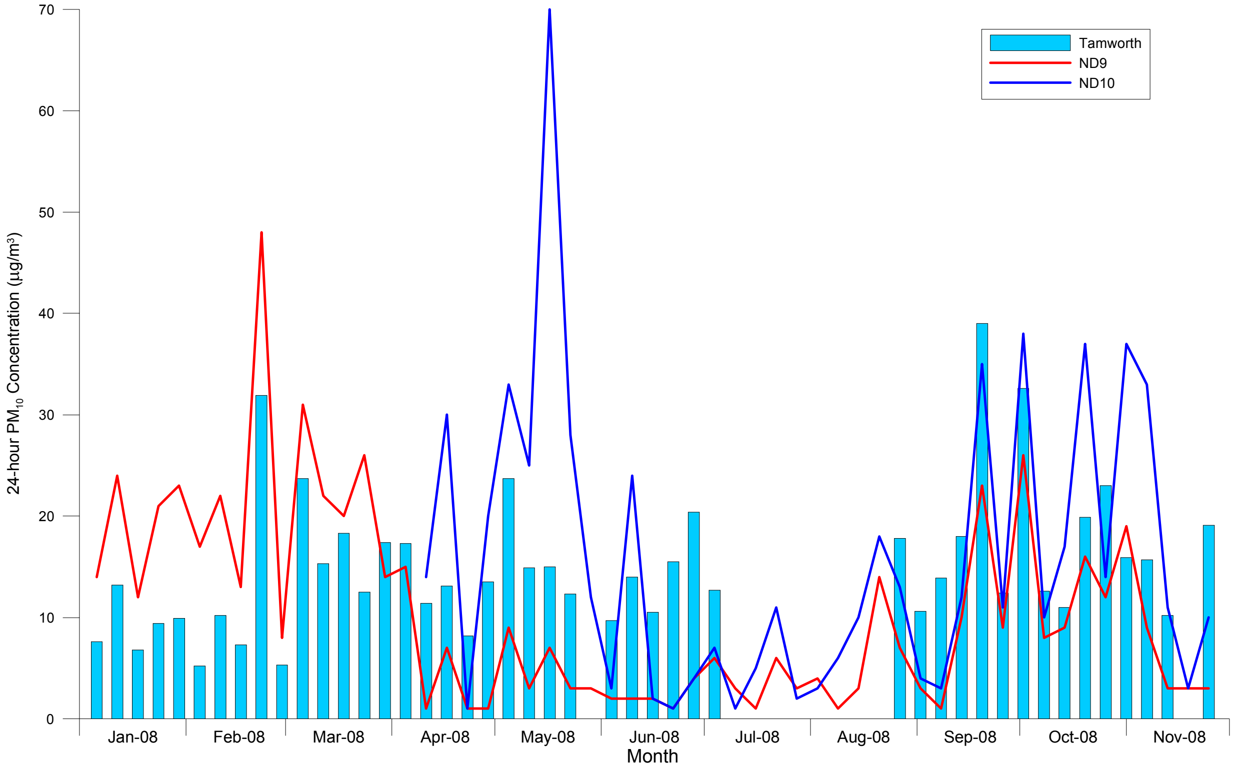


Figure 7
24-hour Average PM_{10} Comparison – Tamworth and Mine Site HVAS Data –2008

Figure 7 highlights that a similar daily variation pattern exists across each dataset. The range of recorded concentrations recorded at each location appears to match well for the concurrent days, with the exception of the maximum recorded concentration at ND10. The maximum recorded 24-hour average PM_{10} concentration at ND10, 70µg/m^3 on 17 May 2008, is likely to be a attributable to a localised source given the significantly lower corresponding concentrations recorded at ND9 and Tamworth.

On the basis of the comparison between concurrent recorded concentrations at the three monitoring locations and the similarity between the range and average of recorded concentrations, the Tamworth 2008 24-hour average varying PM_{10} dataset is considered suitably representative of the potential existing ambient PM_{10} concentrations for use in this assessment.

4.4 Existing Ambient Odour Concentrations

In addition to existing background dust deposition levels and PM_{10} concentrations as discussed above, existing odour concentrations need to be accounted for. Emissions of odour likely to be associated with the operation of the Project are expected to be generated by the ventilation shaft exhaust. The odour characteristic of these emissions will be attributable to the diesel combustion of mobile plant in the underground mine. Given the rural setting of the Mine Site and the relative sparsity of such sources on the surface (trains/vehicles/farm equipment), it is assumed that existing odour concentrations of this nature are negligible.

4.5 Ambient Air Quality Environment for Assessment Purposes

For the purposes of assessing the potential air quality impacts from the Project, an estimation of ambient air quality levels is required. The site-specific ambient air quality levels adopted for this assessment are summarised in **Table 8**.

Table 8
Ambient Air Quality Environment for Assessment Purposes

Air Quality Parameter	Averaging Period	Assumed Background Ambient Level	Data Source
PM_{10}	24-Hour	Daily Varying	DECC
	Annual	15.8µg/m^3	
Dust Deposition	Annual	1.6g/m^2/month	The Proponent
Odour	Nose response average (1-second)	Negligible	Assumed

5 DISPERSION METEOROLOGY

To adequately characterise the dispersion meteorology of the Mine Site, monitoring data from the on-site meteorological station was sourced from the Proponent. The data from this monitoring station was used to characterise the local meteorology and provide the input datasets for the meteorological modelling undertaken. The following parameters, recorded at 15-minute intervals, were available from this station.

- Wind Speed
- Wind Direction
- Temperature
- Relative Humidity
- Dew Point Temperature
- Precipitation

Data recorded between June 2006 and December 2008 was provided by the Proponent. The 2008 calendar year represented the most complete dataset, with a total percentage complete data of 91.0%. On this basis, the 2008 meteorological dataset recorded at the Mine Site weather station meets the requirements of data completeness. The 2006 and 2007 datasets were more disjointed, with 43.8% and 64.9% respectively.

5.1 Meteorological Modelling

Data obtained by the on-site meteorological monitoring station was used as input to the atmospheric dispersion modelling. For indirect parameters not recorded on-site, as well as missing hourly data points, The Air Pollution Model (TAPM) meteorological model (Version 3) was used supplement the 2008 meteorological dataset for the Mine Site.

TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations, with no local data inputs required.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations.

Additionally, the TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values. This function of accounting for actual meteorological observations within the region of interest is referred to as "data assimilation".

Thus, direct measurements for hourly average wind speed and wind direction at the Proponent's on-site meteorological station were input into the TAPM simulations to provide realignment to local and regional conditions.

Table 9 details the parameters used in the meteorological modelling for this assessment.

Table 9
Meteorological parameters used for this study

TAPM (v 3.0)	
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 300 m)
Number of grid points	25 x 25 x 30
Year of analysis	2008
Centre of analysis	30°31' S, 149°54' E
Data assimilation	Meteorological data assimilation using wind data from on-site station.

5.2 Meteorological Conditions

5.2.1 Wind Regime

A summary of the 2008 annual wind behaviour recorded at the Mine Site is presented as a wind rose in **Figure 8.** Additionally, **Figure 8** presents the wind roses generated from the incomplete 2006 and 2007 datasets from the Mine Site weather station.

Figure 8 indicates that winds experienced at the Mine Site are predominantly light to fresh (between 1.5 m/s and 10.5 m/s) from the east-southeast to south-southeast (approximately 38% combined) and from the west to northwest (approximately 22% combined). Calm wind conditions (wind speed less than 0.5 m/s) were recorded approximately 9.2% of the time throughout the dataset.

While incomplete, the 2006 and 2007 wind roses presented in **Figure 8** correlate well with the 2008 wind rose, both with regards to direction and speed. Based on this data comparison, the 2008 dataset can be viewed as representative of the conditions likely at the Mine Site.

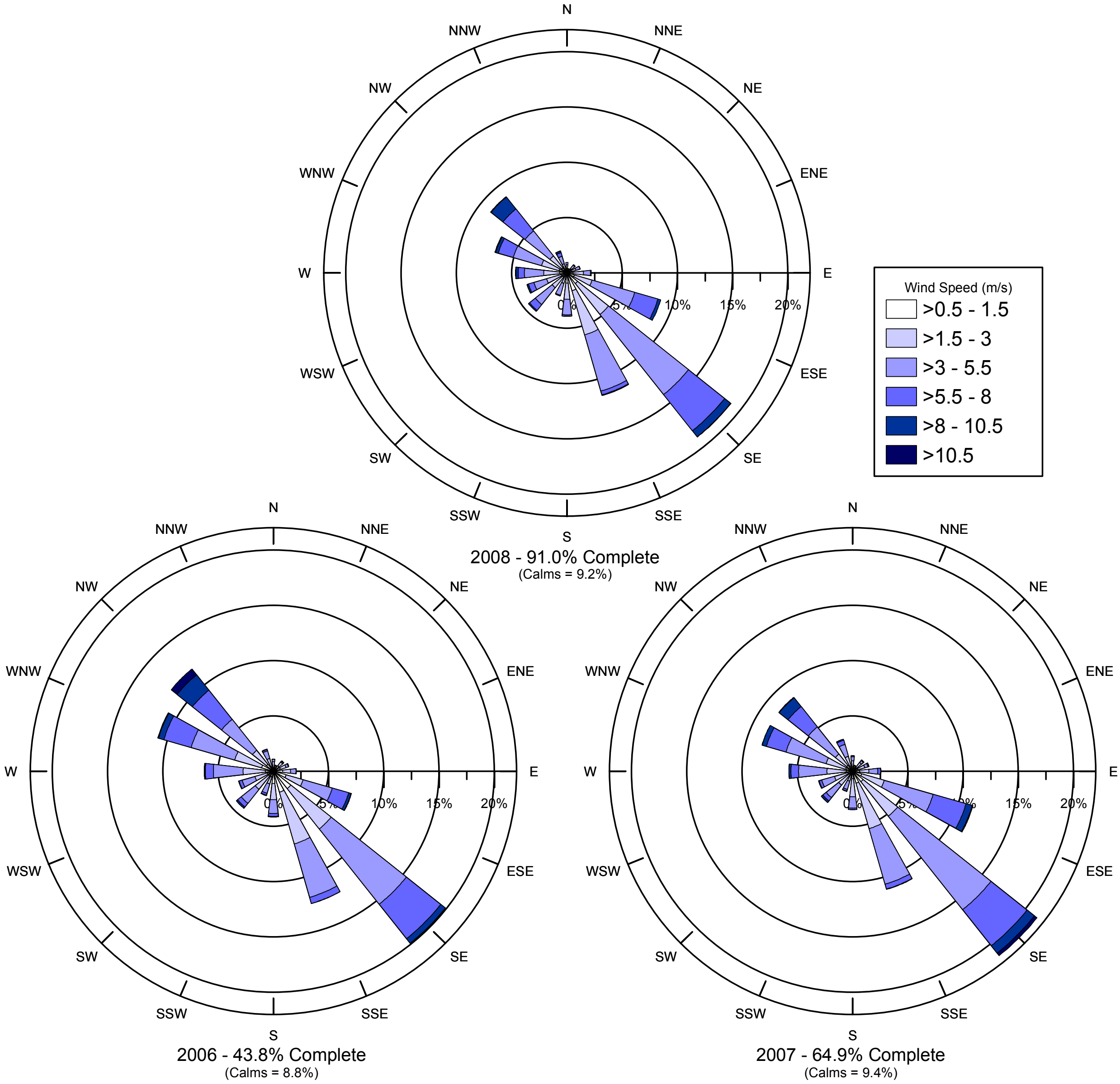


Figure 8
Annual Wind Roses for Mine Site – 2006 to 2008

The seasonal variation in predicted wind behaviour at the Mine Site is presented in **Appendix 1**. The seasonal wind roses indicate that:

- in spring, light to fresh winds are experienced predominantly from the east-southeast to south-southeast (approximately 36% combined) and west to northwest (approximately 29% combined);
- in summer, light to fresh winds are experienced predominantly from the east-southeast to south-southeast (approximately 42% combined);
- in autumn, light to fresh winds are experienced predominantly from the east-southeast to south-southeast (approximately 40% combined); and

- in winter, light to moderate winds (between 1.5 m/s and 8 m/s) are experienced from the east-southeast to south (approximately 43% combined) and light to fresh winds from the southwest to northwest (approximately 34% combined).

5.2.2 Temperature

Recorded monthly temperature variance at the Mine Site during 2008 is illustrated in **Figure 9**. Additionally overlayed in **Figure 9** are the historic maximum/minimum and mean maximum/minimum temperatures recorded at the Bureau of Meteorology's weather station at Narrabri West Post Office between 1962 and 2002. This station, located approximately 23km north-northwest of the Mine Site, provides the most complete historic climate dataset in the local region and is considered representative of the greater region.

It can be seen that the recorded temperature at the Mine Site during 2008 matches well with the historical measurements at Narrabri West Post Office. On this basis, it can therefore be considered that the 2008 dataset is representative of the temperature likely to be experienced within the region of the Mine Site.

