7. Air Quality

This section provides a summary of the air quality assessment undertaken, and the potential impacts identified, in regards to the Project (Mine) during construction and operation. The assessment was undertaken in accordance with the requirements of the Terms of Reference (ToR) and a table cross-referencing these requirements is provided in Volume 4 Appendix C ToR Cross Reference Table. A detailed air quality assessment is included in Volume 4 Appendix S Mine Air Quality Report.

7.1 Introduction

7.1.1 Scope of Reporting

The Project (Mine) comprises a greenfield coal mine over EPC1690 and part of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and offsite infrastructure. The Project (Mine) has an expected operational life of 90 years during which the mining operations have the potential to generate significant air emissions.

The potential for the Project (Mine) to generate air quality impacts has been assessed by:

- Evaluating the existing air quality in the region
- Identifying environmental values to be protected or enhanced
- Determining indicators for project emissions with the potential to compromise environmental values
- Predicting ground-level concentrations of air pollutants in the surrounding areas, due to the construction and operation of the Project (Mine), using approved emission estimation and air dispersion modelling techniques
- Comparison of incremental and cumulative pollutant ground-level concentrations against the air quality objectives identified for the project

7.1.2 Air Quality Assessment Criteria

National air quality guidelines are specified by the Environment Protection and Heritage Council, formerly known as the National Environment Protection Council (NEPC). The National Environment Protection (Ambient Air Quality) Measure (Ambient Air Quality NEPM) specifies national ambient air quality standards and goals for six air pollutants – nitrogen dioxide, sulphur dioxide, carbon monoxide, ozone, particulates (as PM_{10} and $PM_{2.5}$) and lead. The National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) provides monitoring investigation guidelines, principally for large cities with significant traffic emissions, for five air toxics – benzene, benzo(a)pyrene, formaldehyde, toluene and xylenes.

The Environmental Protection (Air) Policy 2008 (Air EPP) applies to the air environment of Queensland and identifies the environmental values to be enhanced or protected in the state. The purpose of the policy is achieved by developing and implementing indicators (air pollutants) and air quality objectives for enhancing and protecting the environmental values and a framework for making consistent, equitable and informed decisions about the air environment. The environmental values to be enhanced or protected relate to:

- The health and biodiversity of ecosystems
- Human health and wellbeing

- Aesthetics
- Agricultural use

Schedule 1 of the Air EPP defines air quality objectives such that environmental values are enhanced or protected. Air quality standards, goals and monitoring investigation levels of indicators specified in the Ambient Air Quality NEPM and Air Toxics NEPM have been adopted as air quality objectives in the Air EPP.

The most important air pollutant associated with emissions from the Project (Mine) is particulate matter. Particulate matter can impact each of the environmental values identified in the Air EPP, particularly human health and wellbeing (as respirable fine particles), aesthetics and amenity (as deposited dust). For this assessment, several size fractions of particulate matter have been assessed as total suspended particulate (TSP), PM_{10}, $PM_{2.5}$ and deposited dust. Disturbance of soil matter is the primary process by which the construction and operation of the Project (Mine) will generate particulate matter.

Due to the remote rural location of the Project (Mine), which is a significant distance from any populated urban centres with significant vehicle traffic and industrial sources, the overwhelming source of ambient particulate matter in the region originates from the disturbance of soil matter. The combustion of diesel fuel in stationary and mobile engines associated with the Project (Mine) will result in the emission of fine particles (PM_{10} and $PM_{2.5}$) and gaseous pollutants such as oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO) and volatile organic compounds (VOC). These emissions have not been assessed for the following reasons:

- The emission of fine particles and gaseous pollutants is considered negligible in comparison with particulate emissions from the disturbance of soil matter.
- Background levels of these emissions in the region are expected to be low due to the project's remote location and the lack of local sources that release the same air pollutants.
- There is significant separation between modelled emissions sources on Project (Mine) and sensitive receptors (see Table 7-2).

Low levels of odorous air pollutants may also be released from underground mine ventilation shafts. Due to the separation distance between the Project (Mine) and sensitive receptors and the lack of similar sources to create cumulative impacts, odour emissions at sensitive receptors were not quantitatively assessed as no impact is expected.

Impacts to air quality associated with particulate emissions have been assessed against the relevant Air EPP objectives for TSP, PM_{10} and $PM_{2.5}$. The objectives of TSP, PM_{10} and $PM_{2.5}$ are compared against the air quality impact of the Project (Mine) combined with the ambient background level. Air quality objectives for deposited dust are not included in the Air EPP. In these circumstances, it is appropriate to review air quality standards and goals in other national and international jurisdictions to obtain a suitable assessment criterion. For the assessment of deposited dust, the NSW Office of Environment and Heritage (OEH) impact assessment criterion has been used. The NSW OEH *Approved methods for the modelling and assessment of air pollutants in NSW* (2005) document provides impact assessment criteria for the project's incremental contribution of deposited dust at sensitive receptor locations of 2 g/m^2/month (insoluble solids, annually averaged), as well as a maximum total deposited dust level of 4 g/m^2/month (insoluble solids, annually averaged) inclusive of background.

The air quality objectives and criteria used in the assessment are presented in Table 7-1.

Table 7-1 Air Quality Objectives and Assessment Criteria used in the Assessment

Indicator	Environmental value	Air Quality Objective	Averaging Period
Total suspended particles (TSP)	Health and wellbeing	90 µg/m^3 [(a)]	1 year
PM_{10}	Health and wellbeing	50 µg/m^3 [(a) (b)]	24 hours
$PM_{2.5}$	Health and wellbeing	25 µg/m^3 [(a)]	24 hours
		8 µg/m^3 [(a)]	1 year
Deposited dust	Protecting aesthetic environment	2 g/m^2 [(c) (d)]	1 month
		4 g/m^2 [(c) (e)]	1 month

Note:

[a] Queensland Air EPP (2008)
[b] Five exceedences allowed
[c] NSW Approved Methods for the modelling and assessment of air pollutants in NSW (2005)
[d] Maximum increase in deposited dust level, based on annual average of monthly observations
[e] Maximum total deposited dust level, based on annual average of monthly observations

7.1.3 Air Quality Assessment Method

7.1.3.1 Mine Plan and Assessment Scenarios

The air quality assessment has been carried out using industry recognised techniques for emissions estimation and air dispersion modelling. Project emissions have been identified based on the outcomes of the Macro-conceptual Mine Plan (Runge 2011) (the Mine Plan) and known emissions from similar sources. To account for the Mine's projected 90 year lifespan, impacts associated with three emission scenarios have been assessed. The assessment scenarios are identified as start-up, full operations and maximum emissions.

The start-up phase is represented by the year 2016 in the Mine plan (Runge 2011). The year 2016 was selected as it represents a situation when both the underground mining (UGM) and open cut mining (OCM) activities are commencing. Estimates of equipment operational hours and earth moved are considered relatively accurate. Predictions of dust levels in terms of applied technology and mine capacity are considered to have a high degree of accuracy as the technology proposed is current.

The full operation phase is represented by the year 2037 in the Mine plan (Runge 2011). The year 2037 was selected as it represents a situation where both the UGM and OCM are at full operations, with numerous OCM pits active and some being rehabilitated. As a result of possible variance over time, there is an increased margin of error for estimates relating to operational equipment hours and types. Estimates relating to applied technology are considered likely to be accurate, as during the start-up phase.

The maximum emissions phase is represented by the year 2067 in the Mine plan (Runge 2011). This is not the year that the mine is at maximum capacity, i.e. maximum output of coal, but is representative of the maximum amount of dust being emitted from mining operations. By this time, nominally 55 years into the future, the UGM has been closed and all identified OCM pits and waste dumps are either active or under rehabilitation. This phase also has the greatest amount of error as it is expected that technology, especially in terms of dust mitigation, should have advanced beyond the standard achievable at present.

Beyond the year 2067, the dust emissions continue to decline as more of the OCM pits are closed and rehabilitated and the overall amount of coal being produced by the mine decreases.

7.1.3.2 Emissions Modelling

Particulate emissions for the start-up, full operation and maximum emissions phases of the Project (Mine) have been estimated using a combination of source emission factors published in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Mining (NPI, 2011) and United States Environmental Protection Agency's AP-42, mine activity information outlined in the Mine Plan and regional meteorological data such as wind speed and rainfall. Particulate emission sources have then been characterised for input into a site-specific CALPUFF air dispersion model to predict ground-level concentrations (GLCs) of TSP, PM10 and PM2.5, as well as deposited dust levels, at sensitive receptors near the Project (Mine). Predicted GLCs and deposited dust levels were then assessed against air quality objectives identified for the project.

7.1.3.3 Meteorological and Dispersion Modelling

Due to the large geographical extent of the mine operations, especially in the north-south direction, standard, steady state, Gaussian plume dispersion models do not adequately simulate the dispersion of air emissions for the prediction of ground-level concentrations. Consequently, the three-dimensional, non-steady state, lagrangian puff model, CALPUFF, was used to simulate the long-range (in this case greater than 15 km for which Gaussian assumptions become invalid) transport of plumes with concentrations carried over from one hour to the next. CALPUFF also allows for the varying terrain, land uses and meteorology (wind direction, wind speed and atmospheric stability change) enabling the model to track releases (puff modelling) across the model domain is required. This provides for the tracking of the plume over varying terrain and land uses.

Meteorological inputs to the CALPUFF model were developed using the prognostic MM5 meteorological model to generate a synthetic site-representative three-dimensional wind field with a grid resolution of one kilometre. A grid resolution of one kilometre was considered suitable for this assessment due to the large model domain and lack of substantive smaller scale terrain features that would influence or diverge the broader regional flows generated with the MM5 model. The MM5 data were obtained from the Atmospheric Studies Group at TRC Environmental Corp (ASG 2011) for the modelling year 2007. Available years for the data were 2006, 2007 and 2008. The middle year was selected as it involved the least number of extreme individual monthly rainfall totals (compared to the long-term average although an unseasonal rain event occurred during June) and the annual rain was the closest to the long-term annual mean (2006 was very dry and 2008 was wetter than average).

The MM5 output was then refined for use in CALPUFF using the diagnostic mass consistent CALMET model Version 5.8, which is the most up to date version approved by the US Environmental Protection Agency (US EPA 2011). CALMET includes an MM5 interface to incorporate the MM5 prognostic meteorological data in a 'no-observations' mode. A CALMET modelling domain was established to have coverage from GDA 94 Eastings 400 to 476 km (Zone 55) and Northings 7,525 to 7,601 km with a one kilometre resolution. The model domain was thus a 75 km by 75 km grid that encompassed the Project (Mine). Additionally, the model extended 10 to 15 km beyond the perimeter of Project (Mine) dust generating activities in all directions. Vertical levels were defined to be concentrated in the lower levels (especially up to 500 m) with ten levels at 0, 20, 40, 80, 120, 210, 300, 500, 1,000, 2,000 and 3,000 m. Terrain and land use data with 1 km resolution were modified to reflect actual ground surface land use as determined by aerial imagery.

7.2 Description of Environmental Values

7.2.1 Local Meteorology

The Project (Mine) is located approximately 160 km north-west of Clermont. The nearest Bureau of Meteorology (BoM) stations to the Project (Mine) are the Carmichael, Twin Hills and Hughenden stations. The Carmichael station is closest, located approximately 12 km from the Project (Mine); the Twin Hills station is approximately 53 km east of the Project (Mine); and the Hughenden station is located approximately 239 km north-west of the Project (Mine) (refer to Figure 7-1).

The existing air shed environment, both locally and in a regional context, has been described by site-representative records of temperature, rainfall and wind speed and direction. The important air dispersion parameters of atmospheric stability and mixing depth are derived parameters best described by reported or calculated conditions over a larger regional context (inland central Queensland). The stations at Twin Hills and Hughenden were found to have sufficient data to describe the airshed environment, while data at Carmichael station was limited.

Climatically, the inland areas surrounding the Project (Mine) can be described as between a ‘grassland’ climate with a sub-classification of ‘hot (winter drought)’ such as found in Hughenden to the west and a ‘subtropical’ climate with a sub-classification of ‘moderately dry winter’ such as found at Twin Hills to the east (Stern et al, 2000).

The Hughenden Post Office has acted as a BoM climatic observing site (number 030024) since 1884 and remains operational. At the preparation of this report, the rainfall record at Hughenden spanned 117 years and the temperature record spanned 36 years.

The Twin Hills Post Office acted as a BoM climatic observing site (number 036047) between 1905 and 1985. At the preparation of this report, the rainfall record at Twin Hills spanned 80 years and the temperature record spanned 20 years.

The Carmichael meteorological station has acted as a BoM rainfall only observing site (number 036122) since January 2003. The station has the operational status of ‘open’, however, data records cease at 31 December 2010 with patchy data returns for all years except 2004-06 and 2008-09. There is also no temperature record at Carmichael meteorological station. Hence, this site cannot be used to classify the climate albeit the limited record can be compared to the nearby climatic sites of Hughenden (grassland – hot winter drought) and Twin Hills (subtropical – moderately dry winter).

7.2.1.1 Carmichael AWS

An Automatic Weather Station (the Carmichael AWS, site number 333300) was commissioned by Adani on 27 October 2011. The Carmichael AWS is situated on the Project (Mine) and is intended to record the local climate with the following parameters.

- Temperature (^{o}C) at 2 m and 10 m above ground level
- Solar radiation (in W/m^{2})
- Wind speed and direction (m/s)
- Rainfall (mm)

Due to the short period of time in which the Carmichael AWS has been operating, the description of the meteorology of the Project (Mine) was primarily based on meteorological data collected at representative

BoM sites across the region (refer to Section 7.2.1). Due to a solar panel fault, no data was recorded from 22 January to 3 May 2012.

