APPENDIX 17

Air Quality Assessment

Austar Coal Mine

Ventilation Shaft
Air Quality Impact Assessment

September 2008

Umwelt
Environmental Consultants

Ventilation Shaft
Air Quality Impact Assessment

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Austar Coal Mine

Project Director:	Peter Jamieson	
Project Manager:	Catherine Pepper	
Report No.	2274/R39/FINAL	Date: September 2008

Umwelt
Environmental Consultants

2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Ph: 02 4950 5322
Fax: 02 4950 5737
Email: mail@umwelt.com.au
Website: www.umwelt.com.au

EXECUTIVE SUMMARY

Austar Coal Mine Pty Limited (Austar) is an underground mine formed from the former Ellalong, Pelton, Cessnock No.1 (Kalingo) and Bellbird South Collieries near Cessnock, NSW (refer to **Figure 1.1**). Austar Coal Mine is proposed to be developed in three stages. A modification to consent (DA 29/56) was granted for Stage 1 of the mine in September 2006 and for the commencement of Stage 2 of the mine in June 2008. The modifications allowed the use Longwall Top Coal Caving (LTCC) technology extract coal at the site.

As part of proposed Stage 3 development, a new Surface Infrastructure Site is to be constructed to support the ongoing operation of the mine. The new infrastructure will include a mine ventilation system, mine access for workers and surface facilities such as administration buildings, a bathhouse and workshop (refer to **Figure 1.2**). The Surface Infrastructure Site is situated approximately 1.5 kilometres south of Kitchener and approximately 6 kilometres south of Cessnock.

The ventilation system at Surface Infrastructure Site will consist of an upcast ventilation shaft and downcast ventilation shaft that are required to provide sufficient quantity of air to support the proposed longwall mining in Stage 3. Umwelt (Australia) Pty Limited (Umwelt) has been commissioned by Austar to conduct an assessment of the air quality impact of the air to be discharged from the proposed upcast ventilation shaft.

The key objectives of the assessment include:

- identifying possible air quality impacts on potentially affected nearest sensitive receptors (private residences);
- identifying the existing ambient air quality environment (dust concentration and deposition) around the shaft; and
- identifying potential emission rates from the proposed vent.

Site-specific ambient air quality levels have been sourced and adopted from Austar local dust deposition and particulate matter observations. Meteorological data has been sourced from the Bureau of Meteorology (BoM) stations Cessnock and Williamtown.

The AUSPLUME Gaussian Plume Dispersion Model software (EPA, Victoria) has been utilised to predict potential dust deposition rates, PM_{10} and Total Suspended Particulate (TSP) emissions associated with operation of the ventilation shaft.

Twenty-five (25) residential dwellings are located within approximately 2 kilometres of the ventilation system. The modelling indicates that the contribution of dust deposition and particulate matter emissions from the ventilation system on these residences is less than relevant air quality criteria and therefore considered negligible.

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 Introduction

Austar Coal Mine Pty Limited (Austar) operates an underground coal mine located approximately 10 kilometres south of Cessnock in the Lower Hunter Valley in NSW (refer to **Figure 1.1**). The mine is an aggregate of the former Ellalong, Pelton, Cessnock No.1 and Bellbird South Collieries and is located in the South Maitland Coalfields. These operations including coal extraction, handling, processing and transport collectively form the Austar Mining Complex.

The underground mining component of the Austar Mining Complex is currently being undertaken within Consolidated Mining Lease 2 (CML2) (refer to **Figure 1.1**) under development consent DA 29/95. The DA 29/95 was granted by the NSW Minister for Urban Affairs and Planning in 1996, enabling coal extraction from the Greta Seam using a conventional retreat longwall extraction method to a height of up to 4.5 metres.

Austar is seeking approval to extend underground mining into the Stage 3 area using Longwall Top Coal Caving (LTCC) technology. The Stage 3 Project (the Project) consists of two components:

- The longwall extraction of up to 7 metres of coal from longwall panels A6 to A17 within the Greta Coal Seam using LTCC technology. It is proposed that longwall extraction will occur at a rate of up to 3.6 million tonnes per year (Mtpa) of Run of Mine Coal (ROM) to facilitate a maximum product coal production rate of 3 Mtpa from Austar's existing Pelton Coal Handling and Preparation Plant (CHPP) over a 21 year mine life.

- The construction and operation of new Surface Infrastructure Site and access road off Quorrobolong Road, south west of Kitchener. The proposed Surface Infrastructure Site will include upcast and downcast ventilation shafts, main ventilation fan, bath house, workshop, electricity substation and distribution line, service boreholes, offices and store. Access to longwalls in the Stage 3 area for men and materials will be via the proposed new Surface Infrastructure Site.

The proposed conceptual mine plan for Stage 3 and the location of the proposed Surface Infrastructure Site are shown in **Figure 1.2**.

The Surface Infrastructure Site is situated approximately 1.5 kilometres south of Kitchener and approximately 6 kilometres south of Cessnock. The ventilation system at Surface Infrastructure Site will consist of an upcast ventilation shaft and downcast ventilation shaft designed to provide sufficient quantity of air to support the proposed longwall mining. Umwelt (Australia) Pty Limited (Umwelt) has been commissioned by Austar to conduct an assessment of the air quality impact of the air to be discharged from the proposed upcast ventilation shaft.

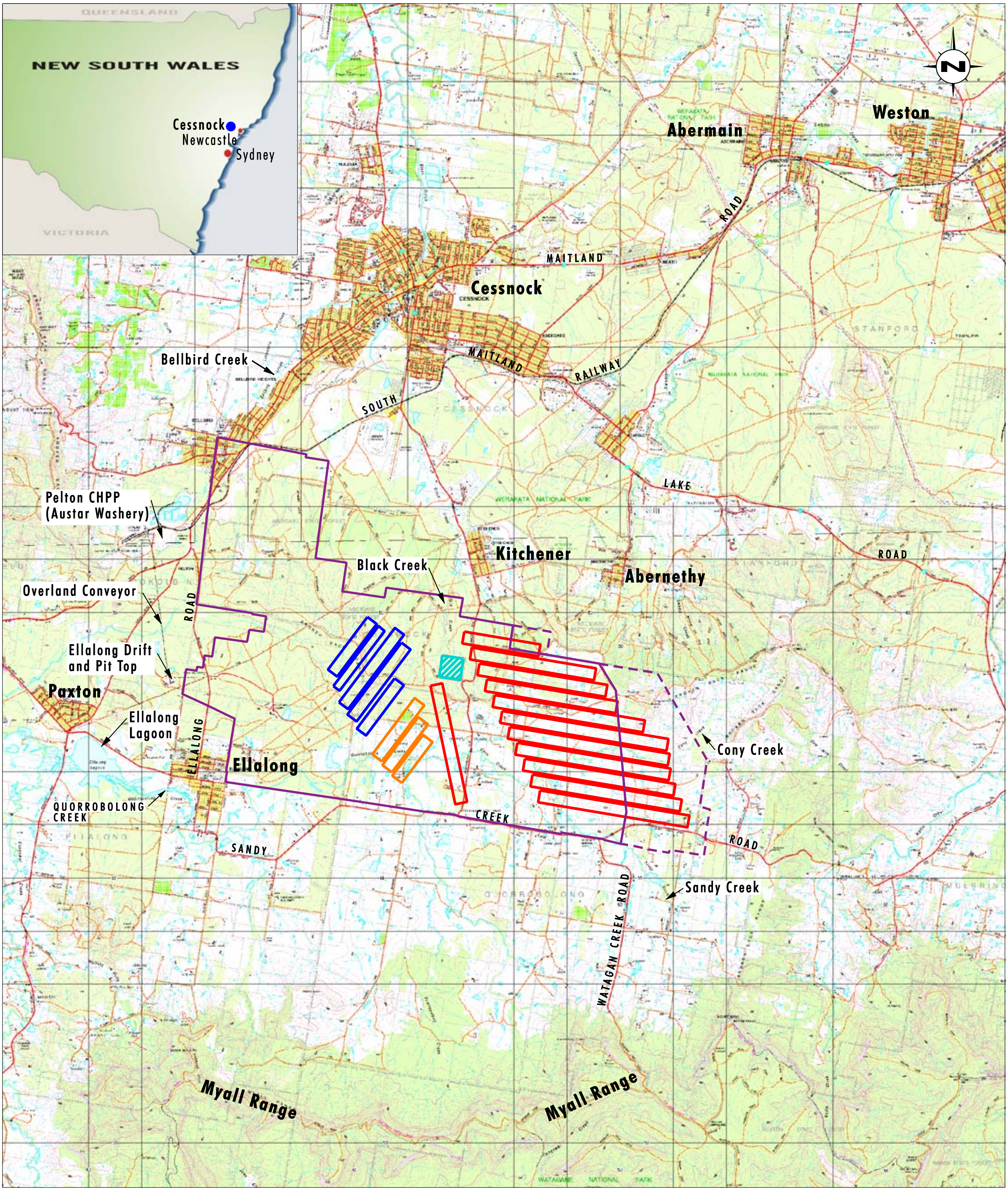
Also assessed are the potential impacts of the discharge air from the operation of the upcast ventilation shaft on the surrounding environment. This Air Quality Impact Assessment has been undertaken as part of the overall Environmental Assessment for the project. The key objectives of the assessment are to:

- identify the existing ambient air quality environment (dust concentration and deposition) around the site;

- identify potential emission rates from the proposed vent; and

- identify possible air quality impacts on potentially affected nearest sensitive receptors (private residences).

Umwelt
Environmental Consultants



Source: Topo Maps: LPI NSW, Longwall Layout: Austar Coal Mine

0 1.0 2.0 4km
1:100 000

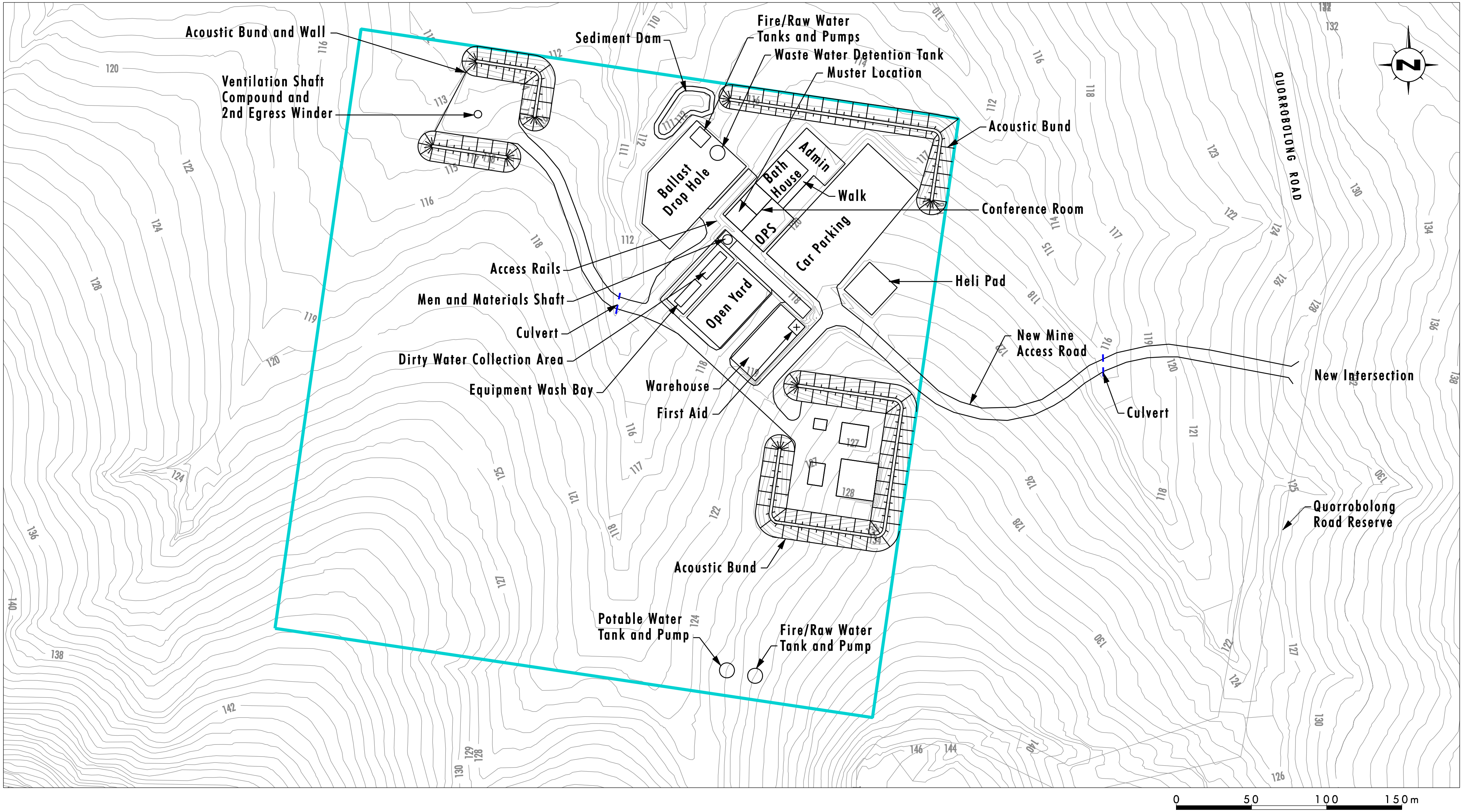
Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary