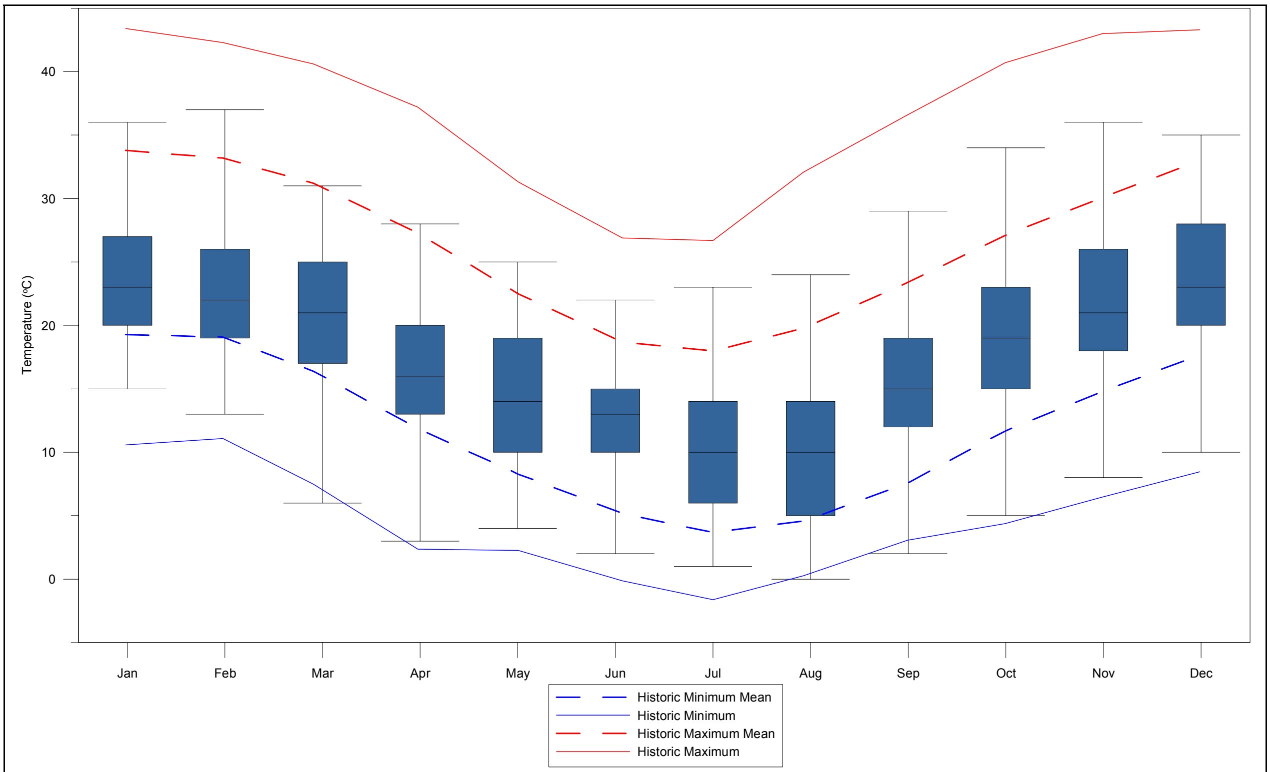


Figure 9
Monthly Temperature Variance – Mine Site (2008) and Regional Historic data

5.2.3 Atmospheric Stability and Mixing Depth

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, "A" to "F", to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models (**Table 10**).

Table 10
Description of atmospheric stability classes

Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

Atmospheric stability class has been derived using the Sigma Theta method, as prescribed within Section 4.4.1 of the Approved Methods. 15-minute average wind direction data was used to derive hourly standard deviation throughout 2008. The Sigma Theta method utilises this standard deviation as a measure of hourly wind direction variability and, following combination with corresponding hourly-average wind speed, estimates hourly atmospheric stability. The calculated frequency of each stability class at the Mine Site is presented in **Figure 10**. The seasonal stability class distributions are included in **Appendix 2**.

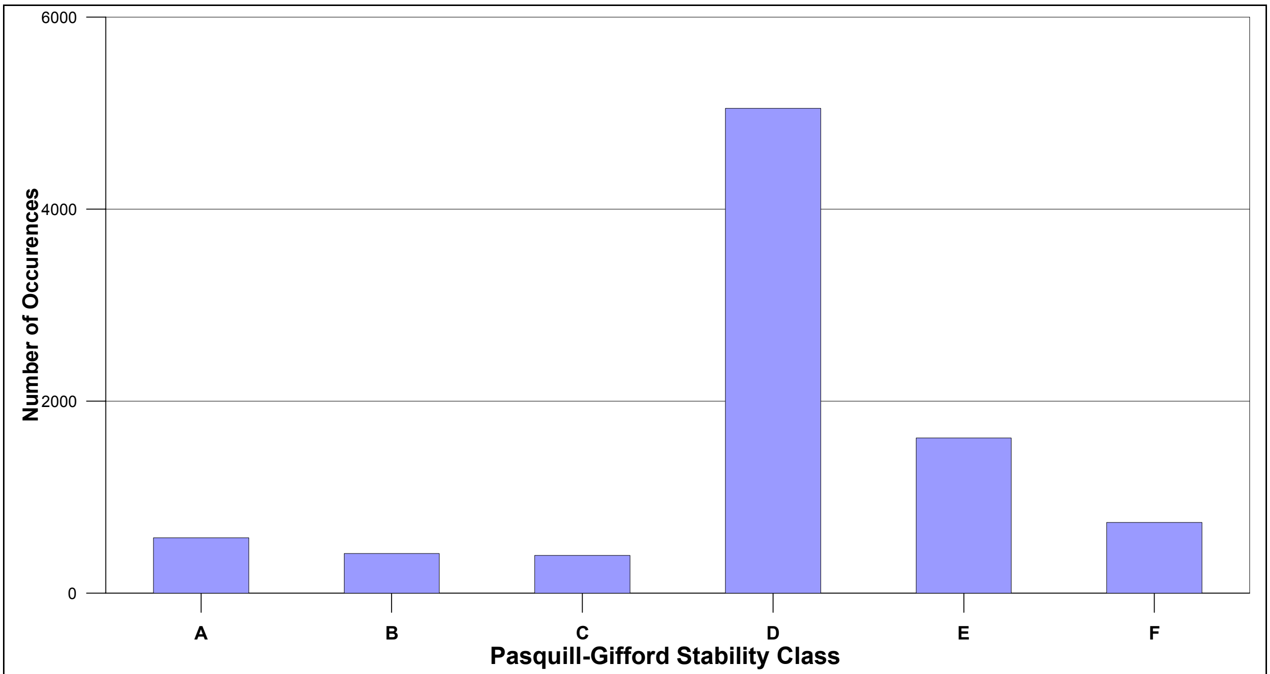


Figure 10
Annual Stability Class Distributions for the Mine Site - 2008

The results indicate a high frequency of conditions typical to Stability Class "D". Stability Class "D" is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing. There is also a relatively high combined frequency of Stability Class "E" and "F", which are both indicative of stable conditions, representing a low potential for pollutant dispersion.

Diurnal variations in maximum and average mixing depths predicted by TAPM at the Mine Site during the dataset are illustrated in **Figure 11**. It can be seen that an increase in the mixing depth during the morning, arising due to the onset of vertical mixing following sunrise, is apparent with maximum mixing heights occurring in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

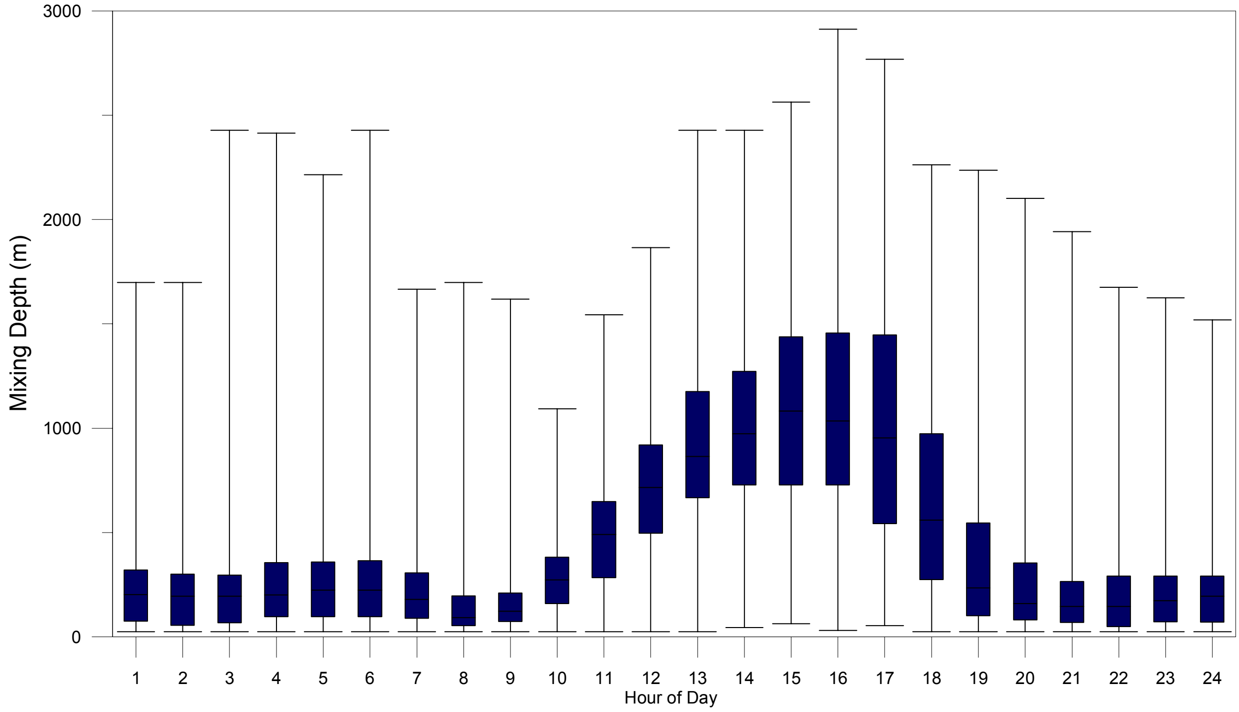


Figure 11
TAPM-Predicted Diurnal Variation in Mixing Depth for the Mine Site - 2008

6 ATMOSPHERIC DISPERSION MODELLING

6.1 Model Selection and Configuration

CALPUFF, a puff dispersion model suitable for use in complex atmospheric dispersion situations, can be configured in screening mode, using a single meteorological input file such as an Ausplume meteorological input file. Using CALPUFF in screening mode assumes steady state conditions with a single one dimensional wind field applied across the entire modelling domain.

The current assessment utilises the CALPUFF (Version 6.2) modelling system run in screening mode using the single point meteorological input file, comprising of the data presented and discussed in **Section 5.1.** The principal advantage of using CALPUFF in screening mode, rather than using a steady state Gaussian dispersion model such as Ausplume, is its ability to handle calm (wind speeds less than 0.5 m/s) wind conditions. Ausplume cannot handle calm conditions because of the inverse wind speed dependence within the Gaussian plume equation. Under calm conditions, Ausplume will assume a minimum wind speed which shoots the plume to the edge of the modelling grid, even though the plume may not have moved at all under actual dispersion conditions (DECC 2005).

CALPUFF can handle these low wind speed conditions and will grow a plume by diffusion alone under zero wind speed conditions. Given the relatively high percentage of calm conditions within the input meteorological dataset (approximately 9.2%, as discussed in **Section 5.2.1**), the use of CALPUFF in screening mode in place of Ausplume is considered appropriate in this assessment.

The potential influence on pollutant dispersion of the proposed amenity walls surrounding the Pit Top Area of the Mine Site have not been factored into the dispersion modelling process. Consequently, the results obtained from dispersion modelling process may be viewed as worse case in this regard.

6.2 Modelling Scenarios

Two scenarios have been modelled to reflect different phases of the Stage 2 mine development, and selected considering the following factors. The scenarios chosen take into consideration the movement of mobile plant and equipment across different sections of the Pit Top Area and Mine Site and aim to be representative of worst case conditions present during a site construction and longwall mining year.

The two modelling scenarios are as follows.

- Scenario 1 - Site Construction - incorporates the construction of Stage 2 mine development components within the Pit Top Area including expansion of ROM Pad, Longwall Assembly Unit area, CPP area, reject emplacement area, ventilation and pre-drainage shaft areas and road and power line path construction.
- Scenario 2 - Longwall Mining Operations – incorporates the production from Stage 2 of the Project, including conveying of coal, CPP operations, stockpiling of ROM and product coal, stockpile management, CPP reject emplacement, construction of Brine Storage Pond and loading of train wagons.

Figure 12 illustrates the location of the sources simulated in the dispersion modelling in each modelling scenario. The selected source locations are deemed appropriate to represent maximum potential impacts at the closest surrounding receptors[2].

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[2] It is noted that an updated Mine Site Layout base plan has subsequently been prepared the Proponent. This updated base plan is reflected in Appendices 4 to 7. It is noted, however, that the activity locations identified on **Figure 12** remain accurate.

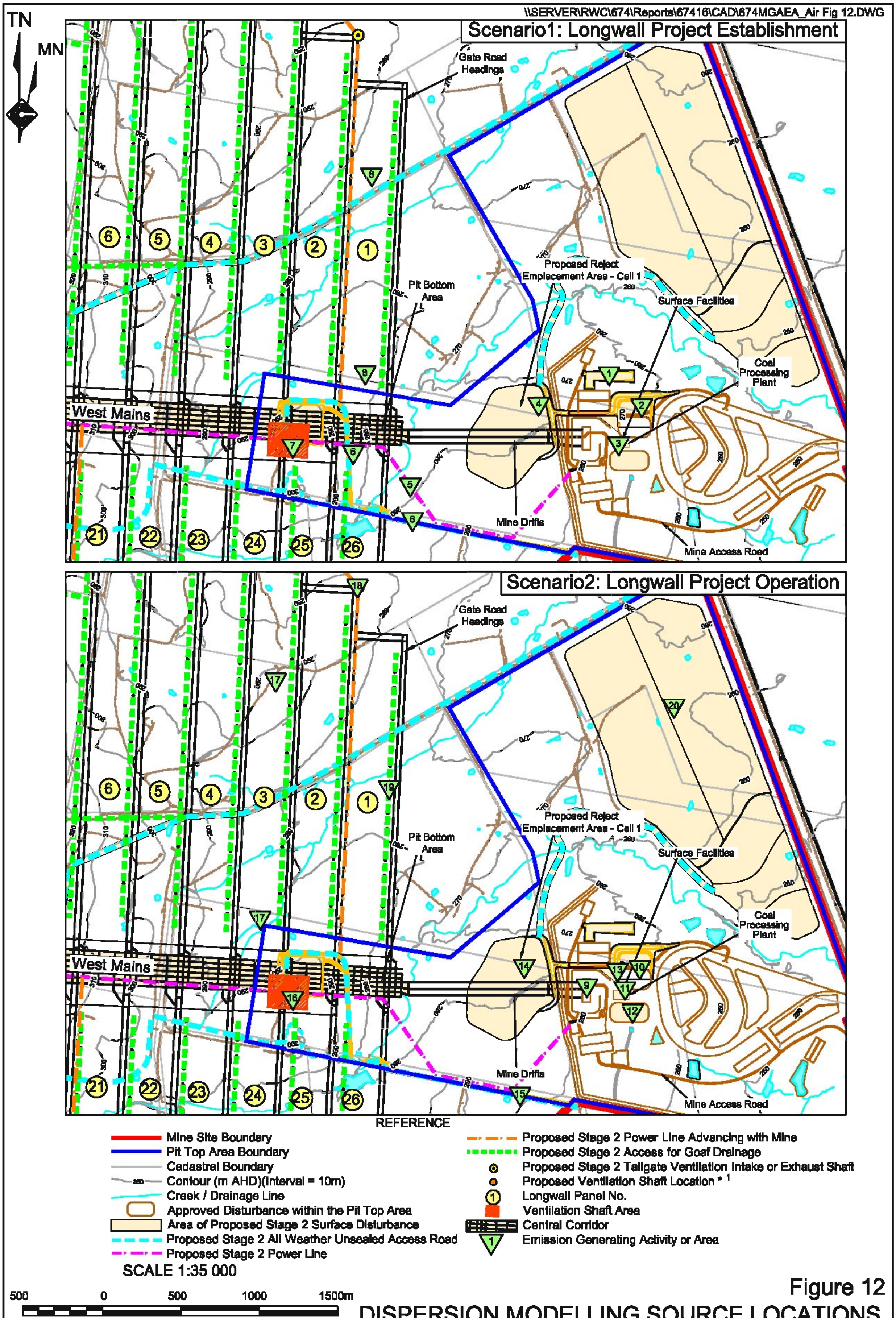

Figure 12

DISPERSION MODELLING SOURCE LOCATIONS

6.3 Emission Factors

Table 11 presents the emission factors for particulate matter from the Mine Site used in the dispersion modelling for this assessment.