Plate 7-1 Carmichael AWS (Site number 333300)

LEGEND

] Major Port	State Road
. Key Centre / Locality	Existing Railway
0 Station	Local Government Area Boundary
Rail (West)	Rail (East)
Project (Mine)	Mine (Offsite)

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:2,700,000 (at A4)

0 20 40 60 80 100

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Weather Stations near the (Project Mine)

Job Number 41-25215
Revision A
Date 11-10-2012

Figure: 7-1

G:\41\25215\GIS\Maps\MXD\800_Social\41-25215_830_rev_a.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Key Centre / Locality (2007); DERM: LGA (2011); DMR: State Roads (2008); BOM: Station (2012); DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012).
Created by: BW, MS

7.2.1.2 Air Temperature and Humidity

Monthly mean temperatures and humidity for Hughenden and Twin Hills are displayed in Figure 7-2 to Figure 7-5. These show the seasonal variation in the temperature range. Mean monthly minimums and associated upper and lower 10 percentiles (decile) are shown in blue and maximums are in red. Monthly mean relative humidity throughout the year is also displayed with both 9 am in the morning (red) and 3 pm in the afternoon (blue) observing times shown. These show both seasonal and diurnal patterns in humidity.

Monthly mean temperatures for Hughenden Post Office (Site Number 036047) show daytime summer temperatures are mostly in the mid-30s with winter overnight temperatures most commonly between 7 and 12 degrees (see Figure 7-2). The temperature record of approximately 36 years shows values ranging from -2°C to 44°C. 'Hot days', with temperatures exceeding 35°C, can be expected up to 101 days per year. 'Frost days' with screen temperatures below 2°C can be expected up to 1.4 days per year. Relative humidity is highest in the mornings and during the February while the lowest is in the mid to late spring mornings and afternoons (see Figure 7-4).

Monthly mean temperatures for Twin Hills Post Office (Site Number 036047) show daytime summer temperatures are mostly in the early to mid-30s with winter overnight temperatures dropping to between 5 and 10 degrees (see Figure 7-4). The temperature record of approximately 20 years shows values ranging from -3.2°C to 43.8°C. 'Hot days', with temperatures exceeding 35°C, can be expected up to 74.6 days per year. 'Frost days'; with screen temperatures below 2°C can be expected up to 10.4 days per year. Relative humidity is highest in the mornings and during the month of February and lowest in the late spring mornings and afternoons (see Figure 7-5).

Figure 7-2 Monthly Mean and Decile (10% and 90%) Maximum and Minimum Temperatures (°C) at Hughenden Post Office

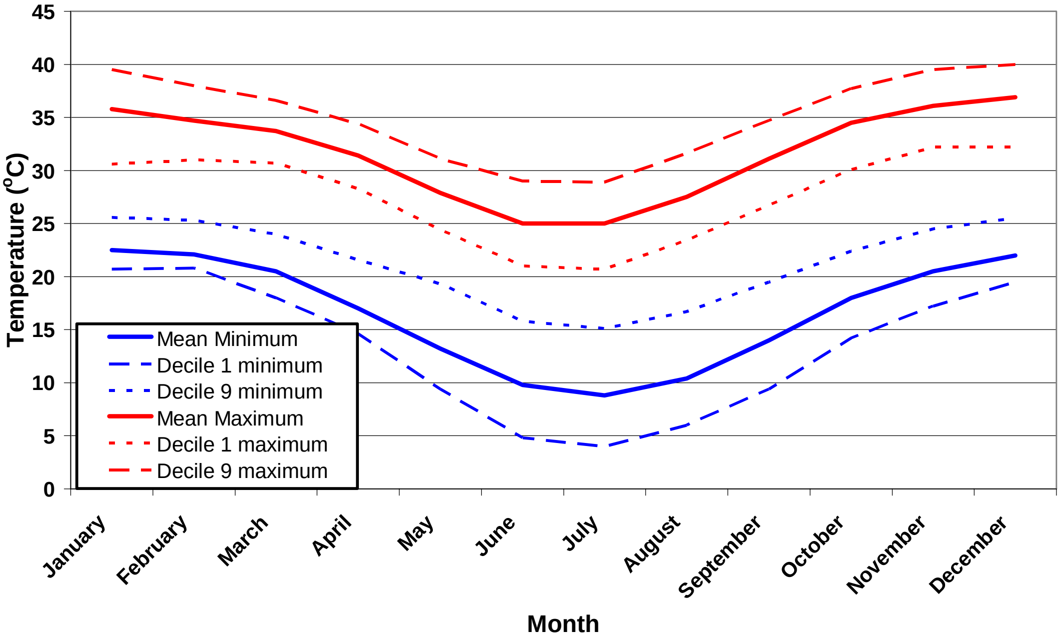


Figure 7-3 Morning and Afternoon Monthly Mean Relative Humidity (%) at Hughenden Post Office

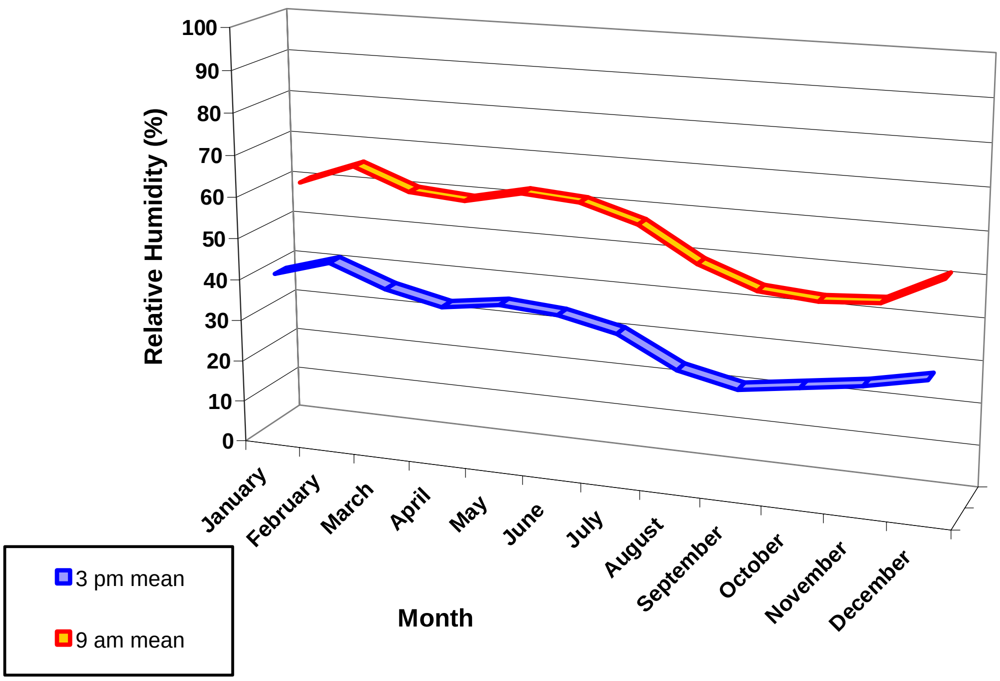


Figure 7-4 Monthly Mean and Decile (10% and 90%) Maximum and Minimum Temperatures (^{0}C) at Twin Hills Post Office

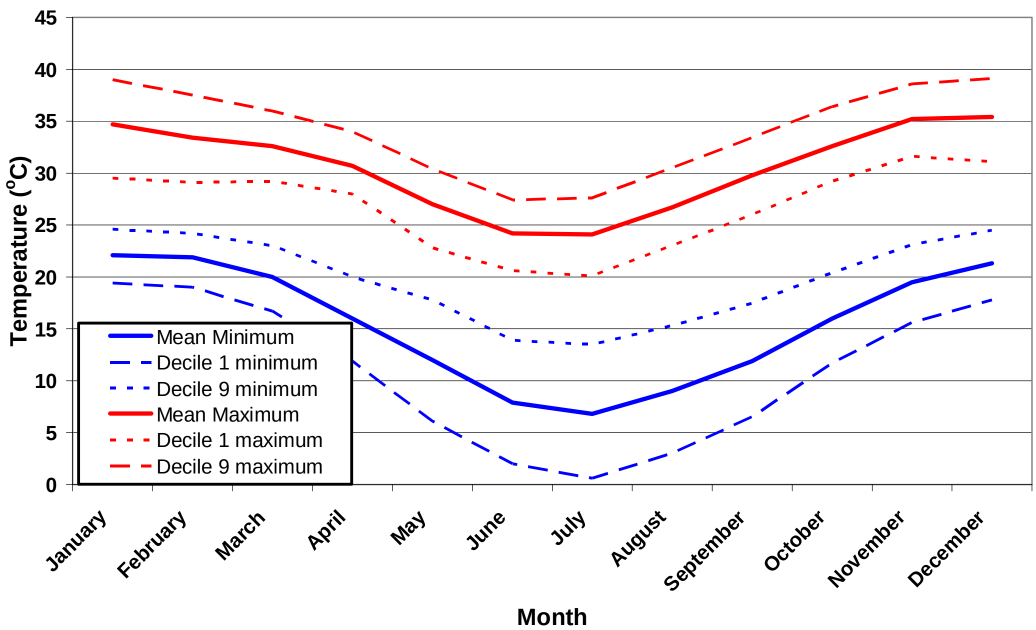
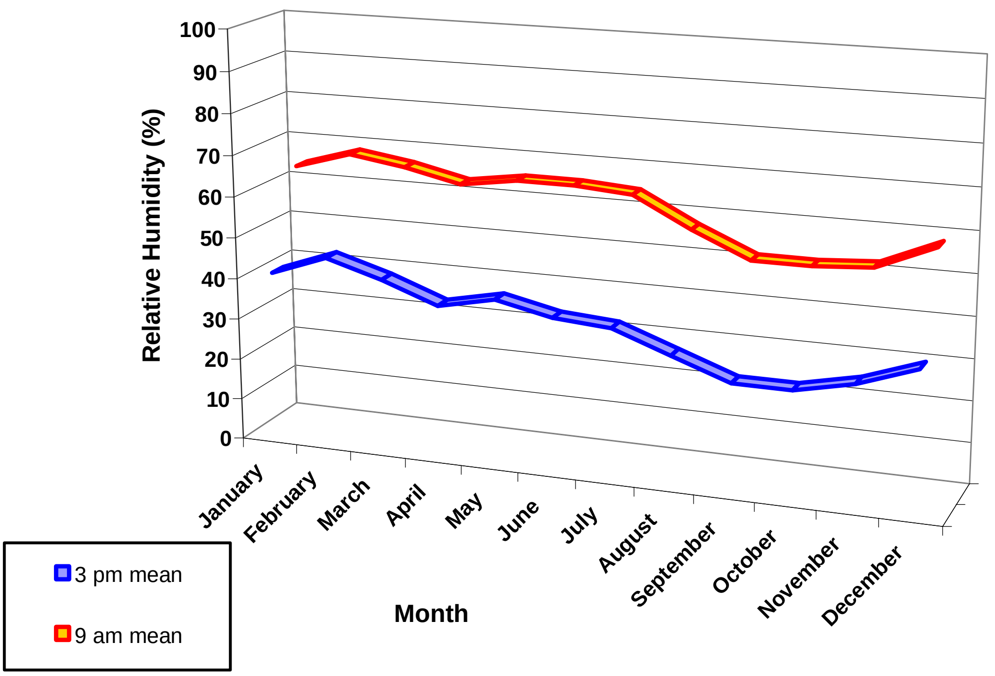


Figure 7-5 Morning and Afternoon Monthly Mean Relative Humidity (%) at Twin Hills Post Office



7.2.1.3 Rainfall

The annual rainfall record at Carmichael station ranges between 252 mm and 700 mm, with a mean of 524 mm, driven primarily by warm months producing convectively driven rainfall. Monthly mean rainfall proportions are shown in Figure 7-6. Rainfall in December through March accounts for 65 per cent of annual mean rainfall. The wettest month is January with a mean of 129.1 mm and the driest month is May with a mean of 11.2 mm.

As the rain record at Carmichael station begins in 2003, the range of rainfall is not reliable at this stage, however similar rainfall patterns can be seen at Twin Hills and Hughenden. The annual rainfall record ranges between 218 mm to 1,477 mm at Twin Hills and 150 mm to 1,085 mm at Hughenden, with means of 610 mm and 492 mm respectively. Monthly mean rainfall proportions are shown in Figure 7-7 and Figure 7-8, with December through March inclusive accounting for the majority of the annual mean rainfall in the region. As would be expected, there is a clear pattern of rainfall decreasing inland with the mean number of rain days per year at 46 at Twin Hills and 43 at Hughenden.

