# Appendix 5

# Air Quality Assessment

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ABN: 45 050 224 250

# Possum Brush Quarry

# Stage 2 Operations and the Modification of Development Consent DA 283/97

# Air Quality Assessment


Prepared by

Ramboll Environ Australia Pty Ltd



September 2015

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# Air Quality Assessment

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**September 2015**

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# EXECUTIVE SUMMARY

Pacific Blue Metal Pty Ltd (the Proponent) is seeking approval from the Secretary of Department of Planning and Environment for the ongoing operation of the existing Possum Brush Quarry (the Quarry) and to modify the existing Development Consent DA 283/97.

Ramboll Environ Australia Pty Ltd (Ramboll Environ) has been commissioned by RW Corkery & Co Pty Limited (RWC) on behalf of the Proponent to conduct an air quality assessment to review potential significance of the proposed increase in production to air quality impacts in the surrounding environment.

This air quality assessment addresses the following aspects.

- Characterisation of the existing environment, specifically the existing air quality, prevailing meteorology and regulatory context.
- Review of potential emission sources and mitigation measures.
- Calculation of annual particulate matter emissions from the Quarry.
- Atmospheric dispersion modelling of emissions for current and future operations at Quarry to predict potential particulate matter impacts at the surrounding sensitive receptor locations and determine the significance of the proposed increase to ambient air quality.

The focus of this assessment was emissions and associated impacts of particulate matter (TSP, $PM_{10}$ and $PM_{2.5}$). Annual emissions from the Quarry were estimated utilising published emission factors from the US-EPA AP-42 Air Pollutant Emission Factors data base and from National Pollutant Inventory emission estimation manuals. Emissions were calculated for existing and proposed future operations.

Atmospheric dispersion modelling for the Quarry was conducted using the CALPUFF modelling system. Local meteorology was incorporated into the dispersion modelling using observations from the Bureau of Meteorology Taree Airport monitoring location (located 21km from the Quarry Site) and meteorological modelling techniques.

In assessing potential air quality impacts from the Quarry, model predictions of daily-varying (24-hour average) and annual average $PM_{10}$ concentrations were made at surrounding neighbouring sensitive receptors. The results of the dispersion modelling conducted indicated that the potential impacts generated by the Quarry were low and exceedance of applicable NSW EPA assessment criteria was therefore unlikely for proposed future increased operations. Additionally, the comparison of model predictions between current and proposed operations highlighted that the proposed increase in Quarry extraction and production activities would unlikely result in a noticeable change in ambient air quality in the local environment.

# 1. INTRODUCTION

Pacific Blue Metal Pty Ltd (the Proponent) is seeking approval from the Secretary of Department of Planning and Environment (DPE) for the ongoing operation of the existing Possum Brush Quarry (the Quarry) and to modify the existing Development Consent DA 283/97.

The Quarry is an existing hard rock extraction operation located approximately 2km west of the Pacific Highway at Possum Brush, 4km northwest of Failford and 5km northeast of Nabiac on the Mid-North Coast of NSW. The local and regional setting of the Quarry is illustrated in **Figure 1**.

The Proponent's application relates to:

- formally presenting the activities for the ongoing operation of the Quarry throughout the next 30 years, i.e. Stage 2 of the Quarry; and
- the Proponent's proposed increase in the production levels from 240 000tpa (existing) to a maximum of 500 000tpa at the Quarry throughout Stage 2 of the Quarry life.

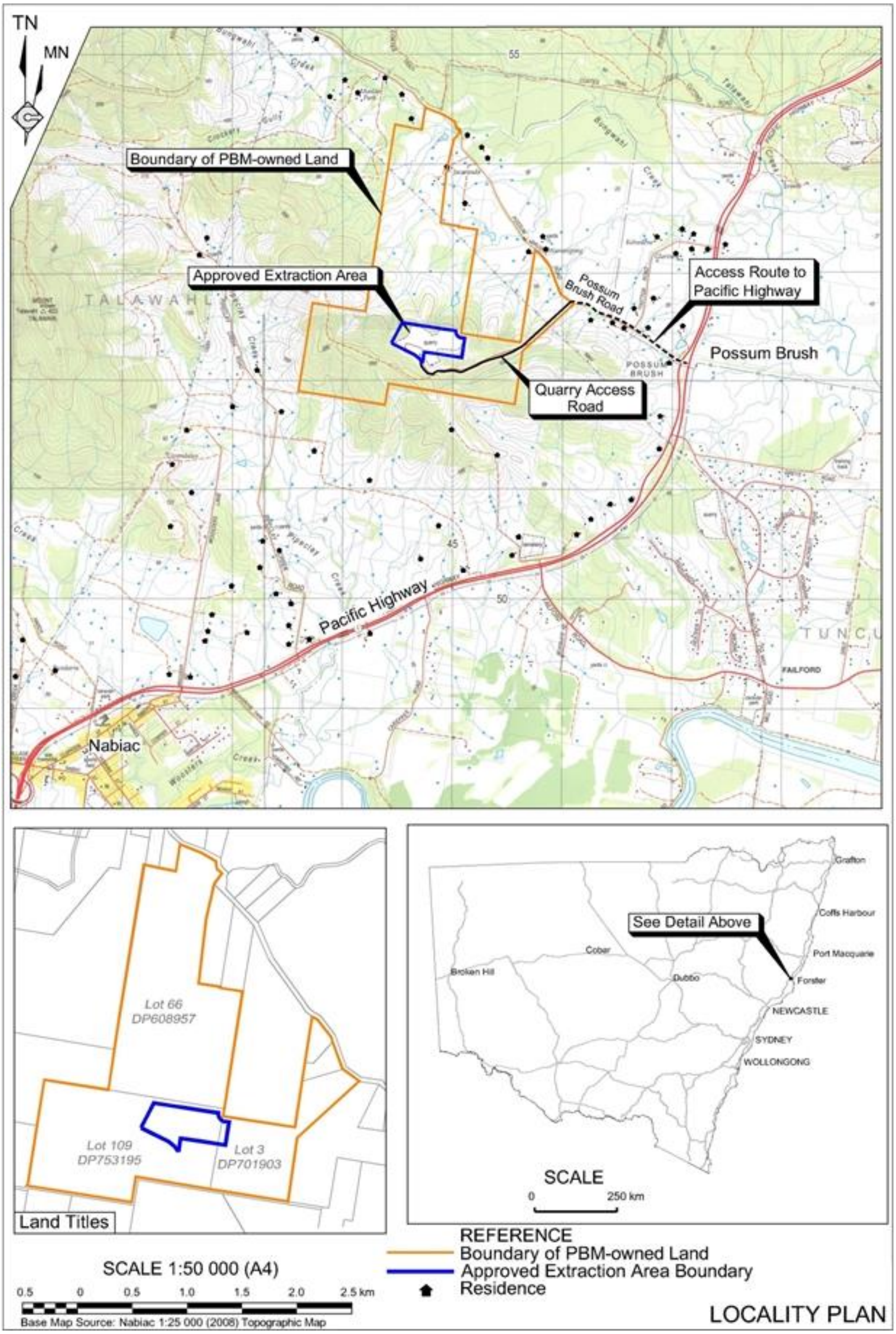
Ramboll Environ Australia Pty Ltd (Ramboll Environ) has been commissioned by RW Corkery & Co Pty Limited (RWC) on behalf of the Proponent to conduct an air quality assessment to review potential significance of the proposed increase in production to air quality impacts in the surrounding environment.

The Applicant is seeking consent to extend the existing extraction area beyond the approved limit of extraction (covering 8ha) to the proposed limit of extraction (covering 15.8ha). Production levels would not exceed the currently approved limit of 500 000tpa, with the annual average production level expected to be approximately 250 000tpa to 300 000tpa.

This air quality assessment will cover the following aspects:

- Characterisation of the existing environment, specifically the existing air quality, prevailing meteorology and regulatory context;
- Review of potential emission sources and mitigation measures;
- Calculation of annual particulate matter emissions from the Quarry;
- atmospheric dispersion modelling of emissions for current and future operations at Quarry site to predict potential particulate matter impacts at the surrounding sensitive receptor locations and determine the significance of the proposed increase to ambient air quality.

**Figure 1 Locality Plan**




Source: RWC (2014)

# 2. PROJECT DESCRIPTION

## 2.1 EXISTING QUARRY OPERATIONS

The following subsections provide an overview of the activities currently undertaken at the Quarry. The layout of the existing Quarry is presented in **Figure 2**.

### 2.1.1 Extraction Operations

Extraction operations continue to be undertaken in both Extraction Areas A and B comprising a combination of select material/weathered rock and fresh rock. All extraction has been undertaken by either ripping with excavators and bulldozers or drill and blast followed by load and haul. Each blast typically generates between 15 000t and 35 000t of fragmented rock, with approximately 15 blasts initiated in one year. Broken and fragmented rock suitable for processing is transported to the on-site processing plant by off-road haul trucks. All oversize rock is either sold as armour rock or transported to protected areas within Areas A and B for size reduction using a hydraulic hammer.

### 2.1.2 Processing Activities

Processing continues to be undertaken at the processing plant which incorporates crushing and screening machinery and a state-of-the-art pugmill/wetmix plant, with processing generally taking place 6 days per week, typically starting at 6:30am and concluding at or before 6:00pm on a weekday and typically starting at 7:00am and concluding at or before 3:00pm on a Saturday, public holidays excluded.

### 2.1.3 Product Despatch

All product trucks travel to and from the Pacific Highway via the Quarry Access Road and Possum Brush Road. The bulk of construction materials have been despatched to Pacific Highway upgrades and local Council projects. Gabion and oversize rock are also sold for use as rock lining/armouring.

### 2.1.4 Asphalt Plant

In addition to quarrying operations, an on-site asphalt batch plant, which commenced production in December 2008, continues to service a range of local infrastructure projects. .

## 2.2 PROPOSED QUARRY OPERATIONS

The Proponent is seeking to extend the life of the Quarry and to increase the annual approved average extraction rate from 200 000tpa to 370 000tpa with a maximum annual production of 500 000tpa. The existing spatial footprint of the Quarry would not change and would be contained with the current approved limit of extraction boundary. The pugmill/wetmix plant and asphalt plant operations would not alter from existing operations.

## 2.3 STUDY AREA LAND USE AND TOPOGRAPHY

The Quarry is located within an area of forested land on the northern side of a minor east-west aligned ridge. Further afield, the Quarry is surrounded by a mixture of agricultural land and State forest areas and rural-residential housing.

The elevation at the northern boundary of the approved limit of extraction is approximately 110m (Australian Height Datum (AHD)), increasing to approximately 192m AHD. The depth of the existing extraction area is approximately 90m AHD in the northeastern corner of the extraction area. The surrounding topography increases to the west to a series of forested peaks and decreases to the north, east and south.

A three-dimensional representation of the topography immediately surrounding the Quarry is presented in **Figure 3**.

## 2.4 SURROUNDING RESIDENCES

The Quarry Site is located in proximity of a number of rural-residential properties. The closest receptors radially around the Quarry have been used to assess air quality impacts from the Quarry. The selected receptor locations are presented in **Table 1** and illustrated in **Figure 4.**

**Table 1**
**Selected Sensitive Receptor Locations Surrounding Quarry Site**

| Receptor ID | Location (m, MGA56S) | | Distance (m) / Direction from Approved Extraction Boundary | Elevation (m, AHD) |
|---|---|---|---|---|
| | Easting | Northing | | |
| R1 | 444977 | 6451591 | 660 / S | 158 |
| R2 | 445719 | 6453182 | 990 / NE | 43 |
| R4 | 446285 | 6452513 | 1,180 / ENE | 53 |
| R8 | 445414 | 6451311 | 960 / SE | 99 |
| R10 | 444260 | 6451086 | 1,180 / S | 55 |
| R11A | 443447 | 6451707 | 1,230 / SW | 52 |
| R11B | 443255 | 6452044 | 1,230 / WSW | 53 |
| R14 | 445153 | 6453618 | 1,160 / N | 48 |

**Figure 2 Existing Quarry Site Layout**

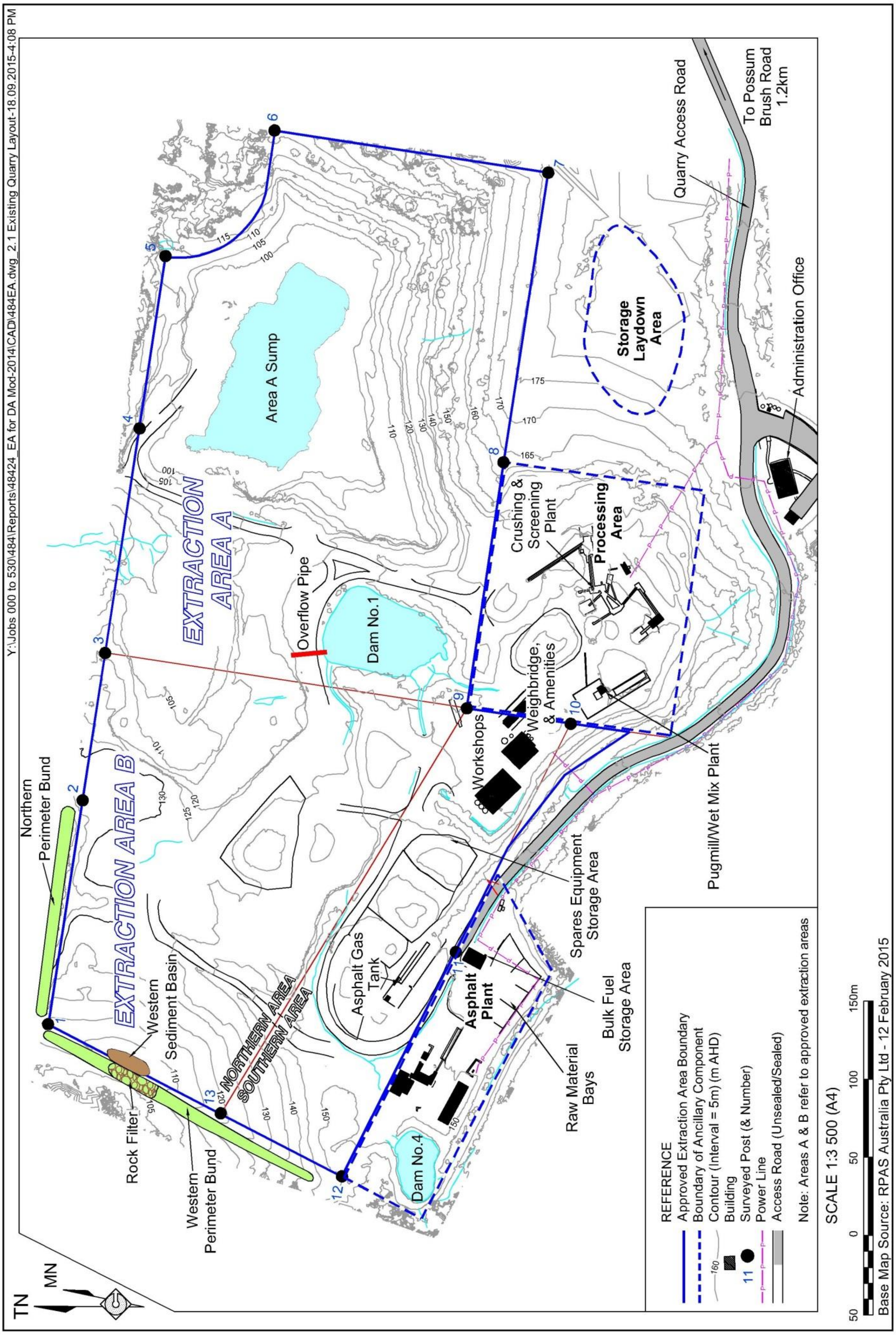
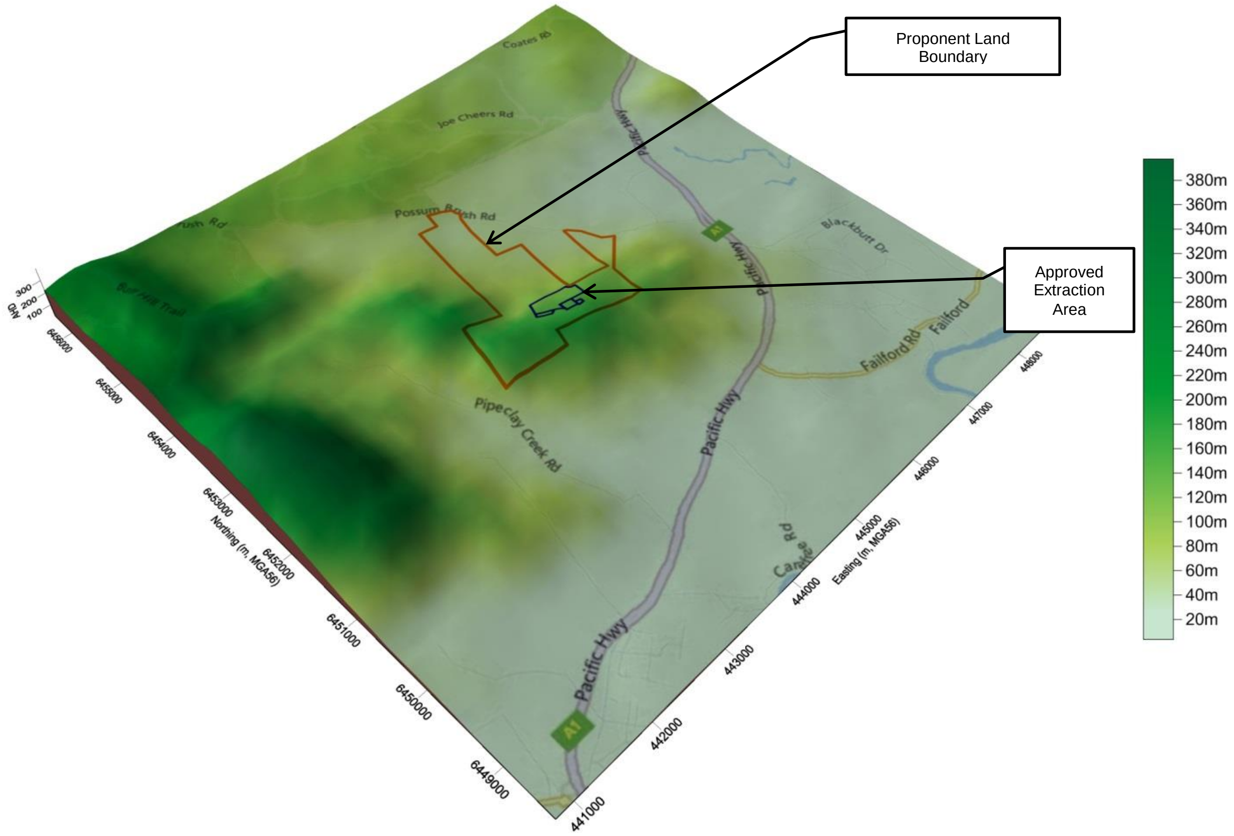
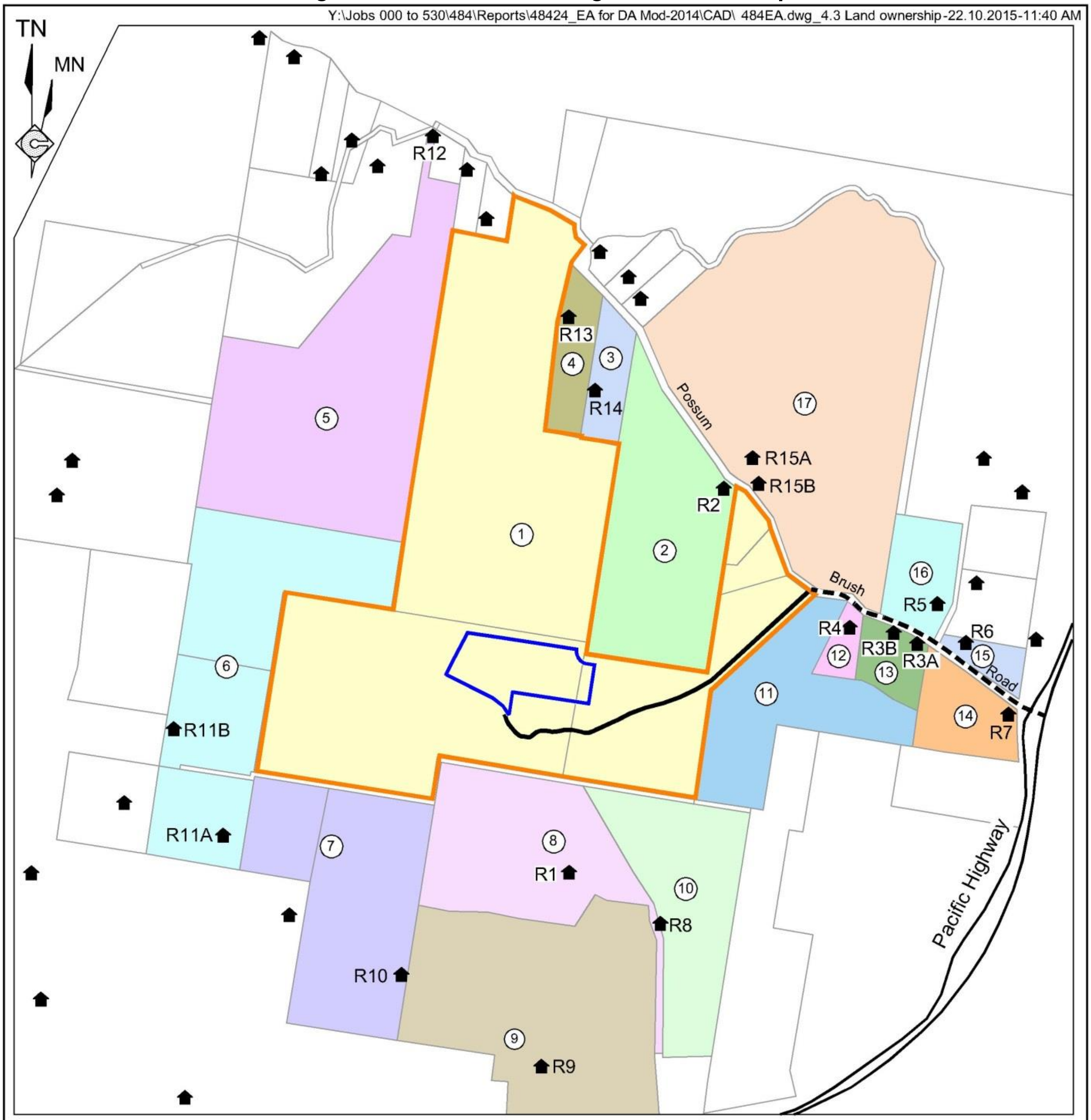