Table 11
Particulate Emission Factors for Air Quality Dispersion Modelling

Activity	Total Particulate Emission Factor	PM_{10} Emission Factor	Emission Factor Units
Bulldozer on ROM coal	29.93	9.54	kg/hr
Bulldozer on product coal	24.12	7.69	kg/hr
Bulldozer on Reject	2.14	0.41	kg/hr
Bulldozer on overburden	4.49	0.98	kg/hr
Excavator/FEL on coal	0.0161	0.0078	kg/t
Excavator/FEL on overburden	0.025	0.012	kg/t
Drilling	0.59	0.31	kg/hole
Scraper	1.1	0.3	kg/VKT
Trucks Dumping OB	0.012	0.0043	kg/t
Train Loading	0.0004	0.0002	kg/t
Wheel Dust – General	2.30	0.61	kg/VKT
Wheel Dust – Miscellaneous Delivery Trucks & Reject Haul	1.86	0.49	kg/VKT
Miscellaneous Conveying Points-ROM Coal	0.0005	0.0002	kg/t
Miscellaneous Conveying Points-Product Coal	0.0004	0.0002	kg/t
Wind Erosion	6,491	3,245	kg/m^2/yr

In general, default emission factors have been used as contained in Table 1 of the *Emission Estimation Technique Manual for Mining, Version 2.3*, (hereafter, "EETMM") (Environment Australia, 2001). In some instances, the moisture content of materials at the Mine Site is not adequately reflected within the default emission factors contained in the EETMM, and the equations given in either *Table 1* of the EETMM document or USEPA AP-42 documentation were therefore used to derive representative emission factors. The following emission factors were derived using this method.

6.3.1 Bulldozer on Coal

$$EF = k \times \frac{s^a}{M^b} \text{ kg/h}$$

where k=35.6 for TSP and 6.33 for PM_{10}, a = 1.2 for TSP and 1.5 for PM_{10}, b = 1.4, s = silt content and M = moisture content.

6.3.2 Bulldozer on Overburden

$$EF = k \times \frac{s^{1.2}}{M^{1.3}} \text{ kg/h}$$

where k=2.6 for TSP and 0.34 for PM_{10}, a = 1.2 for TSP and 1.5 for PM_{10}, b = 1.3 for TSP and 1.4 for PM_{10}, s = silt content and M = moisture content.

6.3.3 FEL on Coal

$$EF = k \times 0.0596 \times (M)^{-0.9} \text{ kg/t}$$

where k=1.56 for TSP and 0.75 for PM_{10} and M = moisture content.

6.3.4 Miscellaneous Conveying Points

$$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2}\right)^{-1.4} \text{ kg/t}$$

where k=0.74 for TSP and 0.35 for PM_{10}, U = mean wind speed and M = moisture content.

6.3.5 Scraper Operation

$$EF = 0.0000076 \times s^{1.3} W^{2.4} \text{ kg/VKT}$$

where s= silt content, W = vehicle gross mass.

6.3.6 Haul Truck Wheel Dust – Unpaved Roads (USEPA AP-42)

The emission factor for wheel generated dust from unpaved roads is estimated from the USEPA emission equation for Wheel Generated Dust from Unpaved Roads (2006).

$$EF = \left(k \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} \times \left(\frac{281.9}{1000}\right) \right) \times \left(\frac{(365 - N)}{365}\right) \text{ kg/VKT}$$

where k=4.9 for TSP and 1.5 for PM_{10}, s = silt content, W = vehicle gross mass and N = number of days with more than 0.254mm of rainfall.

6.3.7 Stockpile Wind Erosion

Hourly-varying wind erosion from exposed surfaces was estimated using the USEPA AP-42 approach for determining wind erosion (Chapter 13, Section 13.2.5 Industrial Wind Erosion). The total wind erosion potential for the modelling period is presented in **Table 11**.

6.4 Model Assumptions

The following section details the assumptions made in creating the emissions inventory for the construction and operational scenario. The majority of details are presented in **Appendix 3**.

- Annual extraction from the underground operations is assumed to be 8Mt.
- It is assumed that one dozer is in operation at the ROM and Product Coal stockpiles (split proportionally between the two sites) and reject emplacement area.
- Capacity for on-site haul trucks is assumed to be 50t. Capacity for reject haulage and miscellaneous delivery trucks is assumed to be 30t.
- The following moisture content (mc) and silt content (sc) will be assumed for the modelling.
    - Surface Materials: mc – 5.5%, sc – 10%.
    - ROM Coal: mc – 6%, sc – 7%.
    - Product Coal: mc – 7%, sc – 7%.
    - Unsealed Gravel Haul Routes: mc – 1.1%, sc – 6.4% (USEPA, 1998).
- Emission reduction factors for water spraying have been applied to conveying transfer points, stockpiles, haul routes and scraper operations, as per the EETMM. These emission controls are in keeping with information provided by the Proponent.
- It is understood that the screening, rotary breaking and CPP operations will be enclosed and largely fitted with water spray technology. Consequently, emissions from these processes have not been included.
- Brine Storage Pond construction operations are assumed to occur continuously in the northern 10ha of the Brine Storage Area. This is considered appropriate for predicting worst case maximum predicted concentrations at the nearest receptors. Brine Storage Pond construction operations involve material extraction and movement by scraper, bulldozer and haul truck during daylight hours.
- The wind erosion emission factor listed above relates to the hourly disturbance of a stockpile or similar emissions source. Consequently, it is assumed that 10% of each identified wind erosion source is active each hour for wind erosion generation.
- As the amenity bunds will be vegetated, a 99% reduction factor has been applied, as per the EETMM.

6.5 Ventilation Shaft Emissions

Odourous and particulate matter (PM_{10} and TSP) emissions from the Ventilation, Tailgate Ventilation, Goaf Gas and Pre-drainage ventilation points have been incorporated within this modelling assessment.

Emissions from these sources have been based on the measured emissions of PM_{10}, TSP and Odour associated with the ventilation shaft of an operational underground coal mine of annual coal production of 5.2Mt (EML, 2005). These monitoring results have been scaled to reflect the annual maximum production rate of 8Mt. **Table 12** presents the modelling parameters assumed for each of the ventilation and exhaust sources. **Table 13** presents the emission rates associated with each source.

Table 12
Underground Ventilation and Exhaust Source Parameters

Source ID	Height (m)	Diameter (m)	Exit Velocity (m/s)	Volumetric Flow Rate (m^3/s)
Ventilation Main	6	6	15.9	450
Ventilation Tailgate	4	2	6.4	20
Goaf Gas Point	5	0.3	31.1	2.2
Pre-Drainage Point	5	0.75	3.0	1.3
Note: Assumed exit temperature for all sources of 20°C				

Table 13
Underground Ventilation and Exhaust Source Emission Rates

Source ID	TSP (mg/s)	PM_{10} (mg/s)	Odour (OU.m3/s) by Stability Class	
			A,B,C	D,E,F
Ventilation Main	1107.7	761.5	85,985[1]	85,985[1]
Ventilation Tailgate	49.2	33.9	19,938[2]	41,538[3]
Goaf Gas Point	N/A	N/A	2,193[2]	4,569[3]
Pre-Drainage Point	N/A	N/A	1,316[2]	2,742[3]

Note 1: P/M60 of 2.3 for wake-affected point source applied, as per Table 6.1 of the Approved Methods

Note 2: P/M60 of 12 for stability classes A, B and C for wake free point source applied, as per Table 6.1 of the Approved Methods

Note 3: P/M60 of 25 for stability classes D, E and F for wake free point source applied, as per Table 6.1 of the Approved Methods

Volumetric flow rates for the Main and Tailgate Ventilation points have been provided by the Proponent. Goaf gas and pre-drainage flow rates have been approximated based on the Carbon Dioxide (CO_2) emission rates provided within a report by Moreby (2009), in litres/second, and the assumption of 90% CO_2-10% Methane (CH_4).

The Approved Methods state that Peak-to-Mean ratios should be incorporated when conducting atmospheric dispersion modelling of odour. It is commonly recognised that dispersion models need to be supplemented to accurately simulate atmospheric dispersion of odours. This is because the instantaneous perception of odours by the human nose typically occurs over a time scale of approximately one second but dispersion model predictions are typically valid for time scales equivalent to ten minutes to one hour averaging periods.

To estimate the effects of plume meandering and concentration fluctuations perceived by the human nose, it is possible to multiply dispersion model predictions by a correction factor called a “peak-to-mean ratio”.

The peak-to-mean ratio (P/M60) is defined as the ratio of peak 1-second average concentrations to mean 1-hour average concentrations.

It is assumed that due to the installation of an amenity bund around the main ventilation shaft, this source is classed as a wake-affected point. The remainder of ventilation and exhaust points are classed as wake-free surface points.

6.6 Emissions from Coal Wagons

Given that product coal from the Mine Site will be distributed solely by rail, it is pertinent to account for potential emissions associated with coal dust from train wagons.

The Proponent forecasts that with the use of the 1 500t capacity overhead load-out bin, a 72 wagon train with a capacity of 5 400t would be loaded in approximately 90 minutes. Slightly larger trains may be introduced throughout the life of the mine. At an anticipated maximum mining rate of 8Mtpa and an initial train capacity of 5 400t, an average of five trains would be loaded and despatched each day of the week. However, the rate of despatch would vary to meet shipping arrival schedules at Port Newcastle, approximately 382km southeast of the Mine Site.

Queensland Rail Limited (QR) recently commissioned a comprehensive study into fugitive dust emissions from a number of their coal rail transportation systems in the Queensland coal fields. This study comprised a literature review, a network of air quality monitoring equipment and atmospheric dispersion and numerical modelling.

During this assessment, conducted by Katestone Scientific (2008), reference was made to a paper by Ferreira et al (2003) which focused on the release of coal dust from train wagons. The study by Ferreira et al (2003) conducted measurement of TSP emissions from coal wagons over a 350km journey, and found that for such a distance, a 60t semi-covered wagon would lose approximately 0.001% of its load. Further testing by Ferreria et al. showed that if the wagon was uncovered, emissions could be increased by up to five times that of a semi-covered wagon.

The findings of Ferreria et al were used to derive emission factors for the dispersion modelling assessment conducted by Katestone Scientific (2009) for QR. The resulting predicted concentrations paired well with the track-side air quality monitoring conducted during the QR study, suggesting that the conclusions of the Ferreria et al study were acceptable for estimating the fugitive coal dust emissions from rail wagons. Consequently, in the absence of site specific emissions estimation methods, the findings of Ferreria et al have been adopted to estimate coal dust emissions from trains leaving the Mine Site.

Following advice from the Proponent, it is unlikely that the coal wagons from the Mine Site will be covered after loading. Therefore, the findings of Ferreria et al relating to uncovered train wagons will be applied. Based on a train load of 5400t, with each train comprising of 72 75t-capacity wagons and travel distance of approximately 382km, a TSP emission rate of 600g/km travelled has been derived for trains leaving the Mine Site. It is assumed that five trains leave the Mine Site daily.

To determine the potential impact along the railway route from the Mine Site, the transportation dispersion model CAL3QHCR, developed by the United States Environmental Protection Agency (USEPA), was used. CAL3QHCR is based on the dispersion algorithms contained within CALINE-3. While this model is designed to represent road emissions, with in-built algorithms to account for thermal turbulence, it is deemed appropriate for the purpose of this assessment.

The initial 8km from the Mine Site rail loop towards Baan Baa has been used to produce an indication of the potential impact associated with fugitive coal dust emissions from rail wagons. Calculation points positioned at 10m, 30m, 50m and 100m from the centre of the railway path have been selected at 10m intervals. Additionally, all sensitive receptor locations presented in **Table 1** have been included as assessment locations.

A representative cross section of 24-hour average TSP predicted concentrations of coal dust from uncovered rail wagons leaving the Mine Site, as predicted by CAL3QHCR, is presented in **Figure 13**. Peak 24-hour average TSP concentrations along the modelled route were predicted to be in the order of 5.2µg/m^3, occurring close to the release point. Beyond this point, concentrations quickly decrease to approximately 0.5µg/m^3 at 100m from the track. All receptor locations are located at distances further than 100m from the track and are therefore predicted to have concentrations less than 0.5µg/m^3.

It is considered that based on the predicted concentrations of TSP, there is unlikely to be a significant impact associated with PM_{10} generated by the movement of coal trains from the Mine Site in uncovered wagons.

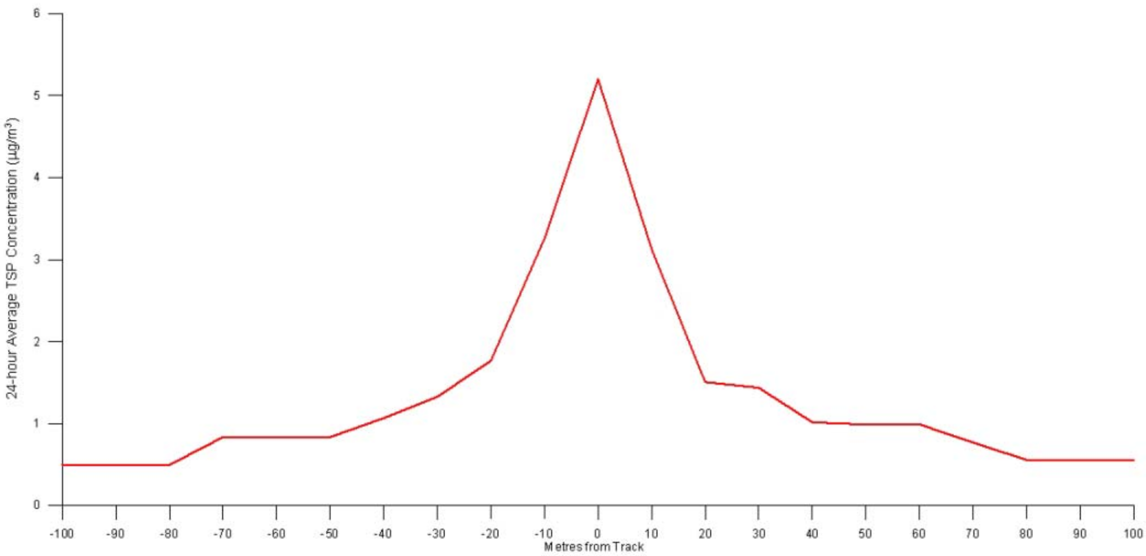

Figure 13
Cross-section of Predicted 24-hour Average TSP Concentrations
Fugitive Coal Dust from Rail Wagons

6.7 Combustion Emissions

In the assessment of Stage 1 operations for the Narrabri Coal Project, conducted by Heggies (Heggies Report 10-4332R3, 2007), dispersion modelling for emissions from the combustion of diesel fuel by mobile mining plant was incorporated. The results of this modelling indicated that for the proposed Stage 1 operations, the level of Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2) were insignificant in comparison with the respective DECC assessment criteria. Given that the level of surface plant proposed for operation in Stage 2 of the Project does not increase markedly from Stage 1, it is considered that there is unlikely to be any adverse impacts associated with the operation of diesel fuelled equipment at the Mine Site. Consequently, emissions of NO_2 and SO_2 have not been considered further in this assessment.

