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Ralston Quarry

Air Quality Impact Assessment

Addressee(s):	OzArk Environment and Heritage
Site Address:	4948 Tooraweenah Road, Mount Tenandra NSW 2828
Report Reference:	20.1038.FR1V1
Date:	16 December 2019

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	GCG	MD
THE QUARRY	Final	Northstar Air Quality	GCG	MD
LEGISLATION REGULATION AND GUIDANCE	Final	Northstar Air Quality	GCG	MD
EXISTING CONDITIONS	Final	Northstar Air Quality	GCG	MD
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Final Authority

This report must by regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below.

Martin Doyle **16th December 2019**

Non-Technical Summary

OzArk Environment and Heritage has engaged Northstar Air Quality Pty Ltd on behalf of Quarry Solutions Pty Ltd to perform an air quality impact assessment for the proposed development of a quarry located at 4948 Tooraweenah Road, Mount Tenandra NSW 2828 (the Quarry site).

This air quality impact assessment forms part of the Environmental Impact Statement prepared to accompany the development application for the Proposal under Part 4 of the *Environmental Planning and Assessment Act* 1979.

Emissions of particulate matter associated with construction phase and operational phase activities have been calculated, including a number of emission control measures proposed to be adopted. To ensure that the assessment provides an appropriately conservative approximation of the potential impacts at surrounding receptor locations, certain control measures which are proposed to be adopted have not been included in the assessment, specifically the watering of exposed areas. In this way, the predicted incremental impacts can be viewed as worst-case.

The air quality impact assessment presents an assessment of the impacts of activities associated with the construction/site establishment phase and operational phases of the Quarry. An assessment of the potential air quality impacts along off-site transportation routes has also been provided. The AQIA has used a quantitative dispersion modelling approach, performed in accordance with the relevant NSW guidelines. The results of the assessment are presented as predicted incremental change, and as a cumulative impact accounting for the prevailing background air quality conditions.

The results of the air quality impact assessment indicate that during the construction phase, and both stages of operation, the air quality criteria can be achieved. In periods when water may not be readily available, haul road watering may be restricted, and low silt aggregate may be used along internal haul roads, in conjunction with a lowering of vehicle speeds, to result in similar off-site impacts.

A Trigger Action Response Plan would be developed prior to Stage 1 operations which would link visible dust generation from all activities with wind conditions experienced at the Quarry site. A range of actions would be listed which would be adopted to reduce visible dust generation, until such time as the adopted trigger levels have reduced. It is noted that the adoption of a Trigger Action Response Plan is not critical to ensure compliance with the adopted air quality criteria, and its use should result in impacts being less than those predicted within this air quality impact assessment.

It is demonstrated within this air quality impact assessment that the Quarry can be operated in such a manner as to ensure compliance with all adopted air quality criteria.

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1. INTRODUCTION

OzArk Environment and Heritage (OzArk) has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Quarry Solutions Pty Ltd (Quarry Solutions) to perform an air quality impact assessment (AQIA) for the proposed construction and operation of the Ralston Quarry (the Quarry) located at 4948 Tooraweenah Road, Mount Tenandra NSW 2828 (the Quarry site).

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the Quarry under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The AQIA presents an assessment of the impacts of activities associated with the construction/site establishment phase and operational phases of the Quarry. An assessment of the potential air quality impacts along off-site transportation routes has also been provided. The AQIA has used a quantitative dispersion modelling approach, performed in accordance with the relevant NSW guidelines. The results of the assessment are presented as predicted incremental change, and as a cumulative impact accounting for the prevailing background air quality conditions.

1.1 Assessment Requirements

Planning Secretary's Environmental Assessment Requirements (EAR 1370) have been provided for the Quarry by the NSW Department of Planning, Industry & Environment (DPIE) on 2 September 2019. In relation to air quality, EAR 1370 states that the EIS must address:

> *"**Air** – including an assessment of the likely air quality impacts of the development in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW. The assessment is to give particular attention to potential dust impacts on any nearby private receivers due to construction activities, the operation of the quarry and/or road haulage."*

Further to the above, NSW EPA has also provided requirements for the EIS. These include the provision of a detailed AQIA which is required to:

"1.1. Identify all potential discharges of fugitive and point source emissions of pollutants including dust for all stages of the proposal and assess the risk associated with those emissions. All processes that could result in air emissions must be identified and describe. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. Assessment of risk relates to environmental harm, risk to human health and amenity.

1.2. Justify the level of assessment undertaken on the basis of risk factors, including but not limited to:
- *a. proposal location;*
- *b. characteristics of the receiving environment;*
- *c. type and quantity of pollutants emitted.*

1.3. Describe the receiving environment in detail. The proposal must be contextualized within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to:
- *a. meteorology and climate;*
- *b. topography;*

c. surrounding land-use; and
d. ambient air quality.

1.4. Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.

1.5. Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.

1.6. Include air dispersion modelling where there is a risk of adverse air quality impacts, or where there is sufficient uncertainty to warrant a rigorous numerical impact assessment. Air dispersion modelling must be conducted in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.

1.7. Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations Act 1997 (the "POEO Act") and the Protection of the Environment Operations (Clean Air) Regulation 2010 (the "Clean Air Regulation").

1.8. Detail emission control techniques and practices that will be employed by the proposal and identify how they will meet the requirements of the POEO Act, Clean Air Regulation and associated air quality limits and guideline criteria. Consideration should be given to dust management techniques that can be used where water is limited or unavailable and the development of a Trigger Action Response Plan (TARP)."

Coonamble Shire Council were consulted during the preparation of the EAR and expressed an interest in the dust suppression control measures to be employed as part of the Quarry operations.

Further to the above, the policies, guidelines and plans which have been referenced during the performance of the AQIA include:

- Protection of the Environment Operations (Clean Air) Regulation 2010.
- Approved Methods for the Modelling and Assessment of Air Quality in NSW (NSW EPA, 2017).
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2006).

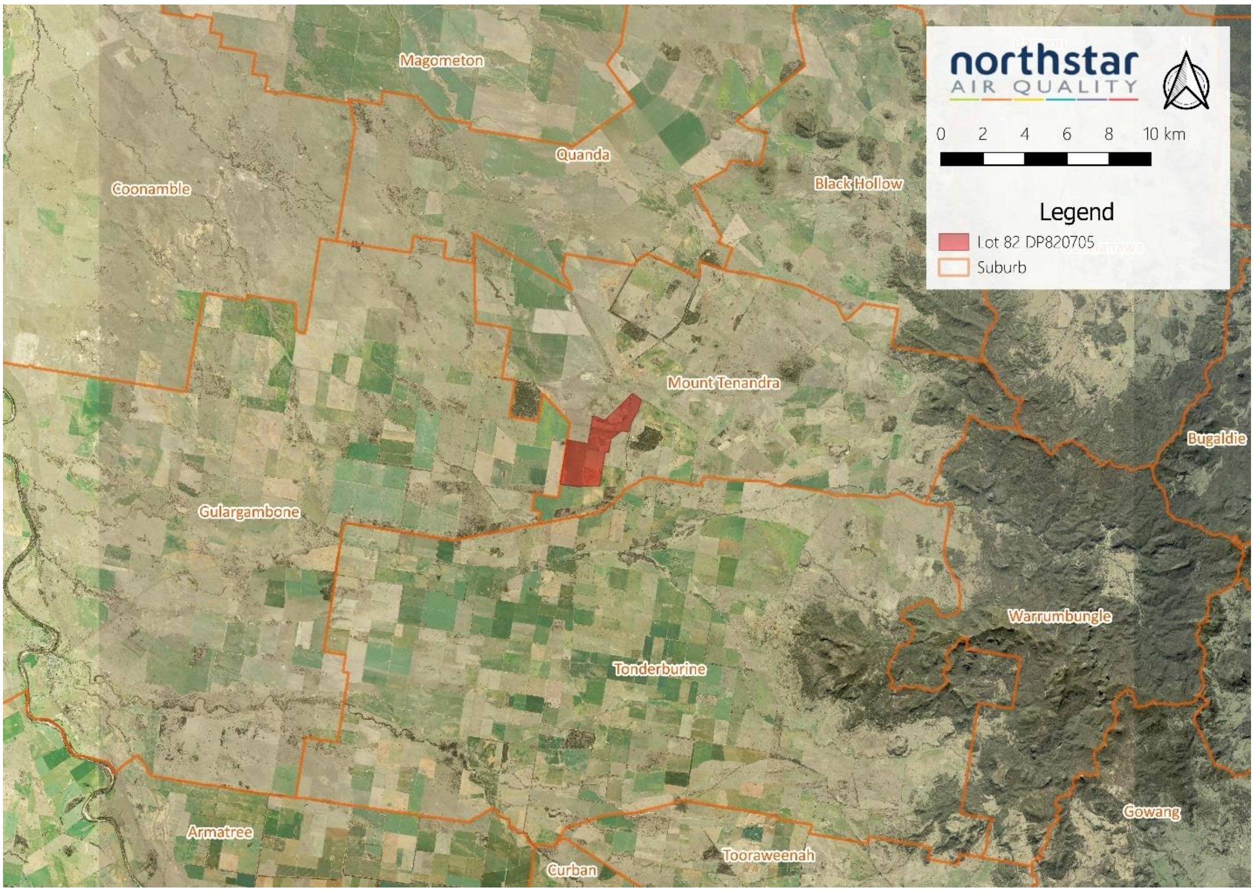
2. THE QUARRY

The following provides a description of the Quarry and describes the potential sources of air emissions associated with the construction and operational phases.

2.1 Overview

Quarry Solutions are proposing to develop the Ralston Quarry at Mt Tenandra, located at 4948 Tooraweenah Road, Mount Tenandra NSW within the Coonamble Shire Council local government area (LGA). The land is formally identified as Lot 82 on DP820705, as presented in **Figure 1**. The Quarry site is located in an area zoned as Primary Production (RU1) in the Coonamble Local Environmental Plan 2011.

Figure 1 Quarry location



The Quarry is proposed to be operated in two stages:

- Stage 1 includes the extraction of up to 490 000 tonnes per annum (tpa) of hard rock material for a period of 5 years, as required to supply construction material to the Inland Rail Project.
- Stage 2 would see a reduction in the extraction rate to 100 000 tpa and is anticipated to supply material to local projects.

It is anticipated that the Quarry footprint, including extraction, processing, stockpile and water management areas would be less than 28.56 hectares (ha) with vehicular access being obtained from Weenya Road off Tooraweenah Road. Extraction will be from two areas shown within Lot 82 DP820705 which is anticipated to yield in total approximately 4.5 million tonnes (Mt) over the 25-year lifecycle of the Quarry. The proposed layout of the Quarry is presented in **Figure 2**.

Figure 2 Quarry layout

The hours of operation are proposed to be 6 am to 6 pm Monday to Friday and 6 am to 1 pm on Saturday with no operations on Sundays or public holidays. It is likely that between five and ten staff will be needed to operate the Quarry which may reduce during Stage 2 of the operations.

The initial phase of development would involve a relatively short period of site establishment, anticipated to occur over a period of three to six weeks. The proposed hours of site establishment are identical to those associated with operations outlined above.

Quarry development will occur with the initial establishment phase consisting of haul road improvement, establishment of erosion and sediment controls, clearing and grubbing of the operational area, and the establishment of associated plant, equipment and infrastructure on-site. To establish the operational area of the quarry, drill and blast activity will be required on the surface to enable the establishment of the first bench. Once the first bench is established the quarry is considered to be in the operation phase.

The operation phase includes production of quarry products through the extraction, crushing and screening of hard rock. Processed material will be stockpiled nearby the processing area where the road haulage fleet will be loaded prior to taking the product off site.

Table 1 provides a summary of the operational characteristics of the Quarry.

Table 1 Proposed characteristics of the Quarry operation

Parameter	Site Establishment	Stage 1	Stage 2
Operating hours (construction, extraction, processing, and haulage)	6 am to 6 pm, Mon to Fri 6 am to 1 pm Saturday No operations Sunday or Public Holiday Blasting will be limited to between 9 am and 3 pm		
Anticipated period of activity	3-6 weeks	5 years	20 years
Working days per year	33	300	300
Material extraction			
Annual rock extraction rate	-	490 000 tpa	100 000 tpa
Average daily rock extraction rate	-	1 633 t	333 t
Maximum daily rock extraction rate	-	1 818 t	333 t
Annual overburden generation rate	-	39 000 t	5 700 t
Average daily overburden generation rate	17.5 t	130 t	19 t
Number of blast holes drilled	50 to 100 per blast	50 to 100 per blast	50 to 100 per blast
Blast holes spacing	3 m	3 m	3 m
Blast hole depth	12 m	12 m	12 m
Blasting frequency	2-3 per month	2-3 per month	1 per month
Volume of material removed per blast	10 000	20 000	10 000

Parameter	Site Establishment	Stage 1	Stage 2
Equipment (type, or equivalent) (*hours operation per day*)	Grader (CAT 140) (*2*) Roller (CAT 20T) (*10*) Dozer (CAT D10) (*10*) Water Cart (Acco) (*12*)	Drill (Atlas Copco T35) (*2*) Excavator (CAT 345) (*10*) Front End Loader (CAT 980G) (*10*) Haul Truck (Volvo A40G) (*10*) Water Cart (Acco) (*12*)	
Material processing			
Annual material processing rate	-	490 000 tpa	100 000 tpa
Average daily processing rate	-	1 633 t	333 t
Maximum daily processing rate	-	1 818 t	333 t
Equipment (type, or equivalent) (*hours operation per day*)	-	Jaw Crusher (Metso L120) (*10*) Secondary Crusher (Metso HP300 or Impactor 1213S) (*10*) Screen (Warrior 20 x 8) (*10*) Generator (CAT 100kVa) (*10*)	
Offsite material haulage			
Annual material haulage rate	-	490 000 t	100 000 t
Average daily haulage rate	-	1 633 t	333 t
Maximum daily haulage rate	-	5 000 t	333 t
Haulage truck capacity	-	38 t	38 t
Annual vehicle trips	-	12 895	2 632
Peak daily vehicle trips	-	132	9
Average daily vehicle trips	-	43	9
Exposed areas			
Extraction area	1.3 ha	13.0 ha	7.6 ha
Processing and storage area	2.7 ha	5.47 ha	

Assumptions adopted in the construction of **Table 1** are presented below:

- An assessment of peak demand during Stage 1 assumes that a maximum of 5 000 t of material may be transported from the Quarry each day.
- The peak haulage rate of 5 000 t·day^{-1} in Stage 1 is not reflected in the peak extraction and processing rates. Peak demand would be served from the stockpiles of material generated and stored in the 'Processing and Storage' area.
- Maximum daily extraction and processing rates in Stage 1 are approximately 10 % greater than the average daily extraction rates and represent the maximum material extraction rates anticipated to be required to recharge stockpiles to serve peak demand.
- The peak demand in Stage 1 is associated with the construction of the Inland Rail Project. This peak demand is not anticipated during Stage 2, and therefore the maximum daily haulage rates are equal to the average daily haulage rates during that stage of operation.

- Overburden is anticipated to be present at an average depth of 1 m across both Stage 1 and Stage 2 extraction areas (Groundwork Plus, 2019). The quantity of overburden present and required to be moved and stored during each year of operation has been calculated on the anticipated depth, the area of the extraction areas in each Stage, and assuming a bulk overburden density of 1.5 $t{\cdot}m^{-3}$. No removal of overburden is assumed within the processing and storage area in Stage 1. The processing area and storage area in Stage 2 are within the extraction area.
  - Stage 1 – Extraction Area 130 000 m^2 x 1 m depth = 130 000 m^3 x 1.5 $t{\cdot}m^{-3}$ = 195 000 t / 5 years = 39 000 $t{\cdot}yr^{-1}$
  - Stage 2 – Extraction, Processing and Storage Area 76 000 m^2 x 1 m depth = 76 000 m^3 x 1.5 $t{\cdot}m^{-3}$ = 114 000 t / 20 years = 5 700 $t{\cdot}yr^{-1}$
- Overburden generation during the construction phase is anticipated to be minor, and for the purposes of this assessment has been assumed to represent the removal of overburden above the initial bench, assumed to be approximately 3 800 m^2 in area.
- Exposed areas during the construction phase are anticipated to be 10 % of the total Stage 1 extraction area, and 50 % of the total Stage 1 processing and storage area.
- Construction phase activities are anticipated to last for a period between three to six weeks. Given the short duration of construction, only potential impacts on short term air quality criteria (24 hour) have been assessed.

2.2 Identified Potential for Emissions to Air

The processes which may result in the emission of pollutants to air during the construction phase would include:

- Removal of overburden, loading of haul trucks, transport, unloading, and storage of overburden;
- Drilling and blasting to establish the initial bench;
- Loading of haul trucks, transport, unloading, and storage of rock;
- Use of grader and roller on disturbed areas and for haul road construction;
- Wind erosion of parts of the extraction area and processing area; and,
- Emissions from vehicle and generator exhaust.

During the operational phases, emissions of pollutants to air would include:

- Drilling and blasting;
- Loading of haul trucks, transport, unloading, and storage of rock and overburden;
- Processing of rock, and storage in stockpiles;
- Loading product trucks with rock, and haulage offsite;
- Wind erosion of the extraction and processing areas; and,
- Emissions from vehicle, equipment, and generator exhaust.

The specific pollutants of interest associated with those activities are:

- Total suspended particulate (TSP);
- Particulate matter with an aerodynamic diameter of 10 microns (PM_{10}); and
- Particulate matter with an aerodynamic diameter of 2.5 microns ($PM_{2.5}$).

Emissions of oxides of nitrogen (NO_X) would be anticipated from blast fume, and (primarily) emissions of NO_X, carbon monoxide (CO) and sulphur dioxide (SO_2) related to diesel combustion would also be experienced (in addition to particulates considered above). Given the distances between the Quarry and nearest sensitive receptors (approximately 2 kilometres ([km]), the frequency of blasting, and the quantity of equipment operating on site, it is not anticipated that emissions associated with diesel combustion, other than particulate matter which have been assessed, would be an issue of concern and have not been addressed further. In relation to blast fume, the timing of any blasts would be managed to ensure that meteorological conditions are appropriate for those to occur.

3. LEGISLATION, REGULATION AND GUIDANCE

3.1 NSW EPA Approved Methods

State air quality guidelines adopted by the NSW EPA are published in the *'Approved Methods for the Modelling and Assessment of Air Quality in NSW'* (NSW EPA, 2017) (the Approved Methods) which has been consulted during the preparation of this assessment report.

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria to be applied.

The criteria listed in the Approved Methods are derived from a range of sources (including National Health and Medical Research Council [NHMRC], National Environment Protection Council [NEPC], Department of Environment [DoE], and World Health Organisation [WHO]).