FIGURE 1.1

Locality Plan

File Name (A4): R39_V1/2274_210.dgn



Legend

Surface Infrastructure Site

FIGURE 1.2

Conceptual Layout for Proposed Surface Infrastructure Site

Note: Contour Interval 1m

File Name (A4): R39_V1/2274_595.dgn

1.1 Description of the Ventilation System

Coal from the proposed Stage 3 mine will be handled and processed utilising existing infrastructure and facilities. Approval for the Project is sought by early 2009 which will allow for the construction of the new ventilation upcast shaft to commence. The new ventilation system is central to the operations of ongoing LTCC longwall mining beyond 2010.

The proposed upcast and downcast ventilation shafts will be approximately 4.5 metres and 6.5 metres in diameter respectively and will be constructed to a depth of approximately 460 metres. The shafts will be constructed using raised bore techniques or drill and blast techniques or a combination thereof. A third construction bore used to raise the cuttings from the large shafts during construction will also be required. This shaft will be approximately 2.4 metres in diameter. The downcast shaft will allow access for employees and materials and provide additional air to enter the mine. The upcast ventilation shaft will allow air to be extracted from the mine and two exhaust fans will be placed over the shaft in order to draw air out of the workings. A second egress winder is proposed to be fitted to this shaft.

2.0 Surface Infrastructure Site

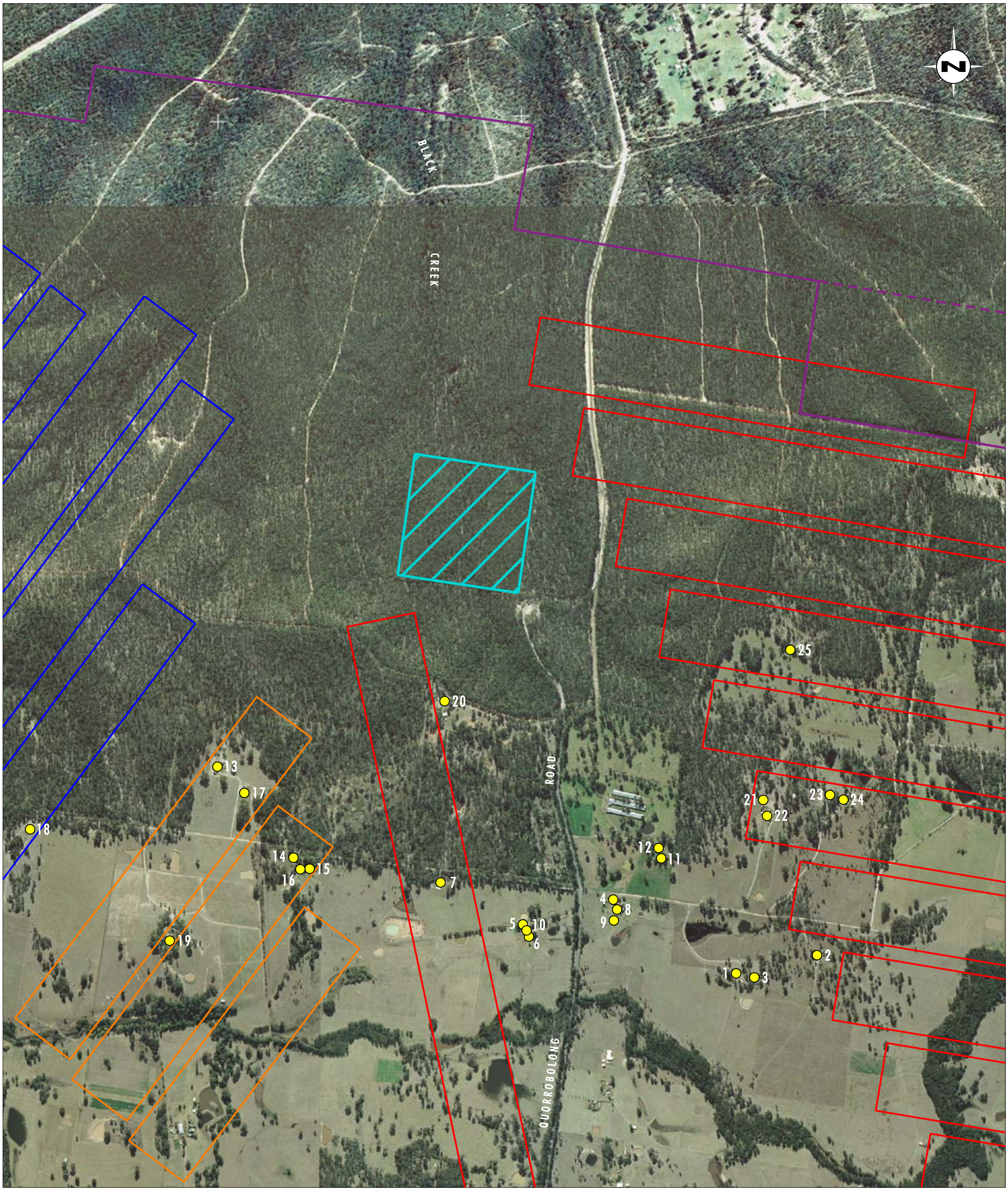
2.1 Location and Topography

The site is located in the upper part of Black Creek catchment area on the northern side of Broken Back Range. The site is located approximately 680 metres to north of the ridgeline, approximately 1.5 kilometres south of Kitchener, and approximately 6 kilometres south of Cessnock (refer to **Figure 1.1**). The predominant land cover of the area surrounding the site is native vegetation and bushland.

The site has an elevation of approximately 113 metres above Australian Height Datum (mAHD) in an area of significant vertical relief. Elevations within a 2 kilometre radius of the site range from approximately 89 mAHD to 225 mAHD.

2.2 Nearby Residential Receptors

The nearest potentially affected residences to the site are shown on **Figure 2.1**. The residences are situated on southern side of Broken Back Range within Quorrobolong Creek catchment. The surrounding area can be characterised as typical of a rural landscape. Residential dwellings located within approximately 2 kilometres of the site have been assessed as being potentially affected by air quality impacts (refer to **Table 2.1**).



Source: Longwall Layout: Austar Coal Mine, Aerial Photography: AAM Hatch 2006

0 300 600 900m
1:17 500

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Residence Location

FIGURE 2.1

Location of Nearby Residences

File Name (A4): R39_V1/2274_596.dgn

Table 2.1 – Summary of Nearby Receptors

Residence ID	Elevation (m AHD)	Distance from source of emissions (m)
1	129	1933
2	130	2027
3	129	1970
4	129	1529
5	127	1520
6	126	1569
7	136	1362
8	128	1563
9	127	1594
10	126	1540
11	137	1472
12	138	1443
13	148	1215
14	135	1364
15	136	1390
16	138	1381
17	140	1239
18	163	1790
19	161	1783
20	169	761
21	157	1527
22	156	1568
23	145	1674
24	143	1722
25	167	1306

3.0 Air Quality Assessment and Criteria

Sources of particulate matter may be anthropogenic (that is, those produced by human activities) or naturally occurring. Naturally occurring particulates may be derived from volcanoes, dust storms, bush and grassland fire, and living vegetation. Human activities, such as the burning of fossil fuel in vehicles, power plants, and many industrial processes also generate significant amounts of fine particles. Anthropogenic dust currently accounts for approximately 10 per cent of the total amount of dust emissions in the global atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease and altered lung function.

3.1 Total Suspended Particulate and PM_{10} Particulate Matter

Particulate matter (PM) refers to tiny particles of solid or liquid suspended in a air. The size of the particles is typically less than 50 micrometers (µm) and ranging down to 0.1 µm. Particulate matter less than 50 µm is size is referred to as total suspended particulate or TSP. The particles less than 10 µm and 2.5 µm in diameter are referred to as PM_{10} and $PM_{2.5}$ particles, respectively.

The current NSW Department of Environment and Climate Change (DECC) Air Quality Assessment Criteria applicable to particulate matter less then 10 µm (PM_{10}) and TSP are outlined in **Table 3.1**.

Table 3.1 – DECC Goals for Particulate Matter Concentrations

Pollutant	Standard/Goal ($\mu g/m^3$)	Averaging Period	Reference
Particulate matter < 10µm (PM_{10})	50	24-hour maximum	DECC
	30	Annual mean	DECC
	50	24-hour average, 5 exceedances allowed per year	NEPC
Total suspended particulate matter (TSP)	90	Annual mean	NHMRC

3.2 Dust Deposition

Dust is a general name for solid particles (insoluble solids) with diameter less than 500 µm. Dust occurs in the atmosphere from various sources such as soil dust lifted up by wind or dust from volcanic eruption. Airborne dust is considered an aerosol and can have an effect on the atmosphere and the local climate. Under certain circumstances, large amounts of dust dispersed within the air in an enclosed space (such coal dust or flour) can be an explosion hazard. Airborne dusts can also contribute to occupational lung diseases such as pneumoconiosis.

Dust deposition is the process by which solid particles collect or deposit themselves on solid surfaces, decreasing the concentration of the particles in the air.

Table 3.2 shows current air quality assessment criteria applicable to dust deposition.

Table 3.2 – DECC Goals for Dust Deposition

Maximum Increase in Deposited Dust level (g/m^2/month)	Maximum Total Deposited Dust level (g/m^2/month)	Averaging Period
2	4	Annual

3.3 Air Quality Goals

A summary of the applicable Air Quality Goals for this assessment are outlined in **Table 3.3**.

Table 3.3 – DECC Air Quality Goals

Pollutant	Maximum Concentration	Averaging Time
PM_{10}	50 µg/m^3 30 µg/m^3	24 hours Annual
TSP	90 µg/m^3	Annual
Dust Deposition	2 g/m^2/month (maximum increase in deposited dust level) 4 g/m^2/month (maximum total in deposited dust level)	Annual

3.4 Assessment Methodology

Dispersion models use a computer model to simulate atmospheric conditions and the behaviour pollutants. Dispersion models are used to determine the impact of a proposed development on the surrounding environment and provided concentration or deposition estimates that can be compared against impact assessment criteria.

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, DECC 2006 provides two methods for undertaking air impact assessment using dispersion models. These are:

Level 1 impact assessments for screening-level assessments using worst-case input data such as maximum pollutant loadings generating maximum exposed levels for off-site receptor overlaid onto the maximum background concentration. The results of the Level 1 dispersion modelling represent a worst-case impact when compared against the relevant impact assessment criterion.

Level 2 impact assessments using refined dispersion modelling assessments based on site-specific input data contemporaneous with the meteorological data and background concentration so that individual dispersion model predictions corresponding to pre-existing background concentration.

