

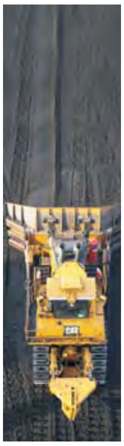


Duralie Open Pit Modification

Environmental Assessment

APPENDIX B

AIR QUALITY ASSESSMENT

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

Report

DURALIE OPEN PIT MODIFICATION – AIR QUALITY ASSESSMENT

DURALIE COAL PTY LTD C/- RESOURCE STRATEGIES PTY LTD

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1 INTRODUCTION

The Duralie Coal Mine (DCM) is owned and operated by Duralie Coal Pty Ltd (DCPL), a wholly owned subsidiary of Yancoal Australia Limited (Yancoal). DCM has been operating since 2003 and is situated approximately 10 kilometres (km) north of the village of Stroud and approximately 20 km south of Stratford in the Gloucester Valley in New South Wales (NSW) (**Figure 1-1**).

In 2008 DCPL submitted a major project application for the Duralie Extension Project (DEP) for approval to continue and extend open pit mining operations at DCM. Project Approval (08_0203) for the DEP was granted in November 2011 by the NSW Land & Environment Court.

DCPL is proposing a modification to the DCM Project Approval (08_0203) (the Duralie Open Pit Modification [the Modification]) and Pacific Environment has been engaged by DCPL to complete an Air Quality Impact Assessment (AQIA) for the Modification.

DURALIE OPEN PIT MODIFICATION

FIGURE 1-1

Regional Location

GCL-14-23_Mod 2_Section 1_101B

2 DESCRIPTION OF MODIFICATION

The DCM is a drill and blast open pit coal mining operation using conventional hydraulic excavator and haul truck fleets. The DCM produces up to 3.0 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal and operates 24 hours per day. The ROM coal is initially sized at the DCM prior to being transported by rail to the Stratford Coal Mine (SCM) coal handling and preparation plant where it is blended and processed (in accordance with the SCM Development Consent). The blended product coal is then railed to Newcastle (in accordance with the SCM Development Consent).

The Modification would result in no increase in currently approved annual ROM coal extraction rate, or annual waste rock extraction, hauling or emplacement. In addition, there would be no material change to the mine footprint.

From an air quality perspective, the modification will result in relatively minor changes to dust emissions, resulting from the following changes in the locations of potential dust sources compared to the previously assessed and approved DCM (**Figure 2-1**):

- Increased waste emplacement height (from relative level (RL) 110 metres (m) to RL 135 m).
- Changes to the mining sequence in the Clareval and Weismantel pits, and changes to pit dimensions (i.e. increased maximum pit depth).

2.1 History of assessment

The environment assessment for the DEP included an AQIA (**Heggies, 2009**) which assessed the expansion of ROM coal production from 1.8 Mtpa to 3 Mtpa. Three conceptual mining scenarios were assessed in the AQIA, Year 3, 5, and 8. The AQIA found:

- No exceedances of the 24-hour average particulate matter with an equivalent aerodynamic diameter of 10 micrometres (µm) (PM_{10}) or less criterion at private residences, with the exception of one residence that is now owned by DCPL. The predicted exceedance occurred in Years 5 and 8 as a result of the project alone.
- No exceedance of the annual average PM_{10} criterion at private residences.
- No exceedance of the annual average total suspended particulate (TSP) criterion at private residences.
- No exceedance of the annual average dust deposition criterion at private residences.

The assessment of cumulative impacts (**Heggies, 2009**) indicated that dust emissions from the DEP and other sources are unlikely to significantly contribute to the existing dust levels.

Following approval of the DEP by the NSW Minister for Planning, an appeal was lodged in the Land and Environment (L&E) Court of NSW on the grounds that (among other things) there would be unacceptable health impacts from particulate matter with an equivalent aerodynamic diameter of 2.5 micrometres (µm) ($PM_{2.5}$) or less. The L&E court judgement found that the potential risk to the health of persons in the locality from $PM_{2.5}$ emissions from the DEP would be acceptably small, the appeal was upheld and the DEP was approved by the NSW Land & Environment Court in November 2011.

Since the approval of the DEP, the compliance monitoring sites, in the vicinity of the DCM, consistently meet air quality goals (refer **Section 4**). Generally, the predictions presented in **Heggies (2009)** appear to have over-estimated potential impact.

Source: DCPL (2014); AAHatch - Aerial Photography flown April 2009 and July 2013

DURALIE OPEN PIT MODIFICATION

FIGURE 2-1
Modification
General Arrangement

GCL-14-23_Mod 2_AQA_101A

3 LOCAL SETTING

The DCM is situated adjacent to Mammy Johnsons River within the Mammy Johnsons River Catchment, between the townships of Wards River and Stroud on the Bucketts Way in NSW. It is located within the Gloucester Basin at an altitude of 70-180 m Australian Height Datum (AHD). There are north-south ranges to the east and west of the DCM that rise up to 300-370 m AHD elevation.

Figure 3-1 shows a pseudo three-dimensional (3D) representation of the local topography in the local area and surrounds. Vertical exaggeration is applied to emphasise terrain features.

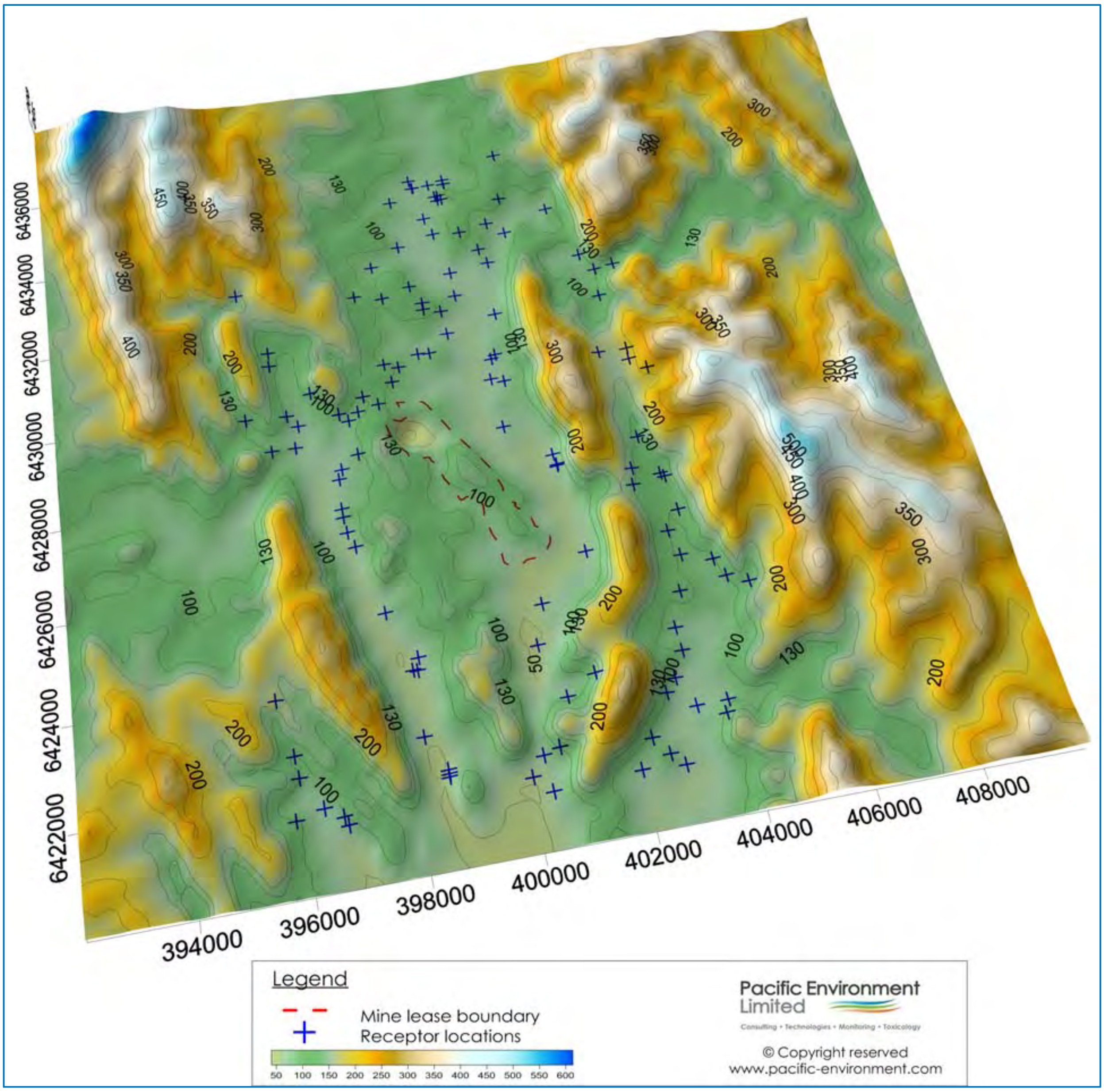

Figure 3-1: Pseudo 3-D representation of regional topography within modelling domain

For the purposes of assessing impacts from the Modification, discrete receiver locations have been selected, also shown on **Figure 3-1**. A land ownership plan is shown in **Figure 3-2** and the complete list of resident IDs and locations are presented in **Appendix A**.

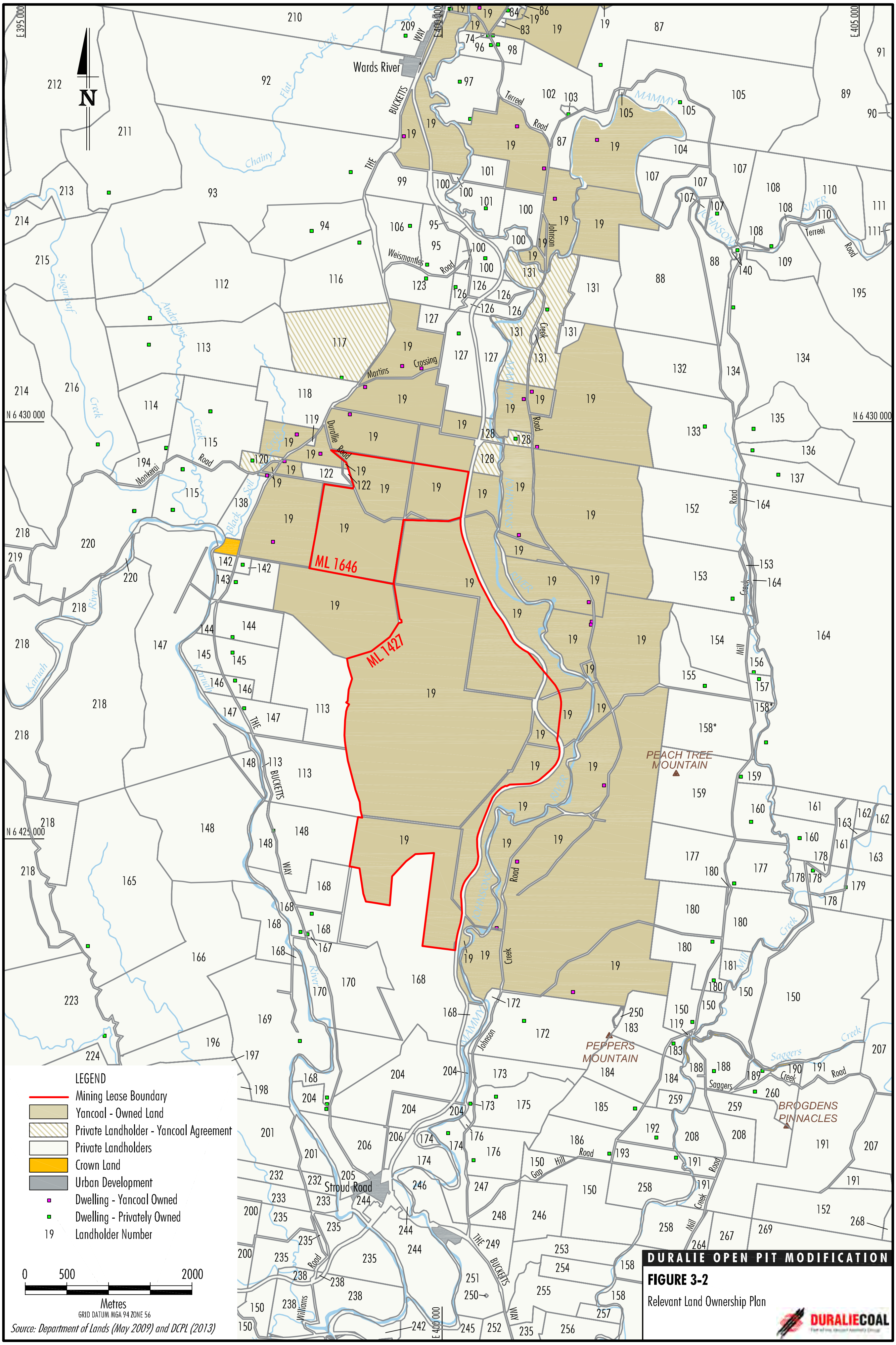

FIGURE 3-2
Relevant Land Ownership Plan

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4 AIR QUALITY CRITERIA

Mining activities have the potential to generate fugitive dust emissions in the form of particulate matter described as TSP, PM_{10} or less, $PM_{2.5}$ or less and deposited dust emissions. Diesel combustion also results in the emission of particulate matter which is accounted for in the estimates of fugitive emissions of particles, which include diesel particles as well as particles derived from the materials being handled.

4.1 Particulate matter and health effects

Particulate matter has the capacity to affect health and to cause nuisance effects, and is categorised by size and/or by chemical composition. The potential for harmful effects depends on both. The particulate size ranges are commonly described as:

- TSP – refers to all suspended particles in the air. In practice, the upper size range is typically 30 µm to 50 µm.
- PM_{10} – refers to all particles with equivalent aerodynamic diameters of 10 µm or less, that is, all particles that behave aerodynamically in the same way as spherical particles with diameters of 10 µm or less and with a unit density. PM_{10} are a sub-component of TSP.
- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of l 2.5 µm or less (a subset of PM_{10}). These are often referred to as the fine particles and are a sub-component of PM_{10}.
- $PM_{2.5-10}$ – defined as the difference between PM_{10} and $PM_{2.5}$ mass concentrations. These are often referred to as coarse particles.

Evidence suggests that health effects from exposure to airborne particulate matter are predominantly related to the respiratory and cardiovascular systems. The human respiratory system has in-built defensive systems that prevent larger particles from reaching the more sensitive parts of the respiratory system. Particles larger than 10 µm, while less significant in terms of health effects, can soil materials and generally degrade aesthetic elements of the environment. For this reason, air quality goals make reference to measures of the total mass of all particles suspended in the air and is referred to as TSP. In practice particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 µm.

Both natural and anthropogenic processes contribute to the atmospheric load of particulate matter. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal[a] materials from roads, farming, mining, dust storms, and so forth. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts. Mining dust is likely to be composed of predominantly coarse particulate matter (and larger).

Fine particles or $PM_{2.5}$ and less are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation, and natural processes such as bush fires. Emissions of these fine particles from coal mining operations are primarily restricted to emissions from the combustion of diesel and would be relatively minor for the DCM operations.

Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions. $PM_{2.5}$, and in particular the ultrafine sub-micron particles, may penetrate beyond the larynx and into the thoracic respiratory tract and evidence suggests that particles (i.e. PM_1) in this size range are more harmful than the coarser component of PM_{10}.

a Crustal dust refers to dust generated from materials derived from the earth's crust.

The size of particles determine their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them. This is demonstrated in **Figure 4-1**, which shows the relative deposition by particle size within various regions of the respiratory tract. Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air; key considerations in assessing exposure.

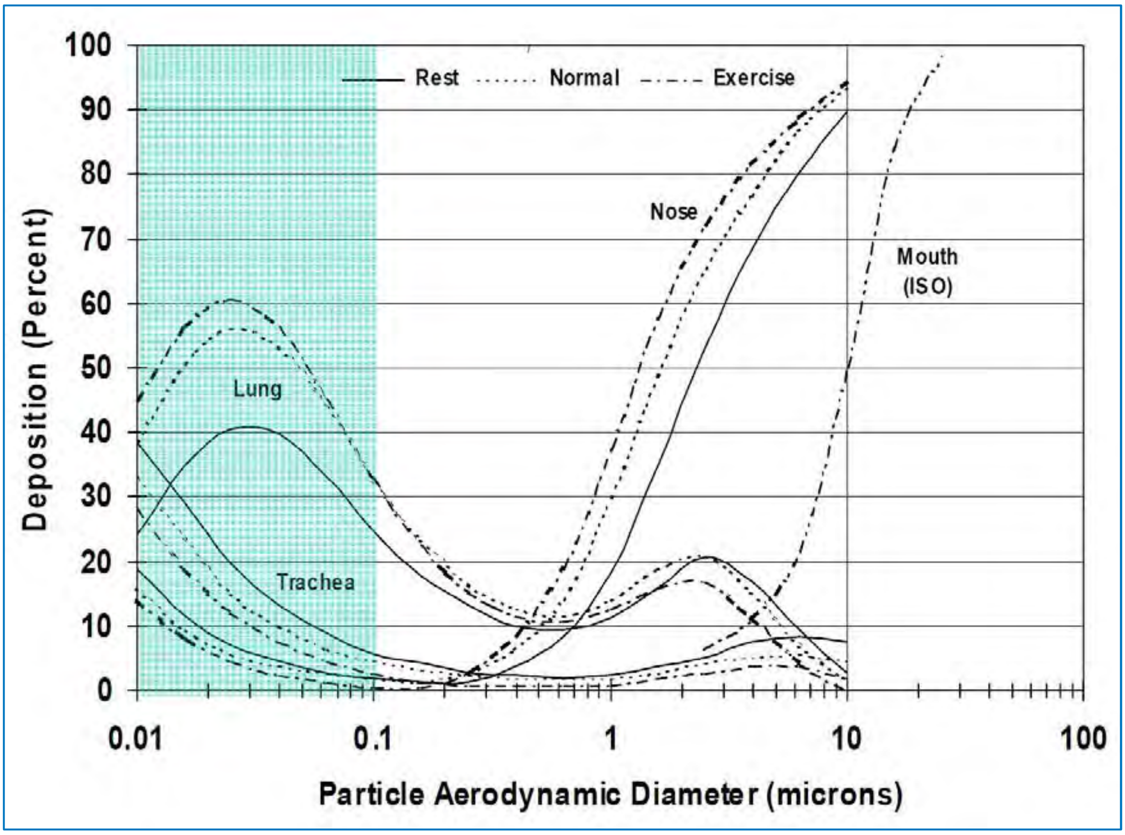


Figure 4-1: Particle Deposition within the Respiratory Track (Source: Chow, 1995)

The health-based assessment criteria used by the NSW Environmental Protection Authority (EPA) have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion (NSW **EPA**, **1998**; **National Environment Protection Council** [**NEPC**], **1998a**; **NEPC**, **1998b**). This means that, in contrast to dust of crustal origin, the particulate matter from urban areas would be composed of smaller particles and would generally contain substances associated with combustion.