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW are presented in **Table 2**.

Table 2 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units	Criterion	Notes
Particulates (as PM_{10})	24 hours	$\mu g \cdot m^{-3}$ (a)	50	Numerically equivalent to the Ambient Air Quality National Environment Protection Measure (AAQ NEPM)(b) standards and goals.
	1 year	$\mu g \cdot m^{-3}$	25	
Particulates (as $PM_{2.5}$)	24 hours	$\mu g \cdot m^{-3}$	25	
	1 year	$\mu g \cdot m^{-3}$	8	
Particulates (as total suspended particulate [TSP])	1 year	$\mu g \cdot m^{-3}$	90	
Deposited dust	1 year	$g \cdot m^{-2} \cdot month^{-1}$ (c)	2	Assessed as insoluble solids as defined by AS 3580.10.1
		$g \cdot m^{-2} \cdot month^{-1}$ (d)	4	

Notes: (a): micrograms per cubic metre of air
(b): National Environment Protection (Ambient Air Quality) Measure
(c): Maximum increase in deposited dust level
(d): Maximum total deposited dust level

3.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations* (POEO) *Act* (1997) sets the statutory framework for managing air quality in NSW, including establishing the licensing scheme for major industrial premises and a range of air pollution offences and penalties.

Should the Quarry gain approval the operations would be defined as a scheduled activity under the POEO Act. As such, an Environment Protection Licence (EPL) would be required to be obtained from NSW EPA and once issued would contain a range of conditions related to minimisation of emissions from the site.

3.3 Protection of the Environment (Clean Air) Regulation 2010

The Protection of the Environment Operations (POEO) (Clean Air) Regulation (2010) sets standards of concentration for emissions to air from both scheduled and non-scheduled activities. For the activities performed at the Quarry, the POEO (Clean Air) Regulation provides general standards of concentration for scheduled premises which are presented in **Table 3** for the pollutants of relevance to this assessment. Requirements associated with nitrogen dioxide (NO_2) have been included in **Table 3** but have not been included as part of this impact assessment, for the reasons discussed in **Section 2.2**.

Table 3 POEO (Clean Air) Regulation – General standards of concentration

Air Impurity	Activity	Standard of Concentration (Group 6)[1]
Solid particles (total)	Any activity or plant (except as listed below)	50 $mg \cdot m^{-3}$
	Any crushing, grinding, separating or materials handling activity	20 $mg \cdot m^{-3}$
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Any activity or plant (except boilers, gas turbines and stationary reciprocating internal combustion engines listed below)	350 $mg \cdot m^{-3}$

Note: (1) Group 6 – pursuant to application made on or after 1 September 2005

Further to the requirements in **Table 3** Part 4 Clause 15 of the POEO (Clean Air) Regulation requires that motor vehicles do not emit excessive air impurities which may be visible for a period of more than 10-seconds when determined in accordance with the relevant standard.

Schedule 8 of the POEO (Clean Air) Regulation indicates that burning of vegetation is prohibited, except with approval in the Coonamble Council area. No burning of materials would be performed as part of the construction or operation of the Quarry.

All vehicles, plant and equipment to be used either at the Quarry site or to transport materials to and from the Quarry site will be maintained regularly and in accordance with manufacturers' requirements, where these vehicles are under the operational control of the operator.

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4. EXISTING CONDITIONS

4.1 Surrounding Land Sensitivity

4.1.1 Discrete Receptor Locations

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed. Typically, these locations are identified as residential properties although other sensitive land uses may include schools, medical centres, places of employment, recreational areas or ecologically sensitive locations.

It is noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see **Section 4.1.2**) that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location sensitive to changes in air quality does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the Proposal site reside, population density data has been examined. Population density data based on the 2016 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km^2) grid, covering mainland Australia (ABS, 2017). Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities.

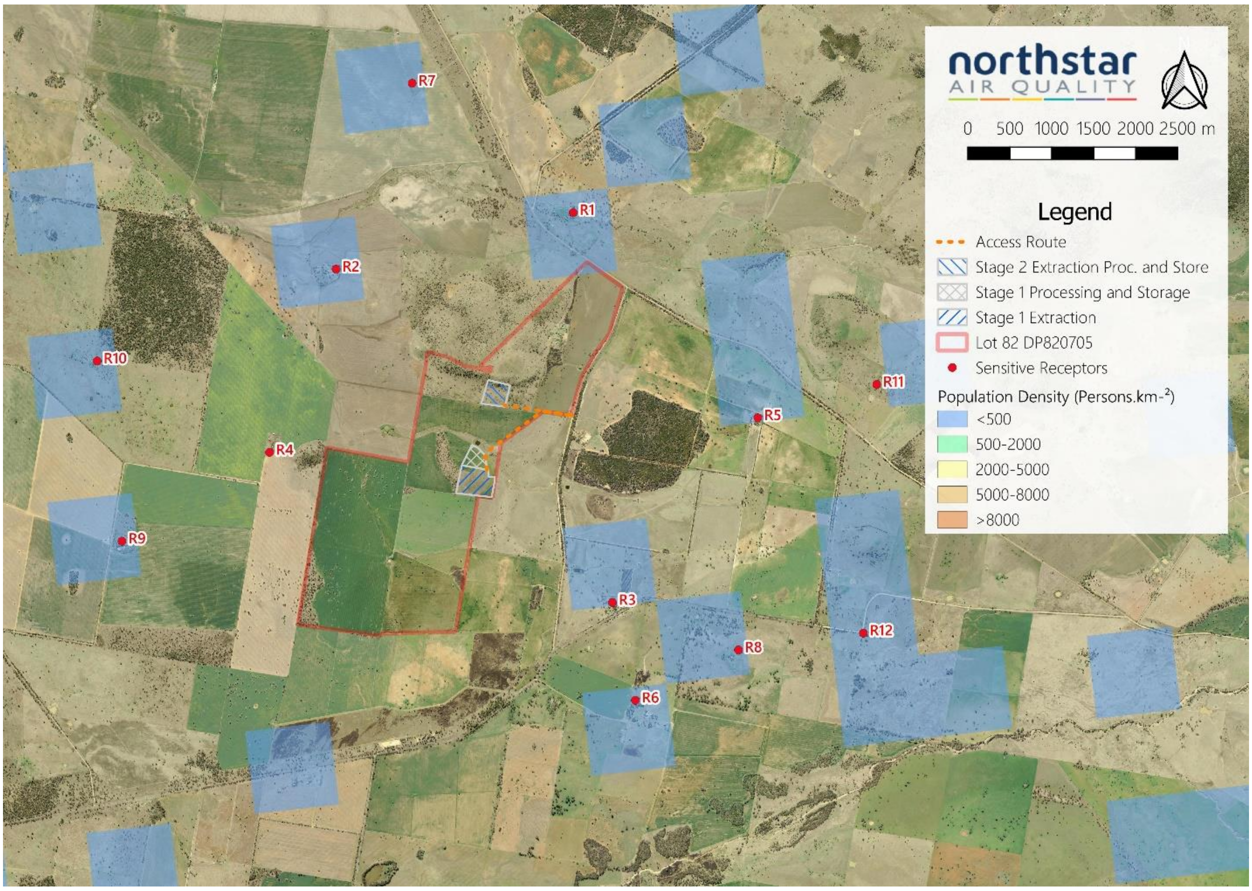
For clarity, the ABS use the following categories to analyse population density ($persons \cdot km^{-2}$):

- Very high >8,000
- High >5,000
- Medium >2,000
- Low >500
- Very low <500
- No population 0

Using ABS data in a GIS, the population density of the area surrounding the Proposal site are presented in **Figure 3**. The Quarry site is located in an area of low to very low population density (between 0 and <500 $persons \cdot km^{-2}$).

A number of residential locations surrounding the Quarry site have been identified and these receptors have been adopted for use within this AQIA as presented in **Table 4**.

Figure 3 Population density and sensitive receptors surrounding the Quarry site



Note: Areas with no colour represents a 1 km^2 grid cell with zero population

It is noted that there is currently a residence on the proposed Quarry site. Given that this residence is associated with the Quarry operations, the impact assessment criteria have not been applied at this location.

Figure 3 identifies a number of 1 km^2 grids that are identified by the ABS as being populated. The desk-top mapping study performed for this AQIA examined those grid cells to ensure all relevant receptor locations had been identified. For a number of cells, sheds were identified that appear to have been erroneously assumed to be residential properties, and for other cells no structures were identified.

Table 4 Discrete sensitive receptor locations used in the study

Receptor ID	Address	Land Use	Location (m, UTM 55)	
			Eastings	Northings
R1	6 Goorianawa Road, Mount Tendandra	Residential	667 495	6 545 996
R2	4926 Tooraweenah Road, Mount Tenandra	Residential	664 668	6 545 322
R3	3063 National Park Road, Mount Tenandra	Residential	667 962	6 541 353
R4	Gulargambone	Residential	663 875	6 543 140
R5	190 Weenya Road, Mount Tenandra	Residential	669 695	6 543 552
R6	4075 National Park Road, Tonderburine	Residential	668 236	6 540 188
R7	4656 Tooraweenah Road, Mount Tenandra	Residential	665 575	6 547 535
R8	4368 National Park Road, Tonderburine	Residential	669 464	6 540 788
R9	246 Herrings Lane, Gulargambone	Residential	662 117	6 542 083
R10	393 Fishers Road, Gulargambone	Residential	661 820	6 544 228
R11	5353 Tooraweenah Road	Residential	671 112	6 543 950
R12	4524 National Park Road	Residential	670 953	6 540 989

4.1.2 Uniform Receptor Locations

Additional to the sensitive receptors identified in **Section 4.1.1**, a grid of uniform receptor locations has been used in the AQIA to allow presentation of contour plots of predicted impacts.

4.2 Meteorology

In accordance with the requirements of the NSW EPA Approved Methods, the AQIA is required to describe and account for the influence of the prevailing meteorological conditions.

The meteorology experienced within an area can govern the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorology of the area surrounding the Quarry site has been examined using data collected by the Australian Government Bureau of Meteorology (BoM) at the Coonamble Airport Automatic Weather Station (AWS), which is approximately 45 km northwest of the Quarry site. This AWS is considered the most representative station for the area surrounding the Quarry site. Coonabarabran Airport AWS is located approximately 50 km to the southeast of the Quarry site, but is located beyond the Warrumbungle Range and is not representative of the meteorology experienced at the Quarry site.

To provide a characterisation of the meteorology which would be expected at the Proposal site, a meteorological modelling exercise has been performed.

Data from the year 2013 have been selected for use in the AQIA to provide an approximation of 'representative' conditions surrounding the Quarry. This year has been selected through examination of meteorology and background air quality conditions for the five-year period 2013 to 2017. The year 2013 was selected as being most representative as wind speed and direction measured at Coonamble Airport AWS in 2013 were considered to be most representative of the five-year period examined.

A summary of the inputs and outputs of the meteorological modelling assessment, including model validation, is presented in **Appendix B**. This analysis includes a discussion of data availability and variability.

4.3 Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

When assessing the impact of any particular source of emissions on the potential air quality at a location, the impact of all other sources of an individual pollutant should also be assessed. This 'background' (sometimes called 'baseline') air quality will vary depending on the pollutants to be assessed and can often be characterised by using representative air quality monitoring data.

The Quarry site is located at significant distance from any of the air quality monitoring stations (AQMS) operated by NSW DPIE. The locations of the nearest AQMS (listed by proximity) are briefly summarised in **Table 5** and presented in **Appendix C**. The year 2013 is indicated in **Table 5** as this is the year selected for assessment. Further information is provided below.

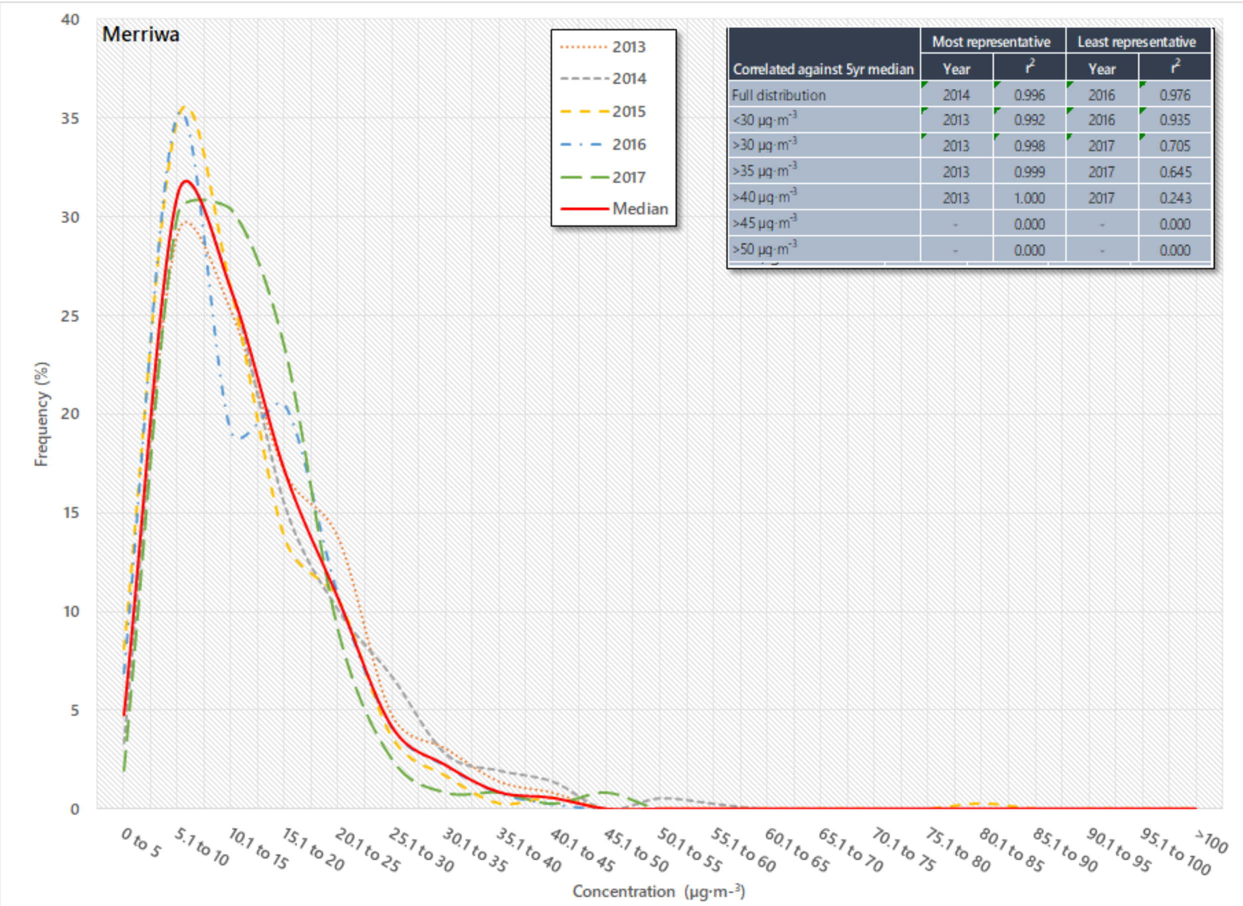
Table 5 Closest DPIE AQMS to the Quarry site

AQMS Location	Approximate distance to Quarry (km)	Screening Parameters			
		2013 Data	Measurements		
			PM_{10}	$PM_{2.5}$	TSP
Narrabri	144	×	×	×	×
Gunnedah	146	×	×	×	×
Merriwa	187	✓	✓	×	×
Tamworth	205	✓	✓	×	×

The closest representative AQMS with data available for the assessment year (see below) of 2013 is noted to be located at Merriwa, and is considered to be the monitoring location most reflective of the conditions at the Quarry site. The adoption of air quality monitoring data, often collected at significant distances from proposed projects, to represent conditions at those locations is a routinely adopted approach in NSW. NSW DPIE operates an extensive air quality monitoring network, generally reflective of the most populated areas of the State. Site specific air quality monitoring funded by proponents can sometimes be used, although for the purposes of use within an AQIA, at least a full year of continuous measurement is required.

Data from the year 2013 have been selected for use in the AQIA to provide an approximation of 'representative' conditions surrounding the Quarry (see **Section 4.2**). This year has been selected through examination of meteorology and air quality for the five-year period 2013 to 2017. In terms of background air quality, the year 2013 was selected as being most representative as PM_{10} data measured at the Merriwa AQMS in 2013 were statistically shown to be most representative of the five-year median particulate distribution at that location, especially when considering the higher concentrations, which are of most concern (see **Figure 4**).

Figure 4 Statistical analysis of PM_{10} concentrations at Merriwa, 2013 to 2017



Correlated against 5yr median	Most representative		Least representative	
	Year	r^2	Year	r^2
Full distribution	2014	0.996	2016	0.976
<30 µg·m-3	2013	0.992	2016	0.935
>30 µg·m-3	2013	0.998	2017	0.705
>35 µg·m-3	2013	0.999	2017	0.645
>40 µg·m-3	2013	1.000	2017	0.243
>45 µg·m-3	-	0.000	-	0.000
>50 µg·m-3	-	0.000	-	0.000

Appendix C provides a detailed assessment of the background air quality monitoring data collected at the Merriwa AQMS.

It is noted that none of the AQMS identified in **Table 5** measured concentrations of TSP or $PM_{2.5}$ in the year 2013. These pollutants are of relevance to the expected emissions from the Quarry. Other sources of data have been adopted to allow representation of the TSP and $PM_{2.5}$ environment in the area surrounding the Quarry, and a full discussion is provided in **Appendix C**.

A summary of the air quality monitoring data used in this assessment is presented in **Table 6**.

