Appendix 6

Air Quality Impact Assessment

prepared by

ENVIRON Australia Pty Ltd

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Air Quality Impact Assessment

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EXECUTIVE SUMMARY

Darryl McCarthy Constructions Pty Ltd (the Applicant) is seeking development consent for the continued operation and extension of Dowe's Quarry (the Quarry), located approximately 8km northeast of Tenterfield, in the New England region of NSW. The Quarry involves the extraction of quartzose material used to produce a range of ivory-coloured stone products used in the manufacture of decorative concrete and landscaping products.

The potential air quality impacts associated with the Project have been assessed within this report through a qualitative impact assessment. Aspects addressed in this assessment are as follows:

- 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 emissions from the Quarry; and
- A qualitative assessment of likely impacts, conducted through the comparison of operations at the Project Site with air quality impact assessments conducted for similar or larger quarry operations.

Particulate matter 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 current and two future scenarios. The calculations showed a slight decrease in annual emissions for future scenarios relative to current operations, despite the increase in disturbed areas. The proposed sealing of the initial section of the site access road from the intersection with Mount Lindesay Road was attributed with this decrease.

In assessing potential air quality impacts from the Quarry, dispersion modelling results presented within three air quality impact assessments recently conducted by ENVIRON for hard rock quarrying operations were reviewed. All three assessments were for extractive operations of greater intensity than the Quarry and were therefore considered conservative (upper-bound) estimations of potential impacts that could be experienced at surrounding sensitive receptors.

On the basis of the review conducted, it is considered unlikely that the current or proposed future modified operations at the Quarry will adversely impact upon the local air quality environment.

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1. INTRODUCTION

Darryl McCarthy Constructions Pty Ltd (the Applicant) is seeking development consent for the continued operation and extension of Dowe's Quarry (the Quarry), located approximately 8km northeast of Tenterfield, in the New England region of NSW. The Quarry involves the extraction of quartzose material used to produce a range of ivory-coloured stone products used in the manufacture of decorative concrete and landscaping products.

The Applicant is proposing to extend the existing extraction area by approximately 1.4ha to the west. Production levels would not exceed 100,000tpa with the annual average production level expected to be approximately 60,000tpa.

ENVIRON Australia Pty Ltd (ENVIRON) has been commissioned by R.W. Corkery & Co. Pty. Limited (RWC) on behalf of the Applicant to conduct an air quality assessment to review potential impacts of the Quarry and to recommend any potential emission mitigation measures.

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 emissions from the Quarry; and
- A qualitative assessment of likely impacts, conducted through the comparison of operations at the Project Site with air quality impact assessments conducted for similar or larger quarry operations.

2. PROJECT DESCRIPTION

2.1 EXISTING PROJECT OPERATIONS

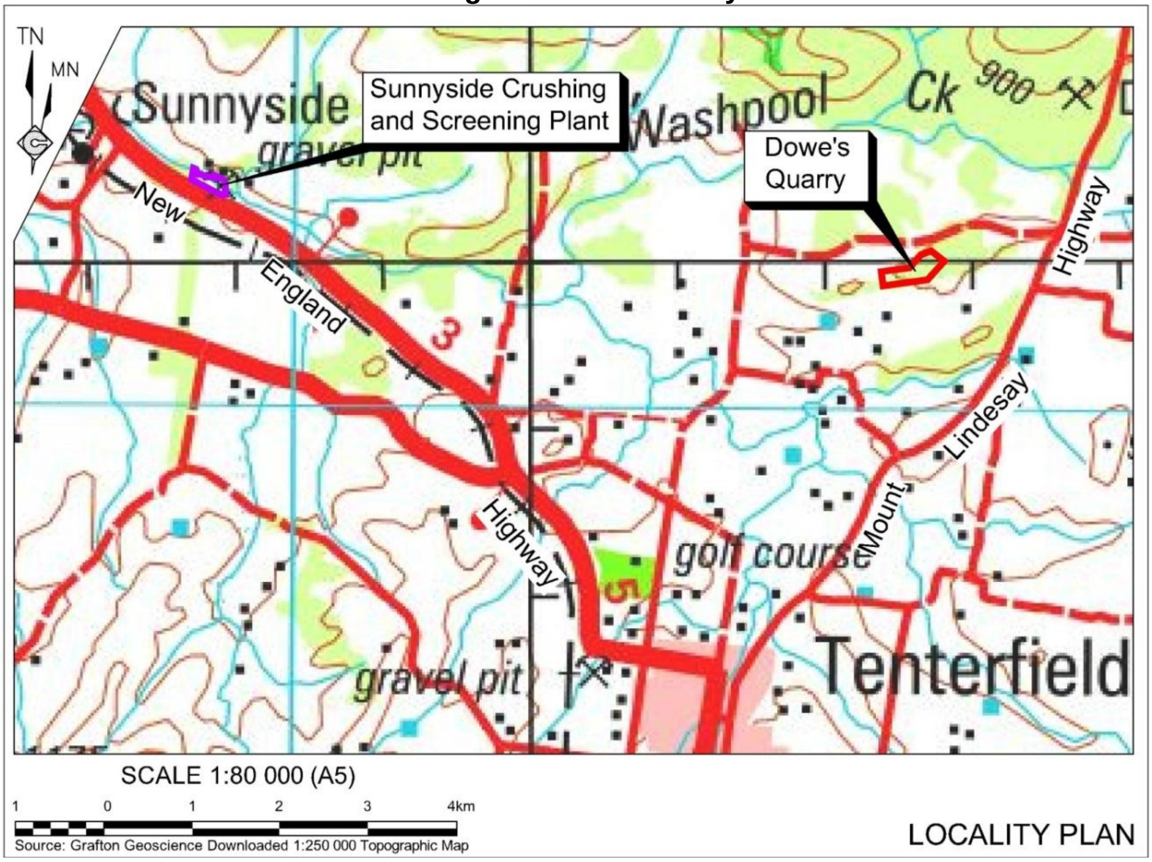
As stated, the Quarry is a quartzose extraction operation located 1.1km west of the Mount Lindesay Road and approximately 8km northeast of Tenterfield, NSW. The Quarry is located on an area of land totalling 13.5ha in area (the Project Site), contained within land owned by Mr Rod Dowe (Dowe's land) and leased by the Applicant.

Following vegetation and topsoil removal, material is extracted at the Project Site through periodic drill and blast activities with fragmented rock loaded into highway trucks for haulage principally to the Sunnyside Crushing and Screening Plant (SCSP).

Figure 1 illustrates the location of the Quarry and the SCSP. The Project Site (illustrated in **Figure 2**) incorporates the following component areas.

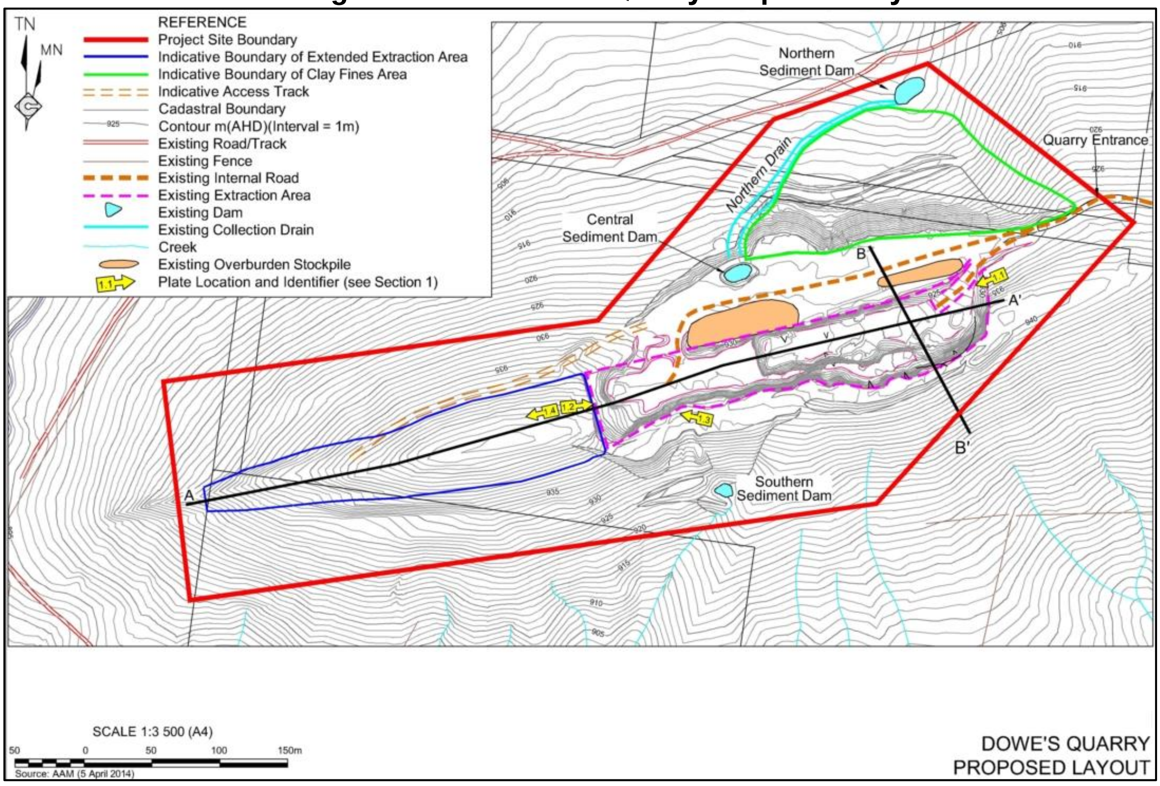
- An existing extraction area covering 1.4ha.
- The proposed extended extraction area covering 1.4ha.
- An existing Overburden Emplacement Area covering 1.3ha.
- A clay fines emplacement area for clay fines that have been back-loaded to the Project Site from the SCSP.
- Three dams associated with water storage, and sediment and erosion control referred to as Dams 1, 2 and 3.