A Level 1 assessment has been used because the predicted worst-case impact of the proposed ventilation system, reported as the 100^{th} percentile or maximum pollutant loadings, generating maximum exposed levels for off-site receptors is well below the relevant impact assessment criterion.

4.0 Existing Environment

4.1 Local Climatic Conditions

Local climate data has been obtained from observations compiled for Cessnock from 1973 to 2000 at Bureau of Meteorology (BoM) Station 61242. Cessnock is located approximately 6 kilometres north of the site. A summary of BoM climate parameters for Cessnock is outlined in **Table 4.1**.

Table 4.1 – Climate Averages (Cessnock, 1973-2000)

Parameter	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Maximum Temperature (°C)	29.9	29.2	27.4	24.6	21.0	17.9	17.5	19.4	22.2	24.9	27.1	29.4
Average Minimum Temperature (°C)	17.5	17.4	15.5	11.8	8.9	6.0	4.5	5.0	7.7	10.8	13.4	15.9
Average Daily Evaporation (mm)	5.7	5.0	4.0	2.9	1.9	1.6	1.8	2.6	3.6	4.3	5.2	6.0
Average Rainfall (mm)	89.7	92.3	91.7	66.0	62.5	54.4	40.1	35.4	44.1	60.7	71.2	64.6
Average Temp. at 9am (°C)	23.0	22.1	21.2	18.3	14.3	10.9	9.9	11.9	15.9	19.2	20.2	22.5
Average Relative Humidity at 9am (%)	69.6	74.5	73.7	73.7	80.2	80.2	78.2	70.4	62.2	59.4	64.0	63.8
Average Cloud Cover at 9am (oktas)	4.9	5.0	4.7	4.3	4.6	4.2	3.8	3.1	3.6	4.4	4.6	4.7
Average Temp. at 3pm (°C)	28.4	27.8	25.9	23.2	19.8	16.7	16.4	18.3	20.9	23.2	25.4	28.0
Average Relative Humidity at 3pm (%)	50.0	52.2	54.2	52.5	56.5	56.4	51.7	44.4	44.0	45.9	46.4	45.3
Average Cloud Cover at 3pm (oktas)	5.1	5.1	5.0	4.8	4.9	4.7	4.3	4.0	4.4	4.8	5.1	4.9

As indicated in **Table 4.1,** January is the warmest month with a mean daily maximum temperature of 29.9 ^{o}C. July is the coldest month with mean daily minimum temperature of 4.5 ^{o}C. February is the wettest month with average monthly rainfall of 92.3 mm. August is the driest month with average monthly rainfall of 35.4 mm. The evaporation rates are highest in December and lowest in June. The relative humidity varies from 44 percent to 80.2 per cent and can be described as medium to high.

4.2 Existing Air Quality

4.2.1 Background Dust Deposition

Background dust deposition monitoring has been undertaken by Carbon Based Environmental since the end of March 2007. There are five deposition gauges installed in the area surrounding Austar lease boundaries. The locations of the gauges are provided in **Figure 4.1**.

Monthly background dust deposition (insoluble solids) monitoring data is available for the period between April and September 2007. **Table 4.2** presents a summary of insoluble solids for the observation period at the monitoring sites.

Table 4.2 – Summary of Monthly Dust Deposition (g/m^2/month)

Month	Monitoring Gauge Number and Location					All Sites Average
	DG01 Pynes	DG02 Pelton	DG03 Bellbird	DG04 Ellalong	DG05 Fan	
April	-	0.9	2.8	1.4	1.5	1.7
May	0.4	0.5	0.2	1.0	1.4	0.7
June	0.4	0.4	0.4	0.2	-	0.4
July	0.6	0.3	0.4	0.3	1.1	0.5
August	0.9	0.6	1.5	0.5	-	0.9
September	0.6	2.5	1.2	0.6	1.4	1.3
Period Average	0.6	0.9	1.1	0.7	1.4	0.9

Dust deposition measurements generally reflect the influence of activities around the monitoring site. Some gauges can be contaminated by bird droppings, vegetation (such as, plant matter, algae, pollen, seeds) and insects. Results showing contamination by bird droppings, vegetation and/or insects have been excluded from the monthly average.

The results of the measurements indicate that the dust deposition level at the monitoring sites for the period from April 2007 to September 2007 is below the DECC Air Quality Impact Assessment criteria for insoluble solids of 4 g/m^2/month.

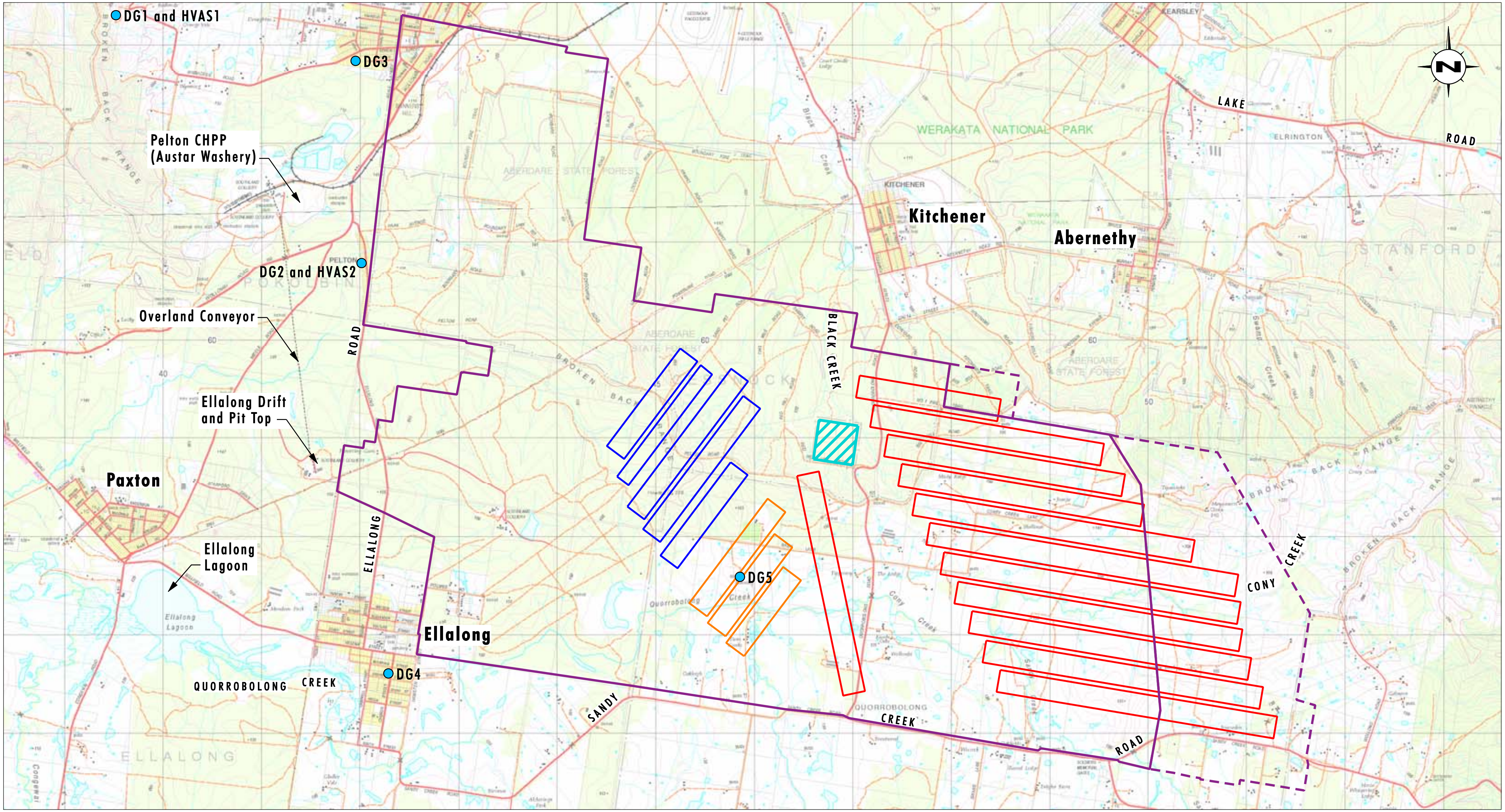
The highest measured dust deposition rate at DG05 of 1.5 g/m^2/month has been assumed as a conservative value for annual background ambient dust fallout at the study area for assessment purposes. DG05 is locate adjacent to similar farming and forest land and is approximately 2 kilometres west of the proposed Surface Infrastructure Site.

4.2.2 Ambient Particulate Matter

Two PM_{10} High Volume Air Samplers (HVAS) separate and collect fine particulates with an effective aerodynamic diameter of less than 10 µm. The PM_{10} HAVS have been installed at the Pelton and Pynes sites. The HVAS commenced monitoring on the 24 March 2007, and are operated for 24 hours every sixth day. The HVAS locations are shown in **Figure 4.1**.

Table 4.3 shows measured PM_{10} concentrations for each PM_{10} HVAS monitoring site for period from April to September 2007 and estimates of TSP concentrations at each site, based on measured PM_{10} concentrations.

Umwelt
Environmental Consultants



Source: Topo Maps: LPI NSW, Longwall Layout: Austar Coal Mine

0 1 2 3km
1:55 000

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Monitoring Site

FIGURE 4.1

Location of Monitoring Sites

File Name (A4): R39_V1/2274_597.dgn

Estimated TSP concentrations were derived from the PM_{10} measurements provided in **Table 4.3** by assuming that PM_{10} is approximately 40 percent of TSP. This relationship is based on measurements published by the NSW Mineral Council (2000).

Analysis of the data in **Table 4.3** indicates that the measured average for PM_{10} for period from April 2007 to September 2007 of 13 μg/m^3 is below the annual average DECC criteria of 30 μg/m^3. The measured daily PM_{10} concentrations presented in **Table 4.3** do not exceed the 24-hour average DECC criteria of 50 μg/m^3. The estimated average for TSP for period from April 2007 to September 2007 of 32 μg/m^3 is less than the annual average DECC criteria of 90 μg/m^3.

Table 4.3 – PM_{10} HVAS Monitoring Results

Sampling Date	Pelton – PM_{10} (μg/m^3)	Pynes – PM_{10} (μg/m^3)	Two sites average - PM_{10} (μg/m^3)	Estimated TSP (μg/m^3)
24/03/2007	17	16	17	41
30/03/2007	14	13	14	34
05/04/2007	23	27	25	63
11/04/2007	22	21	22	54
17/03/2007	31	34	33	81
23/03/2007	13	16	15	36
29/03/2007	12	14	13	33
05/05/2007	39	42	41	101
11/05/2007	17	17	17	43
17/05/2007	16	19	18	44
23/05/2007	12	7	10	24
29/05/2007	23	14	19	46
04/06/2007	13	8	11	26
10/06/2007	6	3	5	11
16/06/2007	0	0	0	0
22/06/2007	1	1	1	3
28/06/2007	6	0	3	8
04/07/2007	4	2	3	8
10/07/2007	1	1	1	3
16/07/2007	10	5	8	19
22/07/2007	9	4	7	16
28/07/2007	5	3	4	10
03/08/2007	11	8	10	24
09/08/2007	12	4	8	20
15/08/2007	12	10	11	28
21/08/2007	12	9	11	26
27/08/2007	20	14	17	43
02/09/2007	19	24	22	54
08/09/2007	6	5	6	14
14/09/2007	18	16	17	43
20/09/2007	8	11	10	24
26/09/2007	16	19	18	44
Average	**13**	**12**	**13**	**32**

4.2.3 Adopted Background Concentrations for Assessment Purposes

DECC standards outlined in the Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005) (AMMAAP) states that for a Level 1 assessment:

- The background concentration of the pollutant being assessed is determined as the maximum level from representative ambient monitoring data for each relevant averaging period.
- The exposure at the off-site receptors is the sum of the maximum background concentration and the 100th percentile dispersion model prediction for each relevant averaging period.
- The total impact is then compared with the relevant impact assessment criterion for each relevant averaging period.

