Appendix 5

Air Quality Impact Assessment

prepared by

Northstar Air Quality Pty Ltd

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This document has been prepared for **R.W. Corkery & Co. Pty Limited** on behalf of **Milbrae Quarries Pty Ltd**:

Northstar Air Quality Pty Ltd,

Suite 1504, 275 Alfred Street, North Sydney, NSW 2060

www.northstarairquality.com | **Tel: +61 (02) 9071 8600**

Strontian Quarry

Air Quality Impact Assessment

Addressee(s):	Milbrae Quarries Pty Ltd
Site Address:	Sturt Highway, Gillenbah NSW
Report Reference:	20.1064.FR2V1
Date:	20 October 2020

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	GCG, CO	Final
THE QUARRY	Final	Northstar Air Quality	GCG, CO	Final
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar Air Quality	GCG, CO	Final
EXISTING CONDITIONS	Final	Northstar Air Quality	GCG, CO	Final
APPROACH TO ASSESSMENT	Final	Northstar Air Quality	GCG, CO	Final
AIR QUALITY IMPACT ASSESSMENT	Final	Northstar Air Quality	GCG, CO	Final
GREENHOUSE GAS ASSESSMENT	Final	Northstar Air Quality	GCG, CO	Final
MITIGATION AND MONITORING	Final	Northstar Air Quality	GCG, CO	Final
CONCLUSION	Final	Northstar Air Quality	GCG, CO	Final

Report Status

Northstar References		Report Status	Report Reference	Version
Year	Job Number	(Draft: Final)	(R*x*)	(V*x*)
20	1064	F	R2	V1
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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 **20th October 2020**

Non-Technical Summary

R.W. Corkery & Co. Pty Limited has engaged Northstar Air Quality Pty Ltd on behalf of Milbrae Quarries Pty Ltd to perform an air quality impact assessment and greenhouse gas assessment for the proposed development of a quarry located off the Sturt Highway, Gillenbah NSW.

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.

The air quality impact assessment has been performed in accordance with the NSW Environment Protection Authority '*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* document and includes a detailed description of the operations to be performed as part of the quarry operation and includes a description of the management measures that will be employed to minimise particulate generation. The locations of surrounding sensitive receptor locations, a description of existing air quality and meteorology, and a description of the method used to assess potential impacts are also provided.

The results of the air quality impact assessment indicate that, during both stages assessed the impacts are predicted to be minimal at all surrounding receptor locations.

In relation to annual average criteria (PM_{10}, $PM_{2.5}$, dust deposition and silica), the addition of those minimal incremental impacts to existing background air quality results in the achievement of all criteria.

The Proposal is not predicted to result in any additional exceedances of the 24-hour maximum PM_{10} and $PM_{2.5}$ concentrations, even when adopting a worst-case approach to the estimation of short-term emissions.

Exceedances of the short-term particulate criteria are identified in the air quality data adopted to represent the existing environment, and are most likely due to grassfires, bushfires, or agricultural activities. For clarity, the Proposal is not anticipated to result in any increases in particulate concentrations which would result in additional exceedances of the criteria.

A range of management measures would be adopted as part of the quarry operation, and their implementation would be a responsibility of the Quarry Manager.

Greenhouse gas emissions anticipated as a result of the quarry operation have been calculated in accordance with Australian Government methods. Emissions are calculated to be insignificant, contributing less than 0.0009 % of NSW and less than 0.0002 % of Australian total greenhouse emissions in 2018.

A range of management measures are to be considered which would result in further reductions in greenhouse gas emissions.

It is respectfully considered that the Proposal should not be rejected on the grounds of air quality

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1. INTRODUCTION

R.W. Corkery & Co. Pty Limited (RWC) has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Milbrae Quarries Pty Ltd (the Applicant) to perform an air quality impact assessment (AQIA) and greenhouse gas assessment (GHGA) for the proposed extension of the Strontian Quarry (the Quarry) located at Sturt Highway, Gillenbah NSW (Lot 134 DP726537 and Lot 133 DP726537) (the Quarry site). The proposed extension of the Quarry is referred to as 'the Proposal'.

The GHGA has been incorporated as part of this over-arching AQIA report. 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 operational phases of the Quarry. 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 GHGA presents a quantification of the likely GHG emissions associated with the operation of the Quarry and presents a comparison of these emissions with National and State GHG emissions totals. Opportunities for GHG reduction are also provided.

1.1 Assessment Requirements

Planning Secretary's Environmental Assessment Requirements (EAR 1351) have been provided for the Quarry by the NSW Department of Planning, Industry & Environment (DPIE) on 17 July 2019. The SEARs included input from NSW Environment Protection Authority (EPA). **Table 2** provides a summary of the SEARs relevant to this AQIA.

Table 1 Coverage of SEARs and other Government Agency requirements relevant to air quality

Authority	Requirement	Relevant section(s)
SEARs	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	Section 6
NSW EPA (12 June 2019)	The goals of the project in relation to air quality should be to ensure sensitive receptors are protected from adverse impacts from dust	Section 3

Authority	Requirement	Relevant section(s)
	Details would need to be provided on the proposed measures to manage dust from all sources. Measures to prevent or control the emission of dust from the quarrying activities must be detailed based on the outcome of an assessment of dust emissions undertaken in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005). All potentially impacted residential or sensitive premises likely to be impacted by the development must be identified and included in the assessment.	Section 5.1.3 Section 5.1.2 Section 4.1
	The EIS should identify any other existing impacts on air quality within the area and if necessary, provide an assessment and commentary on the predicted cumulative impacts that may arise.	Section 4.3 Section 6 Appendix A
	Emissions from any plant must meet the design criteria detailed in the Protection of the Environment Operations (Clean Air) Regulation 2010. Details need to be provided on the proposed air pollution control techniques from any air emission points, including proposed measures to manage and monitor efficiency and performance.	Section 3.3

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).

It is noted that there are no specific requirements relating to the GHG assessment provided within the SEARs, although this has been performed in accordance with standard practice and requirements (refer **Section 3.4**).

2. THE QUARRY

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

2.1 Overview

The Applicant operates the Strontian Quarry located approximately 11 kilometres (km) southeast of Narrandera, NSW. The location of the Quarry is presented in **Figure 1**.

The Quarry is operated to recover indurated sandstone to produce a range of products including aggregates and road base for use in construction and infrastructure projects. Access to the Quarry is from Strontian Road, off the Sturt Highway. The Quarry site is located in an area zoned RU1 (Primary Production) under the Narrandera Local Environmental Plan 2013, which permits extractive industries with consent. Areas to the west of the Quarry site are zoned RU4 (Primary Production Small Lots).

The Quarry originally commenced operations in 2012 and is currently operating under Development Consent DA27/2011/12 issued by Narrandera Shire Council on 27 March 2012. The Quarry has approval to extract and process up to 150 tonnes (t) per day or 30 000 tonnes per annum (tpa) of indurated sandstone material and disturb a total area of no more than 2 hectares (ha). Extracted material is processed on site on a campaign basis using mobile crushing and screening equipment which is brought to the Quarry and placed within the existing extraction area. Quarry products are stockpiled within the extraction area prior to despatch.

The Applicant is seeking development consent for the extension of the operational life of the Quarry (the Proposal) which would include the following:

- Campaign extraction of material from within the proposed extraction area to produce up to 125 000 t of Quarry products per annum.
- Importation of up to 1 500 t of concrete washout and other construction materials per annum for recycling and incorporation in Quarry products.
- Crushing and screening of fragmented rock and imported materials on site using a mobile processing plant.
- Ongoing transportation of up to 125 000 t per annum of Quarry products to end points of use (typically within the Narrandera LGA and the broader Riverina Region).
- Ongoing employment of local personnel.
- Progressive and final rehabilitation of the Quarry to develop a final landform suitable for passive nature conservation.

It is anticipated that the Quarry would operate for approximately 30 years from the commencement of operations under the new consent.

The principal components and their respective approximate area within the Quarry Site are as follows.

- **Extraction area (5.2 ha)**

  The extraction area would be developed in three stages with benches developed at approximately 176 m Australian Height Datum (AHD), 164 m AHD, 152 m AHD. The final floor of the extraction area would extend to approximately 140 m AHD. It is noted that all processing, product stockpiling and product despatch activities would also be undertaken within the footprint of the extraction area.

- **Office and Amenities Area (250 m^2)**

  The demountable office and portaloo would be relocated immediately to the east of the extraction area within the south-eastern quadrant of the Quarry Site. A light vehicle parking area would also be incorporated within this area.

- **Quarry Access Road (450 m)**

  The existing Quarry Access Road which extends from Strontian Road to the office and amenities area would be retained with a sealed surface and would provide ongoing access to the Quarry Site for both heavy and light vehicles.

- **Operational disturbance area (2.3 ha)**

  A corridor would be cleared of vegetation around the extraction area to allow for the construction of a perimeter safety bund, internal roads and erosion and sediment control infrastructure. Soil and mulch would also be stockpiled within the operational disturbance area to the east of the extraction area.

The total area to be designated as the Quarry Site would be approximately 15.0 ha of which the maximum area of disturbance would be approximately 7.6 ha. A layout of the proposed Quarry is presented in **Figure 2**.

A detailed description of extraction, processing, and material transport operations is provided in section 2.6, section 2.7 and section 2.8 of the main EIS document, respectively. Relevant information as it relates to the AQIA is reproduced in **Table 2**.

The Quarry is proposed to be operated in three stages. This AQIA considers the potential impacts on air quality associated with Stage 1 and Stage 3 operations as these provide an appropriate characterisation of operations at the beginning and end of the proposed Quarry life.