6.8 Spontaneous Combustion

Occasional spontaneous combustion may occur at the Mine Site, resulting when oxidation of the coal causes heat to build up to a point where the coal will ignite. The burning of the coal can result in emissions to air, including particulate matter, volatile organic compounds and toxic organic compounds such as PAHs. Odour emissions can also be expected from spontaneous combustion however, odour impacts on residences in the vicinity of the Mine Site cannot readily be quantified. To quantitatively assess the potential for odour impacts, information is needed on odour emission rates as well as data on the frequency of occurrence and duration of events, which is not readily available. However, spontaneous combustion events are expected to be infrequent and impacts expected to be short term. The Proponent will need to take all necessary management actions to ensure spontaneous combustion events are minimised, controlled and monitored to keep offsite impacts on residences to a minimum.

6.9 Water Pipeline Construction

In order to provide sufficient water levels for the operation of the Project, a water pipeline linking the Mine Site with the nearby Namoi River will be constructed. It is understood that construction of this pipeline would involve the use of an excavator and truck. Construction activities would occur during daylight hours only and would be low in intensity. Based on Heggies' experience with operations of this nature, it would be expected that, assuming suitable emission controls (including water spraying and/or wind breaks) are implemented during adverse weather conditions, minimal impact would be experienced at any residences located in proximity to the pipeline alignment. Consequently, emissions from this process have not been considered further in this assessment.

7 MODELLING RESULTS

7.1 Dust Deposition

Table 14 and **Table 15** show the results of the dispersion modelling for dust deposition from the Mine Site for Scenario 1 and 2 respectively, using the emission rates calculated in **Appendix 3**, at each of the identified receptors.

Table 14
Background and Incremental Dust Deposition at Nearest Receptors – Scenario 1

Receptor ID Property Name	Dust - Annual Average (g/m²/month)			
	Background	Increment	Background + Increment	Assessment Criterion
R1 - "Bow Hills"	1.6	0.1	1.7	2 - maximum increase 3.9 – total
R2 - "Ardmona"		0.2	1.8	
R3 - "Naroo"		0.4	2.0	
R4 - "Oakleigh"		0.1	1.7	
R5 - "Pineview"		<0.1	1.6	
R6 - "Matilda"		<0.1	1.6	
R7 - "Haylin View"		<0.1	1.6	
R10 - "Merrilong"		<0.1	1.6	
R11 - "Kurrajong"		<0.1	1.6	
R13 - "Newhaven"		0.1	1.7	
R15 - "Greylands"		0.3	2.0	
R16 - "Belah Park"		0.5	2.1	
R17 – "Bungaree"		0.1	1.7	
R18 – "Merulana"		0.1	1.7	

The results for both Scenario 1 and Scenario 2 show the mean average monthly dust deposition predicted at the nearest receptors surrounding the Mine Site over a one-year time frame. As detailed in **Section 4.2** the background level of dust deposition for the area surrounding the Mine Site is taken to be 1.6 g/m^2/month.

The results presented in **Table 14** and **Table 15** indicate that the total mean monthly dust deposition (background plus increment) associated with the Project are predicted to be less than 2.1g/m^2/month, at all the nearest non-project related receptors for both Scenario 1 and 2 operations. Therefore, the DECC criterion is predicted to be satisfied for both scenarios with respect to dust deposition.

A contour plot of the incremental increase in dust deposition attributable to each scenario is presented in **Appendix 4**. The contour plot is indicative of the levels of dust deposition that could potentially be reached under the conditions modelled.

Table 15
Background and Incremental Dust Deposition at Nearest Receptors – Scenario 2

Receptor ID Property Name	Dust - Annual Average (g/m^2/month)			
	Background	Increment	Background + Increment	Assessment Criterion
R1 - "Bow Hills"	1.6	0.1	1.7	2 - maximum increase 3.9 – total
R2 - "Ardmona"		0.1	1.7	
R3 - "Naroo"		0.2	1.8	
R4 - "Oakleigh"		<0.1	1.6	
R5 - "Pineview"		<0.1	1.6	
R6 - "Matilda"		<0.1	1.6	
R7 - "Haylin View"		<0.1	1.6	
R10 - "Merrilong"		<0.1	1.6	
R11 - "Kurrajong"		<0.1	1.6	
R13 - "Newhaven"		0.1	1.7	
R15 - "Greylands"		0.2	1.8	
R16 - "Belah Park"		<0.1	1.6	
R17 - “Bungaree”		<0.1	1.6	
R18 - “Merulana”		<0.1	1.6	

7.2 PM_{10} (24-Hour Average)

Table 16 and **Table 17** show the results of the dispersion modelling for 24-hour average PM_{10} concentrations from the Mine Site for Scenario 1 and 2 respectively, using the emission rates calculated in **Appendix 3**, at each of the identified receptors.

As detailed in **Section 4.3**, it has been assumed that background levels of PM_{10} vary on a daily basis. These background levels have been incorporated into the model. However as noted previously, elevated PM_{10} concentrations within the background file already exceed the impact assessment criteria on three separate occasions.

In accordance with Section 5 of the Approved Methods, the purpose of this assessment is to demonstrate that no additional exceedances of the impact assessment criterion would occur as a result of the Project. Accordingly, the results in **Table 16** and **Table 17** present the maximum (background plus increment) 24-hour average concentration of PM_{10} predicted at the receptors surrounding the site, excluding the days when the background already exceeds the DECC impact assessment criterion.

It can be seen that, with the exception of R2 and R3 in Scenario 2, the maximum predicted concentrations at all non-Project receptors are below the assessment criterion. The maximum predicted concentration at during Scenario 2 is 69.7$\mu g/m^3$ at R3.

It can be seen that background concentrations listed in **Table 17** vary between the receptor locations. This is attributable to the time-varying meteorological and Tamworth PM_{10} input datasets used in the dispersion modelling process.

Table 16
Maximum (Background and Incremental) 24-hour Average PM_{10} Concentrations at Nearest Receptors – Scenario 1

Receptor ID - Property Name	Background (Date)	Increment	Background + Increment	Assessment Criterion
R1 - "Bow Hills"	46.4 (15/09/2008)	<0.1	46.4	50
R2 - "Ardmona"	46.4 (15/09/2008)	0.6	47.0	
R3 - "Naroo"	46.4 (15/09/2008)	1.2	47.6	
R4 - "Oakleigh"	46.4 (15/09/2008)	0.5	46.9	
R5 - "Pineview"	46.4 (15/09/2008)	<0.1	46.7	
R6 - "Matilda"	46.4 (15/09/2008)	<0.1	46.4	
R7 - "Haylin View"	46.4 (15/09/2008)	<0.1	46.4	
R10 - "Merrilong"	46.4 (15/09/2008)	<0.1	46.4	
R11 - "Kurrajong"	46.4 (15/09/2008)	<0.1	46.4	
R13 - "Newhaven"	46.4 (15/09/2008)	<0.1	46.4	
R15 - "Greylands"	46.4 (15/09/2008)	<0.1	46.4	
R16 - "Belah Park"	46.4 (15/09/2008)	<0.1	46.4	
R17 - “Bungaree”	46.4 (15/09/2008)	<0.1	46.4	
R18 - “Merulana”	46.4 (15/09/2008)	<0.1	46.4	

Table 17
Maximum (Background and Incremental) 24-hour Average PM_{10} Concentrations at Nearest Receptors – Scenario 2

Receptor ID - Property Name	Background (Date)	Increment	Background + Increment	Assessment Criterion
R1 - "Bow Hills"	40.6 (01/07/2008)	7.8	48.4	50
R2 - "Ardmona"	18.4 (27/04/2008)	32.8	51.2	
R3 - "Naroo"	27.4 (18/12/2008)	30.8	58.2	
R4 - "Oakleigh"	46.4 (15/09/2008)	0.8	47.2	
R5 - "Pineview"	46.4 (15/09/2008)	0.4	46.8	
R6 - "Matilda"	46.4 (15/09/2008)	0.0	46.4	
R7 - "Haylin View"	46.4 (15/09/2008)	0.0	46.4	
R10 - "Merrilong"	46.4 (15/09/2008)	0.0	46.4	
R11 - "Kurrajong"	46.4 (15/09/2008)	0.0	46.4	
R13 - "Newhaven"	46.4 (15/09/2008)	0.0	46.4	
R15 - "Greylands"	46.4 (15/09/2008)	0.0	46.4	
R16 - "Belah Park"	41.4 (23/11/2008)	6.2	47.6	
R17 - “Bungaree”	46.4 (15/09/2008)	0	46.4	
R18 - “Merulana”	46.4 (15/09/2008)	0	46.4	

In addition to establishing the maximum (background plus increment) value, it is instructive to evaluate the maximum predicted incremental increase in 24-hour average PM_{10} concentrations at receptors where the assessment criterion is exceeded. **Table 18** presents both the incidences of 10 highest background (and their corresponding predicted increment), and the 10 highest predicted incremental increases (and their corresponding background) at R2 and R3. Background PM_{10} concentrations are from the corresponding Tamworth DECC PM_{10} dataset.

The left side of **Table 18** shows the total predicted concentration on days with the highest background concentration, while the right side of the table shows the total predicted concentration on days with the highest predicted incremental concentration.

From this additional analysis, it can be seen the maximum (increment plus background) PM_{10} is predicted to equal or exceed the 24-hour PM_{10} assessment criterion at R2 and three times at R3, beyond the exceedance initially reported in **Table 17**. Maximum incremental increase at R2 and R3 is predicted to be 32.8μg/m^3 and 30.8μg/m^3.

Table 18
Predicted Background and Incremental 24-Hour PM_{10} Maxima - Receptor R2 and R3 – Scenario 2

Date	PM_{10} - 24-Hour Average (µg/m^3)			Date	PM_{10} - 24-Hour Average (µg/m^3)		
	Highest Background	Predicted increment	Highest Predicted Total		Background	Highest Predicted Increment	Total
Receptor R2							
15/09/2008	46.4	3.6	50.0	27/04/2008	18.4	32.8	51.2
23/11/2008	41.4	0.6	42.0	17/05/2008	15.0	13.1	28.1
19/09/2008	40.9	1.7	42.6	07/08/2008	15.8	11.8	27.6
01/07/2008	40.6	0.8	41.4	27/10/2008	26.0	9.6	35.6
20/09/2008	39.0	4.7	43.7	10/08/2008	15.8	9.2	25.0
17/12/2008	38.9	2.3	41.2	28/09/2008	20.0	8.4	28.4
18/09/2008	38.8	1.3	40.1	21/03/2008	19.9	8.3	28.2
31/10/2008	35.4	6.4	41.8	20/01/2008	9.2	8.2	17.4
31/12/2008	34.3	1.5	35.8	02/04/2008	22.8	7.5	30.3
03/10/2008	33.0	5.8	38.8	31/07/2008	15.8	7.5	23.3
Receptor R3							
15/09/2008	46.4	3.6	53.7	18/12/2008	27.4	30.8	58.2
23/11/2008	41.4	0.3	43.1	27/04/2008	18.4	23.9	42.3
19/09/2008	40.9	3.6	44.5	27/10/2008	26.0	23.4	49.4
01/07/2008	40.6	0.7	41.3	07/08/2008	15.8	20.9	36.7
20/09/2008	39.0	3.9	47.9	17/05/2008	15.0	19.0	34.0
17/12/2008	38.9	3.9	42.8	21/08/2008	15.8	18.6	34.4
18/09/2008	38.8	2.0	40.9	02/04/2008	22.8	16.0	38.8
31/10/2008	35.4	4.0	50.3	10/08/2008	15.8	15.9	31.8
31/12/2008	34.3	2.3	36.6	31/10/2008	35.4	14.9	50.3
03/10/2008	33.0	4.9	43.2	21/03/2008	19.9	14.5	34.4

Inspection of the meteorological conditions within the input 2008 dataset during each of the elevated 24-hour predicted incremental PM_{10} concentrations indicated that moderate to fresh winds from the northwest quadrant were dominant. This would suggest that the primary emissions source influencing the predicted concentrations is wind erosion from exposed surfaces and stockpiles. Further analysis indicated that the worst-case construction footprint associated with the Brine Storage Ponds was notably contributing to the concentrations at R2 and R3. Given the periodic and temporary nature of the Brine Storage Pond construction and the relatively low frequency of moderate to fresh winds from the northwest quadrant (approximately 7% in 2008), it is considered that the predicted incremental PM_{10} concentrations for Scenario 2, presented in the preceding tables, are a conservative representation of the impacts likely to be experienced in the surrounding area.

In addition to the data presented above, the maximum predicted incremental increase at each receptor attributable to the Longwall Project for each scenario, the corresponding background concentration within the Tamworth dataset and the combined predicted concentration is presented in **Table 19** and **Table 20**.

A contour plot of the maximum incremental 24-hour PM_{10} concentrations attributable to each scenario at the Mine Site is presented in **Appendix 5**.