**Figure 3 Surrounding Topographical Features**




NOTE: Vertical exaggeration of two applied

**Figure 4 Surrounding Sensitive Receptors**




REFERENCE
Boundary of PBM-owned Land
Approved Extraction Area Boundary
Cadastral Boundary
① Landowner Reference (See Table)
R1 Residence & Identifier

| Ref | Landowner |
|---|---|
| 1 | Pacific Blue Metal Pty Limited |
| 2 | Shannavalla Pty Ltd |
| 3 | Cetrad Pty Limited |
| 4 | C A Craig |
| 5 | S P & T A C Taylor |
| 6 | B & I L Priestly |
| 7 | G W & V E Hawkins |
| 8 | B R & J S Wynn |
| 9 | Vicron Constructions Pty Limited |
| 10 | D J & B J Brown |
| 11 | R B & C L Perry |
| 12 | G R & R F Phillips |
| 13 | Lifestyle Investment Partners Pty Ltd |
| 14 | J L A Smith & K M Sciberras |
| 15 | H M Dempsey |
| 16 | M J & S Y Earley |
| 17 | G J Apperloo |

SCALE 1:30 000 (A4)

500 0 500 1000 1500 m

Landowner Source: LPI - July 2015

# AIR QUALITY ASSESSMENT CRITERIA

The Quarry must demonstrate compliance with the impact assessment criteria outlined in the Approved Methods for Modelling (EPA, 2005). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

The Approved Methods for Modelling specifies that the impact assessment criteria for 'criteria pollutants[1]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the $100^{th}$ percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be presented, requiring consideration of existing ambient background concentrations for the criteria pollutants assessed.

For this assessment, focus has been given to the emissions of primary particulate matter (PM), including total suspended particulate matter (TSP) and particulate matter with an equivalent aerodynamic diameter of less than 10 microns ($PM_{10}$) and 2.5 microns ($PM_{2.5}$). Dust deposition, as a result of the TSP emissions, is also assessed.

Relevant ambient air quality criteria applicable to the Quarry are presented in this section. For proposed developments within NSW, ground level assessment criteria specified by the NSW EPA within the *Approved Methods for Modelling* are applicable. These assessment criteria are designed to maintain an ambient air quality that allows for adequate protection of human health and well-being.

## 3.1 AIRBORNE PARTICULATE MATTER

Air quality limits for PM are typically given for various particle size metrics, including TSP, $PM_{10}$ and $PM_{2.5}$. $PM_{10}$ and $PM_{2.5}$ require specific consideration due to their health impact potential.

Air quality criteria issued by federal and NSW government for particulates are given in **Table 2**.

**Table 2**
**Impact Assessment Criteria for Airborne Particulates**

| Pollutant | Averaging Period | Concentration (µg/m³) | Reference |
|---|---|---|---|
| TSP | Annual | 90 | NSW EPA[(a)(b)] |
| $PM_{10}$ | 24-hour | 50 | NSW EPA[(a)] |
| | 24-hour | 50[(d)] | NEPM[(c)] |
| | Annual | 30 | NSW EPA[(a)] |
| $PM_{2.5}$ | 24-hour | 25 | NEPM[(e)] |
| | Annual | 8 | NEPM[(e)] |

(a) NSW DEC, 2005 Approved Methods for Modelling
(b) NSW EPA impact assessment criterion based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal.
(c) NEPC, 2003, National Environment Protection (Ambient Air Quality) Measure, as amended.
(d) Provision made for up to five exceedances of the limit per year.
(e) Advisory reporting goal issued by the NEPC (NEPC, 2003).

[1] 'Criteria pollutants' is used to describe air pollutants that are commonly regulated and typically used as indicators for air quality. In the Approved Methods the criteria pollutants are TSP, $PM_{10}$, $NO_2$, $SO_2$, CO, ozone ($O_3$), deposition dust, hydrogen fluoride and lead.

## 3.2 DUST DEPOSITION

Nuisance dust deposition is regulated through the stipulation of maximum permissible dust deposition rates. The NSW EPA impact assessment goals for dust deposition are given in **Table 3** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided.

**Table 3**
**Dust Deposition Criteria**

| Averaging Period | Maximum Increase in Dust Deposition | Maximum Total Dust Deposition |
|---|---|---|
| Annual | 2g/m$^2$/month | 4g/m$^2$/month |
| Source: NSW DEC, 2005 Approved Methods for Modelling | | |

# 4. CLIMATE AND DISPERSION METEOROLOGY

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. Emission generation rates are particularly dependent on wind energy and on the moisture budget, which is a function of rainfall and evaporation rates.

In the absence of on-site meteorological monitoring data, a combination of meteorological modelling and regional monitoring datasets were used. Details regarding the meteorological modelling are presented in Section 4.1.

The following data were used in the meteorological analysis.

- 1-hour average meteorological data and historical climate data from the BoM Automatic Weather Station (AWS) at Taree Airport (Station Number 060141) located 21km north-northeast of the Quarry Site.

Wind roses and frequency histograms of recorded wind speed and direction data have been generated for the period between 2010 and 2014 for the Taree Airport AWS location. These figures are presented within **Annexure 1** and indicate that minimal inter-annual variation in wind direction and speed occurred across this period. On the basis of illustrated inter-annual consistency in recorded wind speed and direction, the most recent complete calendar year, 2014, has been adopted as the modelling period for this assessment.

## 4.1 METEOROLOGICAL MODELLING

Due to the relatively complex terrain of the Quarry and surrounds and proximity to the coastline, both likely to cause complex wind flow in the region, the CALPUFF (Version 6.2) modelling system has been selected for application in this assessment.

The CALPUFF Modelling system comprises three main components: the CALMET meteorological model, the CALPUFF air dispersion model and the CALPOST post-processor, in addition to a large set of pre-processing programs designed to interface the model to standard routinely available meteorological and geophysical databases.

The CALMET meteorological model develops wind and temperature fields on a three-dimensional gridded modelling domain (Scire *et. al*., 2000). Associated two dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final wind field thus reflects regional airflow patterns in addition to the influences of local topography and land uses.

The CALMET model can integrate hourly average surface meteorological data as input, including wind speed, wind direction, mixing depth, cloud cover, temperature, relative humidity, pressure and precipitation. Additionally, CALMET can use concurrent upper air meteorological data containing similar parameters in order to calculate the conditions at heights above ground level.

Hourly-average surface meteorological conditions recorded at the Taree Airport BoM station were processed for input into CALMET. In the absence of a suitably complete upper air monitoring dataset, the CSIRO's The Air Pollution Model (TAPM) software was used to generate the upper air meteorological parameters required for input within CALMET. TAPM is a prognostic model which outputs three-dimensional, time-resolved meteorological data including: wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. TAPM relies on region-specific data drawn from data bases covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses to produce site-specific hourly meteorological predictions for various heights above the ground across the model domains.

TAPM was configured and run in accordance with the Section 4.5 of the Approved Methods for Modelling. The configuration of CALMET using a combination of Prognostic Model output data from TAPM and surface observations is in general accordance with the Hybrid Mode recommended in TRC (2011).

The configuration of the CALMET model applied within this assessment is outlined in **Table 4**.

**Table 4**
**CALMET Configuration**

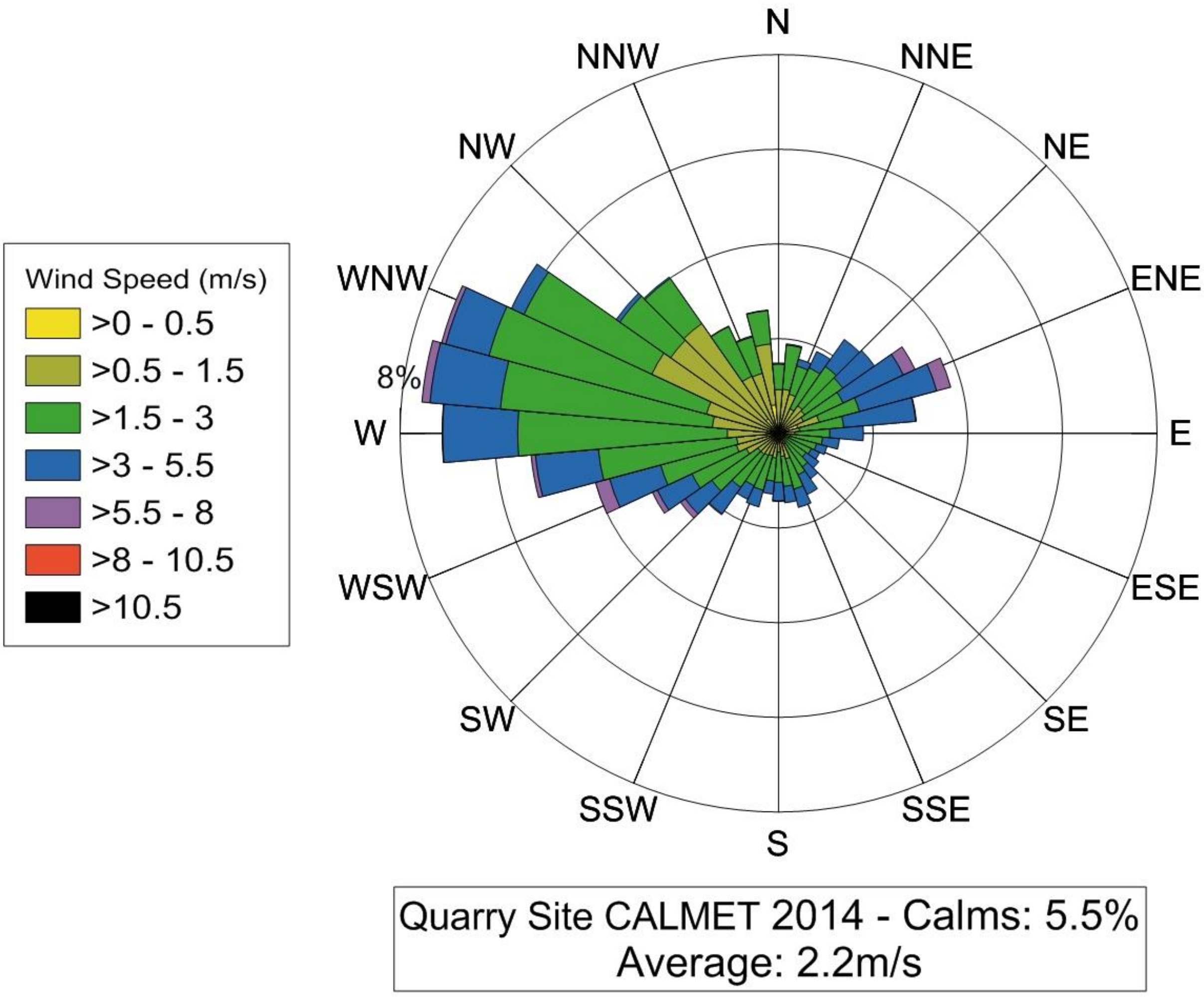
| **CALMET Grid Settings and Input Data** | |
|---|---|
| Meteorological grid domain | 50km x 50km |
| Meteorological grid resolution | 300 m |
| Vertical resolution (cell heights) | 10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1,200 m, 2 000 m, 3 000 m, 4 000 m,) |
| Modelling year | 1 January 2014 to 31 December 2014 |
| Surface meteorological stations | Taree Airport (BoM) |
| Upper air meteorological stations | TAPM 3-Dimensional Prognostic Dataset |
| Land Use | Generated from aerial photography and topographic maps |
| Topography | SRTM-3 Topography Data |
| **CALMET Radius Parameter Values** | |
| TERRAD | 4km |
| R | 10km |
| RMAX | 25km |

## 4.2 PREVAILING ANNUAL WIND REGIME

Annual, seasonal and diurnal wind roses for the Quarry, generated based on hourly wind speed and direction data extracted from the CALMET-predicted dataset, are provided in **Annexure 1**.

Based on the annual wind rose illustrated in **Figure 5**, airflow is predominately experienced from the west to west-northwest and east-northeastern quadrants at the Quarry. This airflow patter is similar to the data recorded at the BoM Taree Airport AWS location. The average predicted wind speed for the 2014 modelling period was 2.2m/s, with a frequency of calm conditions in the order of 6%.

**Figure 5 CALMET-Predicted Annual Average Wind Rose – Quarry Site – 2014**




## 4.3 SEASONAL AND DIURNAL WIND REGIME

Seasonal and diurnal (dividing the day into four periods) wind roses for the 2014 CALMET-generated Quarry Site dataset are presented within **Annexure 1**.

Notable seasonal variation is evident in the wind regime generated for the Quarry Site. The westerly component is most dominant during the autumn, winter and spring months. Summer is dominated by flow from the east-northeast and northwest.

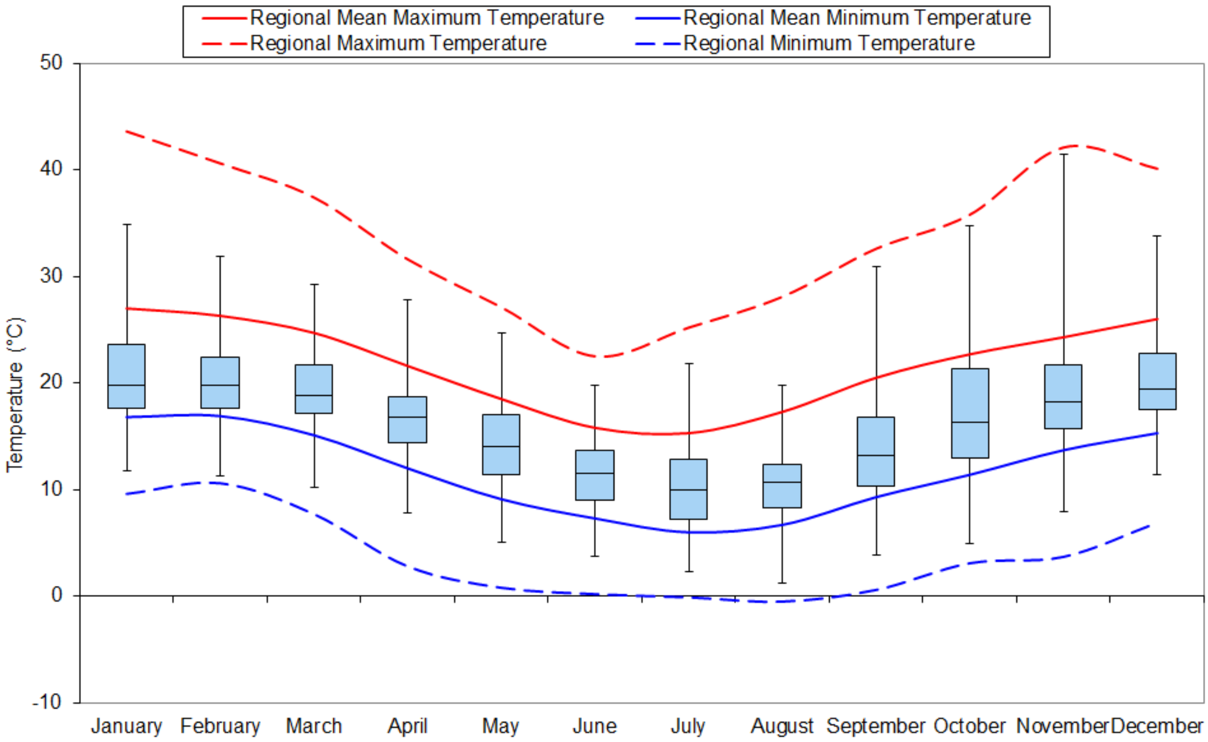
Diurnal variation is also notable in the 2014 CALMET-generated meteorological dataset for the Quarry Site. The westerly component is most defined between 6pm and 11am, before the east-northeasterly air flow becomes dominant between midday and 6pm. This predicted diurnal shift in air flow is considered to be a function of the proximity to the coastline and reflective of the land-sea breeze. The wind speed increases during the daylight hours, with the lowest wind speed recorded during the early hours of the day (00:00hrs to 05:00hrs).

## 4.4 AMBIENT TEMPERATURE

Monthly mean minimum temperatures are in the range of 7°C to 18°C, with mean maxima of 19°C to 28°C, based on the long-term average record from the BoM Taree Airport climate station. Peak temperatures occur during summer months with the highest temperatures typically being recorded between November and March. The lowest temperatures are usually experienced between June and August.

The CALMET-generated temperature for the Quarry site during 2014 has been compared with long-term trends recorded at the BoM Taree Airport climate station to determine the representativeness of the dataset. **Figure 6** presents the monthly variation in predicted temperature during 2014 compared with the recorded regional mean, minimum and maximum temperatures. There is good agreement between temperatures predicted during 2014 and the recorded historical trends, indicating that the dataset is representative of conditions likely to be experienced in the region.

**Figure 6 Temperature Comparison between CALMET-generated Quarry Site 2014 dataset and Historical Averages (1994-2015) – Taree**




Note: CALMET-generated temperatures for the Quarry Site are illustrated by the 'box and whisker' indicators. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values. Maximum and minimum temperatures from long-term measurements at Taree are depicted as line graphs.

## 4.5 RAINFALL

Precipitation is important to air pollution studies since it impacts on dust generation potential and represents a removal mechanism for atmospheric pollutants.

Based on historical data recorded since 1997 at Taree, the region is characterised by high rainfall, with a mean annual rainfall of 1,110 mm, and an annual rainfall range between 900 mm and 1,600 mm. There is significant variation in monthly rainfall throughout the year, with the period between January and June typically experiencing higher falls than the remainder of the year.

To provide a conservative (upper bound) estimate of the airborne particulate matter concentrations occurring due to the Quarry, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report.

## 4.6 ATMOSPHERIC STABILITY

Atmospheric stability refers to the degree of turbulence or mixing that occurs on the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Pasquill-Turner assignment scheme identifies six Stability Classes, “A” to “F”, to categorise the degree of atmospheric stability prevailing at a given time (defined in **Table 5**).

**Table 5**
**Description of Atmospheric Stability Classes**

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

The frequency of occurrence of each atmospheric stability class predicted by CALMET at the Quarry Site for the modelling period is illustrated in **Figure 7**. Stability classes E and F, corresponding to a stable atmosphere, were predicted to occur cumulatively 34% of the time. Stability class D, corresponding to a neutral atmosphere, was predicted to occur approximately 45% of the time.