Figure 1 Quarry location

Figure 2 Quarry layout

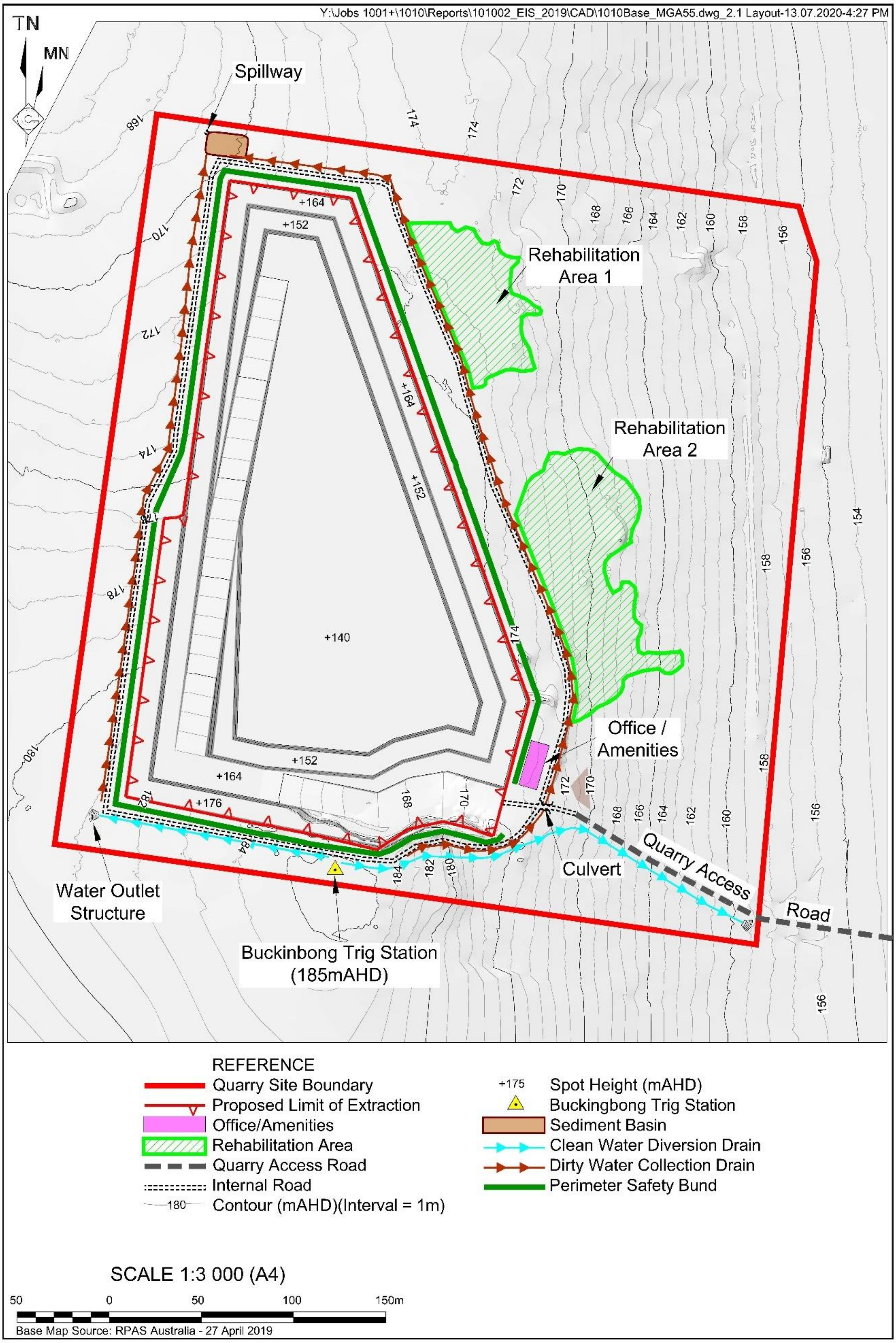


Table 2 provides a summary of the operational characteristics of the Quarry in Stages 1 and 3. It is noted that the operations in Stage 1 and Stage 3 are identical in terms of the materials being extracted and processed, except for the handling and management of overburden. The principal difference in the two stages is the locations of operations, which are shown in **Figure 3** (Stage 1) and **Figure 4** (Stage 3).

Table 2 Proposed characteristics of the Quarry operation

Parameter	Stage 1	Stage 3
Operating hours		
Site development and construction Extraction operations Processing operations Product despatch	6 am to 6 pm, Mon to Fri 6 am to 5 pm Saturday No operations Sunday or Public Holiday Blasting will be limited to between 10 am and 3 pm Mon to Fri	
Maintenance	24 hours per day	
Operating days per year	300	300
Material extraction		
Annual rock extraction rate	125 000 tpa	125 000 tpa
Average daily rock extraction rate	416.6 t	416.6 t
Maximum daily rock extraction rate	Up to 5 100 t	Up to 5 100 t
Annual overburden generation rate	10 000 t	0 t
Average daily overburden generation rate	100 t	0 t
Maximum daily overburden generation rate	3 000 t	0 t
Number of blast holes drilled	170 to 260 per blast	170 to 260 per blast
Blast holes spacing	2.5 m	2.5 m
Blast hole depth	12.5 m	12.5 m
Blasting frequency	No more than 1 per month	No more than 1 per month
Volume of material removed per blast	Between 30 000 t and 50 000 t	Between 30 000 t and 50 000 t
Annual import of materials for blending with product	1 500 t	1 500 t
Equipment	1 x Drill (Atlas Copco 35t) 1 x Excavator (Volvo 38T-50T) 1 x Front End Loader (CAT 966) 1 x Front End Loader (CAT 980 or equivalent) 1 x Bulldozer (CAT D10) 1 x Water Cart (15 000 L or 30 000 L)	
Material processing		
Annual material processing rate	125 000 tpa	125 000 tpa
Average daily processing rate	416.6 t	416.6 t
Maximum daily processing rate	Up to 5 100 t	Up to 5 100 t

Parameter	Stage 1	Stage 3
Equipment	1 x Jaw Crusher 1 x Cone Crusher 1 x Screen (triple deck) 1 x Horizontal Shaft Impactor (HSI) Crusher)	
Product stockpiles	Each stockpile would average 4 000 t	
Offsite material haulage		
Annual material haulage rate	125 000 t	125 000 t
Average daily haulage rate	420 t	420 t
Maximum daily haulage rate	1 440 t	1 440 t
Haulage truck capacity	Average 30 t	Average 30 t
Annual vehicle trips (1-way/laden)	4 200	4 200
Peak daily vehicle trips (1-way/laden)	48	48
Average daily vehicle trips (1-way/laden)	14	14
Annual quantity of material brought to site for crushing and blending	1 500	1 500
Maximum daily quantity of material brought to site for crushing and blending	30	30
Exposed areas		
Disturbance area	7.6 ha	5.8 ha

Assumptions adopted in the construction of **Table 2** are presented below:

- The average daily rock extraction and processing rates have been calculated to allow determination of the likely impact of the Proposal when compared to the relevant annual average air quality criteria. Material extraction and processing would be performed on a campaign basis, although the assessment of impacts on an annual average and potential maximum daily basis allows the appropriate characterisation of potential impacts against both short and longer-term air quality criteria.
- The maximum daily material extraction and processing rate is calculated on the basis of the maximum operating capacity of the processing plant, and 75 % capacity of the Horizontal Impact Crusher (HSI). The HSI operation plus the processing plant operation in any one day is considered to be a conservative assumption.
- The maximum annual extraction and transportation rate from the Quarry will be 125 000 t. Up to 1 500 t of concrete and other building materials may be brought to site for use in product blending. To represent a worst-case scenario, those quantities have been assumed to be both processed and hauled (i.e. a processing and haulage rate of 126 500 tpa).

- The annual overburden generation rate in Stage 1 in its entirety is anticipated to be 30 000 t, and this material would be used to construct the perimeter safety bund. It has been assumed that 10 000 t of overburden would be generated in each year of Stage 1 operations, and as a worst case, 3 000 t per day. This is noted to be a conservative assumption as these quantities of overburden would not be likely to be generated each year, but could potentially be generated in a worst case year. No overburden generation is anticipated during Stage 3 operations.
- Maximum material processing rates have been based on the maximum potential throughputs of processing equipment (i.e. 2 700 t·day^{-1} for the HSI crusher [at 75 % capacity] and screen and 2 400 t·day^{-1} for the mobile processing plant [jaw crusher, cone crusher and triple deck screen]). Although it is likely that only one of the crusher units (Jaw/Cone or HSI) would be operational on any one day, there exists the potential for these units to be operated at the same time, and for the purposes of providing a conservative estimation of maximum 24-hour impacts, they have been assumed to be operational concurrently, at those maximum rates. Again, this is a conservative assumption.
- The HSI would typically be used in isolation with a screen during low production periods although it may also occasionally be used with a screen in line with the main mobile processing plant or concurrently with the mobile processing plant. It has been assumed to be operated with a screen for the purposes of assessment against short- and longer-term air quality criteria.
- Blasting would occur on a campaign basis, with blasting occurring three to five times per year, at a maximum of once per month. Between 30 000 t and 50 000 t of material would be fragmented during each blast. It is likely that during the day of blasting, other operations such as overburden handling, processing etcetera would be limited below their relevant maximum capacities. However, to provide a worst-case assessment, blasting has been assumed to occur concurrently with all other activities at their maximum rates to provide confidence that the Proposal can be operated without exceedance of the relevant short-term air quality criteria (refer **Section 3**).
- Peak daily transportation of material from the Quarry has been assumed to consist of 48 x 30 t loads (1 440 t·day^{-1}). Average daily transportation has been assumed to consist of 14 x 30 t loads (420 t·day^{-1}).
- All processing activities are proposed to be performed within the extraction area.
- The disturbance area assumed in Stage 1 includes the extraction area, Office and Amenities Area, unpaved portion of the Quarry Access Road, and the perimeter safety bund. During Stage 3, this area is assumed to reduce to 5.8 ha as the perimeter safety bund would be stabilised.