Further, the L&E court judgement found that the potential risk to the health of persons in the locality from $PM_{2.5}$ emissions from the DEP would be acceptably small, the appeal was upheld and the DEP was approved by the NSW Land & Environment Court in November 2011.

4.2 Impact assessment criteria

The Approved Methods specifies air quality assessment criteria relevant for assessing impacts from air pollution (**NSW EPA, 2005**). The air quality goals relate to the total dust burden in the air and not just the dust from the project. In other words, consideration of background dust levels needs to be made when using these goals to assess potential impacts. These criteria are health-based (i.e. they are set at levels to protect against health effects). These criteria are consistent with the *National Environment Protection Measure for Ambient Air Quality* (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). However, the EPA's criteria include averaging periods, which are not provided in the Ambient Air-NEPM, and also reference other measures of air quality, namely dust deposition and TSP.

In May 2003, the NEPC released a variation to the Ambient Air-NEPM (**NEPC, 2003**) to include advisory reporting standards for $PM_{2.5}$ or less. The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Ambient Air-NEPM, which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for $PM_{2.5}$ particles. It is noted that the Ambient Air-NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria.

Notwithstanding the above, in the absence of any other relevant standard/goal, the advisory reporting standards have been used in this report for comparison against dispersion modelling results (**Section 8**). **Table 4.1** summarises the air quality goals for pollutants that are relevant to this study. It is important to note that the criteria are applied to the cumulative impacts due to the Proposal and other sources.

Table 4.1: EPA Air Quality Standards/Goals for Particulate Matter Concentrations

Pollutant	Standard	Averaging Period	Source
TSP	90 µg/m³	Annual	National Health and Medical Research Council
PM_{10}	50 µg/m³	24-Hour	**NSW DEC** (**2005**) (assessment criteria) EPA impact assessment criteria; and Ambient Air NEPM reporting goal which allows five exceedances per year.
	30 µg/m³	Annual	EPA impact assessment criteria
$PM_{2.5}$	25 µg/m³	24 – Hour	NEPM Advisory Reporting Standard
	8 µg/m³	Annual	NEPM Advisory Reporting Standard

Notes: µg/m³ – micrograms per cubic metre.

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fall out relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts.

Table 4.2 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts (**NSW EPA, 2005**).

Table 4.2: EPA Criteria for Dust (Insoluble Solids) Fallout

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

Notes: g/m²/month – grams per square metre per month.

5 EXISITING ENVIRONMENT

5.1 Local climatic conditions

Long-term meteorological data for the region is available from the Bureau of Meteorology (**BoM 2014**) operated Automated Weather Station (AWS) at Paterson, located approximately 50 km southwest of the DCM.

Long-term climate statistics are presented in **Table 5.1**. The annual average maximum and minimum temperatures recorded at the Paterson AWS are 24 degrees Celsius (°C) and 12°C respectively. On average, January is the hottest month, with an average maximum temperature of 29.8°C. July is the coldest month, with average minimum temperature of 6.2°C.

The annual average relative humidity reading collected at 9.00 am from the Paterson station is 73 percent (%) and at 3.00 pm the annual average is 53%. The highest relative humidity on average occurs in March and May with 9.00 am and 3.00pm averages of 80% and 58% respectively. The month with the lowest relative humidity is September with 9.00 am and 3.00 pm averages of 64% and 46% respectively.

Rainfall data collected at the Paterson AWS shows that February is the wettest month, with an average rainfall of 121.5 millimetres (mm) over 11.4 rain days. The average annual rainfall is 932 mm with an average of 123.9 rain days.

Table 5.1: Climate Averages for the Paterson AWS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	22.7	22	20.6	18	14.6	11.9	11	12.6	16.2	19.1	20.1	22.2	17.6
Humidity	74	79	80	77	80	78	76	69	64	64	69	69	73
3pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	28.3	27.4	25.7	23	19.7	16.8	16.4	18.3	20.9	23.3	25.1	27.5	22.7
Humidity	52	56	58	56	58	59	55	46	46	48	49	49	53
Daily Maximum Temperature (°C)													
Mean	29.8	28.8	26.9	24.2	20.7	17.7	17.3	19.4	22.5	25	26.7	29	24
Daily Minimum Temperature (° C)													
Mean	17.6	17.6	15.6	12.4	9.6	7.5	6.2	6.6	8.9	11.4	14	16.2	12
Rainfall (mm)													
Mean	102.5	121.5	115.8	79.9	73.8	77.6	41	36.2	48.7	66.3	86.6	78	932
Rain days (Number)													
Mean	11.7	11.4	12.1	10.3	10.9	11	9.5	7.8	7.9	9.6	11.6	10.1	123.9

Source: BOM (2014) Climate averages for Station: 061250; Commenced: 1967; Latitude: 32.63 °S; Longitude: 151.59 °E

5.2 Local wind data

The onsite meteorological station at DCM collects 15-minute averages of wind speed, wind direction and sigma-theta (or standard deviation of wind direction). Windroses for the onsite meteorological station at DCM are presented in **Figure 5-1** and **Figure 5-2**. Although some variability is seen in the annual windroses, the winds are predominantly from northeast and southwest quadrants, which aligns with the orientation of the Gloucester Valley.

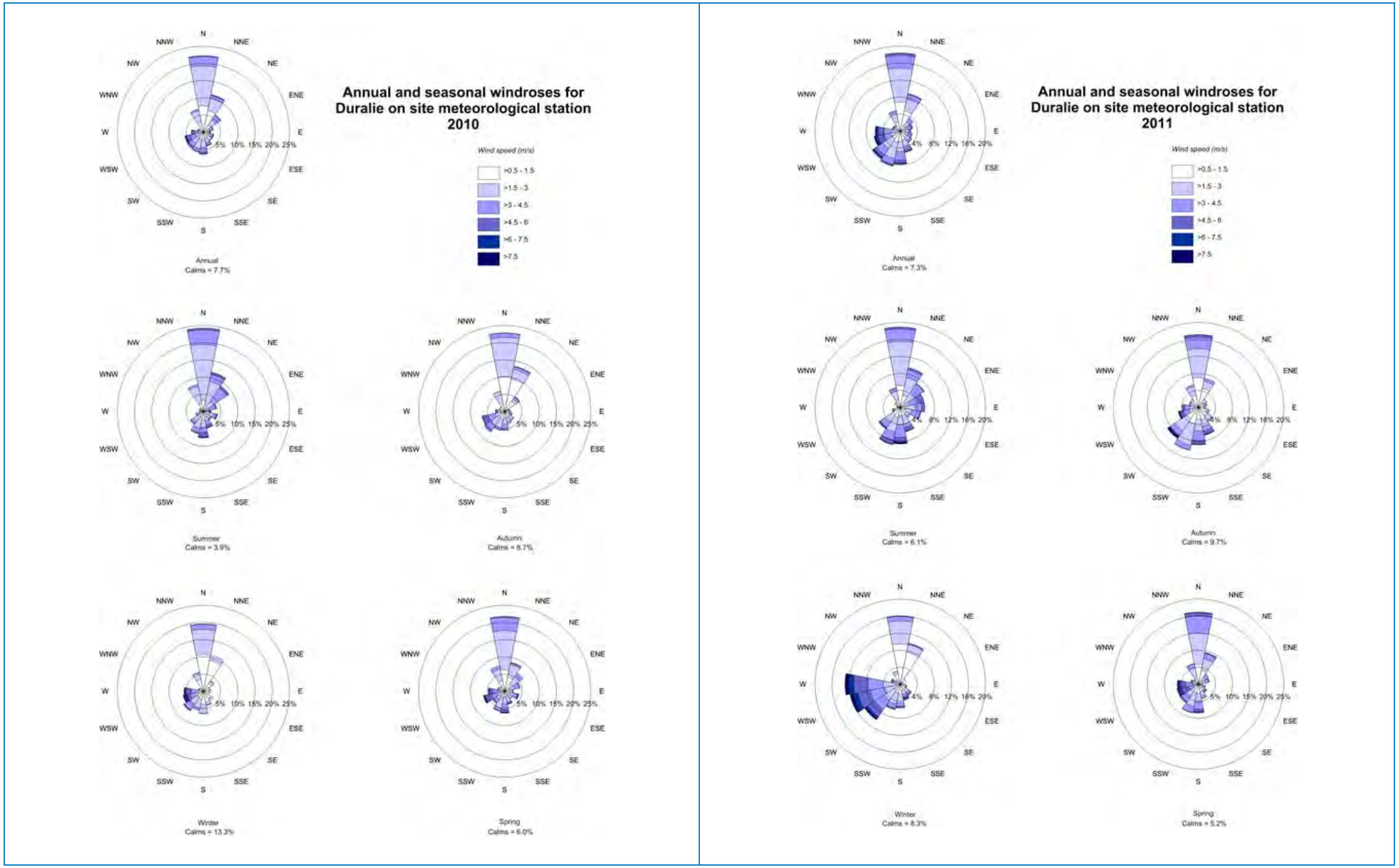


Figure 5-1: Annual and seasonal windroses for Duralie on site meteorological station 2010 and 2011

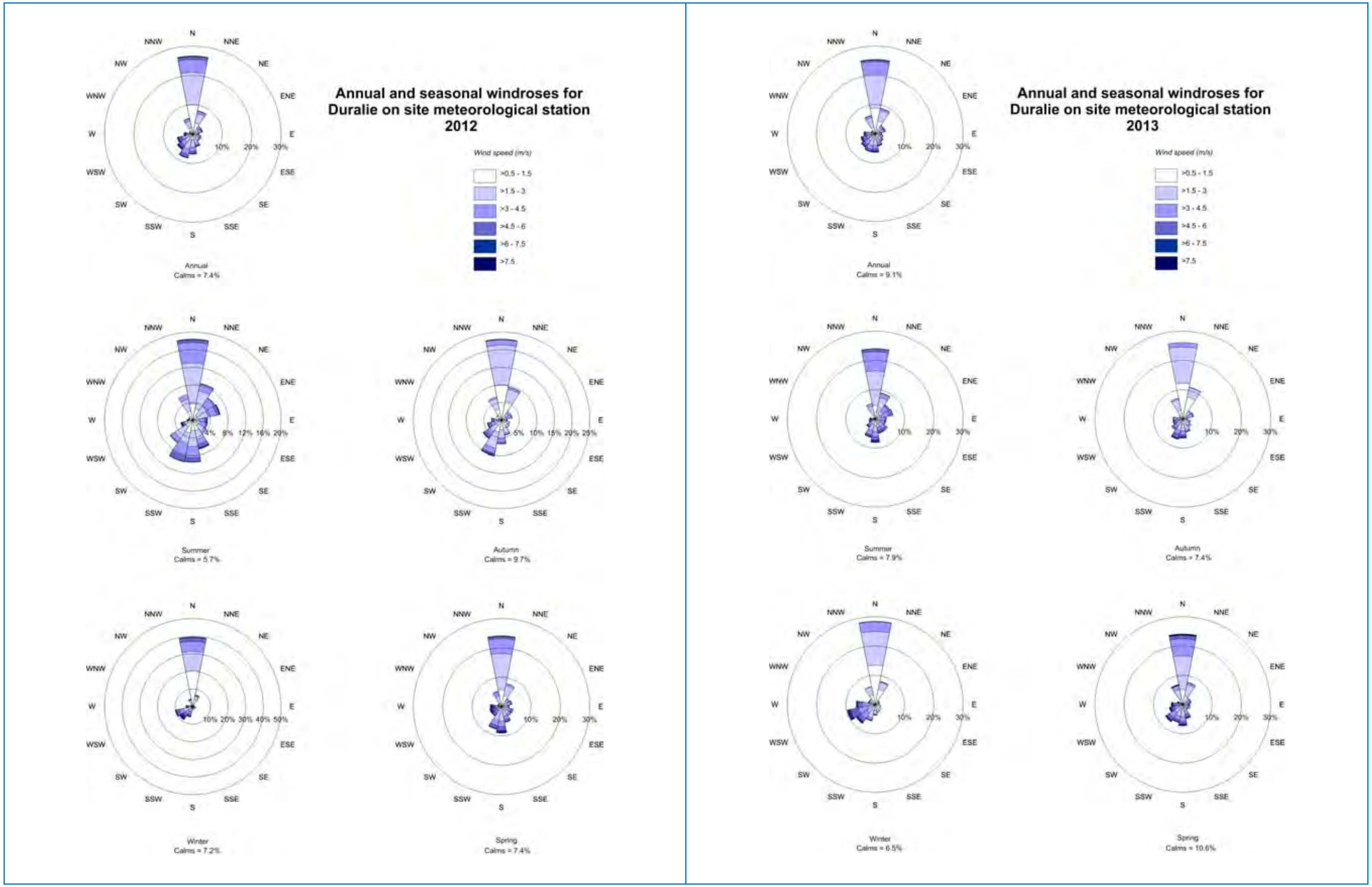


Figure 5-2: Annual and seasonal windroses for Duralie on site meteorological station 2012 and 2013

5.3 Existing ambient air quality

Air quality standards and goals refer to pollutant levels that include the contribution from specific projects and existing sources. To fully assess impacts against the relevant air quality standards and goals it is necessary to have data on existing dust concentration and deposition levels in the area in which the Modification is likely to contribute. It is important to note that the existing air quality conditions (that is, background conditions) will be influenced by existing operations at the DCM.

The DCM air quality monitoring network currently consists of:

- Four High Volume Air Sampler (HVAS) measuring PM_{10} on a one day in six cycle;
- One Tapered Element Oscillating Microbalance (TEOM) measuring PM_{10} and $PM_{2.5}$ continuously; and
- Nine dust deposition gauges.

The locations of the current monitoring sites in place for the mine operations are shown on **Figure 5-3**. Sites D1 and D2 were decommissioned in 2013.

Current ambient air monitoring at the DCM shows that existing operations have a minimal impact on local air quality, with monitoring data showing monitored dust levels are generally well below Project Approval criterion.

5.3.1 Dust deposition

Table 5.2 presents a summary of the dust deposition data collected since 2008 (expressed as insoluble solids). Monitoring data show that generally dust deposition levels are below the EPA impact assessment of 4 g/m^2/month. There has been one exceedance (at Site D1) of the EPA criterion of 4 g/m^2/month during the past 6 years of monitoring. Site D1 was located in close proximity to the mining operations within ML 1427. The average dust deposition rate across all sites for the entire monitoring period is 1.6 g/m^2/month.