The predicted seasonal variation in atmospheric stability at the Quarry is presented in **Figure 8**. Autumn and winter typically experience a higher occurrence of neutral to stable atmospheric conditions than spring and summer.

The diurnal variation in CALMET predicted atmospheric stability is presented in **Figure 9**. The presented profiles illustrate that atmospheric instability increases during daylight hours as convective energy increases, while stable atmospheric conditions prevail during night periods due to the occurrence of lower wind speeds and reduced convective mixing.

## 4.7 MIXING DEPTH

Diurnal variations in CALMET-predicted atmospheric mixing depth for the Quarry are illustrated in **Figure 10**. The atmospheric mixing depth increases during the day as the heat from the sun promotes convective mixing and higher wind speeds result in mechanical mixing, with maximum depths occurring in the afternoon coinciding with peak solar energy and wind speeds. Mixing depth reduces as the sun sets and solar energy decreases.

**Figure 7 CALMET-Predicted Annual Occurrence of Atmospheric Stability Classes at the Quarry Site**

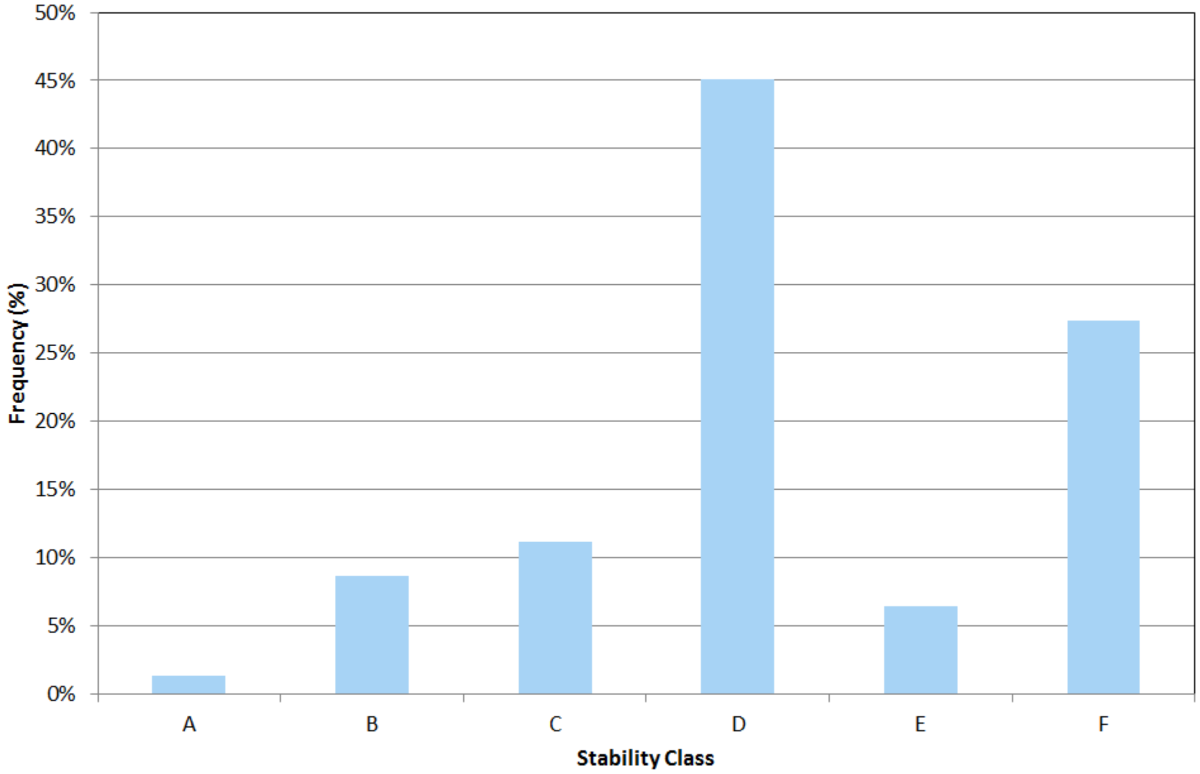



**Figure 8 CALMET-Predicted Seasonal Occurrence of Atmospheric Stability Classes at the Quarry Site**

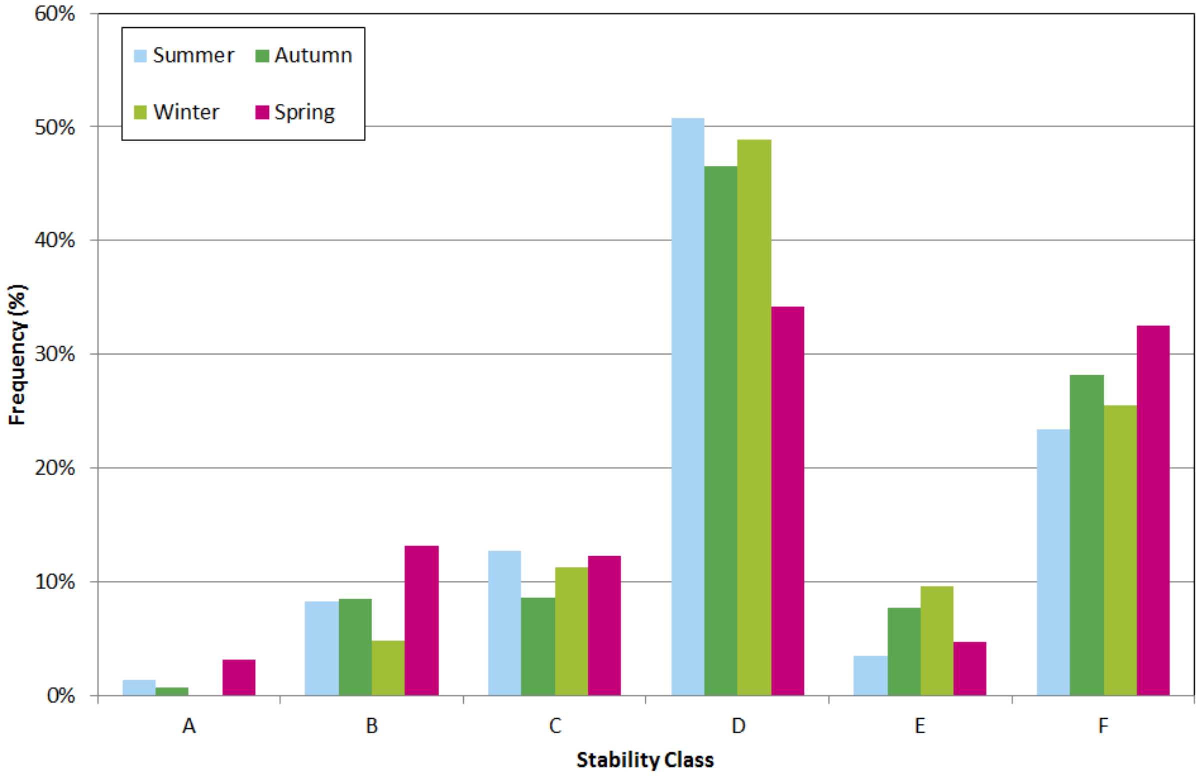


**Figure 9 CALMET-Predicted Diurnal Variation in Atmospheric Stability Classes at the Quarry Site**

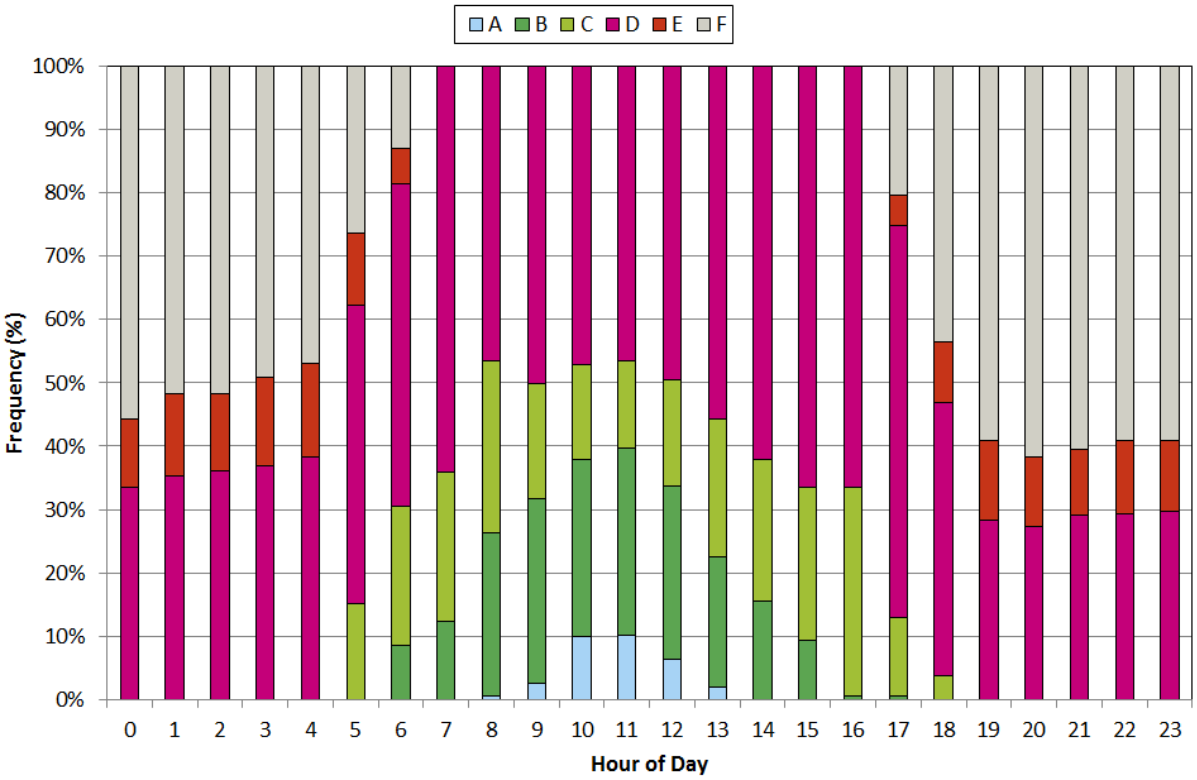
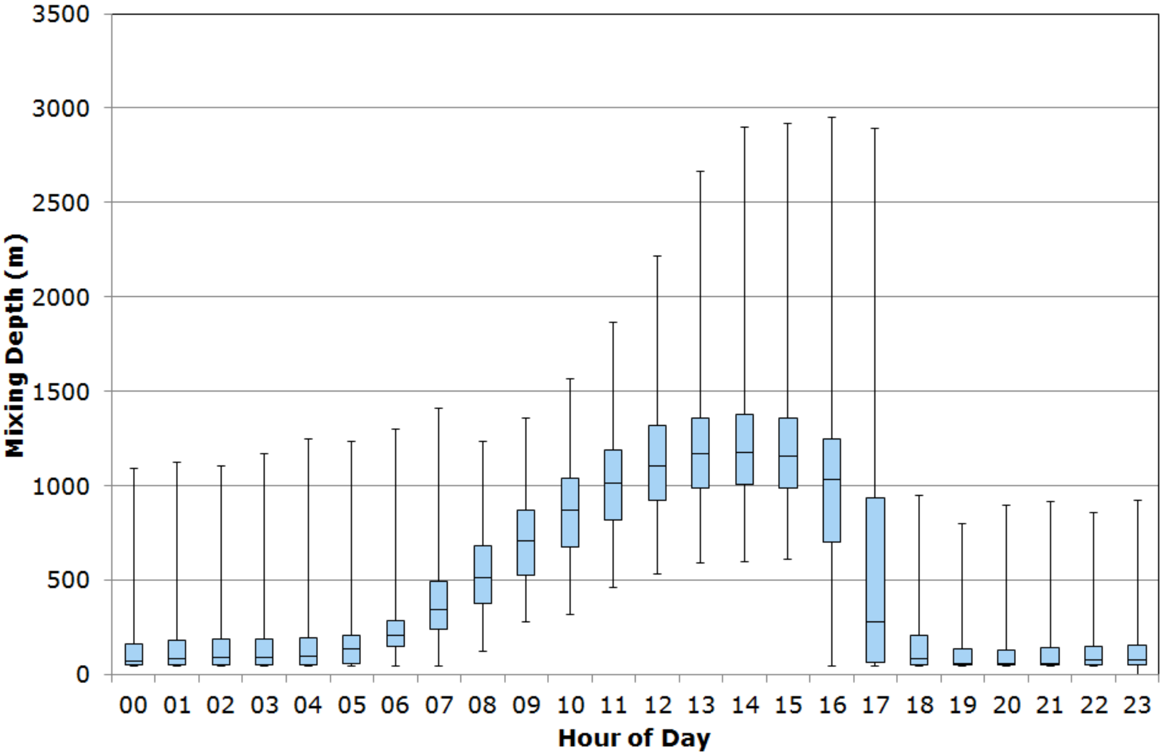



**Figure 10 CALMET Predicted Diurnal Variation in Atmospheric Mixing Depth – Quarry Site**




Note: Boxes indicate 25th, Median and 75th percentile of CALMET-predicted mixing height data while upper and lower whiskers indicate maximum and minimum values.

# 5. EXISTING AIR QUALITY ENVIRONMENT

The quantification of cumulative air pollution concentrations and the assessment of compliance with ambient air quality limits necessitate the characterisation of baseline air quality. Given that particulate matter emissions represent the primary pollutant to be generated by the Quarry, it is pertinent that existing sources and ambient air pollutant concentrations of these pollutants are considered.

## 5.1 EXISTING LOCAL SOURCES OF ATMOSPHERIC EMISSIONS

The National Pollutant Inventory (NPI) and EPA Environment Protection Licence (EPL) databases have been reviewed for significant existing sources of air pollutants in the surrounding region.

The NPI database lists one reporting air emission source in the Greater Taree local government area within 10km of the Quarry; the Holcim-operated Jandra Quarry (4.5km northeast of the Quarry Site). Additionally, the EPA's Environment Protection Licence (EPL) database lists the Failford Quarry (3km south-southeast) as the only other industrial emissions sources within 10km of the Quarry Site.

An air quality modelling study was conducted for the Jandra Quarry in 2014 (SLR, 2014), while limited information is available in the public domain for the Great Lakes Aggregate quarry. The results of the dispersion modelling for the Jandra Quarry indicated that particulate matter concentrations arising from that quarry's operation would be very low beyond 2km from site boundary. Consequently, it is considered that significant cumulative impacts between emissions from the Quarry and either of the neighbouring quarries are unlikely to occur.

In addition to the above operations, it is considered that the following sources contribute to particulate matter emissions in the vicinity of the Quarry.

- Dust entrainment due to vehicle movements along unsealed and sealed public roads.
- Diesel emission from vehicle movements along unsealed and sealed public roads.
- Wind generated dust from exposed areas within the surrounding region.
- Dust and diesel emissions from agricultural activities at neighbouring properties.
- Seasonal emissions from household wood burning fires.
- Episodic emissions from vegetation (e.g. bush and grass) fires.
- Sea salts contained in sea breezes.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. Whereas dust storms predominately contribute primary particulates from mechanical attrition, bushfires are a source of fine particulates including both primary particulates and secondary particulates formed by atmospheric gas to particle conversion processes.

## 5.2 MONITORING DATA AVAILABLE FOR BASELINE AIR QUALITY CHARACTERISATION

Ambient air quality monitoring is not required to be conducted at the Quarry Site, nor are there any publicly available monitoring data sources for the surrounding region at the time of reporting with which to quantify existing air quality levels.

However, during the Environmental Assessment stage of the Pacific Highway upgrade between Sapphire and Woolgoolga, the NSW Roads and Traffic Authority (RTA) commissioned the establishment of a real-time air quality monitoring station at Korora, approximately 55 km north-northeast of the Quarry. This air quality monitoring station was configured to record a range of meteorological and air quality parameters, including $PM_{10}$ and $PM_{2.5}$.

The results of this monitoring were published in Working Paper 8 of the Environmental Assessment for the Sapphire and Woolgoolga (RTA, 2007). While spatially distant from the Quarry site, this air quality monitoring dataset has been adopted in this report to quantify baseline conditions representative of the Mid-North Coast region of NSW.

The monitoring station was situated approximately 20 m from the Pacific Highway, 1km west of the Pacific Ocean and 5km north-northeast of the central business district of Coffs Harbour. The monitoring station was sited along a section of the Pacific Highway marked with a 100km/hr speed limit. Monitoring was conducted for the period between 14 October 2005 and 31 January 2006.

The following points are made regarding the Korora RTA monitoring dataset.

- Monitoring was conducted during the Christmas-New Year period, with traffic rates along the Pacific Highway higher than at other times of the year.
- Monitoring was conducted during summer, where a higher frequency of sea-breeze occurs. Consequently, the influence of sea salt aerosols on recorded particulate matter concentrations would be above average.

Furthermore, the Working Paper 8 (RTA, 2007) states the following:

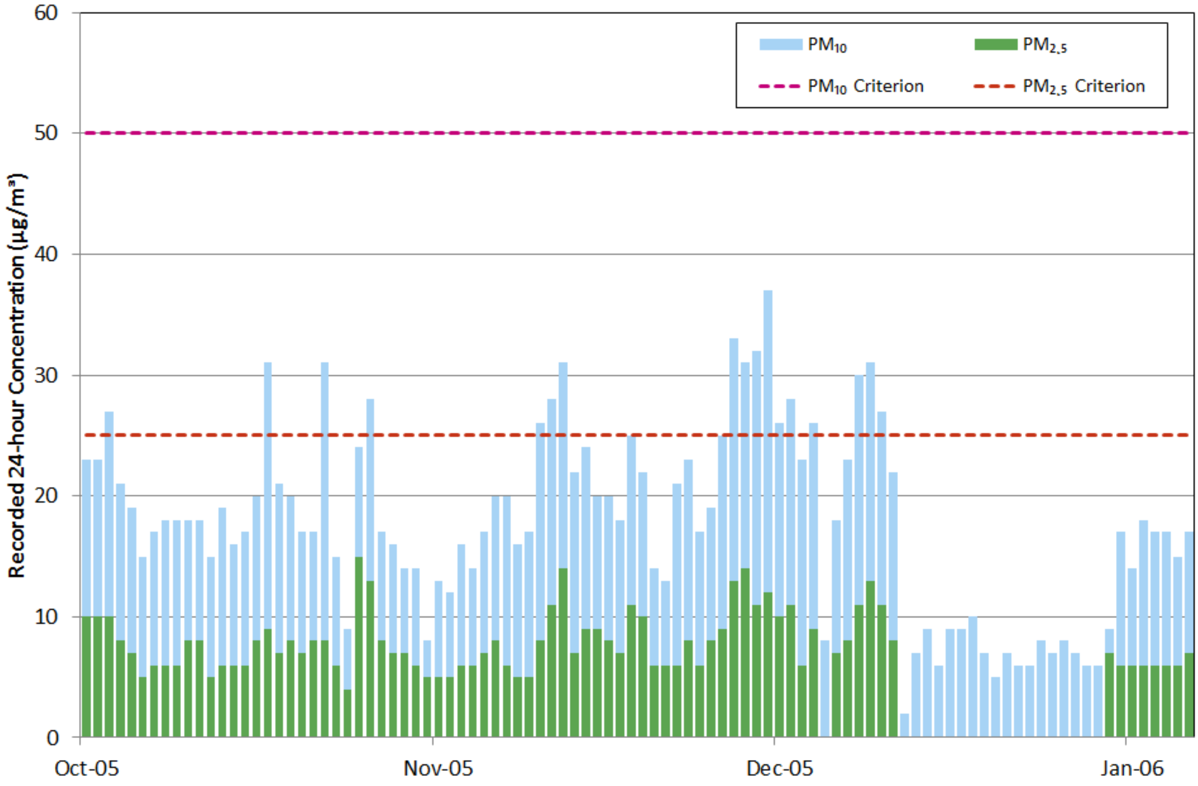
> *Due to the proximity of the monitoring site to the Pacific Highway, the concentrations of air quality parameters measured include traffic emissions. Therefore, the concentrations detected are likely to be higher than the background levels for the local area and will give a conservative indication of the air quality experienced on the NSW north coast.*

Consequently, it is considered that the adoption of the Korora RTA monitoring dataset will provide a conservative estimate of baseline air quality in area surrounding the Quarry site. In the absence of a more recent, local air quality monitoring dataset, it is considered that the use of the Korora RTA monitoring dataset is appropriate for the representation of PM concentrations in coastal, rural NSW within this assessment.