Table 6 Summary of background air quality used in the AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP)	Annual $\mu g.m^{-3}$	34.8	Estimated on a TSP:PM_{10} ratio of 2.3404 : 1
Particles (as PM_{10})	24-hour $\mu g.m^{-3}$	Daily Varying	The 24-hour maximum PM_{10} in 2013 at Merriwa was measured to be 43.3 $\mu g.m^{-3}$
	Annual $\mu g.m^{-3}$	14.9	
Particles (as $PM_{2.5}$)	24-hour $\mu g.m^{-3}$	Daily Varying	The 24-hour maximum $PM_{2.5}$ in 2013 was calculated to be 23.4 $\mu g.m^{-3}$
	Annual $\mu g.m^{-3}$	7.7	
Dust deposition	Annual $g{\cdot}m^{-2}{\cdot}month^{-1}$	2	Difference in NSW OEH maximum allowable and incremental impact criterion

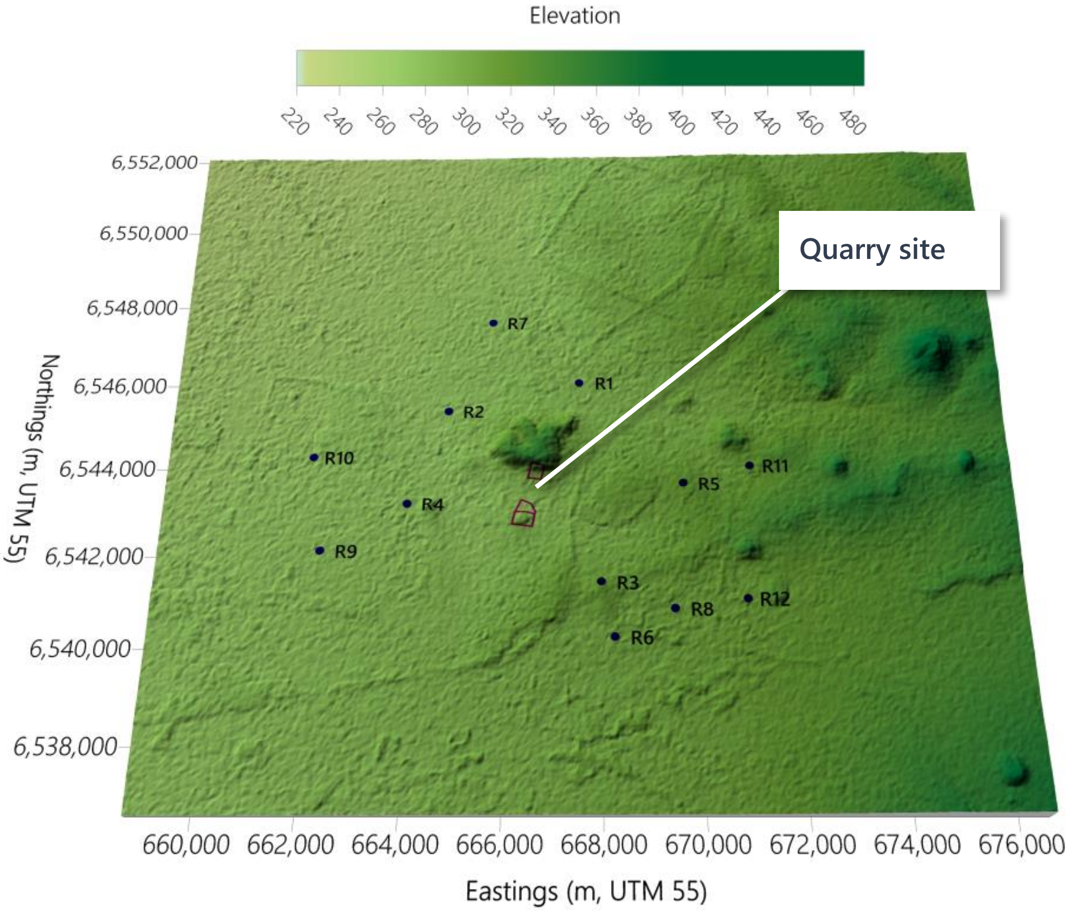
Note: Reference should be made to **Appendix C**

The AQIA has been performed to assess the contribution of the operations at the Quarry to the air quality of the surrounding area. A full discussion of how the Quarry may impact upon air quality is presented in **Section 6**.

4.4 Topography

The elevation of the Proposal site is between approximately 280 m and 360 m Australian Height Datum (AHD). A significant topographical feature is present between the Quarry site and the nearest sensitive receptor locations of receptor 1, 2 and 7 as shown in **Figure 5** which has informed the approach to meteorological modelling (refer **Section 5.1** and **Appendix B**).

Figure 5 3-dimensional representation of topography surrounding the Quarry site



Source: Northstar Air Quality

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5. METHODOLOGY

5.1 Dispersion Modelling

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 3-dimensional (3-D) mode, adopting a 'No-Obs' meteorological modelling simulation, in accordance with NSW DPIE guidance (Barclay & Scire, 2011) (please refer to **Appendix B** for further information). This approach allows the inclusion of topographical features which are present in the area surrounding the Quarry, as discussed in **Section 4.4**.

An assessment of the impacts of the operation of activities at the Quarry has been performed which characterises the likely day-to-day operation of the Quarry, approximating average operational characteristics which are appropriate to assess against longer term (annual average) criteria for particulate matter. The likely peak activities at the Quarry have also been characterised to allow comparison of potential impacts against shorter term (24-hour) criteria for particulate matter.

The modelling scenarios provide an indication of the air quality impacts of the operation of activities at the Quarry site. Added to these impacts are background air quality concentrations (where available and discussed in **Section 4.2** and **Appendix C**) which represent the air quality which may be expected within the area surrounding the Quarry site, without the impacts of the Quarry itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the operation of the Quarry.

5.2 Emissions Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. This assessment has adopted emission factors for drilling, blasting, materials handling processes, movement of trucks on unpaved site roads, crushing and screening, and wind erosion contained within the US EPA AP-42 emission factor compendium (US EPA, 1995 and updates) to represent the emission of particulate matter resulting from the operations occurring at the Quarry site as described in **Section 2.2**. These factors are appropriate for adoption in Australia and are routinely adopted in the assessment of operations of this nature.

In addition to the emissions of process related particulate matter, recent studies have shown that emissions of fine particulate matter resulting from diesel combustion can significantly contribute to the fine particulate matter emissions profile of a site. To appropriately quantify emissions from mobile equipment, information contained within the NSW EPA report '*Reducing Emissions from Non-road Diesel Engines*' (NSW EPA, 2014) has been reviewed. Emissions from the on-site diesel generator have been quantified adopting emission factors outlined in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (EETM) for Combustion Engines (DEWHA, 2008). It has been assumed that all emissions from diesel combustion are fine particulate (i.e. $PM_{2.5}$) emissions.

A number of scenarios have been constructed which cover emissions associated with the construction (site establishment) stage, both stages of operations, and the transportation of material off site, as required within the EARs (refer **Section 1.1**).

5.2.1 Construction

Given that the construction phase is anticipated to last for between three and six weeks, an assessment of the impacts against longer term (annual) particulate criteria has not been performed, although an assessment of the potential short term (24-hour) impacts has been provided.

5.2.2 Operation

Potential emissions of particulate matter during Stage 1 and Stage 2 of operations have been quantified, with an emissions inventory associated with the average operational characteristics, and peak characteristics during each stage calculated.

5.2.3 Transportation

The potential emissions along offsite unpaved transportation routes, during the period of anticipated peak daily haulage (Stage 1) have been quantified. Associated impacts have been assessed against the short term (24-hour) impact assessment criteria. Impacts of offsite transportation have been assessed in a different manner to the activities at the Quarry. Predicted incremental impacts along a nominal 500 m stretch of unsealed road leading from the Quarry site have been modelled to determine the impacts at distance from the road. Discussion is provided in relation to the potential distances of receptors from that transportation route.

A full description of the emission sources included in the assessment, and the emission factors and assumptions adopted are presented in **Appendix D**.

5.3 Emissions Controls

Emissions controls will be employed at the Quarry site. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the Quarry operation.

A summary of the emissions reductions measures that would be adopted during the Quarry construction and operation is presented in **Table 7**. These emission reductions are outlined in the NPI EETM for Mining (NPI, 2012) and relevant AP-42 documentation (US EPA, 1995).

Table 7 Summary of emission reduction methods adopted as part of Quarry operation

Emission control method	Control efficiency (%)
Dust collection on drill rig	90
Application of water on haulage routes (internal)	50
Application of water sprays on materials crushing operations	77.7
Application of water sprays on materials screening operations	91.2
Retention of particulate matter within the pit, for activities occurring in the pit	50 (TSP), 5 (PM_{10}, $PM_{2.5}$)
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified
Minimising travel speeds and distances	Not quantified

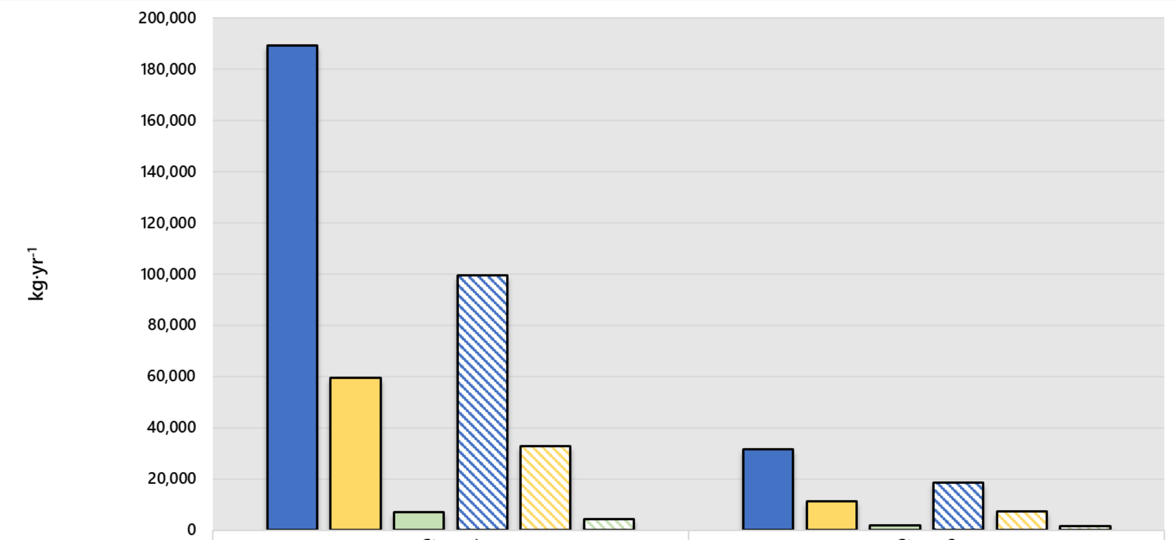
It is noted that the proponent proposes to continually apply water to all exposed areas of the Quarry using the water truck. These emissions reductions have not been applied in any stage of construction or operation in the air quality modelling assessment. The continual application of water to large areas is likely to be unmanageable in periods of water shortage, and therefore the assessment seeks to provide assurances that the air quality criteria can be met at all surrounding sensitive receptor locations, without this additional level of control.

Watering of unpaved haulage routes on site has been assumed to occur continuously and an emission reduction of 50 % has been applied, which is consistent with the application of less than (<) 2 litres of water per square metre per hour ($L \cdot m^{-2} \cdot hr^{-1}$). Should water availability become an issue at the Quarry, or should visible dust be observed to be emitted from haulage routes, the proponent would apply low silt aggregate and reduce the speeds of vehicles along those routes. In this way, the emission reduction efficiencies associated with haulage route watering applied within this assessment can be maintained, even in conditions of water shortage.

The application of water sprays on processing equipment will be maintained continuously throughout the Quarry lifetime.

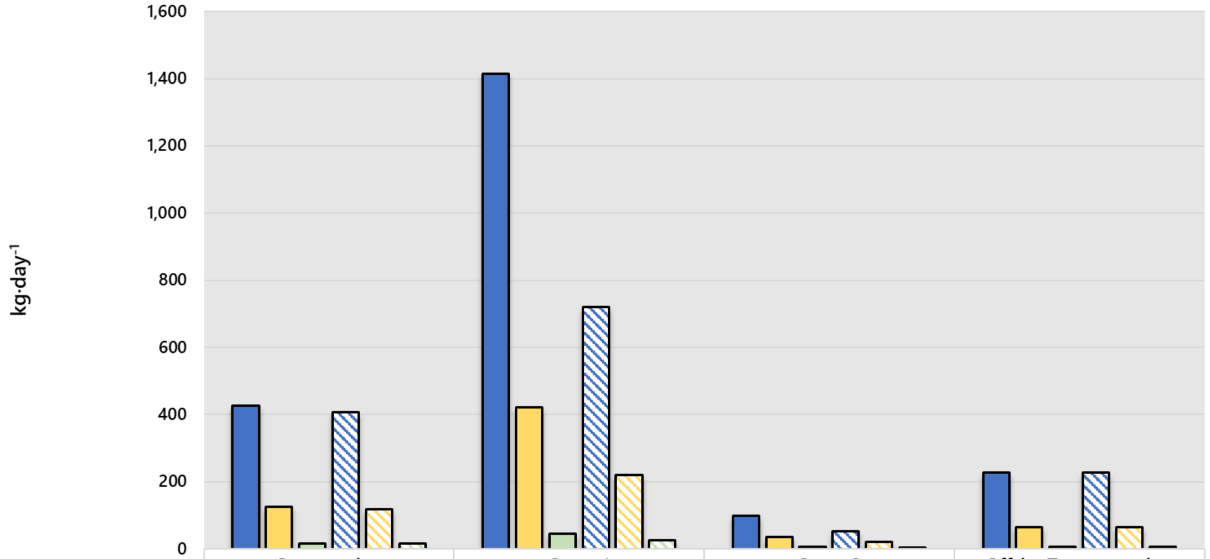
Based on the foregoing, and the information provided in **Appendix D**, the distribution of controlled particulate emissions in each stage of development is presented in **Figure 6** (annual emissions totals) and **Figure 7** (peak daily emissions). Note that emissions associated with offsite transportation of product are associated with 132 vehicles travelling along a nominal 500 m stretch of road and should not be directly compared to the emissions from construction, Stage 1 and Stage 2 activities which are contained within the Quarry site.

Figure 6 Calculated uncontrolled & controlled annual particulate emissions



	Stage 1 Annual	Stage 2 Annual
Uncontrolled TSP	189,409.2	31,564.6
Uncontrolled PM10	59,549.7	11,269.7
Uncontrolled PM2.5	7,000.5	1,879.4
Controlled TSP	99,439.8	18,513.0
Controlled PM10	32,912.9	7,286.6
Controlled PM2.5	4,356.4	1,490.5

Figure 7 Calculated uncontrolled & controlled peak 24-hour particulate emissions



	Construction 24 hr	Stage 1 24 hr	Stage 2 24 hr	Offsite Transportation 24 hr
Uncontrolled TSP	427.2	1,414.0	99.6	227.2
Uncontrolled PM10	124.8	420.7	34.9	64.6
Uncontrolled PM2.5	16.6	45.3	5.4	6.5
Controlled TSP	406.0	719.5	52.3	227.2
Controlled PM10	117.5	220.1	19.9	64.6
Controlled PM2.5	15.9	25.3	4.1	6.5

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6. AIR QUALITY IMPACT ASSESSMENT

This section presents the results of the dispersion modelling assessment and uses the following terminology:

- Incremental impact – relates to the concentrations predicted as a result of the construction and operation of the Quarry in isolation.
- Cumulative impact – relates to the incremental concentrations predicted as a result of the construction and operation of the Quarry PLUS the background air quality concentrations discussed in **Section 4.3**.

The results are presented in this manner to allow examination of the likely impact of the Quarry in isolation and the contribution to air quality impacts in a broader sense.

In the presentation of results, the tables included shaded cells which represent the following:

Model prediction	Pollutant concentration / deposition rate less than the relevant criterion	**Pollutant concentration / deposition rate equal to, or greater than the relevant criterion**

6.1 Particulate Matter - Annual Average PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the operations in Stage 1 and Stage 2 at the Quarry site are presented in **Table 8** and **Table 9**, respectively.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at receptor locations are low (less than (<) 0.5 % of the annual average TSP criterion, <1.1 % of the annual average PM_{10} criterion and less than or equal to (≤) 1.25 % of the $PM_{2.5}$ criterion).

The addition of existing background concentrations (refer **Section 4.3**) results in predicted concentrations of annual average TSP being less than 40 % and annual average PM_{10} being less than 61 % of the relevant criteria at the nearest receptors. Annual average $PM_{2.5}$ is predicted to be 7.8 µg·m^{-3}, but not be exceeding the annual average criterion at the nearest receptors. The existing high background concentration of $PM_{2.5}$ is shown to already be greater than (>) 96 % of the relevant criterion.

Table 8 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Stage 1

Receptor	Annual Average Concentration ($\mu g \cdot m^{-3}$)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	0.3	34.8	35.1	0.2	14.9	15.1	<0.1	7.7	7.8
R2	0.2	34.8	35.0	0.2	14.9	15.1	<0.1	7.7	7.8
R3	0.2	34.8	35.0	0.1	14.9	15.0	<0.1	7.7	7.8
R4	0.4	34.8	35.2	0.3	14.9	15.2	<0.1	7.7	7.8
R5	0.2	34.8	35.0	0.1	14.9	15.0	<0.1	7.7	7.8
R6	0.1	34.8	34.9	0.1	14.9	15.0	<0.1	7.7	7.8
R7	0.1	34.8	34.9	0.1	14.9	15.0	<0.1	7.7	7.8
R8	0.1	34.8	34.9	0.1	14.9	15.0	<0.1	7.7	7.8
R9	0.2	34.8	35.0	0.1	14.9	15.0	<0.1	7.7	7.8
R10	0.1	34.8	34.9	0.1	14.9	15.0	<0.1	7.7	7.8
R11	0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R12	0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
Criterion	-	90		-	25		-	8	

Table 9 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Stage 2

Receptor	Annual Average Concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	0.1	34.8	34.9	0.1	14.9	15.0	<0.1	7.7	7.8
R2	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R3	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R4	0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R5	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R6	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R7	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R8	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R9	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R10	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R11	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
R12	<0.1	34.8	34.9	<0.1	14.9	15.0	<0.1	7.7	7.8
Criterion	-	90		-	25		-	8	

No contour plots of annual average TSP, PM_{10} or $PM_{2.5}$ are presented, given the minor predicted contribution from the operations at the Quarry at the nearest relevant sensitive receptors.

6.2 Particulate Matter – Annual Average Dust Deposition Rates

Table 10 and **Table 11** present the annual average dust deposition predicted as a result of the operations at the Quarry in Stage 1 and Stage 2, respectively.

An assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ is presented in **Table 10** and **Table 11**, although comparison of the incremental concentration with the incremental criterion of 2 $g \cdot m^{-2} \cdot month^{-1}$ is also valid (as discussed within **Section 1**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the Quarry where the predicted impacts in both Stage 1 and Stage 2 are <5% of the incremental criterion at receptor locations.

No contour plots of annual average dust deposition are presented, given the minor predicted contribution from the operations at the Quarry at the nearest sensitive receptors.