Figure 7-6 Monthly Mean Rainfall (mm) Proportions at Carmichael Site Number 036122 (January 2003 to December 2010)

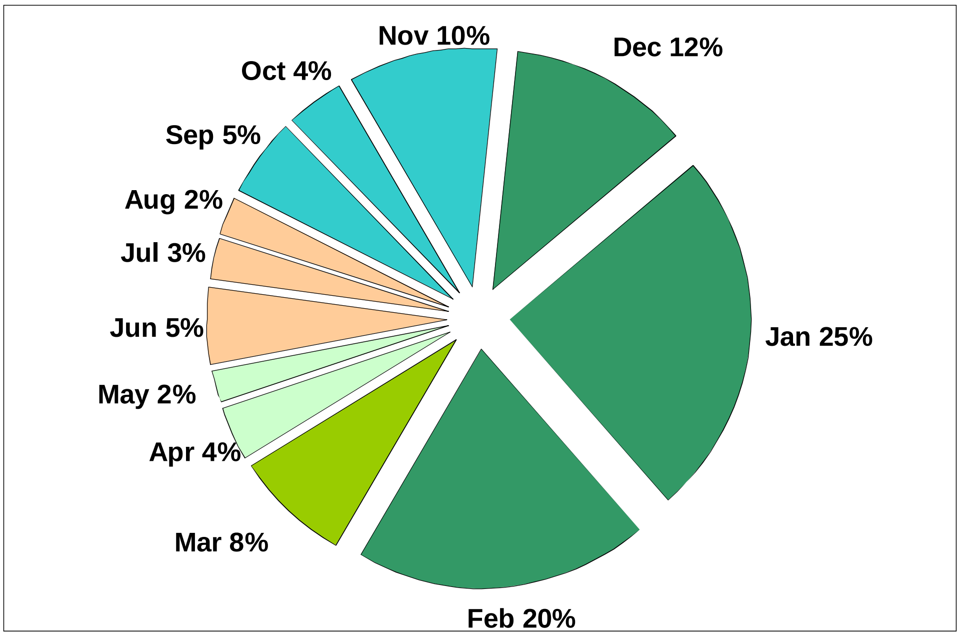


Figure 7-7 Monthly Mean Rainfall (mm) Proportions at Twin Hills Post Office (1905 to 1985)

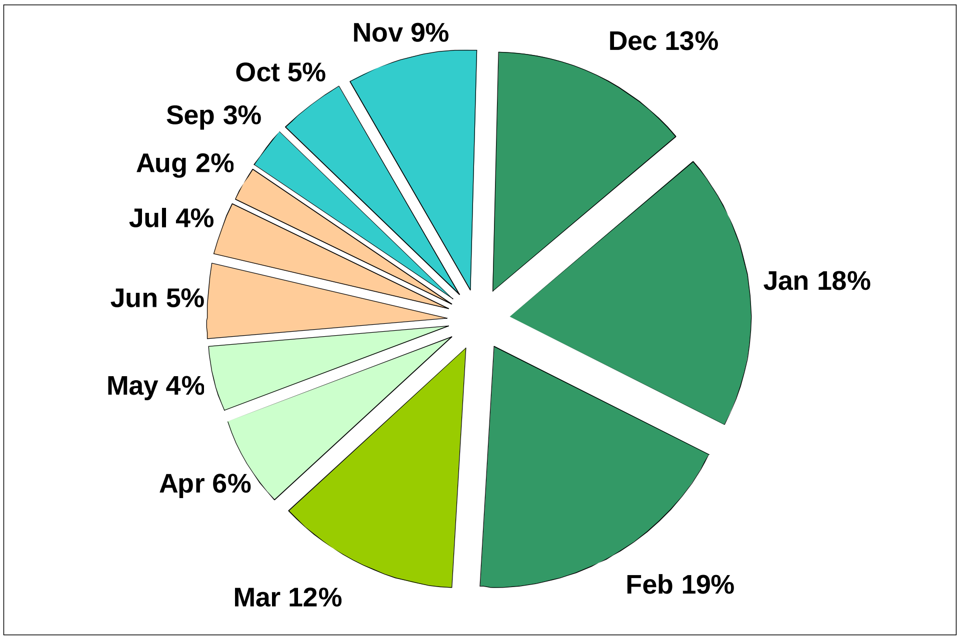
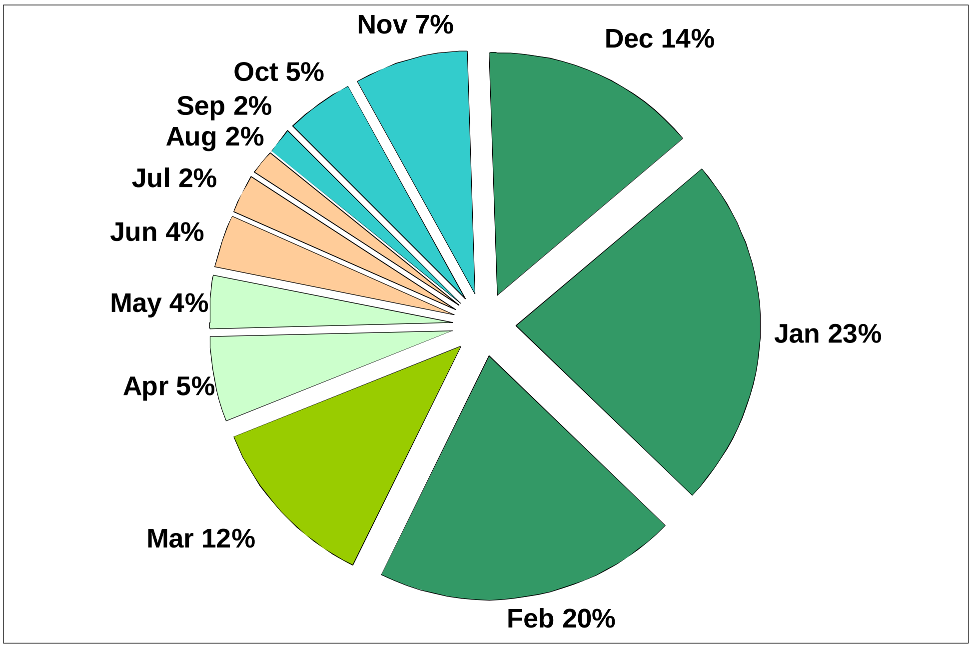


Figure 7-8 Monthly Mean Rainfall (mm) Hughenden Post Office (1884 – 2010)



3.1.1.1 Wind Speed and Direction

The annual wind rose for the Project (Mine) was derived using meteorological modelling tools (refer to Volume 2 Section 7 Air Quality). The prevailing wind directions

7.2.2 Wind Speed and Direction

The effect of wind on pollutant dispersion patterns can be examined using the general wind climate and atmospheric stability class distribution. The general wind climate at a site is most readily displayed by means of wind rose plots, giving the incidence of winds from different directions for various wind speed ranges. The annual distribution of winds at the Project (Mine) site was derived using the MM5 and CALMET meteorological modelling tools (refer to Section 7.1.3.3). Wind speeds were generated across the 75 by 75 km model domain which necessitated the inclusion of an overall surface roughness assumption in the model.

The prevailing wind directions have a strong easterly component. This is expected at this latitude of near 22° south, being dominated by the (south-east) southern hemisphere trade winds. The strongest winds, those above 4.0 m/s, continue the pattern of being mostly out of the east. The annual average wind speed for this dataset is 2.6 m/s. The modelled wind patterns were consistent with an inland sub-tropical climate, typical of the Bowen Galilee Basins. The dataset consistently shows the lack of westerly component winds and the south-easterly at times coming out of the north-east, mostly associated with wet season disruption to the prevailing trade winds.

To assess how well the modelling system represented the wind pattern, the derived annual wind rose for the Project (Mine) (refer to Figure 7-9) was compared with annual wind roses from Sonoma, Hughenden, Emerald (refer to Figure 7-10) and the Carmichael AWS (refer to Figure 7-11). Due to the absence of data from 22 January to 3 May 2012 at the Carmichael AWS, comparison was made for a November to January wet season and a May to August dry season. The comparison concluded that wind was correctly modelled to be predominantly from the north-east sector during the wet season the south-east sector during the dry season, and that the model was consistent with regional and site observations for the purpose of dispersion modelling.

Overall, the modelled wind speeds, were higher than the observed wind speeds at the Carmichael AWS. This can be attributed to the measurement site being well vegetated with a higher surface roughness than the corresponding roughness used in the whole-of-mine model assumptions. However, it was considered that the whole-of-mine model assumptions and derived wind data (refer to Figure 7-9) were suitable for dispersion and modelling purposes, due to the lack of significant terrain or substantive smaller scale terrain features that would influence or diverge the broader regional flows across the model domain.

Figure 7-9 Derived Annual Wind Rose Project (Mine)

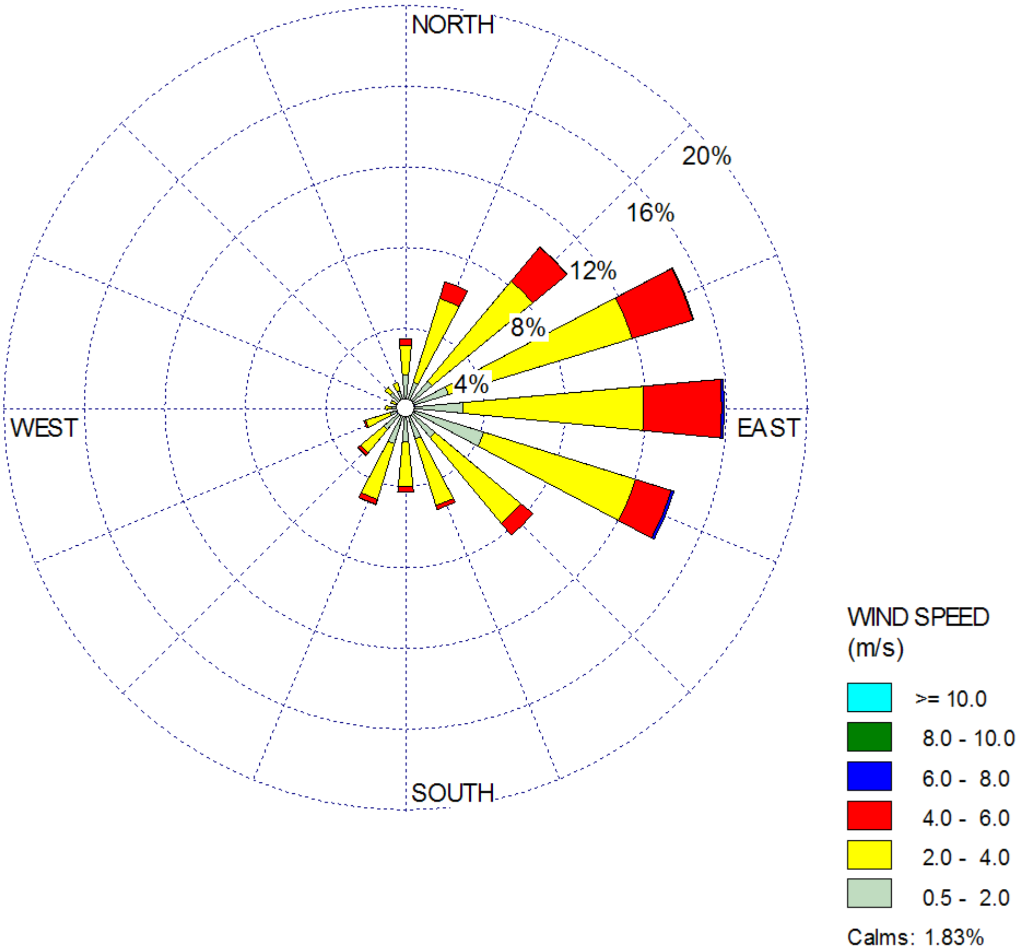
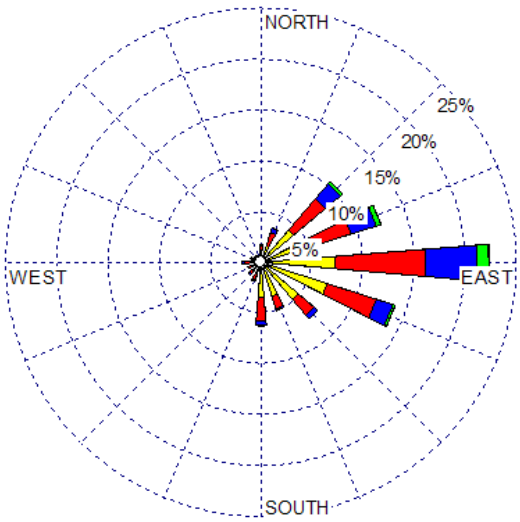
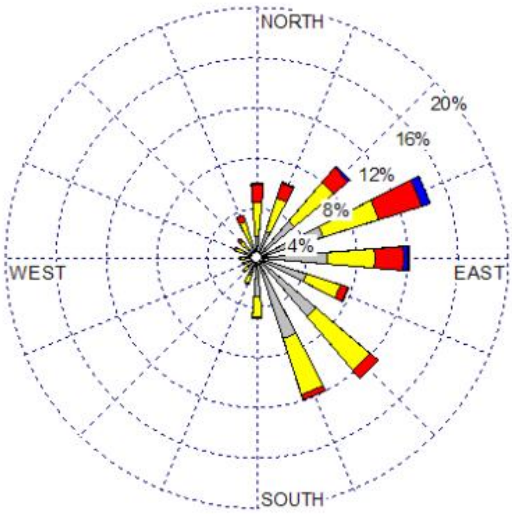


Figure 7-10 Comparison Annual Wind Roses for Inland Central Queensland

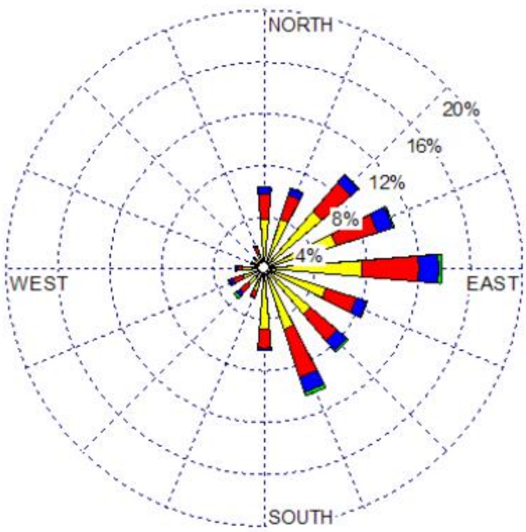
Hughenden (North-west)



Sonoma (North east)



Emerald (South-east)