## 5.3 $PM_{10}$ AND $PM_{2.5}$ CONCENTRATIONS – KORORA RTA DATASET

The daily varying (24-hour average) $PM_{10}$ and $PM_{2.5}$ concentrations recorded at Korora are illustrated in **Figure 11**. It can be seen that the recorded 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations fluctuate throughout the presented period.

**Figure 11: Time-series of 24-hour Average $PM_{10}$ and $PM_{2.5}$ Concentrations recorded at Korora – October 2005 to January 2006**



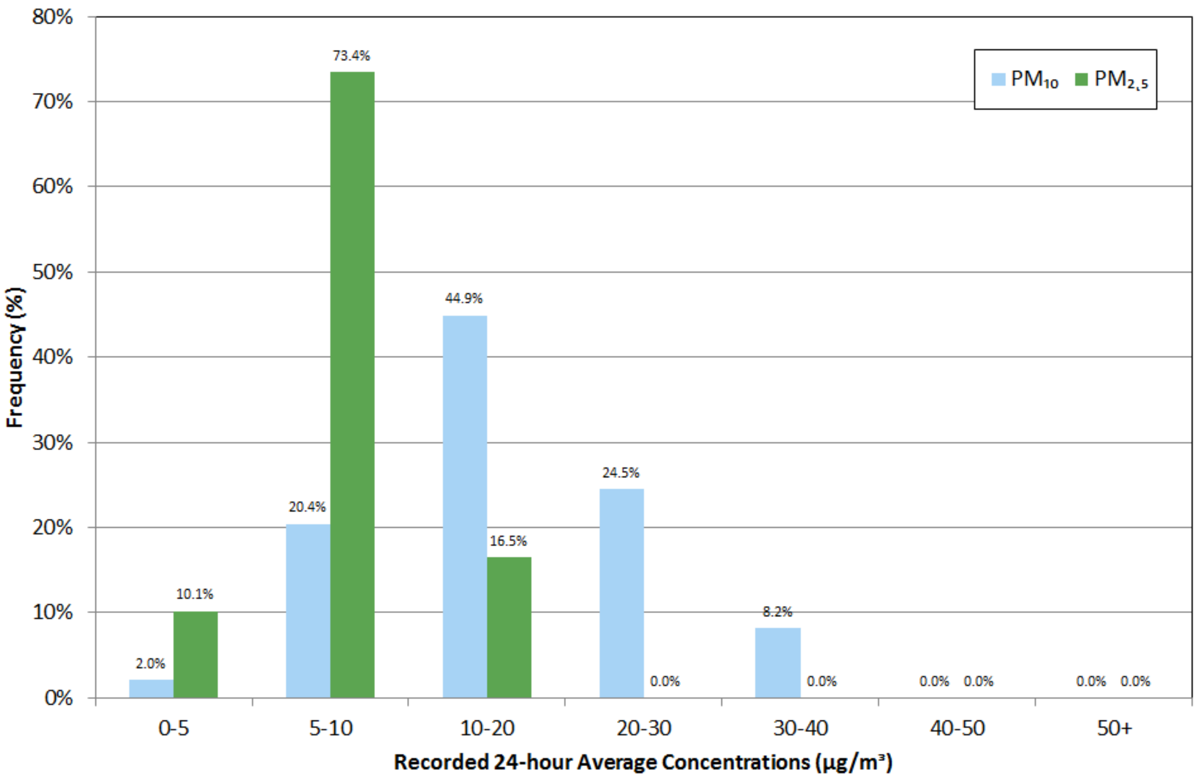

A range of statistics for the Korora RTA monitoring dataset is presented within **Table 6**.

**Table 6**
**Korora RTA $PM_{10}$ Monitoring Dataset Statistics – October 2005 to January 2006**

| Monitoring Statistic | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|
| Number of Measurements | 98 | 80 |
| Minimum | 2µg/m³ | 4.0µg/m³ |
| Maximum | 37µg/m³ | 15.0µg/m³ |
| Average | 18µg/m³ | 7.9µg/m³ |
| 25th Percentile | 13µg/m³ | 7.0µg/m³ |
| 50th Percentile | 17µg/m³ | 6.0µg/m³ |
| 75th Percentile | 23µg/m³ | 7.0µg/m³ |
| Inter-quartile Range | 10µg/m³ | 9.0µg/m³ |

A frequency distribution of 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations recorded by the Korora RTA monitoring station is presented in **Figure 12**. This figure highlight that 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations are typically less than 30µg/m$^3$ and 10µg/m$^3$ respectively throughout the Korora RTA dataset.

**Figure 12: Distribution of 24-hour Average $PM_{10}$ Concentrations – Korora – October 2005 to January 2006**




To assess the cumulative 24-hour average $PM_{10}$ and $PM_{2.5}$ impacts of Quarry emissions with ambient background $PM_{10}$ and $PM_{2.5}$ concentrations, the maximum recorded 24-hour average concentrations recorded at the Korora site will be combined with the maximum 24-hour average predicted concentration at each receptor location to derive the 100th percentile concentration in accordance with Section 5.1.1 of the Approved Methods for Modelling (EPA, 2005). This approach is a conservative approach for assessing maximum impacts as it assumes the maximum background occurs on the same day as the maximum increment from the quarry. Maximum 24-hour average $PM_{10}$ and $PM_{2.5}$ background concentrations of 37µg/m$^3$ and 15µg/m$^3$ will be applied.

The median $PM_{10}$ and $PM_{2.5}$ concentrations of the Korora RTA dataset were used to assess cumulative annual average concentrations at each sensitive receptor location. Due to the limited time period of recorded concentrations and the conservative nature of the dataset (as discussed in Section 5.2), it is considered that the application of the median concentration rather than the average concentration, is appropriate for this assessment. The median $PM_{10}$ and $PM_{2.5}$ concentrations to be adopted as background are 17µg/m$^3$ and 7µg/m$^3$ respectively.

## 5.4 TSP CONCENTRATIONS

There is currently no monitoring of ambient TSP concentrations conducted in the vicinity of the Quarry.

Based on Ramboll Environ's experience of paired $PM_{10}$ and TSP monitoring datasets in rurally-located mining areas (ENVIRON, 2009), the $PM_{10}$ particle size mass fraction is typically of the order of 40% of the recorded TSP mass. On this basis, and in the absence of site-specific monitoring data for TSP, a baseline TSP concentration of 43µg/m$^3$, derived from the median $PM_{10}$ concentration of the Korora RTA dataset (17µg/m$^3$), will be adopted as indicative of existing annual average TSP concentrations.

## 5.5 DUST DEPOSITION

There are no dust deposition monitoring data available suitable to quantify baseline levels in the area surrounding the Quarry site.

Modelling will therefore focus on the incremental contribution from Quarry operational emissions only against the NSW EPA incremental criterion of 2g/m$^2$/month, expressed as an annual average.

# 6. EMISSION ESTIMATION

Fugitive dust sources associated with the operation the Quarry were principally quantified through the application of Australian National Pollutant Inventory (NPI) emission estimation techniques, in particular the NPI Emission Estimation Technique Manual for Mining (NPI EETMM, 2012) and United States Environmental Protection Agency (US-EPA) AP-42 emission factors. PM emissions were quantified for each particle size fractions, with TSP being used to provide an indication of dust deposition rates. Coarse and fine PM emissions ($PM_{10}$ and $PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the US-EPA AP-42).

## 6.1 SOURCES OF OPERATIONAL EMISSIONS

Air emissions associated with the Quarry will primarily comprise fugitive particulate matter releases. Potential sources of emission were identified as follows:

- Removal of weathered rock/overburden by bulldozer.
- Drill and blast activities.
- Loading of blasted rock material to haul trucks for transportation to processing plant.
- Unloading of raw material to processing plant hopper.
- Crushing/screening plant operation and assorted material stockpile loading.
- Loading of processed material to haul trucks for transportation to market, onsite pug mill and onsite asphalt plant.
- Pugmill/wetmix plant operations.
- Asphalt plant operations
- Wheel-generated emissions from unsealed (transportation of extracted rock and crushed rock) and sealed (site access road) roads.
- Wind erosion of exposed surfaces, extraction area and active stockpiling areas.

## 6.2 AIR QUALITY CONTROLS AND EMISSION REDUCTION FACTORS

A range of air quality emission controls are currently implemented at the Quarry, including the following.

- The processing plant is fitted with a range of sprays positioned on the delivery hopper, four crushers and conveyor discharge points. Dust suppression on the plant uses approximately 8ML of water per year.
- The 1.4km Quarry Access Road from its intersection with Possum Brush Road to the asphalt plant is sealed with asphalt.
- Dust suppression on the internal unsealed roads and processing area, amongst other operational areas of the Quarry, is achieved through the regular use of a water cart. Up to approximately 21ML of water is used annually to suppress dust on the internal unsealed road network and operational areas.

- A high amount of water is applied at the pugmill/wetmix plant, ensuring that emissions from this process are minimised.

To account for the above air quality control practices, the following control measures are implemented on site and reflected in the emission calculation process.

- Unsealed haul roads – 75% reduction for water application (NPI, 2012) and 44%[2] reduction for travel speed less 40 km/hr (Countess Environmental, 2006). A combined emission reduction factor of 86% was derived, as per the approach for multiple controls presented in NPI 2012.
- Raw material hopper –50% reduction for water sprays (NPI, 2012).
- Processing Plant – controlled emission factors applied for crushing, screening and transfer points (US-EPA, 2004) to account for water spray use throughout the processing plant.

## 6.3 EMISSION SCENARIOS

To review emissions generated by the ongoing and proposed quarrying operations, two emission scenarios have been developed:

- Scenario 1 – current operations at the Quarry with an average production rate of approximately 240 000tpa; and
- Scenario 2 – proposed future operations at the Quarry with production rate of 500 000tpa.

Details on the assumptions made for each scenario are listed within **Annexure 2**.

## 6.4 PARTICULATE MATTER EMISSIONS

A summary of Quarry-related PM emissions by source type is presented in **Table 7**.

These tables and figures highlight that, for both existing and proposed operations, the most significant source of emissions associated with the Quarry are the movement of vehicles along unsealed roads and the processing plant. The proposed increase in raw material extraction (Scenario 2) increases emissions from unsealed road truck movements, sealed road truck movements and processing plant emissions. No changes to pugmill/wetmix or asphalt plant operational emissions are anticipated with the proposed increase. The wind erosion does not change between scenarios as the total area of the approved extraction area was adopted in the calculation of these emissions.

Further details regarding emission estimation factors and assumptions are provided in **Annexure 2**.

[2] The WRAP Fugitive Dust Handbook (Countess Environmental, 2006) specifies in Chapter 6 that an emission reduction of 44% can be achieved by limiting vehicle travel speed on unsealed roads to approximately 40 km/hr relative to 70 km/hour. The emission estimation factor does not account for site specific vehicle travel speed and was based on travel speeds ranging up to 70 km/hr (US-EPA, 2006). Onsite vehicle travel speed is less than 40km/hr at the Quarry. Consequently, this reduction factor is considered appropriate for application

**Table 7**
**Calculated Annual TSP, $PM_{10}$ and $PM_{2.5}$ Emissions - Scenario 1 and 2**



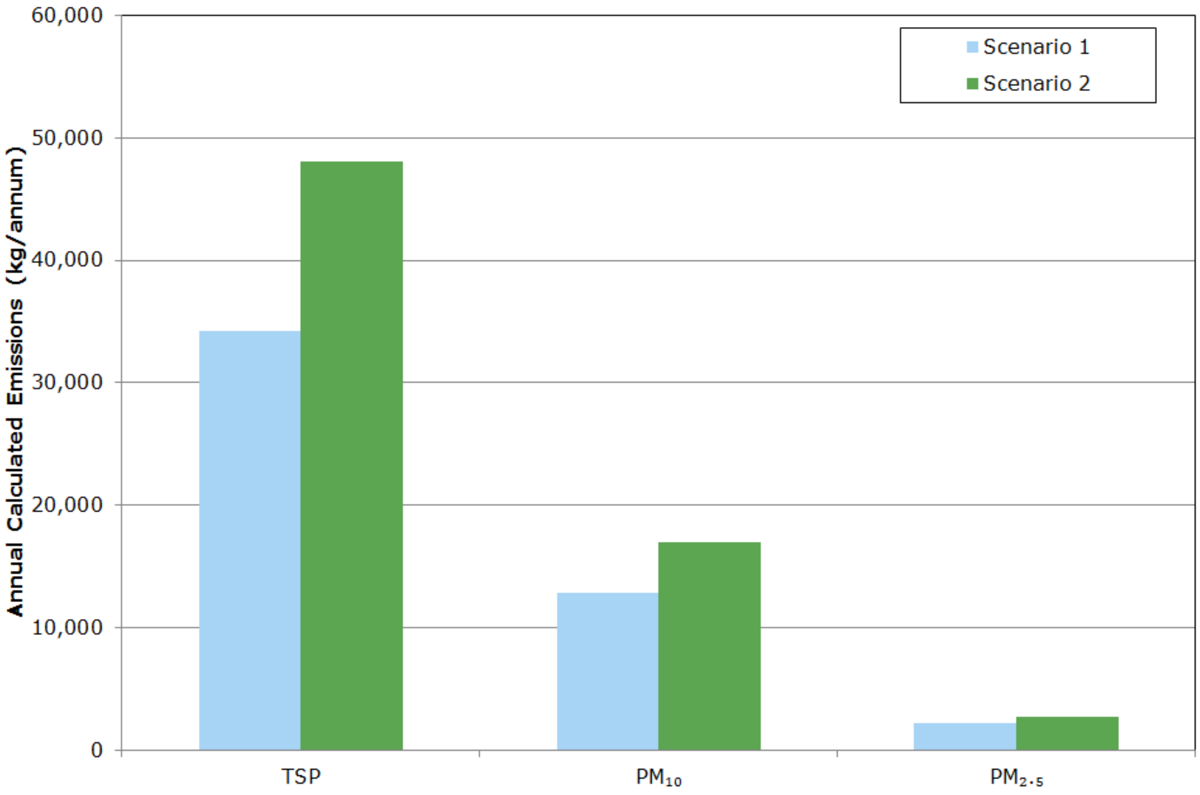
| Emissions Source | Calculated Annual TSP Emissions (kg/annum) by Source | | | Calculated Annual $PM_{10}$ Emissions (kg/annum) by Source | | | Calculated Annual $PM_{2.5}$ Emissions (kg/annum) by Source | | |
|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Difference | Scenario 1 | Scenario 2 | Difference | Scenario 1 | Scenario 2 | Difference |
| Weathered Rock Removal - Bulldozer | 4,014.3 | 4,014.3 | - | 708.5 | 708.5 | - | 421.5 | 421.5 | - |
| Truck Loading in Pit – Raw Material | 336.5 | 701.1 | 364.6 | 159.2 | 331.6 | 172.4 | 24.1 | 50.2 | 26.1 |
| Raw Material Haulage - Unsealed | 4,028.9 | 8,393.4 | 4,364.6 | 1,145.7 | 2,386.8 | 1,241.1 | 114.6 | 238.7 | 124.1 |
| Truck Unloading to Hopper | 168.3 | 350.6 | 182.3 | 79.6 | 165.8 | 86.2 | 12.1 | 25.1 | 13.1 |
| Raw material rehandle | 16.8 | 35.1 | 18.2 | 8.0 | 16.6 | 8.6 | 1.2 | 2.5 | 1.3 |
| Scalper | 453.9 | 605.2 | 151.3 | 152.7 | 203.6 | 50.9 | 10.3 | 13.8 | 3.4 |
| Screen 1 | 408.5 | 544.7 | 136.2 | 137.4 | 183.2 | 45.8 | 9.3 | 12.4 | 3.1 |
| Screen 2 | 408.5 | 544.7 | 136.2 | 137.4 | 183.2 | 45.8 | 9.3 | 12.4 | 3.1 |
| Screen 3 | 317.7 | 423.6 | 105.9 | 106.9 | 142.5 | 35.6 | 7.2 | 9.6 | 2.4 |
| Jaw Crusher | 1,002.7 | 1,336.9 | 334.2 | 445.6 | 594.2 | 148.5 | 82.5 | 110.0 | 27.5 |
| No. 2 Crusher | 947.0 | 1,262.6 | 315.7 | 420.9 | 561.2 | 140.3 | 77.9 | 103.9 | 26.0 |
| No. 3 Crusher | 724.1 | 965.5 | 241.4 | 321.8 | 429.1 | 107.3 | 59.6 | 79.5 | 19.9 |
| No. 4 Crusher | 779.9 | 1,039.8 | 260.0 | 346.6 | 462.1 | 115.5 | 64.2 | 85.6 | 21.4 |
| Scalps Belt Conveyor | 2.9 | 3.9 | 1.0 | 0.9 | 1.3 | 0.3 | 0.3 | 0.4 | 0.1 |
| Jaw to Screen 1 Conveyer | 26.0 | 34.7 | 8.7 | 8.5 | 11.4 | 2.8 | 2.4 | 3.2 | 0.8 |
| No. 3 Belt Conveyor | 1.4 | 1.9 | 0.5 | 0.5 | 0.6 | 0.1 | 0.1 | 0.2 | 0.1 |
| No. 2 Crusher to Screen 2 Conveyor | 24.6 | 32.7 | 8.2 | 8.1 | 10.8 | 2.7 | 2.3 | 3.0 | 0.8 |
| No. 6 Belt Conveyor | 4.3 | 5.8 | 1.4 | 1.4 | 1.9 | 0.5 | 0.4 | 0.5 | 0.1 |
| Screen 2 to No. 2 Crusher Conveyor | 24.6 | 32.7 | 8.2 | 8.1 | 10.8 | 2.7 | 2.3 | 3.0 | 0.8 |
| Screen 2 to No. 3 Crusher Conveyor | 18.8 | 25.0 | 6.3 | 6.2 | 8.2 | 2.1 | 1.7 | 2.3 | 0.6 |
| No. 3 Crusher to Screen 2 Conveyor | 18.8 | 25.0 | 6.3 | 6.2 | 8.2 | 2.1 | 1.7 | 2.3 | 0.6 |
| Screen 2 to No. 4 Crusher Conveyor | 20.2 | 27.0 | 6.7 | 6.6 | 8.9 | 2.2 | 1.9 | 2.5 | 0.6 |
| No. 4 Crusher to Screen 3 Conveyor | 20.2 | 27.0 | 6.7 | 6.6 | 8.9 | 2.2 | 1.9 | 2.5 | 0.6 |
| Screen 3 to Product Conveyor | 20.2 | 27.0 | 6.7 | 6.6 | 8.9 | 2.2 | 1.9 | 2.5 | 0.6 |
| Scalps Pile Loading | 2.9 | 3.9 | 1.0 | 0.9 | 1.3 | 0.3 | 0.3 | 0.4 | 0.1 |