For assessment purposes:

- The highest measured dust deposition rate of 1.5 g/m^2/month has been assumed to represent the worst-case annual background ambient dust fallout level in the study area.
- The highest 24-hour recorded PM_{10} concentration in the study area as reported in **Table 4.3** is 42 $\mu g/m^3$.
- The annual average observed PM_{10} concentration in the study area as reported in **Table 4.3** is 13 $\mu g/m^3$.
- The annual average TSP concentration at the study area for assessment purposes has been estimated to be 32 $\mu g/m^3$ (refer to **Section 4.2.2**).

4.2.4 Estimated Particulate Matter Emissions

A representative rate of particulate matter emission from the proposed ventilation shaft has been estimated based on the proposed Austar annual underground coal production of 3 million tonnes. This estimated emission rate is based on measured PM_{10} emissions from the ventilation shaft of a reference coal mine in the Hunter Valley adjusted for the tonnage of coal extracted from the underground mine.

The annual TSP emissions from the proposed ventilation shaft have been based on the following parameters:

- exhaust velocity – 10 m/s;
- exhaust temperature – 20 ^oC;
- vent release height – 4 m;
- vent diameter – 4 m;
- exhaust flow rate – 126 m^3/s;
- exhaust area – 12.6 m^2;
- in-stack PM_{10} concentration – 2.8 mg/m^3; and
- PM_{10} emission rate – 355.76 mg/s.

This is considered to be a conservative estimate of emission rates from the ventilation shaft and represents an annual TSP emission of 20 tonnes per annum.

5.0 Dispersion Modelling

5.1 Modelling Approach

The dispersion modelling was done using AUSPLUME Gaussian plume dispersion model software (Version 6.0) developed by the Environment Protection Authority (EPA). AUSPLUME is a steady-state model, which assumes the atmosphere is a state of uniform flow, and that wind velocity is a function of height alone and does not vary with direction. AUSPLUME is the dispersion model used for the majority of assessments in New South Wales.

The dispersion modelling was conducted according to methodology published in the AUSLPUME Gaussian Plume Dispersion Model: Technical User Manual (EPA, 2000) and the AMMAAP. The default options specified in the manual have been applied in the modelling, as per the AMMAAP.

5.2 Dispersion Meteorology

The dispersion model requires atmospheric dispersion data, in particular, wind speed, wind direction, atmospheric stability class and mixing heights. Two Bureau of Meteorology sites have been sourced for the purposes of this modelling: Cessnock Automatic Weather Station (AWS) and Williamtown.

A meteorological dataset for the year 2003 has been used in the creation of the meteorological input file for modelling purposes. Cessnock AWS is the closest weather observation site and located approximately 6 kilometres north of the study area. Meteorological parameters (cloudiness, vertical air temperature profile) are not recorded at Cessnock AWS and have been sourced from Williamtown weather station, located approximately 45 kilometres east of the study area. The dataset for 2003 year represents 352 days (that is, 96 per cent coverage, all seasons well-presented), is concurrent with the background data used for this assessment and satisfies the AMMAAP meteorological data requirements.

The technique used in preparation of the meteorological input file for AUSPLUME is detailed in **Appendix A**.

5.2.1 Wind

Wind direction and speed are the most critical parameters in the dispersion modelling. Wind direction determines the initial direction of transport of the pollutant from the source. Wind speed determines the travel time from source to receptor and dilutes the plume in the direction of transport.

An overview of the seasonal wind behaviour for 2003 at Cessnock AWS is presented in **Appendix A**. Analysis of annual and seasonal wind roses indicates that:

- annual predominant wind directions are south-west, south and north-west;
- the prevailing wind speed both annually and for all seasons was measured to be in the order of 2 to 4 m/s;
- the predominant wind directions in summer are south-east and south;
- the predominant wind directions in autumn are south and south-west;
- the predominant wind directions in winter are north-west and south-west; and
- the predominant wind directions in spring are north-west and south.

5.2.2 Atmospheric Stability

The dispersion model uses atmospheric stability data in conjunction with the wind direction and speed data. **Figure 5.1** illustrates annual frequency of occurrence of hourly atmospheric stability classes for dispersion modelling purposes in the study area.

The results indicate the most common stability class is Class ‘D’. This class is indicative of neutral conditions which will neither enhance nor impede pollutant dispersion. The second most typical stability class is Class ‘F’. This class indicates stable conditions which represent very low vertical mixing turbulence. Class ‘F’ stability results in pollutant plumes that have negligible dilution extending for long distance downwind of the emissions source.

6.0 Emissions Assessment

6.1 Dispersion Modelling

6.1.1 Dust Deposition

The results of dispersion modelling for dust fallout at each of the nearby residential receptors are presented in **Table 6.1**. As described in **Section 4.3.1** the background ambient level of dust deposition for the study area has been assumed to be 1.5 g/m^2/month.

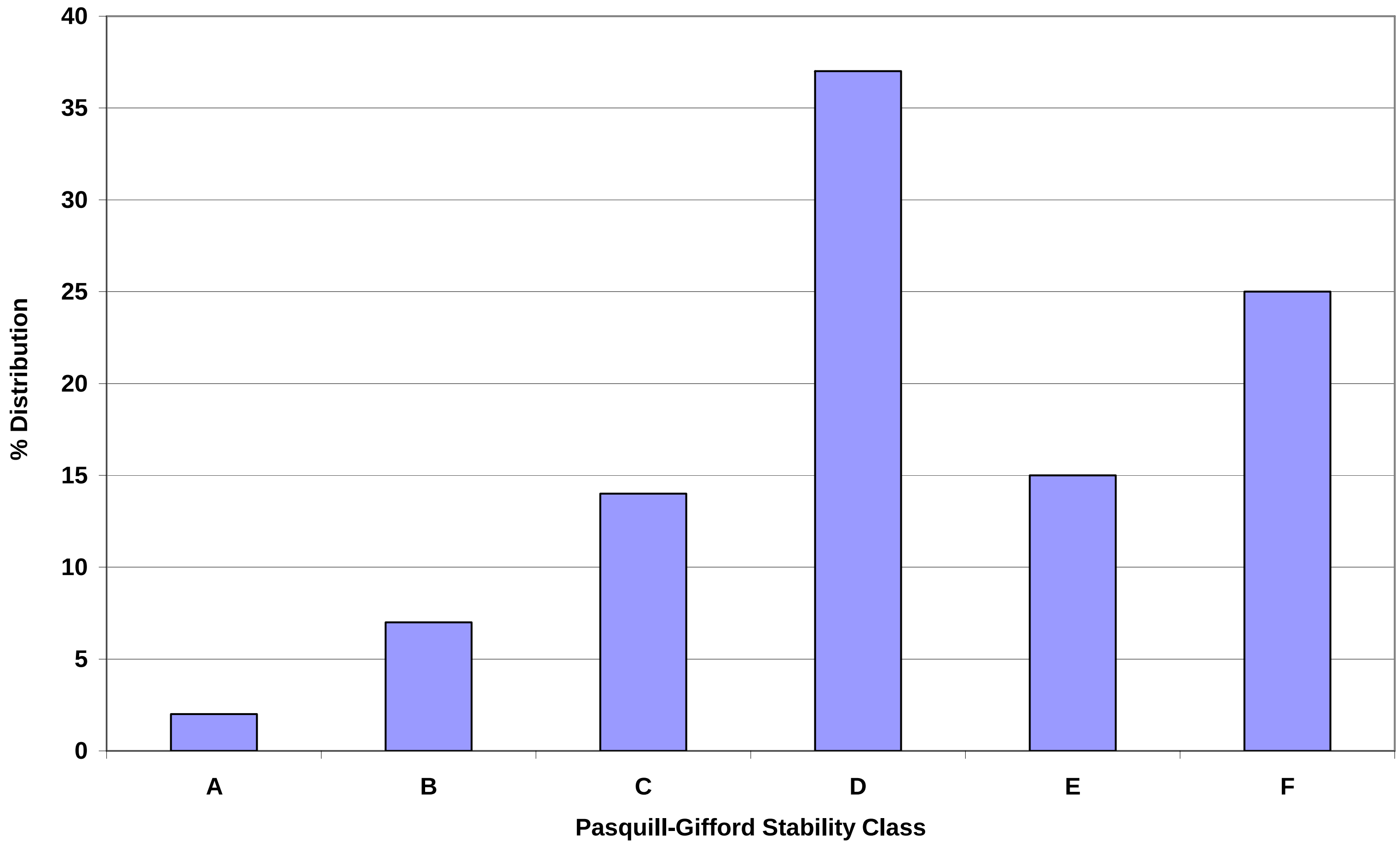


FIGURE 5.1

Frequency of Occurrence of Stability Classes

Table 6.1 – Predicted Dust Depositions at Nearest Residences

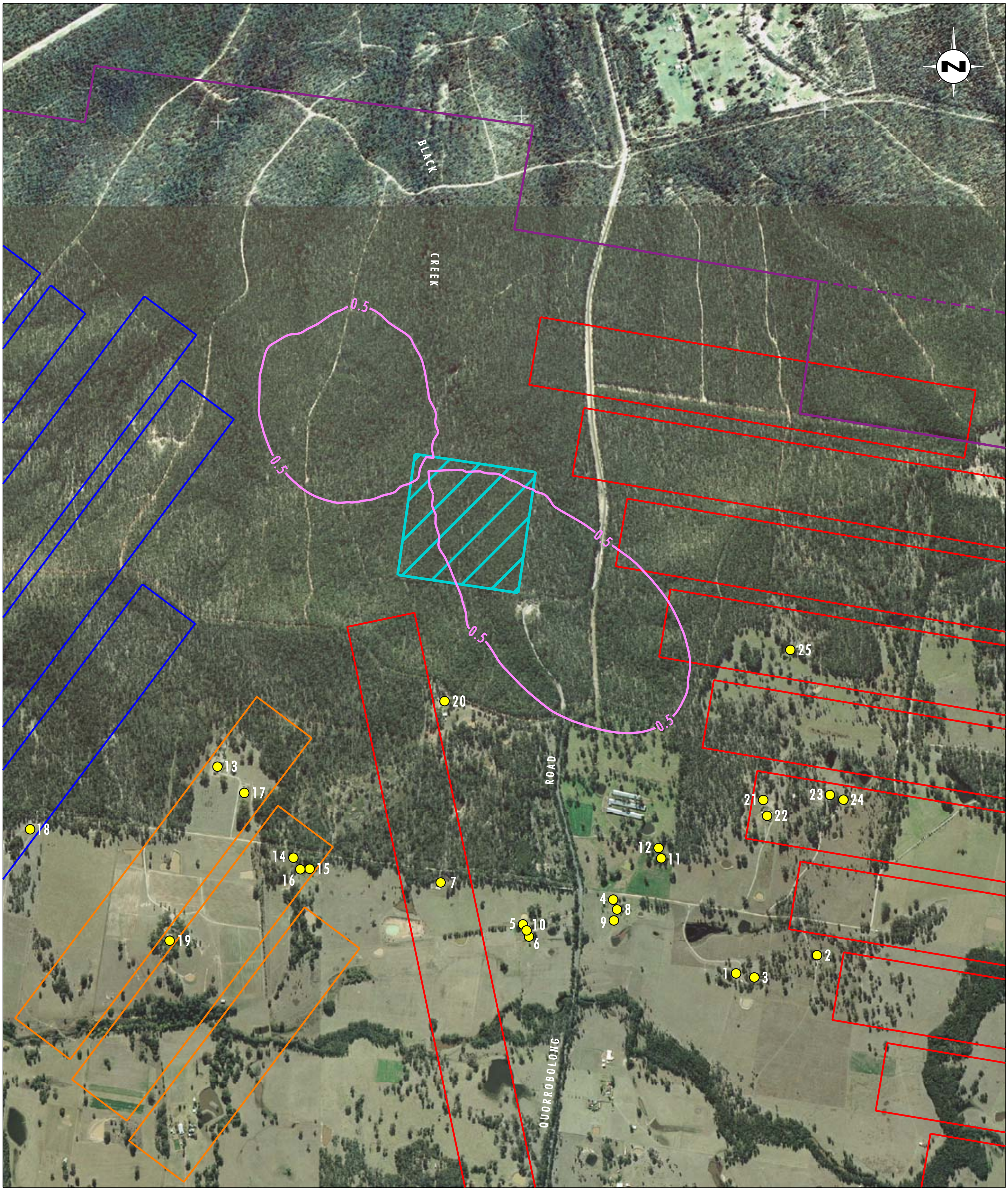
Residence ID	Annual Average Dust Deposition (g/m^2/month)				
	Predicted Increase	Air Quality Goal – Incremental	Representative Background	Total (Background + Predicted)	Air Quality Goal - Total
1	0.09	2	1.5	1.59	4
2	0.10	2	1.5	1.60	4
3	0.09	2	1.5	1.59	4
4	0.09	2	1.5	1.59	4
5	0.06	2	1.5	1.56	4
6	0.06	2	1.5	1.56	4
7	0.06	2	1.5	1.56	4
8	0.09	2	1.5	1.59	4
9	0.08	2	1.5	1.58	4
10	0.06	2	1.5	1.56	4
11	0.14	2	1.5	1.64	4
12	0.15	2	1.5	1.65	4
13	0.03	2	1.5	1.53	4
14	0.04	2	1.5	1.54	4
15	0.04	2	1.5	1.54	4
16	0.04	2	1.5	1.54	4
17	0.03	2	1.5	1.53	4
18	0.02	2	1.5	1.52	4
19	0.02	2	1.5	1.52	4
20	0.15	2	1.5	1.65	4
21	0.17	2	1.5	1.67	4
22	0.16	2	1.5	1.66	4
23	0.14	2	1.5	1.64	4
24	0.13	2	1.5	1.63	4
25	0.13	2	1.5	1.63	4