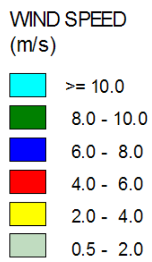
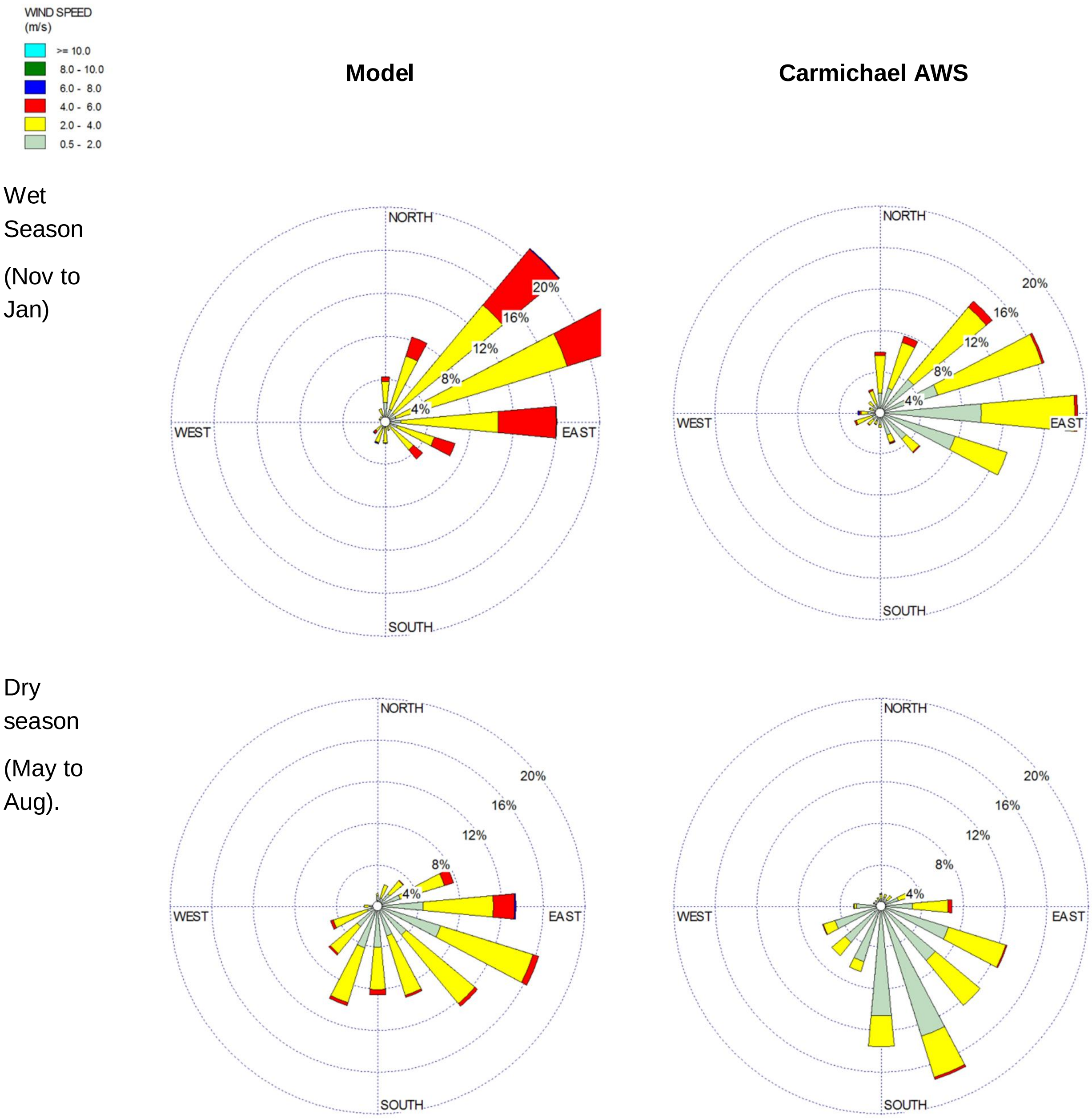


Figure 7-11 Comparison Model and Carmichael AWS Wind Roses



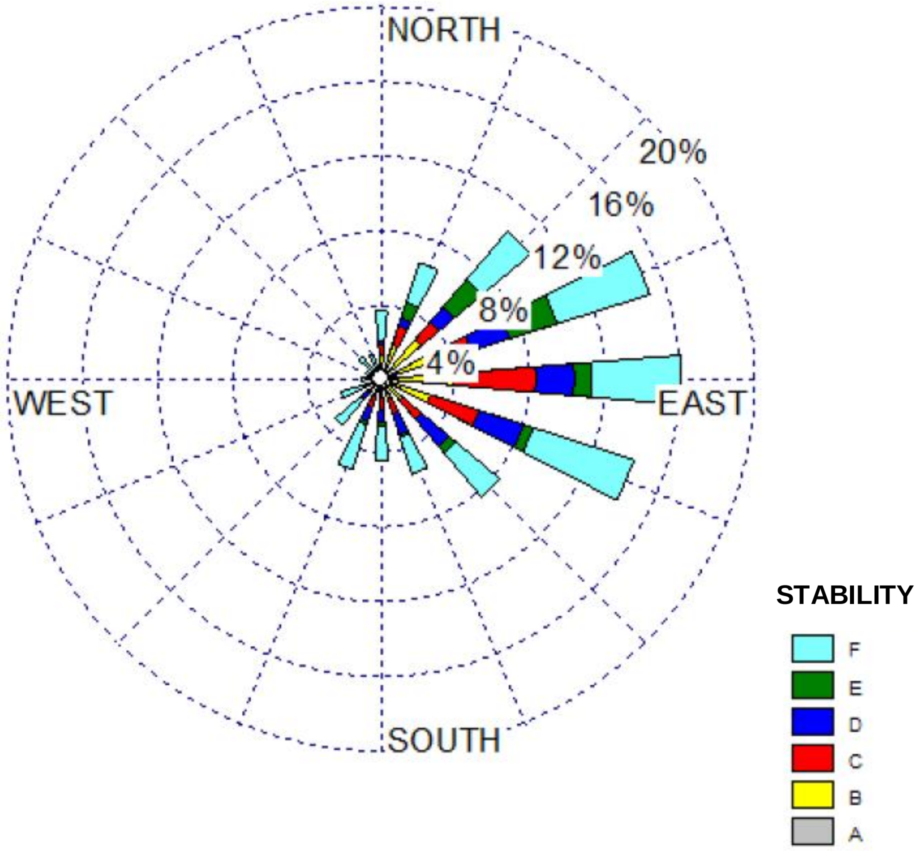
7.2.2.1 Atmospheric Stability

Dispersion meteorology required for modelling air pollutants requires a time varying measure, or estimate, of atmospheric stability. The derived Project (Mine) meteorological data includes stability classified under the Pasquill-Gifford scheme. This scheme categorises stability into six classifications:

- A, B and C for unstable conditions (very, moderate and slight, respectively)
- D for neutral stability
- E and F for stable conditions (moderate and slight, respectively)

As can be seen in the stability rose shown in Figure 7-12, the model domain, incorporating the Project (Mine), exhibits a dominant F-class which prevails most nights due to the light winds producing stable night-time conditions. In tropical regions, prognostic models such as MM5, which are themselves reliant on global scale Numerical Weather Prediction models with grid scales of tens of kilometres, tend to under-predict the higher wind speeds and therefore falls short with the determination of neutral conditions of D-class stability. North of the Tropic of Capricorn, strong solar radiation will result in most unstable conditions being highly convective, hence the derived stability class data frequency is under predicted for both the A and B class stability. The above two under predictions are considered low in importance as this is a conservative consideration for dust dispersion for ground and near-ground emission sources.

Figure 7-12 Derived Annual Stability Rose for the Project (Mine)



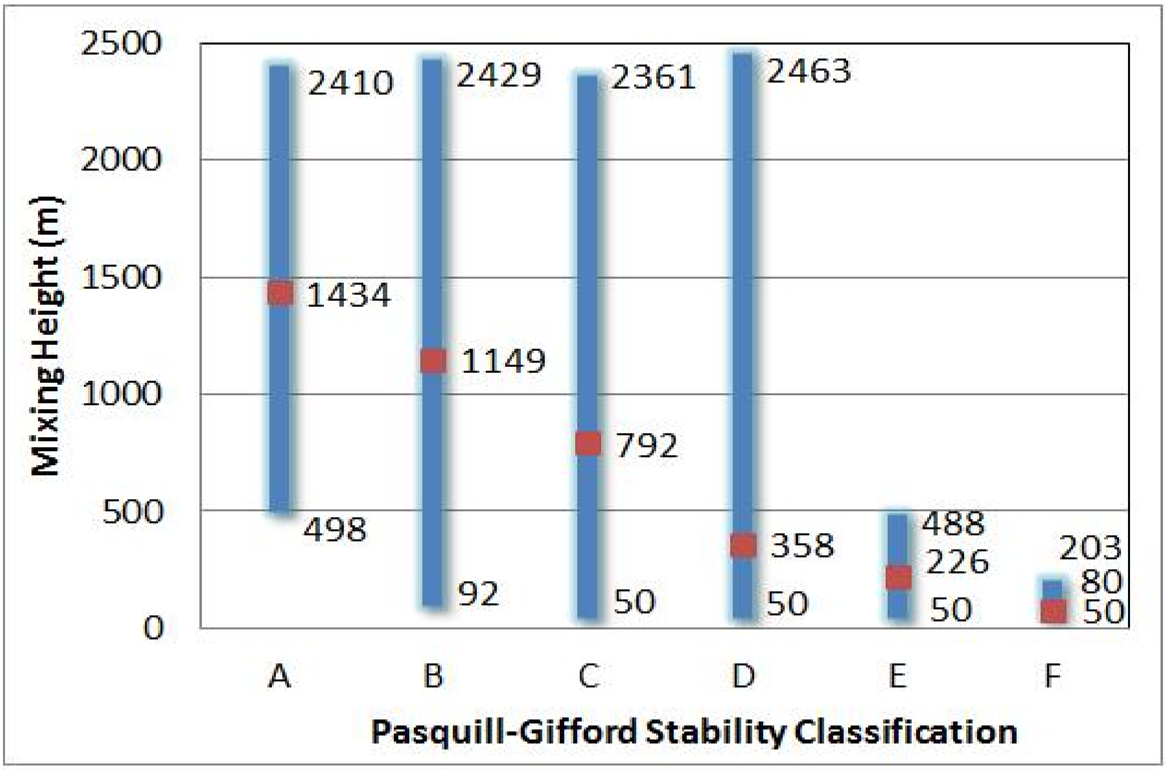
7.2.2.2 Mixing Depth

Mixing depth is an important atmospheric parameter for air dispersion modelling. The mixing depth is an indicator of vertical depth of the atmosphere into which pollutants can mix and is a mixture of mechanical and convective influences. The convective conditions will dominate during the day as temperature can become high in this tropical climate while the night-time mixing height is dominated by the strength of the vertical temperature gradient (and the formation of temperature inversions on most nights in a near desert climate) but which may be moderated by the mechanical mixing of winds that occasionally continue beyond sunset.

No direct measurements of mixing depth are available for the model domain. Therefore, CALMET was configured to calculate a suitable mixing height to be used in the dispersion modelling. The minimum daytime mixing heights were in the range of 50 to 500 m which is reasonable for the most unstable conditions (Class A) and some days likely to have cloudy to overcast skies. Night-time mixing heights were as low as 50 m during the calmest of conditions but could reach to near 500 m during nights with stable conditions but stronger winds. A statistical analysis of mixing heights for each of the stability classes is shown in Figure 7-13.

The derived mixing heights are conservative for the circumstances of the Project (Mine) as the mining emission sources will be at, or near, ground level. Daytime mixing heights reaching no more than 2,500 m using this approach is technically an underestimate during highly convective conditions.

Figure 7-13 Distributions of Derived Mixing Heights by Pasquill-Gifford Stability Class for the Project (Mine)



7.2.3 Pollutants

Significant quantities of particulate matter will be emitted from a range of sources and activities at the Project (Mine) including land clearing activities, the extraction, transport, processing and storage of coal, overburden and waste rock. For the purposes of emissions modelling and the assessment of air quality impacts, mine operations and construction are considered to be part of the same process. Air pollutant emissions are released during the disturbance of soil matter during mining and from diesel combustion engines used in stationary and mobile plant equipment.

The focus of the air quality assessment is particulate emissions associated with the disturbance of soil matter during mining operations. Particulate emissions from engine exhausts are considered negligible by comparison and have not been assessed. The assessment incorporated background levels of PM_{10} (11.0 µg/m^3), TSP (22 µg/m^3), $PM_{2.5}$ (3.3 µg/m^3) and deposited dust (1.6 g/m^2/month) (refer to Section 7.2.5.1). Ambient background concentrations of other criteria air pollutants, hazardous air pollutants and odour were considered to be negligible due to the inland location and lack of any concentrated form of emission sources (industrial, urban or combustion sources, intensive animal husbandry or wastewater).

Particulate matter has been assessed as:

- Total Suspended Particles (TSP). The Queensland Air EPP defines TSP as particles with an equivalent aerodynamic diameter (EAD) of less than or equal to 50 µm
- Particulate matter less than 10 µm in EAD (PM_{10})
- Particulate matter less than 2.5 µm in EAD ($PM_{2.5}$)
- Deposited particulate matter

7.2.3.1 Gaseous Compounds

Due to the inland location and lack of any concentrated form of emission sources (such as industrial, urban or combustion sources), the ambient background levels of gaseous pollutants was considered to be negligible, at a level of zero.

7.2.3.2 Odorous Compounds

Due to the inland location and lack of any concentrated form of emission sources (such as intensive animal husbandry or wastewater), the ambient background levels of odours was considered to be negligible, at a level of zero.

7.2.4 Sensitive Receptors

The assessment of impacts to air quality is carried out by determining whether ground-level concentrations of air pollutants, released from the Project (Mine) in combination with ambient background levels, meet the air quality objectives at sensitive places.