**Table 7 (Cont'd)**
**Calculated Annual TSP, $PM_{10}$ and $PM_{2.5}$ Emissions - Scenario 1 and 2**

Page 2 of 2

| Emissions Source | Calculated Annual TSP Emissions (kg/annum) by Source | | | Calculated Annual $PM_{10}$ Emissions (kg/annum) by Source | | | Calculated Annual $PM_{2.5}$ Emissions (kg/annum) by Source | | |
|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Difference | Scenario 1 | Scenario 2 | Difference | Scenario 1 | Scenario 2 | Difference |
| No3 Belt Pile Loading | 1.4 | 1.9 | 0.5 | 0.5 | 0.6 | 0.2 | 0.1 | 0.2 | 0.1 |
| No6 Belt Pile Loading | 4.3 | 5.8 | 1.4 | 1.4 | 1.9 | 0.5 | 0.4 | 0.5 | 0.1 |
| Post Screen 3 Pile Loading | 20.2 | 27.0 | 6.7 | 6.6 | 8.9 | 2.2 | 1.9 | 2.5 | 0.6 |
| Loading to Trucks - product piles | 182.3 | 182.3 | - | 86.2 | 86.2 | - | 13.1 | 13.1 | - |
| Haulage to/from Pugmill | 364.6 | 364.6 | - | 100.5 | 100.5 | - | 10.1 | 10.1 | - |
| Loading to Hopper | 91.1 | 91.1 | - | 43.1 | 43.1 | - | 6.5 | 6.5 | - |
| Cement to Silo | 58.5 | 58.5 | - | 31.2 | 31.2 | - | 4.7 | 4.7 | - |
| Conveying to Pugmill | 182.3 | 182.3 | - | 86.2 | 86.2 | - | 13.1 | 13.1 | - |
| Pugmill Mixer | 262.1 | 262.1 | - | 8.3 | 8.3 | - | 1.5 | 1.5 | - |
| Loading to Stockpiles | 182.3 | 182.3 | - | 86.2 | 86.2 | - | 13.1 | 13.1 | - |
| Loading to Trucks | 182.3 | 182.3 | - | 86.2 | 86.2 | - | 13.1 | 13.1 | - |
| Loading to Trucks - product piles | 39.3 | 39.3 | - | 18.6 | 18.6 | - | 2.8 | 2.8 | - |
| Haulage to/from Asphalt Plant | 314.2 | 314.2 | - | 86.6 | 86.6 | - | 8.7 | 8.7 | - |
| Unloading to Storage Piles | 39.3 | 39.3 | - | 18.6 | 18.6 | - | 2.8 | 2.8 | - |
| Loading to aggregate bins | 39.3 | 39.3 | - | 18.6 | 18.6 | - | 2.8 | 2.8 | - |
| Conveying to Dryer | 2.1 | 2.1 | - | 0.7 | 0.7 | - | 0.2 | 0.2 | - |
| Asphalt Plant ducted sources | 375.0 | 375.0 | - | 147.0 | 147.0 | - | 14.7 | 14.7 | - |
| Truck Load Out | 12.9 | 12.9 | - | 11.6 | 11.6 | - | 11.6 | 11.6 | - |
| Loading to Product Trucks | 336.5 | 701.1 | 364.6 | 159.2 | 331.6 | 172.4 | 24.1 | 50.2 | 26.1 |
| Unsealed - Product Transportation | 3,561.8 | 8,182.6 | 4,620.7 | 981.7 | 2,255.3 | 1,273.6 | 98.2 | 225.5 | 127.4 |
| Sealed - Product Transportation | 1,683.4 | 3,867.2 | 2,183.8 | 323.1 | 742.3 | 419.2 | 75.6 | 173.6 | 98.0 |
| Drill | 1,515.1 | 1,515.1 | - | 796.1 | 796.1 | - | 119.4 | 119.4 | - |
| Blast | 134.8 | 134.8 | - | 70.1 | 70.1 | - | 10.5 | 10.5 | - |
| Wind Erosion - Exposed surfaces and stockpiles | 10,880.0 | 10,880.0 | - | 5,440.0 | 5,440.0 | - | 816.0 | 816.0 | - |
| **Total** | **34,257.0** | **48,106.8** | **13,849.8** | **12,839.2** | **16,925.7** | **4,086.4** | **2,175.8** | **2,705.2** | **529.4** |

**Figure 13 Comparison of Calculated Annual TSP. $PM_{10}$ and $PM_{2.5}$ Emissions by Scenario**



# 7. ASSESSMENT OF AIR QUALITY IMPACTS

## 7.1 DISPERSION MODEL SELECTION AND APPLICATION

As discussed in Section 4, the CALPUFF (Version 6.2) modelling system was selected for application within this assessment. Model configuration was conducted in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia* (TRC Environmental, 2011).

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the transport pathway. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations and at grid intercepts across the modelling domain. CALPOST is then used to process these files, producing tabulations that summarise results of the simulation (Scire et al., 2006).

Air pollutant concentrations of particulate matter pollutants were simulated for a regular Cartesian receptor grid covering a 7 km (east-west) by 7 km (north-south) computational domain, set within the CALMET modelling domain and centred over the Quarry, with a grid resolution of 300 m. Additionally, concentrations were predicted at the various sensitive receptor locations listed in **Table 1**.

Simulations were undertaken for the 12 month period between 1 January 2014 and 31 December 2014.

## 7.2 METEOROLOGICAL AND EMISSIONS DATA

Meteorological data for the CALPUFF modelling was generated by CALMET using input of hourly varying meteorological observations and prognostic model output. Details regarding the CALMET modelling undertaken for the Quarry are presented in Section 4.1.

The methodology and results of the emissions inventory developed for the study are presented in Section 6 and **Annexure 2**. Emissions were simulated to be released between 6:30am and 6:00pm to coincide with Quarry operating hours. As blasting operations are periodic (15 per year), short-term in nature (less than one hour per release) and would generally occur when all other emissions sources are not active, emissions from blasting were not included in the modelling process. Wind erosion emissions were varied by wind speed, with higher emissions occurring during periods of higher wind speed.

## 7.3 MODEL RESULTS

Dispersion simulations were undertaken and results analysed for $PM_{10}$, concentrations from the Quarry. Tabulated results of $PM_{10}$ concentrations at the four neighbouring receptors are presented and discussed in Section 8.

Cumulative impacts have been assessed by pairing the maximum 24-hour average or annual average Quarry-only $PM_{10}$ increment concentration with the maximum 24-hour average and annual average $PM_{10}$ concentration from the Korora RTA dataset (37µg/m$^3$ and 18µg/m$^3$

respectively). This 100$^{th}$-percentile assessment approach for cumulative concentrations is in accordance with the NSW EPA Approved Methods for Modelling.

# 8. DISPERSION MODELLING RESULTS

## 8.1 RESULTS SUMMARY

The predicted incremental and cumulative TSP, $PM_{10}$ and $PM_{2.5}$ concentrations and dust deposition rates are presented in **Table 8** and **Table 9** for Scenario 1 and Scenario 2 respectively, for each of the identified receptor locations. The criteria applicable to the assessment are also presented generally applicable to cumulative concentrations, with the exception of dust deposition which is assessed against the incremental criterion.

The following key points are noted from the results in **Table 8** and **Table 9**.

- The predicted ground-level concentrations and deposition rates from the current (Scenario 1) operations at the Quarry are well within NSW EPA assessment criteria for all pollutants and averaging periods modelled.
- The proposed increase in annual extraction and production to 500 000tpa, is predicted to increase air quality impacts at all surrounding receptors. However, the predicted concentrations and deposition levels remain well below the applicable criteria for both scenarios at all receptors.
- Predicted incremental concentrations are minor in comparison with the indicative ambient background concentrations.

On the basis of the modelling conducted, adverse air quality impacts arising from the proposed modification of the Quarry are considered unlikely.

Incremental concentration isopleth plots for current and proposed operations are presented in **Annexure 3**.

## 8.2 CHANGE IN IMPACTS FROM QUARRY MODIFICATION

In addition to the presentation of the model predictions and comparison with relevant air quality assessment criteria, it is useful to review the predicted increase in concentrations from Scenario 1 (existing operations) to Scenario 2 (modified operations).

The change in predicted TSP, $PM_{10}$ and $PM_{2.5}$ concentrations by receptor is illustrated **Figure 14**.

Across all pollutants, it can be seen that the receptors most likely to experience an increase in impact associated with the modification in operations at the Quarry are R1, R4 and R8. However, the presented increase in modelled pollutants experienced across all surrounding receptors is predicted to be low and as highlighted previously in Section 8.1, would unlikely result in an exceedance of applicable criterion.

**Table 8**
**Predicted particulate matter concentration/deposition results – Scenario 1 (Existing Operations)**

| Receptor | Concentration/Deposition due to Quarry in Isolation | | | | | | Cumulative Concentration/Deposition due to Quarry + Background Air Quality (b) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TSP Annual Average µg/m³ | $PM_{10}$ Maximum 24-hr µg/m³ | $PM_{10}$ Annual Average µg/m³ | $PM_{2.5}$ Maximum 24-hr µg/m³ | $PM_{2.5}$ Annual Average µg/m³ | Deposition Annual Average g/m²/month | TSP Annual Average µg/m³ | $PM_{10}$ Maximum 24-hr µg/m³ | $PM_{10}$ Annual Average µg/m³ | $PM_{2.5}$ Maximum 24-hr µg/m³ | $PM_{2.5}$ Annual Average µg/m³ |
| **Criteria** | **NA** | **NA** | **NA** | **NA** | **NA** | **2** | **90** | **50** | **30** | **25(a)** | **8(a)** |
| R1 | 0.4 | 2.6 | 0.2 | 0.5 | <0.1 | <0.1 | 43.4 | 39.6 | 17.2 | 15.5 | 7.0 |
| R2 | 0.3 | 1.9 | 0.1 | 0.3 | <0.1 | <0.1 | 43.3 | 38.9 | 17.1 | 15.3 | 7.0 |
| R4 | 0.4 | 1.0 | 0.2 | 0.2 | <0.1 | 0.1 | 43.4 | 38.0 | 17.2 | 15.2 | 7.0 |
| R8 | 0.1 | 0.7 | 0.1 | 0.1 | <0.1 | <0.1 | 43.1 | 37.7 | 17.1 | 15.1 | 7.0 |
| R10 | 0.1 | 0.4 | 0.1 | 0.1 | <0.1 | <0.1 | 43.1 | 37.4 | 17.1 | 15.1 | 7.0 |
| R11A | 0.3 | 0.7 | 0.1 | 0.1 | <0.1 | 0.1 | 43.3 | 37.7 | 17.1 | 15.1 | 7.0 |
| R11B | 0.2 | 0.6 | 0.1 | 0.1 | <0.1 | <0.1 | 43.2 | 37.6 | 17.1 | 15.1 | 7.0 |
| R14 | 0.1 | 0.9 | 0.1 | 0.2 | <0.1 | <0.1 | 43.1 | 37.9 | 17.1 | 15.2 | 7.0 |

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is a sum of the maximum increment and the maximum baseline concentrations.

**Table 9**
**Predicted particulate matter concentration/deposition results – Scenario 2 (Modified Operations)**

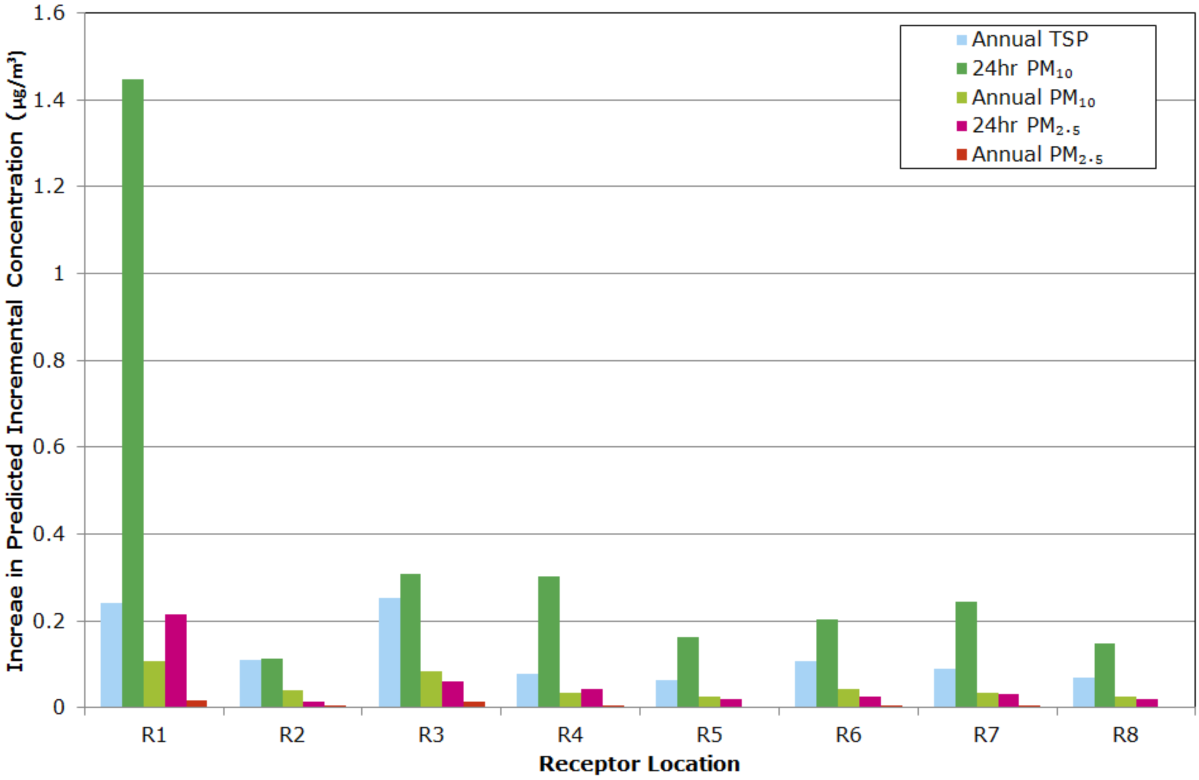
| Receptor | Concentration/Deposition due to Quarry in Isolation | | | | | | Cumulative Concentration/Deposition due to Quarry + Background Air Quality | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TSP Annual Average µg/m³ | $PM_{10}$ Maximum 24-hr µg/m³ | $PM_{10}$ Annual Average µg/m³ | $PM_{2.5}$ Maximum 24-hr µg/m³ | $PM_{2.5}$ Annual Average µg/m³ | Deposition Annual Average g/m²/month | TSP Annual Average µg/m³ | $PM_{10}$ Maximum 24-hr µg/m³ | $PM_{10}$ Annual Average µg/m³ | $PM_{2.5}$ Maximum 24-hr µg/m³ | $PM_{2.5}$ Annual Average µg/m³ |
| **Criteria** | **NA** | **NA** | **NA** | **NA** | **NA** | **2** | **90** | **50** | **30** | **25[(a)]** | **8[(a)]** |
| R1 | 0.7 | 4.1 | 0.3 | 0.8 | 0.1 | 0.1 | 43.7 | 41.1 | 17.3 | 15.8 | 7.1 |
| R2 | 0.4 | 2.0 | 0.2 | 0.4 | <0.1 | 0.1 | 43.4 | 39.0 | 17.2 | 15.4 | 7.0 |
| R4 | 0.7 | 1.3 | 0.3 | 0.2 | 0.1 | 0.1 | 43.7 | 38.3 | 17.3 | 15.2 | 7.1 |
| R8 | 0.2 | 1.0 | 0.1 | 0.2 | <0.1 | <0.1 | 43.2 | 38.0 | 17.1 | 15.2 | 7.0 |
| R10 | 0.2 | 0.6 | 0.1 | 0.1 | <0.1 | <0.1 | 43.2 | 37.6 | 17.1 | 15.1 | 7.0 |
| R11A | 0.4 | 0.9 | 0.2 | 0.2 | <0.1 | 0.1 | 43.4 | 37.9 | 17.2 | 15.2 | 7.0 |
| R11B | 0.3 | 0.8 | 0.1 | 0.1 | <0.1 | 0.1 | 43.3 | 37.8 | 17.1 | 15.1 | 7.0 |
| R14 | 0.2 | 1.1 | 0.1 | 0.2 | <0.1 | <0.1 | 43.2 | 38.1 | 17.1 | 15.2 | 7.0 |

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is a sum of the maximum increment and the maximum baseline concentrations.

**Figure 14 Increase in predicted TSP, $PM_{10}$ and $PM_{2.5}$ concentrations from current operations due to the Proposal**




# 9. CONCLUSIONS

Ramboll-Environ was commissioned by RWC to undertake an Air Quality Impact Assessment for the proposed modification of the development consent Possum Brush Quarry on behalf of the Proponent.

Model predictions of 24-hour average and annual average TSP, $PM_{10}$ and $PM_{2.5}$ concentrations and dust deposition rates were made for two emissions scenarios – current average production rate (240 000tpa) and proposed maximum production rate operations (500 000tpa). The results of the modelling indicate that for the two operational emission scenarios assessed, the potential impacts generated by the Quarry would be low and unlikely to exceed applicable air quality impact assessment criteria. Additionally, the comparison of model predictions between current and proposed operations highlighted that the proposed increase in extraction and production activities within the Quarry would unlikely result in a noticeable change in ambient air quality in the local environment.

# 10. REFERENCES

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

Bureau of Meteorology. Long-term climate statistics and hourly observations from Taree Airport station (Station Number 060141).

Countess Environmental (2006) *WRAP Fugitive Dust Handbook.*

NPI EETM (2012). National Pollutant Inventory, Emission Estimation Technique Manual for Mining, Version 3, Environment Australia.

NSW DEC (2005), Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

Roads and Traffic Authority (2007). Coffs Harbour Highway Planning – Sapphire to Woolgoolga section. Environmental Assessment – Working Paper 8.

Scire, J, Strimaitis, D and Yamartino, R. 2006. *A User's Guide for the CALPUFF Dispersion Model (Version 6)*

SLR (2014). *Jandra Quarry Intensification Project Air Quality Impact Assessment*. June 2014

US-EPA (1998). AP42 Emission Factor Database, Chapter 11.9 Western Surface Coal Mining, United States Environmental Protection Agency, 1998.

US-EPA (2004a). AP42 Emission Factor Database, Chapter 11.1 Hot Mix Asphalt Plants, United States Environmental Protection Agency, 2004.

US-EPA (2004b). AP42 Emission Factor Database, Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing, United States Environmental Protection Agency, 2004.

US-EPA (2006b). AP42 Emission Factor Database, Chapter 11.12 Concrete Batching, United States Environmental Protection Agency, June 2006.

US-EPA (2006b). AP42 Emission Factor Database, Chapter 13.2.2 Unpaved Roads, United States Environmental Protection Agency, November 2006.

US-EPA (2006c). AP42 Emission Factor Database, Chapter 13.2.4 Aggregate Handling and Storage Piles, United States Environmental Protection Agency, 2006.

US-EPA (2011). AP42 Emission Factor Database, Chapter 13.2.1 Paved Roads, United States Environmental Protection Agency.