Table 10 Predicted annual average dust deposition – Stage 1

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R1	<0.1	2.0	2.1
R2	<0.1	2.0	2.1
R3	<0.1	2.0	2.1
R4	<0.1	2.0	2.1
R5	<0.1	2.0	2.1
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R8	<0.1	2.0	2.1
R9	<0.1	2.0	2.1
R10	<0.1	2.0	2.1
R11	<0.1	2.0	2.1
R12	<0.1	2.0	2.1
Criterion	2.0	-	4.0

Table 11 Predicted annual average dust deposition – Stage 2

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R1	<0.1	2.0	2.1
R2	<0.1	2.0	2.1
R3	<0.1	2.0	2.1
R4	<0.1	2.0	2.1
R5	<0.1	2.0	2.1
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R8	<0.1	2.0	2.1
R9	<0.1	2.0	2.1
R10	<0.1	2.0	2.1
R11	<0.1	2.0	2.1
R12	<0.1	2.0	2.1
Criterion	2.0	-	4.0

6.3 Particulate Matter - Maximum 24-hour Average

Presented in **Table 12** are the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest sensitive receptors as a result of the construction, and Stage 1 and Stage 2 operations at the Quarry. No background concentrations are included within this table. Maximum concentrations in each stage/phase are highlighted in bold.

Table 12 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration ($\mu g \cdot m^{-3}$)					
	Construction		Stage 1		Stage 2	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
R1	1.3	0.2	**6.5**	0.8	**0.6**	**0.1**
R2	2.4	0.4	4.0	0.6	0.4	0.1
R3	1.4	0.3	5.0	0.7	0.5	0.1
R4	**3.0**	**0.5**	5.6	**0.8**	0.5	0.1
R5	0.8	0.1	4.0	0.5	0.5	0.1
R6	1.2	0.2	3.0	0.4	0.2	0.1
R7	2.5	0.4	4.6	0.6	0.3	0.1
R8	0.9	0.2	4.2	0.5	0.3	0.1
R9	1.0	0.2	3.4	0.5	0.3	0.1
R10	0.9	0.2	2.5	0.4	0.4	0.1
R11	0.6	0.1	2.2	0.3	0.2	0.0
R12	0.7	0.1	2.5	0.3	0.2	0.1

The predicted incremental concentration of PM_{10} and $PM_{2.5}$ are demonstrated to be minor. At the receptor where the maximum 24-hour PM_{10} impact is expected to occur in any stage (receptor R1), operation of the Quarry in Stage 1 would contribute up to 13 % of the relevant criterion. Similarly, at the receptor where the maximum 24-hour $PM_{2.5}$ impact is expected to occur in any stage (receptor R1) operation of the Quarry during Stage 1 would contribute up to 3.4 % of the relevant criterion.

Table 13 and **Table 14** present the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Quarry, with background included. Results are presented for Stage 1 operations only, as results associated with construction and Stage 2 operations indicate lower predicted impacts at all receptors.

Results are presented for the receptor at which the highest incremental PM_{10} and $PM_{2.5}$ impacts have been predicted, and also for the receptors at which the highest cumulative impacts (increment plus background) have been predicted. These may be different receptors than those at which the highest incremental impacts are predicted.

The left side of the tables show the predicted concentration on days with the highest cumulative impact (principally driven by the highest background concentrations), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations with the contemporaneous background values to derive the respective cumulative predictions.

Contour plots of the incremental contribution of the proposed operations at the Quarry site to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure 8** and **Figure 9**.

Both tables indicate that the operations at the Quarry will not result in any exceedances of the 24-hour particulate criteria, even taking into account existing background conditions.

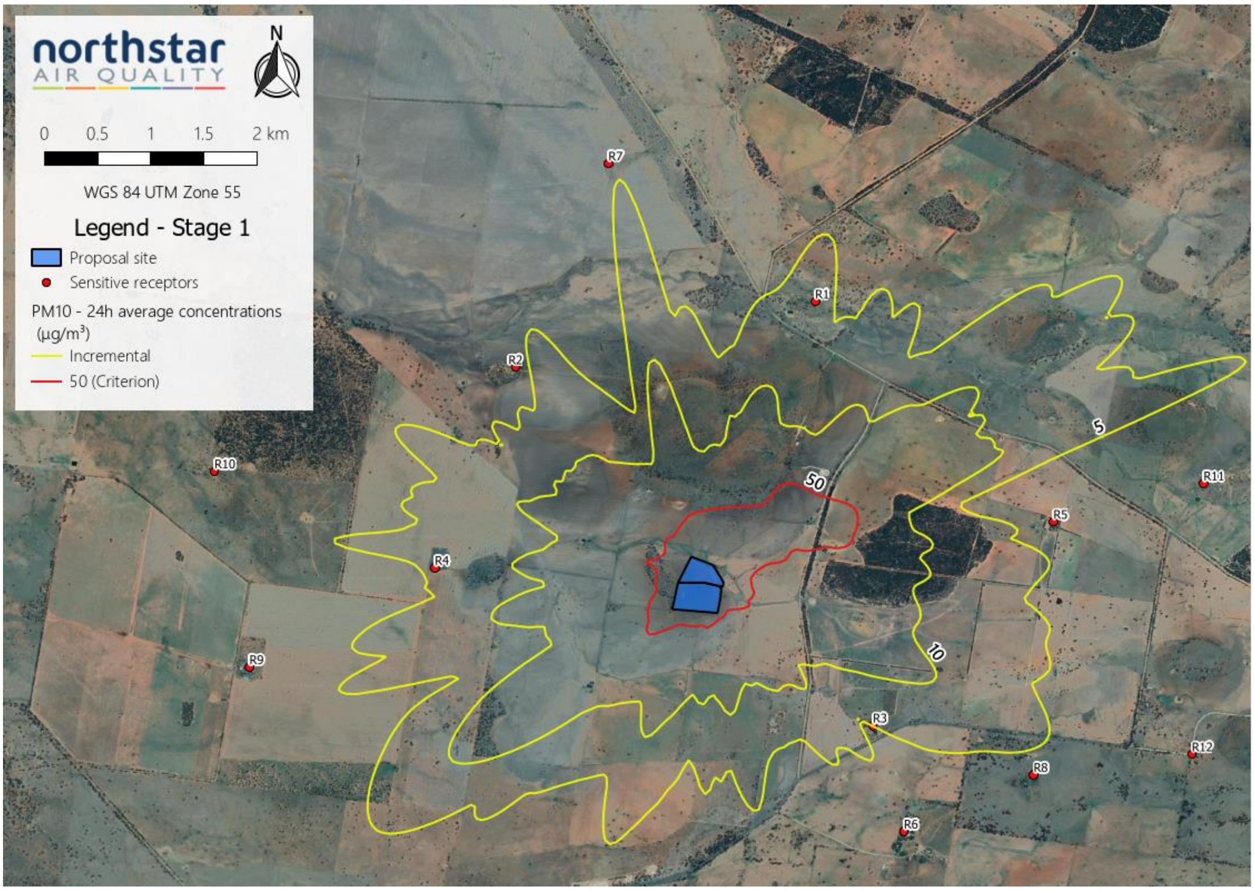
Table 13 Summary of contemporaneous impact and background – PM_{10} Stage 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor 1			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor 1		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
09/01/2013	0.9	43.3	44.2	19/06/2013	6.5	8.1	14.6
18/10/2013	<0.1	42.6	42.7	25/05/2013	4.7	8.0	12.7
30/04/2013	<0.1	42.3	42.4	24/07/2013	4.3	8.6	12.9
29/12/2013	1.7	39.9	41.6	03/06/2013	4.2	6.5	10.7
02/01/2013	1.1	38.9	40.0	24/08/2013	3.2	6.1	9.3
30/12/2013	1.0	38.5	39.5	07/07/2013	3.0	7.1	10.1
19/10/2013	<0.1	38.6	38.7	25/04/2013	2.8	19.4	22.2
04/11/2013	0.3	37.6	37.9	19/04/2013	2.8	24.8	27.6
08/09/2013	0.5	34.7	35.2	26/04/2013	2.8	11.4	14.2
08/11/2013	<0.1	33.3	33.4	21/06/2013	2.4	14.5	16.9
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

Table 14 Summary of contemporaneous impact and background – $PM_{2.5}$ Stage 1

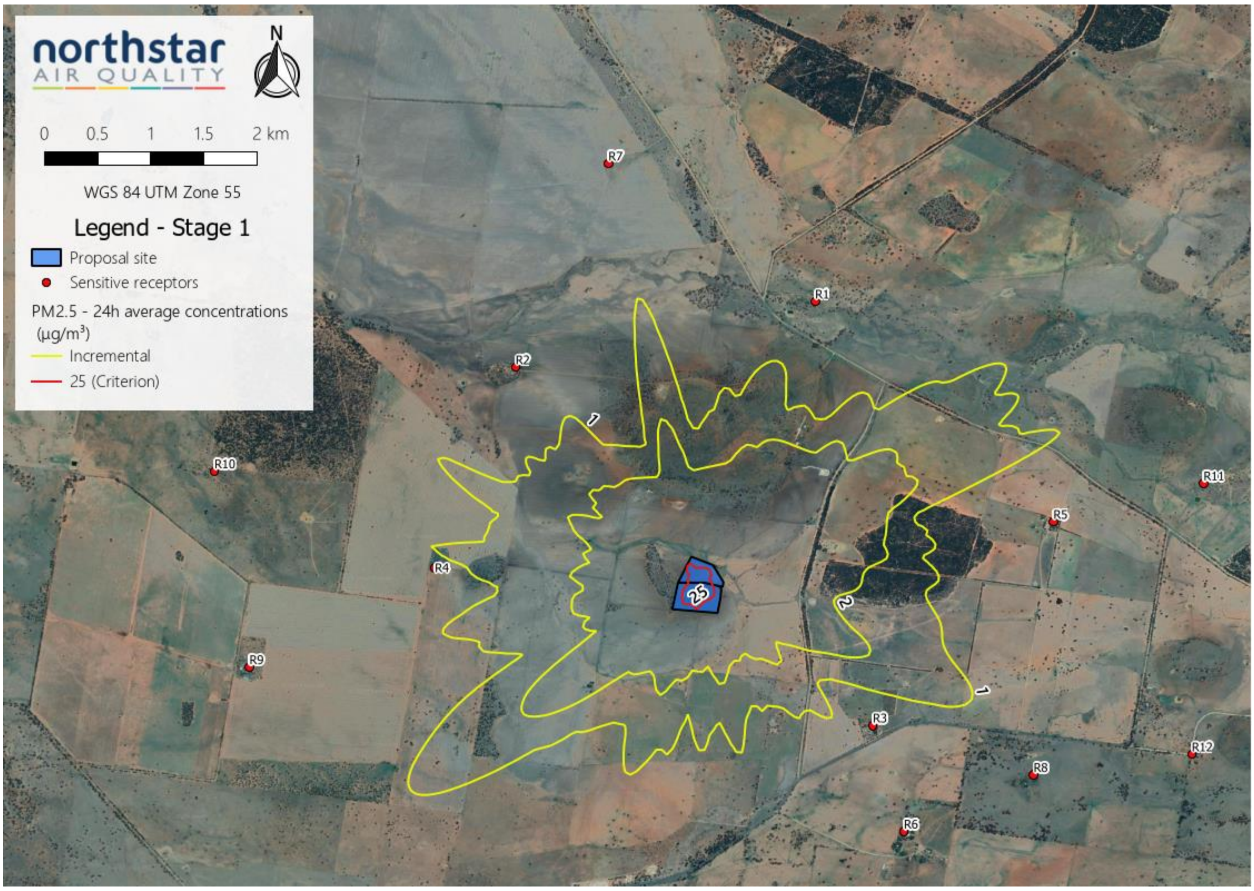
Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor 1			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor 4		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
09/01/2013	0.1	23.4	23.6	21/06/2013	0.8	7.5	8.3
18/10/2013	0.0	23.0	23.0	10/05/2013	0.8	10.9	11.7
30/04/2013	0.0	22.9	22.9	26/07/2013	0.7	5.3	6.0
29/12/2013	0.2	21.5	21.8	29/06/2013	0.6	2.6	3.2
02/01/2013	0.1	21.0	21.1	01/09/2013	0.5	12.5	13.1
30/12/2013	0.1	20.8	20.9	06/05/2013	0.5	10.8	11.3
19/10/2013	0.0	20.8	20.8	01/08/2013	0.5	6.2	6.6
04/11/2013	0.0	20.3	20.3	28/06/2013	0.4	4.4	4.8
08/09/2013	0.1	18.7	18.7	07/08/2013	0.4	4.3	4.7
08/11/2013	0.0	17.9	17.9	24/03/2013	0.4	4.2	4.7
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Proposal.			

Figure 8 Incremental 24-hour PM_{10} concentrations – Stage 1



Note 1: Criterion = 50 µg·m^{-3} (cumulative)

Figure 9 Incremental 24-hour $PM_{2.5}$ concentrations – Stage 1



Note 1: Criterion = 25 µg·m^{-3} (cumulative)

6.4 Emissions Associated with Offsite Transportation

As required within the EARs (refer **Section 1.1**), an assessment of the impact of offsite transportation is required to be provided. Given that offsite transportation would be likely to peak in Stage 1 operations, with up to 132 peak daily vehicles trips occurring between the hours of 6am and 6pm, this is the scenario which has been selected for assessment. The potential incremental impacts at distance from an unpaved road are presented in **Figure 10** and **Figure 11** for PM_{10} and $PM_{2.5}$ concentrations, respectively.

Figure 10 Predicted maximum incremental 24-hour average PM_{10} at distance from roadside

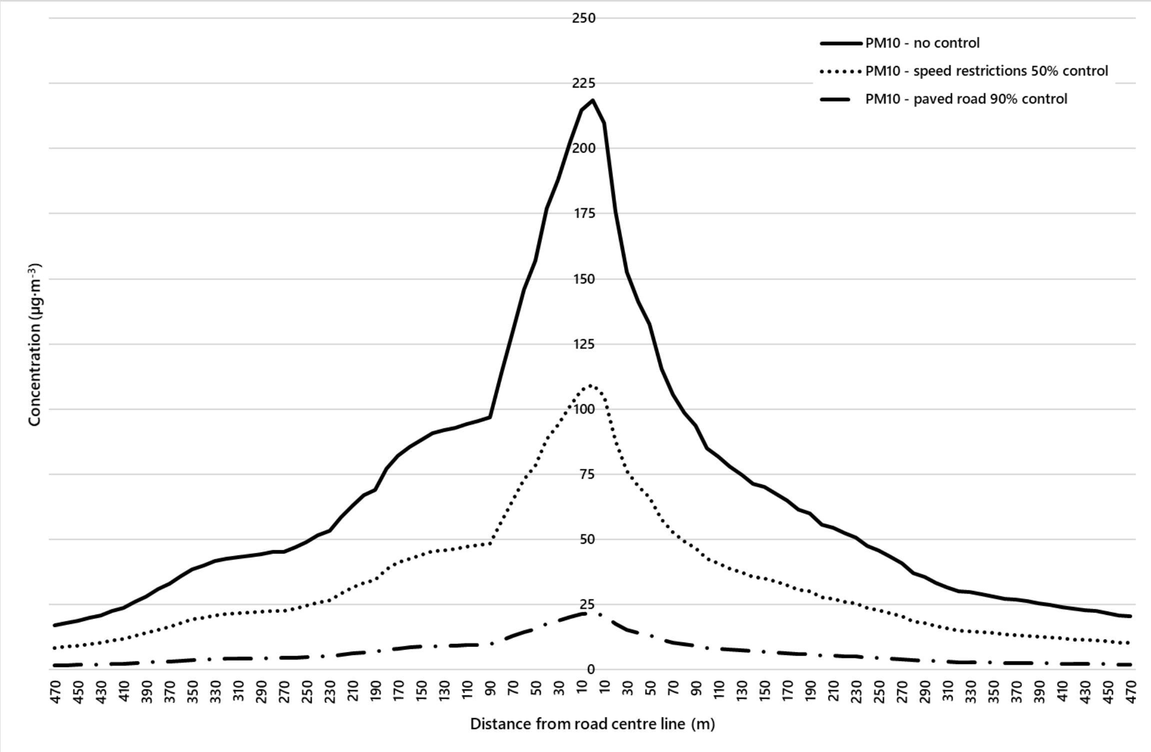
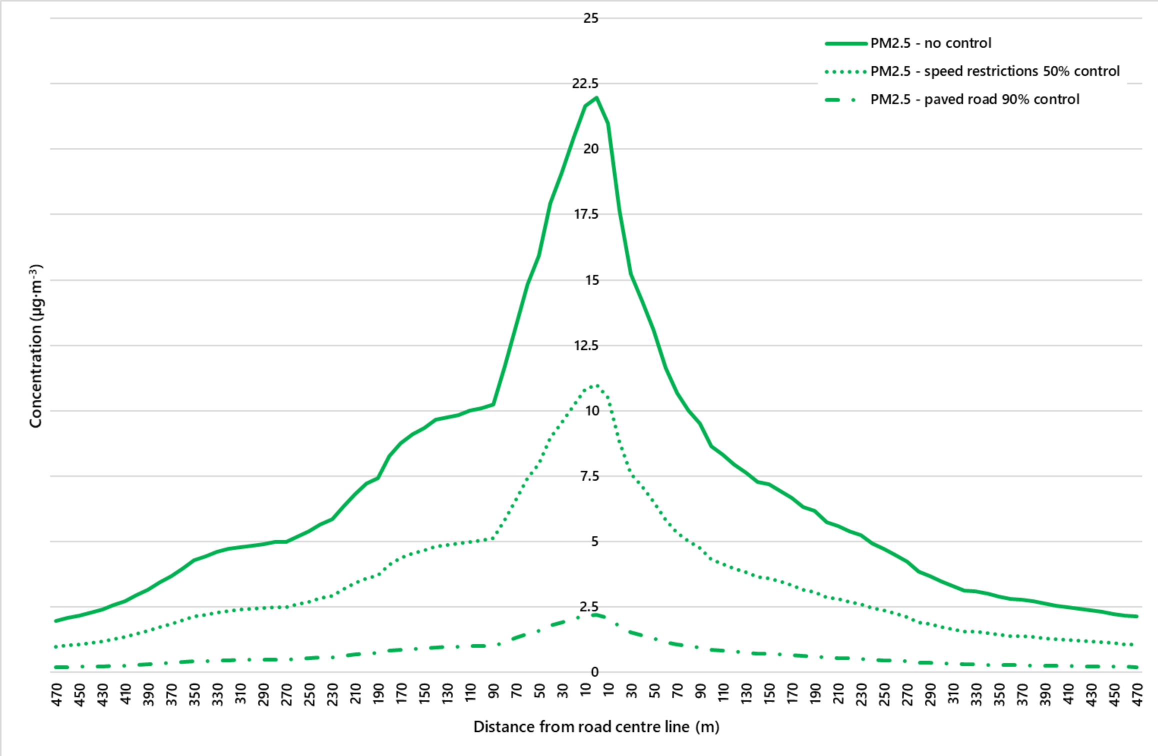


Figure 11 Predicted maximum incremental 24-hour average $PM_{2.5}$ at distance from roadside



The results indicate that concentrations of PM_{10} and $PM_{2.5}$ resulting from offsite transportation of product during peak periods in Stage 1 operations may be significant at distance from the road if uncontrolled. Receptor locations are identified at distances of approximately 30 m from Tooraweenah Road (receptor R6), should trucks head south, and approximately 340 m from Tooraweenah Road (receptor R11) should trucks head north, once at the Tooraweenah Road Gulargambone Road junction.