The predicted incremental increase in dust deposition presented in **Table 6.1** is considerably less than the air quality goal of 2 g/m^2/month at all nearest residences. The maximum incremental increase in dust deposition of 0.17 g/m^2/month is predicted to occur at Residence 21. The predicted mean monthly dust deposition rates presented in **Table 6.1** are less that the project air quality criteria of 4 g/m^2/month at all nearby receptors.

The atmospheric dispersion modelling of the dust emissions from the proposed ventilation shaft indicates that the proposed operation will have and insignificant impact on the dust deposition rates at all the nearby receptors.

Figure 6.1 shows predicted dust deposition rates around the proposed ventilation shaft.

Umwelt
Environmental Consultants



Source: Longwall Layout: Austar Coal Mine, Aerial Photography: AAM Hatch 2006
Note: Contour Interval 0.5g/m²/month

0 300 600 900m
1:17 500

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Modelled Dust Deposition Contour
- Residence Location

FIGURE 6.1

Modelled Dust Deposition ($g/m^2/month$)

File Name (A4): R39_V1/2274_598.dgn

6.1.2 PM_{10}

The modelled results for PM_{10} concentrations at each nearest residence are displayed in **Tables 6.2** and **6.3**. As discussed in **Section 4.3.2** the maximum 24-hour average daily varying measured background PM_{10} data was taken to predict 24-hour maximum average and annual average concentrations is based on the annual average of the available PM_{10} concentrations measured in the study area.

Table 6.2 – Predicted 24-hour Maximum PM_{10} Concentrations at Nearest Residences

Residence ID	Maximum 24-hour Average PM_{10} Concentrations ($\mu g/m^3$)			
	Predicted Increase	Representative Background	Total (Background + Predicted)	Air Quality Goal - Total
1	0.04	42.00	42.04	50
2	0.06	42.00	42.06	50
3	0.04	42.00	42.04	50
4	0.03	42.00	42.03	50
5	0.00	42.00	42.00	50
6	0.00	42.00	42.00	50
7	0.00	42.00	42.00	50
8	0.02	42.00	42.02	50
9	0.02	42.00	42.02	50
10	0.00	42.00	42.00	50
11	0.06	42.00	42.06	50
12	0.06	42.00	42.06	50
13	0.00	42.00	42.00	50
14	0.00	42.00	42.00	50
15	0.00	42.00	42.00	50
16	0.00	42.00	42.00	50
17	0.00	42.00	42.00	50
18	0.01	42.00	42.01	50
19	0.00	42.00	42.00	50
20	0.00	42.00	42.00	50
21	0.10	42.00	42.10	50
22	0.10	42.00	42.10	50
23	0.08	42.00	42.08	50
24	0.08	42.00	42.08	50
25	0.07	42.00	42.07	50

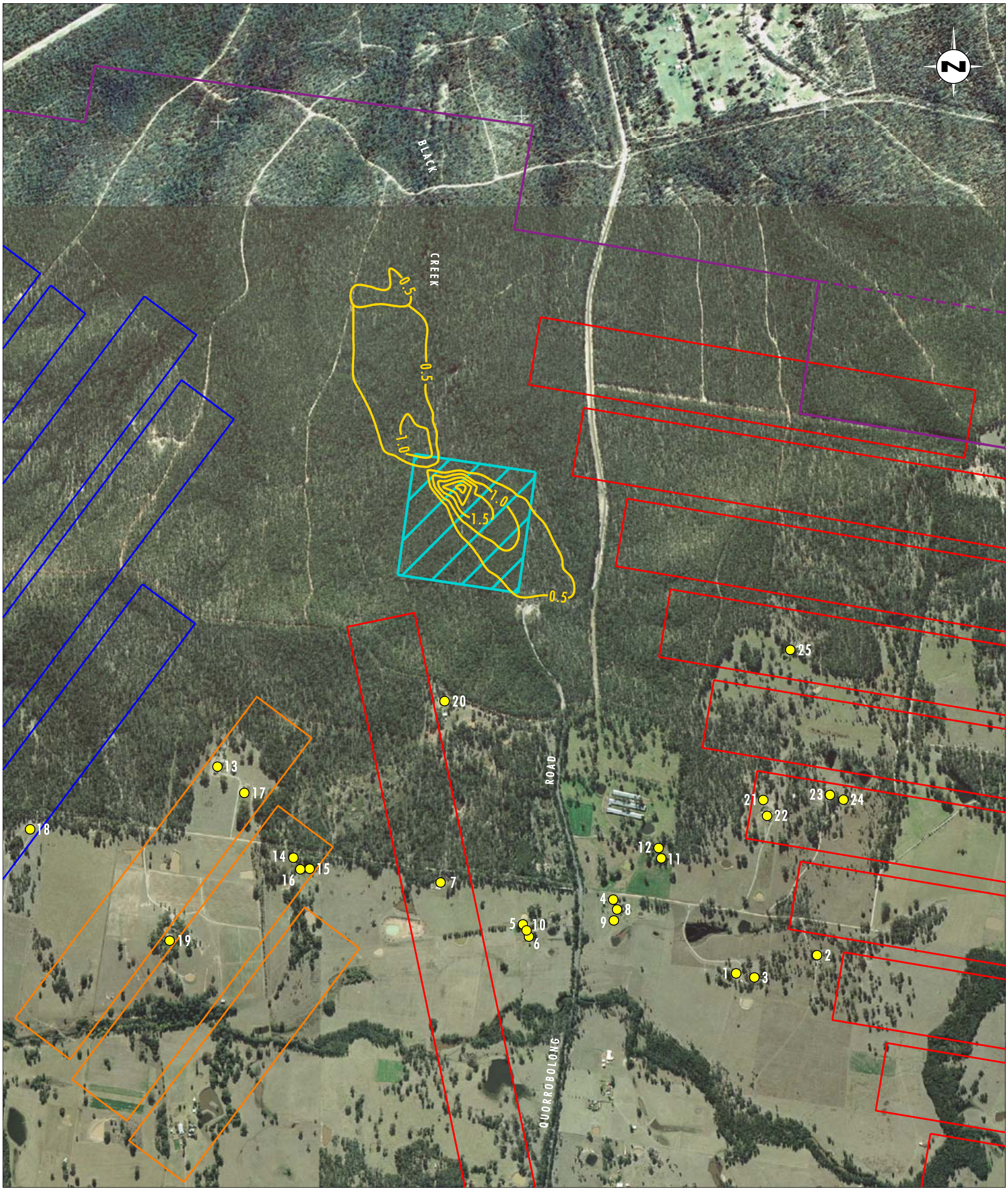
Table 6.3 – Predicted Annual Average PM_{10} Concentrations at Nearest Residences

Residence ID	Annual Average PM_{10} Concentrations (µg/m^3)			
	Predicted Increase	Representative Background	Total (Background + Predicted)	Air Quality Goal - Total
1	0.23	13	13.23	30
2	0.24	13	13.24	30
3	0.23	13	13.23	30
4	0.24	13	13.24	30
5	0.20	13	13.20	30
6	0.20	13	13.20	30
7	0.22	13	13.22	30
8	0.23	13	13.23	30
9	0.22	13	13.22	30
10	0.20	13	13.20	30
11	0.29	13	13.29	30
12	0.29	13	13.29	30
13	0.20	13	13.20	30
14	0.20	13	13.20	30
15	0.19	13	13.19	30
16	0.20	13	13.20	30
17	0.19	13	13.19	30
18	0.17	13	13.17	30
19	0.19	13	13.19	30
20	0.41	13	13.41	30
21	0.32	13	13.32	30
22	0.32	13	13.32	30
23	0.28	13	13.28	30
24	0.27	13	13.27	30
25	0.30	13	13.30	30

Analysis indicates that the predicted PM_{10} concentrations do not exceed the air quality criteria at all nearest residences. The maximum 24-hour incremental PM_{10} concentration increase of 0.1 µg/m^3 (i.e. 0.2 per cent of the background concentration) is predicted for the Residences 21 and 22. The annual average PM_{10} increment of 0.41 µg/m^3 (i.e. 2.2 per cent of the background concentration) is predicted for the Residence 20.

The modelling indicates that contribution of operation of the ventilation shaft to PM_{10} emissions at all residential receptors is negligible.

Figure 6.2 and **6.3** shows modelled 24-hour maximum and annual average PM_{10} concentration contours at the site. The contours indicate the levels of PM_{10} concentrations over potentially affected areas around the emissions source under existing modelling conditions.