Table 5.2: Summary of annual average dust deposition measure at DCM monitor locations (g/m^2/month)

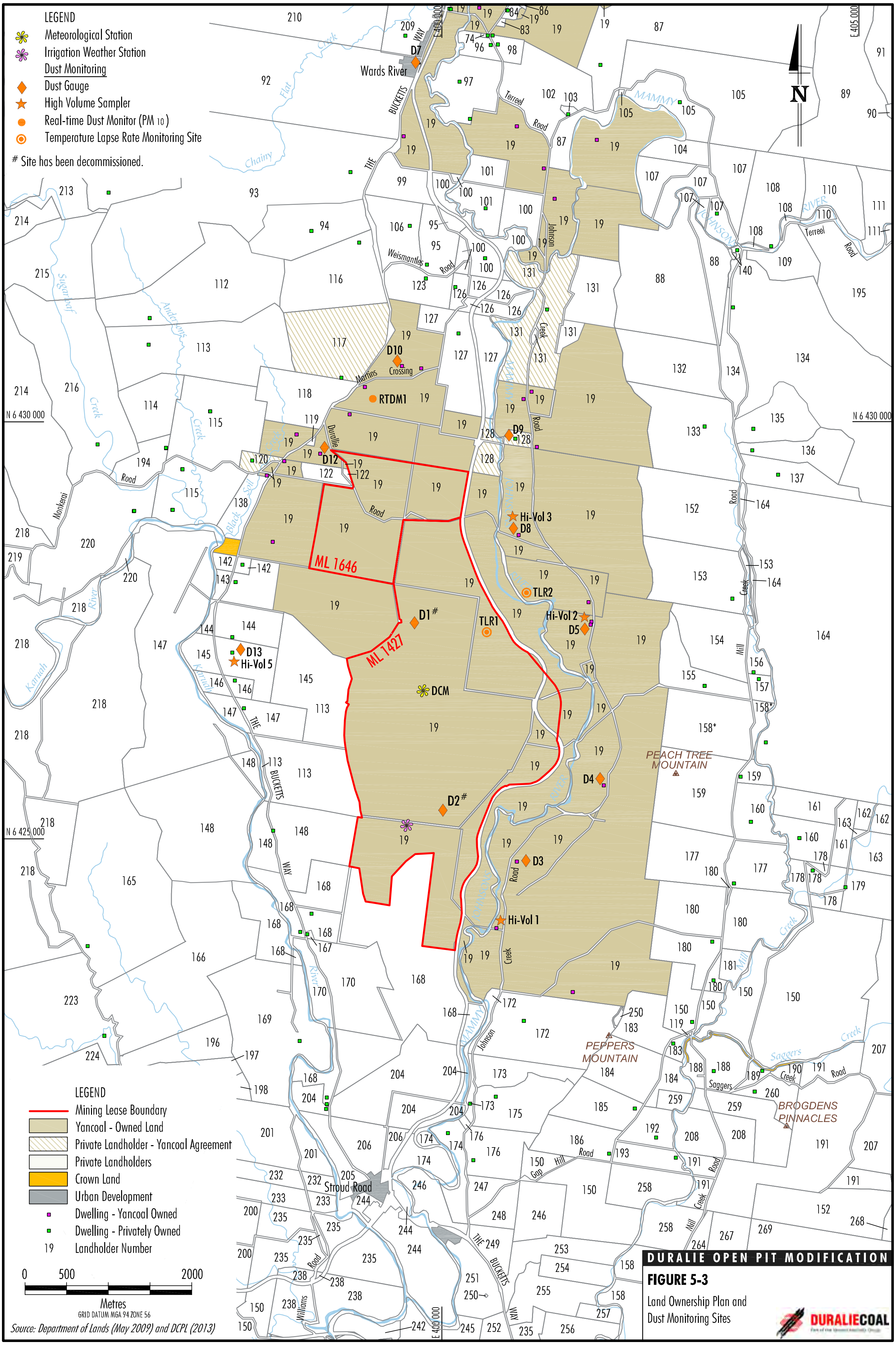
Year	D1	D2	D3	D4	D5	D7	D8	D9	D10	D12	D13
2008	0.8	0.6	1.2	1.4	0.7	0.5					
2009	1.3	1.3	1.2	1.5	2.2	1.0					
2010	2.4	1.6	2.5	3.0	1.5	0.9					
2011	3.5	1.6	1.6	1.0	2.9	0.5	0.6	1.3	1.7	1.3	
2012	**5.4**	1.7	3.2	1.7	2.1	0.7	0.8	2.8	2.2	0.7	1.3
2013	1.9	1.2	2.0	0.7	3.9	0.8	0.6	1.0	1.3	0.9	0.7
Average	**2.5**	**1.3**	**2.0**	**1.5**	**2.2**	**0.7**	**0.7**	**1.7**	**1.8**	**0.9**	**1.5**
Average over all sites											**1.6**

Notes: Annual averages exclude contaminated results for D5 and D13 .

5.3.2 PM_{10} concentrations

A summary of the annual average PM_{10} concentrations from 2008 to 2013 is shown in **Table 5.3**. Monitoring results show that since 2008 there have been no exceedances of the EPA annual average criterion of 30 µg/m^3.

The annual average PM_{10} for 2012 and 2013 (i.e. the period after approval of the DEP) ranges from 11 to 15 µg/m^3.


LEGEND
Meteorological Station
Irrigation Weather Station
Dust Monitoring
Dust Gauge
High Volume Sampler
Real-time Dust Monitor (PM 10)
Temperature Lapse Rate Monitoring Site
Site has been decommissioned.
LEGEND
Mining Lease Boundary
Yancoal - Owned Land
Private Landholder - Yancoal Agreement
Private Landholders
Crown Land
Urban Development
Dwelling - Yancoal Owned
Dwelling - Privately Owned
19 Landholder Number
0 500 2000
Metres
GRID DATUM MGA 94 ZONE 56
Source: Department of Lands (May 2009) and DCPL (2013)
ML 1646
ML 1427
Wards River
PEACH TREE MOUNTAIN
PEPPERS MOUNTAIN
BROGDENS PINNACLES
DURALIE OPEN PIT MODIFICATION
FIGURE 5-3
Land Ownership Plan and Dust Monitoring Sites
DURALIECOAL
GCL-14-23_Mod 2_AQA_102D

The day to day variability in 24-hour PM_{10} concentrations are shown in **Figure 5-4** and **Figure 5-5**. The data show that the 24-hour PM_{10} concentrations are above the criterion of 50 µg/m³ on relatively few occasions in the past 5 years. Since approval of the DEP in November 2011 there has only been a single day above the criterion of 50 µg/m³. The exceedance occurred on the 18 October 2013 and a value over 50 µg/m³ was recorded at the Twin Houses HVAS and TEOM site. Smoke from bushfire activity was present at the DCM on 18 October 2013 and would have contributed to these high PM_{10} concentrations.

Table 5.3: Annual average PM_{10} measured at each HVAS and TEOM site (µg/m³)

Year	High noon	Twin Houses	Hattam	Edwards	TEOM
2008	10.7	12.7			
2009	15.5	17.2			
2010	10.1	11.8			
2011	7.8	9.5	9.8		
2012	11.8	14.1	13.0	11.7	11.0
2013	12.6	15.2	12.3	11.8	11.2

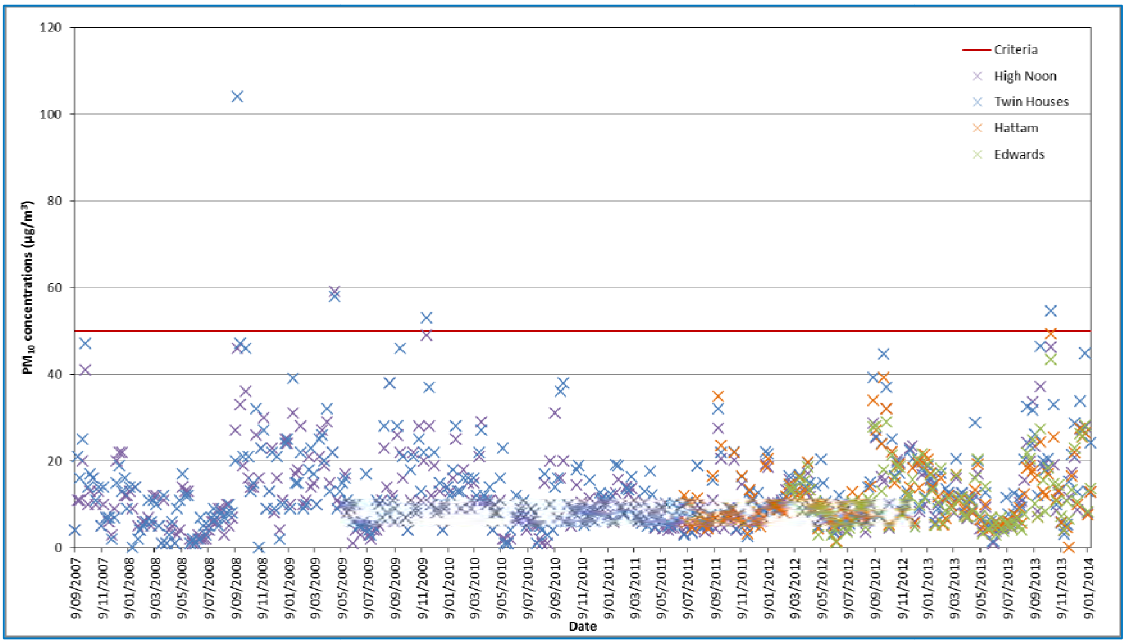


Figure 5-4: 24 hour PM_{10} concentrations at HVAS monitoring sites

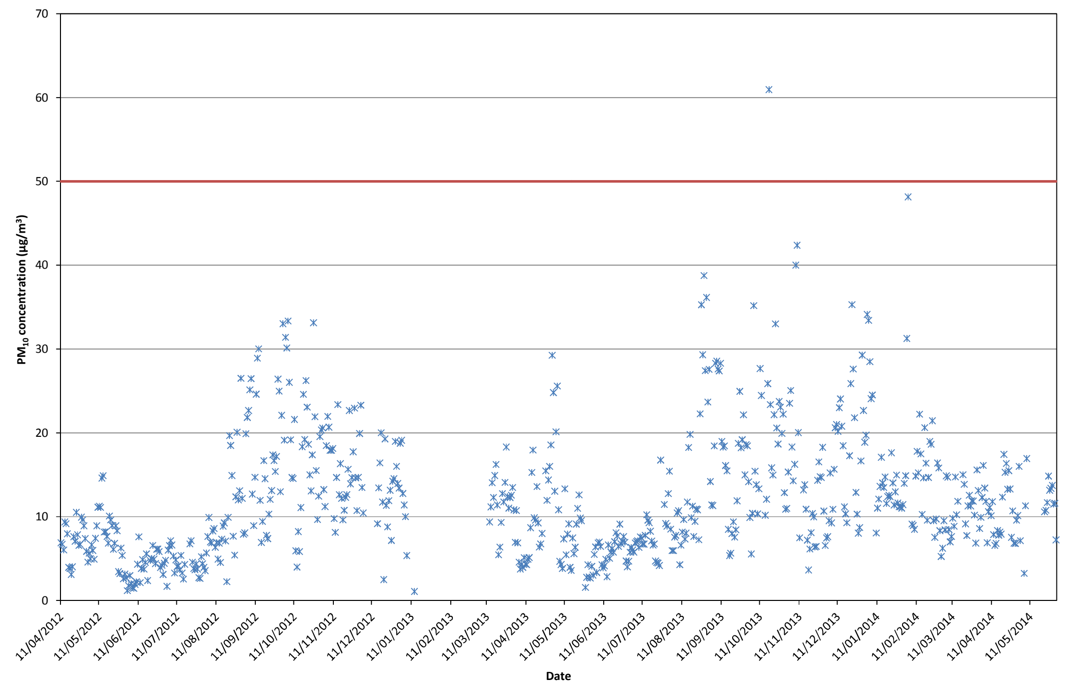


Figure 5-5: 24 hour PM_{10} concentrations at TEOM monitoring site

5.3.3 $PM_{2.5}$ concentrations

Concentrations of $PM_{2.5}$ are also recorded at the TEOM site. The annual average $PM_{2.5}$ concentrations for 2012 and 2013 are shown in **Table 5.4** and the daily variation in 24-hour $PM_{2.5}$ are shown in **Figure 5-6**.

Table 5.4: Annual average $PM_{2.5}$ measured at the TEOM site (µg/m³)

Year	Annual (µg/m³)
2012	5.4
2013	5.7

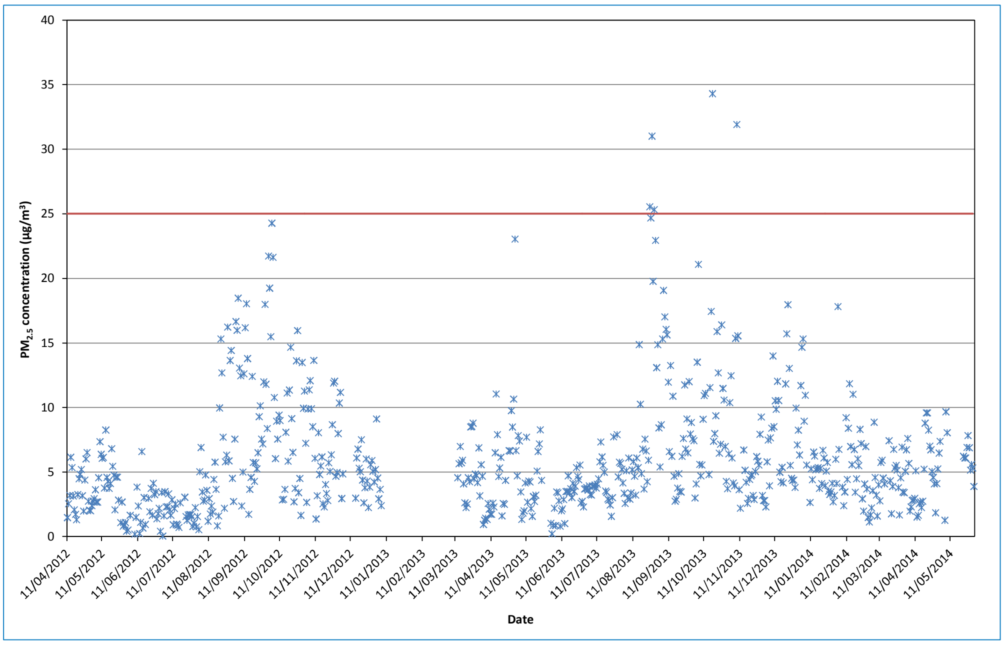


Figure 5-6: 24 hour $PM_{2.5}$ concentrations at DCM monitoring site

5.3.4 Rocky Hill Project background monitoring data

Ambient monitoring in the Gloucester Valley has also been completed for a proposed project located southeast of Gloucester town (the Rocky Hill project). This monitoring data provides an indication of background air quality in the absence of local mining operations as the monitoring locations are approximately 7 km north of the SCM.

The annual average PM_{10} reported in the air Rocky Hill project quality assessment (**Pacific Environment, 2013a**) ranged from 8 – 10 µg/m³ while the annual average $PM_{2.5}$ ranged from 3 – 5 µg/m³.

5.3.5 TSP concentrations

Estimates of annual average TSP concentrations can be made from the PM_{10} measurements by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**). Use of this relationship on the adopted PM_{10} annual average of 12 µg/m³ gives an existing annual average TSP concentration of approximately 30 µg/m³.

5.4 Existing air quality for assessment purposes

The monitoring data collected at the existing DCM air quality monitoring network includes contribution from existing mining operations, as well as all other sources for the area.

Comparing the data collected for the proposed Rocky Hill Coal Project, which is located away from existing mining sources to the DCM data, indicates that the DCM contribution to dust levels is relatively small.

The previous modelling assessment (**Heggies, 2009**) assumed a background PM_{10} concentration of 14.5 µg/m³, a background TSP concentration of 36.6 µg/m³ and a background dust deposition of 1.5 g/m²/month. This appears conservative given the average PM_{10} concentration across all existing DCM sites for the previous 6 years is approximately 12 µg/m³. Also, monitoring data collected away from existing mining operations shows the annual average PM_{10} concentration is approximately 9 µg/m³ (**Pacific Environment, 2013a**).

To be conservative, the existing DCM monitoring data is used to provide an adopted background concentration for annual average PM_{10}. This is conservative for the purposes of non-mining background levels as it includes any contribution from the existing DCM. Background for TSP has been derived based on this PM_{10} value and scaled according to the ratios estimated in **Section 5.3.5**.

An annual average dust deposition level of 2 g/m²/month has been adopted which is consistent with the average across all DCM sites.

In summary, the following background air quality levels are conservatively assumed for all sources other than the existing mining activity.

- 24-hour PM_{10} and $PM_{2.5}$ – varies daily.
- annual average PM_{10} concentration of 12 µg/m³.
- annual average $PM_{2.5}$ concentration of 6 µg/m³.
- annual average TSP concentration of 30 µg/m³.
- annual average dust deposition of 2 g/m²/month.

5.5 Air quality complaints and compliance

Review of the DCM complaints record from 2010 to 2013 shows that DCPL received four complaints in 2010 relating to operational dust emissions and four in 2013 relating to blasting fumes. The property of one complainant, responsible for two complaints in 2010, has since been purchased by DCPL.

Based on the available HVAS air quality monitoring data, it is likely that the operations were compliant with the relevant PM_{10} 24-hour criteria at the time of the complaints relating to operational dust emissions in 2010. Dust deposition levels, TSP and PM_{10} concentrations were well below the annual average criteria in 2010.

DCPL undertakes blasting in accordance with its approved DCM Blast Management Plan. The Blast Management Plan includes Fume Management procedures which assess the likelihood of fume generation and implement control measures as necessary to minimise the potential for blasting related impacts.

An independent environmental audit of the DCM was undertaken by **Glade Consulting** (**2013**). The audit was commissioned by the Department of Planning and Infrastructure (now Department of Planning and Environment). All conditions of the Project Approval relating to air quality and greenhouse gas management were found to be compliant (**Glade Consulting, 2013**).

6 MODELLING APPROACH

6.1 Modelling system

The CALMET/CALPUFF modelling system was chosen for this study. CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the 3D meteorological fields that are utilised in the CALPUFF dispersion model. CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict gridded meteorological fields for the region. CALPUFF is a multi-layer, multi-species non-steady state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal (**Scire *et al.*, 2000**). The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across the puff, and takes into account the complex arrangement of emissions from point, area, volume, and line sources.

In March 2011 generic guidance and optional settings for the CALPUFF modelling system were published for inclusion in the Approved Methods (**TRC, 2011**). The model set up for this study has been conducted in consideration of these guidelines.

The CALPUFF dispersion model has been selected for this assessment as it is considered by the EPA to be appropriate for locations of complex terrain.

6.2 Model set up

CALMET was initially run for a coarse outer grid domain of 40 km x 40 km with a 1 km resolution. Observed hourly surface data were incorporated into the outer domain modelling, including the DCM site data, data from the SCM and data collected as part of the proposed Rocky Hill Coal project. Cloud amount and cloud heights were sourced from the closest available hourly observations (BoM Automatic Weather Station at Murrurundi Gap).

Upper air information was incorporated through the use of prognostic 3D data extracted from The Air Pollution Model (TAPM), a three dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research. Detailed description of the TAPM model and its performance is provided in **Hurley 2008** and **Hurley, Edwards et al., 2009**.

Together, the four surface stations and the 3D file generated by TAPM were used as input to CALMET to create a coarse resolution three-dimensional meteorological field for the region.

The CALMET generated meteorological parameters from the outer grid were then used as input into a finer resolution inner grid to provide better resolution closer to the site. The southwest corner of the inner domain was 392 km Easting and 6420 km Northing (UTM Zone 56 S). This consisted of 90 x 90 grid points, with a 0.2 km resolution along both the X and Y axes. Land use for the domain was determined by aerial photography from Google Earth. **Figure 6-1** presents the modelling domains used in this study.