Sensitive places may be defined as:

- A dwelling, mobile home or caravan park, or other residential premises
- A motel, hotel or hostel
- A kindergarten, school, university or other educational institution
- A medical centre or hospital
- A protected area

- A public park or gardens
- A commercial place or part of the place potentially affected

It includes the immediate surrounds of any such place and any place known or likely to become a sensitive place in the future.

Eight existing sensitive receptors were identified for the Project (Mine), as summarised in Table 7-2 and illustrated in Figure 7-14 as numeric receptors 1 (Mellaluka), 2 (Bygana), 6 (Doongmabulla), 17 (Carmichael), 18 (Moray Downs), 20 (Cassiopeia), 28 (Beenboona) and 32 (Lignum). These are currently established sites for which the ambient air quality was assessed with regards to existing air quality and impacts on them of emissions from the Mine and the short section of the railway line present inside of the modelled domain.

The existing Labona Homestead, situated within the mine area, has been acquired by the proponent and will be removed at commencement of mining operations. Consequently, potential air quality impacts at Labona have not been assessed.

Future sensitive receptors were also identified at the site of Project (Mine) offsite infrastructure. Project (Mine) offsite infrastructure comprising a workers accommodation village, permanent airport and heavy industrial area is proposed to be established east of the Mine and adjacent to the Project (Rail). The Project (Mine) offsite infrastructure is represented in Table 7-2 by the seven alpha-numeric receptors, Vc (Village centre), V1 (Village north west), V2 (Village south west), A1 (Airport terminal), I1 (Industrial Zone rail centre), I2 (Industrial Zone north west) and I3 (Industrial zone south west). These receptors were located at points on Project (Mine) offsite infrastructure facing the Mine and Project (Rail).

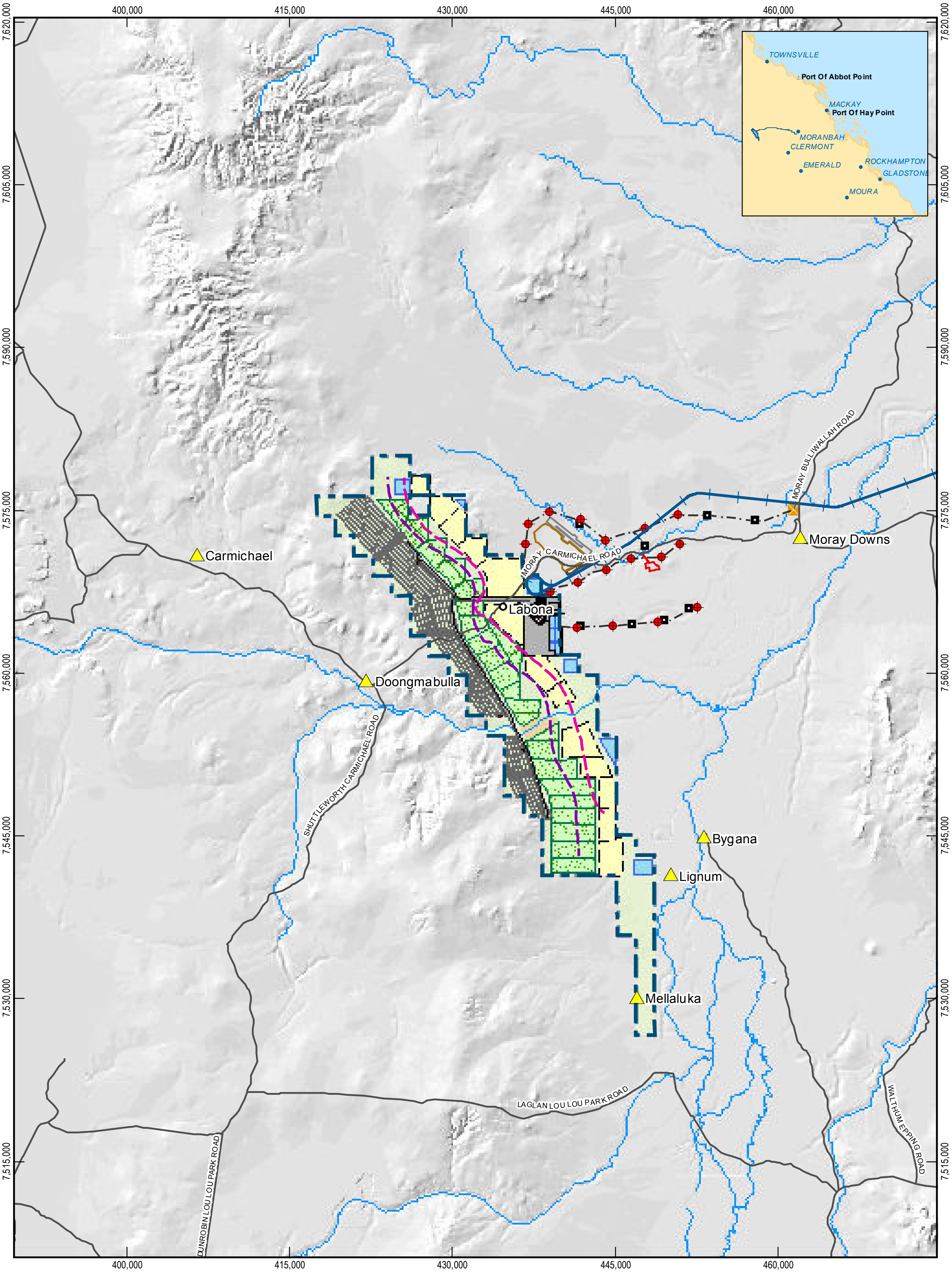
Potential impacts at the eight existing sensitive receptors in addition to the seven receptors representing the Project (Mine) offsite infrastructure were assessed under the same methodology.

The Mine site is situated in a remote area of the Galilee Basin, making the nearest existing sensitive receptors greater than three kilometres from mining activities. The receptors 18 (Moray Downs), 20 (Cassiopeia) and 28 (Beenboona) on the eastern side of the Mine are the furthest from mining activities. However, these receptors have been included in the assessment due to their proximity to the railway line, and their potential to receive cumulative impacts from Mine and Project (Rail) activities. As such, the combined effect of emissions from Project (Mine) activities with windblown coal dust from the Project (Rail) were addressed to the extent that dust contours from the Project (Mine) and Project (Rail) overlap.

Figure 7-14 shows the location of the identified sensitive receptors for the Project (Mine) air quality assessment. Bimbah East, Moonoomoo and Albinia homesteads (refer to Volume 2 Section 2 Project Description) were not considered sensitive receptors as they were a significant distance from modelled dispersion contours (refer to Volume 4 Appendix Mine Noise and Vibration Report).

Table 7-2 **Summary of Sensitive Receptors**

ID	Name	Distance (m)	Nearest Feature	Easting (km)	Northing (km)
1	Mellaluka	11,800	Mine Site	446.973	7530.251
2	Bygana	7,800	Mine Site	453.157	7544.999
6	Doongmabulla	7,100	Mine Site	422.016	7559.462
17	Carmichael	16,900	Mine Site	406.412	7571.007
18	Moray Downs	3,298	Rail Segment	462.027	7572.602
20	Cassiopeia	3,090	Rail Segment	475.674	7575.617
28	Beenboona	5,786	Rail Segment	468.989	7582.756
32	Lignum	4,800	Mine Site	450.080	7541.530
Vc	Village Centre	2950	Rail Segment	448.412	7569.905
V1	Village north west	2400	Rail Segment	447.835	7570.065
V2	Village south west	3180	Rail Segment	448.219	7569.456
A1	Airport Terminal	3180	Rail Segment	440.512	7572.324
I1	Industrial Zone rail centre	660	Rail Segment	441.505	7570.081
I2	Industrial Zone north west	2,800	Mine Site	437.708	7572.132
I3	Industrial Zone south west	660	Rail Segment	440.304	7569.536



LEGEND

- Sensitive Receptor
- Local Road
- River / Watercourse
- AB1 Cropline
- D1 Cropline
- Overland Conveyors
- Rail (West)
- Mine (Onsite)
- Open Cut Blocks
- Out of Pit Waste Dumps
- Water Management Dams
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:500,000 (at A4)

0 5 10 15

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Nearest Receptor Locations with respect to CALPUFF Modelled Layout

Job Number	41-25215
Revision	B
Date	06-11-2012

Figure 7-14

G:\41\25215\GIS\Maps\MXD\700_Environment\41-25215_724_rev_b.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GHD: Sensitive Receptors (2012); GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure, Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: JVC

7.2.5 Baseline Monitoring Results

Ambient air quality monitoring is generally carried out in regions of significant population and where that population may be exposed to significant quantities of air pollutants from a range of sources such as motor vehicle traffic and industry including mining. For the Carmichael Coal Mine, its remote location in the Galilee Basin means that ambient monitoring has not been undertaken anywhere in the broader region.

In the absence of available site specific air quality data and to characterise the ambient background concentrations of the key air pollutant of interest for this study, i.e. particulate matter, and to carry out a impact assessment a review of publicly available information was conducted. The review included monitoring undertaken by the Queensland Government, and data provided in environmental impact assessments for other projects in representative rural regions.

7.2.5.1 Particulates

As noted above, there is a lack of publically available datasets that concern particulate matter levels in the general region of the Galilee Basin. Further east there is some data on existing and proposed projects in the Bowen Basin as well as data available from monitoring undertaken by the Queensland Government at west Mackay and Townsville (further north) on the coast. The available data identified for use in this assessment was for ambient concentrations of PM_{10} and dust deposition rates. Comparable background information for TSP and the finer $PM_{2.5}$ dust fractions were derived by use of suitable ratios found for agricultural use dominated dust sources.

The Caval Ridge Air Quality Impact Assessment Report (URS 2009) in the Moranbah region provides statistics for up to 18 months of PM_{10} monitoring. During a monitoring period involving two dry seasons, April 2007 to October 2008, homestead sites generally upwind of mining operations had a 70th percentile statistic of 11.0 µg/m^3. While the Project (Mine) area has a drier climate than the Bowen Basin, there are less existing mining operations and other anthropogenic sources that contribute significantly to dust generation in that region. By comparison Queensland Government monitoring in urban centres indicates higher concentrations of PM_{10}, such as 26 µg/m^3 at west Mackay (PAE-Holmes 2011) or a 75th percentile of 16.2 µg/m^3 at Townsville (DERM 2011). Both Mackay and Townsville are situated in coastal areas, are significant industrial hubs and have a significant motor vehicle fleet due to their large population in comparison to the Project (Mine) area. Consequently, the Caval Ridge Mine Air Quality Impact Assessment Report value of 11.0 µg/m^3 has been used for the assessment.

To determine background TSP levels, a PM_{10} to TSP ratio of 50 per cent is preferred for ambient conditions for the Project (Mine). This is due to the location where a higher proportion of suspended matter will originate from dust rather than from the main sources of the finer particles associated with the sources that are industrial or combustion related. A background TSP level of 22 µg/m^3 was adopted for the assessment.

For the respirable particle fraction of $PM_{2.5}$, it is considered that a background $PM_{2.5}$ level can be based on a ratio to the background PM_{10} level. However, even with well documented studies involving co-located instruments, the ratio has been shown to vary "*depending on season and location, and can range from 0.3 to 0.9*" (NEPC 2002, p.5) across a range of conditions within Australia. Since the Project (Mine) is remote from urban populations, involving high emission contributions from vehicle and other combustion process, the ratio of $PM_{2.5}$ to PM_{10} used in this report is at the lower estimate from the NEPC work of 30 per cent. The adopted $PM_{2.5}$ background level for the Project (Mine) has therefore been set at 3.3 µg/m^3.

To characterise the background level of deposited dust, the Ensham Central Project (Katestone 2006) within the Bowen Basin (to the east of the Galilee Basin) was assessed as having the most comprehensive data in the publically available literature. The Ensham Central Project EIS reported on a number of dust deposition monitoring sites around the Ensham Coal Mine, one of which showed consistently low deposition rates thought to be representative of places relatively unaffected by coal mining activities. As such this site which would therefore be appropriate to represent the true ambient 'background' away from existing mine and other sources (such as found currently in the Galilee Basin). The rolling annual average ranged from 0.09 to 1.6 g/m^2/month with the conservatively highest level assumed for this assessment.

7.2.5.2 Other Minor Air Pollutants

Due to the inland location and lack of any concentrated form of emission sources (such as industrial, urban or combustion sources, intensive animal husbandry or wastewater), ambient background concentrations of other criteria air pollutants, hazardous air pollutants and odour were considered to be negligible. These air pollutants will also be emitted from the Project (Mine) in very small quantities. Consequently, Project (Mine) emissions of these substances and the background levels have not been quantitatively assessed.

7.3 Potential Impacts and Mitigation

7.3.1 Overview

Sources of particulate emissions associated with Project (Mine) construction and operation were identified from the Mine Plan and based on experience with the assessment of air quality impacts from mining for three phases of mining operations over the 90-year life of the project. For the purposes of the air quality assessment, construction and operation of the Mine are considered to be part of the same process and take place concurrently. Consequently, they have been assessed simultaneously and presented as a combined impact.