Table 19
Maximum Predicted Incremental Increase and Corresponding Background – Scenario 1

Receptor ID Property Name	PM_{10} – 24-hour Average (µg/m^3)			
	Maximum Predicted Increment	**Background (Date)**	**Background + Increment**	**Assessment Criterion**
R1 - "Bow Hills"	4.1	14.0 (10/06/2008)	18.1	50
R2 - "Ardmona"	2.5	20.2 (26/08/2008)	22.7	
R3 - "Naroo"	3.3	14.2 (01/12/2008)	17.5	
R4 - "Oakleigh"	1.5	19.3 (12/09/2008)	20.8	
R5 - "Pineview"	1.2	15.8 (14/07/2008)	17.0	
R6 - "Matilda"	1.8	12.2 (13/10/2008)	14.0	
R7 - "Haylin View"	1.9	12.2 (13/10/2008)	14.1	
R10 - "Merrilong"	1.1	15.8 (16/07/2008)	16.9	
R11 - "Kurrajong"	2.5	15.8 (16/07/2008)	18.3	
R13 - "Newhaven"	1.4	20.4 (28/06/2008)	21.8	
R15 - "Greylands"	2.6	15.8 (04/03/2008)	18.4	
R16 - "Belah Park"	1.6	20.9 (28/05/2008)	22.5	
R17 - “Bungaree”	1.3	17.1 (04/05/2008)	18.4	
R18 - “Merulana”	1.2	7.4 (08/01/2008)	8.6	

Table 20
Maximum Predicted Incremental Increase and Corresponding Background – Scenario 2

Receptor ID Property Name	PM_{10} – 24-hour Average (µg/m^3)			
	Maximum Predicted Increment	**Background (Date)**	**Background + Increment**	**Assessment Criterion**
R1 - "Bow Hills"	8.2	15.8 (03/08/2008)	24.0	50
R2 - "Ardmona"	32.8	18.4 (27/04/2008)	51.2	
R3 - "Naroo"	30.8	27.4 (18/12/2008)	58.2	
R4 - "Oakleigh"	6.8	27.4 (18/12/2008)	34.2	
R5 - "Pineview"	3.9	15.8 (21/08/2008)	19.7	
R6 - "Matilda"	3.3	15.8 (19/07/2008)	19.1	
R7 - "Haylin View"	3.2	18.9 (11/09/2008)	22.1	
R10 - "Merrilong"	1.7	18.7 (15/03/2008)	20.4	
R11 - "Kurrajong"	4.3	15.8 (19/07/2008)	20.1	
R13 - "Newhaven"	6.1	15.7 (05/06/2008)	21.8	
R15 - "Greylands"	15.6	15.8 (29/07/2008)	31.4	
R16 - "Belah Park"	19.4	19.9 (21/03/2008)	39.3	
R17 - “Bungaree”	5.5	15.8 (09/08/2008)	21.3	
R18 - “Merulana”	5.1	23.7 (06/03/2008)	28.8	

7.3 PM_{10} (Annual Average)

Table 21 and **Table 22** show the results of the dispersion modelling for annual average PM_{10} concentrations from the Mine Site for Scenarios 1 and 2, using the emission rates calculated in **Appendix 3**, at each of the identified receptors

As detailed in **Section 4.3** the annual average background concentration of PM_{10} assumed for the Mine Site is 15.8µg/m^3. This background level has been incorporated into the model through the hourly varying background file.

Table 21
Annual Average PM_{10} Concentrations at Nearest Receptors – Scenario 1

Receptor	PM_{10} – Annual Average (µg/m^3)			
	Background	Increment	Background + Increment	Assessment Criterion
R1 - "Bow Hills"	15.8	0.3	16.1	30
R2 - "Ardmona"		0.3	16.1	
R3 - "Naroo"		0.4	16.2	
R4 - "Oakleigh"		0.2	16.0	
R5 - "Pineview"		0.1	16.0	
R6 - "Matilda"		0.1	15.9	
R7 - "Haylin View"		0.1	15.9	
R10 - "Merrilong"		0.1	15.9	
R11 - "Kurrajong"		0.2	16.0	
R13 - "Newhaven"		0.2	16.0	
R15 - "Greylands"		0.4	16.3	
R16 - "Belah Park"		0.2	16.1	
R17 - “Bungaree”		0.1	15.9	
R18 - “Merulana”		0.1	15.9	

Table 22
Annual Average PM_{10} Concentrations at Nearest Receptors – Scenario 2

Receptor	PM_{10} – Annual Average (µg/m^3)			
	Background	Increment	Background + Increment	Assessment Criterion
R1 - "Bow Hills"	15.8	1.3	17.2	30
R2 - "Ardmona"		1.5	17.3	
R3 - "Naroo"		2.6	18.4	
R4 - "Oakleigh"		0.6	16.4	
R5 - "Pineview"		0.4	16.3	
R6 - "Matilda"		0.3	16.1	
R7 - "Haylin View"		0.4	16.2	
R10 - "Merrilong"		0.2	16.0	
R11 - "Kurrajong"		0.5	16.3	
R13 - "Newhaven"		1.1	17.0	
R15 - "Greylands"		2.3	18.1	
R16 - "Belah Park"		2.7	18.5	
R17 - “Bungaree”		0.9	16.7	
R18 - “Merulana”		0.7	16.5	

The results presented in **Table 21** and **Table 22** indicate that for both scenarios, the annual average PM_{10} concentrations (background plus increment) associated with the Project are predicted to be below the assessment criterion of 30 µg/m^3 (annual average) at each receptor.

Based on the low magnitude of predicted incremental annual average PM_{10} concentrations for both modelling scenarios, it is considered that the construction and operation of the Mine Site will unlikely impact upon the surrounding receptors under the typical meteorological conditions to be experienced in the region.

A contour plot of the annual average PM_{10} concentrations (background plus increment) attributable to the Mine Site for each modelling scenario is presented in **Appendix 6.**

7.4 Odour Impact

Table 23 shows the results of the dispersion modelling for the 99th percentile odour concentrations at each of the nearest receptors with relevant peak-to-mean ratios applied, over a one year time frame.

The results presented in **Table 23** indicate that at all receptors, the predicted odour concentrations associated with the underground ventilation and exhaust points do not exceed the project goal of 6.0 OU (99th percentile) expressed as a nose response average (1-second) value. A contour plot of the predicted 99th percentile 1-second average odour concentrations attributable to the Project is presented in **Appendix 7.**

Table 23
Predicted 99th Percentile Odour Concentrations at Nearest Receptors

Receptor ID Property Name	99th percentile Odour Concentration (OU)	Assessment Criterion(OU)
R1 - "Bow Hills"	0.1	6
R2 - "Ardmona"	0.1	
R3 - "Naroo"	0.2	
R4 - "Oakleigh"	0.1	
R5 - "Pineview"	0.1	
R6 - "Matilda"	0.1	
R7 - "Haylin View"	0.1	
R10 - "Merrilong"	0.0	
R11 - "Kurrajong"	0.1	
R13 - "Newhaven"	0.5	
R15 - "Greylands"	0.5	
R16 - "Belah Park"	0.3	
R17 - “Bungaree”	0.3	
R18 - “Merulana”	0.2	

8 MITIGATION AND MONITORING RECOMMENDATIONS

The results and trends provided by the dispersion modelling results within this assessment should be used in highlighting key areas of potential impact and focusing site management practices. Primary sources of emissions during the construction and operational scenarios are considered to be:

- bulldozers managing the ROM and Product coal stockpiles;
- the removal of topsoil/overburden via scrapers during site construction activities;
- wind-generated emissions from exposed surfaces and stockpiles.

Consequently, site management practices should focus on these operations. Ongoing vigilance to the implementation of site dust management practices, particularly during periods of adverse weather conditions (strong winds from the northwest quadrant) can assist in the minimisation of potential impacts.

Some such methods include:

- minimisation of exposed surfaces at goaf drainage, ventilation, waste emplacement and brine storage pond construction areas;
- implementation of water spray technology wherever practical and possible to increase the moisture content of overburden and ROM coal. Such technology can be applied to Project components including topsoil removal, stockpiles, conveyor and truck transfer points and haul routes; and
- ensuring that haul routes, both unsealed and sealed, are maintained regularly.

The existing air quality monitoring network comprising of eight dust deposition gauges and two HVAS for PM_{10} is considered appropriate for future monitoring purposes which should be an important tool in assessing the ongoing performance of future operations at the Mine Site. The results of the air quality monitoring should be reviewed in conjunction with corresponding meteorological data from the onsite weather station to determine the likely source the recorded levels. This analysis can assist greatly in assessing the effectiveness of site management practices.

9 CONCLUSIONS

The air quality impact impacts associated with the Stage 2 Narrabri Coal project are assessed in accordance with the DGRs for assessment.

The results from the dispersion modelling conducted indicate that for emissions of dust, PM_{10} and odour from the Mine Site, there is unlikely to be an adverse impact upon the surrounding environment. Furthermore, it was concluded that emissions from the rail transportation of coal to Port Newcastle would be unlikely to adversely impact upon potential receptors situated in close proximity to the rail corridor.

Greenhouse Gas emissions of CO_2 and CH_4 are considered separately (Heggies report "10-7193R2") – see Part 8 of the Specialist Consultant Compendium.

The modelling scenarios have been compiled to reflect a conservative representation of the likely processes to occur during a daily operation. In particular, the operations associated with the site construction scenario are proposed to be periodic and unlikely to all occur continuously at the same time as modelled in this assessment. Furthermore, the odour emission data adopted for the goaf gas and pre-drainage points has been obtained from stack testing of an operational ventilation shaft, as detailed in **Section 6.5**. The odour character of an operational ventilation shaft is likely to differ to that of a coal seam gas vent. Indeed, it is expected that there will be minimal odourous emissions from the goaf gas and pre-drainage points given that coal seam gas is typically odourless. Consequently, the odour modelling conducted in this assessment is considered conservative.

The existing air quality monitoring network comprising of eight dust deposition gauges and two HVAS for PM_{10} is considered appropriate for future monitoring purposes. Continuation of these locations will assist in site management and provide an indication of the level of conservatism contained within this assessment.

10 REFERENCES

The following documents and resources have been used in the production of this report.

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Ferreria, A, Viega, D, Sousa, A. (2003) Full-scale Measurements for evaluation of coal dust release from train wagons with two different shelter covers. *Jnl of Wind Engineering and Industrial Aerodynamics*, Vol 91, pp 1271-1283.

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US EPA (2000), Meteorological Monitoring Guidance for Regulatory Modeling Applications.

US EPA (2003) Compilation of Air Pollutant Emission Factors AP-42 - Chapter 13.2.2 Unpaved Roads.

US EPA (2006) Compilation of Air Pollutant Emission Factors AP-42 (Chapter 13, Section 13.2.5 Industrial Wind Erosion).

Narrabri Coal Operations PtyLimited (2009), Dust Deposition, PM_{10} and Meteorological Monitoring Data from established monitoring equipment at Mine Site.

11 GLOSSARY

AHD	Australian Height Datum
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
CH_4	Methane
CO_2	Carbon Dioxide
CPP	Coal Preparation Plant
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECC	NSW Department of the Environment and Climate Change
EETMM	Emission Estimation Technique Manual for Mining, Version 2.3
$g/m^2/month$	Grams per square metre per month
Heggies	Heggies Pty Ltd
HVAS	High Volume Air Sampler
µg	Microgram ($g \times 10^{-6}$)
µm	Micrometre or micron ($metre \times 10^{-6}$)
m^3	Cubic metre
MGA	Map Grid of Australia
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
PM_{10}	Particulate matter less than 10microns in aerodynamic diameter
The Mine Site	Narrabri Coal Mine Site
The Proponent	Narrabri Coal Operations Pty Ltd
QR	Queensland Rail Limited
ROM	Run-Of-Mine
RWC	R.W. Corkery and Co Pty Limited
tpa	Tonnes per Annum
TAPM	“The Air Pollution Model”
TSP	Total Suspended Particulate
USEPA	United States Environmental Protection Agency
VKT	Vehicle Kilometres Travelled

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APPENDICES

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APPENDIX 1

Annual and Seasonal Wind Roses – Project Site

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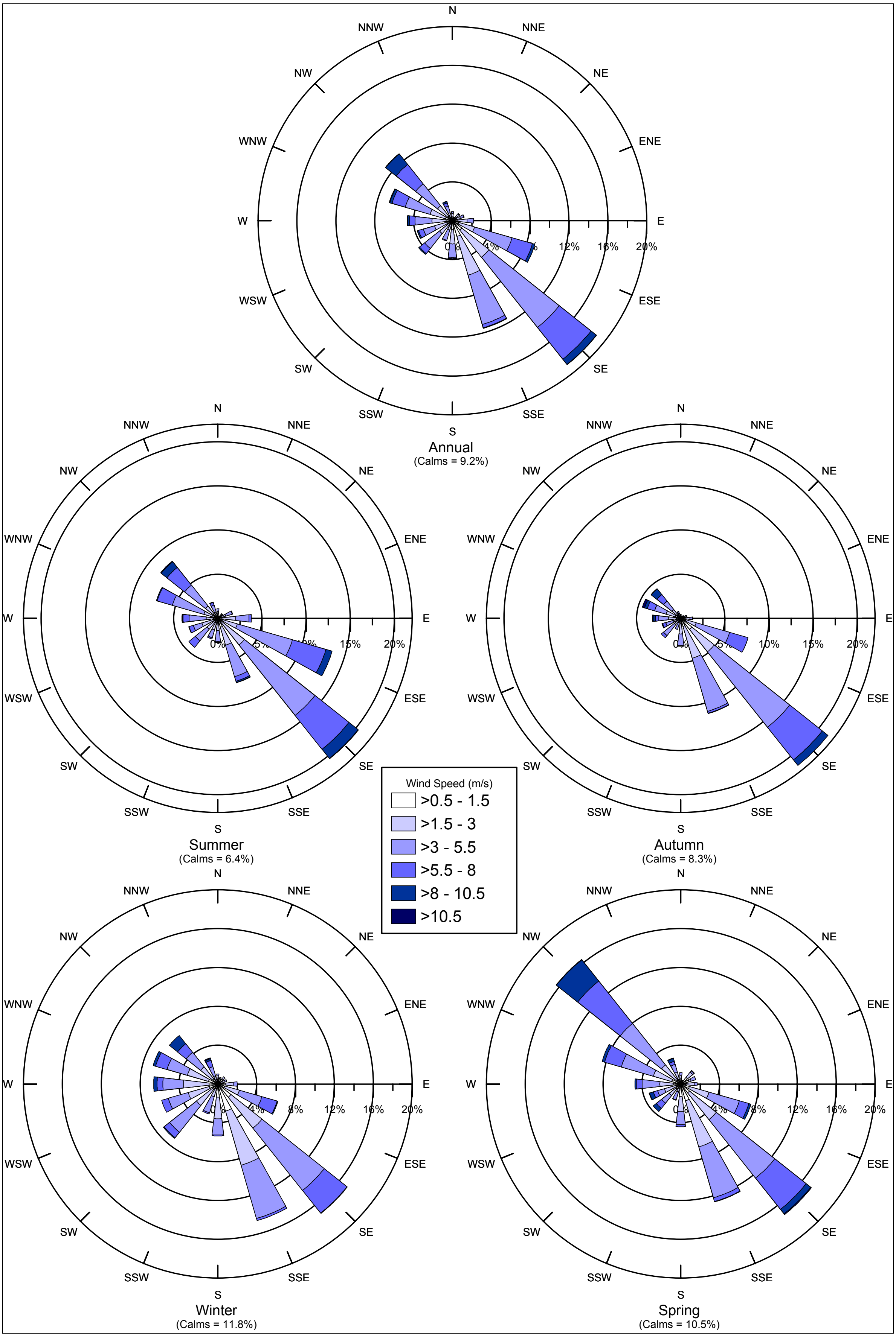
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NNE
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SSW
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NNW
0%
4%
8%
12%
16%
20%
Annual
(Calms = 9.2%)
Summer
(Calms = 6.4%)
Autumn
(Calms = 8.3%)
Winter
(Calms = 11.8%)
Spring
(Calms = 10.5%)
5%
10%
15%
20%
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5