Terrain data for the modelling was sourced from Shuttle Radar Topographic Mission (SRTM) data. SRTM data for Australia is sampled at three arc seconds resulting in an approximate resolution of 90 m, shown in **Figure 6-1.** This terrain data was also supplemented with detailed mine terrain for the modelled mine general arrangement.

6.3 Model performance

The CALMET generated wind field is compared with the measured data from the DCM site and presented in **Figure 6-2**. It is important to note that CALMET is not a steady state model; rather it produces 3D meteorological fields that vary across the entire domain. The windroses presented in **Figure 6-2** are extracted for a single grid point (at the DCM meteorological station) and are therefore an over simplification of the meteorological conditions used by the model to predict pollutant dispersion.

The CALMET extract displays broadly similar characteristics to the measured data, although the dominant winds from north in the measured data are shifted to the northwest. The CALMET wind speeds are generally lower, as indicated by the colour shading in the wind rose and by comparing the annual winds speed (2.3 m/s for DCM and 1.9 m/s for CALMET). The percentage occurrence of calm conditions (defined as wind speeds <0.5m/s) are similar, 6.7% recorded at DCM compared with 6.6% predicted by CALMET.

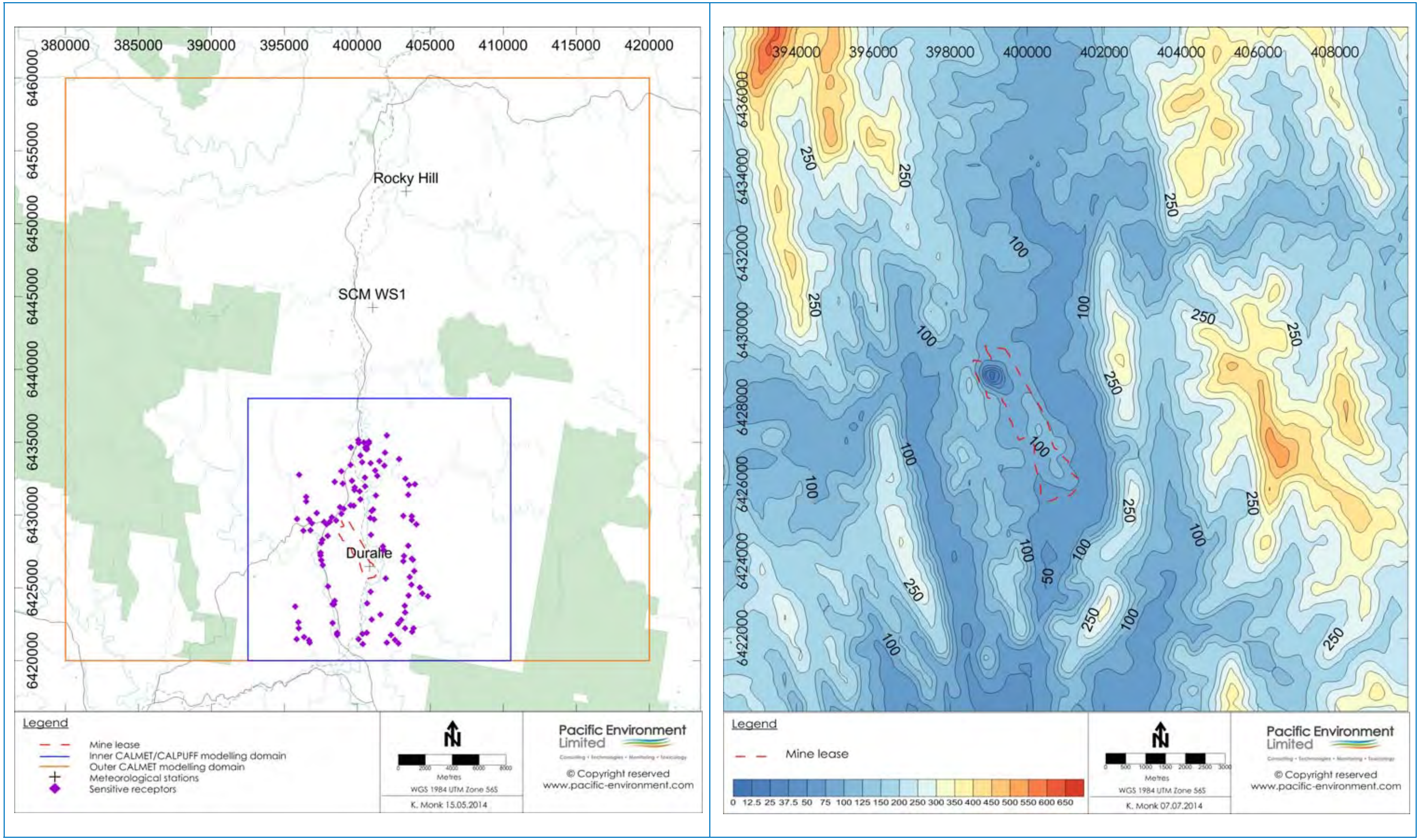


Figure 6-1: Model domain and terrain data

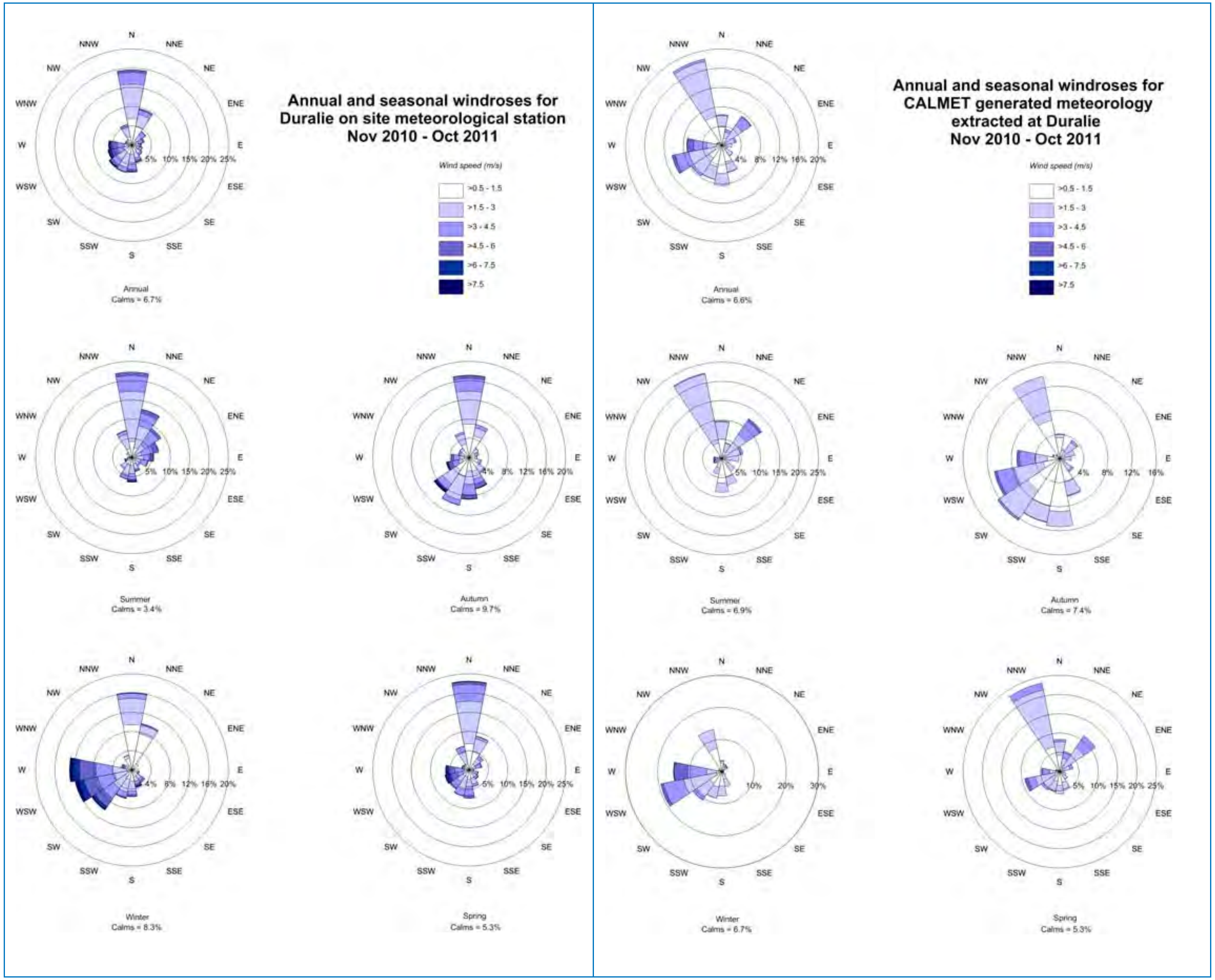


Figure 6-2: Annual and seasonal windroses generated by CALMET at the DCM

7 EMISSIONS TO AIR

Heggies, 2009 presented emission estimates for Year 3, 5 and 8 of the DEP based on the following mine production schedule:

- Year 3 – ROM extraction at 2.4 Mtpa and waste rock removal at 14.2 million bank cubic metres (Mbcm).
- Year 5 – ROM extraction at 3 Mtpa and waste rock removal at 14.4 Mbcm.
- Year 8 – ROM extraction at 2.5 Mtpa and waste rock removal at 11.7 Mbcm.

The estimated DEP annual emissions are shown in **Table 7.1**.

Table 7.1: Estimated annual dust emissions presented in DEP AQIA

Year 3		Year 5		Year 8	
TSP (tonnes/yr)	PM_{10} (tonnes/yr)	TSP (tonnes/yr)	PM_{10} (tonnes/yr)	TSP (tonnes/yr)	PM_{10} (tonnes/yr)
1,410	481	992	361	1,155	378

Revised modelling is presented for a single mine year scenario, representative of mining in 2015 for the Modification (refer **Appendix D**).

The 2015 scenario was chosen as it represents a year where waste emplacement occurs at the maximum elevation of 135 m AHD (i.e. the subject of the Modification) coinciding with maximum ROM coal production and waste rock extraction for the remainder of the life of the DCM (i.e. within the currently approved limits for ROM coal production and waste rock extraction).

Dust emissions are estimated based on a maximum ROM production rate of 3 Mtpa and a maximum overburden removal rate of 10.6 Mbcm (i.e. less than the maximum of 14.4 Mbcm previously assessed), for the following activities and equipment:

- Drilling and blasting overburden.
- Dozer/loader pushing overburden.
- Dozer/loader ripping ROM coal.
- Excavator loading to haul trucks.
- Hauling overburden on unsealed roads from mine area to emplacement area.
- Hauling ROM coal on unsealed roads from mine area to infrastructure/stockpile area.
- Grading roads.
- Crushing ROM coal.
- Wind erosion from active mine and emplacement areas and infrastructure and ROM and topsoil stockpiles.

A summary of emission estimates are presented in **Table 7.2**. The estimated emissions are lower than those presented in **Heggies (2009)**. The lower emissions are largely accounted for in the different activity data (such as lower waste rock production) and the higher levels of control (for hauling – refer **Section 7.1**).

All activities and emissions are assumed to occur for 24 hours per day and seven days per week. TSP, PM_{10} and $PM_{2.5}$ emission rates were calculated using emission factors derived from **US EPA (1995)** (see **Appendix B**).

Table 7.2: Estimated annual dust emissions for DCM incorporating the Modification activities 2015

ACTIVITY	Emission (kg/y)		
	TSP	PM_{10}	$PM_{2.5}$
PIT			
OB – Drilling	6,903	3,590	207
OB – Blasting	50,870	26,452	1,526
OB - Dozers on OB in-pit	6,556	1,043	688
OB - Excavator loading trucks	5,535	2,618	396
OB - Hauling OB to waste dump (CAT 785)	102,197	23,710	2,371
OB - Hauling OB to waste dump (CAT 789)	114,394	26,539	2,654
OB - Emplacing OB at waste dump	5,535	2,618	396
OB - Dozers on waste dump	8,741	1,391	918
CL - Dozers on ROM coal in-pit	4,594	1,104	101
CL - Excavator loading ROM coal to trucks	286,216	34,637	5,438
CL - Hauling ROM coal to infrastructure area	62,741	14,556	1,456
Grading Roads	30,192	10,549	936
ROM			
CL - Unloading coal direct to ROM Hopper	173	82	12
CL - Unloading coal to ROM stockpiles	86	41	6
CL - FEL Loading ROM from stockpile to hopper	14,350	2,064	273
CL - Crushing (Tertiary controlled)	1,800	810	150
CL - Loading ROM coal to trains	432	204	31
WIND EROSION			
WE - Active Pit and OB emplacement Area	173,448	86,724	13,009
WE - Partially rehabilitated areas	13,140	6,570	986
WE - Soil stockpile areas	8,760	4,380	657
WE - Infrastructure area	3,504	1,752	263
WE - ROM stockpiles	438	219	33
TOTAL	**900,605**	**251,651**	**32,507**

7.1 Overview of dust management

In accordance with Project Approval (08_0203) DCPL implements dust management and monitoring measures in accordance with the Air Quality and Greenhouse Gas Management Plan (AQGGMP) (**DCPL, 2013**).

The AQMMP describes:

- Ongoing dust management measures.
- Proactive dust management measures during adverse weather conditions.
- Dust monitoring locations and frequency, including real-time monitoring.
- Performance indicators which, if exceeded, trigger the implementation of additional dust management measures.

Further detail regarding the existing dust management measures with reference to the NSW EPA Pollution Reduction Programs (PRPs) required under the DCM Environmental Protection Licence (EPL) (no. 11701) is provided below.

Pollution Reduction Programs

Since the approval of the DEP, the PRPs, known as the 'Dust Stop PRPs' were included in the DCM Environmental Protection Licence (EPL) (no. 11701).

The PRPs were an outcome of the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (**Donnelly *et al.*, 2011**) (the Best Practice Report), a study that was commissioned by the NSW EPA.

DCPL responded to the Coal Mine Particulate Matter Control Best Practice PRP in July 2012 and existing air quality management measures are described in the Duralie Coal Mine – Particulate Matter Control Best Practice Pollution Reduction Program (**PAEHolmes, 2012**).

Following this, on 21 March 2013, the EPL was modified to include PRPs related to Particulate Matter Control, as follows:

- U2: Particulate Matter Control Best Practice Implementation - Wheel Generated Dust.
- U3: Particulate Matter Control Best Practice Implementation - Disturbing and Handling Overburden under Adverse Weather Conditions.

Condition U2 (*Particulate Matter Control Best Practice - Wheel Generated Dust)* states that DCM must achieve and maintain a dust control efficiency of 80% or more on its haul roads and requires the licensee to prepare a Monitoring Program to assess compliance with this condition. Pacific Environment was commissioned by DCPL to develop a monitoring program and then measure the effectiveness of watering to control dust emissions from unsealed haul roads (**Pacific Environment 2013b**; **Pacific Environment, 2014**). Monitoring was completed using the Road Emissions eXpert tool and the control efficiency was found to be 96%-98%. The 90% control applied for the modelling is therefore considered to be easily achievable on a day to day basis.

Pacific Environment was also commissioned by DCPL to respond to Condition U3 of the EPL (*Particulate Matter Control Best Practice Implementation - Disturbing and Handling Overburden under Adverse Weather Conditions)* which requires DCM to alter or cease the use of equipment on overburden and loading dumping overburden during adverse weather conditions (**Pacific Environment 2013c**; **Pacific Environment, 2013d**). Adverse conditions for unacceptable dust levels beyond the site boundary were identified as wind speeds greater than 7 m/s, although 5 m/s is identified as an "investigation level".

The best practice management measures employed at the site are presented in **Table 7.3** and are incorporated into the emission estimation and modelling presented in this report, based on the control efficiencies shown.

Table 7.3: Existing dust controls

PRP activity category	Current control measure	Control efficiency (%)
Hauling on unsealed roads	Water carts on all trafficked areas	90%
	Use of larger vehicles	Not quantified
Dozers on OB	Keeping travelling routes damp	50%
Wind erosion from exposed areas	Minimise pre-strip	Not quantified
	Rehabilitation goals	Not quantified
Wind erosion from coal stockpiles	Bypassing stockpiles	Not quantified
Blasting	Delay shot to avoid unfavourable weather conditions	Not quantified
Drilling	Water injection sprays while drilling	70%
Loading/unloading OB (trucks)	Modify activities in windy conditions	Not quantified
Loading/unloading ROM coal	Water sprays on ROM bin/hopper	50%
Grading roads	Water grader roads	50%

8 IMPACT ASSESSMENT

8.1 Ground level concentrations – DCM incorporating the Modification

Contour plots of 24-hour PM_{10} and $PM_{2.5}$ concentrations and annual average PM_{10}, $PM_{2.5}$, TSP and deposition levels are shown in **Figure 8-1** to **Figure 8-6**. A summary of the predicted dust concentrations at each of the receiver locations are presented in **Table 8.1**. There are no residences that are predicted to experience exceedance of PM_{10}, $PM_{2.5}$, TSP and dust deposition above their relevant assessment criteria, due to the DCM incorporating the Modification alone.

A maximum predicted 24-hour PM_{10} concentration of 12.9 µg/m³ occurs at resident 128. This is lower than the predicted 24-hour PM_{10} concentration at the same resident in the DEP for Year 5 (17.7 µg/m³) (**Heggies, 2009**). The highest annual average PM_{10} at resident 128 for this Modification (1.4 µg/m³) is also lower than the annual average PM_{10} presented for the DEP (1.9 µg/m³) (**Heggies, 2009**).

Potential cumulative impacts (i.e. incorporating background levels) are provided in **Section 8.2**.