7.3.1.1 Project (Mine) Activities

Particulate emissions are generated during the following mining activities:

- Blasting
- Land clearing and removal and stockpiling of soil from the OCM pits
- Removal of overburden by truck-shovels
- Removal of overburden by bulldozer
- Removal of overburden by draglines
- Excavators mining coal and loading haul trucks
- Loading of haul trucks with overburden
- Transportation of coal by haul truck to nearest Run-Of-Mine (ROM) pad
- Transportation of overburden by haul truck to nearest waste dump
- Dumping of waste material at nearest out of pit waste dumps
- Coal handling (loading, unloading etc.) at the open cut mine and UGM ROMs
- Coal handling at the coal handling preparation plant (CHPP)

- Underground mine venting
- Primary, secondary and tertiary crushing of coal
- Coal conveying from northern and southern ROMs to Central ROM
- Wind erosion from active coal stockpiles
- Wind erosion from exposed waste dumps (including soil stockpiles)
- Wind erosion from active OCM pits
- Train loading
- Dust emissions from train transport of coal within the vicinity of mine
- Grading of haul roads, waste dumps and OCM pits

7.3.1.2 Emissions Estimation

Particulate emissions have been estimated from information provided in the Mine Plan and emission factors published in the NPI Emission Estimation Technique Manual for Mining (NPI, 2011) and United States Environmental Protection Agency (US EPA) AP-42 documents. An emissions inventory was first developed for uncontrolled particulate emissions from mine operations, with an initial dispersion modelling assessment indicating that mitigation and control measures would be necessary for a range of dust generating activities. Consequently, the methods and findings presented in this report illustrate the assessment of air quality impacts for the Project (Mine) associated with dust generating mine activities and the application of a range of dust mitigation and control measures identified in the NPI and AP-42 literature. Emissions from the Project (Mine) offsite infrastructure will be assessed during the detailed design phase.

As discussed in Section 7.1.3.3, meteorological and dispersion modelling was conducted using the MM5/CALMET/CALPUFF model suite. Modelling has been carried out for each hour of the selected year, 2007, and ground-level concentrations of particulate matter have been predicted at locations across the modelled grid and sensitive receptors. An evaluation of the meteorological model data found that the distributions of wind speed, wind direction and atmospheric stability were in reasonable agreement with information from other regional observations and the conditions considered likely to be experienced in the Project (Mine) location. Consequently, the model and study approach was considered to be suitable for the assessment of impacts under worst case dispersion conditions at the Mine. The predicted maximum ground-level concentrations of particulate matter from Mine activities emissions have been assessed inclusive of background levels, as either suspended or deposited particles in various particle size fractions (TSP, PM_{10} and $PM_{2.5}$), and compared against the air quality objectives at sensitive receptor locations.

7.3.2 Emission Sources

7.3.2.1 Unit Operations

The dust from the operations at the Mine was divided into eight different categories based on their source. These are summarised as:

- OCM pits
- ROM pads
- Haul roads

- CHPP
- Coal transfer points
- Waste dumps, including soil stockpiles
- Railway line
- Underground mine infrastructure

Wind erosion was considered as a completely separate source type due to its dependency on wind speed.

7.3.2.2 Particulate Emission Assumptions and Calculation

The general equation used to estimate TSP, PM_{10} and $PM_{2.5}$ emissions from mining activities is described mathematically as:

$$E_i = A \times EF_i \times \left(\frac{100 - CE}{100}\right)$$

Where:

E_i = Emission rate of pollutant *i* (kg per activity)

A = Activity data (units dependent on emission factors)

EF_i = Uncontrolled emissions factor for pollutant *i* (kg per activity)

CE = Control efficiency (%)

Activity data is usually dependent on the amount of soil moved as kilograms of TSP/PM_{10} per tonne of material or on the total distance of a vehicle travelled (Vehicle Kilometres Travelled, VKT). Therefore, a reduction in the total gross amount of earth processed, or in the total number of kilometres travelled by vehicles will reduce emissions. It should be noted that NPI (2011) emission factors for particulate emissions are independent of vehicle speeds except for dust emissions from small vehicle movements, i.e. 4WD's, utility vehicles and graders.

The NPI (2011) does not contain emission factors for $PM_{2.5}$ associated with mining operations. Therefore, emissions of $PM_{2.5}$ have been estimated as 25 per cent of TSP from coal sources and 11.6 per cent of TSP from overburden sources. These values are conservative when compared against other reported values in EIS coal projects for the region (PAE-Holmes, 2011, p.7), which applies a generic value of 12.5 per cent of PM_{10}. The overburden value was based on site specific measurements, while the coal value is based on industry standard.

The moisture content for coal and overburden used in this modelling is described as follows:

- Coal: 16 per cent (Runge 2011)
- Overburden: 2 per cent (PAE-Holmes, 2011, p.A-7)

The silt content for the modelling was based on results from a medium intensity (1:100,000) soil survey over EPC1690 and associated soil testing, which put the average silt content for the surveyed area at 7.7 per cent (see Volume 4 Appendix L Mine Soils Assessment). The average silt content for EPC1690 was judged a conservative estimate for dust modelling purposes over the Project (Mine), including EPC1080. This will be confirmed as part of surveys of EPC1080 during detailed design of the Project (Mine).

The calculation of particulate emissions associated with wind erosion from a surface is a function of silt content, the number of days per year when the rainfall is greater than 0.25 mm and the percentage of the time when the wind speed is greater than 5.4 m/s at the mean height of a stockpile. Although Twin Hills and Hughenden were sufficient to characterise the climate of the Project (Mine), the Clermont Post Office BoM station was judged to have a longer and more current record of rain days per annum, for the purpose of quantifying the dust management requirement. The mean number of rain days at Clermont Post Office was 57.2. Analysis of the CALMET data indicates that the wind speed is greater than 5.4 m/s (at a reference height of 10 m) 1.53 per cent of the time. This 1.53 per cent value is conservative since most wind erosion takes place at ground level, where the wind speed is lower.

Furthermore, wind erosion was modelled as wind speed dependent, based on a third order relationship with respect to wind speed. That is:

$$EF_i = kU^3$$

Where:

EF_i = Uncontrolled emissions factor for pollutant *i* (kg per hectare per year)

U = the wind speed at the reference height of 10 m and

k = a proportional constant to maintain total annual emissions as constant.

In effect, the annualised emissions as determined by AP-42 are distributed throughout the year based on a wind dependent relationship. As the dispersion model CALPUFF does not allow a continuous function with respect to wind speed to be entered via the DEFAULT methods, a “binned” approach to the wind erosion EF’s was determined.

Details of emission factors for uncontrolled particulate emission, emission control efficiencies and emission rates for each source are summarised and presented in Volume 4 Appendix S Mine Air Quality Assessment Technical. A summary of the emission sources and key assumptions for the estimation of particulate emission rates from the Project (Mine) are discussed below.

Open Cut Mine Operations

The following activities were identified as occurring inside of the OCM pits.

- Draglines on overburden
- Bulldozers on overburden
- Bulldozers on coal
- Loading overburden onto trucks
- Loading coal onto trucks
- Blasting
- Graders

The dust emissions from the OCM operations were based on the information provided in the Mine plan. This specified the amount of material (overburden and coal) that was estimated to be moved and the number and type of operational equipment for each year that the Mine was operational. The following emissions factors for identified activities were applied to the OCM operations:

- Dragline emissions were based on the NPI (2011) default values, as an alternative calculation method could not be used as bucket drop heights were not known. The amount of earth moved by the draglines, Bank Cubic Metres (bcm), was sourced from the Mine Plan.
- Bulldozer operations were based on the estimated number of operational hours and the number of operating vehicles contained in the Mine plan. As both silt and moisture content were known, the most accurate method to estimate dust emissions was by the use of the equations as opposed to the default values.
- Loading overburden into haul trucks was assumed to be undertaken by front end and shovel loaders. The NPI Mining equations (NPI, 2011, equations 10 and 11) were applied as information regarding the average moisture content and the average wind speed were known. The amount of overburden moved was provided in the Mine Plan. This method was considered conservative as wind speeds inside the pit are likely to be lower than those outside of it, where the average wind speed was determined. Furthermore, the assumed overburden moisture content of 2 per cent is unlikely to be representative of moisture levels at depths beyond 30 cm, at which can be rapidly removed using modern earth moving equipment.
- For estimation of the dust emissions from the excavating and loading coal into haul trucks, the default NPI (2011) values were used. Application of the NPI equations (12 and 13) were investigated, however, for the high moisture content coal (at 16 per cent), the equations predicted TSP emissions to be greater than PM_{10}. Therefore, for high moisture content coal, the NPI (2011) supplied equations (NPI, 2011, equations 12 and 13) are considered unreliable compared to the default values. The total amount of coal moved was supplied by the Mine plan.
- Blasting emissions were modelled as evenly distributed throughout the year (every second day) across active OCM pits. The NPI emissions factor for TSP (equation 19) was applied. As per the NPI, PM_{10} was assumed to be 52 per cent of TSP. $PM_{2.5}$ was assumed to be 50 per cent of PM_{10}.
- Dust emissions from grader operations were estimated from the number of operational hours of all graders and an average grader speed of 5 km/h, which was used to estimate annual VKT. The total earth moved (overburden and coal) in the OCM pits was assumed to be evenly distributed across all of the active pits.
- Operational equipment hours inside the OCM pits, as defined in the Mine plan (Runge 2011), were evenly distributed across all active OCM pits.

Detail of Project (Mine) emissions estimates is provide in Appendix B of Volume 4 Appendix S Mine Air Quality Report.

Run-of-Mine Pads

The following activities were identified as occurring at the Run of Mine (ROM) pads:

- Loading ROM stockpiles
- Unloading ROM stockpiles

Wind erosion from stockpiles was considered as a separate item.

ROM pad activities are summarised as follows:

- Three ROM pads will be in operation for the duration of mining operations, north, south and central.

- It was assumed that all coal from either the UGM or the OCM pits would be processed at the closest ROM pad to which the coal was mined.
- Coal would be conveyed to the CHPP where it would be put through the crushers and loaded onto a train using a “just-in-time” process.
- Minimal stockpiling, especially at the northern and southern ROM pads was assumed. This removed the need for haul truck dumping onto a stockpile prior to a front-end loader loading the conveyor. Consequently, this eliminated a potential dust source.

Emissions from the ROM pads were assumed to be evenly distributed, unless otherwise specified, i.e. south ROM not operational in 2016. Default NPI (2011) dust emission factors were applied.

Haul Roads

The following assumptions were made regarding haul road dust emissions:

- Dust emissions from haul roads were assumed to be 100 per cent generated from the movement of large haul vehicles.
- Wind erosion emissions from the haul roads were not modelled as it was assumed that the haul roads would be within the confines of either an OCM pit or a waste dump, and consequently, haul road wind erosion emissions were not double accounted.
- Dust emissions from haul truck movement were assumed to originate from either an OCM pit or a waste dump source.
- Emissions were assumed to be evenly distributed across all of the active OCM pits and waste dumps as specific haul road paths have not been determined at this time, and would be likely to change during the Mine’s entire planned operation.
- The dust generated from the movement of light vehicles was not modelled as:
  - It was considered negligible in comparison to the heavy vehicle emissions.
  - For safety, it is unlikely that frequently traversed light vehicle roads would be combined with haul truck routes.
- Haul trucks were modelled with an empty weight of 65 tonnes, and a payload capacity of 175 tonnes (full load weight of 240 tonnes). NPI (2011) emission factors for mining, unlike previous NPI Mining Manual versions, separates heavy and light vehicle wheel generated dust into separate categories. The default values specified in the NPI (2011) were deemed inappropriate for use as they are based on an assumption that the average vehicle weight (mass) is 48 tonnes. As the average haul truck mass for the Project (Mine) is predicted to be over 150 tonnes, the application of the default values represents a gross under-estimate of dust emissions.
- The VKT of the haul trucks was estimated using information for the truck capacity, the amount of overburden and coal removed from the OCM pits and the distance between the OCM pit and the nearest ROM pad or waste dump. It was assumed that the coal and overburden removal was evenly distributed to all of the active OCM pits and waste dumps.

Some haul trucks may have a full load weight of 550 tonnes.. It is estimated that VKT will be lower for these trucks as they will require fewer trips between the OCM pits, ROM pad and waste dump for a given quantity of overburden or coal. As such, actual PM_{10} dust emissions from haul road trucks are likely to be lower than predicted.

Coal Handling Preparation Plant

The following activities were identified as occurring at the Coal Handling Preparation Plant (CHPP):

- Loading primary crusher
- Primary crushing
- Secondary crushing
- Tertiary crushing

Wind erosion from any stockpiles or exposed surfaces was considered as a separate item.

The following assumptions were made regarding CHPP dust emissions:

- The default NPI (2011, Table 3) emission factor for each process was assumed.
- The coal is considered as "high moisture" content (NPI 2011, p.60).
- Screening processes for the coal occur at the CHPP. However, as per NPI (NPI 2011, p.60) "…*emissions from a primary crushing activity include emissions from the screens, the crusher, the surge bin, the apron feeder, and conveyor belt transfer points that are integral to the crusher*."

Coal Transfer Points

The following activities were identified as occurring at coal transfer points:

- Conveyor transfers
- Loading to trains

Default NPI (NPI 2011) emission factors for each activity were assumed.

Waste Dumps and Soil Stockpiles

The following activity was identified as occurring at waste dumps and soil stockpiles.

- Dumping of overburden

The default NPI (2011) factor was assumed for this activity.

Wind erosion from the exposed areas of the waste dumps was considered as a separate item.

Dust emissions from grader operations were modelled at the waste dumps; however, they were calculated for OCM operations and assumed to be equally distributed between the Mine and the waste dumps.

Railway Line

Dust emissions from the railway line were limited to those associated with windblown coal dust from the train as it moves away from the mine, fully loaded. The emission factor of coal dust from the train motion was calculated using the equation detailed in Connell-Hatch (2008), as shown below:

$$EF_{train} = 0.0000378(V)^2 - 0.000126(V) + 0.000063 \quad \text{[g/km/tonne of coal]}$$

Where V is the speed of the train (km/h)

Wind erosion from exposed areas of the railway line was not considered as a dust source as any exposed areas during the construction phase are likely to have been revegetated by the time operations

commence.