Figure 3 Quarry layout – Stage 1

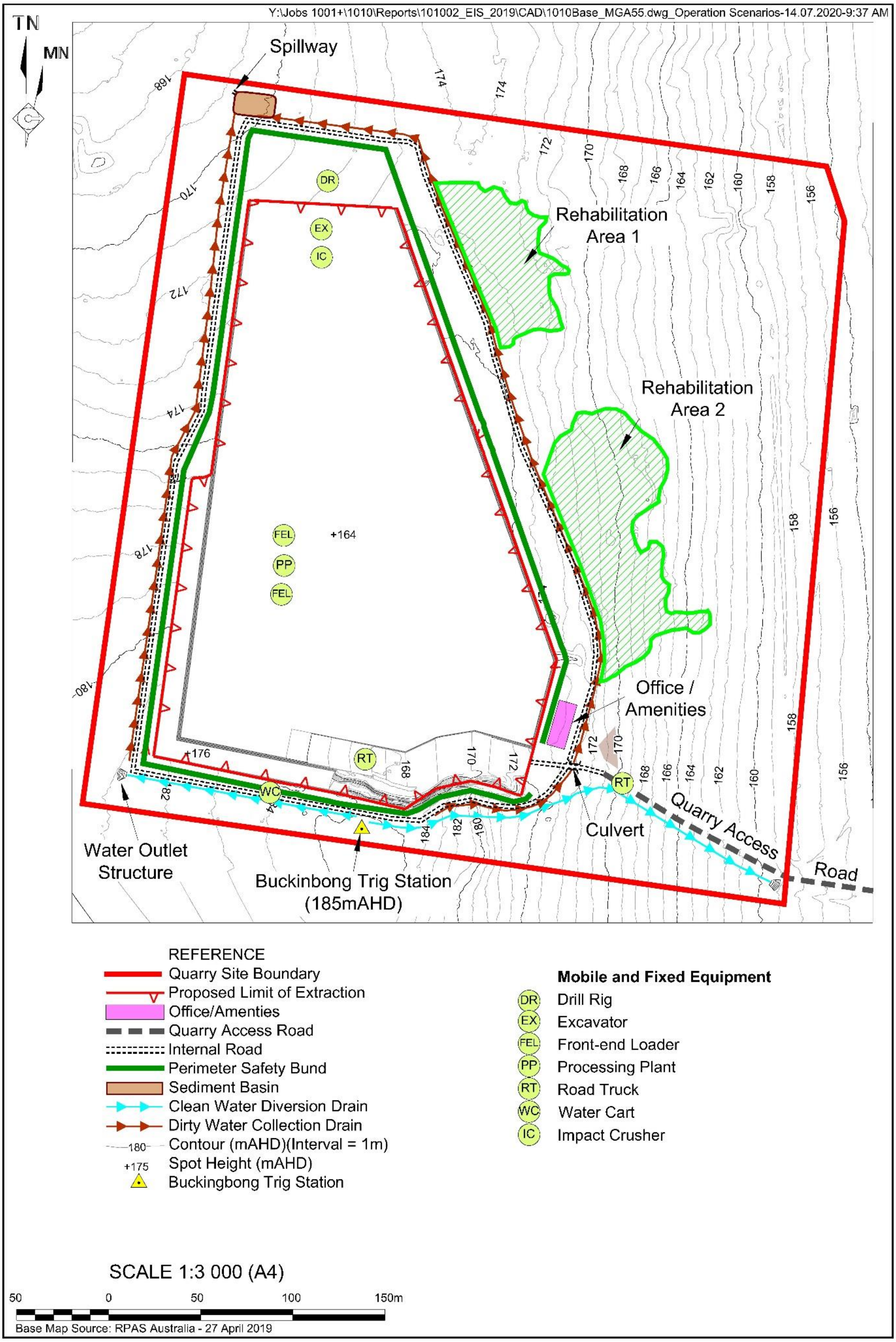
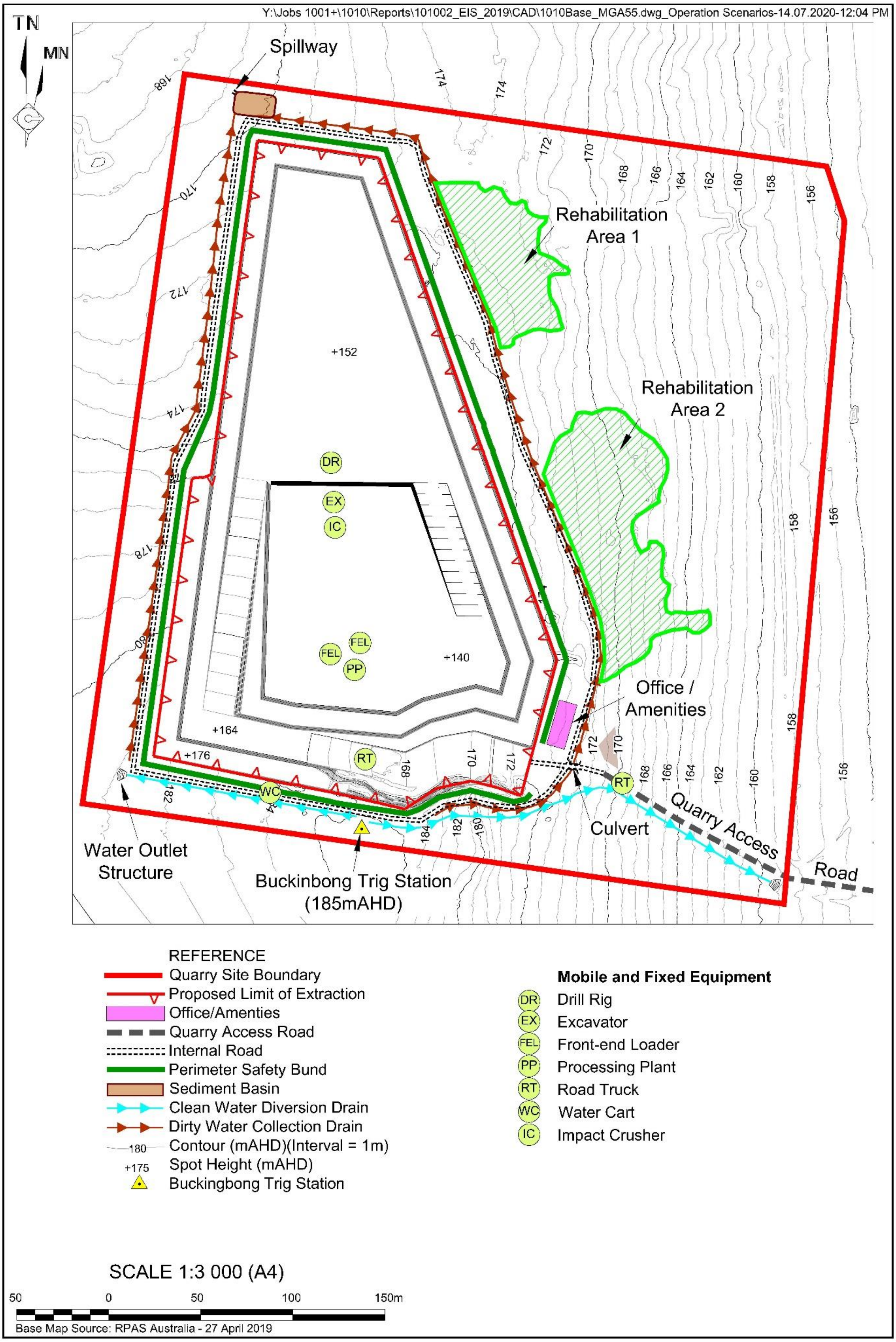


Figure 4 Quarry layout – Stage 3



2.2 Identified Potential for Emissions to Air

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

- Pushing of overburden to create the Perimeter Safety Bund;
- Drilling and blasting;
- Loading of processing equipment, processing of rock, and storage in stockpiles;
- Loading of product trucks, and transport offsite;
- Wind erosion of disturbed areas; and,
- Emissions from vehicle and equipment 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});
- Particulate matter with an aerodynamic diameter of 2.5 microns ($PM_{2.5}$); and,
- Silica (Si).

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 3.7 kilometre ([km]), the frequency of blasting (maximum of once per month), and the quantity of equipment operating on site, it is not anticipated that emissions associated with diesel combustion (other than particulate matter and silica 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.

Previous dispersion modelling assessments performed by Northstar (e.g. Karuah South Quarry, 2019[1]) indicate that maximum 1-hour NO_2 concentrations associated with blast fume were approximately 8 $\mu g \cdot m^{-3}$ at a distance of 1.5 km from the site. Given that the closest residential receptor to the Proposal site is 3.7 km (refer **Section 4.1.1**), impacts associated with blast fume are anticipated to be negligible and do not warrant quantitative assessment, although various management control measures are identified to minimise the potential rate of emissions from blasts.

[1] https://www.planningportal.nsw.gov.au/major-projects/project/9901

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 3**.

Table 3 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

Given the nature of the material to be extracted at the Quarry, silica may be generated during extraction activities. NSW EPA do not provide air quality criteria for this pollutant, although VIC EPA in their State Environmental Planning Policy (SEPP) Protocol for Environmental Management: Mining and Extractive Industries (PEM) (VIC EPA, 2007) do include an annual average criterion for respirable crystalline silica (as $PM_{2.5}$) as 3 µg·m^{-3}, which has been adopted from the California EPA Office for Environmental Health Hazard Assessment Reference Exposure Levels.

This criterion is referenced in this assessment and calculates respirable crystalline silica by adjusting annual average $PM_{2.5}$ modelling results on a *pro-rata* basis to account for the determined maximum free silica content of the extracted material (approximately 81 %). Respirable crystalline silica is generally an occupational health and safety issue (i.e. on-site) rather than an environmental issue (i.e. off-site) when considering quarrying activities but has been presented within this AQIA for completeness.