Table 8.1: Predicted ground level concentrations for DCM incorporating the Modification – 2015

ID	PM_{10}		$PM_{2.5}$		TSP	Dust Deposition
	24 hour	Annual	24 hour	Annual	Annual	Annual
Units	µg/m³		µg/m³		µg/m³	g/m²/month
Assessment criteria	50	30	25	8	90	2
			Private residences			
74	2.2	0.2	0.5	0.0	0.3	0.0
84(1)	2.1	0.2	0.5	0.0	0.2	0.0
84(2)	2.0	0.2	0.5	0.0	0.2	0.0
87	4.6	0.2	1.0	0.0	0.3	0.0
93	5.4	0.4	1.1	0.1	0.7	0.0
94	4.9	0.5	0.9	0.1	1.0	0.0
95	5.0	0.5	1.1	0.1	0.9	0.0
96	2.3	0.2	0.5	0.0	0.3	0.0
97(1)	3.0	0.3	0.7	0.1	0.4	0.0
97(2)	2.8	0.2	0.6	0.0	0.4	0.0
98(1)	2.3	0.2	0.5	0.0	0.3	0.0
98(2)	2.2	0.2	0.5	0.0	0.3	0.0
100	6.7	0.5	1.4	0.1	0.9	0.0
101	5.2	0.4	1.1	0.1	0.7	0.0
103	5.1	0.3	1.0	0.1	0.4	0.0
145	7.6	0.9	1.1	0.1	2.5	0.2
146	5.7	0.8	0.8	0.1	2.1	0.2
147	4.9	0.7	0.7	0.1	1.7	0.2
148	4.1	0.5	0.6	0.1	1.1	0.1
150	0.6	0.0	0.1	0.0	0.1	0.0
153	9.9	0.3	1.6	0.0	0.5	0.1
154	4.8	0.2	0.7	0.0	0.3	0.0
155	4.4	0.2	0.7	0.0	0.3	0.0
156	3.9	0.1	0.6	0.0	0.3	0.0
157	3.7	0.1	0.6	0.0	0.3	0.0
159	1.8	0.1	0.3	0.0	0.2	0.0
160(1)	0.8	0.0	0.2	0.0	0.1	0.0
160(2)	1.1	0.1	0.2	0.0	0.1	0.0

ID	PM10		PM2.5		TSP	Dust Deposition
	24 hour	Annual	24 hour	Annual	Annual	Annual
Units	µg/m³		µg/m³		µg/m³	g/m²/month
Assessment criteria	50	30	25	8	90	2
164	3.0	0.1	0.4	0.0	0.2	0.0
165	2.0	0.2	0.3	0.0	0.5	0.0
167	2.0	0.3	0.3	0.1	0.7	0.0
168(1)	1.2	0.2	0.2	0.0	0.4	0.0
168(2)	1.2	0.2	0.2	0.0	0.3	0.0
168(3)	2.1	0.4	0.4	0.1	0.8	0.1
168(4)	2.0	0.3	0.3	0.1	0.7	0.0
169	1.5	0.2	0.2	0.0	0.5	0.0
172	1.5	0.1	0.3	0.0	0.2	0.0
173	1.3	0.1	0.2	0.0	0.2	0.0
174	0.9	0.1	0.1	0.0	0.2	0.0
175	1.3	0.1	0.2	0.0	0.1	0.0
176	1.0	0.1	0.1	0.0	0.1	0.0
177	1.1	0.0	0.2	0.0	0.1	0.0
178	0.9	0.0	0.2	0.0	0.1	0.0
179	0.7	0.0	0.1	0.0	0.1	0.0
180(1)	0.7	0.0	0.2	0.0	0.1	0.0
180(2)	0.7	0.0	0.2	0.0	0.1	0.0
183	0.7	0.0	0.1	0.0	0.1	0.0
185	0.7	0.0	0.1	0.0	0.1	0.0
186	0.7	0.0	0.1	0.0	0.1	0.0
188	0.5	0.0	0.1	0.0	0.0	0.0
189	0.4	0.0	0.1	0.0	0.0	0.0
192	0.6	0.0	0.1	0.0	0.1	0.0
193	0.5	0.0	0.1	0.0	0.0	0.0
194	4.4	0.3	1.0	0.1	0.8	0.0
198	1.3	0.1	0.2	0.0	0.3	0.0
199	1.3	0.1	0.2	0.0	0.3	0.0
200	1.2	0.1	0.2	0.0	0.2	0.0
204	1.2	0.2	0.2	0.0	0.3	0.0
105	2.9	0.2	0.7	0.0	0.3	0.0
106	4.1	0.4	0.9	0.1	0.7	0.0
107	3.6	0.2	0.5	0.0	0.4	0.0
108	3.5	0.2	0.6	0.0	0.3	0.0
112	4.4	0.3	0.9	0.0	0.6	0.0
113	4.5	0.3	1.0	0.0	0.6	0.0
115(1)	4.8	0.4	1.1	0.1	1.0	0.0
115(2)	6.7	0.5	1.3	0.1	1.3	0.0
115(3)	8.9	0.5	1.8	0.1	1.0	0.0
116	6.1	0.6	1.3	0.1	1.1	0.0
117	10.0	1.3	1.8	0.2	4.0	0.2
120	8.5	0.9	1.6	0.1	2.8	0.1
123	5.2	0.5	1.2	0.1	1.1	0.0
126	6.1	0.5	1.4	0.1	1.1	0.0
127	7.6	0.7	1.7	0.1	1.6	0.1

ID	PM10		PM2.5		TSP	Dust Deposition
	24 hour	Annual	24 hour	Annual	Annual	Annual
Units	µg/m³		µg/m³		µg/m³	g/m²/month
Assessment criteria	50	30	25	8	90	2
128	12.9	1.4	1.8	0.2	3.2	0.2
131	7.2	0.6	1.3	0.1	1.2	0.1
133	8.1	0.4	1.3	0.1	0.8	0.1
134	4.1	0.2	0.6	0.0	0.4	0.0
135	7.1	0.3	1.1	0.1	0.7	0.1
136	7.8	0.4	1.2	0.1	0.8	0.1
137	6.7	0.4	1.0	0.1	0.7	0.1
140	3.9	0.2	0.6	0.0	0.4	0.0
142	7.9	0.9	1.2	0.1	2.8	0.2
143	6.8	0.8	1.0	0.1	2.6	0.2
144	6.7	0.9	0.9	0.1	2.7	0.2
209	2.7	0.2	0.5	0.0	0.3	0.0
211	2.8	0.2	0.6	0.0	0.3	0.0
216	2.2	0.2	0.5	0.0	0.4	0.0
220	6.3	0.3	1.3	0.1	0.6	0.0
223	1.9	0.2	0.3	0.0	0.3	0.0
224	1.7	0.1	0.3	0.0	0.3	0.0
225	1.4	0.1	0.2	0.0	0.3	0.0
260	0.4	0.0	0.1	0.0	0.0	0.0
UKN1	2.5	0.2	0.4	0.0	0.3	0.0
UKN2	2.5	0.2	0.4	0.0	0.3	0.0
SRN339	2.0	0.2	0.4	0.0	0.2	0.0
SRN338	2.4	0.2	0.4	0.0	0.3	0.0
Mine owned						
19(1)	13.7	0.8	2.1	0.1	1.3	0.1
19(2)	3.7	0.4	0.9	0.1	0.8	0.0
19(3)	32.3	2.4	4.8	0.4	4.8	0.3
19(4)	21.6	1.0	3.3	0.2	1.7	0.1
19(5)	1.5	0.1	0.3	0.0	0.1	0.0
19(6)	5.2	0.4	0.8	0.1	0.9	0.0
19(7)	12.3	1.2	1.8	0.2	2.7	0.2
19(8)	10.8	1.2	2.1	0.2	3.8	0.1
19(9)	11.1	1.3	1.6	0.2	4.7	0.3
19(10)	15.2	1.7	2.5	0.2	5.2	0.2
19(11)	9.9	1.2	1.9	0.2	3.2	0.1
19(12)	9.4	1.1	2.0	0.2	2.8	0.1
19(13)	11.7	1.1	1.7	0.2	2.4	0.1
19(14)	16.8	1.6	2.6	0.2	5.6	0.2
19(15)	17.1	1.7	3.0	0.3	5.9	0.2
19(16)	26.5	3.4	3.9	0.5	13.5	0.5
19(17)	17.7	2.3	2.8	0.3	7.8	0.3
19(18)	2.9	0.3	0.5	0.1	0.7	0.0
19(19)	13.2	0.8	2.0	0.1	1.3	0.1
19(20)	4.7	0.3	1.0	0.1	0.4	0.0
19(21)	2.9	0.2	0.6	0.0	0.2	0.0

ID	PM_{10}		$PM_{2.5}$		TSP	Dust Deposition
	24 hour	Annual	24 hour	Annual	Annual	Annual
Units	µg/m³		µg/m³		µg/m³	g/m²/month
Assessment criteria	**50**	**30**	**25**	**8**	**90**	**2**
19(22)	3.9	0.3	0.8	0.1	0.4	0.0
19(23)	11.3	1.0	1.6	0.2	2.1	0.1
19(24)	6.0	0.4	1.3	0.1	0.6	0.0
19(25)	5.8	0.4	1.2	0.1	0.5	0.0
19(26)	3.4	0.3	0.7	0.1	0.5	0.0
19(27)	2.1	0.2	0.4	0.0	0.3	0.0

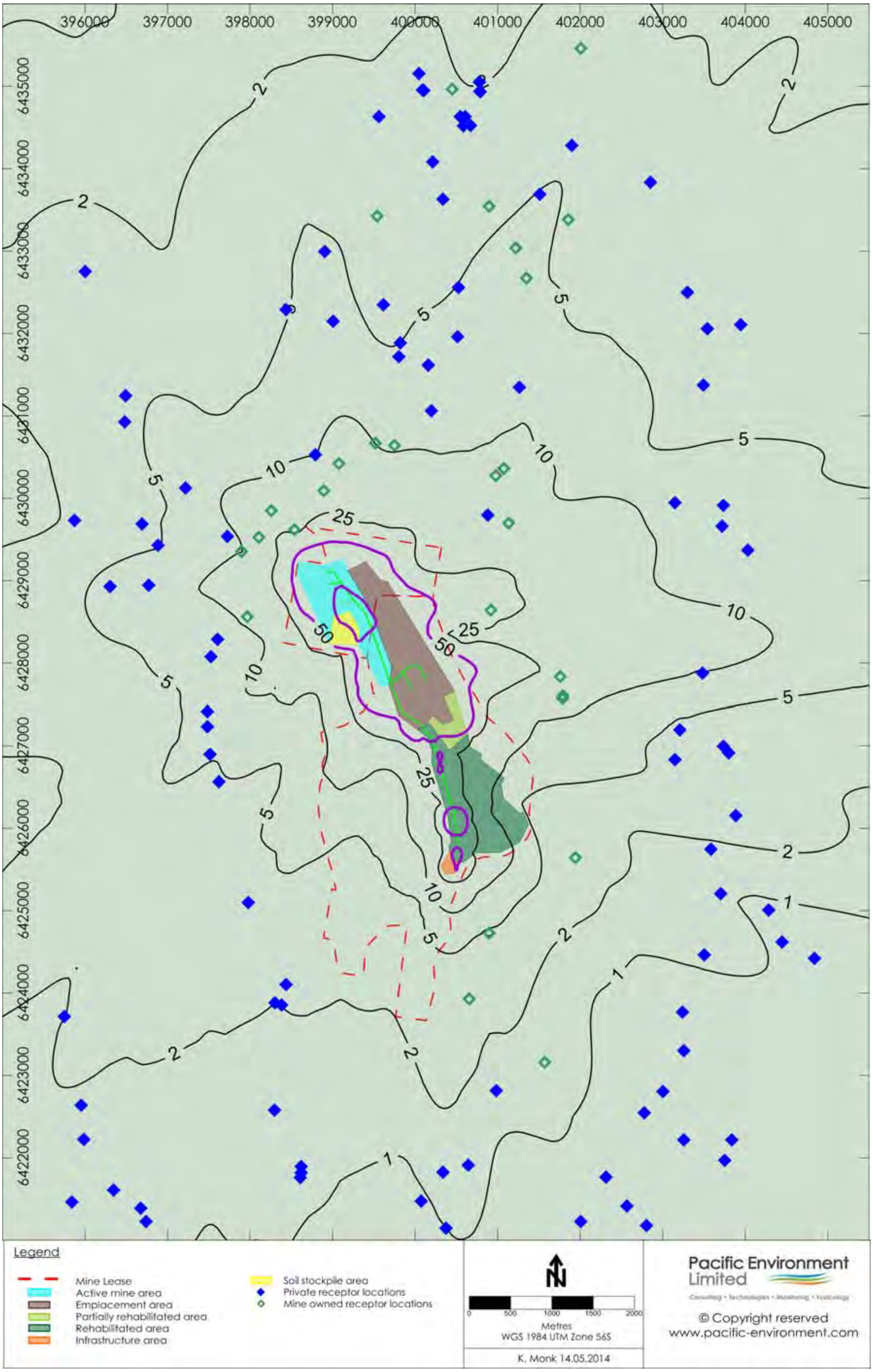


Figure 8-1: Predicted maximum 24 hour average PM_{10} ground level concentrations