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APPENDIX 2

Seasonal Stability Class – Mine Site

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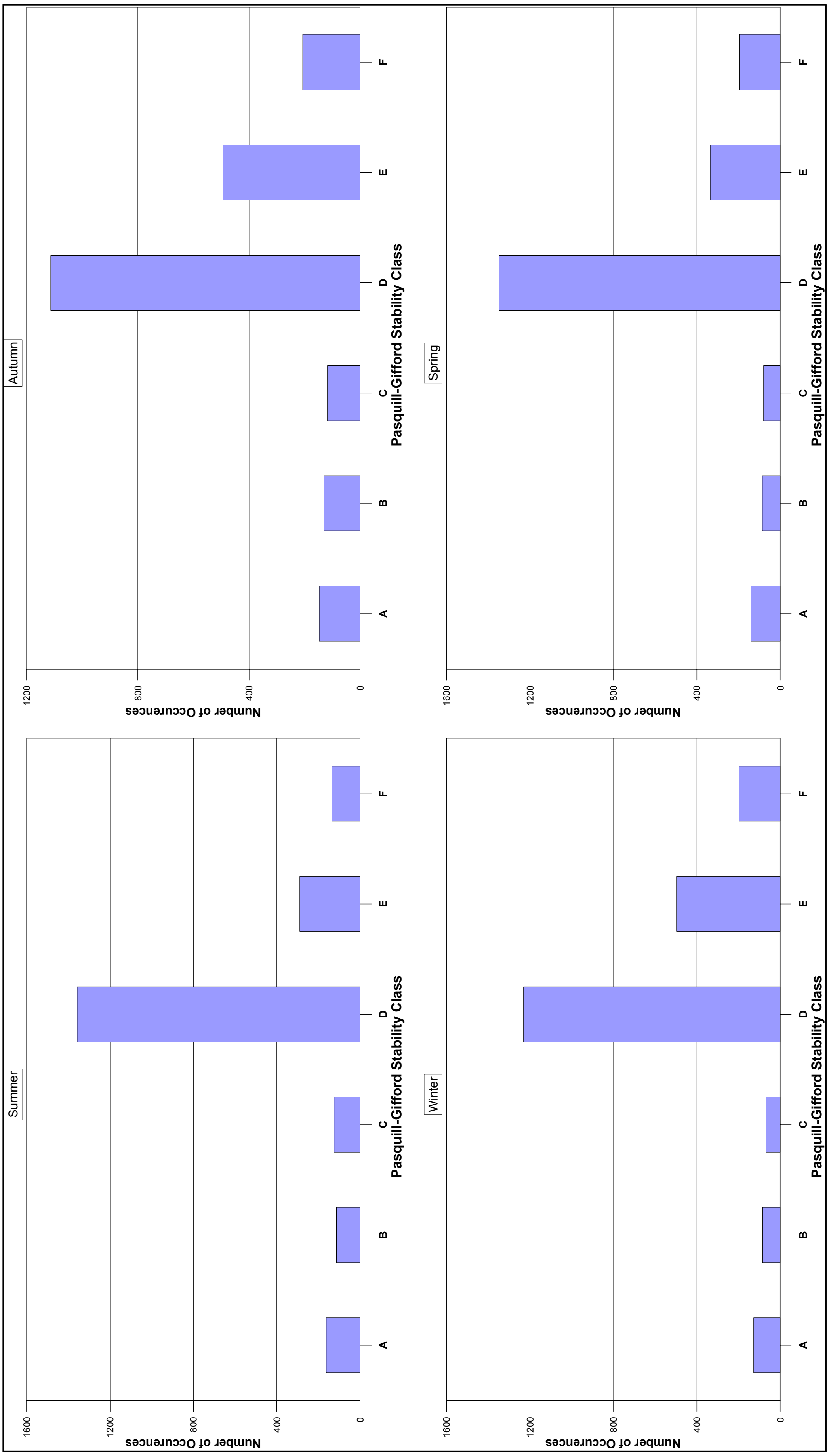
Autumn
Spring
Summer
Winter
Pasquill-Gifford Stability Class
Number of Occurences
A
B
C
D
E
F

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APPENDIX 3

Emissions Inventory

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Scenario 1 - Site Construction	Moisture Content (%)	Silt Content (%)	TSP Emission Factor	PM10 Emission Factor	Emission Factor Unit	Notes/Contols	Emissions Reduction From Controls	Variable		Mine Working Days	Modelled Working hours	TSP Emission Rate (g/s)	PM10 Emission Rate (g/s)	TSP Emission Flux (mg/s/m2)	PM10 Emission Flux (mg/s/m2)
Surface Operations															
Longwall Unit Area Scraper	5.5	10	1.06110	0.33552	kg/VKT	50% reduction for water spraying	50%	5.0	VKT/hr	366	15	736.9	233.0	N/A	N/A
Longwall Unit Area FEL	5.5	10	0.0250	0.0120	kg/t			50.0	t/hour	366	15	347.2	166.7	N/A	N/A
ROM Coal Pad Dozer	5.5	10	4.49264	0.98849	kg/hr			8.0	hours/day	366	8	1248.0	274.6	N/A	N/A
ROM Coal Pad Scraper	5.5	10	1.06110	0.33552	kg/VKT	50% reduction for water spraying	50%	5.0	VKT/hr	366	15	736.9	233.0	N/A	N/A
ROM Coal Pad FEL	5.5	10	0.0250	0.0120	kg/t			33.0	t/hour	366	15	229.2	110.0	N/A	N/A
CPP Dozer	5.5	10	4.49264	0.98849	kg/hr			7.0	hours/day	366	7	1248.0	274.6	N/A	N/A
CPP FEL	5.5	10	0.0250	0.0120	kg/t			6.0	t/hour	366	15	41.7	20.0	N/A	N/A
General Haulage	1.1	6	2.3017	0.6134	kg/VKT	75% for water spraying	75%	1.5	VKT/hr	366	15	239.8	63.9	N/A	N/A
Reject Area Dozer	5.5	10	4.49264	0.98849	kg/hr			15.0	hours/day	366	15	1248.0	274.6	N/A	N/A
Reject Area Scraper	5.5	10	1.06110	0.33552	kg/VKT	50% reduction for water spraying	50%	5.0	VKT/hr	366	15	736.9	233.0	N/A	N/A
Reject Area FEL	5.5	10	0.0250	0.0120	kg/t			105.0	t/hour	366	15	729.2	350.0	N/A	N/A
Reject Area Haulage	1.1	6	2.3017	0.6134	kg/VKT	75% for water spraying	75%	1.5	VKT/hr	366	15	239.8	63.9	N/A	N/A
Powerline Corridor Dozer	5.5	10	4.49264	0.98849	kg/hr			6.0	hours/day	366	6	208.0	45.8	N/A	N/A
Road Construction Dozer	5.5	10	4.49264	0.98849	kg/hr			6.0	hours/day	366	6	208.0	45.8	N/A	N/A
Ventilation Shaft Dozer	5.5	10	4.49264	0.98849	kg/hr			15.0	hours/day	366	15	1248.0	274.6	N/A	N/A
Ventilation Shaft Drilling	5.5	10	0.5900	0.3100	kg/hole			1.0	hole/hour	366	15	163.9	86.1	N/A	N/A
Ventilation Shaft FEL	5.5	10	0.0250	0.0120	kg/t			75.0	t/hour	366	15	520.8	250.0	N/A	N/A
Ventilation Shaft Haul Dump	5.5	10	0.0120	0.0043	kg/t			75.0	t/hour	366	15	250.0	89.6	N/A	N/A
Ventilation Shaft Haulage	1.1	6	2.3017	0.6134	kg/VKT	75% for water spraying	75%	0.3	VKT/hr	366	15	53.3	14.2	N/A	N/A
MRD Pre-drainage Dozer	5.5	10	4.49264	0.98849	kg/hr			15.0	hours/day	366	15	1248.0	274.6	N/A	N/A
MRD Pre-drainage Drilling	5.5	10	0.5900	0.3100	kg/hole			1.0	hole/hour	366	15	163.9	86.1	N/A	N/A
MRD Pre-drainage FEL	5.5	10	0.0250	0.0120	kg/t			9.4	t/hour	366	15	65.1	31.3	N/A	N/A
MRD Pre-drainage Haul Dump	5.5	10	0.0120	0.0043	kg/t			9.4	t/hour	366	15	31.3	11.2	N/A	N/A
MRD Pre-drainage Haulage	1.1	6	2.3017	0.6134	kg/VKT	75% for water spraying	75%	0.3	VKT/hr	366	15	53.3	14.2	N/A	N/A
Miscellaneous Delivery Trucks (4 Sources)	1.1	6	1.8629	0.4965	kg/VKT	75% reduction for sprays	75%	1.0	VKT/hour	366	15	32.3	8.6	N/A	N/A
Wind Erosion															
Reject Emplacement Area	6	7	3.4234	1.7117	kg/ha/hr	Assume 10% of total area is active		2.7	Hectares	366	24	N/A	N/A	Variable by each hour of year	
Waste Stockpile	6	7	3.4234	1.7117	kg/ha/hr	Assume 10% of total area is active		0.04	Hectares	366	24	N/A	N/A		
ROM Stockpile	6	7	3.4234	1.7117	kg/ha/hr	Assume 10% of total area is active		0.5	Hectares	366	24	N/A	N/A		
Product Stockpile	6	7	3.4234	1.7117	kg/ha/hr	Assume 10% of total area is active		0.3	Hectares	366	24	N/A	N/A		

	Moisture Content (%)	Silt Content (%)	TSP Emission Factor	PM10 Emission Factor	Emission Factor Unit	Notes/Contols	Emissions Reduction From Controls	Variable		Mine Working Days	Modelled Working hours	TSP Emission Rate (mg/s)	PM10 Emission Rate (mg/s)	TSP Emission Flux (mg/s/m^2)	PM_{10} Emission Flux (mg/s/m^2)
Surface Operations															
Drift Conveyor Transfer	6	7	0.0005	0.0002	kg/t	50% reduction for water spraying	50%	3500.0	t/hour	365	24	223.0	105.5	N/A	N/A
Dozer ROM S.P	6	7	29.9334	9.5420	kg/hr			24.0	hours/day	365	24	8314.8	2650.6	N/A	N/A
ROM Stockpile Loading	6	7	0.0005	0.0002	kg/t	50% reduction for water spraying	50%	3500.0	t/hour	365	24	223.0	105.5	N/A	N/A
Rotary Breaker Transfer	6	7	0.0005	0.0002	kg/t	50% reduction for water spraying	50%	1000.0	t/hour	365	24	63.7	30.1	N/A	N/A
Dry Screen Transfer	6	7	0.0005	0.0002	kg/t	50% reduction for water spraying	50%	1000.0	t/hour	365	24	63.7	30.1	N/A	N/A
Tertiary Sizer Transfer	7	7	0.0004	0.0002	kg/t	50% reduction for water spraying	50%	1000.0	t/hour	365	24	51.4	24.3	N/A	N/A
Product SP Loading	7	7	0.0004	0.0002	kg/t	50% reduction for water spraying	50%	1000.0	t/hour	365	24	51.4	24.3	N/A	N/A
Dozer Product SP	7	7	24.1229	7.6898	kg/hr			24.0	hours/day	365	24	6700.8	2136.0	N/A	N/A
Train Loading	7	7	0.0004	0.0002	kg/t			5500.0	t/hour	365	5	611.1	259.7	N/A	N/A
Reject Pile SP Loading	7	7	0.0004	0.0002	kg/t	50% reduction for water spraying	50%	175.0	t/hour	365	24	9.0	4.3	N/A	N/A
FEL Reject Truck Loading	7	7	0.0161	0.0078	kg/t			175.0	t/hour	365	24	784.4	377.1	N/A	N/A
Reject Haulage (2 Sources)	1.1	6	1.8629	0.4965	kg/VKT	75% reduction for Water Spraying	75%	9.3	VKT/hour	365	24	603.7	55.2	N/A	N/A
Reject Dumping	7	7	0.0100	0.0042	kg/t			175.0	t/hour	365	24	486.1	204.2	N/A	N/A
Dozer at Reject Emplacement Area	7	7	2.14025	0.41304	kg/hr			24.0	hours/day	365	24	594.5	114.7	N/A	N/A
Reject Area Scraper	5.5	10	1.06110	0.33552	kg/VKT	50% reduction for water spraying	50%	5.0	VKT/hr	365	24	736.9	233.0	N/A	N/A
Miscellaneous Delivery Trucks (4 Sources)	1.1	6	1.8629	0.4965	kg/VKT	75% reduction for Water Spraying	75%	1.0	VKT/hour	365	15	32.3	8.6	N/A	N/A
Brine Storage Pond - Scraper (3 sources)	5.5	10	1.06110	0.33552	kg/VKT	50% reduction for water spraying	50%	5.0	VKT/hr	365	12	245.6	77.7	N/A	N/A
Brine Storage Pond - Haulage (3 sources)	1.1	6	2.3017	0.6134	kg/VKT	75% for water spraying	75%	5.0	VKT/hr	365	12	266.4	71.0	N/A	N/A
Brine Storage Pond - Dozer	5.5	10	4.49264	0.98849	kg/hr			15.0	hours/day	365	12	1248.0	274.6	N/A	N/A
Wind Erosion															
Reject Emplacement Area	6	7	3.4234	1.7117	kg/ha/hr	Assume 10% of total area is active		2.7	Hectares	366	24	N/A	N/A	Variable by each hour of year	
Waste Stockpile	6	7	3.4234	1.7117	kg/ha/hr	50% reduction for water spraying	50%	0.04	Hectares	366	24	N/A	N/A		
ROM Stockpile	6	7	3.4234	1.7117	kg/ha/hr	50% reduction for water spraying	50%	0.5	Hectares	366	24	N/A	N/A		
Product Stockpile	6	7	3.4234	1.7117	kg/ha/hr	50% reduction for water spraying	50%	0.3	Hectares	366	24	N/A	N/A		
Brine Storage Pond Area	5.5	10	3.4234	1.7117	kg/ha/hr	Assume 10% of total area is active		10.0	Hectares	366	24	N/A	N/A		
Amenity Bunds	5.5	10	0.4000	0.2000	kg/ha/hr	99% Vegetation Reduction	99%	0.7	Hectares	366	24	N/A	N/A		