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 4** for the pollutants of relevance to this assessment. Requirements associated with nitrogen dioxide (NO_2) have been included in **Table 4** but have not been included as part of this impact assessment, for the reasons discussed in **Section 2.2**.

Table 4 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·m^{-3}
	Any crushing, grinding, separating or materials handling activity	20 mg·m^{-3}

Air Impurity	Activity	Standard of Concentration (Group 6)[1]
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 4** 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, or in relation to certain domestic waste in the Narrandera LGA. No burning of materials would be performed as part of the quarrying operations.

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 proponent.

3.4 Greenhouse Gas Legislation and Guidance

The Australian Government Clean Energy Regulator administers schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions.

Schemes administered by the Clean Energy Regulator include:

- National Greenhouse and Energy Reporting Scheme, under the *National Greenhouse and Energy Reporting Act* (2007).
- Emissions Reduction Fund, under the *Carbon Credits (Carbon Farming Initiative) Act* (2011).
- Renewable Energy Target, under the *Renewable Energy (Electricity) Act* (2000).
- Australian National Registry of Emissions Units, under the *Australian National Registry of Emissions Units Act* (2011).

3.4.1 National Greenhouse and Energy Reporting Scheme

The National Greenhouse and Energy Reporting (NGER) scheme, established by the *National Greenhouse and Energy Reporting Act* (2007) (NGER Act), is a national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.

The objectives of the NGER scheme are to:

- inform government policy.

- inform the Australian public.
- help meet Australia's international reporting obligations.
- assist Commonwealth, state and territory government programmes and activities.
- avoid duplication of similar reporting requirements in the states and territories.

Further information on the NGER scheme, specifically the definitions of various scopes and types of GHG emissions which have also been adopted for the purposes of this assessment, is provided in **Section 5.2**.

3.4.2 Relevant NSW Legislation

There is no specific GHG legislation administered within NSW. The NGER scheme (and other identified Commonwealth schemes in **Section 3.4.1**) forms the applicable legislation within NSW.

3.4.3 Guidance

The GHG accounting and reporting principles adopted within this GHG assessment are based on the following financial accounting and reporting standards:

- Australian Government Department of the Environment, Australian National Greenhouse Accounts, National Greenhouse Accounts Factors, July 2018 (DoE, 2018).
- The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) GHG Protocol: A Corporate Accounting and Report Standard (WRI, 2004).
- ISO 14064-1:2006 (Greenhouse Gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removal).
- ISO 14064-2:2006 (Greenhouse Gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements).
- ISO 14064-3:2006 (Greenhouse Gases – Part 3: Specification with guidance for the validation and verification of GHG assertions) guidelines (internationally accepted best practice).

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.

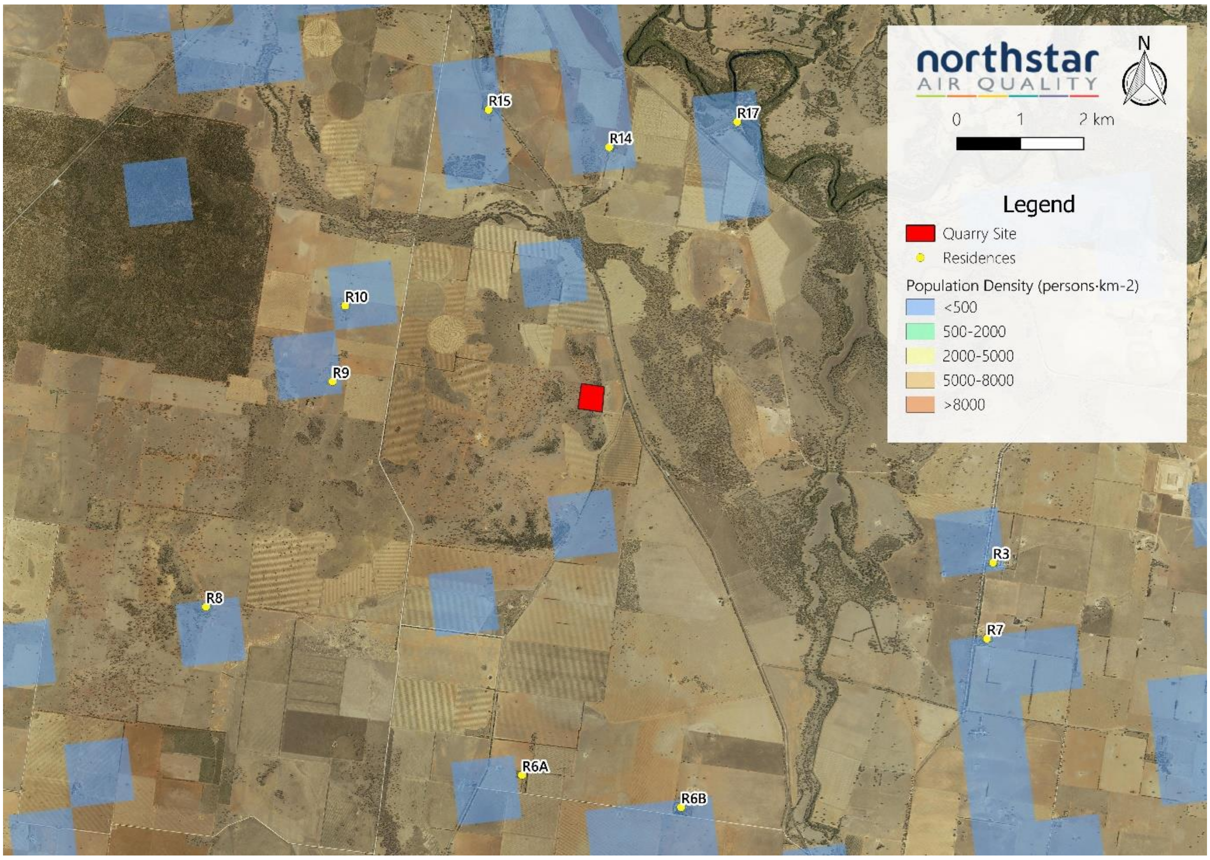
For clarity, the ABS use the following categories to analyse population density ($persons \cdot km^{-2}$):

- 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 5**. The Quarry site is located in an area of 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 5**.

Figure 5 Population density and sensitive receptors surrounding the Quarry site



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

Figure 5 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 or derelict buildings were identified that appear to have been erroneously assumed to be residential properties, and for other cells no structures were identified.

Table 5 Discrete sensitive receptor locations used in the study

ID	Owner	Name	Distance	Location (m, UTM 55)	
				Eastings	Northings
R3	Lawndock Property Investments Pty Ltd	Oakdale	6.6 km	468 310	6 142 624
R6A	MA Quilter	Kanimbla	5.8 km	460 894	6 139 279
R6B	MA Quilter	Belalie	6.3 km	463 399	6 138 773
R7	HG Beecher	Rosedale	7.0 km	468 214	6 141 428
R8	JDR Bull	Currajong	6.6 km	455 919	6 141 930
R9	Booleroo Pty Ltd, DB Seidel	Booleroo	3.9 km	457 911	6 145 476
R10	GRA Bartley	Allambi	3.9 km	458 112	6 146 671
R14	BA Whitby	Wilga	3.7 km	462 268	6 149 167
R15	KJ Myers, GP Myers		4.5 km	460 367	6 149 758
R17	MA Walker, SR Walker	Duck Bend	4.6 km	464 282	6 149 565

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 Narrandera Airport Automatic Weather Station (AWS), which is approximately 16 km northwest of the Quarry site. This AWS is considered the most representative station for the area surrounding the Quarry site.

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

Data from the year 2014 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 2014 to 2018. The year 2014 was selected as being most representative as wind speed and direction measured at Narrandera Airport AWS in 2014 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 6** and presented in **Appendix C**. The year 2014 is indicated in **Table 6** as this is the year selected for assessment. Further information is provided below.

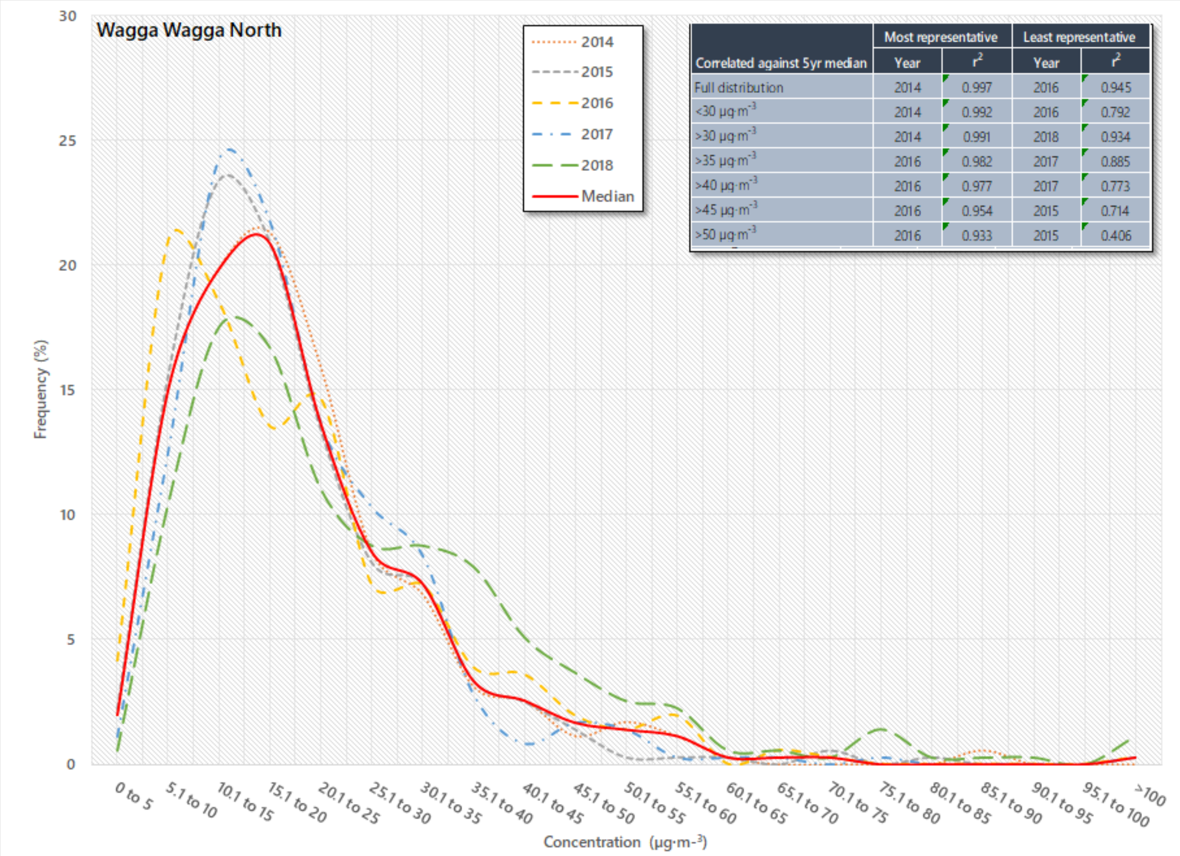
Table 6 Closest DPIE AQMS to the Quarry site