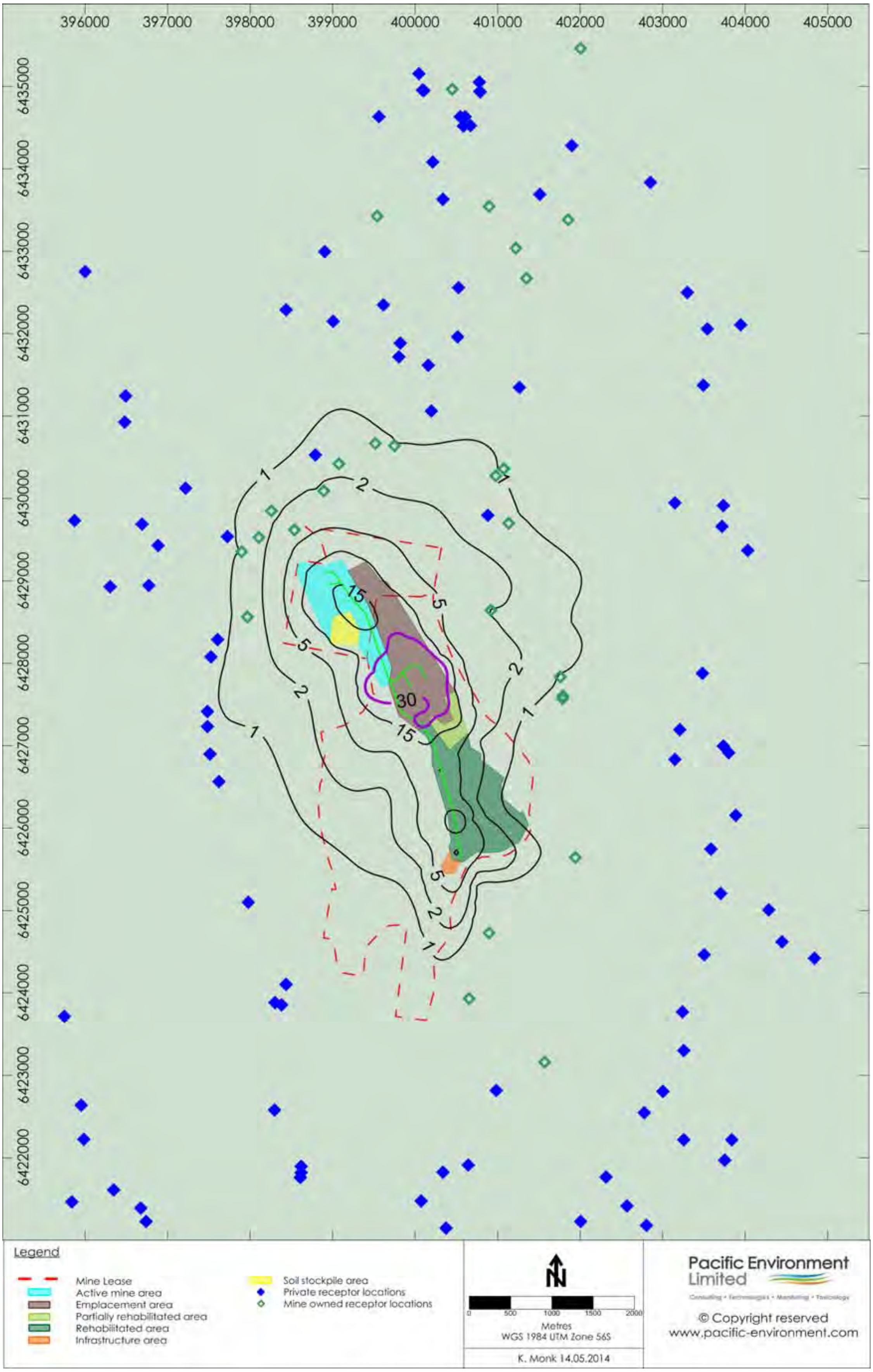


Figure 8-2: Predicted annual average PM_{10} ground level concentrations

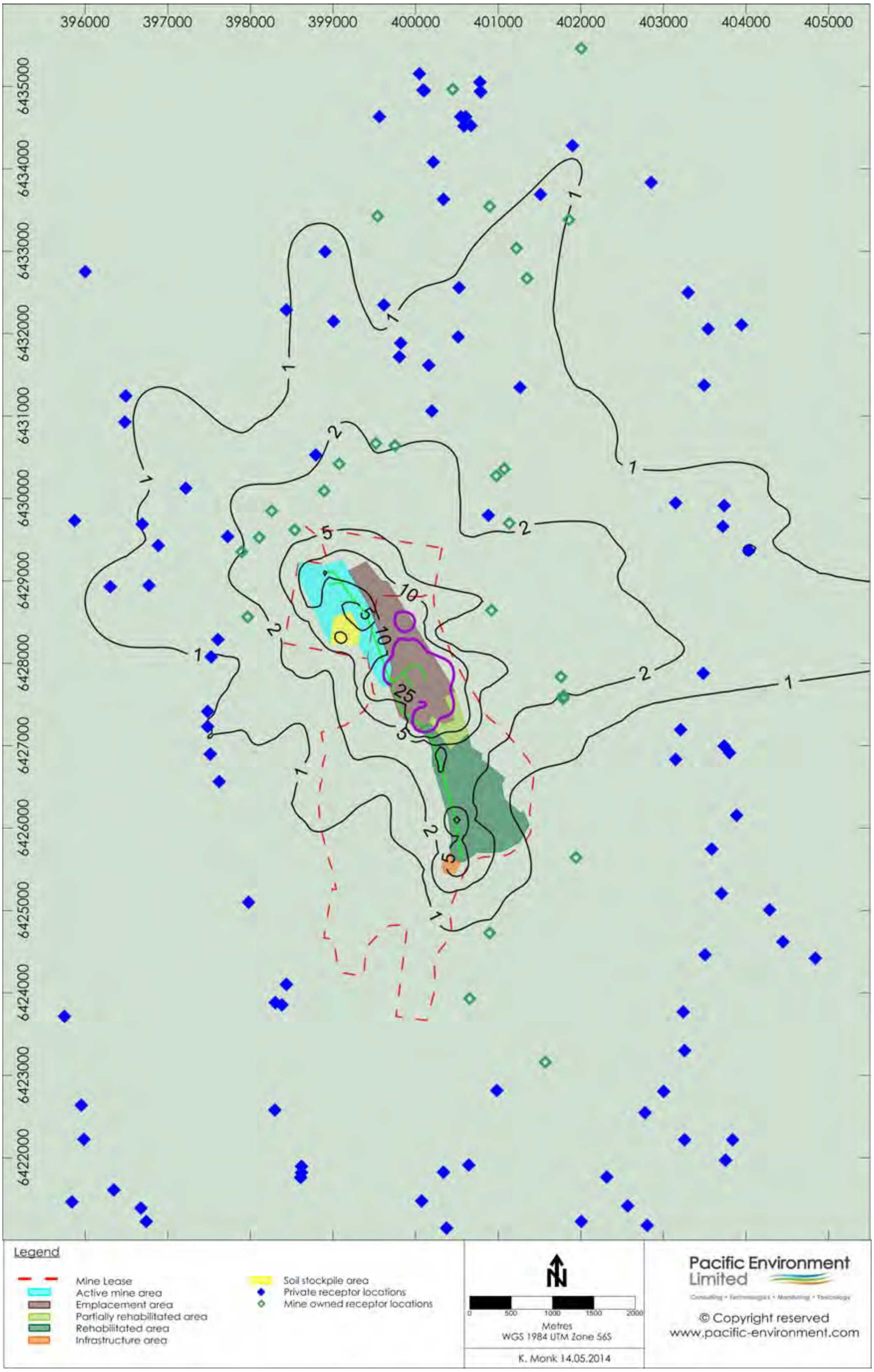


Figure 8-3: Predicted maximum 24 hour average $PM_{2.5}$ ground level concentrations

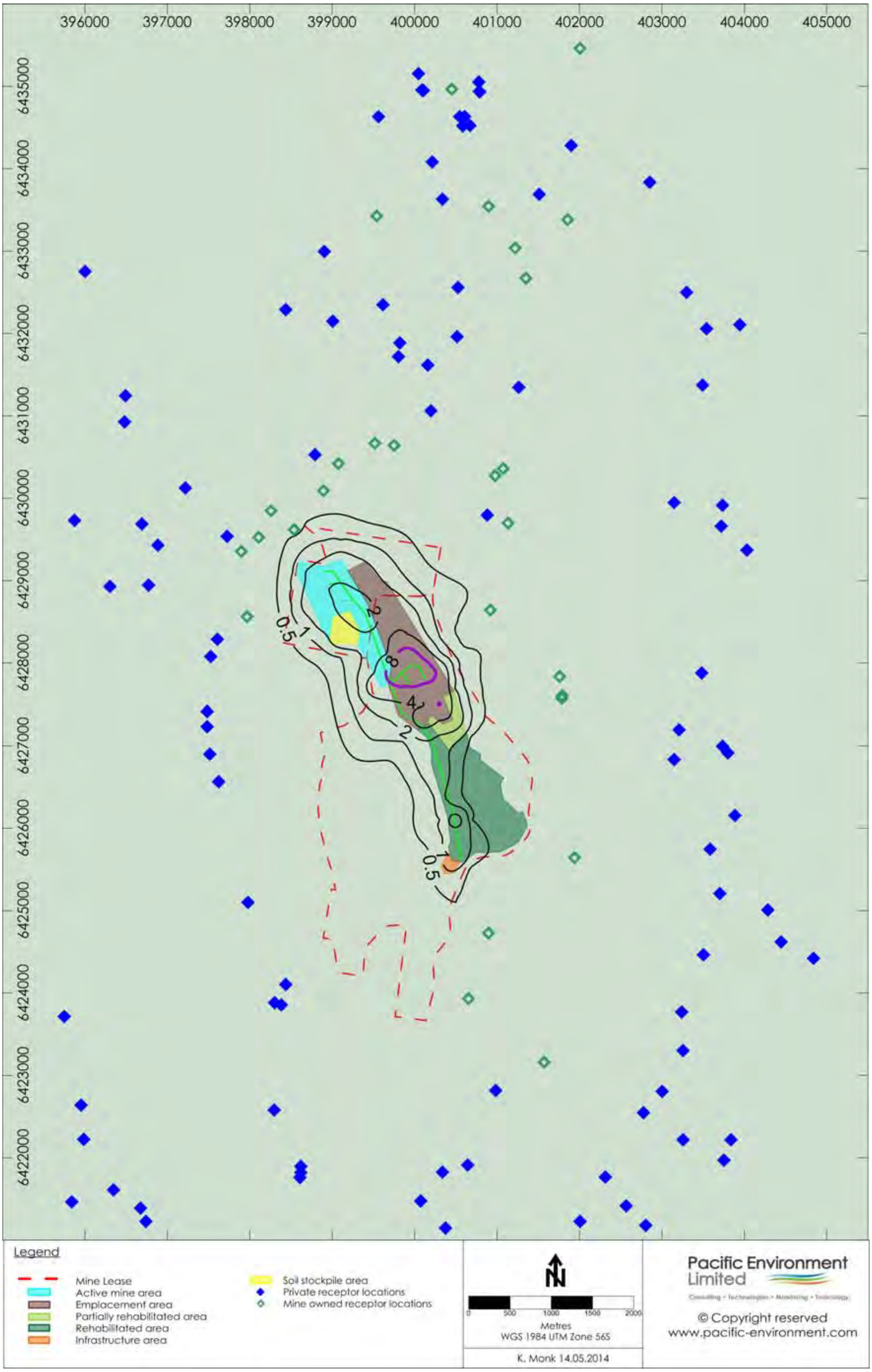


Figure 8-4: Predicted annual average $PM_{2.5}$ ground level concentrations

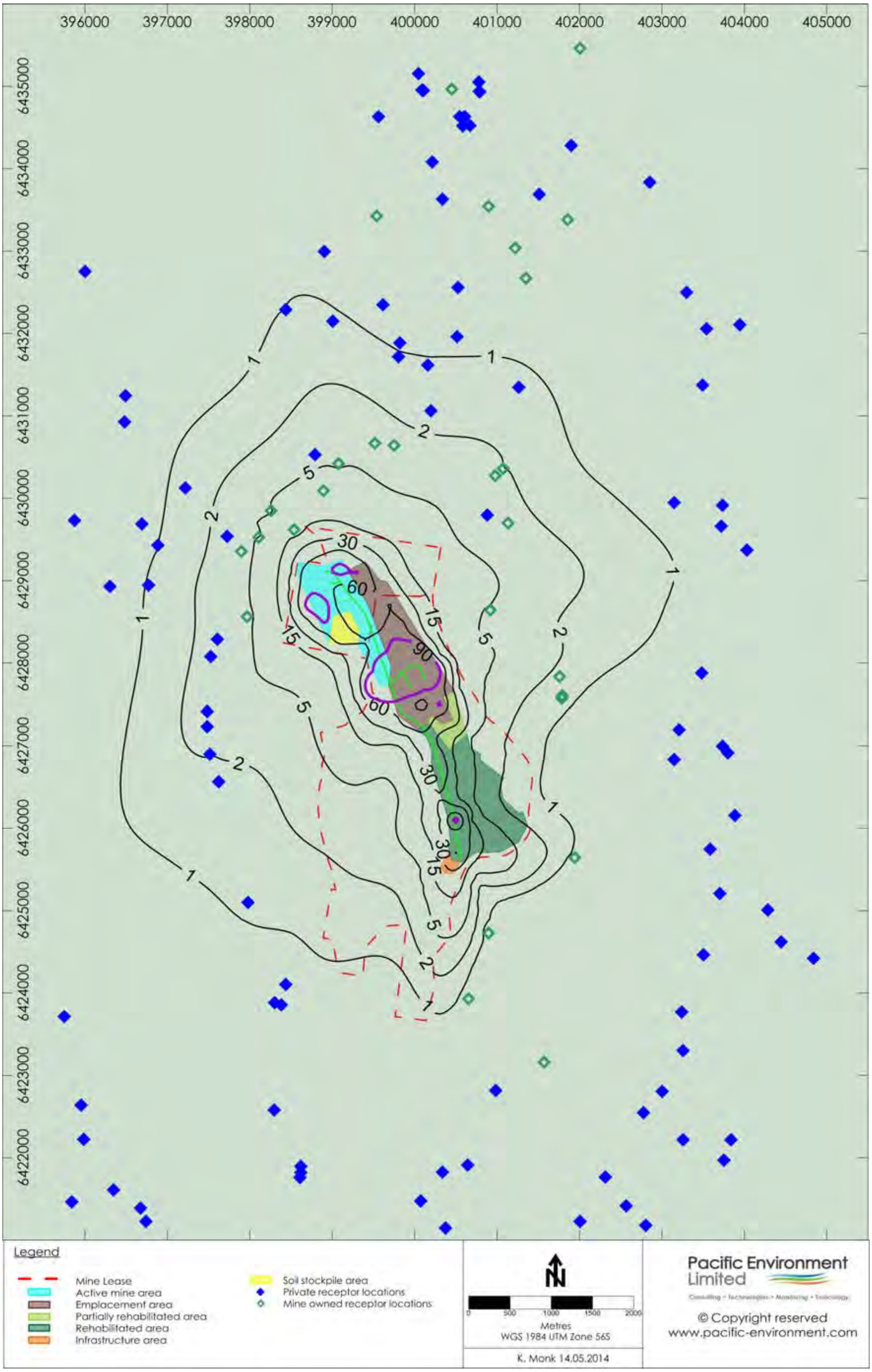


Figure 8-5: Predicted annual average TSP ground level concentrations

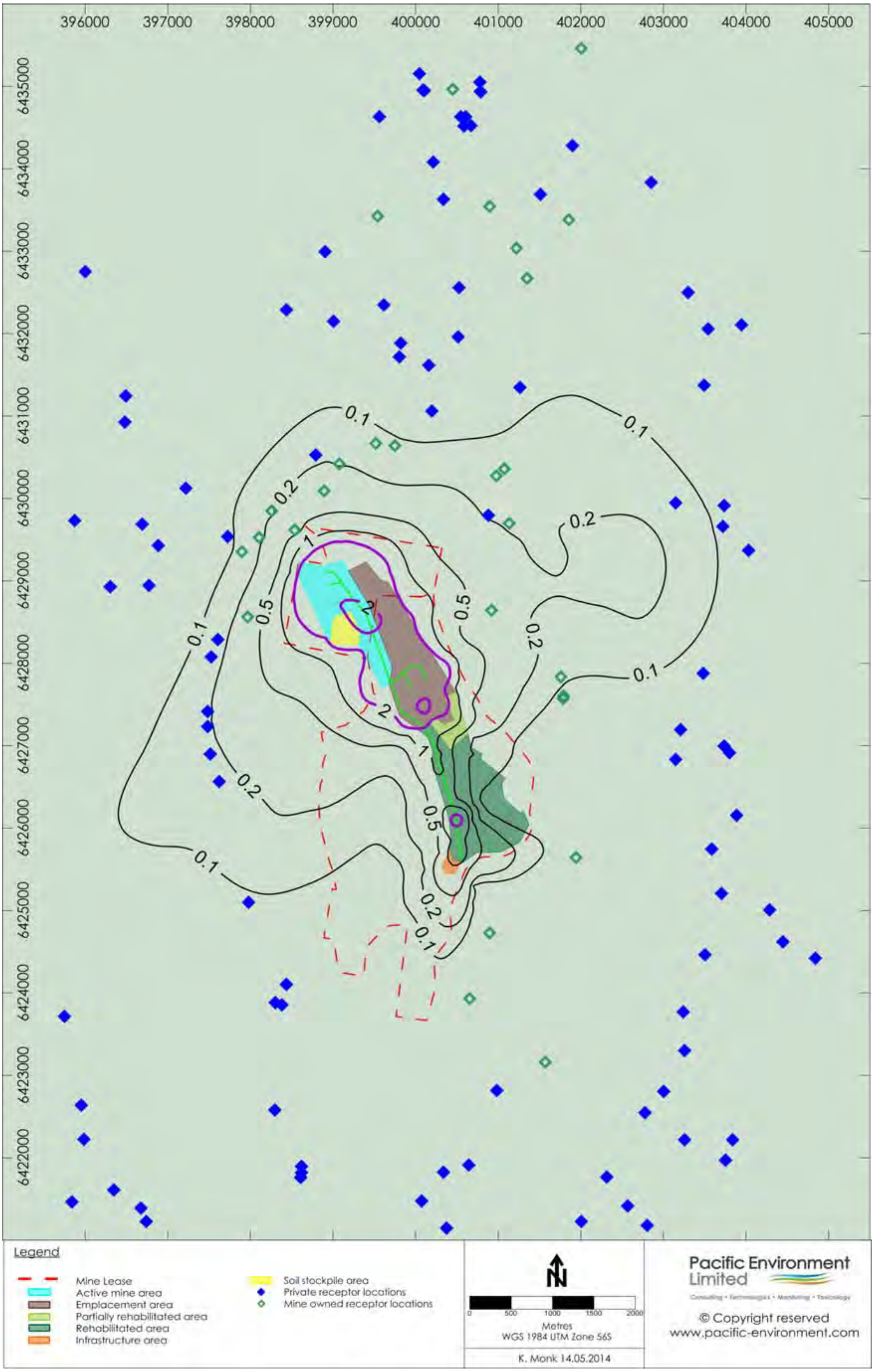


Figure 8-6: Predicted annual average dust deposition

8.2 Cumulative impact

Section 5 describes the existing environment and the monitoring data presented includes the contribution from the existing operations at the DCM. When compared to data collected close to Gloucester and away from existing mining sources, the contribution from existing operations at DCM is small. For example, annual average PM_{10} concentrations during 2012, in the vicinity of the DCM range from 11 µg/m^3 to14 µg/m^3, compared to annual average PM_{10} concentrations of 8 µg/m^3 to 10 µg/m^3, reported as background for the Rocky Hill project, which is remote from existing mining.

Modelling results for the DCM incorporating the Modification show a similarly small increment in annual average PM_{10} (maximum increments of 1-2 µg/m^3, as shown in **Table 8.1**).

As discussed previously, the Modification would not increase TSP emissions compared to those assessed for the DEP, and the Modification would not increase the maximum predicted 24-hour average PM_{10} concentration predicted for the DEP at any private residence. Therefore, the Modification is not expected to increase potential air quality impacts in comparison to the currently approved DEP.

As described in **Section 5**, the existing monitoring data demonstrate that there have been no exceedances of the annual average PM_{10} criterion of 30 µg/m^3 while DCM has been operational, and only a few occasions when the 24-hour PM_{10} concentrations were above the criterion of 50 µg/m^3. This is not expected to change as a result of the Modification.

Cumulative 24-hour Average PM_{10}

The minimal impact of the Modification to cumulative 24-hour average PM_{10} concentrations is demonstrated by using a statistical simulation to predict the number of days over the criterion of 50 µg/m^3 into the future.

A Monte Carlo simulation takes all of the available background monitoring data from the HVAS and TEOM and randomly generates a daily 24-hour PM_{10}. This random daily background concentration is added to model predictions for each day of the year, at selected receptor locations. The addition of the random background to the model predicted 24-hour PM_{10} is repeated 250,000 times to generate a probability distribution of cumulative 24-hour PM_{10} concentrations. The process assumes that a randomly selected background value from the real dataset would have a chance equal to that of any other background value from the dataset of occurring on the given future day when the Modification is operational.

The results of the simulation are extracted and the predicted number of days that cumulative 24-hour PM_{10} concentration would exceed certain 24-hour PM_{10} concentrations is determined at the worst impacted residence (R128). **Figure 8-7** shows the predicted cumulative 24-hour PM_{10} concentration compared with the existing background. As shown there is a very low probability that cumulative 24-hour PM_{10} concentrations would result in any additional days over 50 µg/m^3 than would occur anyway due to background. This supports that ambient air quality is not expected to differ significantly as a result of the Modification.