A number of controls can be applied to the transportation of material on unpaved road surfaces, and may include the restriction of vehicle speeds, which can reduce emissions of particulate by between 50 % and 85 % if a reduction in speed from 65 km·hr^{-1} to 30 km·hr^{-1} is achieved (Katestone, 2011). Alternatively, emissions of particulate matter can be controlled by over 90 % should the surface be paved (Katestone, 2011). The impact of those emissions reductions is presented in **Figure 10** and **Figure 11** for PM_{10} and $PM_{2.5}$ respectively.

It is noted that the predicted impacts result from 132 vehicles leaving the Quarry each day during peak Stage 1 operations and therefore represent a worst-case scenario. Impacts during average Stage 1 operations would be likely to represent around a third of those impacts, with impacts in Stage 2 lower still.

It is recommended that a management plan is constructed which enforces vehicle speed restrictions when within 500 m of any residence which is located within a distance of 200 m of the offsite haulage route and road signs are placed at the appropriate locations to help enforce that control. Alternatively, a further assessment of off-site haulage routes might be performed to provide a more targeted assessment of these impacts which is outside the scope of this report.

Should complaints be received by residents along the transport route, or should excessive dust be observed to be generated, surface treatments/improvements such as paving should be investigated and employed for those particular stretches of road. In reality, the paving of road surfaces should result in significantly greater than 90 % control of particulate emissions, although the road surfaces would be required to be constructed with sufficient camber to allow any silt which may settle to be flushed during any rainfall events.

It is considered that particulate matter generation during offsite transportation of product can be adequately managed through a combination of the above controls.

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7. MITIGATION AND MONITORING

7.1 Mitigation

Based on the findings of the operational phase air quality impact assessment, it is considered that the particulate control measures proposed to be implemented will be sufficient to ensure that exceedances of all particulate criteria would not be experienced as a result of the construction or operation of the Quarry.

No additional exceedances of the 24-hour PM_{10} or $PM_{2.5}$ criteria are predicted as a result of the proposed activities at the Quarry. The incremental contributions from the Quarry are predicted to be low and are not anticipated to significantly alter the air quality environment of the local area.

A number of mitigation measures are proposed to be implemented as part of the Quarry operation. Where defensible quantification of the control efficiencies afforded by these measures can be determined, these have been applied within the assessment.

The mitigation measures which will be used as part of the Quarry activities are summarised in **Table 15**.

Table 15 Summary of emission reduction methods adopted as part of Proposal operation

Emission control method	Control efficiency (%)
Road Haulage	
Surface treatment – application of water	50
Drilling	
Dust collection on drill rig	90
Materials Handling	
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified
Minimising travel speeds and distances	Not quantified
Keep travel routes and materials moist	50
Materials Processing	
Application of water on crushing activities	77.7
Application of water on screening activities	91.2
Wind Erosion	
Application of water	(see below)
All Activities within Building	
Enclosure of activities	70
Off-site Unpaved Road Emissions	
Road speed reduction from 65 $km{\cdot}hr^{-1}$ to 30 $km{\cdot}hr^{-1}$	50 - 85

As previously discussed, the proponent proposes to continually apply water to all exposed areas of the Quarry using the water truck. Apart from on-site haulage routes, these emissions reductions have not been applied in any stage of construction or operation in the air quality modelling assessment. The continual application of water to large areas is likely to be unmanageable in periods of water shortage, and therefore the assessment seeks to provide assurances that the air quality criteria can be met at all surrounding sensitive receptor locations, without this additional level of control.

Watering of unpaved haulage routes on site has been assumed to occur continuously and an emission reduction of 50 % has been applied, which is consistent with the application of <2 $L{\cdot}m^{-2}{\cdot}hr^{-1}$. Should water availability become an issue at the Quarry, or should visible dust be observed to be emitted from haulage routes, the proponent would apply low silt aggregate and reduce the speeds of vehicles along those routes. In this way, the emission reduction efficiencies associated with haulage route watering applied within this assessment can be maintained, even in conditions of water shortage.

NSW EPA has requested that consideration be given to dust management techniques that can be used when water is limited or unavailable. It is respectfully considered that this assessment has demonstrated that impacts can be managed even when water is limited, through the adoption of alternative control techniques. It is noted that the model predictions assume that no control is applied to exposed areas, and therefore the impacts presented represent a potential worst-case scenario in that regard.

7.2 Monitoring

The predictions presented in this AQIA indicate that there would be no predicted exceedances of the adopted air quality criteria. It is not anticipated that any air quality monitoring would be required to be performed, although it is recommended that regular audits are performed to ensure that the Quarry site is implementing the air quality control measures appropriately, as outlined within this report.

NSW EPA has requested that a Trigger Action Response Plan (TARP) is considered to be developed for the Quarry site. A TARP identifies conditions (triggers) under which dust controls are applied, or activities are modified or ceased (actions) in response to increasing risk of elevated particulate concentrations at surrounding receptor locations. Given that no air quality monitoring is proposed, the increased risk of elevated particulate concentrations would be determined through examination of visible dust generation, and the observation of prevailing wind conditions (wind speed and direction). Wind conditions can be appropriately observed through the installation of a wind cone, and an appropriate trigger level which results in visible dust generation from all activities would be reviewed prior to Stage 1 operations. It is noted that the determination of these triggers is not critical to the compliance of air quality criteria at off-site locations, as the AQIA predicts compliance in all wind speed/direction combinations assessed (8,760 hours, or 1 full year of hourly meteorological predictions).

8. CONCLUSION

OzArk Environment and Heritage has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Quarry Solutions Pty Ltd (Quarry Solutions) to perform an air quality impact assessment (AQIA) for the proposed development of a quarry located at 4948 Tooraweenah Road, Mount Tenandra NSW 2828 (the Quarry site).

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the Proposal under Part 4 of the *Environmental Planning and Assessment Act* 1979.

Emissions of particulate matter associated with construction phase and operational phase activities have been calculated, including a number of emission control measures proposed to be adopted. To ensure that the assessment provides an appropriately conservative approximation of the potential impacts at surrounding receptor locations, certain control measures which are proposed to be adopted have not been included in the assessment, specifically the watering of exposed areas. In this way, the predicted incremental impacts can be viewed as worst-case.

The AQIA presents an assessment of the impacts of activities associated with the construction/site establishment phase and operational phases of the Quarry. An assessment of the potential air quality impacts along off-site transportation routes has also been provided. The AQIA has used a quantitative dispersion modelling approach, performed in accordance with the relevant NSW guidelines. The results of the assessment are presented as predicted incremental change, and as a cumulative impact accounting for the prevailing background air quality conditions.

The results of the AQIA indicate that during the construction phase, and both stages of operation, the air quality criteria can be achieved. In periods when water may not be readily available, haul road watering may be restricted, and low silt aggregate may be used along internal haul roads, in conjunction with a lowering of vehicle speeds, to result in similar off-site impacts. As previously noted, the assessment of wind erosion has assumed that no control is applied, with the results indicating that control of this source of emissions is not critical to compliance with air quality criteria. It is stressed that watering of exposed areas will be performed when possible.

A Trigger Action Response Plan (TARP) would be developed prior to Stage 1 operations which would link visible dust generation from all activities with wind conditions experienced at the Quarry site. A range of actions would be listed which would be adopted to reduce visible dust generation, until such time as the adopted trigger levels have reduced. It is noted that the adoption of a TARP is not critical to ensure compliance with the adopted air quality criteria, and its use should result in impacts being less than those predicted within this AQIA.

It is demonstrated that the Quarry can be operated in such a manner as to ensure compliance with all adopted air quality criteria, and the development should not be refused on the grounds of air quality.

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9. REFERENCES

Barclay, J., & Scire, J. (2011). *Generic Guidance and Optimum Model Settings for th CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia', prepared for NSW OEH.*

DEWHA. (2008). *Emission Estimation Technique Manual for Combustion Engines Version 3.0.*

Groundwork Plus. (2019). *Inland Rail Project: Preliminary Resource Investigation - Ralston.*

NPI. (2012). *National Pollutant Inventory Emission Estimation Technique Manual for Mining, Version 3.1.*

NSW EPA. (2013). *Technical Report No.7, Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year.*

NSW EPA. (2014). *Reducing Emissions from Non-Road Diesel Engines.* Prepared by ENVIORN Australia Pty Ltd.

US EPA. (1987). *User's Guide – Emission Control Technologies and Emission Factors for Unpaved Road Fugitive Emissions, Centre for Environmental Research Information, Office of Research and Development, USEPA, September 1987.*

US EPA. (1995). *Compilation of Air Pollutant Emission Factors, January 1995.*

US EPA. (2004). *AP-42 Emission Factors Section 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing.*

USEPA. (1998). *AP-42 Emission Factors Section 11.9 Western Surface Coal Mining.*

USEPA. (2006a). *AP-42 Compilation of Air Pollutant Emission Factors, Chapter 13.2.4 Aggregate Handling and Storage Piles.*

USEPA. (2006c). *AP42 Compilation of Air Pollutant Emission Factors, Chapter 13.2.2 Unpaved Roads.*

USEPA. (2006c). *AP-42 Compliation of Air Pollutant Emission Factors, Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.*

APPENDIX A

Report Units and Common Abbreviations

Units Used in the Report

All units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units. In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. For example:

- 50 micrograms per cubic metre would be presented as 50 $\mu g{\cdot}m^{-3}$ and not 50 $\mu g/m^3$; and,
- 0.2 kilograms per hectare per hour would be presented as 0.2 $kg{\cdot}ha^{-1}{\cdot}hr^{-1}$ and not 0.2 kg/ha/hr.

Table A1 Common Abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AWS	automatic weather station
BoM	Bureau of Meteorology
°C	degrees Celsius
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIE	NSW Department of Planning, Industry and Environment
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
FEL	front end loader
GDA	Geocentric Datum of Australia
GIS	geographical information system
K	kelvin (-273°C = 0 K, ±1°C = ±1 K)
kW	kilowatt
MGA	Map Grid of Australia
$mg{\cdot}m^{-3}$	milligram per cubic metre of air
$mg{\cdot}Nm^{-3}$	Milligram per normalised cubic metre of air
$\mu g{\cdot}m^{-3}$	microgram per cubic metre of air
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
OEH	NSW Office of Environment and Heritage (now defunct)
PM	particulate matter

Abbreviation	Term
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEE	Statement of Environmental Effects
TAPM	The Air Pollution Model
TPM	total particulate matter
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VKT	vehicle kilometres travelled

APPENDIX B

Meteorology

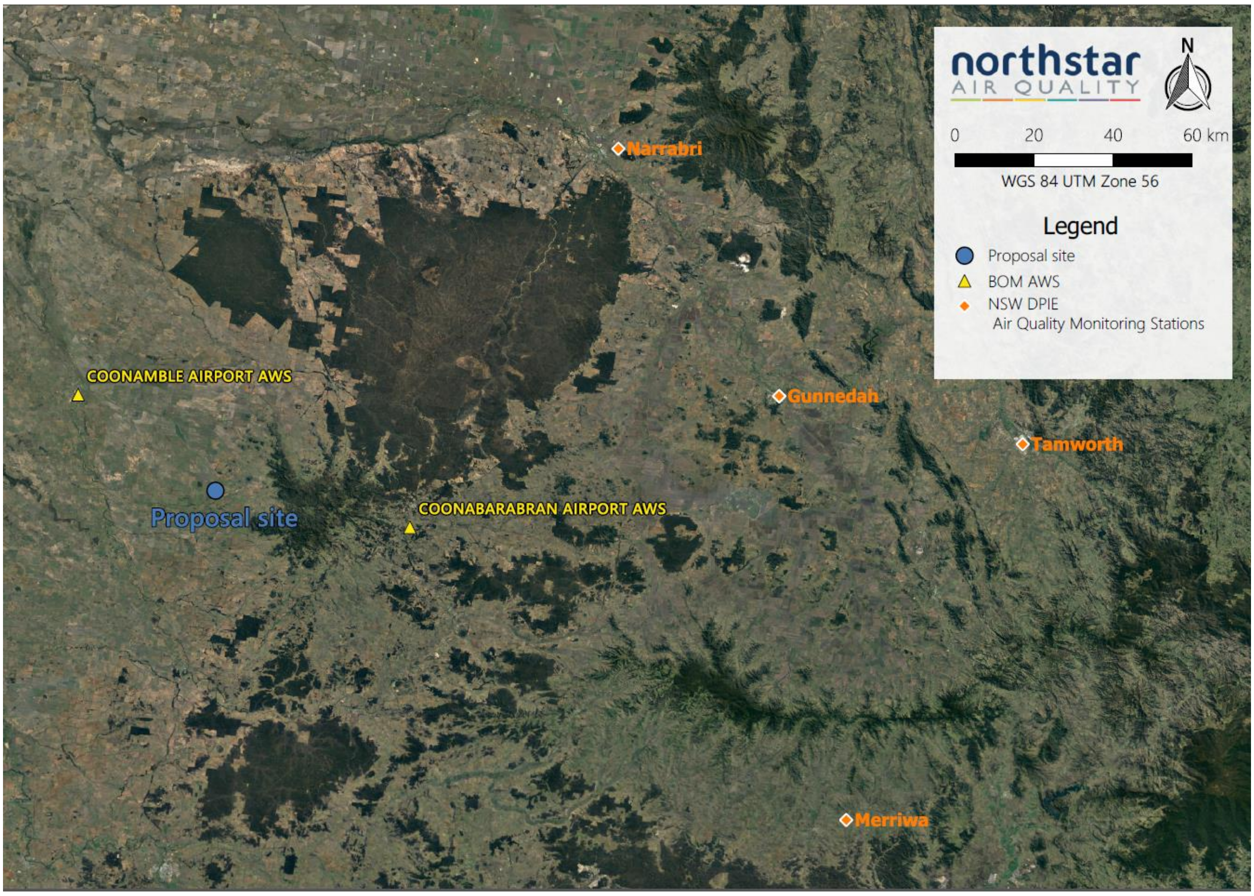
As discussed in **Section 4.2** a meteorological modelling exercise has been performed to characterise the meteorology of the Quarry site in the absence of site-specific measurements. The meteorological modelling has been based on measurements taken at a number of surrounding automatic weather stations (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

A summary of the relevant AWS is provided in **Table B1** and also displayed in **Figure B1**.

Table B1 Details of the meteorological monitoring surrounding the Proposal site

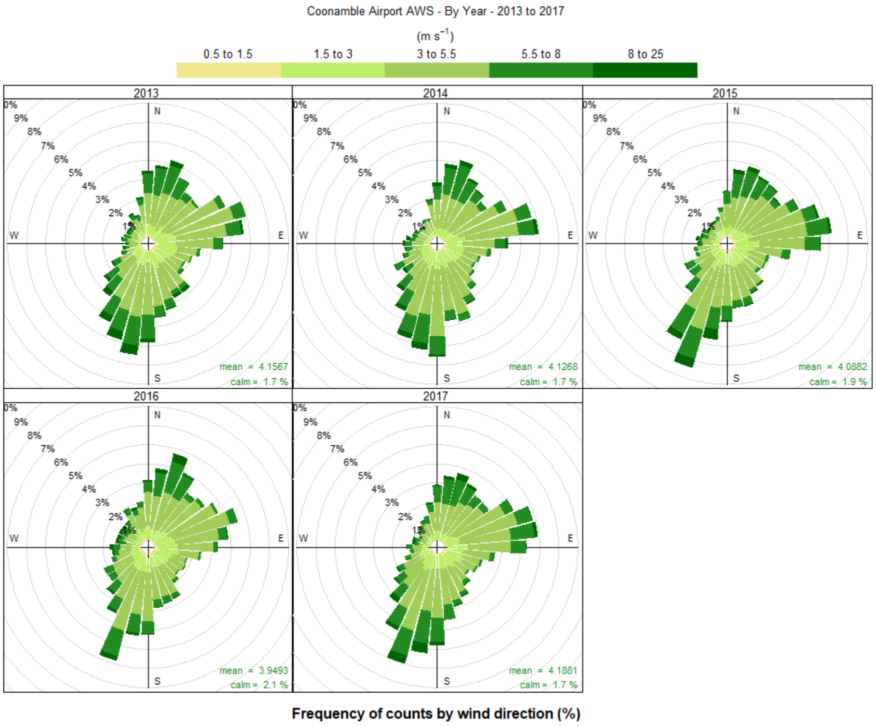
Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Coonamble Airport AWS #051161	BoM	631 761	6 572 064	22.8
Coonabarabran Airport AWS #064017	BoM	715 967	6 531 267	72.4

Figure B1 Meteorological and air quality monitoring surrounding the Quarry site



Meteorological conditions at Coonamble Airport AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2013 to 2017) are presented in **Figure B2**. Coonabarabran Airport AWS is located approximately 50 km to the southeast of the Quarry site, but is located beyond the Warrumbungle Range and is not representative of the meteorology experienced at the Quarry site.

Figure B2 Annual wind roses 2013 to 2017, Coonamble Airport AWS



The wind roses indicate that from 2013 to 2017, winds at Coonamble Airport AWS shows a predominant north-easterly and south-westerly component to the wind direction.

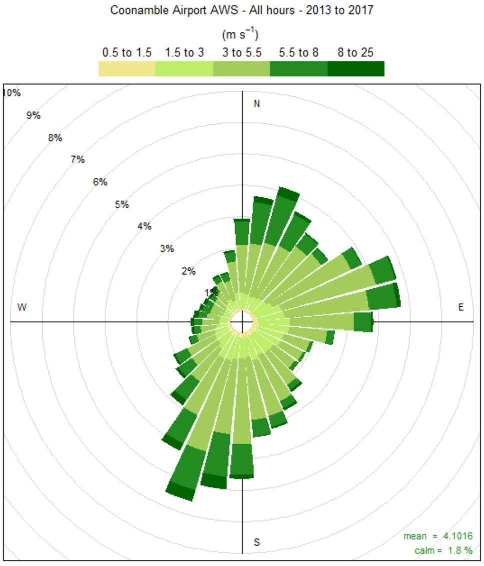
The majority of wind speeds experienced at Coonamble Airport AWS over the 5-year period, 2013 to 2017 are generally in the range <3 metres per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from a south-westerly direction. Winds of this speed are not frequent, occurring during 3.8% of the observed hours over the 5-year period at Coonamble Airport AWS. Calm winds (<0.5 $m \cdot s^{-1}$) occur during 1.9% of hours on average across the 5-year period.