AQMS Location	Approximate distance to Quarry (km)	Screening Parameters			
		2014 Data	Measurements		
			PM_{10}	$PM_{2.5}$	TSP
Wagga Wagga North	77	✓	✓	✓	×
Wagga Wagga	79	×	×	×	×
Albury	140	✓	✓	×	×
Bathurst	318	✓	✓	×	×

The closest representative AQMS with data available for the assessment year (see below) of 2014 is noted to be located at Wagga Wagga North 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 2014 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 2014 to 2018. In terms of background air quality, the year 2014 was selected as being most representative as PM_{10} data measured at the Wagga Wagga North AQMS in 2014 were statistically shown to be most representative of the five-year median particulate distribution at that location, when considering the full particulate distribution (see **Figure 6**).

Figure 6 Statistical analysis of PM_{10} concentrations at Wagga Wagga North, 2014 to 2017



Correlated against 5yr median	Most representative		Least representative	
	Year	r^2	Year	r^2
Full distribution	2014	0.997	2016	0.945
<30 µg·m^{-3}	2014	0.992	2016	0.792
>30 µg·m^{-3}	2014	0.991	2018	0.934
>35 µg·m^{-3}	2016	0.982	2017	0.885
>40 µg·m^{-3}	2016	0.977	2017	0.773
>45 µg·m^{-3}	2016	0.954	2015	0.714
>50 µg·m^{-3}	2016	0.933	2015	0.406

It is noted from **Figure 6** that the 24-hour PM_{10} distribution in the year 2016 is shown to be most representative of the 5-year median conditions when considering higher particulate concentrations, particularly those greater than 35 µg·m^{-3}. Data from the year 2016 has not been selected for use as background in this assessment for two reasons:

- PM_{10} data collected in 2016 at Wagga Wagga North is shown to be the least representative of all five years assessed, when considering the full particulate distribution; and,
- Wind direction data collected in 2016 at Narrandera Airport AWS is shown to not be representative of the broader 5-year period studied.

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

It is noted that none of the AQMS identified in **Table 6** measured concentrations of TSP in the year 2014. This pollutant is of relevance to the expected emissions from the Quarry. Other sources of data have been adopted to allow representation of the TSP 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 7**. A discussion of the measured exceedances of the 24-hour PM_{10} and $PM_{2.5}$

Table 7 Summary of background air quality used in the AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP)	Annual µg·m^{-3}	48.4	Estimated on a TSP:PM_{10} ratio of 2.3404 : 1
Particles (as PM_{10})	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum PM_{10} in 2014 at Wagga Wagga North was measured to be 88.2 µg·m^{-3} (which exceeds the air quality criterion)
	Annual µg·m^{-3}	20.7	
Particles (as $PM_{2.5}$)	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum $PM_{2.5}$ in 2014 at Wagga Wagga North was measured to be 27.6 µg·m^{-3} (which exceeds the air quality criterion)
	Annual µg·m^{-3}	7.6	
Dust deposition	Annual g·m^{-2}·month^{-1}	2	Difference in NSW EPA 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**.

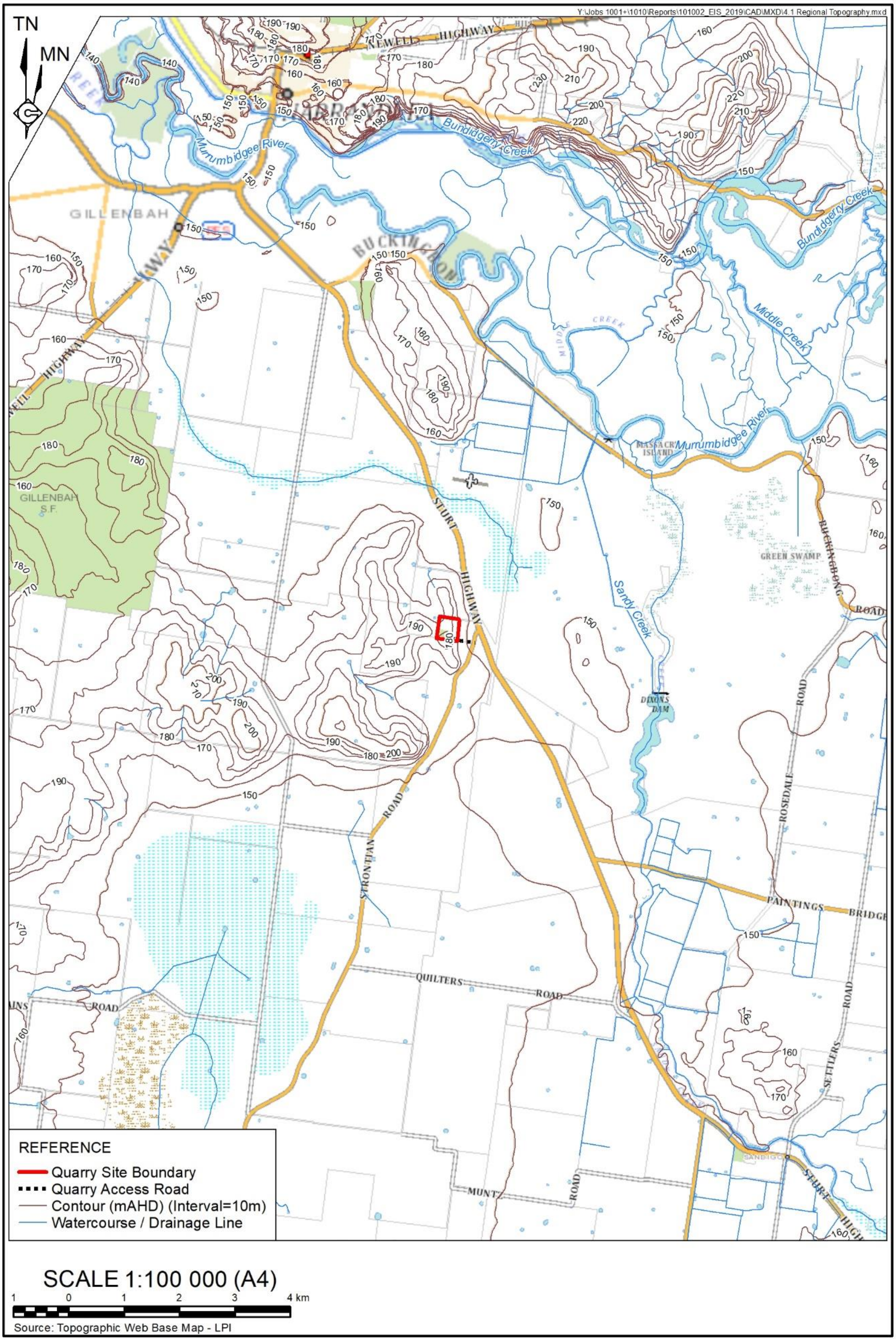
4.4 Topography

The Quarry is located within an undulating landscape (refer **Figure 7**) and the elevation of the Quarry site is between approximately 160 m and 185 m AHD. The topography of the area, and the locations of surrounding receptors in relation to the Quarry and surrounding topography has informed the approach to meteorological modelling (refer **Section 5.1**).

4.5 Potential for Cumulative Impacts

The area surrounding the Quarry site is generally agricultural in nature, with no significant sources of particulate matter that may impact cumulatively with the Quarry on nearby sensitive receptors. The inclusion of the background air quality data as described in **Section 4.3** would appropriately account for any potential cumulative impacts associated with surrounding land uses.

Figure 7 Topography surrounding the Quarry site



4.6 Greenhouse Gas

Emissions of GHG are tracked by the Commonwealth of Australia through the Australian National Greenhouse Accounts program. This program, and the reports and data submitted as part of the program, fulfils Australia's international and domestic reporting requirements. Carbon emission totals by State and Territory by year and by sector are reported in the 'State and Territory Greenhouse Gas Inventories' report for each reporting year.

These data are used to:

- meet Australia's reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC);
- track progress against Australia's emission reduction commitments; and,
- inform policy makers and the public.

Data from the 2018 report for Australia (DISER, 2020a) and NSW (DISER, 2020b) have been obtained for the purposes of this GHG assessment. These reports are the most recent available at the time of reporting.

Emissions of GHG from Australia in 2018 across all economic sectors were 537.5 Mt carbon dioxide equivalent (CO_2-e). Emissions from the quarrying industry sector (including metal ore and non-metallic mineral mining and quarrying) accounted for 12.7 Mt CO_2-e, or 2.3 % of total emissions (DISER, 2020a).

GHG emissions in NSW in 2017 were 131.7 Mt CO_2-e with no information provided on the sectoral split of these emissions (DISER, 2020b).