Figure 1 Locality Plan



Source: RWC (2014)

Figure 2 Dowe's Quarry Proposed Layout



Source: RWC (2014)

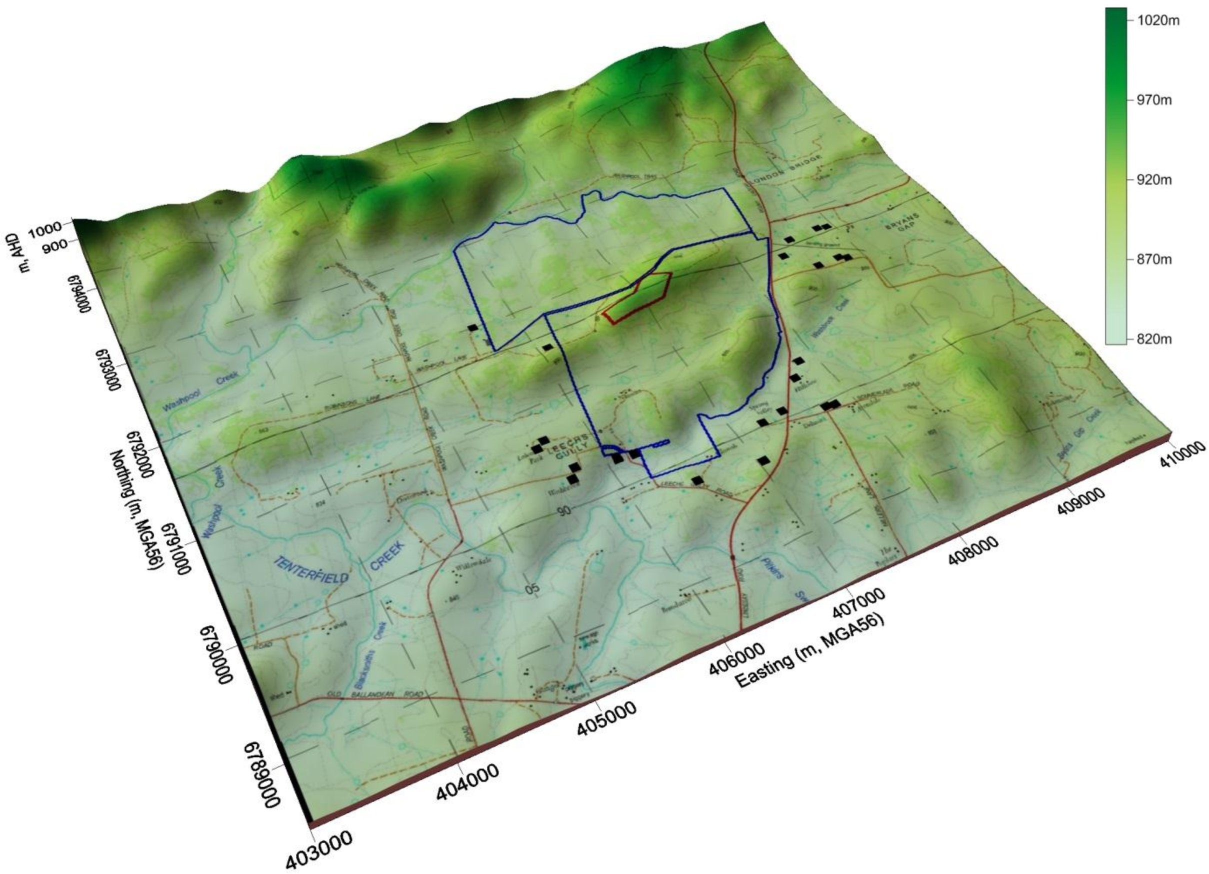
2.2 PROJECT AREA LAND USE AND TOPOGRAPHY

The Project Site is surrounded by mixed agricultural activities, including light grazing and pasture improvement. The quarrying activities on the Project Site are surrounded by forested land.

The Project Site is located on an elevated east-west aligned ridge line, elevations on the Project Site range between approximately 918m (Australian Height Datum (AHD)) and 945m AHD. The surrounding area features an east-west aligned valley, with undulating terrain surrounding the Project Site leading to notably elevated terrain to the north (2km) and south (7km).

A three-dimensional representation of the topography immediately surrounding the Project Site is presented in **Figure 1**3.

Figure 3 Surrounding Topographical Features



NOTE: Vertical exaggeration of four applied

NOTE: Red line marks Project Site boundary, blue line marks Dowe's-owned land and black squares mark surrounding non-Project receptors.

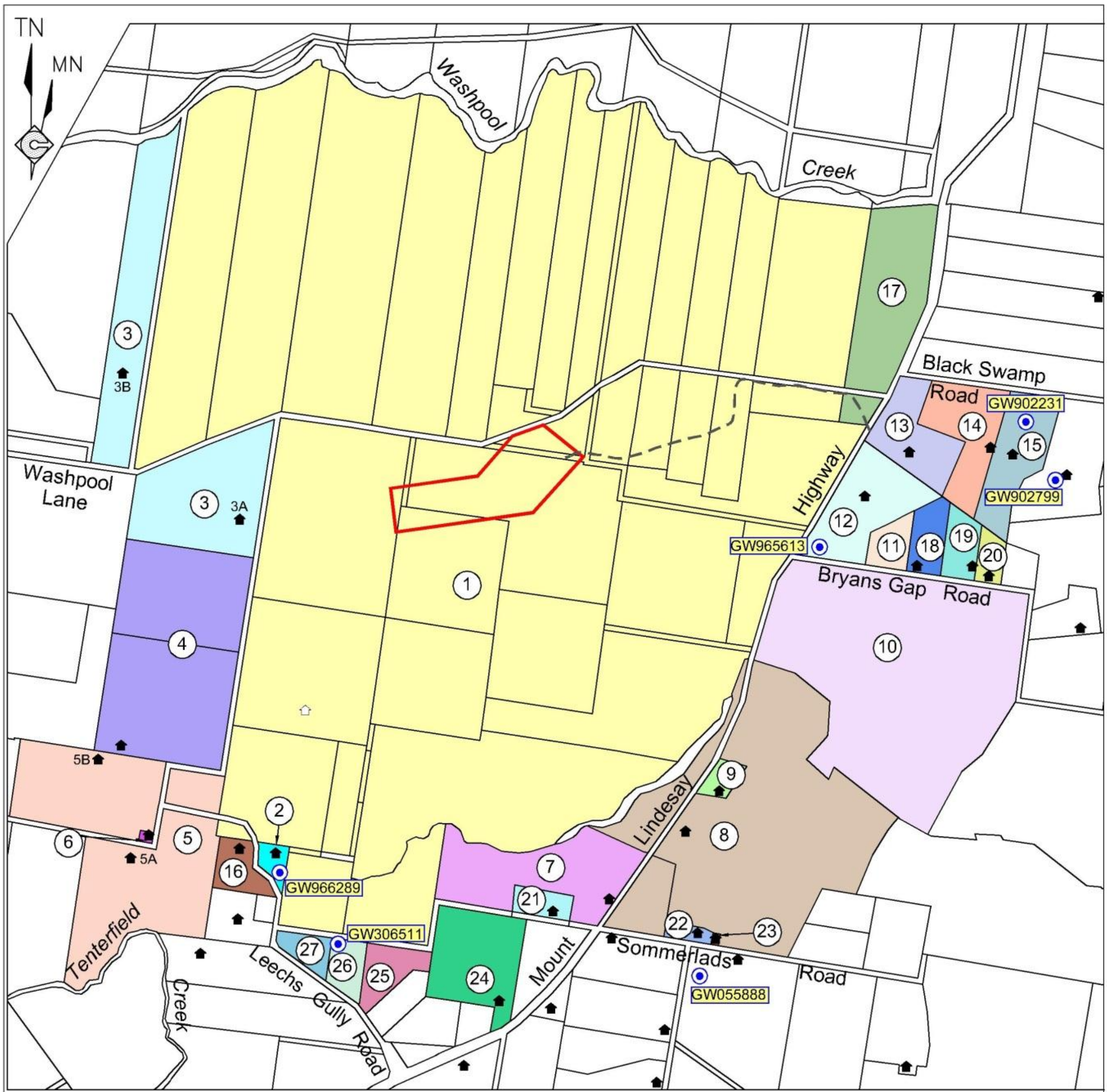
2.3 SURROUNDING RESIDENCES

The Project Site is located in proximity of a number of rural-residential properties beyond the boundary of Dowe's land. The selected receptor locations are presented in **Table 1** and illustrated in **Figure 4**.