Source: Longwall Layout: Austar Coal Mine, Aerial Photography: AAM Hatch 2006
Note: Contour Interval 0.5μg/m3

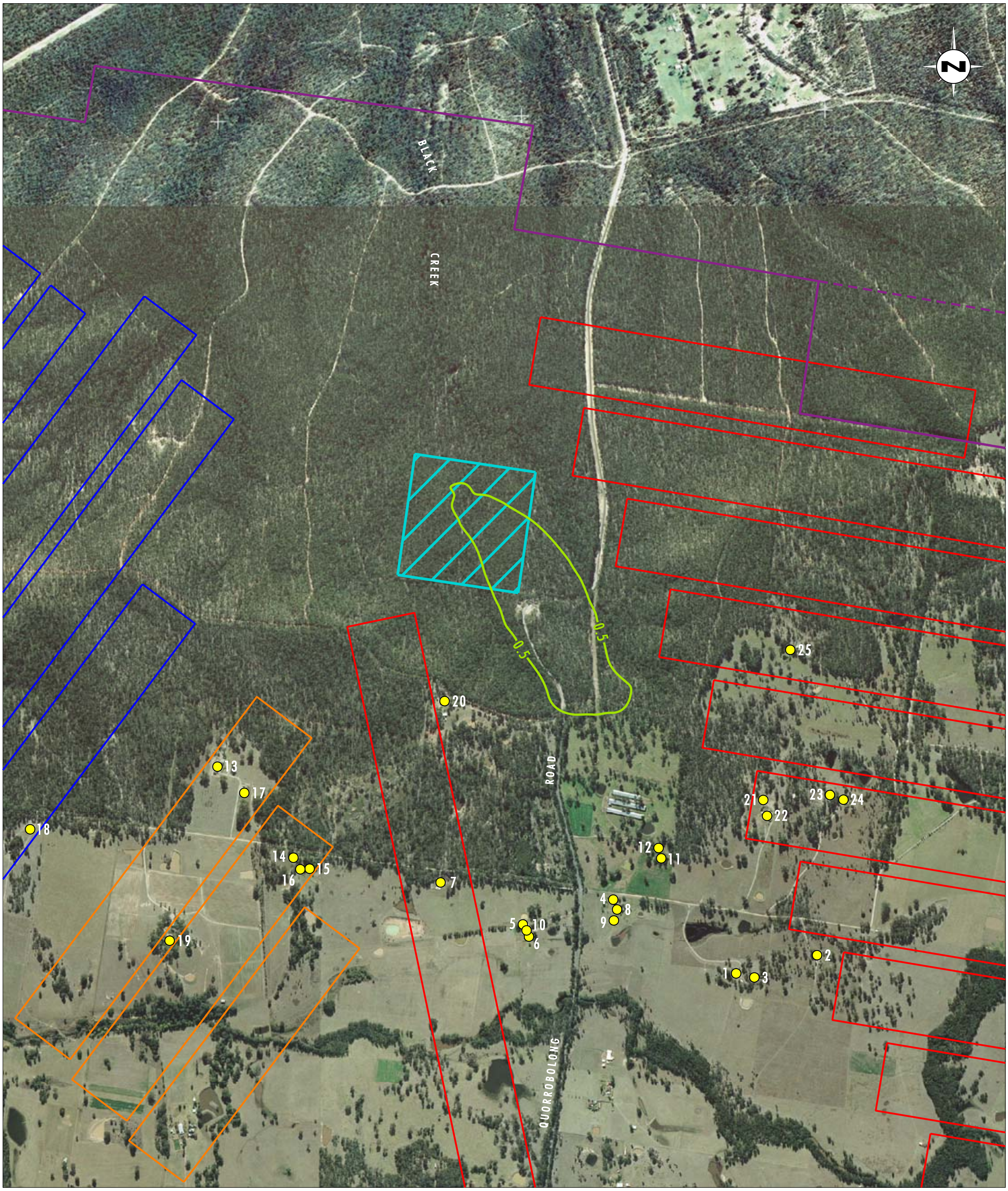
Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Modelled 24-hour Maximum PM10 Concentration Contour
- Residence Location

FIGURE 6.2

Modelled 24-hour maximum PM10 Concentrations (μg/m3)

File Name (A4): R39_V1/2274_601.dgn



Source: Longwall Layout: Austar Coal Mine, Aerial Photography: AAM Hatch 2006
Note: Contour Interval 0.5μg/m3

0 300 600 900m
1:17 500

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Modelled Annual Average PM10 Concentration Contour
- Residence Location

FIGURE 6.3

Modelled Annual Average PM10 Concentrations (μg/m3)

File Name (A4): R39_V1/2274_604.dgn

6.1.3 TSP

Table 6.4 presents the modelled results for TSP concentrations at each nearest residence. As discussed in **Section 4.3.2** the estimated annual average background ambient TSP concentration was taken to be 32 μg/m^3. This background level has been incorporated into the model.

Table 6.4 – Predicted TSP Concentrations at Nearest Residences

Residence ID	Annual Average TSP Concentrations (μg/m^3)			
	Predicted Increase	Representative Background	Total (Background + Predicted)	Air Quality Goal - Total
1	0.37	32.0	32.37	90
2	0.36	32.0	32.36	90
3	0.36	32.0	32.36	90
4	0.41	32.0	32.41	90
5	0.32	32.0	32.32	90
6	0.31	32.0	32.31	90
7	0.39	32.0	32.39	90
8	0.40	32.0	32.4	90
9	0.37	32.0	32.37	90
10	0.32	32.0	32.32	90
11	0.55	32.0	32.55	90
12	0.56	32.0	32.56	90
13	0.25	32.0	32.25	90
14	0.29	32.0	32.29	90
15	0.29	32.0	32.29	90
16	0.32	32.0	32.32	90
17	0.26	32.0	32.26	90
18	0.13	32.0	32.13	90
19	0.19	32.0	32.19	90
20	0.99	32.0	32.99	90
21	0.57	32.0	32.57	90
22	0.55	32.0	32.55	90
23	0.48	32.0	32.48	90
24	0.46	32.0	32.46	90
25	0.53	32.0	32.53	90

Analysis indicates that the predicted TSP concentrations do not exceed the air quality impact assessment criteria at all nearest residences. The maximum annual average increment of TSP concentration of 0.99 μg/m^3 (i.e. 2.1 per cent of the estimated background) is predicted for Residence 20.

The modelling indicates that the contribution of the operation of the ventilation system to TSP emissions at all residential receptors is negligible.

Figure 6.4 shows the predicted increase in the TSP concentration in the study area due to the operation of the ventilation system. The contours indicate the levels of TSP concentrations over potentially affected areas around the emissions source under existing modelling conditions.

6.2 Gas Emissions

The daily average exhaust volumes of carbon dioxide, oxygen, carbon monoxide, methane and nitrogen area measured and recorded by Austar at the existing ventilation shaft. The results, summarised in **Table 6.5**, show traces levels of carbon dioxide and carbon monoxide but methane is below the detectable limit of the monitoring system.

Table 6.5 – Gaseous Air Content as Measured by Umwelt

Gas	Measurement
Carbon Dioxide	0.1 to 0.2%
Oxygen	20.05 to 20.60%
Carbon Monoxide	0.55 to 2.9 ppm
Methane	0.00%
Nitrogen	79.4 to 79.75%

Source: Austar

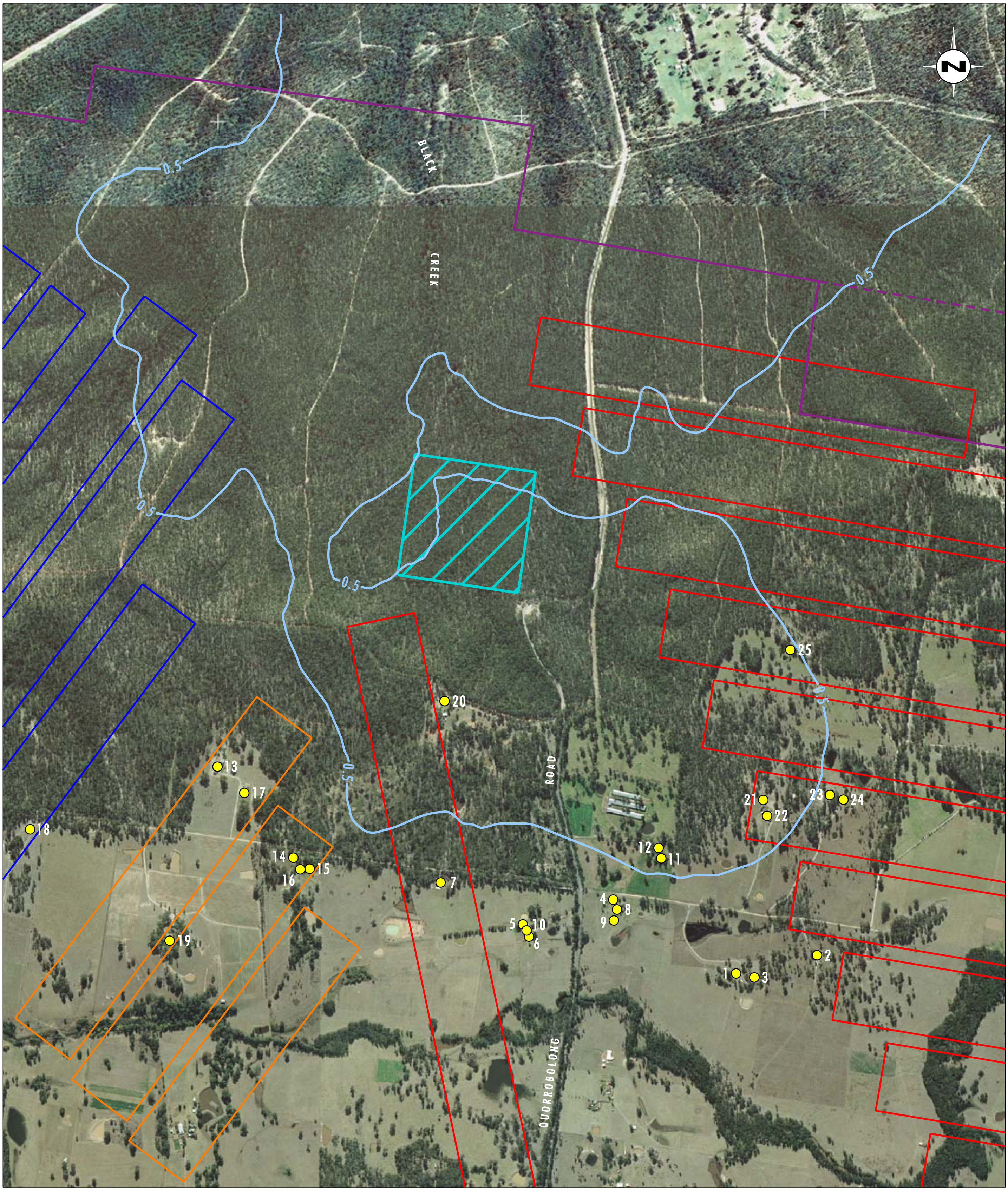
Austar mine has high levels of Iron Pyrite within the coal seams which, when exposed to air and biological activity, have the potential to form sulphur dioxide and hydrogen sulphide.

Further testing was undertaken by Umwelt to record methane levels with a more sensitive instrument and to monitor sulphur dioxide and hydrogen sulphide levels. The maximum levels recorded over an 8 hour period are presented in **Table 6.6**.

Table 6.6 – Gaseous Air Content as Measured by Umwelt

Gas	Measurement	Maximum Recording Levels Over an 8 Hour Period
CO S/N: 0705725181	Max (ppm)	2
	TWA (ppm)	0.02
	STEL (ppm)	0.5
SO2 S/N: 0110283160077	Max (ppm)	0
	TWA (ppm)	0
	STEL (ppm)	0
H2S S/N: 0705724073	Max (ppm)	0
	TWA (ppm)	0
	STEL (ppm)	0
O2 S/N: 0610730980087	%	20.9
CH4 S/N: 0710768169	% of LEL	3

Where: PPM = Parts Per Million
TWA = Time Weighted Average
STEL = Short Term Exposure Level
LEL = Lower Explosive Limit (typically 7% CH_4 content)



Source: Longwall Layout: Austar Coal Mine, Aerial Photography: AAM Hatch 2006
Note: Contour Interval 0.5μg/m3

0 300 600 900m
1:17 500

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Modelled Annual Average TSP Concentration Contour
- Residence Location

FIGURE 6.4

Modelled Annual Average TSP Concentrations (μg/m3)

File Name (A4): R39_V1/2274_603.dgn

The levels of oxygen and carbon dioxide detected during the test period are consistent with the Austar daily average gas concentrations recordings. The level of methane detected during the test period is equivalent to 0.2% as reported by the Austar monitoring system.

The measurements for sulphur related compounds indicate that there are no sulphur dioxide or hydrogen sulphide emissions within the exhaust gases of the existing ventilation system.

7.0 Conclusion

The Air Quality Impact Assessment of the proposed operation of a ventilation system as a component of the Austar underground coal mining operations extension. was undertaken using the AUSPLUME Gaussian Plume Dispersion Model software developed by EPA (Victoria). To predict dust emission impacts the model used available meteorological information, background air quality records and digital terrain data.

The results of the dispersion modelling indicate very small incremental increase in particulate matter concentration and dust deposition at all nearest potentially affected residences. The predictions indicate that dust deposition rates, PM_{10} and TSP concentrations will be within the relevant DECC air quality criteria at all surrounding residences.

Gas monitoring of the existing Austar ventilation shaft indicated that the concentration of coal related gases such as methane and sulphur compounds is negligible and will not have an impact on the surrounding environment.