5. APPROACH TO ASSESSMENT

5.1 Air Quality Impact Assessment

5.1.1 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.

5.1.2 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. It has been assumed that all emissions from diesel combustion are fine particulate (i.e. $PM_{2.5}$) emissions.

Operation

Potential emissions of particulate matter during Stage 1 and Stage 3 of operations have been quantified, with an emissions inventory associated with the average operational characteristics, and peak characteristics during each stage calculated.

Extraction and processing operations would occur on a campaign basis with approximately four campaigns between 20 to 30 days in duration required per year. Product loading and transportation operations would occur year-round with peaks in activity driven by demand. The estimation of annual emissions associated with the Proposal has assumed that operations are being performed at a steady rate across the year which is appropriate. In the assessment of maximum potential 24-hour impacts, it has been assumed that the day of maximum activity during a campaign occurs on every day of the year. The assessment is required to be performed in this way to ensure that potential worst-case meteorological conditions occur at the same time as potential worst-case emissions, although the resulting impacts should be viewed with that conservatism in mind. Importantly, the AQIA is provided to confirm that the Proposal can be operated to be compliant with the air quality criteria in **Section 3**.

5.1.3 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 as part of the Quarry construction and operation is presented in **Table 8**. These emission reductions are outlined in the NPI EETM for Mining (NPI, 2012) and relevant AP-42 documentation (US EPA, 1995).

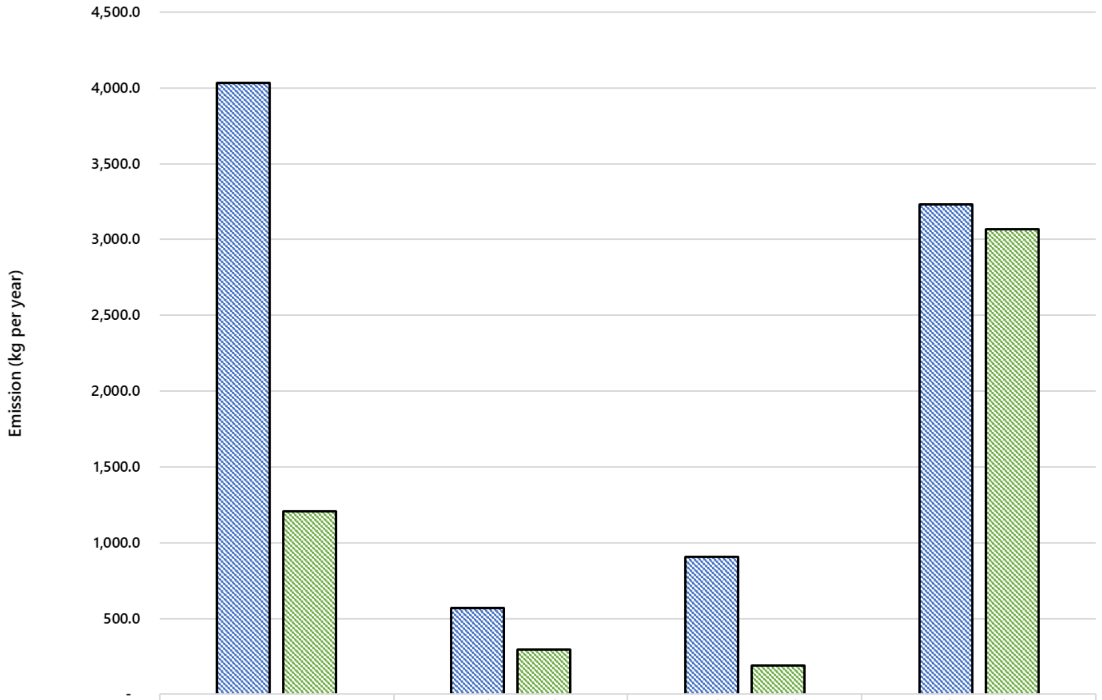
Table 8 Summary of emission reduction methods adopted as part of Quarry operation

Emission control method	Control efficiency (%)
Fabric filters on drill rigs	99
Application of water on unsealed haulage routes (internal) < 2 $L \cdot m^{-2} \cdot hr^{-1}$	50
Reduction in vehicle speeds below 40 $km \cdot hr^{-1}$	44
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

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 8** and **Figure 9** (annual emissions totals) and **Figure 10** and **Figure 11** (peak daily emissions).

The main differences in the emissions between Stage 1 and Stage 3 are a result of the slightly longer haulage distance into the extraction area/processing plant in Stage 3 compared to Stage 1, the lack of overburden handling in Stage 3, and the slight reduction in assumed disturbance area in Stage 3, once the perimeter safety bund has been constructed during Stage 1.

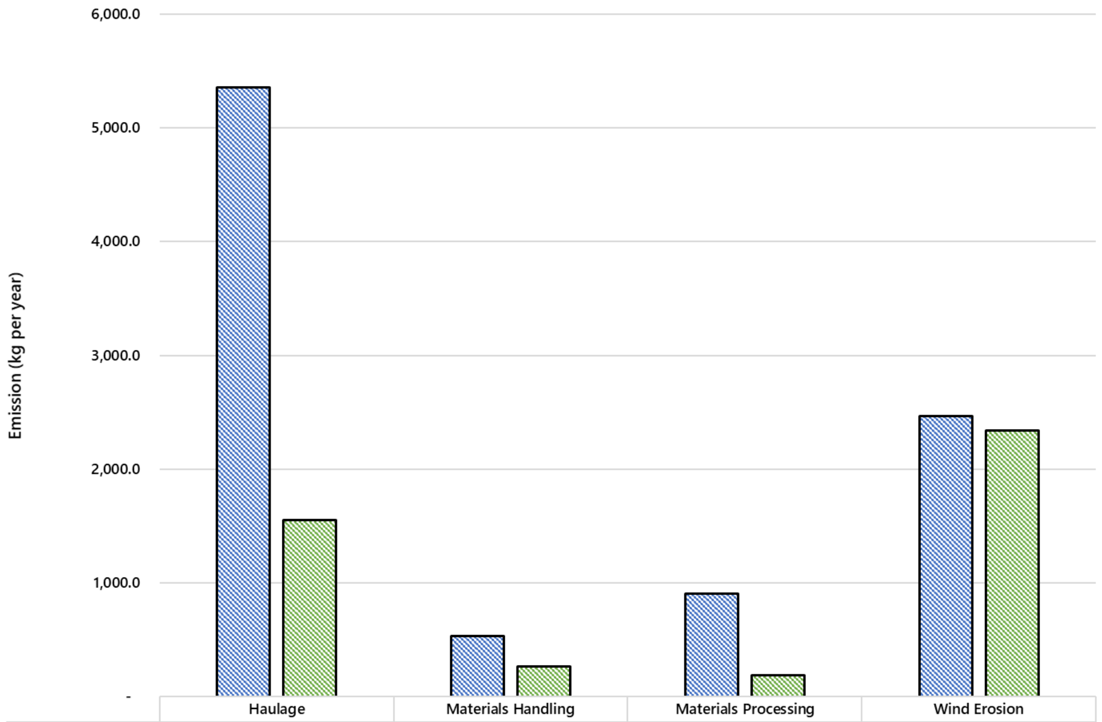
Figure 8 Calculated uncontrolled & controlled annual particulate emissions – Stage 1



	Haulage	Materials Handling	Materials Processing	Wind Erosion
Uncontrolled PM10	4,034.9	567.4	906.9	3,230.0
Controlled PM10	1,205.2	296.5	189.6	3,068.5

Uncontrolled PM10 Controlled PM10

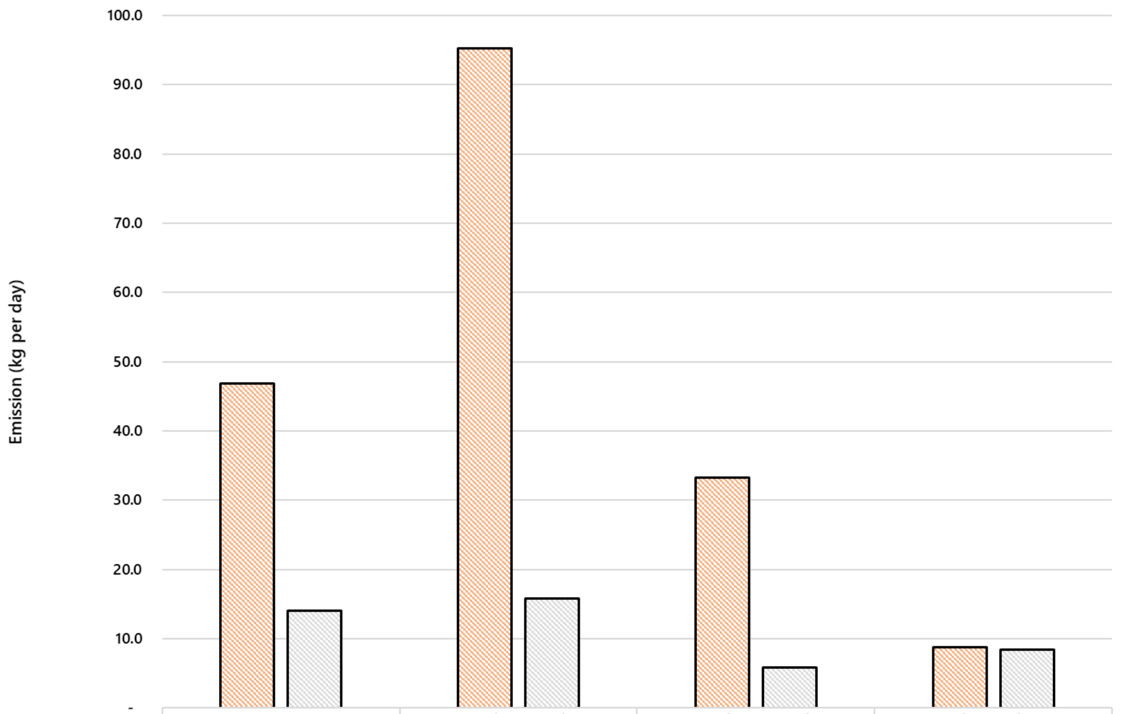
Figure 9 Calculated uncontrolled & controlled annual particulate emissions – Stage 3