Table 1
Selected Sensitive Receptor Locations Surrounding Project Site

Receptor ID	Location (m, MGA56S)		Distance (km) / Direction from		Elevation (m, AHD)
	Easting	Northing	Project Site Boundary	Site Access Road	
2	406218	6790241	1.3 / SSW	1.6 / SSW	839
3A	406085	6791470	0.6 / W	1.0 / W	892
3B	405655	6792008	1.1 / WNW	1.5 / WNW	861
4	405648	6790638	1.3 / SW	1.7 / SW	862
5A	405684	6790223	1.5 / SW	2.0 / SW	848
5B	405564	6790586	1.4 / SW	1.8 / SW	861
6	405750	6790308	1.4 / SW	1.9 / SW	853
7	407446	6790072	1.5 / SSE	1.6 / SSE	858
8	407727	6790321	1.3 / SSE	1.4 / S	860
9	407851	6790470	1.2 / SE	1.3 / SSE	858
12	408388	6791555	1.0 / E	0.2 / S	883
13	408551	6791718	1.2 / E	0.2 / ESE	880
14	408850	6791735	1.5 / E	0.5 / E	879
15	408932	6791710	1.6 / E	0.5 / E	881
16	406084	6790258	1.3 / SSW	1.7 / SW	843
18	408580	6791299	1.3 / ESE	0.5 / SSE	893
19	408783	6791298	1.5 / ESE	0.6 / SE	897
20	408844	6791262	1.6 / ESE	0.7 / SE	901
21	407239	6790027	1.5 / S	1.6 / S	864
22	407772	6789947	1.7 / SSE	1.8 / S	864
23	407838	6789927	1.7 / SSE	1.8 / SSE	868
24	407041	6789697	1.8 / S	1.9 / S	867
26	406508	6789770	1.7 / S	1.9 / SSW	859

Figure 4 Land Ownership, Surrounding Residences and Groundwater Bores



REFERENCE
- Project Site Boundary
- Cadastral Boundary
- Quarry Access Road
- Residence (Project Related)
- Residence (Non-Project Related)
- (1) Landowner Reference (See Table)
- GW965613 Groundwater Bore and Identifier

Ref	Landowner	Ref	Landowner
1	RSH & MO Dowe	14	GM O'Reilly, MP Watt
2	J-P Jacquet, MJ Bielski	15	WH & GM Cooper
3	Vibrato Investments Pty Limited	16	PA & KM Willis
4	RL Caldwell	17	The State of New South Wales
5	GL & JM Smith	18	MP & CA Moore
6	DB Weir, GR Smith, WF Marsden	19	GB & DK Phillips
7	SJ & JM Martin	20	CA Jackson, D Bunic
8	RB & CA Sewell	21	DM & AJ Mullins
9	MJ & NJ Lewis, RB & CA Sewell	22	JP & SL Doyle
10	KR & LA Willcocks	23	LD Merchant
11	JK & HJ Ingram	24	Harewood Investments Pty Limited
12	TE Barratt (Jnr), NL Bush	25	D Puglisi
13	IM Ibbett	26	JE Ferguson
		27	D Parsons

SCALE 1:25 000 (A4)

250 0 250 500 750 1000 1250 m

Cadastral Source: LPI (2014)
Landowner Source: Department of Lands Online Search - March 2014

LAND OWNERSHIP, SURROUNDING RESIDENCES AND GROUNDWATER BORES

Source: RWC (2014)

3. AIR QUALITY ASSESSMENT CRITERIA

The air quality assessment criteria that would be applicable to the Quarry are those specified by the NSW Environment Protection Authority (NSW EPA) within the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005). The primary pollutants generated by the Quarry are expected to be particulate matter, including Total Suspended Particulates (TSP), particulate matter less than 10microns in aerodynamic diameter (PM_{10}) and particulate matter less than 2.5microns in aerodynamic diameter ($PM_{2.5}$). Gaseous pollutants associated with diesel combustion and blasting activities may also be generated by the Quarry, however it is expected that these emissions would be minor.

With regards to air quality compliance, impacts from PM_{10} and dust deposition (derived from TSP emissions) are the most relevant pollutants arising from operations at the Quarry. Consequently, the specific goals that would be applied at surrounding receptors are as follows:

- PM_{10}: A 24-hour maximum of 50µg/m^3.
  An Annual average of 30µg/m^3.
- Dust Deposition: An incremental annual average dust deposition level of 2g/m^2/month.

To be in compliance with specific goals for PM_{10}, operations must demonstrate that cumulative air pollutant concentrations, taking into account incremental concentrations due to the operation's emissions and existing background concentrations, are within ambient air quality limits. This qualitative assessment has reviewed potential PM_{10} and dust deposition impacts from the Quarry.

4. CLIMATE AND DISPERSION METEOROLOGY

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

No meteorological observations are recorded at the Quarry. The following data sets were used in the meteorological analysis:

- 1-hour average meteorological predictions for the Project Site generated by the CSIRO using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM). A complete 12-months of modelling was conducted (2013 calendar year), in accordance with the TAPM configuration guidelines specified within the *Approved Methods for Modelling*.; and
- Long-term climate statistics obtained from the Bureau of Meteorology climate stations at Tenterfield (Federation Park) (Station Number 056032) and Applethorpe (Station Number 041175), located 7km south-southwest and 43km north-northwest of the Quarry respectively.

In order to review the likely dispersion meteorology for the Quarry area, analysis of dominant wind regime, temperature and moisture budget has been undertaken.

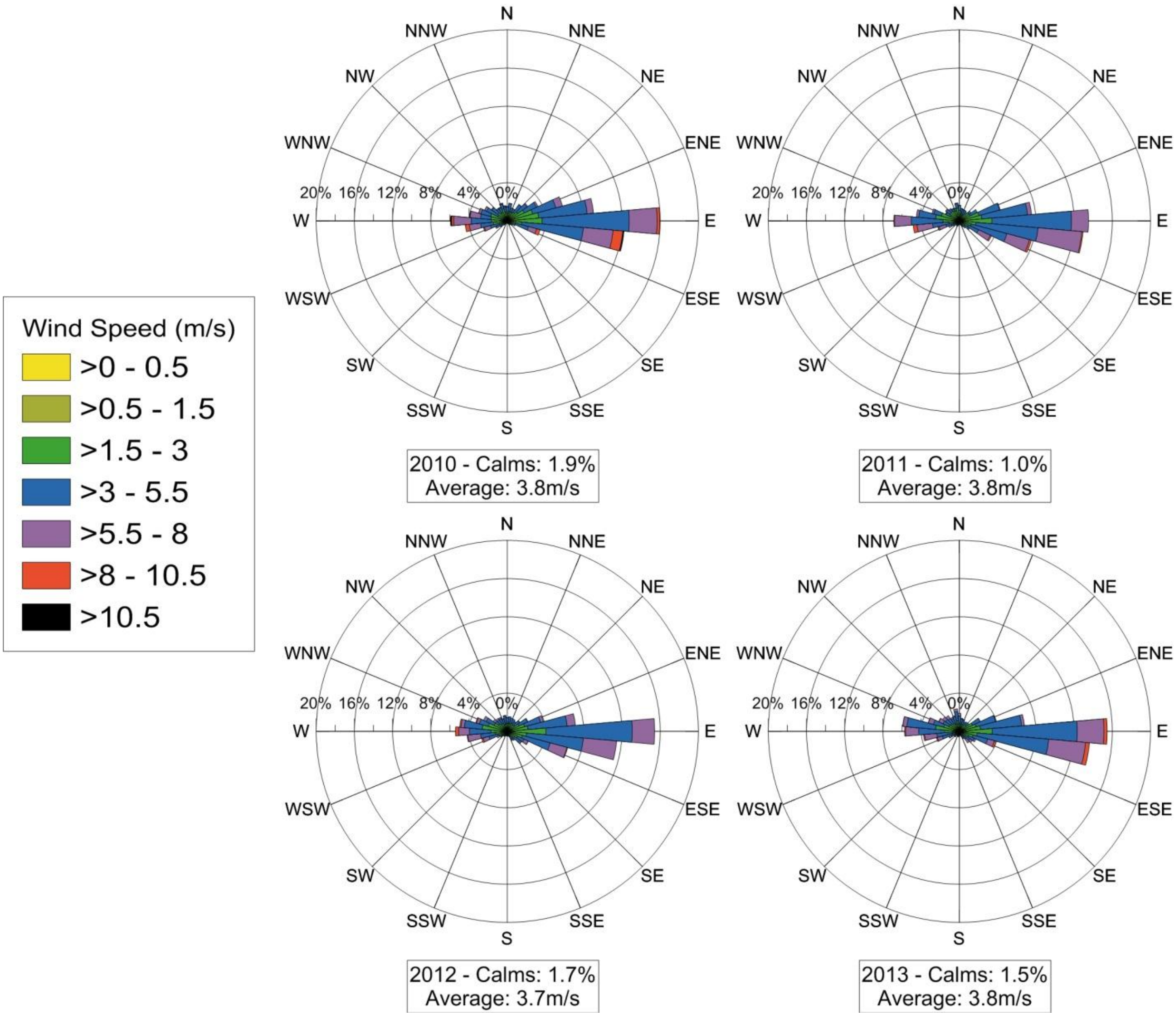
4.1 PREVAILING ANNUAL WIND REGIME

In the absence of reliable wind speed and direction measurements in the Tenterfield region, the CSIRO prognostic meteorological model TAPM was configured to predict a four complete years of meteorological data between 2010 and 2013 for the Project Site.

Annual wind roses of recorded wind speed and direction data from the TAPM predicted data between 2010 and 2013 is presented in **Figure 5**. It is noted that for all four modelled years, pronounced easterly flow dominates the predicted wind direction data. The defined east-west alignment of the regional topography (as discussed in **Section 2.2**) is considered to be a key contributor to this wind alignment.