# 11. GLOSSARY OF ACRONYMS AND SYMBOLS

| | |
|---|---|
| Approved Methods for Modelling | Approved Methods for the Modelling and Assessment of Air Pollutants in NSW |
| AHD | Australian Height Datum |
| BoM | Bureau of Meteorology |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| EPA | Environment Protection Authority |
| EPL | Environment Protection Licence |
| NPI | National Pollutant Inventory |
| OEH | NSW Office of Environment and Heritage |
| PBM | Pacific Blue Metal |
| $PM_{10}$ | Particulate matter less than 10 microns in aerodynamic diameter |
| $PM_{2.5}$ | Particulate matter less than 2.5 microns in aerodynamic diameter |
| Ramboll Environ | Ramboll Environ Australia Pty Ltd |
| RWC | R.W. Corkery & Co Pty Limited |
| TAPM | "The Air Pollution Model" |
| The Proponent | Pacific Blue Metal Pty Ltd |
| The Quarry | Possum Brush Quarry |
| TSP | Total Suspended Particulate |
| US-EPA | United States Environmental Protection Agency |
| VKT | Vehicle Kilometres Travelled |
| µg | Microgram (g x $10^{-6}$) |
| µm | Micrometre or micron (metre x $10^{-6}$) |
| $m^3$ | Cubic metre |

# Annexures

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# ANNEXURE 1 – Wind Roses

**Figure A1.1 Annual Wind Roses - Taree Airport BoM – 2009 to 2013**

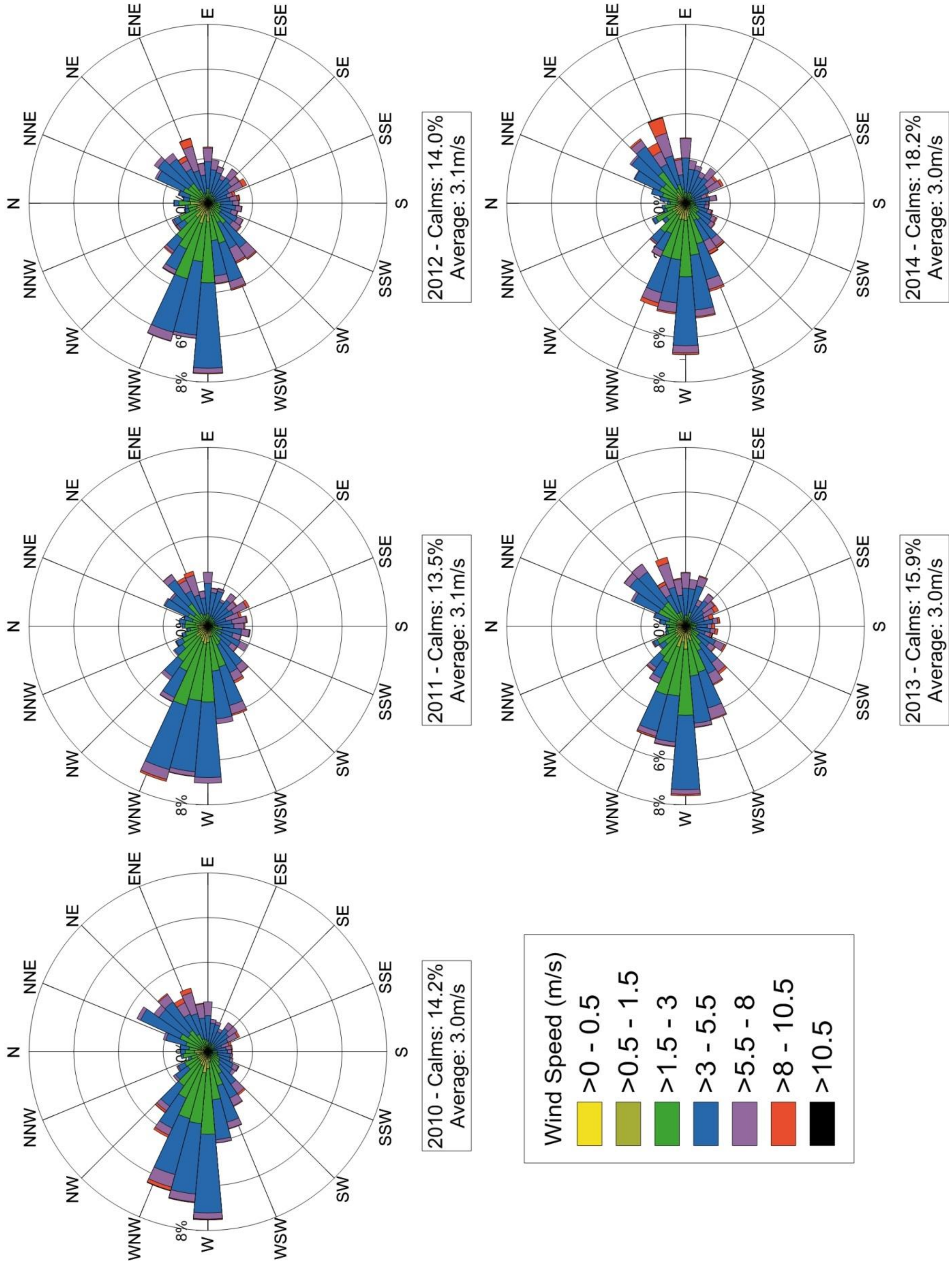
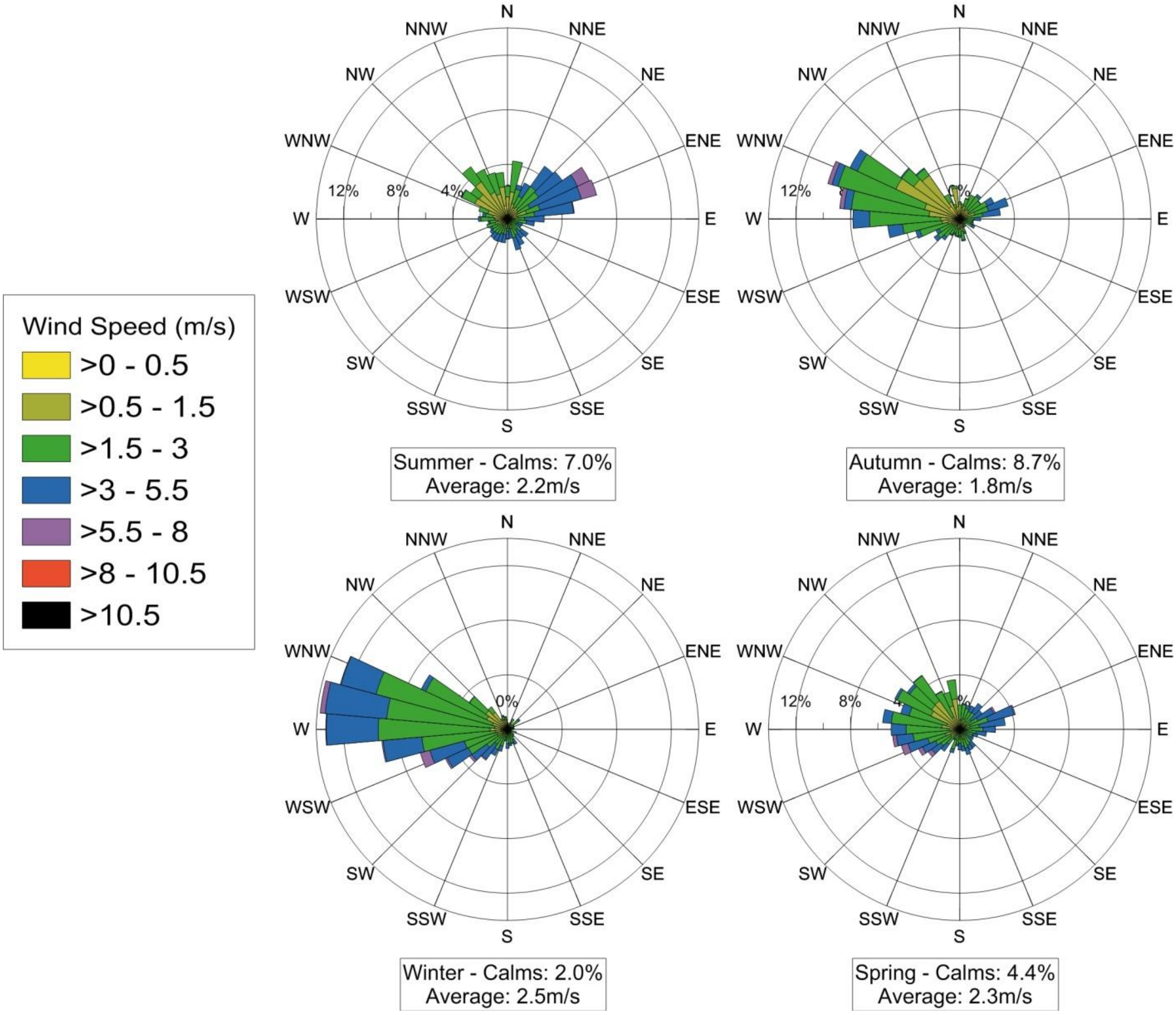
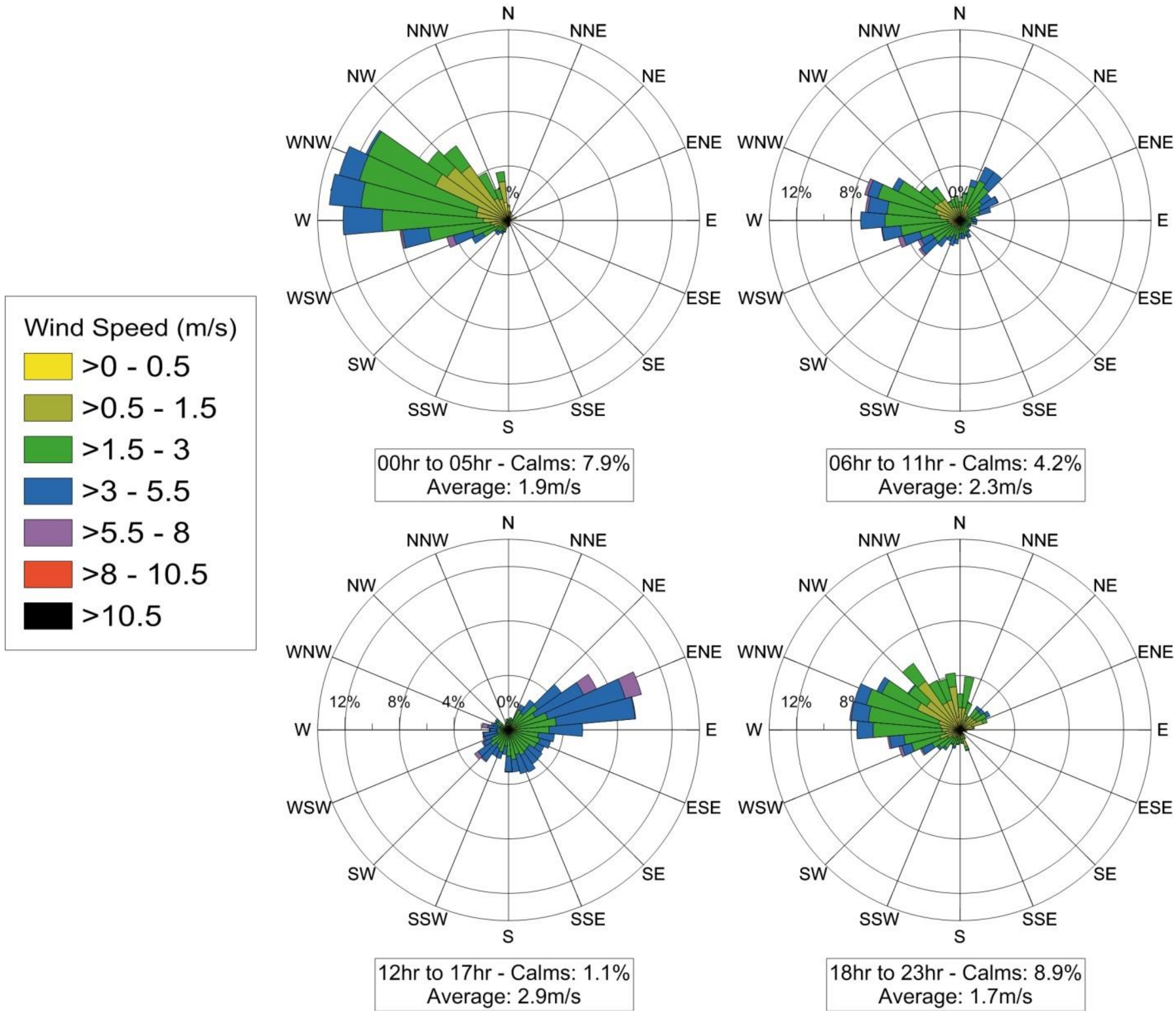


**Figure A1.2 CALMET Seasonal Wind Roses – Quarry Site - 2014**



## Figure A1.3 CALMET Diurnal Wind Roses – Quarry Site - 2014



# ANNEXURE 2 – Emission Inventory Background

## Introduction

Air emission sources associated with the various phases of the Quarry were identified and quantified through the application of accepted published emission estimation factors, collated from a combination of United States Environmental Protection Agency (US-EPA) AP-42 Air Pollutant Emission Factors and NPI emission estimation manuals, including the following:

- NPI Emission Estimation Technique Manual for Mining (NPI, 2012);
- AP-42 Chapter 11.1 – Hot Mix Asphalt Plant (US-EPA, 2004a);
- AP-42 Chapter 11.12 – Concrete Batching (US-EPA, 2006a) (for Pugmill operations);
- AP-42 Chapter 11.19.2 – Crushed Stone Processing and Pulverized Mineral Processing (US-EPA, 2004b);
- AP-42 Chapter 13.2.2 – Unpaved Roads (US-EPA 2006b);
- AP-42 Chapter 13.2.4 – Aggregate Handling and Storage Piles (US-EPA 2006c);
- AP-42 Chapter 13.2.1 – Paved Roads (US-EPA 2011); and
- AP-42 Chapter 11.9 - Western Surface Coal Mining (US-EPA 1998).

Particulate releases were quantified for TSP, $PM_{10}$ and $PM_{2.5}$, using ratios for that particle size fraction available within the literature (principally the US-EPA AP-42 and Countess Environmental, 2006), as documented in subsequent sections.

## Sources of Particulate Matter Emissions

Air emissions associated with the Quarry will primarily comprise of fugitive particulate matter releases. Key sources of emission were identified as follows:

- Removal of weathered rock/overburden by bulldozer.
- Drill and blast activities.
- Loading of blasted rock material to haul trucks for transportation to processing plant.
- Unloading of raw material to processing plant hopper.
- Crush/screen plant operation and assorted material stockpile loading.
- Loading of processed material to haul trucks for transportation to market, onsite pug mill and onsite asphalt plant.
- Pugmill/wetmix plant operations.
- Asphalt plant operations
- Wheel Generated emissions from unsealed (transportation of extracted rock and crushed rock) and sealed (site access road) roads.
- Wind erosion of exposed surfaces, open pit and active stockpiling areas.

## Particulate Matter Emission Factors Applied

The emission factor equations applied within the assessment are documented in this subsection. **Table A2.1** lists the uncontrolled emission factors that were applied for the two emission scenarios, references the source of the listed factors and whether the factor is derived from a specific equation or a published default emission factor.

**Table A2.1**
**Emission Estimation Factors Applied for All Scenarios**

Page 1 of 2

| Emission Source | Emission Factor | | | Emission Factor Unit | Source of Factor |
|---|---|---|---|---|---|
| | TSP | $PM_{10}$ | $PM_{2.5}$ | | |
| Waste Rock Management - Bulldozer | 1.118806 | 0.19747 | 0.117475 | kg/hour | AP-42 11.9 - Bulldozer on Material Other Than Coal |
| Truck Loading in Pit - Rock + Waste | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Raw Material Haulage - Unsealed | 3.996877 | 1.136568 | 0.113657 | kg/Vehicle KM Travelled | AP-42 13.2.2 - Unpaved Road Equation |
| Truck Unloading to Hopper | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Raw material rehandle | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Scalper | 0.0011 | 0.00037 | 0.000025 | kg/tonne | USEPA AP-42 11.19.2 - Screening Factor (controlled) |
| Screen 1 | 0.0011 | 0.00037 | 0.000025 | kg/tonne | USEPA AP-42 11.19.2 - Screening Factor (controlled) |
| Screen 2 | 0.0011 | 0.00037 | 0.000025 | kg/tonne | USEPA AP-42 11.19.2 - Screening Factor (controlled) |
| Screen 3 | 0.0011 | 0.00037 | 0.000025 | kg/tonne | USEPA AP-42 11.19.2 - Screening Factor (controlled) |
| Jaw Crusher | 0.0027 | 0.0012 | 0.000222 | kg/tonne | USEPA AP-42 11.19.2 - Tertiary Crushing Factor (controlled) |
| No. 2 Crusher | 0.0027 | 0.0012 | 0.000222 | kg/tonne | USEPA AP-42 11.19.2 - Tertiary Crushing Factor (controlled) |
| No. 3 Crusher | 0.0027 | 0.0012 | 0.000222 | kg/tonne | USEPA AP-42 11.19.2 - Tertiary Crushing Factor (controlled) |
| No. 4 Crusher | 0.0027 | 0.0012 | 0.000222 | kg/tonne | USEPA AP-42 11.19.2 - Tertiary Crushing Factor (controlled) |
| Scalps Belt Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Jaw to Screen 1 Conveyer | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No. 3 Belt Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No. 2 Crusher to Screen 2 Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No. 6 Belt Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Screen 2 to No. 2 Crusher Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Screen 2 to No. 3 Crusher Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No. 3 Crusher to Screen 2 Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Screen 2 to No. 4 Crusher Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No. 4 Crusher to Screen 3 Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Screen 3 to Product Conveyor | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |

**Table A2.1**
**Emission Estimation Factors Applied for All Scenarios**

Page 2 of 2

| Emission Source | Emission Factor | | | Emission Factor Unit | Source of Factor |
|---|---|---|---|---|---|
| Scalps Pile Loading | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No3 Belt Pile Loading | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| No6 Belt Pile Loading | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Post Screen 3 Pile Loading | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Loading to Trucks - product piles | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Haulage to/from Pugmill | 2.754852 | 0.759292 | 0.075929 | kg/Vehicle KM Travelled | AP-42 13.2.2 - Unpaved Road Equation |
| Loading to Hopper | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Cement to Silo | 0.0045 | 0.0024 | 0.000363 | kg/tonne | AP-42 11.12 - Cement supplement to silo |
| Conveying to Pugmill | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Pugmill Mixer | 0.067206 | 0.002126 | 0.000397 | kg/tonne | AP-42 11.12 - Central Mix Operation Equation |
| Loading to Stockpiles | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Loading to Trucks | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Loading to Trucks - product piles | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Haulage to/from Asphalt Plant | 2.754852 | 0.759292 | 0.075929 | kg/Vehicle KM Travelled | AP-42 13.2.2 - Unpaved Road Equation |
| Unloading to Storage Piles | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Loading to aggregate bins | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Conveying to Dryer | 0.00007 | 0.000023 | 6.5E-06 | kg/tonne | USEPA AP-42 11.19.2 - Conveyor Transfer (controlled) |
| Asphalt Plant ducted sources | 0.0125 | 0.0049 | 0.00049 | kg/tonne | AP-42 11.1 - Batch Mix Ducted Emission Sources |
| Truck Load Out | 0.000431 | 0.000388 | 0.000388 | kg/tonne | AP-42 11.1 - Batch Plant Load Out equation |
| Loading to Product Trucks | 0.001402 | 0.000663 | 0.0001 | kg/tonne | AP-42 13.2.4 - Materials Handling Equation / NPI Mining Equation 10 |
| Unsealed - Product Transportation | 2.754852 | 0.759292 | 0.075929 | kg/Vehicle KM Travelled | AP-42 13.2.2 - Unpaved Road Equation |
| Sealed - Product Transportation | 0.040506 | 0.007775 | 0.001818 | kg/Vehicle KM Travelled | AP-42 13.2.1 - Paved Road Equation |
| Drill | 0.59 | 0.31 | 0.0465 | kg/hole | AP-42 11.9 - Drilling factor |
| Blast | 5.616313 | 2.920483 | 0.438072 | kg/blast | AP-42 11.9 - Blasting Equation |
| Wind Erosion - Exposed surfaces and stockpiles | 850 | 425 | 63.75 | kg/ha/year | AP-42 11.9 - Wind erosion of exposed areas factor |

Details relating to the emission equations referenced in **Table A2.1** are presented in the following sections.

### *Unpaved Roads Equation*

The emissions factors for unsealed roads, as documented within AP42 Chapter 13.2.2 - "Unpaved Roads" (USEPA 2006), was applied as follows:

$E = k\,(s/12)^{a}(W*1.1023/3)^{b}$

Where:

E = Emissions Factor (lb/VMT)

s = surface material silt content (%)

W = mean vehicle weight (tonnes)

The following constants are applicable:

| Constant | $PM_{10}$ |
|---|---|
| K (lb/VMT) | 1.5 |
| A | 0.9 |
| B | 0.45 |

The metric conversion from lb/VMT to g/VKT is as follows:

1 lb/VMT = 0.2819 kg/VKT

Material parameters are listed in **Table A2.2**.

### *Paved Roads Equation*

The emissions factors for sealed roads, as documented within AP42 Chapter 13.2.2 -"Paved Roads" (US-EPA 2011), was applied as follows:

$E = k\,(sL)^{0.91}(W)^{1.02}$

Where:

E = Emissions Factor (g/VKT)

sL = road surface silt loading ($g/m^2$)

W = mean vehicle weight (tonnes)

k = constant of 1.5 for $PM_{10}$

Material parameters are listed in **Table A2.2**.

### *Materials Handling*

Particulate matter emissions from material transfer operations were calculated through the application of the US-EPA predictive emission factor equation for continuous and batch drop loading and tipping operations (AP42, Section 13.2.4), given as follows:

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

where,

E =Emissions (kg/tonne transferred)

U = mean wind speed (m/s)

M = material moisture content (%)

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

Emission rates were calculated on an hourly basis to reflect hourly variations in the wind field.

This emission factor was applied to the following sources:

- Extraction and loading of raw sand material and overburden;
- Unloading from trucks and FEL; and
- Various transfer points about along the crushing/screening plant circuit.

Material parameters are listed in **Table A2.2**.

## *Blasting Equation*

The emissions factors for blasting were taken from AP-42 Chapter 11.9 – "Western Surface Coal Mining" (USEPA 1998).

| Units | TSP | $PM_{10}$ |
|---|---|---|
| kg/blast | $0.00022(A)^{1.5}$ | TSP x 0.52 |

Where: A= horizontal area ($m^2$) with blasting depth ≤ 21.

## Quarry Related Input Data

Material property inputs used in the emission equations presented in **Table A2.1** are detailed in **Table A2.2**. It is noted that minimal details relating to the material properties were available at the time of reporting. To compensate, values were adopted from the literature.