	Haulage	Materials Handling	Materials Processing	Wind Erosion
Uncontrolled PM10	5,353.0	534.9	906.9	2,465.0
Controlled PM10	1,555.8	263.9	189.6	2,341.8

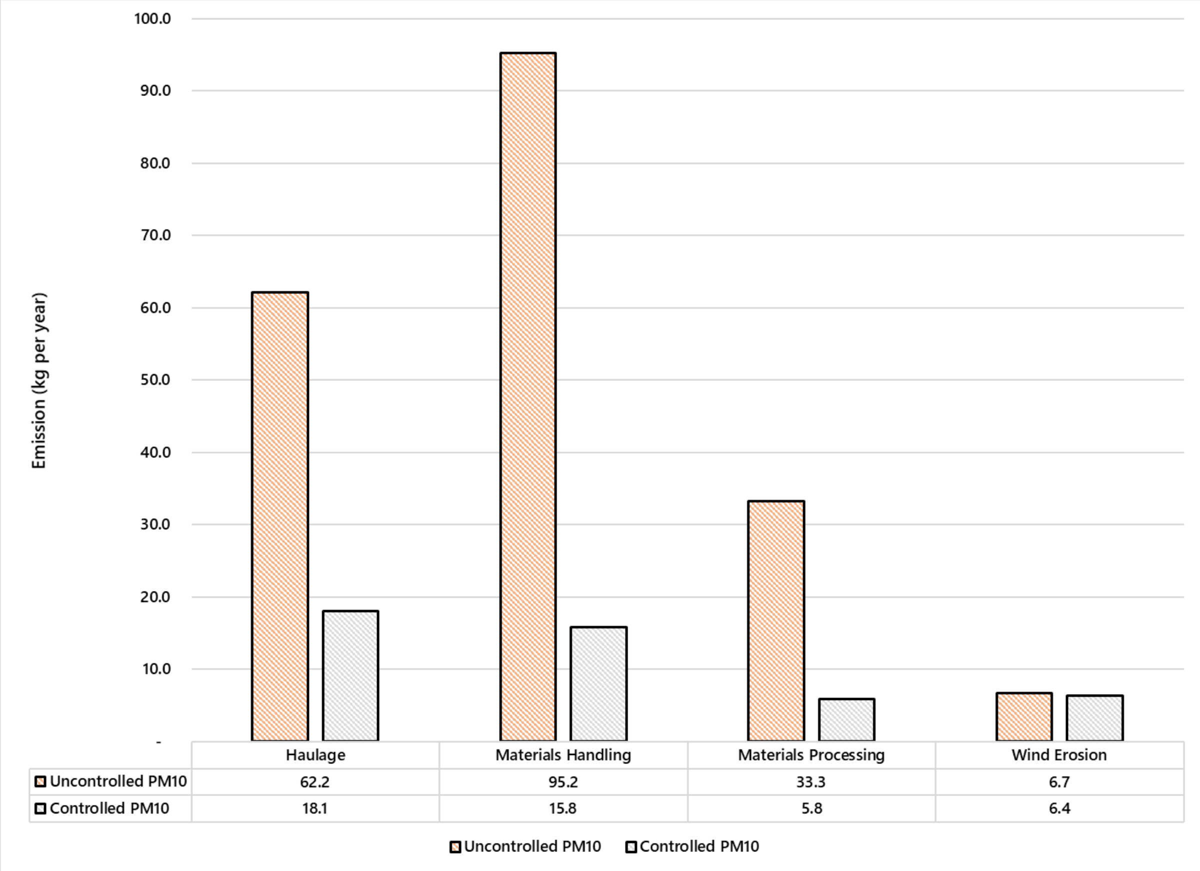
Uncontrolled PM10 Controlled PM10

Figure 10 Calculated uncontrolled & controlled peak daily particulate emissions – Stage 1



	Haulage	Materials Handling	Materials Processing	Wind Erosion
Uncontrolled PM10	46.9	95.2	33.3	8.8
Controlled PM10	14.0	15.8	5.8	8.4

Figure 11 Calculated uncontrolled & controlled peak daily particulate emissions – Stage 3



5.2 Greenhouse Gas Assessment

The purpose of the GHG assessment is to examine the potential impacts of the operation of the Quarry relating to emissions of GHG. A quantitative assessment of emissions is performed with direct emissions compared with total national and NSW GHG emissions for context (refer **Section 4.6**).

The scope of the GHG assessment is to provide a quantitative assessment of GHG emissions arising from the operation of the Quarry. This report does not provide a definitive quantification of GHG emissions arising from the Quarry operation but provides the general context of the likely quantum of emissions.

Opportunities for reduction of GHG emissions are discussed.

5.2.1 Emission Types

The Australian Government Department of the Environment (DoE) document, "National Greenhouse Accounts Factors" Workbook (NGA Factors) (DoEE, 2019a), defines two types of GHG emissions (see **Table 9**), namely 'direct' and 'indirect' emissions. This assessment considers both direct emissions and indirect emissions resulting from the operation of the Quarry.

Table 9 Greenhouse gas emission types

Emission Type	Definition
Direct	Produced from sources within the boundary of an organisation and as a result of that organisation's activities (e.g. consumption of fuel in on-site vehicles)
Indirect	Generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation (e.g. consumption of purchased electricity).

Note: Adapted from NGA Factors Workbook (DoEE, 2019a)

5.2.2 Emission Scopes

The NGA Factors (DoEE, 2019a) identifies two 'scopes' of emissions for GHG accounting and reporting purposes as shown in **Table 10**.

Table 10 Greenhouse gas emission scopes

Emission Scope	Definition
Scope 1	Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate Scope 1 emissions.
Scope 2	Indirect emission factors are used to calculate Scope 2 emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.

Note: Adapted from NGA Factors Workbook (DoEE, 2019a)

A third scope of emissions, Scope 3 Emissions, are also recognised in some GHG assessments. The Greenhouse Gas Protocol (GHG Protocol) (WRI, 2004) defines Scope 3 emissions as "other indirect GHG emissions":

> *"Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services."*

Scope 3 emissions related to the extraction and transport of fuels, and the use of fuels in employee transport have been considered. Emissions associated with the transport of materials from the Quarry are considered in this assessment as Scope 1 emissions as they are under the operational control of the Applicant.

5.2.3 Emission Source Identification

The geographical boundary set for this GHG assessment covers the Quarry Site and also includes the transport of materials from the Quarry to market. All Scope 1 and Scope 3 emissions within the defined boundary have been identified and reported as far as possible.

The GHG emission sources associated with the operation of the Quarry have been identified through the review of the proposed broad activities as described in **Section 1**. The activities/operations being performed, as part of the Quarry, which have the potential to result in emissions of GHG, are presented in **Table 11** below.

Electricity is not anticipated to be used a part of the Proposal, and associated GHG emissions have not been considered further within this report.

Table 11 Greenhouse gas emission sources

Proposal Component	Scope	Emission Source Description
Consumption of diesel fuel in mobile plant and equipment at the Quarry site	1,3	Emissions from combustion of fuel (Scope 1) Emissions associated with the extraction and processing of fuel (Scope 3)
Consumption of diesel fuel / unleaded fuel for material transport purposes	1,3	Emissions from combustion of fuel (Scope 1) Emissions associated with the extraction and processing of fuel (Scope 3)
Consumption of diesel fuel / unleaded fuel for employee transport purposes	3	Emissions associated with the extraction and processing of fuel (Scope 3)

5.2.4 Emissions Estimation

Emissions of GHG from the source identified in **Table 11** have been calculated using activity data for the source per annum (i.e. per kilolitre (kL) of diesel) and the relevant emission factor for each source.

The assumptions used in the calculation of activity data for the emission source and emission factors, are presented below.

Activity Data

The assumptions relating to activity data are outlined in **Table 12**.

Table 12 Calculated activity data

Component	Assumptions	Activity	Units
Consumption of diesel fuel in mobile plant and equipment at the Quarry	Information provided by the Applicant indicates the diesel fuel use to be 100 000 L per annum in mobile equipment, and 165 000 L per annum in the mobile processing plant.	265	$kL{\cdot}annum^{-1}$
Consumption of diesel fuel / unleaded fuel for employee transport purposes	Up to five full-time equivalent (FTE) positions to be generated by the Quarry (including four to ten truck drivers). Assume employees reside in Narrandera (22 km as a two-way journey) 300 days per year 10.6 L per 100km fuel efficiency (ABS, 2017)	10.5	$kL{\cdot}annum^{-1}$
Consumption of diesel fuel / unleaded fuel for material transport purposes	Laden trucks to travel: 26.6 km to/from Narrandera (60 %, 2 520 trips) 81.2 km to/from Boree Creek (15 %, 630 trips) 171.4 km to/from Wagga Wagga (25 %, 1 050 trips) 56.3 L per 100 km fuel efficiency (ABS, 2017)	159.8	$kL{\cdot}annum^{-1}$

Emission Factors

Emissions factors used for the assessment of GHG emissions associated with the operation of the Proposal have been sourced from the NGA Factors (DoEE, 2019a) (refer to **Table 13**).