Highest wind speeds are most frequently experienced from the easterly direction. The average predicted wind speed for all years was in the order of 4m/s, with a frequency of calm conditions (wind speeds less than 0.5 m/s) below 2%. It is noted however that the under prediction of calm wind conditions is a noted weakness of the TAPM meteorological model and it is likely that actual calm conditions in the area would be higher, particularly during night/early morning hours in winter.

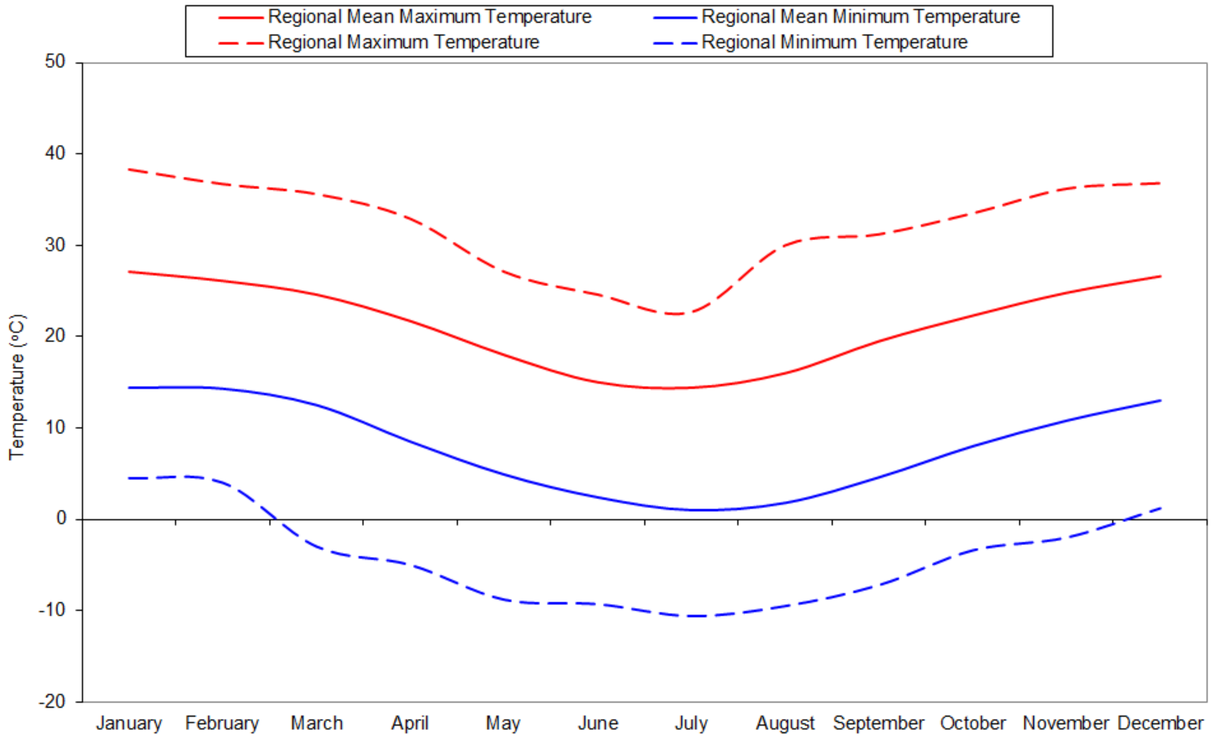
Figure 5 Annual TAPM-predicted Wind Roses – Project Site – 2010 to 2013



4.2 AMBIENT TEMPERATURE

Monthly mean minimum temperatures are in the range of 1°C to 14°C, with mean maxima of 14°C to 27°C, based on the long-term average record. Peaks occur during summer months with the highest temperatures typically being recorded between November and February. The lowest temperatures are usually experienced between June and August.

Figure 6 Monthly Temperature Variance – Tenterfield (Federation Park) – 1907 to 2014



4.3 RAINFALL AND EVAPORATION

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

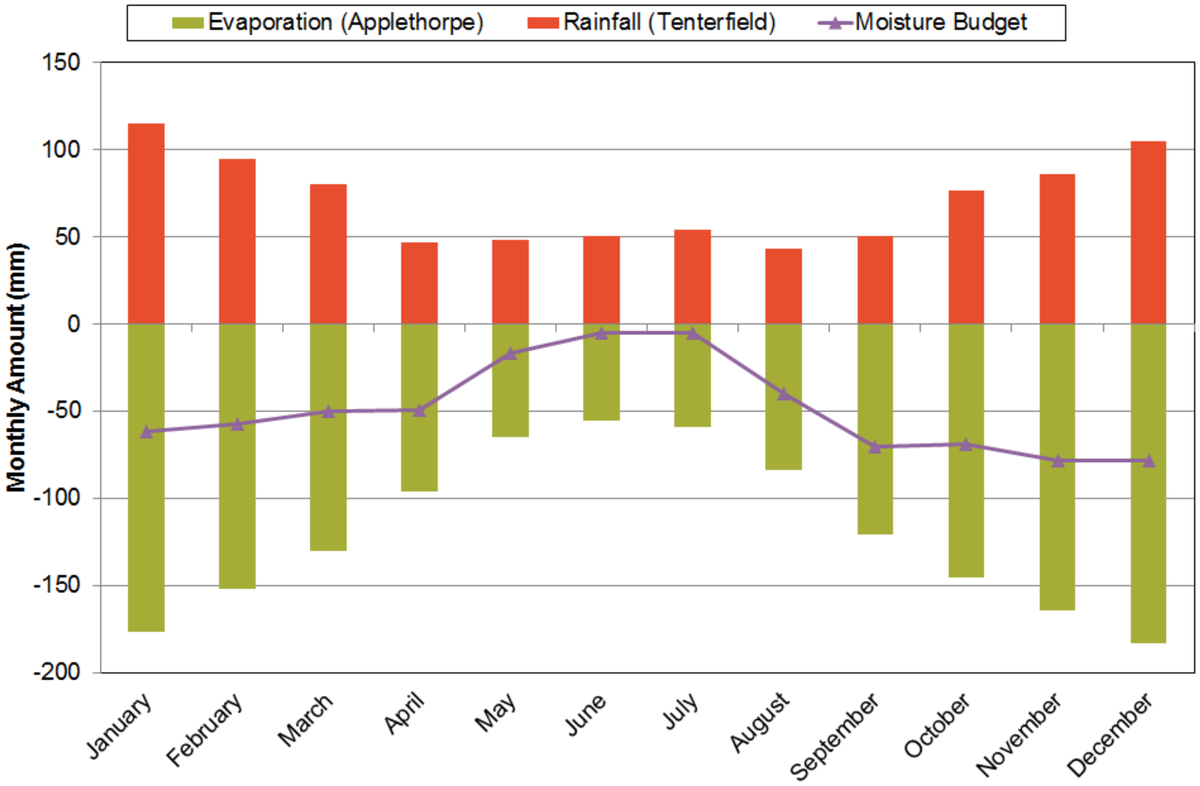
Based on historical data recorded since 1870 in Tenterfield, the region is characterised by reasonably high rainfall, with a mean annual rainfall of approximately 850 mm, and an annual rainfall range between 430mm and 1,430mm. Rainfall is most pronounced between October and March, with significantly lower rainfall during the colder months of the year. According to the records, an average of 99 rain days occur per year.

Evaporation is a function of ambient temperature, wind and the saturation deficit of the air. The closest evaporation measurement station to the Quarry is the BoM Applethorpe station (Station Number 041175). On average, the region experiences an annual evaporation rate of 1,430mm/year, with greatest evaporation rates occurring during the summer months.

Mean monthly rainfall amounts recorded by the BoM at Tenterfield were compared with mean monthly evaporation rates recorded by the BoM at Applethorpe to determine the likely moisture budget at the Quarry. The monthly variation in moisture budget is illustrated in **Figure 7**.

This figure illustrates that a moisture deficit occurs (evaporation exceeds rainfall) throughout the year. The deficit is greatest during the summer months and near zero during winter.

Figure 7: Monthly Moisture Budget - Tenterfield



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 Project, 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 NSW EPA environment protection licence (EPL) databases have been reviewed for significant existing sources of air pollutants in the surrounding region.

The NPI database has no major emission sources listed for the Tenterfield local government area. The NSW EPA EPL database lists a number of minor sources in the Tenterfield local government area, the majority of which are operated by Tenterfield Shire Council. The closest of these operations are the Boonoo Boonoo Landfill, located approximately 10km northeast of the Project Site, and the Tenterfield Sewage Treatment Plant, located approximately 3km southwest of the Project Site.

It is not considered likely that any of the above identified industrial sources would cause significant direct cumulative impacts with emissions from the Project Site. Rather, these emissions would contribute to the regional air pollution levels.

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

- 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; and
- Episodic emissions from vegetation (e.g. bush and grass) fires.