**Table A2.2**
**Material Property Inputs for Emission Estimation Factors Applied for All Scenarios**

| Material Properties | Units | Value | Source of Information |
|---|---|---|---|
| Silt Content of Unsealed Roads - onsite | % | 8.3 | US-EPA AP42 (2006) mean value for "haul road to/from pit" for "Stone Quarrying and Processing" |
| Silt Content of Unsealed Roads materials storage area | % | 7.1 | US-EPA AP42 (2006) mean value for "Sand and Gravel Processing - Material Storage Area" |
| Silt Content of Overburden | % | 6 | US-EPA AP42 (2006c) mean value for Clay |
| Moisture Content of overburden | % | 10 | US-EPA AP42 (2006c) mean value for Clay |
| Silt Content of Raw Material | % | 3.9 | US-EPA AP42 (2006c) mean value for Stone Quarrying |
| Moisture Content of raw material | % | 1.77 | US-EPA AP42 (2006a) mean value for Aggregate |
| Silt Loading of Sealed Roads | g/m2 | 0.6 | Default baseline loading for roads with traffic <500 vehicles per day - US-EPA AP42 (2011) |

Key operational details by process used in the emission calculations are listed in **Table A2.3**. It is noted that the processing plant components are based on hourly processing rates of 120t/h and 160t/h for current and future operations respectively. Indicative percentage breakdown by stage of processing plant provided by the Proponent has been used to calculated annual processing rate by component. It is noted that annual processing rates total higher than raw extraction or final product dispatch amounts due to this calculation method.

**Table A2.3**
**Emission Estimation Activity Rates Applied for All Scenarios**

| Process | Unit | Scenario 1 | Scenario 2 |
|---|---|---|---|
| Raw material extraction | Amount of Rock (tonnes) | 240 000 | 500 000 |
| Scalper | | 412 620 | 550 160 |
| Screen 1 | | 371 358 | 495 144 |
| Screen 2 | | 371 358 | 495 144 |
| Screen 3 | | 288 834 | 385 112 |
| Jaw Crusher | | 371 358 | 495 144 |
| No. 2 Crusher | | 350 727 | 467 636 |
| No. 3 Crusher | | 268 203 | 357 604 |
| No. 4 Crusher | | 288 834 | 385 112 |
| Scalps Belt Conveyor | | 41 262 | 55 016 |
| Jaw to Screen 1 Conveyer | | 371 358 | 495 144 |
| No. 3 Belt Conveyor | | 20 631 | 27 508 |
| No. 2 Crusher to Screen 2 Conveyor | | 350 727 | 467 636 |
| No. 6 Belt Conveyor | | 61 893 | 82 524 |
| Screen 2 to No. 2 Crusher Conveyor | | 350 727 | 467 636 |
| Screen 2 to No. 3 Crusher Conveyor | | 268 203 | 357 604 |
| No. 3 Crusher to Screen 2 Conveyor | | 268 203 | 357 604 |
| Screen 2 to No. 4 Crusher Conveyor | | 288 834 | 385 112 |
| No. 4 Crusher to Screen 3 Conveyor | | 288 834 | 385 112 |
| Screen 3 to Product Conveyor | | 288 834 | 385 112 |
| Scalps Pile Loading | | 41 262 | 55 016 |
| No3 Belt Pile Loading | | 20 631 | 27 508 |
| No6 Belt Pile Loading | | 61 893 | 82 524 |
| Post Screen 3 Pile Loading | | 288 834 | 385 112 |
| Pugmill | | 130 000 | 130 000 |
| Asphalt Plant | | 28 000 | 28 000 |
| Haulage – Pit to Processing hopper | Distance (km) | 0.6 | 0.6 |
| Haulage – Stockpiles to Sealed Exit Road | | 0.4 | 0.4 |
| Haulage - Sealed Exit Road | | 1.8 | 1.8 |
| Wind Erosion | Area (ha) | 12.8 | 12.8 |
| Drill Holes | Holes per year | 2 568 | 2 568 |
| Blast Area | Area ($m^2$) | 867 | 867 |

# ANNEXURE 3 – Incremental Pollutant Isopleths

**Figure A3.1 Predicted Annual Average TSP Concentrations from Quarry-only – Current Operations (µg/m³)**

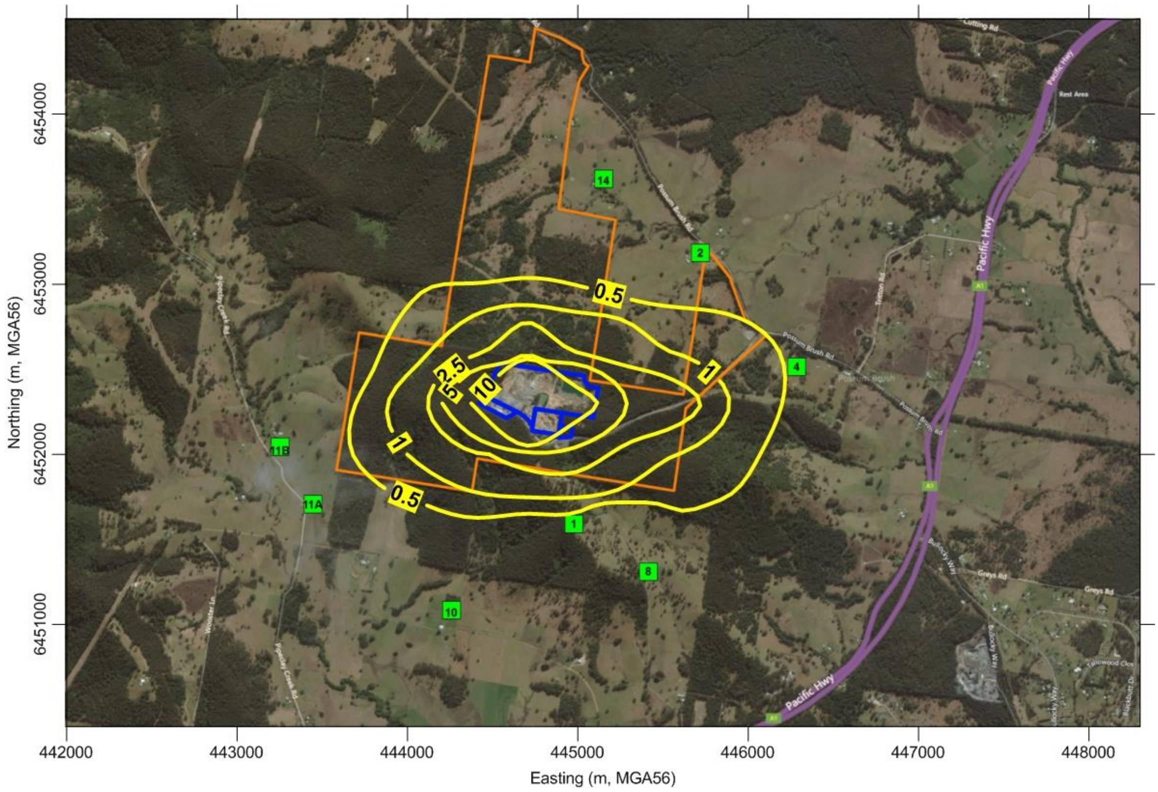
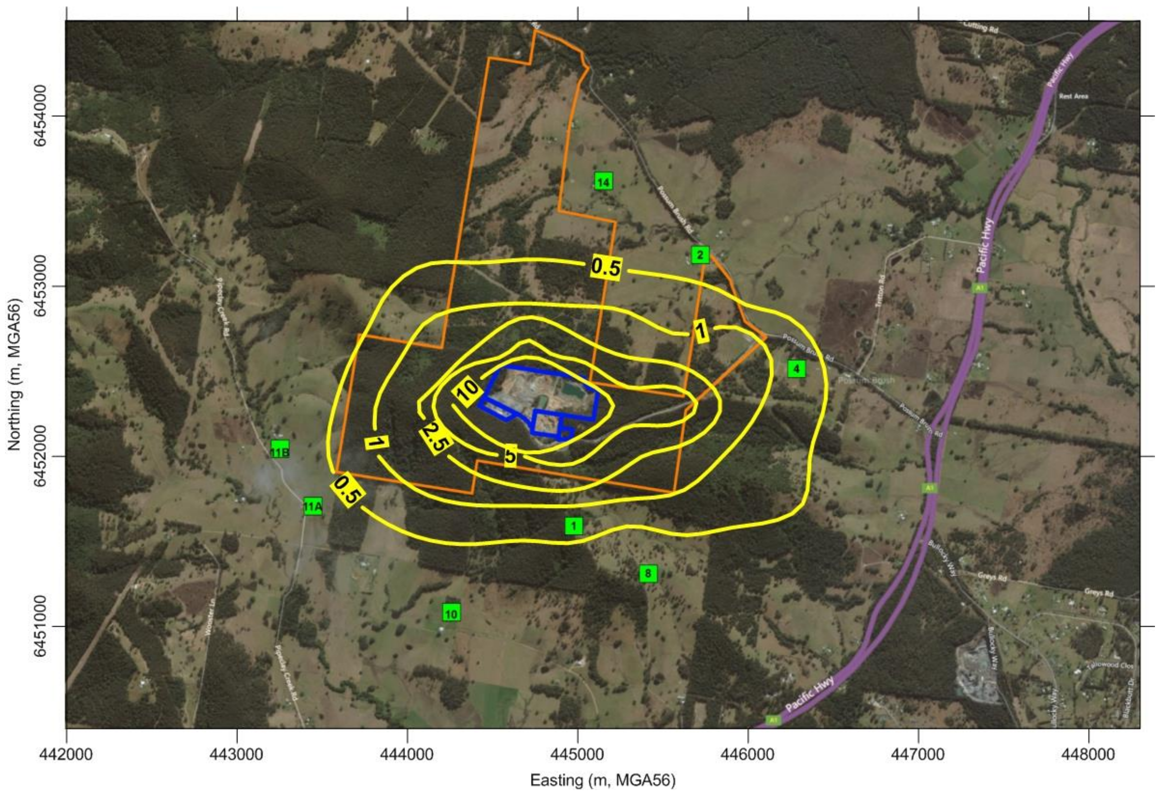
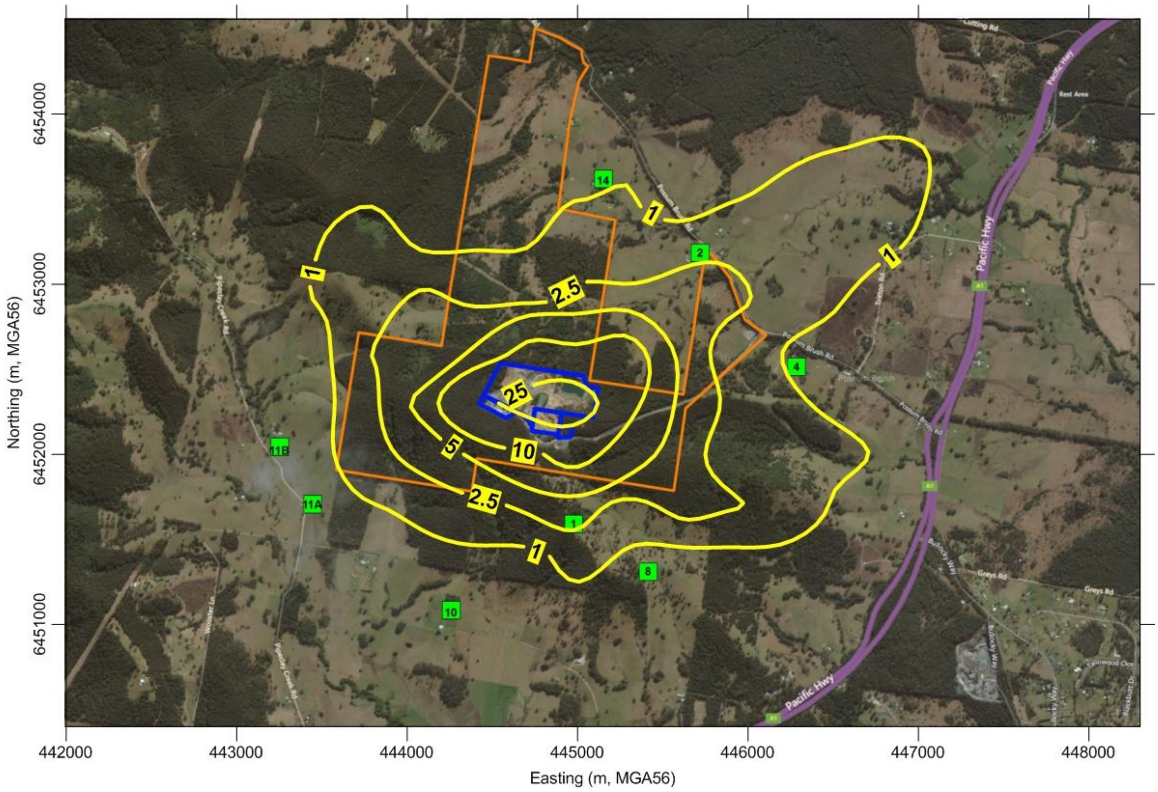



**Figure A3.2 Predicted Annual Average TSP Concentrations from Quarry-only – Future Operations (µg/m³)**



### Figure A3.3 Maximum Predicted 24-hour Average $PM_{10}$ Concentrations from Quarry-only – Current Operations (µg/m³)




### Figure A3.4 Maximum Predicted 24-hour Average $PM_{10}$ Concentrations from Quarry-only – Future Operations (µg/m³)

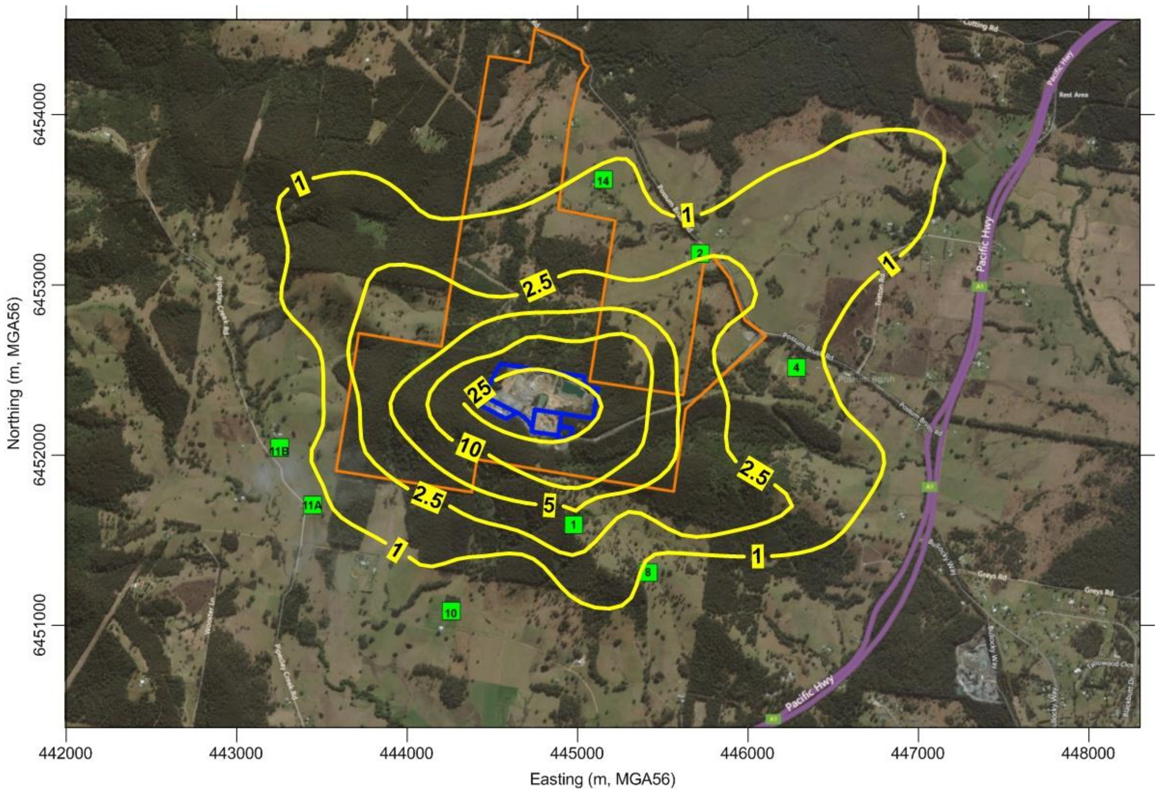


**Figure A3.5 Predicted Annual Average $PM_{10}$ Concentrations from Quarry-only – Current Operations (µg/m³)**

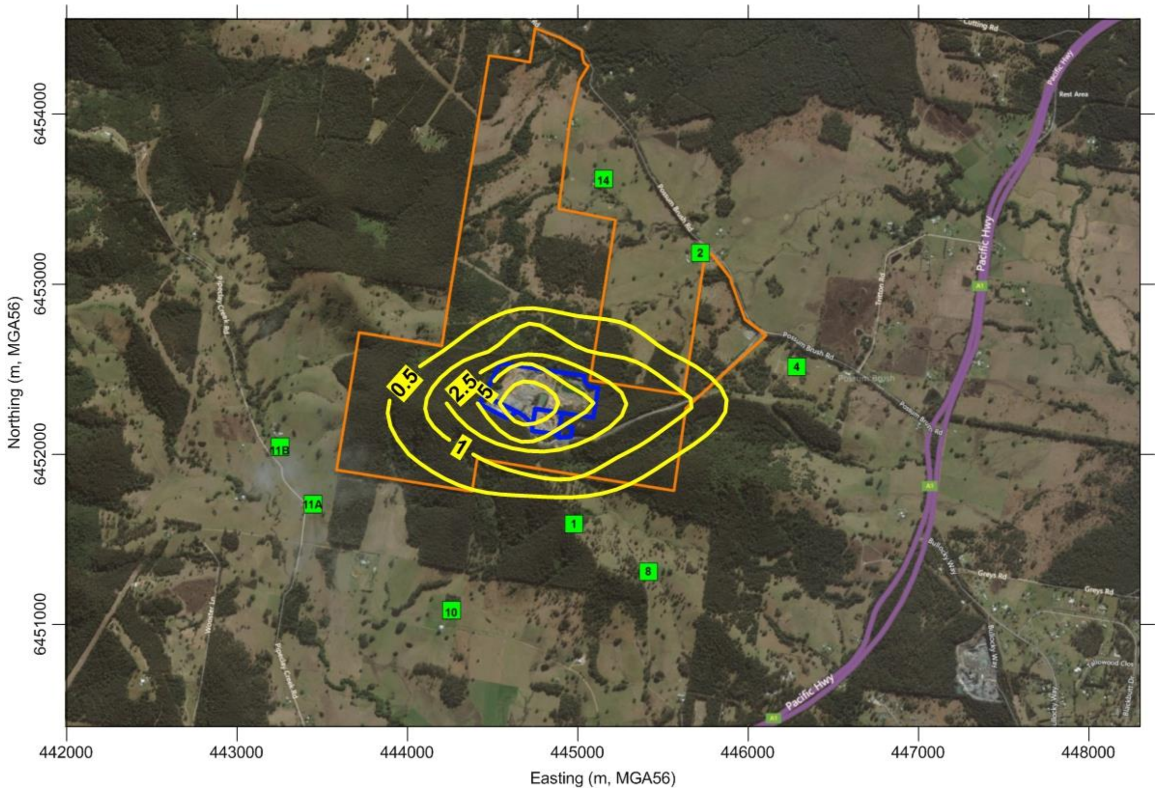



**Figure A3.6 Predicted Annual Average $PM_{10}$ Concentrations from Quarry-only – Future Operations (µg/m³)**

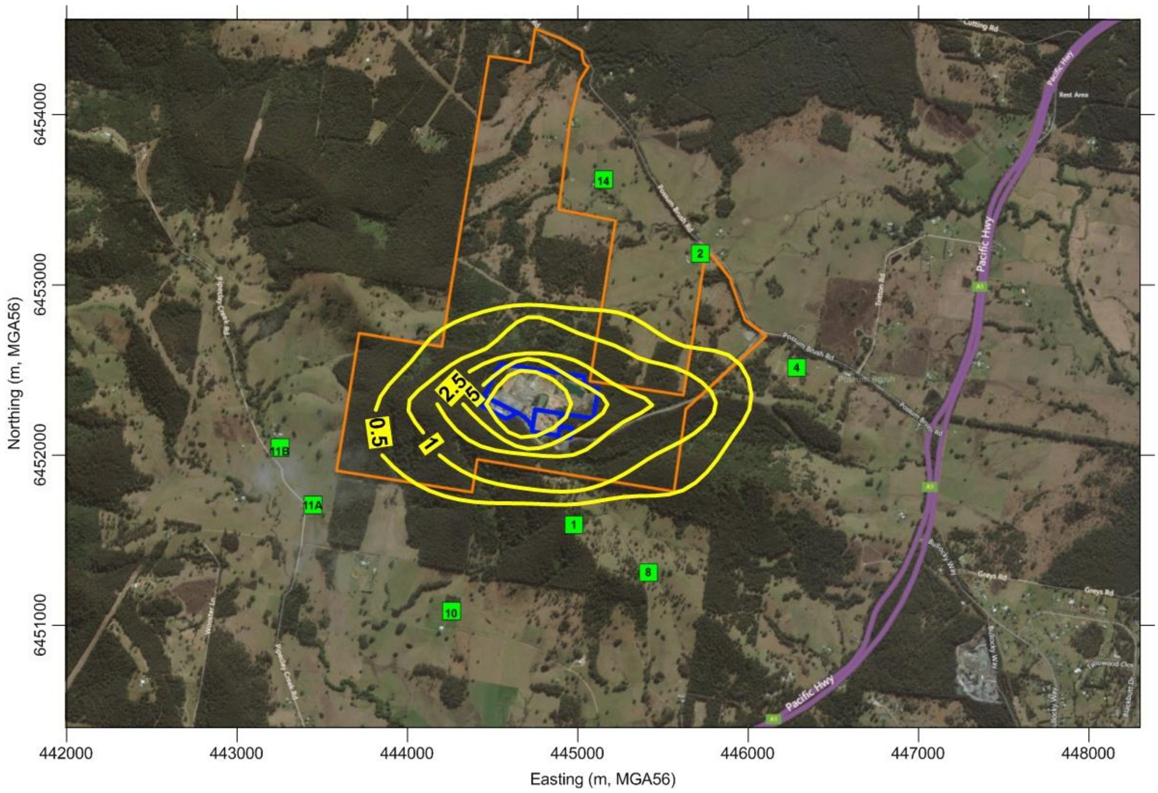


**Figure A3.7 Maximum Predicted 24-hour Average $PM_{2.5}$ Concentrations from Quarry-only – Current Operations (µg/m³)**