Given the wind distributions across the years examined, data for the year 2013 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied.

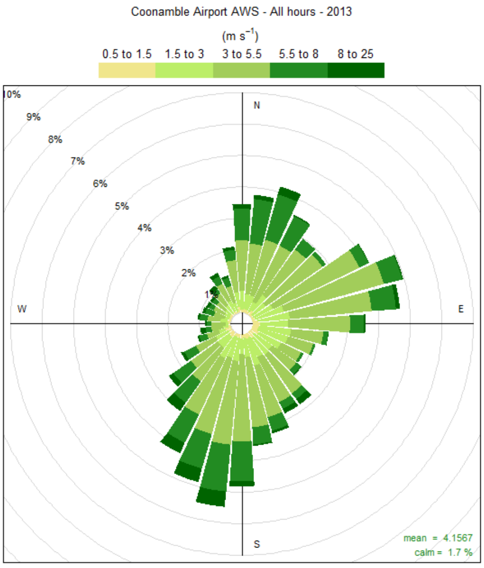
Presented in **Figure B3** are the annual wind rose for the 2013 to 2017 period and the year 2013 and in **Figure B4** the annual wind speed distribution for Coonamble Airport AWS. These figures indicate that the distribution of wind speed and direction in 2013 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2013 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure B3 Annual wind roses 2013 to 2017, and 2013 Coonamble Airport AWS

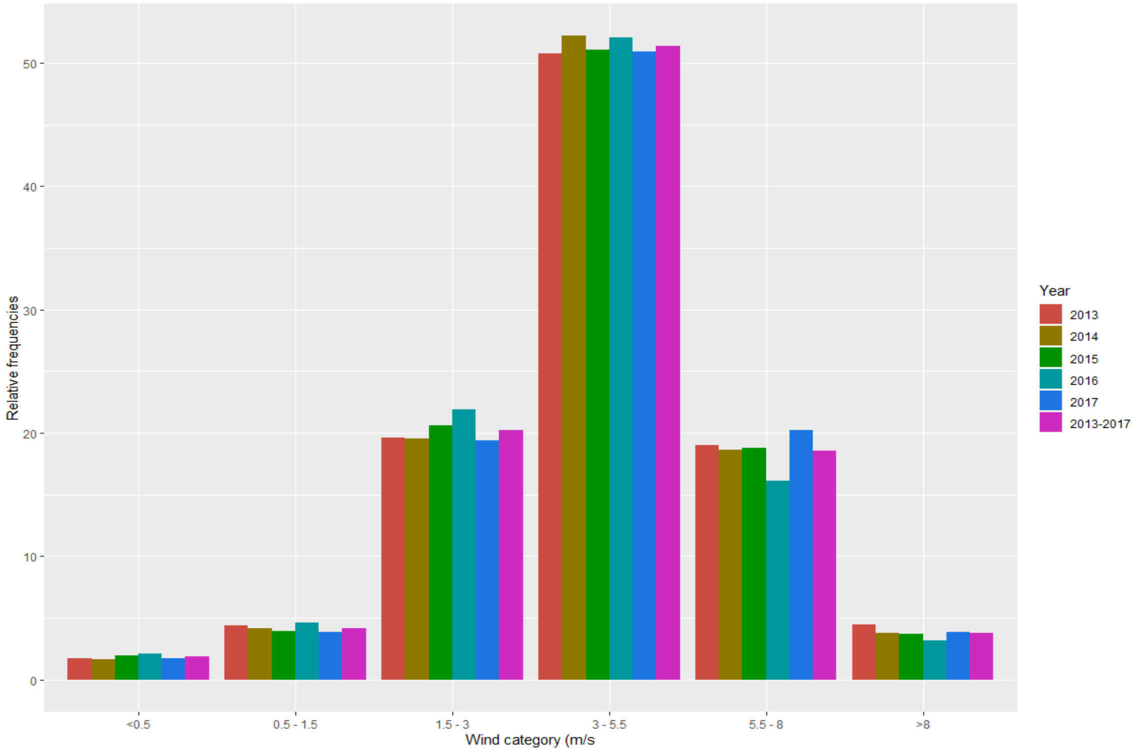


Frequency of counts by wind direction (%)



Frequency of counts by wind direction (%)

Figure B4 Annual wind speed distribution – Coonamble Airport AWS



Meteorological Modelling

The BoM data adequately covers the issues of data quality assurance, however it is limited by its location compared to the Quarry site. To address these uncertainties, a multi-phased assessment of the meteorological data has been performed.

In absence of any measured onsite meteorological data, site representative meteorological data for this Quarry was generated using the CALMET meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 4.2**).

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. 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 and thus the final wind field reflects the influences of local topography and current land uses.

In this study, CALMET has been run in no-observations (no-obs) mode using gridded prognostic data generated by The Air Pollution Model (TAPM, v 4.0.5), developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

TAPM is a prognostic model which predicts wind speed and direction, temperature, pressure, water vapour, cloud, rainwater and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

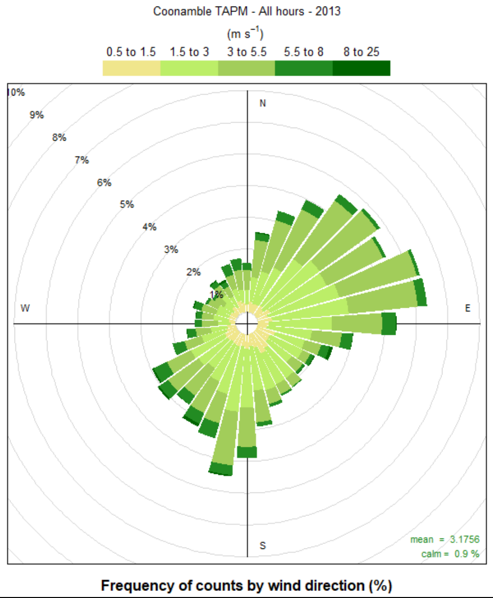
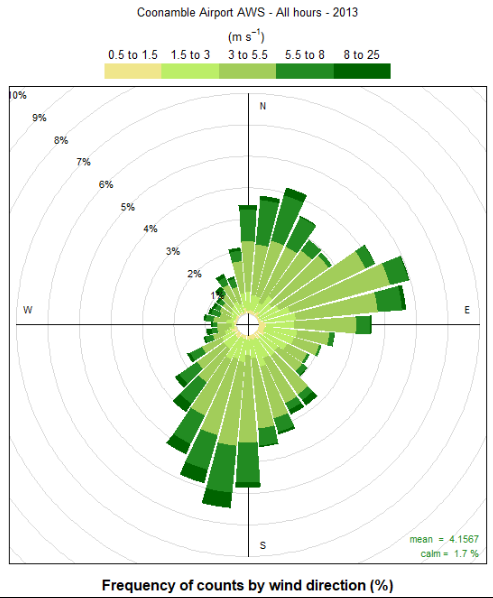
The parameters used in TAPM and CALMET modelling are presented in **Table B2**.

Table B2 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2013 to 31 December 2013
Centre of analysis	647 000 mE, 6 555 000 mN (UTM Coordinates)
Number of grid points	60 x 60 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	No data assimilation
CALMET	
Modelling period	1 January 2013 to 31 December 2013
South-West corner of analysis	661 000 mS, 6 537 500 mN (UTM Coordinates)
Meteorological grid domain (resolution)	11 km x 11 km (0.25 km)
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data assimilation	No-obs approach using TAPM – 3D.DAT file

A comparison of the TAPM generated meteorological data, and that observed at the Coonamble Airport AWS are presented in **Figure B5**. These data generally compare well which provides confidence that the meteorological conditions modelled as part of this assessment are appropriate. Comparison of the CALMET modelled data and the observations at Coonamble Airport AWS is not possible due to the large separation distances between the Quarry site and that AWS.

Figure B5 Modelled and observed meteorological data – Coonamble Airport AWS, 2013

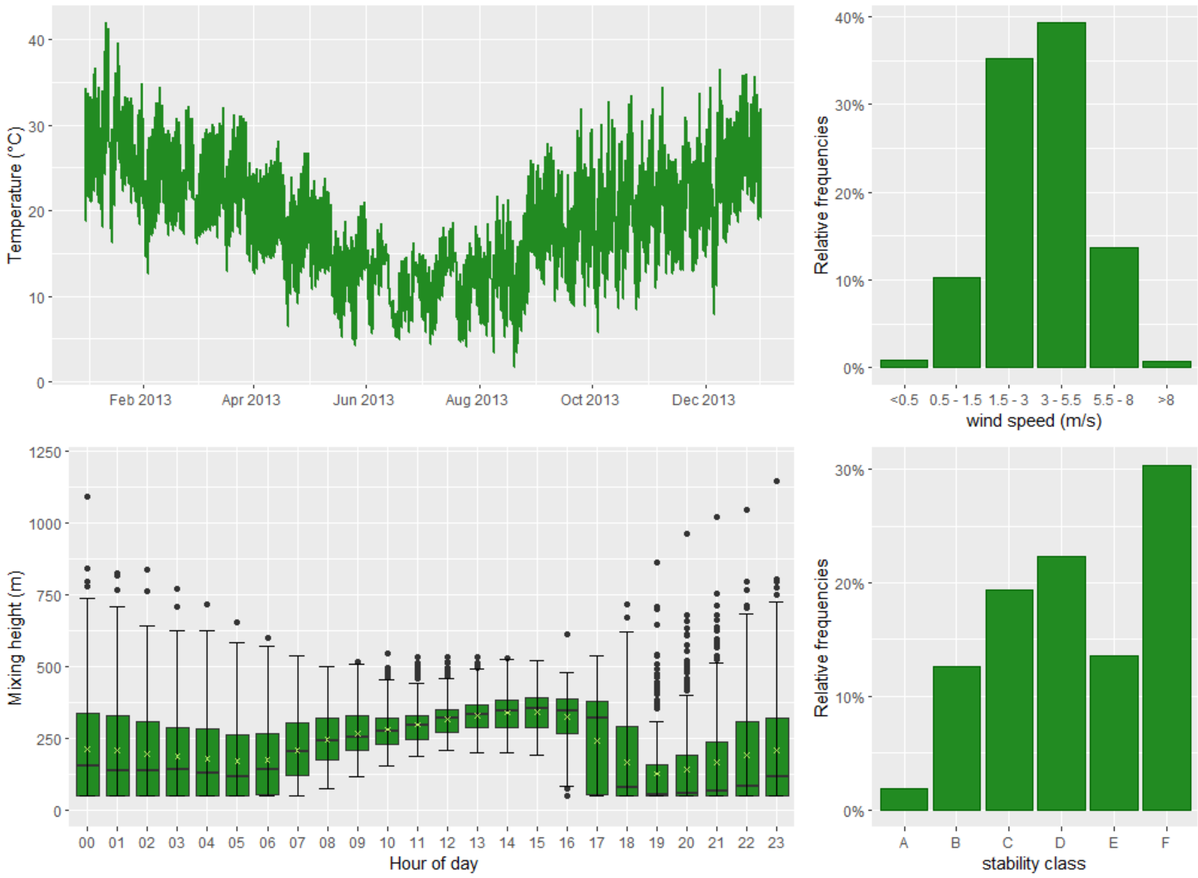
Coonamble Airport TAPM generated windrose	Observations at Coonamble Airport AWS
	

As generally required by the NSW EPA the following provides a summary of the modelled meteorological dataset. Given the nature of the pollutant emission sources at the Quarry site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirulation potential of the Quarry site has not been provided. Details of the CALMET predictions of wind speed and direction, mixing height, temperature and stability class at the Quarry site are provided in **Figure B6**.

The modelled temperature variations at the Quarry site during 2013 predicted a maximum temperature of 42°C on 12 January 2013 and a minimum temperature of 2°C on the 20 August 2013.

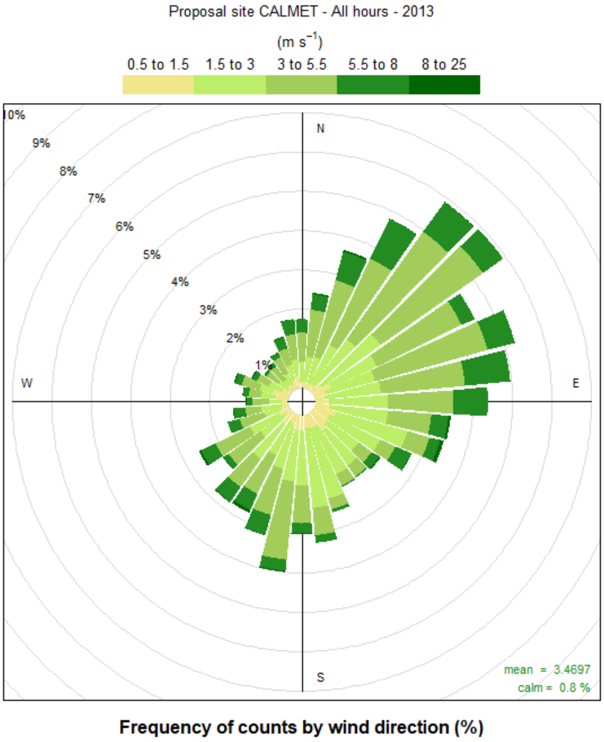
Diurnal variations in maximum and average mixing heights during the 2013 period shows that, as expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure B6 Predicted temperature, mixing height and wind speed frequency – Quarry site 2013



The modelled wind speed and direction at the Proposal site during 2013 are presented in **Figure B8**.

Figure B7 Predicted wind speed and direction – Quarry site 2013



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APPENDIX C

Background Air Quality Data

Air quality is not monitored at the Quarry site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this assessment. Determination of data to be used as a location representative of the Quarry site and during a representative year can be complicated by factors which include:

- the sources of air pollutant emissions around the Quarry site and representative air quality monitoring station(s); and,
- the variability of particulate matter concentrations (often impacted by natural climate variability).

Air quality monitoring is performed by the NSW Department of Planning, Industry and Environment (DPIE) at four air quality monitoring station (AQMS) within a 210 km radius of the Quarry site. Details of the monitoring performed at these AQMS is presented in **Table C1** and **Figure B1**. As discussed in **Section 4.2** and **Section 4.3**, the year 2013 was selected for assessment based upon an analysis of meteorological and background air quality data.

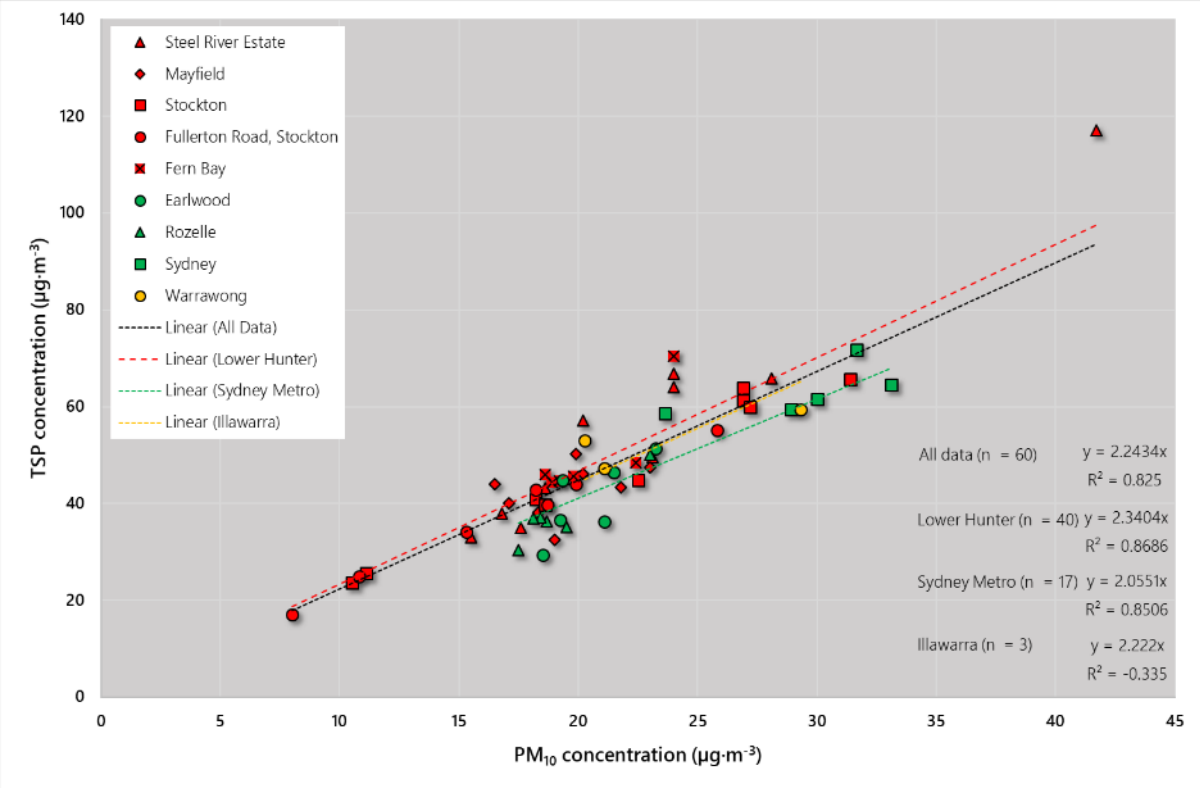
Table C1 Details of closest AQMS surrounding the Quarry

AQMS Location	Approximate distance to Quarry (km)	Screening Parameters			
		2013 Data	Measurements		
			PM_{10}	$PM_{2.5}$	TSP
Narrabri	144	×	×	×	×
Gunnedah	146	×	×	×	×
Merriwa	187	✓	✓	×	×
Tamworth	205	✓	✓	×	×

Based on the sources of AQMS data available and their proximity to the Quarry, Merriwa was selected as the source of AQMS data for use in this assessment.

Concentrations of TSP are not measured at any AQMS surrounding the Quarry site. An analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure C1**. The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.3404 : 1 (i.e. PM_{10} represents ~43% of TSP) from the Lower Hunter is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA, resulting in a background annual average TSP concentration of 34.8 $\mu g \cdot m^{-3}$ being adopted.

Figure C1 Co-located TSP and PM_{10} Measurements, Lower Hunter, Sydney Metro and Illawarra



Similarly, no dust deposition data is available for the area surrounding the Quarry. The incremental impact criterion of 2 g·m^{-2}·month^{-1} as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of 2 g·m^{-2}·month^{-1} (the total allowable deposition being 4 g·m^{-2}·month^{-1}).