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 PM_{10} MONITORING DATA

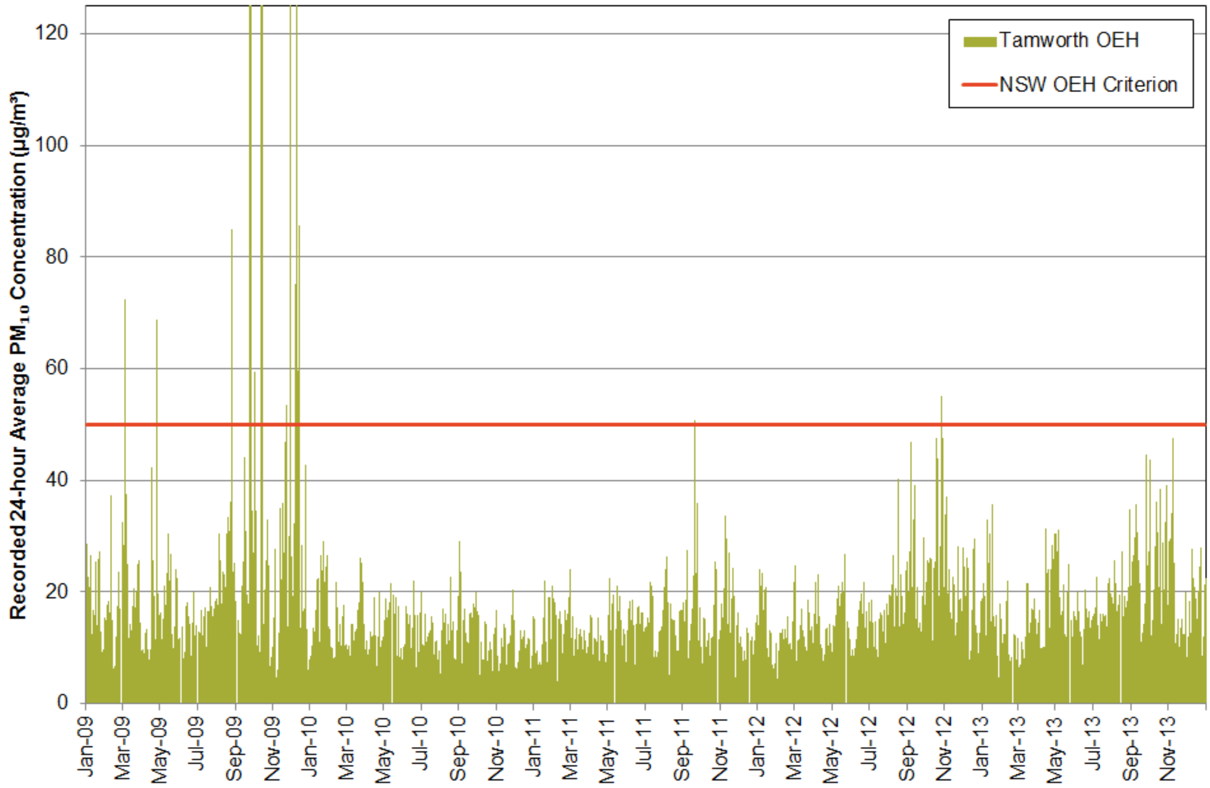
Air quality monitoring has not previously been undertaken at the Project Site. There are no publicly available air quality monitoring datasets for the Tenterfield region with which to characterise existing air quality levels.

In order to provide an understanding of potential background concentrations of PM_{10}, air quality monitoring data has been sourced from the NSW Office of Environment and Heritage (OEH) New England District air quality monitoring station located at Tamworth. While geographically removed from the Project Site (approximately 260km to the southwest), from ENVIRON experience the use of the rural NSW OEH monitoring stations provides a reliable source to illustrate regional trends in particulate matter concentrations in the absence of local monitoring data.

It is noted that Tamworth has a higher level of residential, commercial and industrial development than Tenterfield, therefore it is considered that particulate matter levels recorded at the Tamworth OEH station would be a conservative reflection of levels at the Project Site. In the absence of local monitoring data, NSW OEH monitoring data will be drawn upon to assist in the analysis of particulate matter concentrations that could reasonably be expected to occur in the area of the Quarry.

The daily varying (24-hour average) PM_{10} concentrations recorded at the NSW OEH Tamworth monitoring station between 2009 and 2013 are illustrated in **Figure 8**. It can be seen that the 24-hour average PM_{10} concentrations recorded at Tamworth fluctuate throughout the presented period.

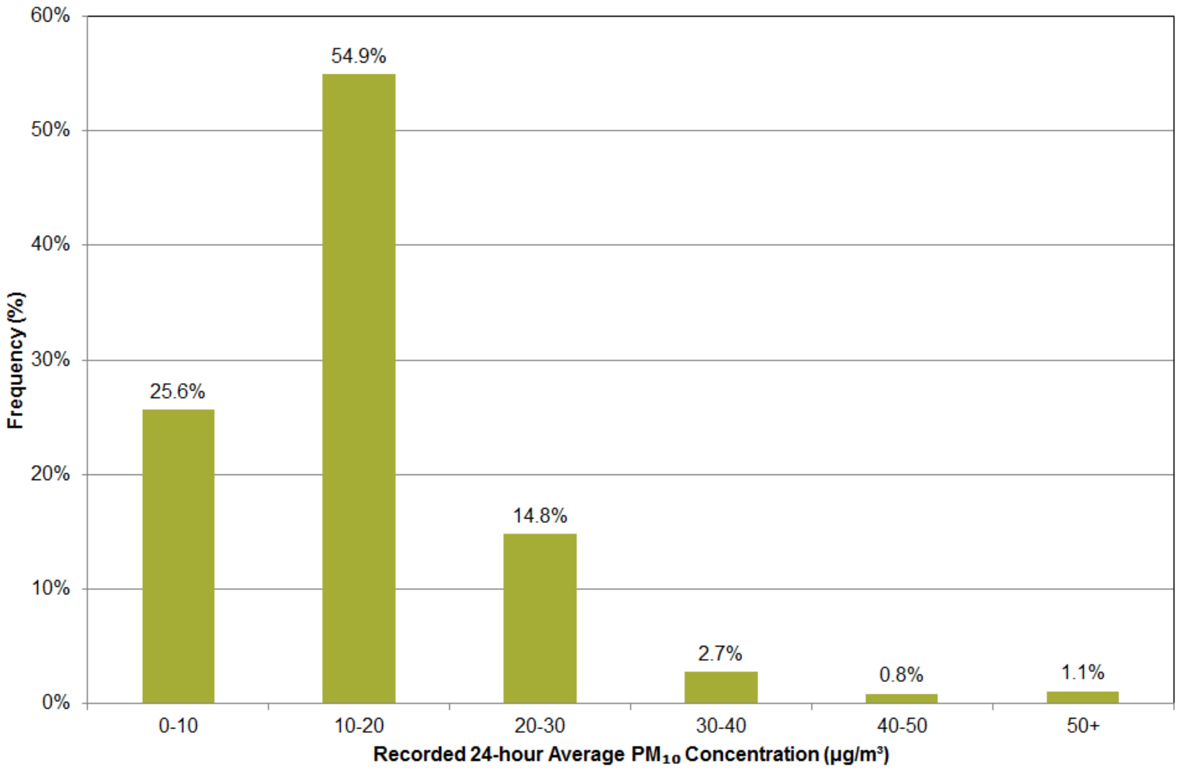
Figure 8: Time-series of 24-hour Average PM_{10} Concentrations recorded at OEH Tamworth – 2009 to 2013



Note: Plot Y-axis cropped at 125µg/m³ for visual purposes. Maximum of the dataset was 1,791.4µg/m³ recorded on 23/09/2009 and was associated with the significant dust storm event that affected the east coast of Australia at that time.

The frequency distribution of 24-hour average PM_{10} concentrations recorded by the NSW OEH Tamworth station is presented in **Figure 9**, which highlights that 24-hour average PM_{10} concentrations at Tamworth were less than 30µg/m³, approximately 95% of the time between 2009 and 2013. The average PM_{10} concentration at Tamworth recorded between 2009 and 2013 was 16.9µg/m³.

Figure 9 Distribution of 24-hour Average PM_{10} Concentrations – Tamworth– 2009 to 2013



6. EMISSION ESTIMATION

Fugitive dust sources associated with the operation the Project 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. Particulate releases were quantified for various particle size fractions, with the TSP fraction being estimated and simulated to provide an indication of dust deposition rates. Fine particulates (PM_{10} and $PM_{2.5}$) were estimated using ratios for the smaller particle size fractions available within the literature.

6.1 SOURCES OF OPERATIONAL EMISSIONS

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

- Loading, onsite haulage and unloading of topsoil/overburden material
- Drill and blast activities
- Secondary breakage and loading of blasted rock to highway trucks for transportation to the SCSP;

- Wheel Generated emissions from Unpaved Roads (transportation of extracted rock, overburden material and crusher fines from the SCSP); and
- Wind erosion of exposed surfaces at open pit and active stockpiling areas