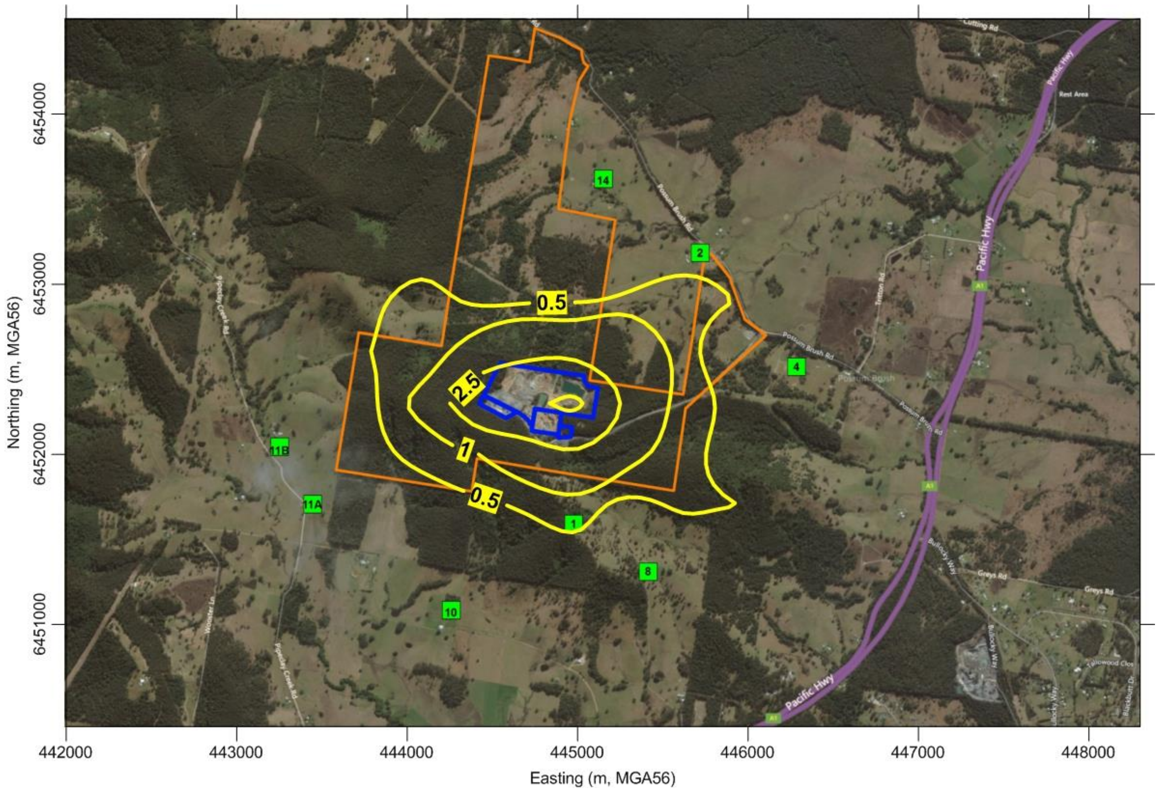



**Figure A3.8 Maximum Predicted 24-hour Average $PM_{2.5}$ Concentrations from Quarry-only – Future Operations (µg/m³)**

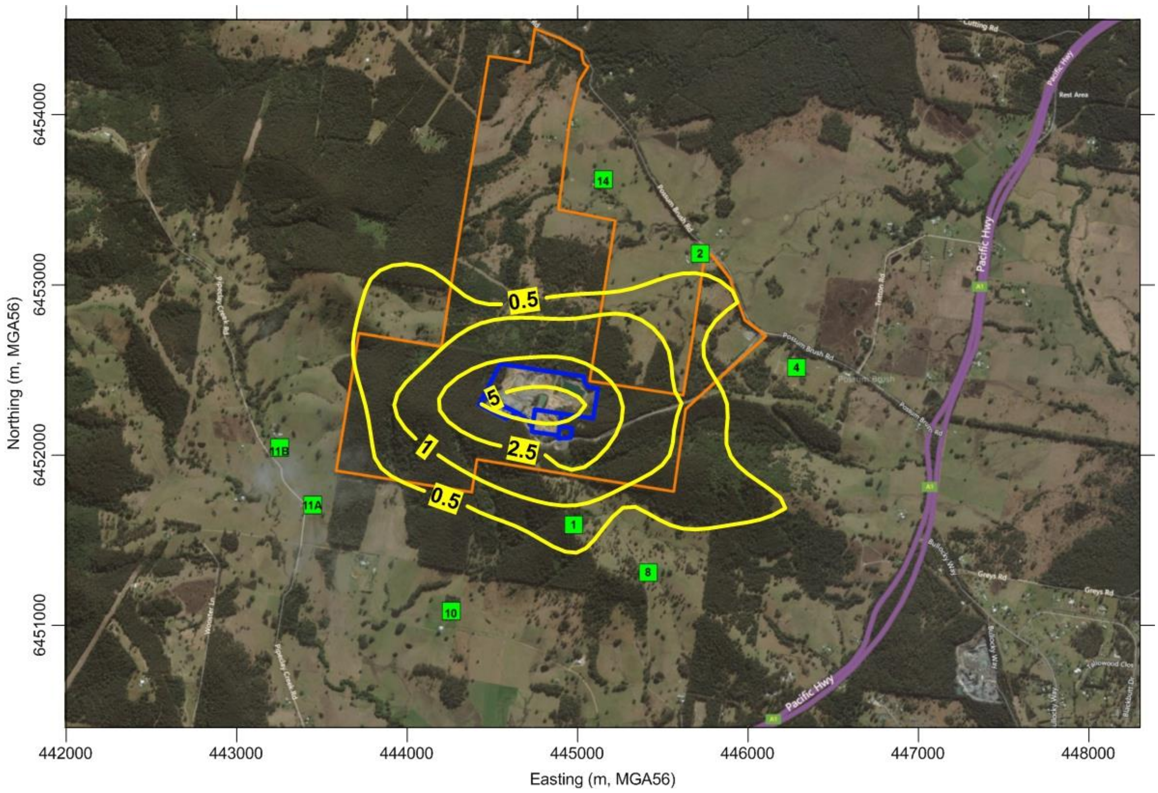


**Figure A3.9 Predicted Annual Average $PM_{2.5}$ Concentrations from Quarry-only – Current Operations (µg/m³)**

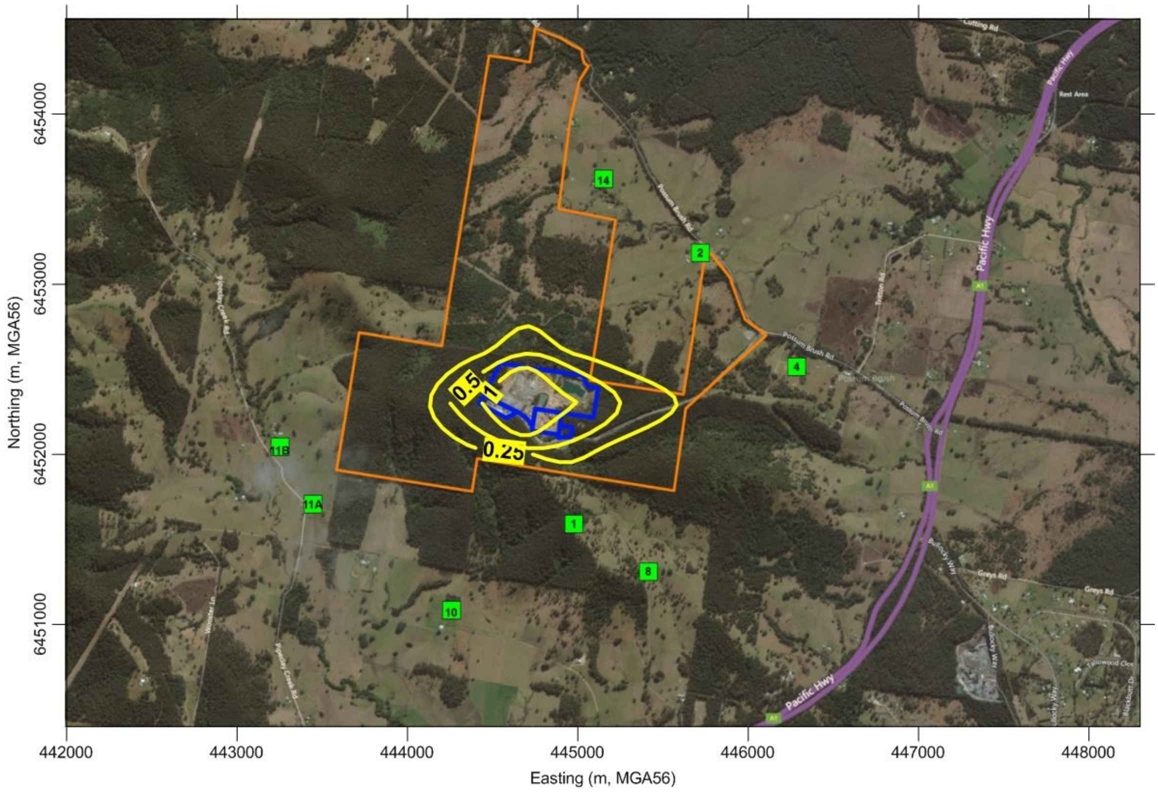



**Figure A3.10 Predicted Annual Average $PM_{2.5}$ Concentrations from Quarry-only – Future Operations (µg/m³)**

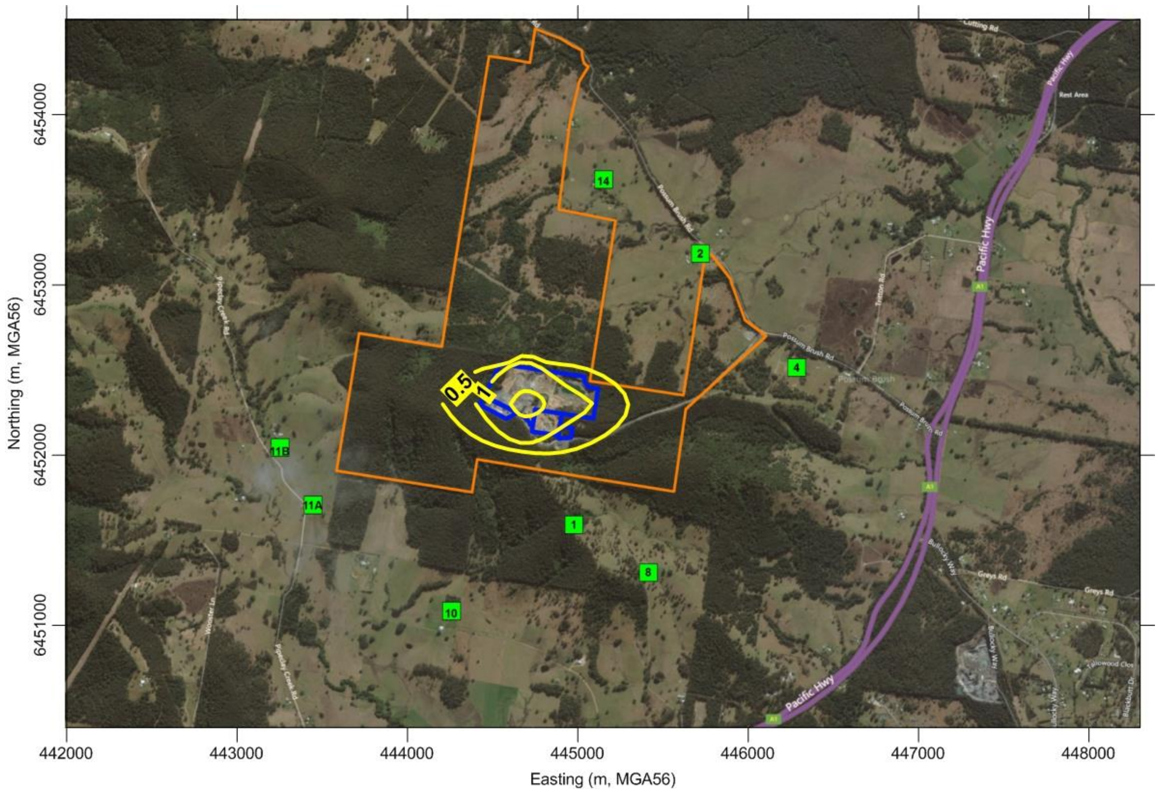


**Figure A3.11 Predicted Annual Average Dust Deposition Rates from Quarry-only – Current Operations (g/m²/month)**

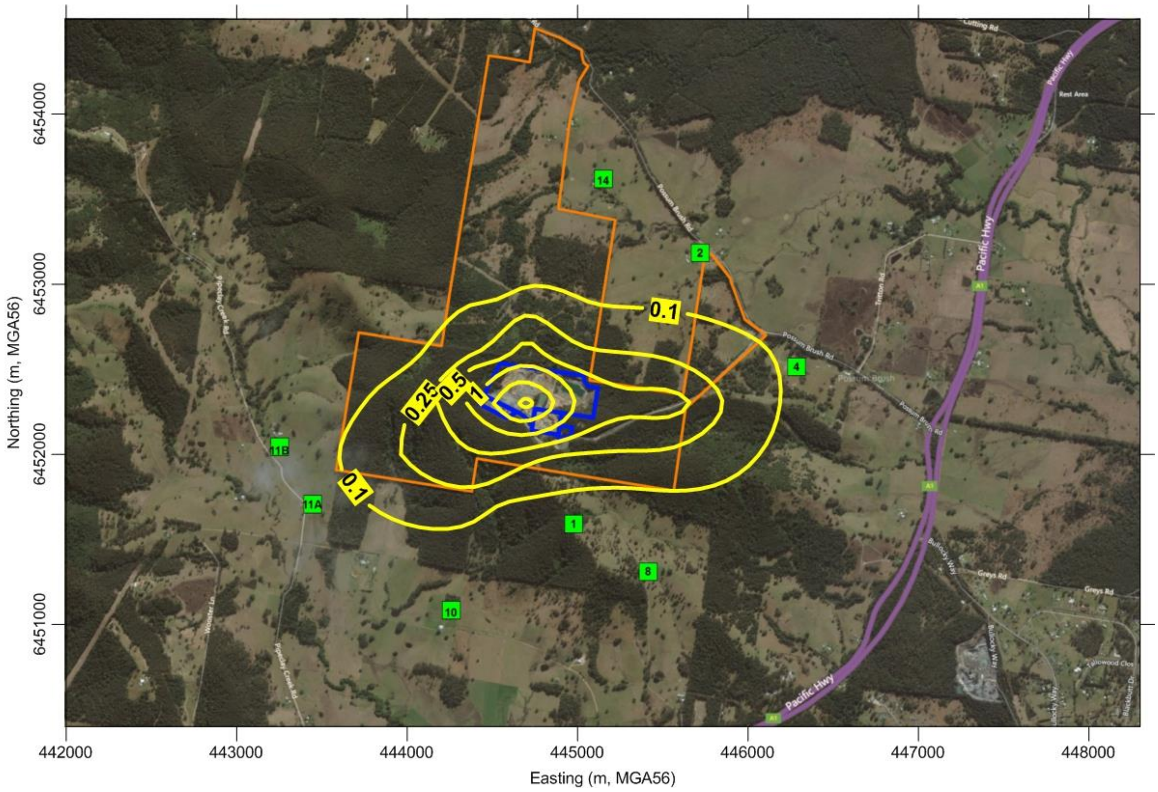
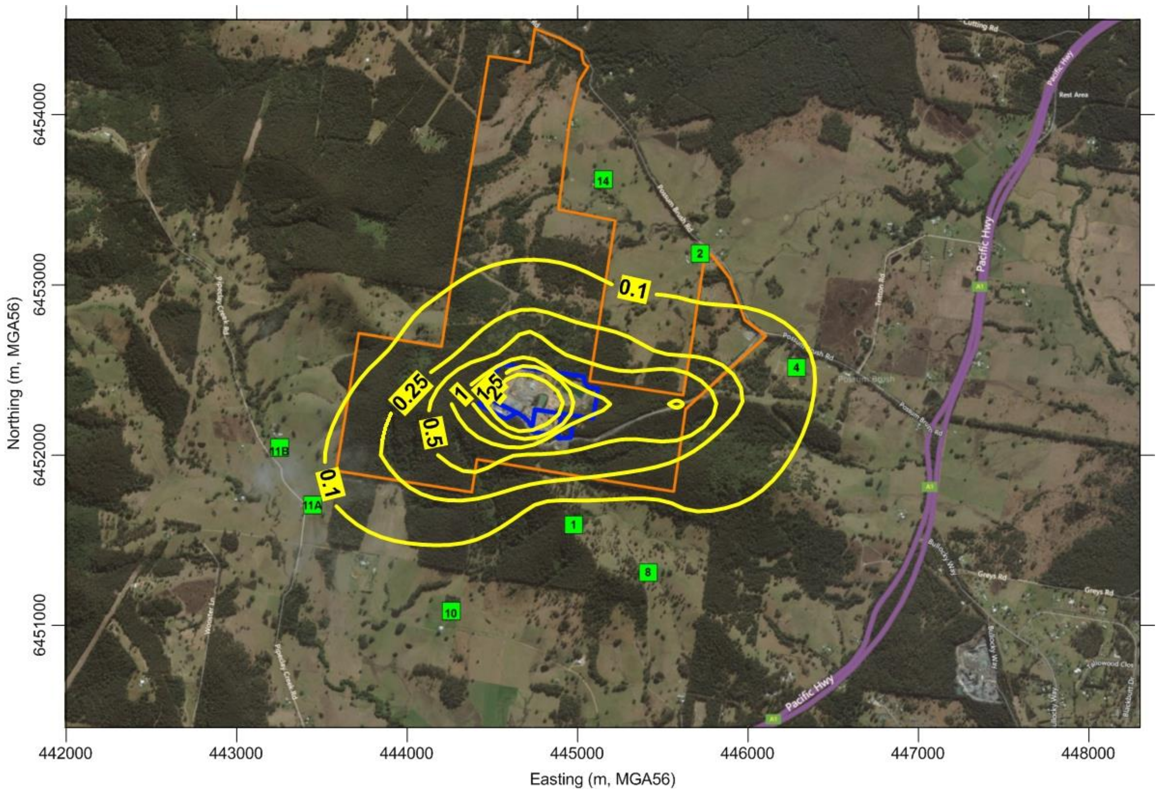



**Figure A3.12 Predicted Annual Average Dust Deposition Rates from Quarry-only – Future Operations (g/m²/month)**



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