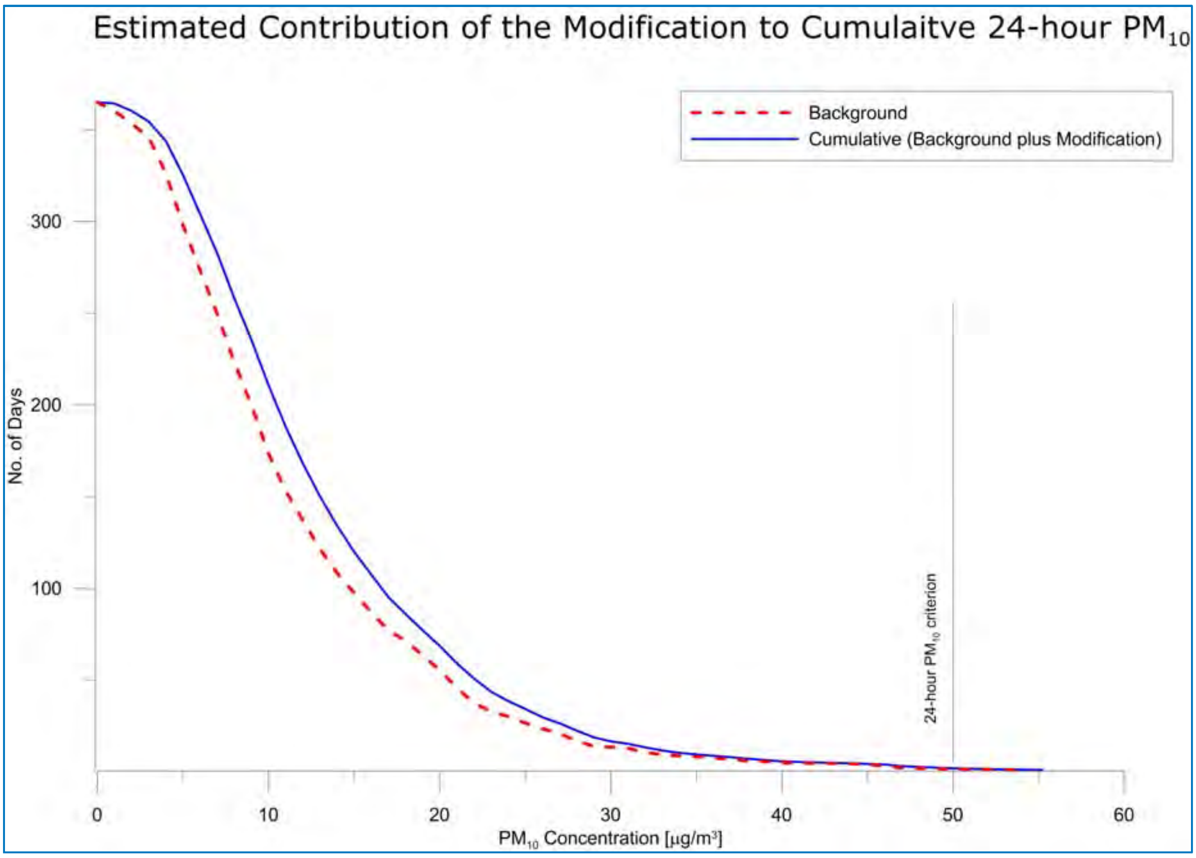


Figure 8-7: Predicted days over 24-Hour PM_{10} concentration at worst impacted residence

Cumulative Annual Average

Cumulative predictions have also been made for annual average impacts, as presented in **Table 8.2**. An assumed background (**Section 5.4**) (which includes the contribution from existing operations) is added to the modelled increment from the DCM incorporating the Modification.

Despite the conservative approach of using the existing monitoring data as background (i.e. which "double-counts" the contribution of the existing DCM), there are no private residences that are predicted to experience exceedance of PM_{10}, $PM_{2.5}$, TSP and dust deposition above their relevant assessment criteria.

Table 8.2: Cumulative ground level concentrations– 2015

ID	PM_{10}	$PM_{2.5}$	TSP	Dust Deposition
	Annual	Annual	Annual	Annual
Units	µg/m³	µg/m³	µg/m³	g/m²/month
Assessment criteria	30	8	90	4
		Private residences		
74	12.2	6.0	30.3	2.0
84(1)	12.2	6.0	30.2	2.0
84(2)	12.2	6.0	30.2	2.0
87	12.2	6.0	30.3	2.0
93	12.4	6.1	30.7	2.0
94	12.5	6.1	31.0	2.0
95	12.5	6.1	30.9	2.0

ID	PM10	PM2.5	TSP	Dust Deposition
	Annual	Annual	Annual	Annual
Units	µg/m³	µg/m³	µg/m³	g/m²/month
96	12.2	6.0	30.3	2.0
97(1)	12.3	6.1	30.4	2.0
97(2)	12.2	6.0	30.4	2.0
98(1)	12.2	6.0	30.3	2.0
98(2)	12.2	6.0	30.3	2.0
100	12.5	6.1	30.9	2.0
101	12.4	6.1	30.7	2.0
103	12.3	6.1	30.4	2.0
145	12.9	6.1	32.5	2.2
146	12.8	6.1	32.1	2.2
147	12.7	6.1	31.7	2.2
148	12.5	6.1	31.1	2.1
150	12.0	6.0	30.1	2.0
153	12.3	6.0	30.5	2.1
154	12.2	6.0	30.3	2.0
155	12.2	6.0	30.3	2.0
156	12.1	6.0	30.3	2.0
157	12.1	6.0	30.3	2.0
159	12.1	6.0	30.2	2.0
160(1)	12.0	6.0	30.1	2.0
160(2)	12.1	6.0	30.1	2.0
164	12.1	6.0	30.2	2.0
165	12.2	6.0	30.5	2.0
167	12.3	6.1	30.7	2.0
168(1)	12.2	6.0	30.4	2.0
168(2)	12.2	6.0	30.3	2.0
168(3)	12.4	6.1	30.8	2.1
168(4)	12.3	6.1	30.7	2.0
169	12.2	6.0	30.5	2.0
172	12.1	6.0	30.2	2.0
173	12.1	6.0	30.2	2.0
174	12.1	6.0	30.2	2.0
175	12.1	6.0	30.1	2.0
176	12.1	6.0	30.1	2.0
177	12.0	6.0	30.1	2.0
178	12.0	6.0	30.1	2.0
179	12.0	6.0	30.1	2.0
180(1)	12.0	6.0	30.1	2.0
180(2)	12.0	6.0	30.1	2.0
183	12.0	6.0	30.1	2.0
185	12.0	6.0	30.1	2.0
186	12.0	6.0	30.1	2.0
188	12.0	6.0	30.0	2.0
189	12.0	6.0	30.0	2.0
192	12.0	6.0	30.1	2.0
193	12.0	6.0	30.0	2.0
194	12.3	6.1	30.8	2.0

ID	PM10	PM2.5	TSP	Dust Deposition
	Annual	Annual	Annual	Annual
Units	µg/m³	µg/m³	µg/m³	g/m²/month
198	12.1	6.0	30.3	2.0
199	12.1	6.0	30.3	2.0
200	12.1	6.0	30.2	2.0
204	12.2	6.0	30.3	2.0
105	12.2	6.0	30.3	2.0
106	12.4	6.1	30.7	2.0
107	12.2	6.0	30.4	2.0
108	12.2	6.0	30.3	2.0
112	12.3	6.0	30.6	2.0
113	12.3	6.0	30.6	2.0
115(1)	12.4	6.1	31.0	2.0
115(2)	12.5	6.1	31.3	2.0
115(3)	12.5	6.1	31.0	2.0
116	12.6	6.1	31.1	2.0
117	13.3	6.2	34.0	2.2
120	12.9	6.1	32.8	2.1
123	12.5	6.1	31.1	2.0
126	12.5	6.1	31.1	2.0
127	12.7	6.1	31.6	2.1
128	13.4	6.2	33.2	2.2
131	12.6	6.1	31.2	2.1
133	12.4	6.1	30.8	2.1
134	12.2	6.0	30.4	2.0
135	12.3	6.1	30.7	2.1
136	12.4	6.1	30.8	2.1
137	12.4	6.1	30.7	2.1
140	12.2	6.0	30.4	2.0
142	12.9	6.1	32.8	2.2
143	12.8	6.1	32.6	2.2
144	12.9	6.1	32.7	2.2
209	12.2	6.0	30.3	2.0
211	12.2	6.0	30.3	2.0
216	12.2	6.0	30.4	2.0
220	12.3	6.1	30.6	2.0
223	12.2	6.0	30.3	2.0
224	12.1	6.0	30.3	2.0
225	12.1	6.0	30.3	2.0
260	12.0	6.0	30.0	2.0
UKN1	12.2	6.0	30.3	2.0
UKN2	12.2	6.0	30.3	2.0
SRN339	12.2	6.0	30.2	2.0
SRN338	12.2	6.0	30.3	2.0
Mine owned				
19(1)	12.8	6.1	31.3	2.1
19(2)	12.4	6.1	30.8	2.0
19(3)	14.4	6.4	34.8	2.3
19(4)	13.0	6.2	31.7	2.1

ID	PM_{10}	$PM_{2.5}$	TSP	Dust Deposition
	Annual	Annual	Annual	Annual
Units	µg/m³	µg/m³	µg/m³	g/m²/month
19(5)	12.1	6.0	30.1	2.0
19(6)	12.4	6.1	30.9	2.0
19(7)	13.2	6.2	32.7	2.2
19(8)	13.2	6.2	33.8	2.1
19(9)	13.3	6.2	34.7	2.3
19(10)	13.7	6.2	35.2	2.2
19(11)	13.2	6.2	33.2	2.1
19(12)	13.1	6.2	32.8	2.1
19(13)	13.1	6.2	32.4	2.1
19(14)	13.6	6.2	35.6	2.2
19(15)	13.7	6.3	35.9	2.2
19(16)	15.4	6.5	43.5	2.5
19(17)	14.3	6.3	37.8	2.3
19(18)	12.3	6.1	30.7	2.0
19(19)	12.8	6.1	31.3	2.1
19(20)	12.3	6.1	30.4	2.0
19(21)	12.2	6.0	30.2	2.0
19(22)	12.3	6.1	30.4	2.0
19(23)	13.0	6.2	32.1	2.1
19(24)	12.4	6.1	30.6	2.0
19(25)	12.4	6.1	30.5	2.0
19(26)	12.3	6.1	30.5	2.0
19(27)	12.2	6.0	30.3	2.0

8.3 Coal Transportation

ROM coal from the DCM is transported by rail to the SCM for processing, prior to transportation to the Port of Newcastle for export.

There would be no change to the amount of ROM coal railed to the SCM due to the Modification, and therefore, no further assessment is required.

9 CONCLUSION

The Modification would result in no increase in annual ROM coal extraction or annual waste rock extraction, hauling or emplacement. In addition there would be no material change to the mine footprint. From an air quality perspective, the Modification would not increase TSP emissions in comparison to those assessed for DEP.

The existing ambient air monitoring in the vicinity of the DCM indicates that existing operations have a minimal impact on local air quality, with no exceedances of the annual average PM_{10} criterion while DCM has been operational. Since approval of the DEP in November 2011, there has only been a single exceedance of the 50 µg^3 24-hour criteria which attributed to non-mining sources (i.e. bushfires), and very isolated occasions when the 24-hour PM_{10} concentrations were above the criterion of 50 µg/m^3 which are generally attributable to background (i.e. non-mining) sources.

Dispersion modelling indicates there are no privately owned receivers predicted to experience 24-hour average PM_{10} concentrations above the assessment criterion, due to emissions from the DCM incorporating the Modification. A cumulative assessment, incorporating existing background levels, indicates the Modification is unlikely to result in any additional exceedances of relevant impact assessment criteria at the private receptors.

There are no privately owned receivers that are predicted to experience annual average PM_{10}, TSP or dust deposition above the impact assessment criteria, either from the DCM incorporating the Modification alone or cumulatively. There are no receivers that are predicted to experience 24-hour or annual average $PM_{2.5}$ concentrations above the advisory reporting standard.

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Appendix A DISCRETE RECEPTOR LOCATIONS

Table A.1: Relevant receptor locations

ID	Easting	Northing
Private residences		
74	400549	6434633
84(1)	400791	6434933
84(2)	400782	6434937
87	401901	6434280
93	398903	6432995
94	398434	6432289
95	399819	6431885
96	400584	6434519
97(1)	400335	6433632
97(2)	400212	6434081
98(1)	400670	6434525
98(2)	400607	6434633
100	400517	6431961
101	400524	6432561
103	401513	6433689
145	397485	6427232
146	397516	6426897
147	397624	6426565
148	397976	6425097
150	403001	6422805
153	403480	6427877
154	403206	6427193
155	403150	6426834
156	403737	6426998
157	403801	6426917
159	403583	6425746
160(1)	404287	6425008
160(2)	403705	6425206
164	403885	6426156
165	395751	6423713
167	398384	6423856
168(1)	398618	6421897
168(2)	398618	6421820
168(3)	398435	6424102
168(4)	398301	6423883
169	398294	6422577
172	400982	6422817
173	400337	6421826
174	400072	6421473
175	400646	6421909
176	400377	6421147
177	403502	6424466
178	404447	6424620
179	404839	6424420
180(1)	403256	6423302
180(2)	403242	6423768
183	402775	6422546
185	402313	6421767
186	402005	6421225
188	403259	6422216
189	403840	6422217
192	402569	6421417
193	402805	6421177
194	396691	6429686
198	396349	6421609
199	396677	6421391

ID	Easting	Northing
200	396737	6421230
204	398611	6421760
105	402853	6433834
106	399615	6432350
107	403297	6432499
108	403948	6432107
112	396494	6431245
113	396482	6430925
115(1)	396885	6429432
115(2)	397220	6430125
115(3)	396770	6428945
116	399007	6432150
117	398794	6430529
120	397723	6429537
123	399806	6431720
126	400161	6431617
127	400198	6431062
128	400881	6429798
131	401261	6431348
133	403149	6429944
134	403491	6431373
135	403735	6429917
136	403721	6429660
137	404031	6429368
140	403541	6432060
142	397608	6428288
143	397525	6428080
144	397485	6427417
209	399561	6434630
211	396001	6432750
216	395870	6429730
220	396304	6428930
223	395951	6422639
224	395986	6422225
225	395839	6421464
260	403751	6421970
	Mine owned	
19(1)	401794	6427604
19(2)	401941	6425642
19(3)	400919	6428644
19(4)	401758	6427837
19(5)	401569	6423163
19(6)	400898	6424728
19(7)	401137	6429699
19(8)	397899	6429355
19(9)	397970	6428562
19(10)	399076	6430419
19(11)	399519	6430670
19(12)	399752	6430643
19(13)	400979	6430273
19(14)	398109	6429528
19(15)	398256	6429849
19(16)	398540	6429620
19(17)	398894	6430090
19(18)	400653	6423931
19(19)	401784	6427569
19(20)	401856	6433382
19(21)	402008	6435464
19(22)	400898	6433544

ID	Easting	Northing
19(23)	401076	6430361
19(24)	401351	6432674
19(25)	401223	6433039
19(26)	399541	6433425
19(27)	400448	6434965

Appendix B EMISSION ESITIMATES

B.1 EMISSION FACTOR EQUATIONS

Silt and moisture content

Silt and moisture content values for in pit activities are based either on values used in the previous EA (**Heggies, 2009**) or other assessments of similar facilities.

	Silt content (%)	Moisture content (%)
Overburden	3.5	5.6
Coal (in-pit)	4.5	4.5
ROM Coal at infrastructure area	4.5	8
Hauling - unsealed	3	-

Drilling overburden and coal

The emission factor used for drilling has been taken to be 0.59 kg/hole for TSP and then multiplied by 0.52 for PM_{10} and by 0.03 for $PM_{2.5}$ (**US EPA, 1985 and updates**).

Blasting overburden and coal

TSP emissions from blasting were estimated using the **US EPA** (**1985 and updates**) emission factor equation given in Equation 2.

$$E_{TSP} = 0.00022 \times A^{1.5}$$

$$E_{TSP} = 0.52 \times E_{TSP}$$

$$E_{TSP} = 0.03 \times E_{TSP}$$

Where,
A = area to be blasted in m^2

The area blasted for each scenario is based on ha per blast provided in mine schedule each year.

Loading / transfer material dumping

Each tonne of material loaded will generate a quantity of particulate matter that will depend on the wind speed and the moisture content according to the US EPA emission factor equation (**US EPA, 1985 and updates**) shown below:

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

Where:

K = 0.74 for TSP and 0.35 for PM_{10} and 0.053 $PM_{2.5}$

U – wind speed (m/s)

M – moisture content (%)

The wind speed is taken from the CALMET generated wind at the project site.

Hauling material on unsealed surfaces

The emission estimate of wheel generated dust associated with hauling at the pit top areas (i.e. for hauling of waste rock material during construction is based the US EPA AP42 emission equation for unpaved surfaces at industrial sites (**US EPA, 1985 and updates**) shown below:

$$E_{TSP}\ (kg/VKT) = 0.2819 \times 4.9 \times [\times (s/12)\text{^}0.7 \times ((W \times 1.1023)/3)\text{^}0.45]$$

$$E_{PM_{10}}\ (kg/VKT) = 0.2819 \times 1.5 \times [\times (s/12)\text{^}0.9 \times ((W \times 1.1023)/3)\text{^}0.45]$$

$$E_{PM_{2.5}}\ (kg/VKT) = 0.2819 \times 0.15 \times [\times (s/12)\text{^}0.9 \times ((W \times 1.1023)/3)\text{^}0.45]$$

Where:

s = silt content of road surface
W = mean vehicle weight (average weight between loading and unloaded)

The mean vehicle weight used in the emissions estimates is an average of the loaded and unloaded gross vehicle mass, to account for one empty trip and one loaded trip.