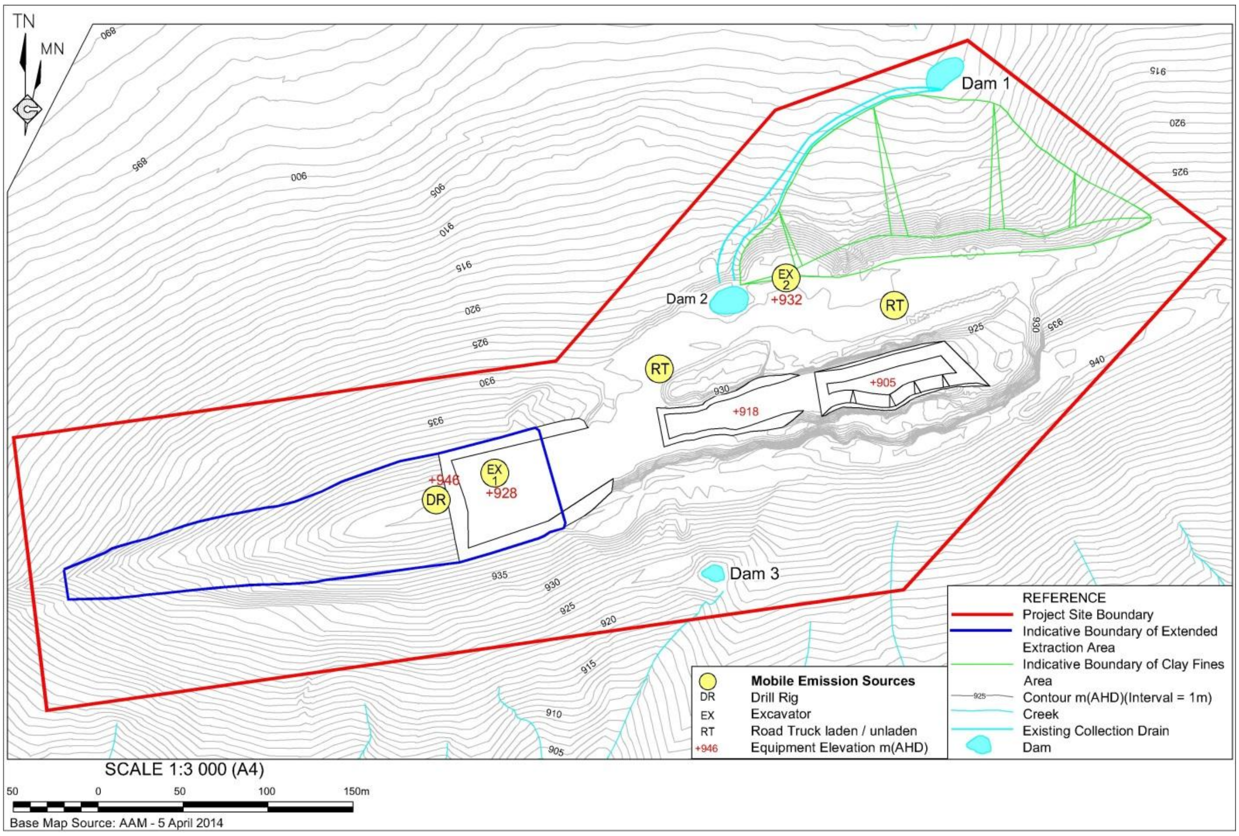
6.2 EMISSION SCENARIOS

To review the potential change in emissions associated with the ongoing operation and extension of the Quarry, three emission scenarios have been developed:

- Existing operations;
- Scenario 1 – Future operations 1 and
- Scenario 2 – Future operations 2.

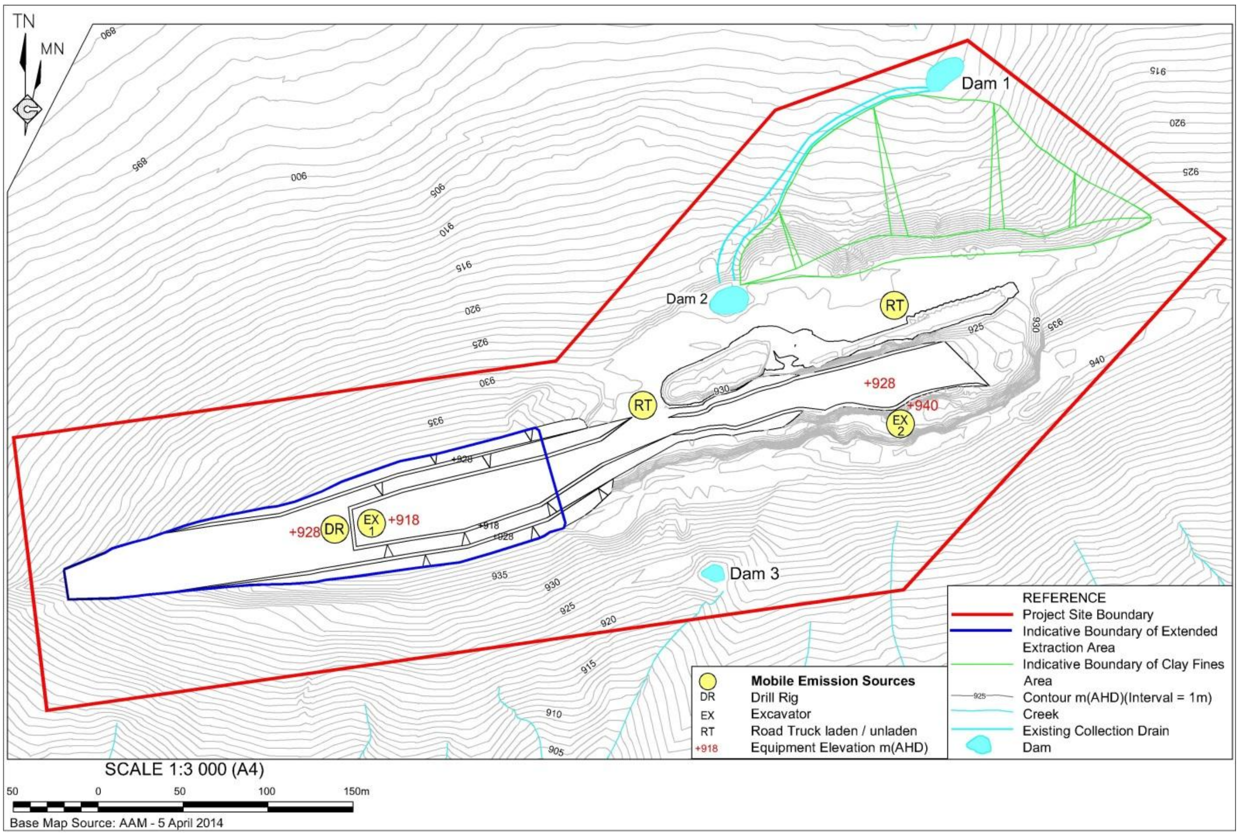
The layout for the existing operations is based on the existing Project Site layout illustrated in **Figure 2**. Indicative operational scenario layouts for Scenario 1 and 2 are illustrated in **Figure 10** and **Figure 11** respectively.

Figure 10 Indicative Site Layout – Scenario 1



Source: RWC (2014)

Figure 11 Indicative Site Layout – Scenario 2



Source: RWC (2014)

Details on the modelling assumptions made for each scenario are listed within **Appendix 1**.

6.3 EMISSION REDUCTION FACTORS

Based on information provided by the Applicant, it is understood that the 400m section of the site access road between the intersection with Mount Lindesay Road and the 90-degree bend would be sealed i.e. extending the existing sealed section by approximately 320m. Consequently, a 100% emission reduction to unpaved road emissions (NPI EETMM, 2012) has been applied to this section of road. To account for the movement of trucks along the sealed section of road, the US-EPA AP-42 paved roads emission factor has been applied.

6.4 PARTICULATE MATTER EMISSIONS

A summary of Project-related TSP, PM_{10} and $PM_{2.5}$ emissions by source type and modelling scenario is presented in **Table 2**. The total annual emissions by scenario are presented in **Table 3** and illustrated in **Figure 12**. Control measures proposed for implementation (i.e. sealing part of the site access road), as documented in **Section 6.3**, have been taken into account in the emission estimates.

These tables and figures highlight that, for both existing and proposed operations, the most significant source of emissions associated with the Proposal is the movement of vehicles along unpaved roads (blasted rock, clay fines and overburden).

A decrease in annual emissions is calculated for the two future scenarios relative to existing operations. This decrease is attributable to the sealing of the first 400m of the site access road from the intersection with the Mount Lindesay Road. By sealing this section of road, the emissions from unpaved roads, the most significant source of emissions for all scenarios, is reduced. The partial sealing of the site access road offsets the increase in wind erosion emissions associated with the future expansion.

Further details regarding emission estimation factors and assumptions are provided in **Appendix 1**.

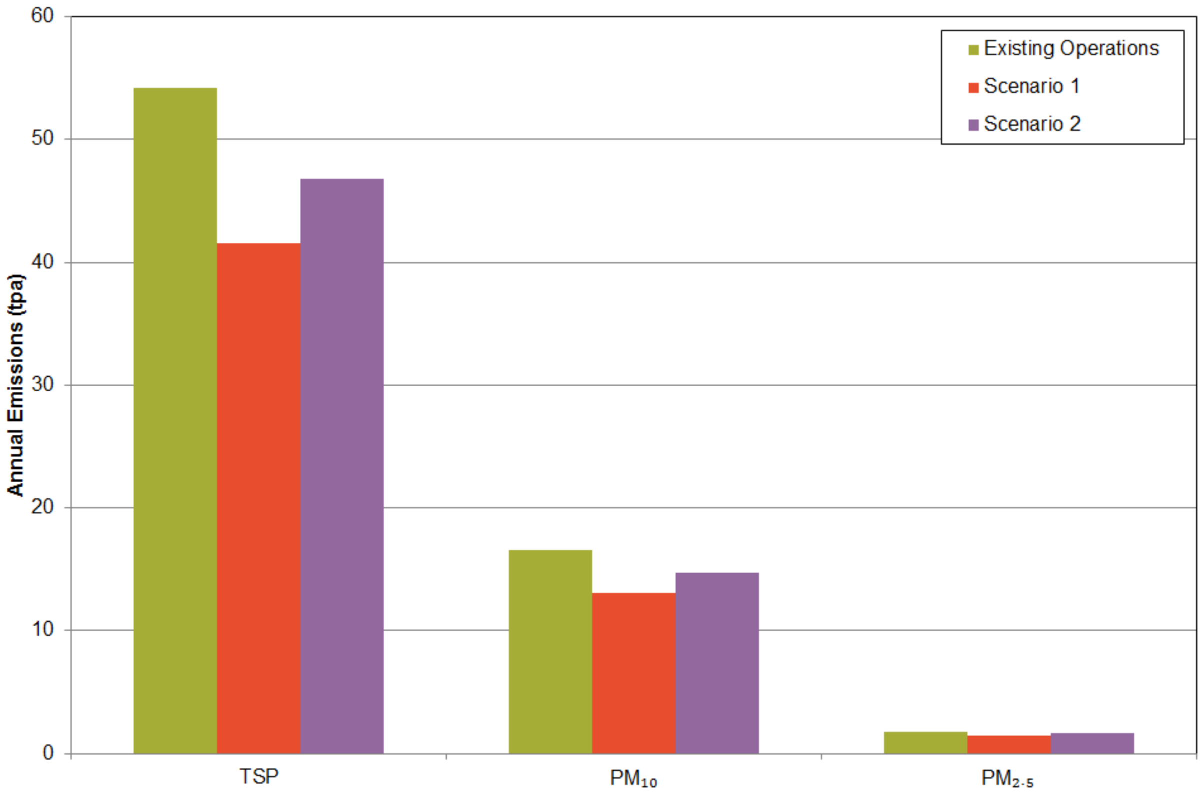
Table 2
Calculated Annual Particulate Matter Emissions by Scenario