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APPENDIX 4

Average Incremental Dust Deposition

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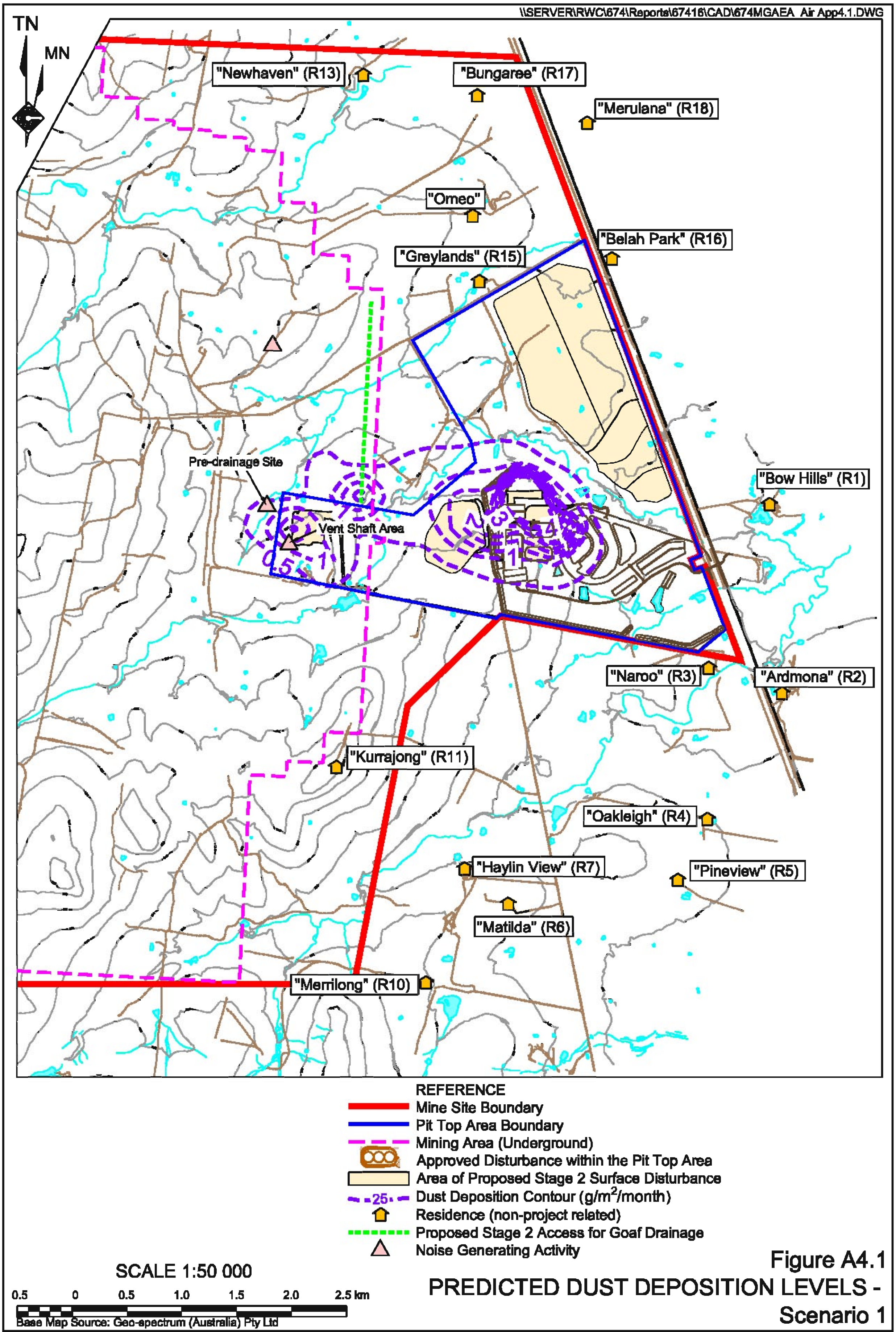

Figure A4.1
PREDICTED DUST DEPOSITION LEVELS - Scenario 1

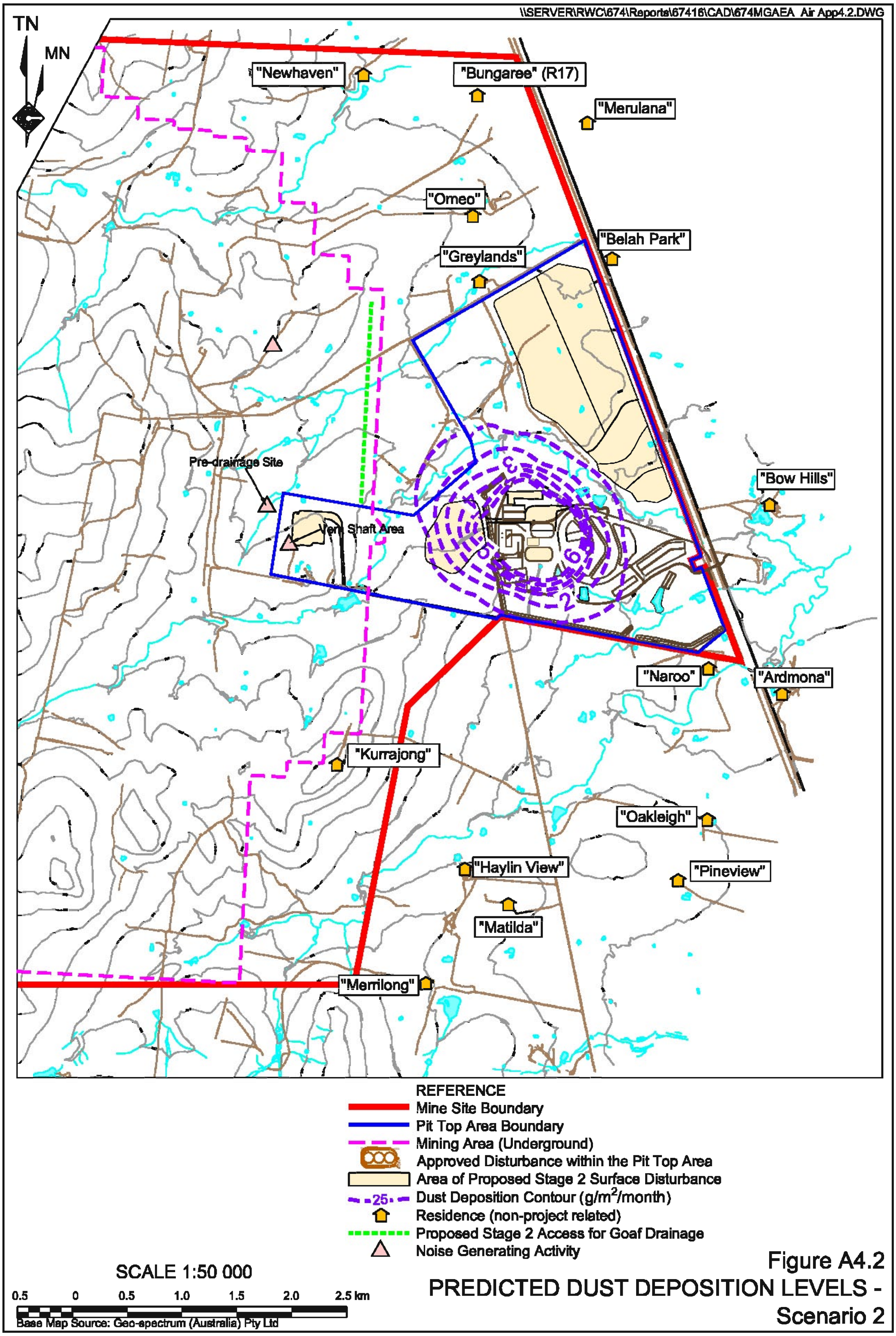

Figure A4.2
PREDICTED DUST DEPOSITION LEVELS - Scenario 2

APPENDIX 5

Incremental 24-hour Average PM_{10}

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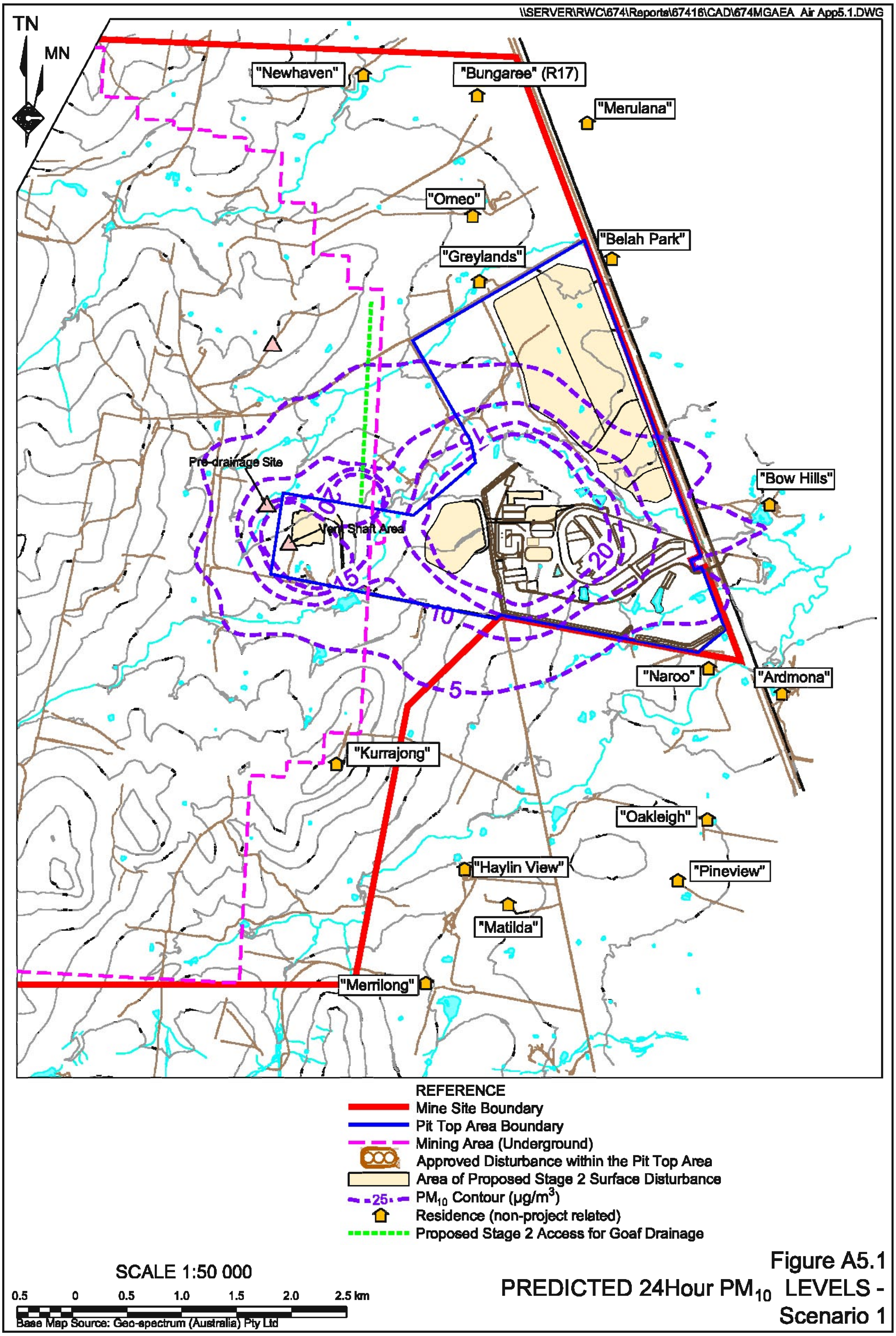
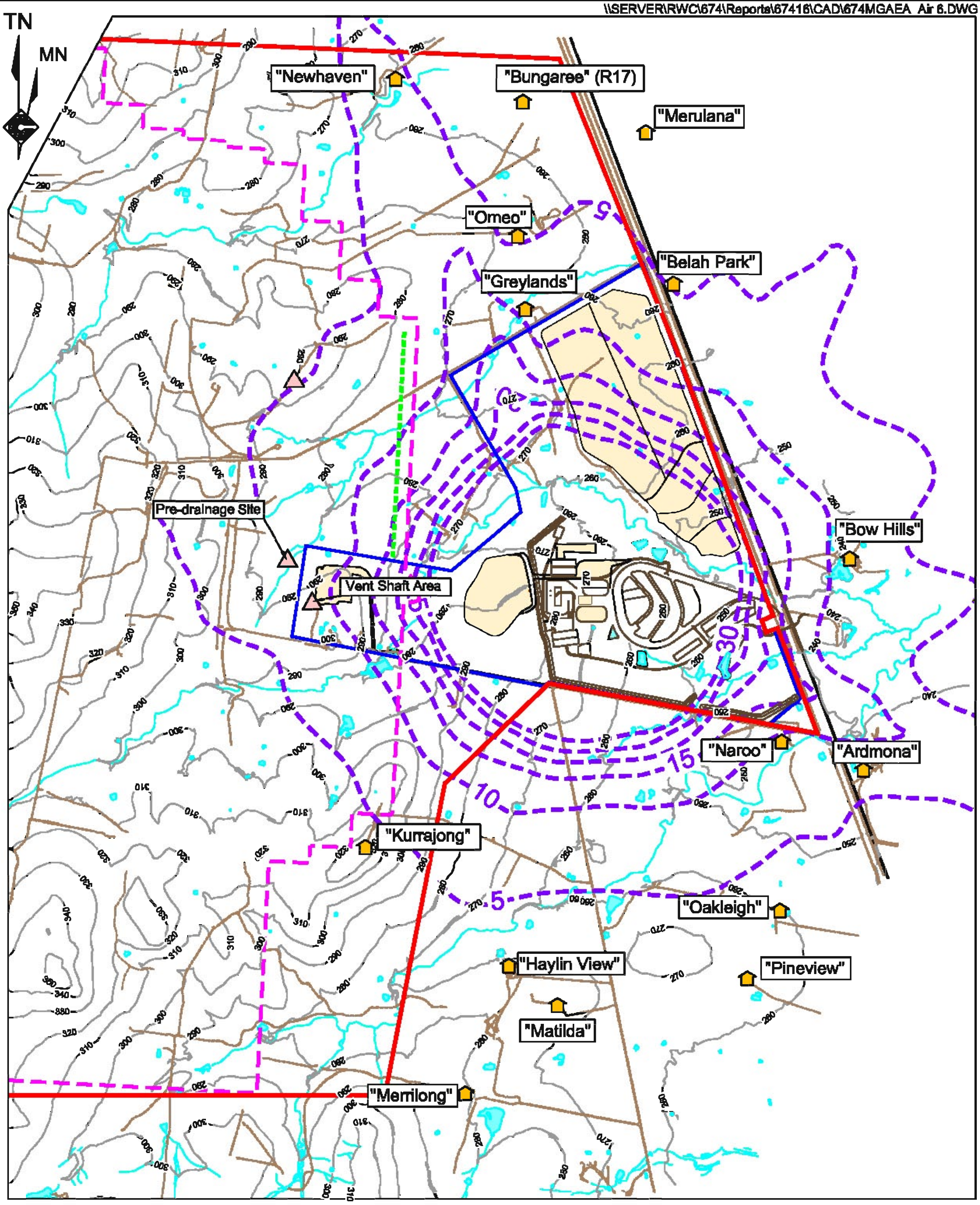