No $PM_{2.5}$ monitoring data are available at the Merriwa AQMS in 2013, nor for any AQMS within 210 km of the Quarry site. In the absence of those data, an analysis of co-located PM_{10}/$PM_{2.5}$ measurements derived from monitoring data at the Gunnedah and Narrabri AQMS in 2018 has been performed (given their proximity to the Quarry).

A scatter plot of all $PM_{2.5}$ and PM_{10} data collected in 2018 at both Narrabri and Gunnedah AQMS is presented in **Figure C2**. The general relationship can be seen to be skewed by high PM_{10} and $PM_{2.5}$ concentration readings. The same data, but with all PM_{10} concentration values greater than 50 µg·m^{-3} (i.e. exceedances of the PM_{10} criterion) removed from the analysis is presented in **Figure C3**. The correlation between PM_{10} and $PM_{2.5}$ data shows the strongest relationship (R^2), both with and without exceedances removed at the Gunnedah AQMS in 2013. To determine an appropriate continuous $PM_{2.5}$, those relationships have been applied to PM_{10} data collected at the Merriwa AQMS in 2013. Of the four relationships, the application of the relationship derived from Gunnedah data, with PM_{10} exceedances removed yields the highest $PM_{2.5}$ concentrations, and these data have been adopted as part of this assessment.

Figure C2 Relationship between PM_{10} and $PM_{2.5}$ at Narrabri and Gunnedah, 2018 (all measurements)

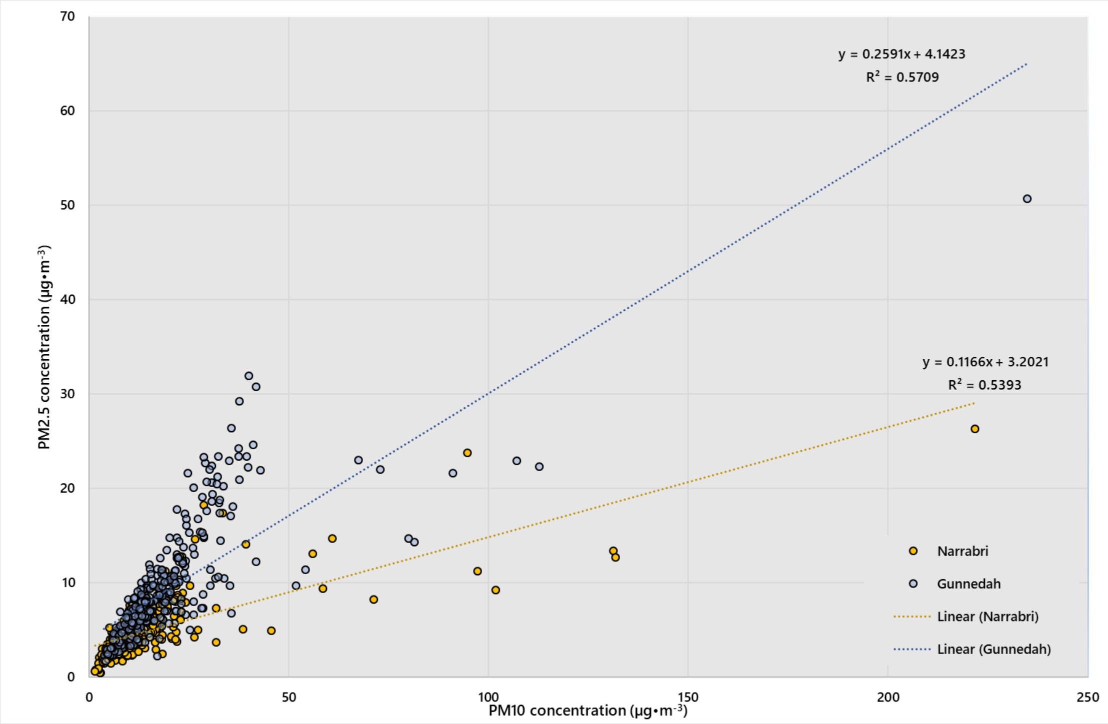
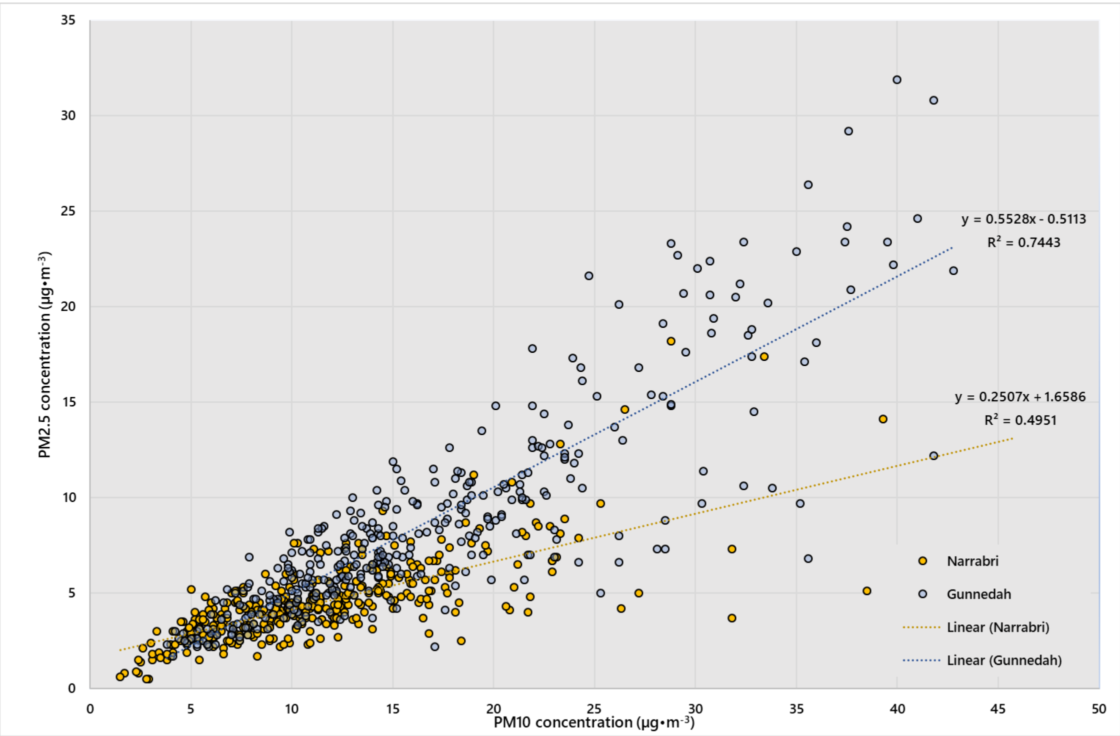


Figure C3 Relationship between PM_{10} and $PM_{2.5}$ at Narrabri and Gunnedah, 2018 (PM_{10} exceedances removed)



Graphs presenting the daily varying PM_{10} and (derived) $PM_{2.5}$ data recorded at Merriwa in 2013 are presented in **Figure C2** and **Figure C3**, respectively. It is noted that no exceedances of the maximum 24-hr average PM_{10} criterion were experienced at the Merriwa AQMS in 2013.

Figure C2 PM_{10} Measurements, Merriwa 2013

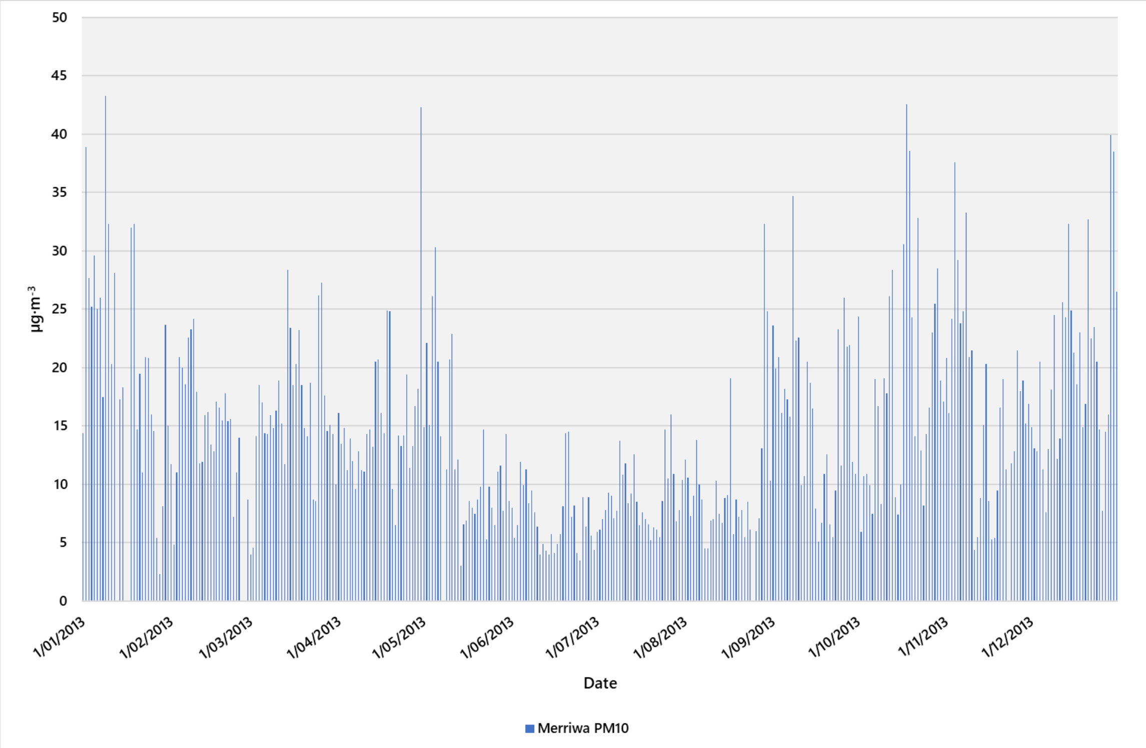
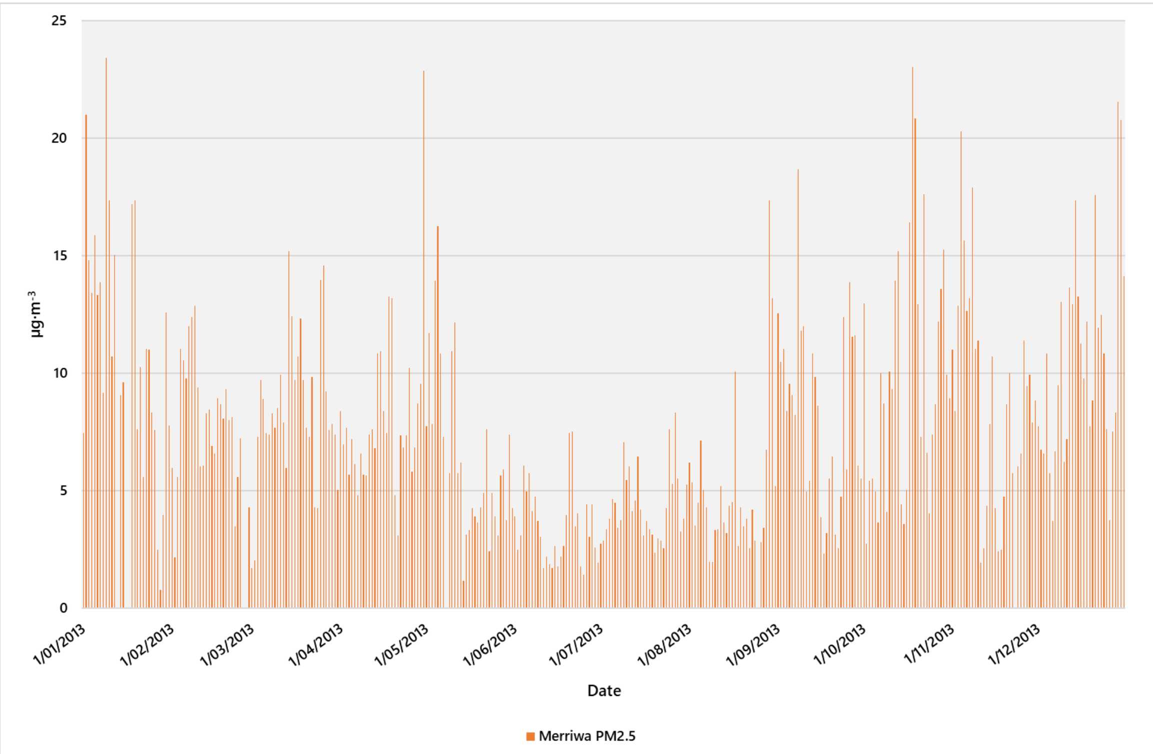


Figure C3 Derived $PM_{2.5}$ Measurements, Merriwa 2013



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APPENDIX D

Emissions Inventory

As outlined in **Section 2.2**, a number of operations to be performed as part of the Quarry construction and operation have the potential to result in emissions of particulate matter. A detailed outline of the emission estimation techniques adopted to derive total emissions from the sources identified are presented below.

A detailed summary and justification of all parameters adopted within the emissions estimation calculations is provided. Emission factors are presented in alphabetical order.

The silt and moisture content of overburden, rock and product has been taken to be 2 % which is considered to represent a conservative assumption.

Blasting

The emissions of particulate matter from blasting operations have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mine) (US EPA, 1998). The emission factors are:

$$EF_{TSP}\ (kg.blast^{-1}) = 0.00022 \times (A)^{1.5}$$

$$EF_{PM_{10}}\ (kg.blast^{-1}) = 0.52 \times (EF_{TSP})$$

$$EF_{PM_{2.5}}\ (kg.blast^{-1}) = 0.03 \times (EF_{TSP})$$

where:

$EF_{\ (kg \cdot blast^{-1})}$ = emission factor for particulate matter

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

The quality rating for this emission factor is rated is rated C for TSP, D for PM_{15}, and D for $PM_{2.5}$.

Bulldozing (Overburden)

The emissions of particulate matter from the bulldozing (overburden [or material other than coal in the NPI]) process have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mining) (US EPA, 1998). The emission factor is:

$$EF_{TSP}\ (kg.hr^{-1}) = \frac{2.6 \times (s)^{1.2}}{(M)^{1.3}}$$

$$EF_{PM_{15}}\ (kg.hr^{-1}) = \frac{0.45 \times (s)^{1.5}}{(M)^{1.4}}$$

$$EF_{PM_{10}}(kg.hr^{-1}) = 0.75\ \times EF_{PM_{15}}$$

$$EF_{PM_{2.5}}\ (kg.hr^{-1}) = 0.105 \times EF_{TSP}$$

where:

$EF_{(kg \cdot hr^{-1})}$ = emission factor for particulate matter

$s_{(\%)}$ = silt content in %, by weight

$M_{(\%)}$ = moisture content of overburden in %, by weight

The quality rating for this emission factor is rated B for TSP, C for PM_{15}, D for PM_{10}, D for $PM_{2.5}$.

Crushing (Primary and Secondary)

Emissions of particulate matter resulting from the processing of materials (primary and secondary crushing) have been estimated using the emission factors presented in Section 11.19.2 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for the operations outlined above. No emission factors associated with primary or secondary crushing are available within AP-42 although emission factors for tertiary crushers can be used as an upper limit for primary or secondary crushing (US EPA, 2004). The control efficiency used for tertiary crushing is 77.7% as calculated in AP-42 (US EPA, 2004).

$PM_{2.5}$ emission factors are not available for uncontrolled crushing sources in AP-42 although have been taken to be 18% of PM10 as per controlled tertiary crushing in table 11.19.2-1 (US EPA, 2004)

For uncontrolled tertiary crushing (and uncontrolled primary and secondary crushing):

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0027$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.0012$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.00012$$

For controlled tertiary crushing (and controlled primary and secondary crushing):

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0006$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.00027$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.00005$$

The quality rating for these emission factors is: Tertiary Crushing (uncontrolled) = E & C (TSP & PM_{10} respectively), and Tertiary Crushing (controlled) = E, C & E (TSP, PM_{10} & $PM_{2.5}$ respectively). All other crushing emission factors calculated have a quality rating of U (no rating).

Diesel combustion

Emissions of particulate matter resulting from the combustion of diesel fuel in plant and equipment used at the Quarry have been estimated using emission parameters outlined in the NSW EPA report '*Reducing Emissions from Non-road Diesel Engines*' (NSW EPA, 2014). Emissions from the on-site diesel generator have been quantified adopting emission factors outlined in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (EETM) for Combustion Engines (DEWHA, 2008). The assumptions adopted in the assessment of diesel emissions are presented below.

Assumptions adopted within the diesel particulate matter assessment

Equipment	kW rating	Operating hours per day			Load factor[1]	$PM_{2.5}$ emission factor ($g \cdot kWh^{-1}$)[2]
		Constr.	Stage 1	Stage 2		
Grader (CAT 140)	110	2	2	2	0.59	0.2
Roller (Cat 20T)	75	10	10	10	0.59	0.2
Dozer (Cat D10)	522	10	10	10	0.59	0.2
Drill (Atlas Copco T35)	100	2	2	2	0.59	0.2
Excavator (CAT 345)	216	2	2	2	0.59	0.2
Front End Loader (CAT 980G)	240	2	2	2	0.59	0.2
Water Cart (Acco)	250	12	12	12	0.59	0.2
Generator (100 kVa)	80	12	12	12	0.59	0.2

Notes: 1: From Table D1 of (NSW EPA, 2014)
2: From Table 5 of (NSW EPA, 2014)
3: 1996 Australian Design Rule (ADR) 70/00 in (NSW EPA, 2013)

Vehicle	Vehicle kilometres travelled			$PM_{2.5}$ emission factor ($g \cdot VKT^{-1}$)[2]
	Const.	Stage 1	Stage 2	
Onsite haulage vehicles	8.1 (peak daily)[1] N/A (annual)	45 (peak daily) 12 208 (annual)	6.0 (peak daily) 1 788 (annual)	0.584
Offsite haulage vehicles	N/A	329 (peak daily) 32 237 (annual)	14 (peak daily) 4 158 (annual)	0.584

Notes: 1: No annual scenario assessed for construction impacts
2: 1996 Australian Design Rule (ADR) 70/00 in (NSW EPA, 2013)

Emission factors contained within table 49 of the NPI EETM for Combustion Engines (DEWHA, 2008) have been adopted, specifically associated with stationary small (<450 kW) diesel engines:

$$EF_{PM_{10}}\ (kg.kWh^{-1}) = 0.0013$$

$$EF_{PM_{2.5}}\ (kg.kWh^{-1}) = 0.00013$$

Drilling

Emissions of particulate matter resulting from drilling (overburden) operations have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The emission factors within table 11.9-4 have been adopted for the operations outlined above. The emission factor is:

$$EF_{TSP}\ (kg.hole^{-1}) = 0.59$$

where:

EF_{TSP} = emission factor for total suspended particulate matter (kg per hole)

PM_{10} & $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 52% of TSP for PM10 and, 3% of TSP for $PM_{2.5}$ as per AP-42 blasting (Table 11.9-2) (US EPA, 1998).