Emissions Source	Calculated Annual Emissions (kg/annum) by Source		
	Existing Operations	Scenario 1 – Future Operations 1	Scenario 2 – Future Operations 2
TSP Emissions			
Drill	1,573.3	1,573.3	1,573.3
Blast	35.2	35.2	35.2
In Pit Truck Loading	150.0	150.0	150.0
Raw Material Haulage - Unsealed	37,708.1	27,233.7	31,423.4
Raw Material Haulage - Sealed	0.0	113.0	113.0
OB Loading	10.8	10.8	10.8
OB Haulage	226.2	377.1	527.9
OB Unloading	10.8	10.8	10.8
Clay Fines Haulage - Unsealed	10,998.2	8,065.4	8,065.4
Clay Fines Haulage - Sealed	0.0	113.0	113.0
Clay Fines Unloading	52.5	52.5	52.5
Wind Erosion - Stockpiles and Exposed Surfaces	3,400.0	3,825.0	4,675.0
PM_{10} Emissions			
Drill	826.7	826.7	826.7
Blast	18.3	18.3	18.3
In Pit Truck Loading	70.0	70.0	70.0
Raw Material Haulage - Unsealed	10,722.8	7,744.3	8,935.7
Raw Material Haulage - Sealed	0.0	21.7	21.7
OB Loading	5.0	5.0	5.0
OB Haulage	64.3	107.2	150.1
OB Unloading	5.0	5.0	5.0
Clay Fines Haulage - Unsealed	3,127.5	2,293.5	2,293.5
Clay Fines Haulage - Sealed	0.0	21.7	21.7
Clay Fines Unloading	24.5	24.5	24.5
Wind Erosion - Stockpiles and Exposed Surfaces	1,700.0	1,912.5	2,337.5
$PM_{2.5}$ Emissions			
Drill	124.0	124.0	124.0
Blast	2.7	2.7	2.7
In Pit Truck Loading	10.5	10.5	10.5
Raw Material Haulage	1,072.3	774.4	893.6
Raw Material Haulage - Sealed	0.0	5.2	5.2
OB Loading	0.8	0.8	0.8
OB Haulage	6.4	10.7	15.0
OB Unloading	0.8	0.8	0.8
Clay Fines Haulage - Unsealed	312.7	229.3	229.3
Clay Fines Haulage - Sealed	0.0	5.2	5.2
Clay Fines Unloading	3.7	3.7	3.7
Wind Erosion - Stockpiles and Exposed Surfaces	255.0	286.9	350.6

Table 3
Calculated Annual Particulate Matter Emissions by Scenario

Pollutant	**Calculated Total Annual Emissions (t/annum)**		
	Existing Operations	**Scenario 1 – Future Operations 1**	**Scenario 2 – Future Operations 2**
TSP	54.2	41.6	46.8
PM_{10}	16.6	13.1	14.7
$PM_{2.5}$	1.8	1.5	1.6

Figure 12 Comparison of Calculated Annual Emissions by Scenario



7. ASSESSMENT OF AIR QUALITY IMPACTS

In order to provide a qualitative statement regarding the potential impacts that could be associated with the Quarry and the proposed extension of the extraction area, recent air quality impact assessments for quarrying operations conducted by ENVIRON involving atmospheric dispersion modelling have been reviewed. The assessments are:

- ENVIRON (2013a) *Mawsons Quarry Expansion – Air Quality Impact Assessment* (Assessment 1);
- ENVIRON (2013b) *Allandale Quarry Expansion – Air Quality Impact Assessment* (Assessment 2); and

- ENVIRON (2012) Talbragar Quarry Modification – Air Quality Impact Assessment (Assessment 3).

An overview of the key operational features of the three reviewed air quality impact assessments, along with the same parameters relevant to the Quarry, are presented in **Table 4**.

Table 4
Comparison of Reviewed Quarry Assessments with Proposal

Parameter	**Assessment 1**	**Assessment 2**	**Assessment 3**	**The Quarry**
Operation Type	Hard rock quarry + concrete batching plant	Hard rock quarry	Hard rock quarry	Quartzose quarry
On-site Processing	Yes	Yes	Yes	No
Annual Extraction (tonnes)	350,000	800,000	350,000	100,000 (peak operations)
Quarry Area (ha)	60	575	110	13.5
Daily Product Dispatch by Road (tonnes)	760 (some dispatch by train)	3,200	1,200	600 (peak operations)
Calculated Annual PM_{10} Emission (tpa)	22.9	88.9	83.8	13.1-16.6

The following key points are identified from the review of these three air quality impact assessments and comparison with the Project:

- Extractive intensity at all three reviewed quarry sites is higher than the peak annual extraction rate at the Quarry;
- All three reviewed quarry sites process raw extracted material (crushing and screening) on site, whereas raw material at the Project Site is hauled to the SCSP;
- The land area and daily dispatch rate is higher at the three reviewed quarry sites relative to the Project; and
- The calculated annual PM_{10} emissions associated with the Quarry are notably lower than the three reviewed quarry sites.

Consequently, the air quality impacts associated with these quarry operations (i.e. Assessments 1, 2 and 3) as presented within the reviewed reports are expected to be higher than air quality impacts associated with the Quarry. The extent of impacts from these operations is considered to provide a conservative reflection of potential impacts from the Quarry.

On the basis of annual extraction rate, daily product dispatch numbers and annual calculated PM_{10} emissions, the most comparable of the three assessments to the Quarry is

Assessment 1. It is noted with regards to annual emissions from each site that the specific configuration of each site, including haul road length, equipment fleet, control measures and extent of exposed areas, plays a significant role in the resultant annual emissions.

Due to the nature of emission sources at the Quarry (specifically dominated by non-buoyant, ground-level releases) and the gravitational settling of airborne particulates, concentrations and deposition levels will decrease with distance from the point of release.

As detailed in **Table 1**, the closest residential receptor to the Quarry is located approximately 200m to the south and east-southeast of the site access road (receptors 12 and 13 respectively) and 600m to the west of the Project Site boundary (receptor 3A). The distance to the receptors located to the south of the Project Site boundary is notably greater (at a minimum, receptor 9 is located 1.2km to the southeast).

It is noted that taking the dominant wind direction (east-west aligned as per **Section 4.1**) and the separation distance (greater than 1.2km from site boundary), the potential for adverse impacts at the receptors to the south of the Project Site boundary is considered minimal. Impacts at these receptors have not been considered further in this assessment.

To assess potential air quality impacts associated with the Project, the maximum predicted 24-hour and annual average PM_{10} concentrations and annual average dust deposition levels at 200m and 600m from the site boundary reported within Assessment 1, 2 and 3 were analysed. Relevant model predictions at 200m and 600m from boundary were as follows:

24-hour Average PM_{10}

- At 200m, the maximum predicted incremental 24-hour average PM_{10} concentrations ranged between approximately 3µg/m^3 and 15µg/m^3 for Assessment 1, 3µg/m^3 and 22µg/m^3 for Assessment 2 and between 7µg/m^3 and 33µg/m^3 for Assessment 3; and
- At 600m, the maximum predicted incremental 24-hour average PM_{10} concentrations ranged between approximately 1µg/m^3 and 6µg/m^3 for Assessment 1, 2µg/m^3 and 15µg/m^3 for Assessment 2 and between 4µg/m^3 and 12µg/m^3 for Assessment 3.

Annual Average PM10

- At 200m, the predicted incremental annual average PM_{10} concentrations ranged between approximately 0.1µg/m^3 and 0.9µg/m^3 for Assessment 1, 0.1µg/m^3 and 0.2µg/m^3 for Assessment 2 and between 1µg/m^3 and 5µg/m^3 for Assessment 3; and
- At 600m, the predicted incremental annual average PM_{10} concentrations ranged between approximately 0.1µg/m^3 and 0.2µg/m^3 for Assessment 1, 0.1µg/m^3 and 0.6µg/m^3 for Assessment 2 and between 0.2µg/m^3 and 2µg/m^3 for Assessment 3.