The railway line was modelled in CALPUFF as 10 segments, most of which were approximately 4 km in length, representing the nominal 40 km path from the Mine to the edge of the CALPUFF model domain. Dust emissions from the Project (Rail) were calculated based on the average speed of the train through each section of the railway line. The train was modelled at a nominal start speed of 10 km/h on leaving the Mine before reaching a maximum speed of 80km/h approximately 5.5 km away.

Underground Mine Infrastructure

The following assumptions were made regarding dust emissions associated with UGM infrastructure:

- Dust emissions from the UGM were assumed to be from the exhaust ventilation system and a single conveyor transfer point from the UGM to the overland conveyors.
- NPI (2011) default values were applied to the conveyor transfer point dust emissions, with the mass of coal for each of the three UGM infrastructure points as specified in the Mine plan.
- Exhaust ventilation for the UGM was based on dust concentration measurements for an existing UGM operated by Illawarra Coal (PAE-Holmes, 2010). This information has been used in previous EIS air quality assessments (PAE-Holmes, 2011) and is considered conservative due to the higher UGM ventilation rates associated with more gassy underground mines in the Illawarra region. The calculated dust mass emissions rates for the Illawarra Coal mine were scaled pro-rata with the extracted coal capacity difference of the mine and that estimated for the Project (Mine) UGM.

7.3.2.3 Particulate Emission Mitigation and Control Efficiencies

Particulate emission mitigation and control options were identified in the NPI and US EPA literature and have been assumed and modelled for each of the sources identified at each phase of the Mine operations. Some processes have no controls, while other particulate emission sources can be completely removed through the application of full enclosures. The control efficiencies used in developing the emissions inventory for the air quality assessment are presented in the Volume 4 Appendix S Mine Air Quality Assessment.

Pit Retention Factors

Pit retention factors were applied to all dust sources, including wind erosion, from within any OCM pit. NPI (2011) default pit retention factors are applied to all pit emissions based on the following reduction factors:

- TSP – 50 per cent pit reduction
- PM_{10} – 5 per cent pit reduction
- $PM_{2.5}$ – 5 per cent pit reduction

This includes 50 per cent of the emissions from the following sources:

- Haul roads
- Bulldozers on overburden
- Graders

7.3.2.4 Summary of Total Modelled PM_{10} Emissions by Operational Scenario

Three scenarios were modelled to represent the dust emissions from Mine operations during its projected 90-year lifespan. These are identified as Start-up, Full Operations and Maximum Emissions (refer to Section 7.1.3.1). A summary PM_{10} for each scenario is provided in Table 7-3.

Table 7-3 Summary of PM_{10} Dust emissions with Maximum Controls Applied (Excluding Wind Erosion)

Phase	Uncontrolled Production Emissions (tonne/y)	Controlled Production Emissions (tonne/y)	Percentage Reduction (%)
Start-up	12,352	2,853	77
Full Operations	25,497	6,968	73
Maximum Emissions	32,427	8,648	73

7.3.3 Impacts to Humans

Predicted ground-level concentrations of PM_{10}, $PM_{2.5}$, TSP and deposited dust have been presented for mine emissions both in isolation and combined with ambient background concentrations (combined impact) at sensitive receptor locations. The air quality assessment has been made by the comparison of the predicted combined impact at sensitive receptor locations against the relevant air quality objectives identified for the project. The Air EPP defines air quality objectives such that indicator pollutants do not affect various environmental values. The main indicator pollutant of concern for a coal mining project is particulate matter, and the health and wellbeing of humans is the environmental value of concern.

7.3.3.1 Assessment of Ambient PM_{10} Levels

The predicted maximum 24-hour average ground-level concentrations of PM_{10} are presented for each phase of the Mine operations in Table 7-4, Table 7-5 and Table 7-6, respectively. A constant 70th percentile background level of 11 µg/m³ has been included for the assessment.

Ambient PM_{10} levels have been assessed with regards to Air EPP, including a maximum ambient level criterion of 50 µg/m³ (including background) with an averaging period of 24 hours. There is an exceedence allowance of five days per annum, which is designed to take into account high background dust levels due to 'natural events' such as dust storms and bushfires. For all three phases, no sensitive receptor exceeds the PM_{10} GLC criterion of 50 µg/m³. During the maximum emissions phase, the Lignum homestead equals the PM_{10} GLCs criterion of 50 µg/m³.

Table 7-4 Start-Up Phase (2016) – Existing Sensitive Receptor Predicted PM_{10} GLCs

ID	Name	Maximum Predicted Incremental PM_{10} (24hr avg) (µg/m³)	Background PM_{10} (µg/m³)	Maximum Total PM_{10} (24hr avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	4	11	15	30
2	Bygana	5	11	16	32
6	Doongmabulla	13	11	24	49
17	Carmichael	9	11	20	39
18	Moray Downs	8	11	19	38

20	Cassiopeia	3	11	14	29
28	Beenboona	6	11	17	34
32	Lignum	7	11	18	36

Note: Criterion = 50 µg/m³ (24 hour average)

Table 7-5 Full Operations Phase (2037) – Existing Sensitive Receptor Predicted PM_{10} GLCs

ID	Name	Maximum Predicted Incremental PM_{10} (24hr avg) (µg/m³)	Background PM_{10} (µg/m³)	Maximum Total PM_{10} (24hr avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	20	11	31	61
2	Bygana	21	11	32	64
6	Doongmabulla	27	11	38	76
17	Carmichael	17	11	28	56
18	Moray Downs	16	11	27	54
20	Cassiopeia	12	11	23	45
28	Beenboona	12	11	23	46
32	Lignum	25	11	36	71

Note: Criterion = 50 µg/m³ (24 hour average)

Table 7-6 Maximum Emissions Phase (2067) – Existing Sensitive Receptor Predicted PM_{10} GLCs

ID	Name	Maximum Predicted Incremental PM_{10} (24hr avg) (µg/m³)	Background PM_{10} (µg/m³)	Maximum Total PM_{10} (24hr avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	30	11	41	83
2	Bygana	24	11	35	70
6	Doongmabulla	24	11	35	71
17	Carmichael	12	11	23	46
18	Moray Downs	15	11	26	52
20	Cassiopeia	12	11	23	47
28	Beenboona	12	11	23	46
32	Lignum	39	11	50	100

Note: Criterion = 50 µg/m³ (24 hour average)

Project (Mine) Offsite Infrastructure

The Project (Mine) workers accommodation village is situated 6.1 km east of the Mine site. As mine workers will be off-duty when occupying the workers accommodation village it is considered a dwelling, separate to the Mine site. As such air quality at the workers accommodation village was assessed against the objectives of the Air EPP. The permanent airport and heavy industrial area are considered commercial or public spaces. As such air quality at the permanent airport and heavy industrial area were also assessed against the objectives of the Air EPP. Sensitive receptors were selected for Project (Mine) offsite infrastructure (refer to Section 7.2.4).

Predicted 24-hour average ground-level concentration statistics for PM_{10} at the workers accommodation village, permanent airport and industrial were modelled. Results for the most affected sensitive receptors for each piece of Project (Mine) offsite infrastructure are presented and assessed against the relevant objective of the Air EPP in Table 7-7. During start-up (2016), only the NW corner of the heavy industrial area is predicted to exceed 50 µg/m^3, but the number of exceedences is within objectives of the Air EPP. During full operations (2037), the industrial area is predicted to exceed 50 µg/m^3 more often than allowed by the Air EPP objective. During maximum emissions (2067), the permanent airport is also expected to exceed the objectives of the Air EPP. At no point is it predicted that the workers accommodation village will exceed the objectives of the Air EPP.

An environmental management plan for the Project (Mine) will be designed and implemented to manage compliance with the Air EPP objectives at the workers accommodation village and other potentially affected sensitive receptors.

Table 7-7 Project (Mine) Offsite Infrastructure Exposure to GLCs of PM_{10}

Zone	Village	Village	Airport	Industrial	Industrial
Location	SW corner	NW corner	Terminal (centre)	NW corner	SW corner
ID	V2	V1	A1	I2	I3
Coords (mE, mN)	(448,219, 7,569,456)	(447,835, 7,570,065)	(440,512, 7,572,324)	(437,708, 7,572,132)	(440,304, 7,569,536)
Start-up (2016)					
Max PM_{10}	27.9	28.7	45.2	58.4	43.0
Full Operations (2037)					
Max PM_{10}	40.0	40.6	68.7	76.5	80.9
Maximum Emissions (2067)					
Max PM_{10}	40.8	42.1	66.3	73.9	74.9

NOTE: Village centre and Industrial centre (rail siding) not reported due to levels being lower than corresponding locations above.

7.3.3.2 Assessment of Ambient $PM_{2.5}$ Levels

The predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ are presented for each phase of the Mine operations in Table 7-8, Table 7-9 and Table 7-10. A constant 70th percentile background level of 3.3 µg/m³ has been included for the 24-hour and annual average cumulative assessments. The assessments of the 24-hour and annual average ground-level concentration of $PM_{2.5}$ are presented for each phase of the Mine operations in Table 7-11, Table 7-12 and Table 7-13. The assessment has been made against the Air EPP objectives of 25 µg/m³ and 8 µg/m³, respectively.

No existing sensitive receptor is predicted to exceed the 24-hour average Air EPP objective, with the predicted maximum cumulative impact at any sensitive receptor equal to 88 per cent of the objective at 32 (Lignum) during the maximum emissions phase. No existing sensitive receptor is predicted to exceed the annual average Air EPP objective, although it is expected to be equalled at 6 (Doongmabulla) during the full operations phase (2037). Similar to the assessment of ambient PM_{10} levels (refer to Section 7.3.3.1), predicted $PM_{2.5}$ levels at the NW corner of the heavy industrial area and permanent airport increasingly exceed the 24-hour Air EPP objective as the Project (Mine) progresses. No future sensitive receptor is predicted to exceed the annual average Air EPP objective. Results for the most affected sensitive receptors at each piece of Project (Mine) offsite infrastructure are presented.

Table 7-8 Start-Up Phase (2016) – Summary of Sensitive Receptor Predicted 24-hour average $PM_{2.5}$ GLCs

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (24 hr avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (24 hr avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	2.0	3.3	5.3	21
2	Bygana	2.4	3.3	5.7	23
6	Doongmabulla	6.4	3.3	9.7	39
17	Carmichael	4.0	3.3	7.3	29
18	Moray Downs	3.6	3.3	6.9	27
20	Cassiopeia	1.5	3.3	4.8	19
28	Beenboona	2.8	3.3	6.1	24
32	Lignum	3.2	3.3	6.5	26
V1	Village NW corner	8.2	3.3	11.5	46
A1	Airport Terminal	16.3	3.3	19.6	78
I2	Industrial Zone NW corner	22.5	3.3	**25.8**	**103**

Note: Criterion = 25 µg/m³ (24 hour average)

Table 7-9 Full Operations Phase (2037) – Summary of Sensitive Receptor Predicted 24-hour average $PM_{2.5}$ GLCs

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (24 hr avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (24 hr avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	9.3	3.3	12.6	50
2	Bygana	10.2	3.3	13.5	54
6	Doongmabulla	12.6	3.3	15.9	64
17	Carmichael	8.3	3.3	11.6	46
18	Moray Downs	7.6	3.3	10.9	43
20	Cassiopeia	5.9	3.3	9.2	37
28	Beenboona	5.8	3.3	9.1	36
32	Lignum	11.6	3.3	14.9	60
V1	Village NW corner	14.1	3.3	17.4	70
A1	Airport Terminal	28.3	3.3	31.6	126
I2	Industrial Zone NW corner	32.3	3.3	35.6	142

Note: Criterion = 25 µg/m³ (24 hour average)

Table 7-10 Maximum Emissions Phase (2067) – Summary of Sensitive Receptor Predicted 24-hour average $PM_{2.5}$ GLCs

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (24 hr avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (24 hr avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	14.0	3.3	17.3	69
2	Bygana	11.0	3.3	14.3	57
6	Doongmabulla	11.5	3.3	14.8	59
17	Carmichael	5.8	3.3	9.1	36
18	Moray Downs	7.1	3.3	10.4	42
20	Cassiopeia	6.3	3.3	9.6	38
28	Beenboona	5.6	3.3	8.9	36
32	Lignum	18.6	3.3	21.9	88
V1	Village NW corner	15.0	3.3	18.3	73

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (24 hr avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (24 hr avg) (µg/m³)	Percentage of EPP (%)
A1	Airport Terminal	26.5	3.3	29.8	119
I2	Industrial Zone NW corner	29.6	3.3	32.9	131

Note: Criterion = 25 µg/m³ (24 hour average)

Table 7-11 Start-Up Phase (2016) – Summary of Sensitive Receptor Predicted Annual Average $PM_{2.5}$ GLCs

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (Annual avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (Annual avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	0.1	3.3	3.4	42
2	Bygana	0.1	3.3	3.4	42
6	Doongmabulla	1.9	3.3	5.2	65
17	Carmichael	0.7	3.3	4.0	51
18	Moray Downs	0.2	3.3	3.5	44
20	Cassiopeia	0.1	3.3	3.4	42
28	Beenboona	0.1	3.3	3.4	43
32	Lignum	0.1	3.3	3.4	42
V1	Village NW corner	0.5	3.3	3.8	47
A1	Airport Terminal	1.2	3.3	4.5	56
I2	Industrial Zone NW corner	1.8	3.3	5.1	64

Note: Criterion = 8 µg/m³ (Annual average)

Table 7-12 Full Operations Phase (2037) – Summary of Sensitive Receptor Predicted Annual

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (Annual avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (Annual avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	0.4	3.3	3.7	46
2	Bygana	0.3	3.3	3.6	46
6	Doongmabulla	4.7	3.3	8.0	100

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (Annual avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (Annual avg) (µg/m³)	Percentage of EPP (%)
17	Carmichael	1.8	3.3	5.1	64
18	Moray Downs	0.7	3.3	4.0	50
20	Cassiopeia	0.2	3.3	3.5	44
28	Beenboona	0.4	3.3	3.7	46
32	Lignum	0.5	3.3	3.8	47
V1	Village NW corner	1.5	3.3	4.8	60
A1	Airport Terminal	2.7	3.3	6.0	75
I2	Industrial Zone NW corner	3.3	3.3	6.6	82

Note: Criterion = 8 µg/m³ (Annual average)

Table 7-13 Maximum Emissions Phase (2067) – Summary of Sensitive Receptor Predicted Annual Average $PM_{2.5}$ GLCs

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (Annual avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (Annual avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	0.6	3.3	3.9	49
2	Bygana	0.6	3.3	3.9	48
6	Doongmabulla	3.4	3.3	6.7	84
17	Carmichael	1.3	3.3	4.6	57
18	Moray Downs	0.8	3.3	4.1	51
20	Cassiopeia	0.2	3.3	3.5	44
28	Beenboona	0.4	3.3	3.7	46
32	Lignum	0.7	3.3	4.0	50
V1	Village NW corner	1.6	3.3	4.9	61
A1	Airport Terminal	2.7	3.3	6.0	75
I2	Industrial Zone NW corner	3.3	3.3	6.6	82

Note: Criterion = 8 µg/m³ (Annual average)

7.3.3.3 Assessment of Ambient TSP Levels

The predicted maximum annual average ground-level concentrations of TSP are presented for each phase of the Mine operations in Table 7-14, Table 7-15 and Table 7-16 respectively. A constant 70th percentile background level of 22 µg/m³ has been included for the annual average cumulative assessment.