The quality rating for this emission factor is C.

Excavators/Frontend Loaders

Emissions associated with all loading and unloading operations have been characterised using the factor outlined in AP-42 for Batch Drop processes (Section 13.2.4.3) (US EPA, 2006b). This equation is consistent with that associated with the use of excavators, shovels and front end loaders outlined in the NPI EETM for Mining (NPI, 2012):

$$EF\ (kg \cdot tonne^{-1}) = k(0.0016)\,\frac{\left(\frac{U\ (m \cdot s^{-1})}{2.2}\right)^{1.3}}{\left(\frac{M\ (\%)}{2}\right)^{1.4}}$$

where:

$EF_{TSP\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

$EF_{PM_{10}\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

k_{TSP} = 0.74 for particles less than 30 micrometres aerodynamic diameter

$k_{PM_{10}}$ = 0.35 for particles less than 10 micrometres aerodynamic diameter

$k_{PM_{2.5}}$ = 0.053 for particles less than 2.5 micrometres aerodynamic diameter

U = mean wind speed ($m \cdot s^{-1}$)

M = material moisture content (% by weight)

The quality rating for this application is rated U (no rating).

Grading

The emissions of particulate matter from grading operations have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mine) (US EPA, 1998). The emission factor is:

$$EF_{TSP}\ (kg.VKT^{-1}) = 0.0034 \times (S)^{2.5}$$

$$EF_{PM_{10}}\ (kg.VKT^{-1}) = 0.60 \times (EF_{PM_{15}})$$

$$EF_{PM_{2.5}}\ (kg.VKT^{-1}) = 0.031 \times (EF_{TSP})$$

where:

$EF_{(kg \cdot VKT^{-1})}$ = emission factor for particulate matter

S = mean vehicle speed (km·hr^{-1}), taken to be 10 km·hr^{-1}.

The quality rating for this emission factor is rated C for TSP, D for PM_{10}, D for $PM_{2.5}$.

Screening

Emissions of particulate matter resulting from the screening of material have been estimated using the emission factors presented in Section 11.19.2 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for the operations outlined above. PM2.5 emission factors are not available for uncontrolled screening sources in AP-42 although have been taken to be 7% of PM10 as per controlled screening activities in table 11.19.2-1 (US EPA, 2004). The control efficiency used for screening is 91.2% as calculated in AP-42 (US EPA, 2004).

For uncontrolled screening:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0125$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.0043$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.00030$$

For controlled screening:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0011$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.00037$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.000025$$

The quality rating for these emission factors is: screening (uncontrolled) = E & C (TSP & PM_{10} respectively), and screening (controlled) = E, C & E (TSP, PM_{10} & $PM_{2.5}$ respectively). All other screening emission factors calculated have a quality rating of U (no rating).

Unpaved Roads

Emissions of particulate matter resulting from the movement of materials on unpaved roads have been estimated using the emission factors presented in Section 13.2.2 (Unpaved Roads) of AP-42 (US EPA, 2006a).

The emission factor in section 13.2.2 of (US EPA, 2006a) has been adopted for the operations of vehicles on unpaved roads:

$$EF_{(kg.VKT^{-1})} = 0.2819 \times k \times (\frac{s}{12})^{a} \times (\frac{W \times 0.907185}{3})^{b}$$

where:

$EF_{(kg.VKT^{-1})}$ = emission factor (kg per vehicle kilometre travelled) multiplied by 0.2819 to convert from lb per vehicle mile travelled

k = particle size multiplier (dimensionless)

s = surface material silt content (%)

W = mean vehicle weight (tons) multiplied by 0.907185 to convert from metric tonnes

The particle size multipliers for TSP, PM_{10} and $PM_{2.5}$ (k) are provided in (US EPA, 2006a) as 4.9, 1.5 and 0.15, respectively.

The quality rating for this application is rated B for TSP, B for PM_{10} and B for $PM_{2.5}$.

The silt content of unpaved haul roads at the Quarry site has been taken to be 8.3% which is consistent with haul roads at stone quarrying and processing sites (Table 13.2.2-1 of (US EPA, 2006a)).

The mean weight of vehicles use on site has been calculated based on the use of '40 t' dump trucks, such as the CAT A40G (or similar) which has a payload of 39 t, tare weight of 29.9 t and a loaded weight of 68.9 t (ritchiespecs.com). The average vehicle weight has therefore been calculated to be 49.4 t (metric).

Vehicles transporting product offsite have been assumed to have a payload of 38 t, tare weight of 18t and and loaded weight of 56 t, resulting in an average vehicle weight of 37 t.

Wind Erosion (Exposed Areas)

Emissions of particulate matter resulting from the wind erosion of exposed areas have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The emission factors within table 11.9-4 have been adopted for the operations outlined above. The emission factor applies to the materials: seeded land, stripped overburden and graded overburden. The emission factor is:

$$EF_{TSP}\ (tonne.(hectare.year)^{-1}) = 0.85$$

where:

$EF_{TSP}\ (tonne.(hectare.year)^{-1})$ = emission factor for total suspended particulate matter

PM_{10} and $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 50% of TSP for PM_{10} and, 7.5% of TSP for $PM_{2.5}$ as per AP-42 section (13.2.5) for industrial wind erosion (US EPA, 2006c).

The quality rating for this emission factors is C.

Construction phase - 24-hour maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling of blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59	0.306	0.0177	kg·hole^{-1}	10	holes	Dust collection on drill rig (90%)	0.590	0.307	0.018
Blasting of fresh rock to establish bench	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	4.026	2.093	0.121	kg·blast^{-1}	1	blasts		4.026	2.094	0.121
Loading of haul truck (rock)	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	333	t		0.371	0.176	0.027
Hauling rock to 'Processing Area'	AP-42 Unpaved roads - Section 13.2.2	3.933	1.118	0.111	kg·VKT^{-1}	7.68	VKT	Level 1 watering (50%)	15.112	4.297	0.430
Unloading of rock at 'Processing Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.0005	0.00008	kg·t^{-1}	333	t		0.371	0.176	0.027
Grader on disturbed areas	AP-42 - Grading - Table 11.9-2	0.19007	0.08400	0.00589	kg·VKT^{-1}	20	VKT		3.801	1.680	0.118
Roller on haul roads	AP-42 Unpaved roads - Section 13.2.2	3.45	0.98	0.098	kg·VKT^{-1}	100	VKT		345.34	98.20	9.82
Dozer on extraction area (in construction)	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42	0.36	0.25	kg·hr^{-1}	10	hr		24.26	3.62	2.55
Wind erosion of 'Extraction Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	kg·ha^{-1}·yr^{-1}	1.3	ha		3.02	1.51	0.23
Wind erosion of 'Processing Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	kg·ha^{-1}·yr^{-1}	2.7	ha		6.17	3.09	0.46
Loading of overburden	AP-42 - Batch drop - Section 13.2.4.3	0.0011	0.0005	0.00008	kg·t^{-1}	17.5	t		0.02	0.009	0.001

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Hauling of overburden	AP-42 Unpaved roads - Section 13.2.2	3.933	1.118	0.1118	kg·VKT^{-1}	0.40	VKT	Level 1 watering (50%)	0.79	0.23	0.023
Unloading overburden in 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.0005	0.00008	kg·t^{-1}	17.5	t		0.02	0.009	0.001
Emissions from diesel combustion	various	-	-	-	-	-	-	-	2.1	2.1	2.1
								Total	**406.0**	**117.5**	**15.9**

Stage 1 - 24-hour maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg{\cdot}day^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling of blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59	0.306	0.0177	$kg{\cdot}hole^{-1}$	10	holes	Dust collection on drill rig (90%) Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	0.30	0.29	0.02
Blasting of fresh rock	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	4.02	2.09	0.12	$kg{\cdot}blast^{-1}$	1	blasts	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	2.01	1.99	0.11
Loading of haul truck (rock)	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	1,818	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	1.01	0.91	0.14
Hauling rock to 'Processing and Storage Area'	AP-42 Unpaved roads - Section 13.2.2	3.93	1.11	0.111	$kg{\cdot}VKT^{-1}$	41.95	VKT	Level 1 watering (50%)	82.50	23.46	2.35
Unloading of rock at 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	1,818	t		2.03	0.96	0.15
FEL loading Jaw Crusher at 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	1,818	t		2.03	0.96	0.15
Crushing of rock in Jaw Crusher	AP-42 - Primary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	$kg{\cdot}t^{-1}$	1,818	t	Controlled crushing (77.7%)	1.09	0.49	0.09
Crushing of rock in Secondary Crusher	AP-42 - Secondary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	$kg{\cdot}t^{-1}$	1,818	t	Controlled crushing (77.7%)	1.09	0.49	0.09
Screening of rock	AP-42 - Screening - Table 11.19.2.1	0.0125	0.0043	0.0003	$kg{\cdot}t^{-1}$	1,818	t	Controlled screening (91.2%)	2.00	0.69	0.05

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Loading material stockpiles from processing	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	1,818	t	Water sprays (50%)	1.01	0.48	0.07
Loading road trucks with product	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	5,000	t		5.57	2.64	0.40
Hauling of product from 'Processing and Storage Area' to road	AP-42 Unpaved roads - Section 13.2.2	3.45	0.982	0.0982	kg·VKT^{-1}	329	VKT	Level 1 watering (50%)	567.99	161.51	16.15
Wind erosion of 'Extraction Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	kg·ha^{-1}·yr^{-1}	13.0	ha		30.23	15.11	2.27
Wind erosion of 'Processing and Storage Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	kg·ha^{-1}·yr^{-1}	5.47	ha		12.34	6.17	0.93
Loading of overburden	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	130	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	0.07	0.07	0.01
Hauling of overburden	AP-42 Unpaved roads - Section 13.2.2	3.93	1.118	0.1118	kg·VKT^{-1}	3	VKT	Level 1 watering (50%)	5.90	1.68	0.17
Unloading overburden in 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	130	t		0.14	0.07	0.01
Emissions from diesel combustion	various	-	-	-	-	-	-	-	2.2	2.2	2.2
								Total	**719.5**	**220.1**	**25.3**

Stage 1 – Off Site Haulage of Product

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg \cdot day^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Haulage of material offsite on unpaved roads	AP-42 Unpaved roads - Section 13.2.2	3.45	0.98	0.098	$kg \cdot VKT^{-1}$	66[(A)]	VKT		227.2	64.6	6.5

Note (A): Assuming a 500 m section of road, and transporting 5,000 t per day in 38 t capacity vehicles.

Stage 2 - 24-hour maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg{\cdot}day^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling of blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59	0.306	0.0177	$kg{\cdot}hole^{-1}$	10	holes	Dust collection on drill rig (90%) Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	0.295	0.291	0.017
Blasting of fresh rock	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	4.02	2.09	0.12	$kg{\cdot}blast^{-1}$	1	blasts	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	0.712	0.703	0.041
Loading of haul truck (rock)	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	333	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	0.186	0.167	0.025
Hauling rock to 'Processing Area'	AP-42 Unpaved roads - Section 13.2.2	3.93	1.11	0.111	$kg{\cdot}VKT^{-1}$	5.64	VKT	Level 1 watering (50%)	11.082	3.151	0.315
Unloading of rock at 'Processing Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	333	t		0.371	0.176	0.027
FEL loading Jaw Crusher at 'Processing Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	333	t		0.371	0.176	0.027
Crushing of rock in Jaw Crusher	AP-42 - Primary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	$kg{\cdot}t^{-1}$	333	t	Controlled crushing (77.7%)	0.200	0.089	0.016
Crushing of rock in Secondary Crusher	AP-42 - Secondary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	$kg{\cdot}t^{-1}$	333	t	Controlled crushing (77.7%)	0.200	0.089	0.016
Screening of rock	AP-42 - Screening - Table 11.19.2.1	0.0125	0.0043	0.0003	$kg{\cdot}t^{-1}$	333	t	Controlled screening (91.2%)	0.366	0.126	0.009

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Loading material stockpiles from processing	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	333	t	Water sprays (50%)	0.186	0.088	0.013
Loading road trucks with product	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	333	t		0.371	0.176	0.027
Hauling of product from 'Processing Area' to road	AP-42 Unpaved roads - Section 13.2.2	3.45	0.982	0.0982	kg·VKT^{-1}	14	VKT	Level 1 watering (50%)	23.90	6.79	0.68
Wind erosion of 'Extraction and Processing Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	kg·ha^{-1}·yr^{-1}	5.0	ha		11.64	5.82	0.87
Loading of overburden	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	12.5	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	0.007	0.006	0.001
Hauling of overburden	AP-42 Unpaved roads - Section 13.2.2	3.93	1.118	0.1118	kg·VKT^{-1}	0.2	VKT	Level 1 watering (50%)	0.416	0.118	0.012
Unloading overburden in 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	12.5	t		0.014	0.007	0.001
Emissions from diesel combustion	various	-	-	-	-	-	-	-	1.96	1.96	1.96
								Total	**52.3**	**19.9**	**4.1**

Stage 1 – Annual Average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg{\cdot}yr^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling of blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59	0.306	0.0177	$kg{\cdot}hole^{-1}$	3,600	holes	Dust collection on drill rig (90%) Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	106.2	104.9	6.1
Blasting of fresh rock	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	4.02	2.09	0.12	$kg{\cdot}blast^{-1}$	36	blasts	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	72.5	71.6	4.1
Loading of haul truck (rock)	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	490,000	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	273.1	245.4	37.2
Hauling rock to 'Processing and Storage Area'	AP-42 Unpaved roads - Section 13.2.2	3.93	1.11	0.111	$kg{\cdot}VKT^{-1}$	11,307.69	VKT	Level 1 watering (50%)	22,236.8	6,323.3	632.3
Unloading of rock at 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	490,000	t		546.1	258.3	39.1
FEL loading Jaw Crusher at 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	490,000	t		546.1	258.3	39.1
Crushing of rock in Jaw Crusher	AP-42 - Primary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	$kg{\cdot}t^{-1}$	490,000	t	Controlled crushing (77.7%)	295.0	131.1	23.6
Crushing of rock in Secondary Crusher	AP-42 - Secondary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	$kg{\cdot}t^{-1}$	490,000	t	Controlled crushing (77.7%)	295.0	131.1	23.6
Screening of rock	AP-42 - Screening - Table 11.19.2.1	0.0125	0.0043	0.0003	$kg{\cdot}t^{-1}$	490,000	t	Controlled screening (91.2%)	539.0	185.4	13.0

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg{\cdot}yr^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Loading material stockpiles from processing	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	490,000	t	Water sprays (50%)	273.1	129.1	19.6
Loading road trucks with product	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	490,000	t		546.1	258.3	39.1
Hauling of product from 'Processing and Storage Area' to road	AP-42 Unpaved roads - Section 13.2.2	3.45	0.982	0.0982	$kg{\cdot}VKT^{-1}$	32,237	VKT	Level 1 watering (50%)	55,662.7	15,828.5	1,582.8
Wind erosion of 'Extraction Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	$kg{\cdot}ha^{-1}{\cdot}yr^{-1}$	13.0	ha		11,033.0	5,516.5	827.5
Wind erosion of 'Processing and Storage Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	$kg{\cdot}ha^{-1}{\cdot}yr^{-1}$	5.47	ha		4,505.0	2,252.5	337.9
Loading of overburden	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	39,000	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	21.7	19.5	3.0
Hauling of overburden	AP-42 Unpaved roads - Section 13.2.2	3.93	1.118	0.1118	$kg{\cdot}VKT^{-1}$	900	VKT	Level 1 watering (50%)	1,769.9	503.3	50.3
Unloading overburden in 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	$kg{\cdot}t^{-1}$	39,000	t		43.5	20.6	3.1
Emissions from diesel combustion	various	-	-	-	-	-	-	-	675.1	675.1	675.1
								Total	**99,439.8**	**32,912.9**	**4,356.4**

Stage 2 – Annual Average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·yr^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling of blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59	0.306	0.0177	kg·hole^{-1}	10	holes	Dust collection on drill rig (90%) Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	35.4	35.0	2.0
Blasting of fresh rock	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	4.02	2.09	0.12	kg·blast^{-1}	12	blasts	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	8.5	8.4	0.5
Loading of haul truck (rock)	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	100,000	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	55.7	50.1	7.6
Hauling rock to 'Processing Area'	AP-42 Unpaved roads - Section 13.2.2	3.93	1.11	0.111	kg·VKT^{-1}	1,692.3	VKT	Level 1 watering (50%)	3,328.0	946.4	94.6
Unloading of rock at 'Processing Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	100,000	t		111.5	52.7	8.0
FEL loading Jaw Crusher at 'Processing Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	100,000	t		111.5	52.7	8.0
Crushing of rock in Jaw Crusher	AP-42 - Primary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	kg·t^{-1}	100,000	t	Controlled crushing (77.7%)	60.2	26.8	4.8
Crushing of rock in Secondary Crusher	AP-42 - Secondary crushing - Table 11.19.2.1	0.0027	0.0012	0.00022	kg·t^{-1}	100,000	t	Controlled crushing (77.7%)	60.2	26.8	4.8
Screening of rock	AP-42 - Screening - Table 11.19.2.1	0.0125	0.0043	0.0003	kg·t^{-1}	100,000	t	Controlled screening (91.2%)	110.0	37.8	2.6

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·yr^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Loading material stockpiles from processing	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	100,000	t	Water sprays (50%)	55.7	26.4	4.0
Loading road trucks with product	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	100,000	t		111.5	52.7	8.0
Hauling of product from 'Processing Area' to road	AP-42 Unpaved roads - Section 13.2.2	3.45	0.982	0.0982	kg·VKT^{-1}	4,158	VKT	Level 1 watering (50%)	7,179.4	2,041.5	204.2
Wind erosion of 'Extraction and Processing Area'	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.8	kg·ha^{-1}·yr^{-1}	5.0	ha		4,250.0	2,125.0	318.8
Loading of overburden	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	3,750	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	2.1	1.9	0.3
Hauling of overburden	AP-42 Unpaved roads - Section 13.2.2	3.93	1.118	0.1118	kg·VKT^{-1}	63.5	VKT	Level 1 watering (50%)	124.8	35.5	3.5
Unloading overburden in 'Processing and Storage Area'	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	3,750	t		4.2	2.0	0.3
Emissions from diesel combustion	various	-	-	-	-	-	-	-	625.6	625.6	625.6
								Total	**16,261.1**	**6,174.2**	**1324.6**