Annual Average Monthly Dust Deposition

- At 200m, the predicted incremental annual average monthly dust deposition levels ranged between approximately 0.1g/m^2/month and 0.5g/m^2/month for Assessment 1, 0.1g/m^2/month and 0.3g/m^2/month for Assessment 2 and between 0.2g/m^2/month and 1.5g/m^2/month for Assessment 3; and

- At 600m, the predicted incremental annual average monthly dust deposition levels ranged between approximately 0.1g/m^2/month and 0.2g/m^2/month for Assessment 1, 0.1g/m^2/month or less for Assessment 2 and between 0.1g/m^2/month and 0.5g/m^2/month for Assessment 3.

From the above results, 24-hour average PM_{10} concentrations are the highest relative to applicable assessment criterion and therefore most significant with regards to compliance for the Quarry.

It is noted that within all three assessments reviewed, the top three contributing sources to air quality impacts were emissions from unpaved roads, the crushing and screening plant and wind erosion of exposed surfaces. In particular, for Assessment 1, peak impacts were predicted to occur in the vicinity of the processing plant/product stockpiling area of that site.

Due to the absence of an onsite processing plant, lower daily truck movements and smaller land area with wind erosion potential, it is considered that the impacts likely to be associated with both existing and proposed future operations at the Project Site would be significantly lower than the results presented above. As stated previously, Assessment 1 is considered to be the most relevant of the three reviewed assessments to review air quality impacts from the Quarry.

Finally, it is noted that for each of the reviewed assessments, the peak concentrations occurred downwind of operations relative to the dominant wind direction at each site (i.e. dominant easterly flow; peak impacts predicted to the west of the site). Furthermore, it is noted that the predicted concentrations reduced notably outside of the dominant wind direction. On this basis, peak concentrations are expected to be experienced to the west of the Project Site. As discussed, receptors in this direction are greater than 600m from the Project Site boundary.

From the above results, it is considered that for the Quarry, peak incremental 24-hour average PM_{10} concentrations of less than 15µg/m^3 could be experienced at 200m from the Project Site emission sources in the worst case (based on maximum predictions at this distance with Assessment 1). Given the low material extraction rate, lack of on-site raw materials processing and low daily truck movement rate in comparison to the quarry in Assessment 1, this concentration is highly conservative. As demonstrated in **Section 5.2**, daily PM_{10} concentrations in rural NSW (based on monitoring data from Tamworth) are typically less than 30µg/m^3. It is therefore highly unlikely that cumulative impacts (Quarry increment combined with ambient background) would exceed the NSW EPA 24-hour average PM_{10} assessment criterion of 50µg/m^3.

Current operations at the Project Site are unlikely to adversely impact on the surrounding area. As highlighted in **Section 6**, emissions calculated for the proposed future operational scenarios are lower than current operations due to the proposed sealing of the initial 400m of the site access road. Given that the proposed extended extraction area is within the existing Project Site boundary, the level of potential air quality impact on the surrounding environment is unlikely to significantly change from current operations.

8. CONCLUSIONS

ENVIRON was commissioned by RWC to undertake an Air Quality Impact Assessment for the proposed modification to the existing Dowe's Quarry on behalf of the Applicant.

A qualitative air quality impact assessment has been undertaken for the proposed expansion, involving an analysis of existing air quality and dispersion meteorological conditions, and a review of current and proposed activities and predicted impacts from larger quarrying operations historically assessed by ENVIRON.

In assessing the potential air quality impacts from the Quarry on the surrounding environment, the following factors have been considered.

- The existing sources of air quality in the local area.
- The topography of the area surrounding the Quarry and the location of nearest sensitive receptors.
- The dominant wind regime and moisture balance.
- The proposed operations at the Quarry and associated sources of particulate matter emissions.
- The likely concentrations that could be experienced downwind of the Quarry based on similar operations quantitatively assessed by ENVIRON.

On the basis of the above review, it is considered unlikely that the current or proposed future modified operations at the Quarry will adversely impact upon the local air quality environment.

9. REFERENCES

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

Bureau of Meteorology. Long-term climate statistics Tenterfield (Federation Park) (Station Number 056032) and Applethorpe (Station Number 041175).

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

ENVIRON (2012) *Talbragar Quarry Modification – Air Quality Impact Assessment*.

ENVIRON (2013a) *Mawsons Quarry Expansion – Air Quality Impact Assessment*

ENVIRON (2013b) *Allandale Quarry Expansion – Air Quality Impact Assessment*

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.

US-EPA (2004). AP42 FIRE Emission Factor Database

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

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

10. 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
ENVIRON	ENVIRON Australia Pty Ltd
EPA	Environmental Protection Authority
mg	Milligram (g x 10-3)
µg	Microgram (g x 10-6)
µm	Micrometre or micron (metre x 10-6)
m^3	Cubic metre
NPI	National Pollutant Inventory
OEH	NSW Office of Environment and Heritage
PM_{10}	Particulate matter less than 10microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5microns in aerodynamic diameter
RWC	R.W. Corkery & Co Pty Limited
SCSP	Sunnyside Crushing and Screening Plant
TAPM	"The Air Pollution Model"
The Applicant	Darryl McCarthy Constructions Pty Ltd
The Quarry	Dowe's Quarry
TSP	Total Suspended Particulate
US-EPA	United States Environmental Protection Agency

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APPENDIX 1 – Emission Inventory

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Introduction

Air emission sources associated with the various phases of the project 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:

- US-EPA AP-42 AP42 FIRE Emission Factor Database – Stone Quarrying Factors (2004)
- NPI Emission Estimation Technique Manual for Mining (NPI, 2012);
- AP-42 Chapter 13.2.2 – Unpaved Roads (US-EPA 2006);
- 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 various particle size fractions, TSP, PM_{10} and $PM_{2.5}$, using ratios for the different particle size fractions 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 project will primarily comprise of fugitive particulate matter releases. Key sources of emission were identified as follows:

- Loading, onsite haulage and unloading of topsoil/overburden material
- Drill and blast activities
- Loading of blasted rock to highway trucks for transportation to the SCSP;
- Dumping of rock to the hopper and hopper pad;
- Wheel Generated from Unpaved Roads (hauling of extracted rock, overburden material and crusher fines from the SCSP); and
- Wind erosion of exposed surfaces at 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 A1.1
Emission Estimation Factors Applied for All Scenarios

Emission Source	Emission Factor			Emission Factor Unit	Source of Factor
	TSP	PM_{10}	$PM_{2.5}$		
Drilling	0.59	0.31	0.0177	kg/hole	US-EPA AP42 Western Surface Coal Mining - Default Factor
Blasting	34.1	17.7	1.0	kg/blast	US-EPA AP42 Western Surface Coal Mining - Blasting Equation
Excavator in pit; overburden loading/unloading; clay fines unloading	0.0015	0.0007	0.0001	kg/tonne	US-EPA AP42 FIRE Database – Miscellaneous Handling (Stone Quarrying)
Unpaved haulage of raw material / overburden / clay fines	3.14	0.89	0.09	kg/Vehicle KM Travelled	US-EPA AP42 Unpaved Roads
Paved haulage of raw material / clay fines	0.042	0.008	0.002	kg/Vehicle KM Travelled	US-EPA AP42 Paved Road Equation
Wind Erosion – Active stockpiling, quarrying areas, exposed surfaces	850.0	425.0	63.8	kg/ha/year	US-EPA AP42 - Western Surface Coal Mining - Default Factor - Wind erosion of exposed areas factor

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

<u>Unpaved Roads Equation</u>

The emissions factors for unpaved 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	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
K (lb/VMT)	4.9	1.5	0.15
A	0.7	0.9	0.9
B	0.45	0.45	0.45

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

$$1 \text{ lb/VMT} = 0.2819 \text{ kg/VKT}$$

Load in truck was assumed to be 30t, with an average vehicle mass of 30t (15t empty, 45t loaded). Material parameters are listed in **Table A2.2**.

Paved Roads Equation

The emissions factors for paved 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)

The following constants are applicable:

Constant	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
k (g/VKT)	4.9	1.5	0.15

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}	$PM_{2.5}$
kg/blast	$0.00022(A)^{1.5}$	TSP x 0.52	PM_{10} x 0.1

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

RWC advised that each blast would fragment between 5,000 and 10,000 t raw material. A blast area of 400m^2 was applied to all blasts, assuming an amount of 10,000t/blast and a density of 2.5t/m^3 and bench depth of 10m. The number of drill holes per blast applied was 133, based on a drill hole pattern of 3m^2. It was calculated that 20 blasts per year would occur based on annual fragmented tonnage of 100,000t and a blast size of 5,000t (worst case pairing).

Project 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 Unpaved Roads	%	8.3	US-EPA AP42 (2006) mean value for "haul road to/from pit" for "Stone Quarrying and Processing"
Silt Loading of Paved Roads	g/m^2	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**.

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

Process	Unit	Existing Operations	Scenario 1	Scenario 2
Raw material extraction	Amount of Rock (tonnes)	100,000		
Overburden handling	Amount of Rock (tonnes)	7,200		
Clay fines delivery	Amount of Rock (tonnes)	35,000		
Raw Material Haulage - Unpaved	Distance (km)	1.8	1.3	1.5
Raw Material Haulage - Paved	Distance (km)	-	0.4	0.4
Overburden Haulage - Unpaved	Distance (km)	0.15	0.25	0.35
Clay Fines Haulage - Unpaved	Distance (km)	1.5	1.1	1.1
Clay Fines Haulage -Paved	Distance (km)	-	0.4	0.4
Wind Erosion	Area (ha)	4.0	4.5	5.5