The assessment of the annual average ground-level concentration of TSP has been made against the Air EPP objective of 90 µg/m³. There are no exceedences of the Air EPP objective, with the predicted maximum impact at any sensitive receptor equal to 36 per cent of the objective during the full operations phase. Predictions at all sensitive receptors, existing and future, for all phases of the Project (Mine) were compliant with the Air EPP objective. Results for the most affected sensitive receptors for each piece of Project (Mine) offsite infrastructure are presented.

Table 7-14 Start-Up Phase (2016) – Summary of Sensitive Receptor Predicted TSP GLCs

ID	Name	Maximum Predicted Incremental TSP (Annual avg) (µg/m³)	Background TSP (µg/m³)	Maximum Total TSP (Annual avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	0.1	22.0	22.1	25
2	Bygana	0.2	22.0	22.2	25
6	Doongmabulla	4.1	22.0	26.1	29
17	Carmichael	1.5	22.0	23.5	26
18	Moray Downs	0.4	22.0	22.4	25
20	Cassiopeia	0.1	22.0	22.1	25
28	Beenboona	0.3	22.0	22.3	25
32	Lignum	0.2	22.0	23.0	26
V1	Village NW corner	1.0	22.0	23.0	26
A1	Airport Terminal	2.5	22.0	24.5	27
I2	Industrial Zone NW corner	4.1	22.0	26.1	29

Note: Criterion = 90 µg/m³ (Annual average)

Table 7-15 Full Operations Phase (2037) – Summary of Sensitive Receptor Predicted TSP GLCs

ID	Name	Maximum Predicted Incremental TSP (Annual avg) (µg/m³)	Background TSP (µg/m³)	Maximum Total TSP (Annual avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	0.8	22.0	22.8	25
2	Bygana	0.7	22.0	22.7	25

ID	Name	Maximum Predicted Incremental TSP (Annual avg) (µg/m³)	Background TSP (µg/m³)	Maximum Total TSP (Annual avg) (µg/m³)	Percentage of EPP (%)
6	Doongmabulla	10.2	22.0	32.2	36
17	Carmichael	3.8	22.0	25.8	29
18	Moray Downs	1.5	22.0	23.5	26
20	Cassiopeia	0.4	22.0	22.4	25
28	Beenboona	0.9	22.0	22.9	25
32	Lignum	1.0	22.0	23.0	26
V1	Village NW corner	3.2	22.0	25.2	28
A1	Airport Terminal	5.8	22.0	27.8	31
I2	Industrial Zone NW corner	7.4	22.0	29.4	33

Note: Criterion = 90 µg/m³ (Annual average)

Table 7-16 Maximum Emissions Phase (2067) – Summary of Sensitive Receptor Predicted TSP GLCs

ID	Name	Maximum Predicted Incremental TSP (Annual avg) (µg/m³)	Background TSP (µg/m³)	Maximum Total TSP (Annual avg) (µg/m³)	Percentage of EPP (%)
1	Mellaluka	1.3	22.0	23.3	26
2	Bygana	1.2	22.0	23.2	26
6	Doongmabulla	7.6	22.0	29.6	33
17	Carmichael	2.8	22.0	24.8	28
18	Moray Downs	1.7	22.0	23.7	26
20	Cassiopeia	0.4	22.0	22.4	25
28	Beenboona	0.9	22.0	22.9	25
32	Lignum	1.5	22.0	23.5	26
V1	Village NW corner	3.4	22.0	25.4	28
A1	Airport Terminal	5.8	22.0	27.8	31
I2	Industrial Zone NW corner	7.3	22.0	29.3	33

Note: Criterion = 90 µg/m³ (Annual average)

7.3.3.4 Assessment of Deposited Dust

The predicted maximum incremental dust deposition rate is presented for each phase of the Mine operations in Table 7-17. The assessment has been made against the NSW Approved Methods (DEC, 2005) impact assessment criterion of 2 g/m²/month (annually averaged). No background level needs to be applied as the criterion is for the incremental deposition rate. For all three phases, each of the sensitive receptors were significantly below the assessment criteria as deposited dust levels were found to decrease rapidly beyond their source. Even with the addition of a background dust deposition of a conservative 1.6 g/m^2/month, deposited dust at all sensitive receptors is compliant with the 2 g/m²/month (annually averaged) criterion. Results for the most affected sensitive receptors at each piece of Project (Mine) offsite infrastructure are presented.

Table 7-17 Summary of Sensitive Receptor Predicted Incremental Deposited Dust

ID	Name	Predicted Incremental Deposited Dust (Annual average) (g/m²/month)		
		Start Up	Full Operations	Maximum Emissions
1	Mellaluka	0.001	0.004	0.012
2	Bygana	0.001	0.005	0.012
6	Doongmabulla	0.041	0.110	0.075
17	Carmichael	0.016	0.032	0.021
18	Moray Downs	0.003	0.009	0.010
20	Cassiopeia	0.002	0.007	0.007
28	Beenboona	0.003	0.012	0.012
32	Lignum	0.001	0.005	0.022
V1	Village NW corner	0.005	0.016	0.015
A1	Airport Terminal	0.024	0.038	0.038
I2	Industrial Zone NW corner	0.123	0.322	0.188

Note: Criterion = 2 g/m²/month (Annual average)

7.3.4 Impacts to Flora and Fauna

Connell Hatch (2008) carried out a literature review as part of the *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains*, which concluded that coal dust deposits on vegetation at the levels predicted in this impact assessment for the Project (Mine) are unlikely to affect the growth of vegetation or the palatability of feed for cattle livestock. The Connell Hatch (2008) report concluded that:

- *Mineral dusts, resulting from mining, quarrying, road operations, mineral processing, and wind erosion may be deposited on vegetation to the extent that they impede growth and threaten the survival of plants.*
- *Dusts that are chemically inert, or which do not markedly alter substrate pH, are generally effective [adversely affecting plant growth] if the dust load is greater than 5 g/m^2.*

- *Model calculations on a cotton crop suggest that dust loads of 5 g/m² or dust deposition rates of 500 mg/m²/day are unlikely to have a detectable effect on vegetative growth under the sunny conditions most conducive to cotton growth. A dust deposition rate of 1000 mg/m²/day is predicted to result in measurable reductions in crop growth during overcast weather, but the effect may be more difficult to detect in sunny weather.*
- *Cattle did not find feed unpalatable if coal mine dust was present at a level equivalent to a dust deposition rate of 4,000 mg/m²/day.*
- *The presence of coal mine dust in feed did not affect the amount of feed that the cattle ate or the amount of milk that the cattle produced at a level equivalent to a dust deposition rate of 4,000 mg/m²/day.*
- *Cattle did not preferentially eat feed that did not contain coal mine dust. The cattle were able to choose between feed that was free of coal mine dust, feed that contained 4,000 mg/m²/day of coal mine dust and feed that contained 8,000 mg/m²/day of coal mine dust.*

The dust deposition rates at sensitive receptors and in the areas beyond the boundary of the Project (Mine) area are predicted to be well below the impact assessment criteria and the levels that may affect crop growth and livestock feed palatability.

A discussion relating to impacts of dust generation on flora and fauna is provided in Volume 4 Appendix N Mine Terrestrial Ecology Report and Appendix O Mine Aquatic Ecology Report.

7.3.5 Management and Mitigation

7.3.5.1 Best Practice Dust Control

The following best practice dust control measures will be employed, where practical:

- Disturb only the minimum area necessary for mining and related activities
- Reshape topsoil and rehabilitate completed overburden dumps as soon as practicable
- Revegetate long term stockpiles not regularly used
- Clearly define edges of haul roads and designated paths on overburden dumps
- Revegetate dis-used haul roads
- Minimise hauling distance
- Set appropriate vehicle speed limits
- Limit the number of minor roads
- Water frequently used minor roads and if possible, seal
- Assess meteorological conditions prior to any blasting and delay (if possible) during periods of higher wind speeds
- Limit the activities and drop heights of draglines (if possible) during periods of high wind speed

7.3.5.2 Dust Monitoring

Dust monitoring will be undertaken to determine whether predicted emissions levels occur. In order to monitor background dust levels, a system of dust monitors will be installed upwind and downwind of the Project (Mine). Dust monitors will also be installed at sensitive receptors predicted to receive dust levels close to or reaching the Air EPP objectives. Dust monitoring will also be performed in the industrial area and permanent airport. By monitoring dust upwind of the Project (Mine), downwind of the Project (Mine) and at sensitive receptor locations, dust impacts will be quantified. The Carmichael AWS will record local wind conditions at the time of any high-dust event to inform future management measures. Management measures will be applied to mitigate emissions impacts wherever a criterion is shown to be exceeded.

7.3.5.3 Further Mitigation

The control measures applied to the potential emissions from the Mine operations are considered to be near to the maximum that could be practicably applied to a mine of such large capacity and physical size. Exceedence of some Air EPP objectives for some areas near the Mine site, as reflected in the predicted elevated dust levels at the proposed industrial zone and airport terminal to the east of the Mine and adjacent to the Project (Rail). Predicted PM_{10} and $PM_{2.5}$ also equal the Air EPP objective at a couple of homesteads during the full operations and maximum emissions phases. Where dust monitoring indicates actual or potential exceedences of dust criterion at any of the sensitive receptors, additional mitigation measures may include:

- Implementation of a dust management plan including the use of a meteorological forecasting system coupled with a dust impact index for the management and control of significant dust sources during adverse conditions.
- Sealing of haul roads with bitumen or similar
- Increased use of conveyors rather than trucks to move coal
- Use of conveyors to haul a proportion of overburden
- Application of a filtration system in underground mine vents

Increased use of conveyors for coal and overburden haulage would be expected to produce a substantial reduction in emissions. Such a system would entail the coal conveyor system being integrated into the OCM pits as currently exists in other coal mines, e.g. Loy Yang OCM in the Latrobe Valley, Victoria. As the amount of overburden removed is far greater than the amount of coal being extracted, estimated to be in excess of five to one in the year 2067, a substantial reduction in dust emissions due to haulage would be obtained.

7.4 Summary

An air quality impact assessment has been carried out according to the Project (Mine) ToR, using industry recognised emission calculation and dispersion modelling techniques, to predicted ground-level concentrations of important air pollutants associated with emissions from the Mine. The most important air pollutant associated with the Mine was found to be particulate matter generated through the disturbance, handling and transportation of soil matter including coal and overburden. Particulate matter concentrations at existing and future sensitive receptors identified in areas surrounding the Mine have been assessed as TSP, PM_{10}, $PM_{2.5}$ and deposited dust. Potential impacts at existing and future sensitive receptors were assessed against the air quality objectives of the Air EPP. Deposited dust was assessed against the NSW Approved Methods (DEC, 2005) criterion. Compared against the objectives, particulate matter concentrations are generally found to be acceptable.

The assessment of impacts to humans at existing sensitive receptors found that, with the inclusion of background levels, there are no exceedences of the air quality objectives predicted at sensitive receptor locations for PM_{10} (24-hour average), $PM_{2.5}$ (24-hour average and annual average), TSP (annual average) and deposited dust (monthly average) during the start-up, full operations and maximum emissions scenarios. However results indicated that the PM_{10} (24-hour average) criterion is equalled at receptor 32 (Lignum) in the maximum emissions scenario and the $PM_{2.5}$ (annual average) criterion is equalled at receptor 6 (Doongmabulla) in the full operations scenario. The assessment of future sensitive receptors found that the industrial zone exceeded the PM_{10} (24-hour average) criterion in the start-up scenario. Both the industrial zone and airport terminal exceeded the $PM_{2.5}$ (24-hour average) criterion and PM_{10} (24-hour average) criterion in the full operations and maximum emissions scenarios. The $PM_{2.5}$ (annual average) criterion, the TSP annual objective and the deposited dust objective were not exceeded at any future sensitive receptor in any scenario.

The assessment of impacts to flora and fauna found that the predicted levels of deposited dust were well below levels that may affect crop growth and livestock feed palatability.

Monitoring at this site will be undertaken during the commencement of operations to verify the model predictions. Management measures will be applied to mitigate emissions impacts wherever a criterion is shown to be exceeded.