8.0 Abbreviations and Glossary

mAHD	metres above Australian Height Datum
AMMAAP	Approved Methods for the Modeling and Assessment of Air Pollutants
AWS	Automatic Weather Station
DECC	Department of Environment and Climate Change
EPA	Environmental Protection Authority
HVAS	High Volume Air Sampler
km	Kilometres
mg	milligram
Mt	megatonnes
m^3	cubic metres
^oC	Degrees Celsius
oktas	eight (Cloud cover scale used in meteorology)

PM_{10}	Particulate Matter in the size range of zero to ten microns in diameter
TEOM	Tapered Element Oscillating Microbalance
TSP	Total Suspended Particulate matter, usually in the size range of zero to 50 microns in diameter
Umwelt	Umwelt (Australia) Pty Limited
μg	microgram

9.0 References

Austar Coal Mine Pty Ltd, 2006. Austar Coal Mine Mining Operations Plan 1/1/06 – 31/12/08.

DECC, August 2006. Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

EPA Victoria, 2004. Ausplume Gaussian Plume Dispersion Modelling, Technical User Manual.

NSW Mineral Council, 2000. Particulate Matter and Mining Interim Report, Technical Paper.

Umwelt (Australia) Pty Limited, 2007. Environmental Assessment Report – Ventilation Shaft and Powerline Corridor for South Eastern Mining Area, Baal Bone Colliery.

APPENDIX A

Meteorological Input File for AUSPLUME

Input Meteorological data file for AUSPLUME

Cessnock-2003 for Ellalong, NSW

This file was exclusively compiled for Umwelt (Australia) Pty Ltd. By pDs MultiMedia & Consultancy Service.

pDs Consultancy
@2007

Introduction

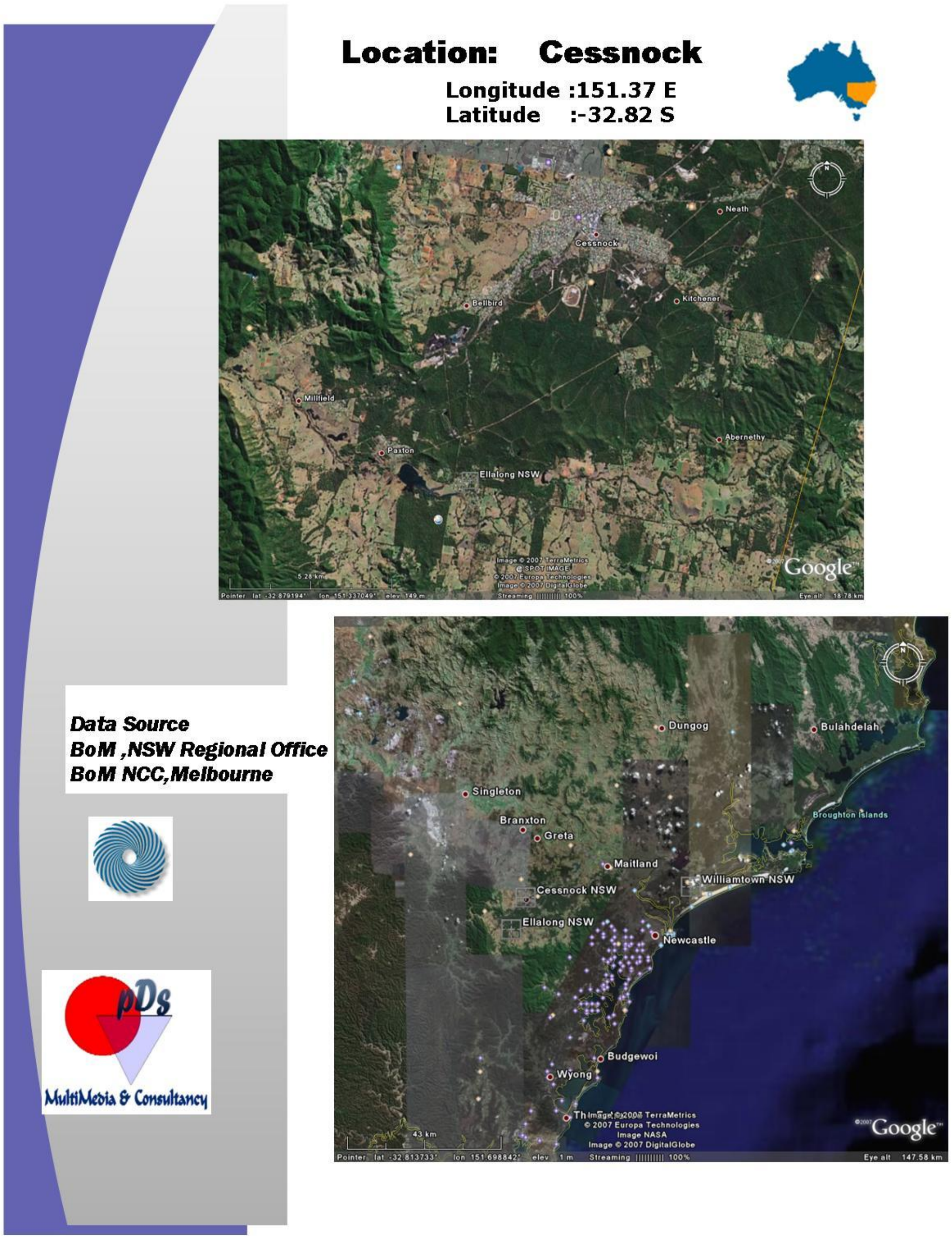
Gaussian plume models require hourly averaged meteorological data from a single site which is preferably in the model domain (site-specific data). While site-specific data is preferred, data from the nearest off-site meteorological station can be used when on-site data are not available. This data should represent the area of concern and the meteorological parameters should chracterise the transport and dispersion conditions of the area of concern.

Meteorological input is crucial in Gaussian plume modeling. Therefore compilation of input meteorological data files should be done meeting the procedures and algorithms set by environment regulators. It is always preferred to collect mandatory data such as wind speed, direction, sigamatheta (Calculated from Wind Direction measurements) and ambient temperature onsite. And again instrumentations and siting should meet Australian Standard (2923 -ambient air guide for measurement of horizontal wind for air quality applications).

Cessnock weather station found to be the best available data source maintained by Bureau of Meteorology to prepare input meteorological data file for **Ella long** (NSW).

This file was complied following the set procedure and the algorithms recommended by EPA, Victoria.

LOCATION:


Location: Cessnock
Longitude :151.37 E
Latitude :-32.82 S
Neath
Cessnock
Bellbird
Kitchener
Millfield
Abernethy
Paxton
Ellalong NSW
Google
Data Source
BoM ,NSW Regional Office
BoM NCC,Melbourne
MultiMedia & Consultancy
Dungog
Bulahdelah
Singleton
Broughton Islands
Branxton
Greta
Maitland
Williamtown NSW
Cessnock NSW
Ellalong NSW
Newcastle
Budgewoi
Wyong
Google

DATA PROCESSING

Data Source

1. **Cessnock** AWS Data- BoM, NSW (Regional Office).

2. **Williamtown Cloud** data and **Williamtown** Airport Vertical temperature Profiles -National Climate Centre- Bureau of Meteorology, Melbourne.

Input Information

- Onsite (**Cessnock**) parameters
  a. Wind speed (km/h)
  b. Wind direction
  c. Ambient Temperature (C)
  d. Surface Pressure
  e. Dew point
- Offsite (**Williamtown**)
  f. Total Clod amount

Wind was measured at 10m (Anemometer Height), surface roughness assumed to be 0.3m

- OFFSITE

- **Williamtown (NSW)**
  1. Vertical temperature profiles; Temperature, Dew point (1 profile per day)

Other Info:

Land use category: Mixed Rural
Surface Roughness: 0.3 m
Anemometre Height :10m

QA/QC on Raw data

This data set was treated as follows

- Incomplete days removed
- Suspected wind stalls (both wind direction and speed) removed
- Small gaps filled with previous or following data

- Pressure, Dew point Temperature and cloud amount were checked for unusual values

Williamtown (BoM)Vertical Temperature Profiles

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

DETERMINATION OF 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/m²)			
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 Hour before sunset or after sunrise	Night-time cloud amount (Octas)		
	Strong (>600)	Moderate (300-600)	Slight (<300)	Overcast		0-3	4-7	8
< 2	A	A-B	B	D	D	F	F	D
< 3	A-B	B	C	D	D	F	E	D
< 5	B	B-C	C	D	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 (Convective & Mechanical)

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). **Williamtown** 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.

MixHm=0.185* Ustar/Cterm

Where Ustar=.35*Usfc/Ln (Htanemo/Z0)

Cterm = Coriolis Term =2 Ω Sin(ϕ)

Where Ω is the angular velocity of the earth

ϕ is the latitude

Htanemo= Anemometer Height, Z0 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.

Analysis

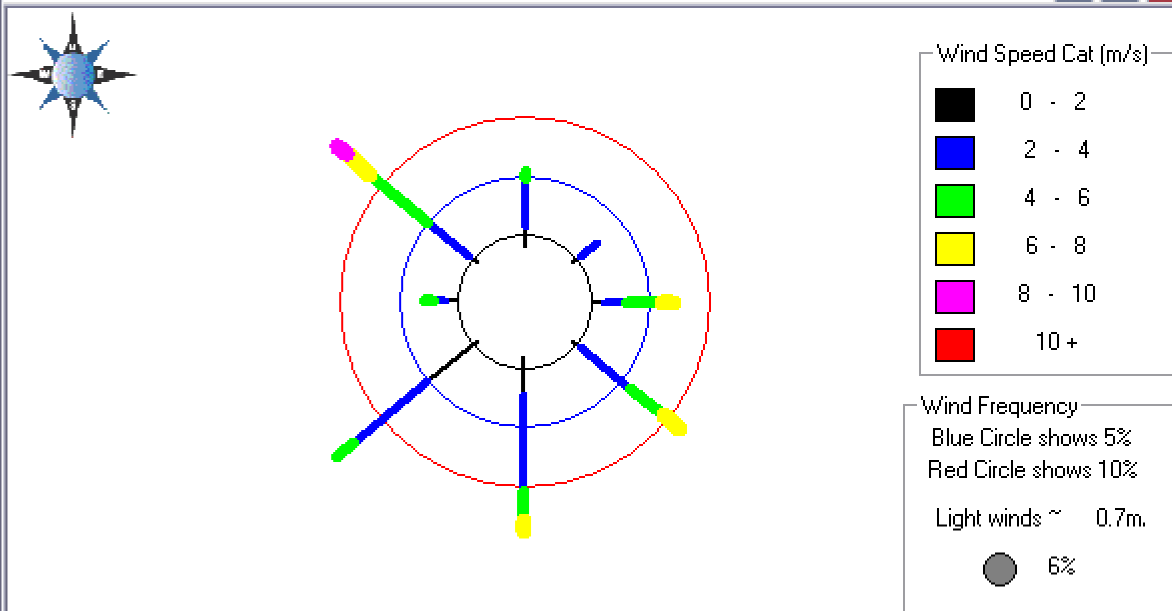
Data Coverage

Season	No. of Days	Percentage
Summer (90 days)	89	99%
Autumn (92 days)	82	89%
Winter(92 days)	90	98%
Spring (91 days)	91	100%
Annual (365 days)	352	96%

All seasons are well represented.