Figure A5.1
PREDICTED 24Hour PM_{10} LEVELS - Scenario 1



REFERENCE

- Mine Site Boundary
- Pit Top Area Boundary
- Mining Area (Underground)
- Contour (m AHD)(Interval = 10m)
- Sealed Road
- Unsealed Road / Track
- Creek / Drainage Line
- Approved Disturbance within the Pit Top Area
- Area of Proposed Stage 2 Surface Disturbance
- 25 PM_{10} Contour ($\mu g/m^3$)
- Residence (non-project related)
- Proposed Stage 2 Access for Goaf Drainage

SCALE 1:50 000

0.5 0 0.5 1.0 1.5 2.0 2.5 km

Base Map Source: Geo-spectrum (Australia) Pty Ltd

Figure A5.2
PREDICTED 24Hour PM_{10} LEVELS - Scenario 2

APPENDIX 6

Incremental Annual Average PM_{10}

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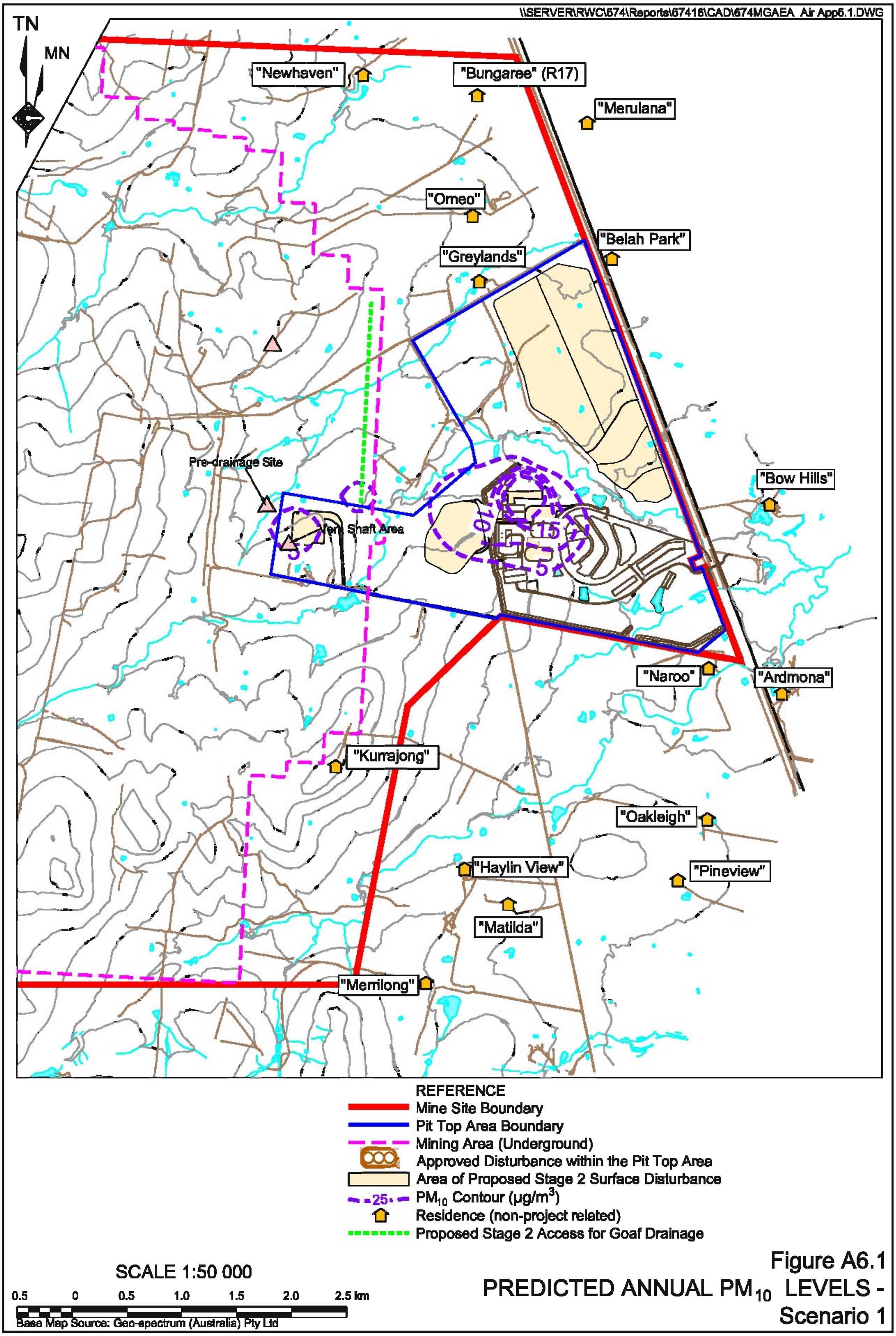
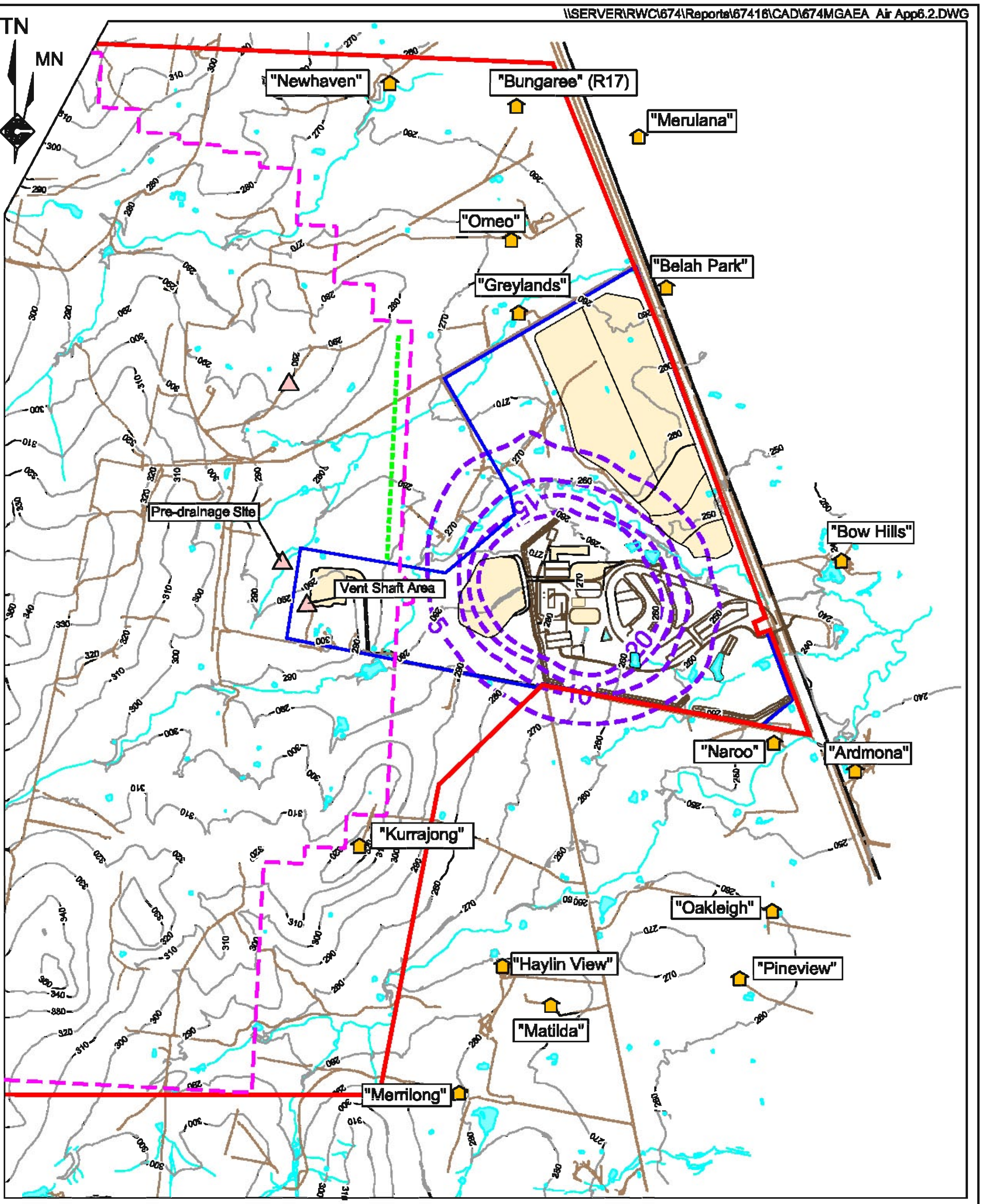


Figure A6.1
PREDICTED ANNUAL PM_{10} LEVELS - Scenario 1



REFERENCE

- Mine Site Boundary
- Pit Top Area Boundary
- Mining Area (Underground)
- 310 Contour (m AHD)(Interval = 10m)
- Sealed Road
- Unsealed Road / Track
- Creek / Drainage Line
- Approved Disturbance within the Pit Top Area
- Area of Proposed Stage 2 Surface Disturbance
- 25 PM_{10} Contour ($\mu g/m^3$)
- Residence (non-project related)
- Proposed Stage 2 Access for Goaf Drainage

SCALE 1:50 000

0.5 0 0.5 1.0 1.5 2.0 2.5 km

Base Map Source: Geo-spectrum (Australia) Pty Ltd

Figure A6.2
PREDICTED ANNUAL PM_{10} LEVELS - Scenario 2

APPENDIX 7

99th Percentile 1-Second Odour Concentrations (OU/m^3)

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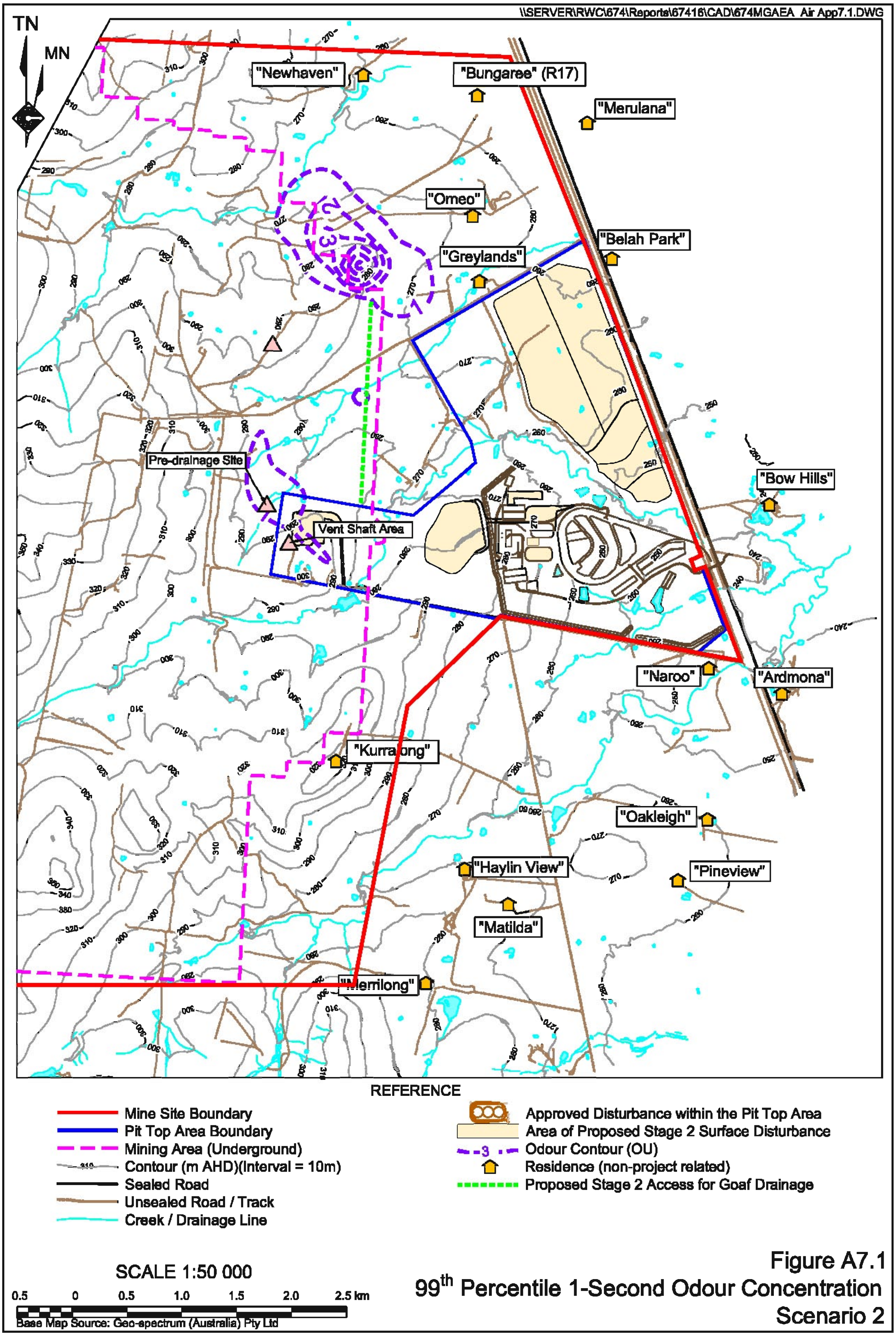

Figure A7.1
99th Percentile 1-Second Odour Concentration
Scenario 2

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