Vehicle type	Unloaded (tare) weight	Loaded (GVM) including load	Capacity (tonnes)
CAT 785	114	250	136
CAT 789	143	324	181

Dozers on Overburden

Emissions from dozers on waste have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**).

$$E_{TSP}(kg/hr) = 2.6\ \times \frac{s^{1.2}}{M^{1.3}}$$

$$E_{PM_{10}}(kg/hr) =\ 0.3375 \times \frac{s^{1.5}}{M^{1.4}}$$

$$E_{PM_{2.5}}(kg/hr) =\ 0.105 \times E_{TSP}$$

Where:

s = silt content (%)

M = moisture content (%)

Dozers on Coal

Emissions from dozers on waste have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**).

$$E_{TSP}(kg/hr) = 35.6\ \times \frac{s^{1.2}}{M^{1.3}}$$

$$E_{PM_{10}}(kg/hr) =\ 6.33 \times \frac{s^{1.5}}{M^{1.4}}$$

$$E_{PM_{2.5}}(kg/hr) =\ 0.022 \times E_{TSP}$$

Where:

s = silt content (%)

M = moisture content (%)

Loading/unloading coal

The **US EPA** (**1985 and updates**) emission factor equation has been used.

$$E_{TSP}\left(\frac{kg}{t}\right) = \frac{5.8}{M^{1.2}}$$

$$E_{PM_{10}}\left(\frac{kg}{t}\right) = \frac{0.0447}{M^{0.9}}$$

$$E_{PM_{2.5}}\left(\frac{kg}{t}\right) = 0.019 \times E_{TSP}$$

Where,

M = moisture (%)

Crushing

The emission factor used for crushing have been taken to from the US EPA emission factors (**US EPA, 1985 and updates**), which are shown in the table below:

Activity	TSP	PM_{10}	$PM_{2.5}$
Tertiary crushing (controlled)	0.0006	0.00027	0.00005

Grading roads

Estimates of emissions from grading roads have been made using the US EPA AP42 emission factor equations for each particle size fraction, as shown below.

$$E_{TSP}\left(\frac{kg}{km}\right) = 0.0034 \times S^{2.5}$$

$$E_{PM_{10}}\left(\frac{kg}{km}\right) = 0.00336 \times S^{2.0}$$

$$E_{PM_{2.5}}\left(\frac{kg}{km}\right) = 0.0001054 \times S^{2.5}$$

Where,

S = speed of the grader in km/h (taken to be 8 km/h)

Wind Erosion

The emission factor used for wind erosion has been taken as 0.1 kg/ha for TSP, 0.5 kg/ha for PM_{10} and 0.075 for $PM_{2.5}$ **US EPA (1985 and updates)**

B.2 EMISSION ESTIMATES

Table B.1: Summary of TSP Emissions

ACTIVITY	TSP emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Control	units
PIT																	
OB - Drilling	6,903	39,000	holes/y	0.59	kg/hole											70	% control
OB - Blasting	50,870	156	blasts/y	326	kg/blast	13,000	Area of blast in square metres									0	% control
OB - Dozers on OB in-pit	6,556	10,530	h/y	1.2	kg/h	3.5	silt content in %	5.6	moisture content in %							50	% control
OB - Excavator loading trucks	5,535	23,350,000	t/y	0.0002	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	5.6	moisture content in %							0	% control
OB - Hauling OB to waste dump (CAT 785)	102,197	10,017,666	t/y	0.10	kg/t	136	t/load	182	Vehicle gross mass (t)	4.00	km/return trip	3.5	kg/VKT	3	% silt content	90	% control
OB - Hauling OB to waste dump (CAT 789)	114,394	13,332,334	t/y	0.09	kg/t	181	t/load	234	Vehicle gross mass (t)	4.00	km/return trip	3.9	kg/VKT	3	% silt content	90	% control
OB - Emplacing OB at waste dump	5,535	23,350,000	t/y	0.0002	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	5.6	moisture content in %							0	% control
OB - Dozers on waste dump	8,741	7,020	h/y	1.2	kg/h	3.5	silt content in %	5.6	moisture content in %							0	% control
CL - Dozers on ROM coal in-pit	4,594	150	h/y	30.6	kg/h	4.5	silt content in %	4.5	moisture content in %							0	% control
CL - Excavator loading ROM coal to trucks	286,216	3,000,000	t/y	0.095	kg/t	4.5	moisture content in %									0	% control
CL - Hauling ROM coal to CHPP	62,741	3,000,000	t/y	0.2	kg/t	136	t/load	182	Vehicle gross mass (t)	8.2	km/return trip	3.5	kg/VKT	3	% silt content	90	% control
Grading Roads	30,192	98,112	km/yr	0.62	kg/VKT	8	speed of graders in km/h									50	% control
ROM																	
CL - Unloading coal direct to ROM Hopper	173	2,400,000	t/y	0.00014	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							50	% control
CL - Unloading coal to ROM stockpiles	86	600,000	t/y	0.00014	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							0	% control
CL - FEL Loading ROM from stockpile to hopper	14,350	600,000	t/y	0.048	kg/t	8	moisture content in %									50	% control
CL - Crushing (Tertiary controlled)	1,800	3,000,000	t/y	0.0006	kg/t											0	% control
CL - Loading ROM coal to trains	432	3,000,000	t/y	0.00014	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							0	% control
WIND EROSION																	
WE - Active Pit and OB emplacement Area	173,448	198	ha	0.1	kg/ha/h	8760	h/y									0	% control
WE - Partially rehabilitatied areas	13,140	15	ha	0.1	kg/ha/h	8760	h/y									0	% control
WE - Soil stockpile areas	8,760	10	ha	0.1	kg/ha/h	8760	h/y									0	% control
WE - Infrastructure area	3,504	4	ha	0.1	kg/ha/h	8760	h/y									0	% control
WE - ROM stockpiles - OC coal	438	0.5	ha	0.1	kg/ha/h	8760	h/y									0	% control
TOTAL	**900,605**																

Table B.2: Summary of PM_{10} Emissions

ACTIVITY	PM_{10} emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Control	units
PIT																	
OB - Drilling	3,590	39,000	holes/y	0.31	kg/hole											70	% control
OB - Blasting	26,452	156	blasts/y	170	kg/blast	13,000	Area of blast in square metres									0	% control
OB - Dozers on OB in-pit	1,043	10,530	h/y	0.2	kg/h	3.5	silt content in %	5.6	moisture content in %							50	% control
OB - Excavator loading trucks	2,618	23,350,000	t/y	0.0001	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	5.6	moisture content in %							0	% control
OB - Hauling OB to waste dump (CAT 785)	23,710	10,017,666	t/y	0.02	kg/t	136	t/load	182	Vehicle gross mass (t)	4.00	km/return trip	0.8	kg/VKT	3	% silt content	90	% control
OB - Hauling OB to waste dump (CAT 789)	26,539	13,332,334	t/y	0.02	kg/t	181	t/load	234	Vehicle gross mass (t)	4.00	km/return trip	0.9	kg/VKT	3	% silt content	90	% control
OB - Emplacing OB at waste dump	2,618	23,350,000	t/y	0.0001	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	5.6	moisture content in %							0	% control
OB - Dozers on waste dump	1,391	7,020	h/y	0.2	kg/h	3.5	silt content in %	5.6	moisture content in %							0	% control
CL - Dozers on ROM coal in-pit	1,104	150	h/y	7.4	kg/h	4.5	silt content in %	4.5	moisture content in %							0	% control
CL - Excavator loading ROM coal to trucks	34,637	3,000,000	t/y	0.012	kg/t	4.5	moisture content in %									0	% control
CL - Hauling ROM coal to CHPP	14,556	3,000,000	t/y	0.0	kg/t	136	t/load	182	Vehicle gross mass (t)	8.2	km/return trip	0.8	kg/VKT	3	% silt content	90	% control
Grading Roads	10,549	98,112	km/yr	0.22	kg/VKT	8	speed of graders in km/h									50	% control
ROM																	
CL - Unloading coal direct to ROM Hopper	82	2,400,000	t/y	0.00007	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							50	% control
CL - Unloading coal to ROM stockpiles	41	600,000	t/y	0.00007	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							0	% control
CL - FEL Loading ROM from stockpile to hopper	2,064	600,000	t/y	0.007	kg/t	8	moisture content in %									50	% control
CL - Crushing (Tertiary controlled)	810	3,000,000	t/y	0.0003	kg/t											0	% control
CL - Loading ROM coal to trains	204	3,000,000	t/y	0.00007	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							0	% control
WIND EROSION																	
WE - Active Pit and OB emplacement Area	86,724	198	ha	0.05	kg/ha/h	8760	h/y									0	% control
WE - Partially rehabilitatied areas	6,570	15	ha	0.05	kg/ha/h	8760	h/y									0	% control
WE - Soil stockpile areas	4,380	10	ha	0.05	kg/ha/h	8760	h/y									0	% control
WE - Infrastructure area	1,752	4	ha	0.05	kg/ha/h	8760	h/y									0	% control
WE - ROM stockpiles - OC coal	219	0.5	ha	0.05	kg/ha/h	8760	h/y									0	% control
TOTAL	**251,651**																

Table B.3: Summary of $PM_{2.5}$ Emissions

ACTIVITY	$PM_{2.5}$ emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Control	units
PIT																	
OB - Drilling	207	39,000	holes/y	0.02	kg/hole											70	% control
OB - Blasting	1,526	156	blasts/y	10	kg/blast	13,000	Area of blast in square metres									0	% control
OB - Dozers on OB in-pit	688	10,530	h/y	0.1	kg/h	3.5	silt content in %	5.6	moisture content in %							50	% control
OB - Excavator loading trucks	396	23,350,000	t/y	0.0000	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	5.6	moisture content in %							0	% control
OB - Hauling OB to waste dump (CAT 785)	2,371	10,017,666	t/y	0.00	kg/t	136	t/load	182	Vehicle gross mass (t)	4.00	km/return trip	0.1	kg/VKT	3	% silt content	90	% control
OB - Hauling OB to waste dump (CAT 789)	2,654	13,332,334	t/y	0.00	kg/t	181	t/load	234	Vehicle gross mass (t)	4.00	km/return trip	0.1	kg/VKT	3	% silt content	90	% control
OB - Emplacing OB at waste dump	396	23,350,000	t/y	0.0000	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	5.6	moisture content in %							0	% control
OB - Dozers on waste dump	918	7,020	h/y	0.1	kg/h	3.5	silt content in %	5.6	moisture content in %							0	% control
CL - Dozers on ROM coal in-pit	101	150	h/y	0.7	kg/h	4.5	silt content in %	4.5	moisture content in %							0	% control
CL - Excavator loading ROM coal to trucks	5,438	3,000,000	t/y	0.002	kg/t	4.5	moisture content in %									0	% control
CL - Hauling ROM coal to CHPP	1,456	3,000,000	t/y	0.0	kg/t	136	t/load	182	Vehicle gross mass (t)	8.2	km/return trip	0.1	kg/VKT	3	% silt content	90	% control
Grading Roads	936	98,112	km/yr	0.02	kg/VKT	8	speed of graders in km/h									50	% control
ROM																	
CL - Unloading coal direct to ROM Hopper	12	2,400,000	t/y	0.00001	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							50	% control
CL - Unloading coal to ROM stockpiles	6	600,000	t/y	0.00001	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							0	% control
CL - FEL Loading ROM from stockpile to hopper	273	600,000	t/y	0.001	kg/t	8	moisture content in %									50	% control
CL - Crushing (Tertiary controlled)	150	3,000,000	t/y	0.0001	kg/t											0	% control
CL - Loading ROM coal to trains	31	3,000,000	t/y	0.00001	kg/t	0.8	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %							0	% control
WIND EROSION																	
WE - Active Pit and OB emplacement Area	13,009	198	ha	0.0075	kg/ha/h	8760	h/y									0	% control
WE - Partially rehabilitatied areas	986	15	ha	0.0075	kg/ha/h	8760	h/y									0	% control
WE - Soil stockpile areas	657	10	ha	0.0075	kg/ha/h	8760	h/y									0	% control
WE - Infrastructure area	263	4	ha	0.0075	kg/ha/h	8760	h/y									0	% control
WE - ROM stockpiles - OC coal	33	0.5	ha	0.0075	kg/ha/h	8760	h/y									0	% control
TOTAL	**32,507**																

Appendix C MODEL SETUP

Table C.1: TAPM and CALMET setup Options used

TAPM (v 4.0.4)	
Number of grids (spacing)	30 km, 10 km, 3 km
Number of grid points	40 x 40 x 35
Year of analysis	November 2010 – October 2011
Centre of domain	-32°5' S, 151°58.5' E
	403417mE, 6449769mN
Surface meteorological stations: (Outer domain)	Murrurundi Gap AWS (BoM, Station No. 061392)
	- Cloud amount - Cloud height
	Rock Hill
	- Wind speed - Relative humidity
	- Wind direction Sea Level Pressure
	- Temperature
	Stratford Coal Mine
	- Wind speed - Relative humidity
	- Wind direction
	- Temperature
	Duralie Coal Mine
	- Wind speed -
	- Wind direction
	- Temperature
CALMET (v. 6.333)	
Meteorological grid domain	40 km x 40 km (Outer) and 18 km x 18 km (Inner)
Meteorological grid resolution	1km (Outer) and 0.2 km (Inner)
3D.dat	Data extracted from 3 km TAPM

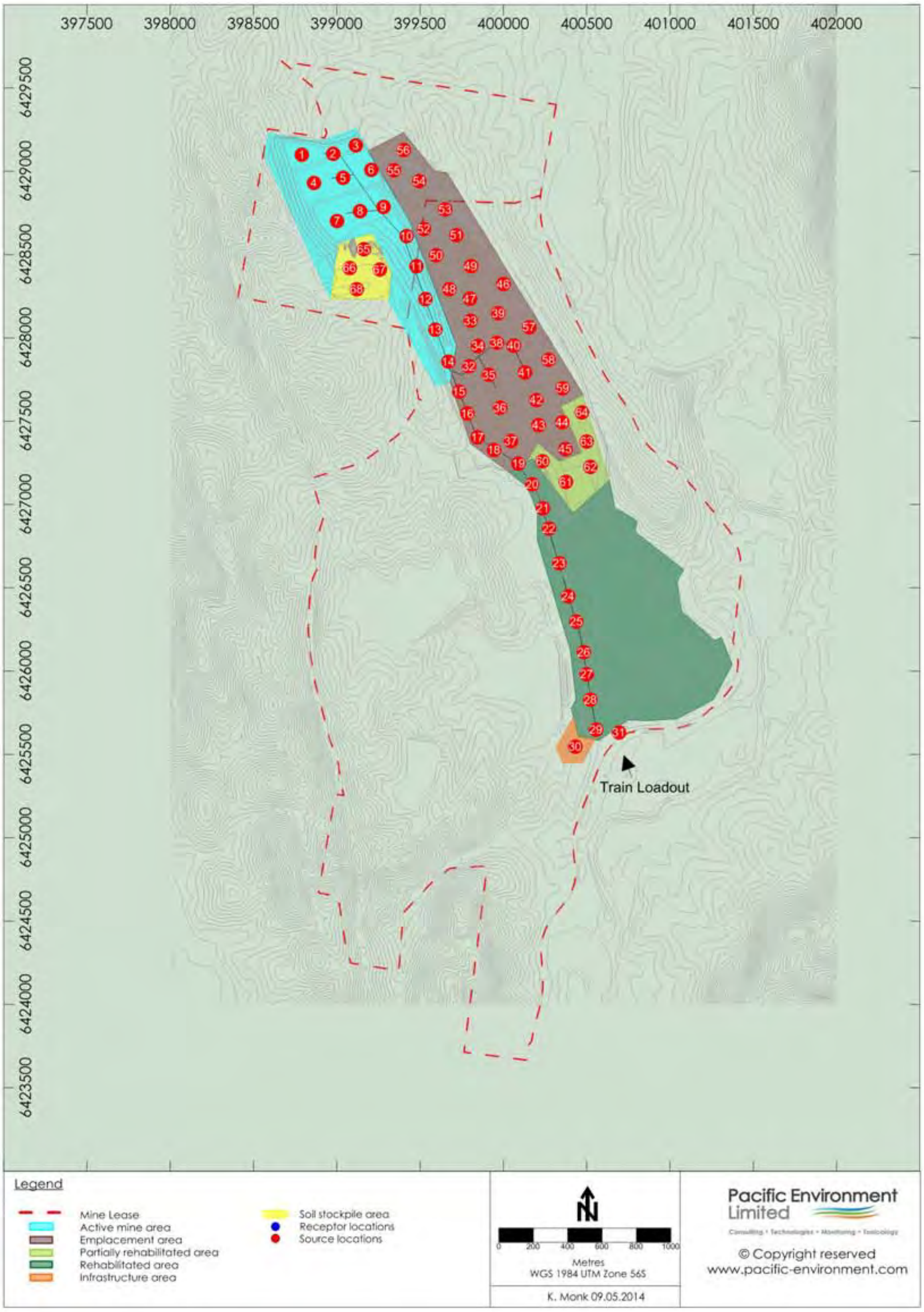
Table C.2: CALMET Model Options used

Flag	Descriptor	Default	Value Used
IEXTRP	Extrapolate surface wind observations to upper layers	Similarity theory	Similarity theory (Outer only)
BIAS (NZ)	Relative weight given to vertically extrapolated surface observations versus upper air data	NZ * 0	-1, 0 for all other layers (Outer)
TERRAD	Radius of influence of terrain	No default (typically 5- 15km)	10 km (Outer)
RMAX1 and RMAX2	Maximum radius of influence over land for observations in layer 1 and aloft	No Default	3km (Outer)
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind fields are weighted equally	No Default	1.5 km

Table C.3: CALPUFF Model Options used

Flag	Flag Descriptor	Value Used	Value Description
MCHEM	Chemical Transformation	0	Not modelled
MDRY	Dry Deposition	1	Yes
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Briggs plume rise
MSHEAR	Vertical wind Shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff Splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
MDISP	Dispersion Coefficients	2	Based on micrometeorology
MPDF	Probability density function used for dispersion under convective conditions	1	Yes
MROUGH	PG sigma y, z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment

Appendix D MODELLED SOURCE LOCATIONS


397500
398000
398500
399000
399500
400000
400500
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402000
6429500
6429000
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6428000
6427500
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6424500
6424000
6423500
Train Loadout
Legend
Mine Lease
Active mine area
Emplacement area
Partially rehabilitated area
Rehabilitated area
Infrastructure area
Soil stockpile area
Receptor locations
Source locations
N
0 200 400 600 800 1000
Metres
WGS 1984 UTM Zone 56S
K. Monk 09.05.2014
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