Annual WindRoses

Annual WindRoses for Annual WindRoses for Cessnock (NSW):2003

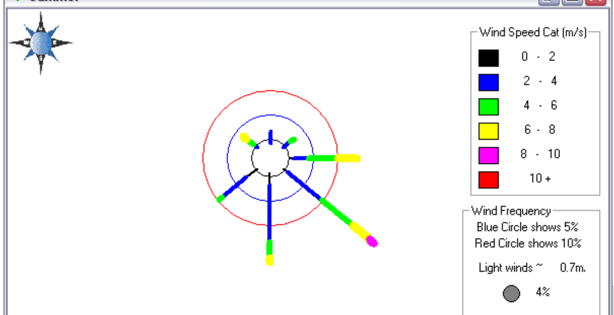


Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.5	1.5	1.7	4.2	6.5	1.2	1.2	2.2	20%
2 - 4	2.4	2.9	6.0	10.5	9.4	1.7	5.0	5.1	43%
4 - 6	0.6	3.3	4.5	3.8	2.5	1.2	7.8	1.2	25%
6 - 8	0.1	1.4	2.0	1.2	0.4	0.6	3.4	0.3	9%
8 - 10	0.0	0.1	0.3	0.1	0.1	0.3	1.3	0.0	2%
10 +	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0	1%
Total Dir Freq	5%	9%	15%	20%	19%	5%	19%	9%	

SEASONAL WINDROSES

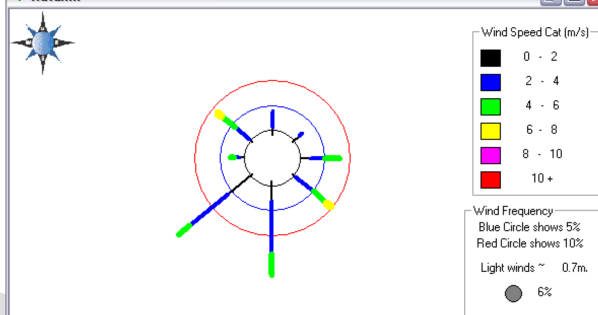
Summer



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	0.7	1.5	1.6	3.4	3.1	0.6	0.4	0.7	12%
2 - 4	2.7	3.9	10.9	14.6	7.7	0.5	1.4	3.2	45%
4 - 6	1.2	6.8	9.1	4.1	1.1	0.3	2.4	1.0	26%
6 - 8	0.4	4.2	5.5	1.8	0.2	0.1	1.6	0.6	14%
8 - 10	0.0	0.4	1.1	0.3	0.0	0.1	0.6	0.0	3%
10 +	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	%
Total Dir Freq	5%	17%	28%	24%	12%	2%	7%	6%	

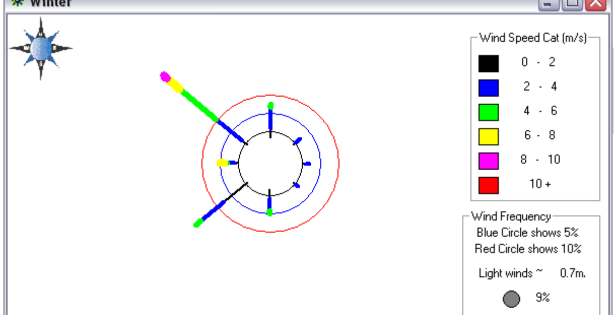
Autumn



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	2.2	2.0	1.8	5.3	7.1	1.5	1.3	2.9	24%
2 - 4	1.9	3.6	5.8	13.8	12.0	1.5	4.1	4.7	47%
4 - 6	0.5	3.4	4.4	5.7	3.8	1.1	4.4	0.5	24%
6 - 8	0.0	0.2	1.2	1.0	0.4	0.2	1.5	0.0	4%
8 - 10	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.0	%
10 +	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	%
Total Dir Freq	5%	9%	13%	26%	23%	4%	12%	8%	

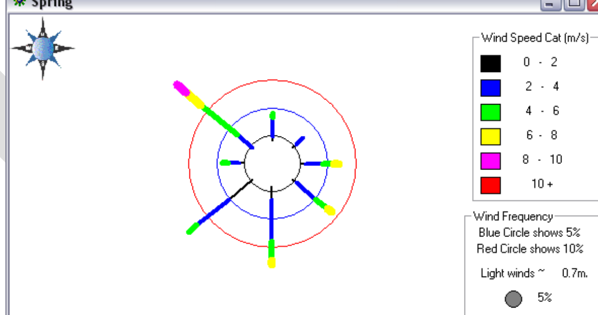
Winter



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.9	1.4	1.9	4.0	9.6	1.6	2.4	3.7	26%
2 - 4	2.6	1.1	1.7	4.4	9.9	2.5	10.1	7.6	40%
4 - 6	0.0	0.2	0.9	1.3	3.0	1.9	15.0	1.6	24%
6 - 8	0.0	0.0	0.1	0.1	0.4	1.2	5.4	0.2	7%
8 - 10	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	2%
10 +	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1%
Total Dir Freq	5%	3%	4%	10%	23%	7%	35%	13%	

Spring



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.2	1.0	1.5	4.0	6.5	1.3	0.8	1.5	18%
2 - 4	2.3	3.3	5.6	9.8	8.4	2.2	4.3	4.9	41%
4 - 6	0.7	3.0	3.6	4.1	2.1	1.4	9.2	1.7	26%
6 - 8	0.0	1.0	1.3	1.7	0.6	0.9	4.9	0.3	11%
8 - 10	0.0	0.0	0.1	0.2	0.3	0.9	2.5	0.0	4%
10 +	0.0	0.0	0.0	0.0	0.2	0.1	0.7	0.0	1%
Total Dir Freq	4%	8%	12%	20%	18%	7%	22%	8%	

Annual Stability Distribution

Stability Category	% Distribution	Avg Wind Speed	Avg Temperature	Avg Mixing Height
A	2	1.6	21.4	824
B	7	3.	20.8	1110
C	14	4.	20.5	1195
D	37	4.8	18.	1155
E	15	3.4	15.	786
F	25	1.7	12.	428

STATISTICS OF CESSNOCK (NSW) INPUT METEOROLOGICAL DATA FILE-2003

Stability	Stat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
A	Max of Temp	32.0	30.0	25.0	24.0	20.0				20.0	23.0	25.0	31.0	32.0
	Min of Temp	16.0	20.0	16.0	17.0	20.0				7.0	11.0	11.0	19.0	7.0
	Average of Temp	24.1	25.5	20.7	20.6	20.0				14.4	18.3	19.1	23.6	21.4
	Max of WS	2.5	2.5	2.5	1.4	1.1				2.5	2.5	2.5	2.5	2.5
	Min of WS	0.6	0.6	0.6	0.6	1.1				0.6	1.1	0.6	0.6	0.6
	Average of WS	1.7	1.8	1.2	1.2	1.1				1.4	1.6	1.6	1.7	1.6
	Max of MixH	2539	1850	1459	803	710				1377	2127	1600	1800	2539
	Min of MixH	141	188	276	170	710				287	270	141	234	141
	Average of MixH	969	924	626	434	710				779	987	784	818	824
B	Max of Temp	38.0	33.0	28.0	25.0	23.0	20.0	20.0	18.0	25.0	27.0	36.0	33.0	38.0
	Min of Temp	18.0	18.0	15.0	7.0	11.0	8.0	6.0	6.0	3.0	10.0	11.0	16.0	3.0
	Average of Temp	25.5	25.6	22.9	20.7	18.6	13.9	14.0	12.9	17.2	19.3	22.7	24.1	20.8
	Max of WS	4.7	4.7	4.7	4.7	4.2	1.4	4.2	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	1.1	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	3.8	3.1	3.1	2.4	1.8	1.1	1.4	2.4	3.2	3.3	3.4	3.3	3.0
	Max of MixH	2615	2346	1915	1693	1548	1397	1389	1685	2015	2646	2205	2178	2646
	Min of MixH	422	322	357	141	299	141	328	141	322	264	504	188	141
	Average of MixH	1378	1120	1107	1021	911	476	653	748	1285	1372	1244	1024	1110
C	Max of Temp	40.0	35.0	28.0	26.0	25.0	22.0	22.0	23.0	29.0	28.0	37.0	40.0	40.0
	Min of Temp	19.0	18.0	17.0	10.0	10.0	5.0	5.0	0.0	2.0	10.0	14.0	17.0	0.0
	Average of Temp	28.3	25.6	23.0	18.9	17.3	15.2	14.3	15.1	18.2	18.4	22.7	26.0	20.5
	Max of WS	9.2	8.3	5.8	5.8	5.8	4.7	5.8	5.8	10.8	10.8	9.2	9.7	10.8
	Min of WS	2.5	1.1	2.2	0.6	1.1	0.6	2.2	0.6	0.6	2.2	0.6	1.4	0.6
	Average of WS	5.2	4.1	3.8	3.4	3.7	3.3	3.6	3.4	4.5	4.1	4.3	4.5	4.0
	Max of MixH	2801	2792	2081	1772	1777	1637	1729	2347	2402	2545	2714	2776	2801
	Min of MixH	539	340	469	281	469	298	432	170	381	404	328	475	170
	Average of MixH	1547	1230	1303	990	942	918	926	1051	1427	1350	1356	1279	1195
D	Max of Temp	42.0	35.0	30.0	26.0	26.0	22.0	22.0	23.0	34.0	29.0	37.0	39.0	42.0
	Min of Temp	11.0	15.0	8.0	7.0	3.0	0.0	-2.0	-4.0	-1.0	3.0	4.0	12.0	-4.0
	Average of Temp	23.8	23.4	20.5	17.5	15.6	13.6	11.4	13.5	18.0	16.5	18.9	22.6	18.0
	Max of WS	11.4	8.6	8.6	7.8	11.4	9.2	10.8	13.9	12.8	10.8	10.8	10.3	13.9
	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	5.3	4.7	4.0	3.7	4.4	4.6	4.7	4.8	5.9	4.7	4.7	4.8	4.8
	Max of MixH	2576	2117	1955	1949	2607	2156	2226	3011	2818	2448	2750	2902	3011
	Min of MixH	141	141	252	141	141	141	170	141	141	229	141	141	141
	Average of MixH	1298	1151	998	892	1043	1073	1079	1155	1435	1179	1175	1171	1155
E	Max of Temp	34.0	29.0	24.0	22.0	24.0	22.0	20.0	22.0	30.0	28.0	33.0	29.0	34.0
	Min of Temp	11.0	17.0	12.0	9.0	3.0	6.0	3.0	0.0	2.0	8.0	10.0	11.0	0.0
	Average of Temp	20.9	21.0	18.0	15.7	13.9	11.6	9.7	10.8	13.5	14.6	17.3	19.4	15.0
	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	3.5	3.5	3.2	3.2	3.4	3.6	3.3	3.3	3.6	3.2	3.3	3.6	3.4
	Max of MixH	1459	1160	1365	1102	1236	1283	1207	1324	1242	1201	1154	1248	1459
	Min of MixH	439	375	357	357	404	422	422	410	387	357	439	480	357
	Average of MixH	803	792	729	722	786	841	761	759	840	756	768	819	786
F	Max of Temp	36.0	29.0	21.0	24.0	23.0	19.0	20.0	20.0	24.0	23.0	32.0	31.0	36.0
	Min of Temp	11.0	14.0	8.0	7.0	4.0	-1.0	-2.0	-4.0	-1.0	4.0	4.0	12.0	-4.0
	Average of Temp	17.5	19.4	15.8	13.3	11.5	8.3	6.4	6.2	8.5	12.2	13.4	17.5	12.0
	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	2.0	2.1	1.8	1.8	1.6	1.5	1.4	1.6	1.6	1.8	1.8	1.8	1.7
	Max of MixH	721	750	697	715	814	750	926	797	961	943	973	850	973
	Min of MixH	141	188	141	141	141	141	141	141	141	141	141	141	141
	Average of MixH	503	508	434	442	398	384	374	393	425	449	450	438	428

DISCLAIMER

Compilation of input meteorological data file for AUSPLUME was done under the supervision of qualified and experienced meteorologists. Although all due care has been taken, we cannot give any warranty, nor accept any liability (except that required by law) in relation to the information given, its completeness or its applicability to a particular problem. These data and other material are supplied on the condition that you agree to indemnify us and hold us harmless from and against all liability, losses, claims, proceedings, damages, costs and expenses, directly or indirectly relating to, or arising from the use of or reliance on the data and material which we have supplied.

COPYRIGHT

BIBLIOGRAPHY

Australian Standard 2923-1987 :Standards Association of Australia

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.