Table 13 Greenhouse gas emission factors

Emission Scope	Emission Source	Emission Factor	Energy Content Factor
Scope 1	Diesel fuel for mobile plant and equipment and material transport	70.5 kg CO_2-e$\cdot GJ^{-1}$	38.6 $GJ{\cdot}kL^{-1}$
Scope 3	Diesel fuel for mobile plant and equipment	3.6 kg CO_2-e$\cdot GJ^{-1}$	38.6 $GJ{\cdot}kL^{-1}$
	Unleaded fuel for employee transport	3.6 kg CO_2-e$\cdot GJ^{-1}$	34.2 $GJ{\cdot}kL^{-1}$
	Diesel fuel for material transport	3.6 kg CO_2-e$\cdot GJ^{-1}$	38.6 $GJ{\cdot}kL^{-1}$

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 4.2**.

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 TSP, 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 3 at the Quarry site are presented in **Table 14** and **Table 15**, respectively.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at receptor locations are all less than (<) 0.1 $\mu g \cdot m^{-3}$ in both Stage 1 and Stage 3 operations, which represents < 0.2 % of the annual average TSP criterion, < 0.4 % of the annual average PM_{10} criterion, and < 1.5 % of the annual average $PM_{2.5}$ criterion.

The addition of existing background concentrations (refer **Section 4.2**) results in predicted concentrations of annual average TSP being < 54 %, PM_{10} < 84 %, and $PM_{2.5}$ < 96.5 % of the relevant criteria at modelled receptor locations during both Stages assessed.

Table 14 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
R3	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R6A	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R6B	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R7	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R8	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R9	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R10	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R14	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R15	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R17	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
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 Proposal site at the nearest relevant sensitive receptors.

In relation to silica, even assuming that 100 % of annual average $PM_{2.5}$ incremental impacts are silica (the actual content is more likely to be 81 %), the Proposal operation is anticipated to result in impacts far below the relevant criterion of as 3 $\mu g \cdot m^{-3}$ (annual average), which has been adopted from the California EPA Office for Environmental Health Hazard Assessment Reference Exposure Levels (refer **Section 3**). Impacts associated with silica are predicted to be < 3.5 % of the criterion at all surrounding receptors, during both Stages subject to assessment, even assuming 100 % of $PM_{2.5}$ is silica, which is a conservative assumption).

Table 15 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Stage 3

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
R3	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R6A	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R6B	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R7	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R8	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R9	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R10	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R14	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R15	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
R17	<0.1	48.4	48.5	<0.1	20.7	20.8	<0.1	7.6	7.7
Criterion	-	90		-	25		-	8	

6.2 Particulate Matter – Annual Average Dust Deposition Rates

Table 16 and **Table 17** present the annual average dust deposition predicted as a result of the operations at the Quarry in Stage 1 and Stage 3, respectively.

An assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ is presented in **Table 16** and **Table 17**, 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 3**). In either case, the resulting conclusions drawn are identical. The Proposal in either stage of operations is predicted to result in incremental increases of dust deposition of < 0.1 $g \cdot m^{-2} \cdot month^{-1}$ which represents < 5 % of the incremental criterion. Addition of an assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ results in predicted dust deposition in both stages being < 53 % of the criterion.

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 16 Predicted annual average dust deposition – Stage 1

Receptor	Annual Average Dust Deposition ($g{\cdot}m^{-2}{\cdot}month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R3	<0.1	2.0	2.1
R6A	<0.1	2.0	2.1
R6B	<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
R14	<0.1	2.0	2.1
R15	<0.1	2.0	2.1
R17	<0.1	2.0	2.1
Criterion	2.0	-	4.0

Table 17 Predicted annual average dust deposition – Stage 3

Receptor	Annual Average Dust Deposition ($g{\cdot}m^{-2}{\cdot}month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R3	<0.1	2.0	2.1
R6A	<0.1	2.0	2.1
R6B	<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
R14	<0.1	2.0	2.1
R15	<0.1	2.0	2.1
R17	<0.1	2.0	2.1
Criterion	2.0	-	4.0

6.3 Particulate Matter - Maximum 24-hour Average

Presented in **Table 18** 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 Stage 1 and Stage 3 operations at the Quarry. No background concentrations are included within this table. Maximum concentrations in each stage are highlighted in bold.

Table 18 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration (µg·m^{-3})			
	Stage 1		Stage 3	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
R3	0.4	<0.1	0.4	<0.1
R6A	0.3	<0.1	0.3	<0.1
R6B	0.4	<0.1	0.4	<0.1
R7	0.2	<0.1	0.2	<0.1
R8	0.3	<0.1	0.3	<0.1
R9	0.8	0.1	0.8	0.1
R10	0.6	<0.1	0.6	<0.1
R14	**1.0**	**0.2**	**1.0**	**0.2**
R15	0.5	<0.1	0.5	<0.1
R17	0.8	0.1	0.8	0.1
Criterion	50	25	50	25

The predicted incremental concentration of PM_{10} and $PM_{2.5}$ are demonstrated to be minor, with impacts at surrounding sensitive receptor locations predicted to be identical during both Stage 1 and Stage 3 operations. Maximum incremental PM_{10} and $PM_{2.5}$ impacts are predicted to be 1.0 µg·m^{-3} and 0.2 µg·m^{-3}, respectively at receptor R14. These maximum incremental impacts represent 2 % and 0.8 % of the relevant criteria.

The following tables present the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Proposal, with background included.

Results are presented for the receptor at which the highest incremental PM_{10} and $PM_{2.5}$ impacts have been predicted (R14), and also for the receptor at which the highest cumulative impacts (increment plus background) have been predicted which, in this case, is also R14.

The left side of the tables show the predicted concentration on days with the highest cumulative impacts (typically driven by the days of the highest contemporaneous background), and the right side shows the total predicted cumulative impact on days with the highest predicted incremental concentrations.

Model predictions presented in **Table 19** and **Table 20** indicate that there are exceedances of the 24-hour average PM_{10} criterion at surrounding receptors, although as identified in **Section 4.3** and discussed in **Appendix C**, these were often the result of bushfires or grassfires in the area of the Wagga Wagga North AQMS (from which background data has been adopted). Importantly, the results indicate that:

- the Proposal is not predicted to result in any additional exceedances of the maximum 24-hour PM_{10} criterion; and,
- when considering the maximum modelled incremental 24-hour PM_{10} impact from the Proposal, this would not result in an exceedance of the relevant criterion.

The same conclusions are drawn in relation to maximum 24-hour $PM_{2.5}$, with those results presented in **Table 21** and **Table 22**. For clarity;

- the Proposal is not predicted to result in any additional exceedances of the maximum 24-hour $PM_{2.5}$ criterion; and,
- when considering the maximum modelled incremental 24-hour $PM_{2.5}$ impact from the Proposal, this would not result in an exceedance of the relevant criterion.

Although incremental impacts associated with all pollutants are predicted to minor at all surrounding receptor locations, to allow a visualisation of the extent of any impacts surrounding the Proposal site, a contour plot of the incremental contribution to the 24-hour average PM_{10} concentration during Stage 1 operations is presented in **Figure 12**.

Table 19 Summary of contemporaneous impact and background – PM_{10} Receptor 14 – Stage 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
31/01/2014	<0.1	88.2	88.3	20/07/2014	1.0	17.5	18.5
10/02/2014	<0.1	87.3	87.4	4/09/2014	0.6	18.1	18.7
8/02/2014	<0.1	62.4	62.5	22/07/2014	0.6	20.3	20.9
18/01/2014	<0.1	58.8	58.9	19/08/2014	0.5	13.1	13.6
29/12/2014	<0.1	58.0	58.1	24/03/2014	0.5	23.0	23.5
15/01/2014	<0.1	57.7	57.8	22/02/2014	0.5	24.0	24.5
20/01/2014	<0.1	55.3	55.4	6/06/2014	0.4	13.1	13.5
14/11/2014	<0.1	54.8	54.9	6/04/2014	0.4	6.5	6.9
17/03/2014	<0.1	54.4	54.5	25/01/2014	0.4	12.0	12.4
9/02/2014	<0.1	53.8	53.9	5/09/2014	0.4	18.3	18.7
29/01/2014	<0.1	52.6	52.7	13/04/2014	0.3	12.8	13.1
18/03/2014	<0.1	52.1	52.2	29/08/2014	0.3	28.1	28.4
20/11/2014	<0.1	50.8	50.9	27/04/2014	0.3	19.4	19.7
22/01/2014	<0.1	50.0	50.1	8/08/2014	0.3	22.5	22.8
4/02/2014	<0.1	46.8	<46.9	1/05/2014	0.3	19.4	19.7
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 20 Summary of contemporaneous impact and background – PM_{10} Receptor 14 – Stage 3

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
31/01/2014	<0.1	88.2	88.3	20/07/2014	1.0	17.5	18.5
10/02/2014	<0.1	87.3	87.4	4/09/2014	0.6	18.1	18.7
8/02/2014	<0.1	62.4	62.5	22/07/2014	0.5	20.3	20.8
18/01/2014	<0.1	58.8	58.9	19/08/2014	0.5	13.1	13.6
29/12/2014	<0.1	58.0	58.1	24/03/2014	0.5	23.0	23.5
15/01/2014	<0.1	57.7	57.8	22/02/2014	0.5	24.0	24.5
20/01/2014	<0.1	55.3	55.4	6/06/2014	0.4	13.1	13.5

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
14/11/2014	<0.1	54.8	54.9	6/04/2014	0.4	6.5	6.9
17/03/2014	<0.1	54.4	54.5	25/01/2014	0.4	12.0	12.4
9/02/2014	<0.1	53.8	53.9	5/09/2014	0.3	18.3	18.6
29/01/2014	<0.1	52.6	52.7	27/04/2014	0.3	19.4	19.7
18/03/2014	<0.1	52.1	52.2	1/05/2014	0.3	19.4	19.7
20/11/2014	<0.1	50.8	50.9	13/04/2014	0.3	12.8	13.1
22/01/2014	<0.1	50.0	50.1	8/08/2014	0.3	22.5	22.8
4/02/2014	<0.1	46.8	<46.9	29/08/2014	0.3	28.1	28.4
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.			

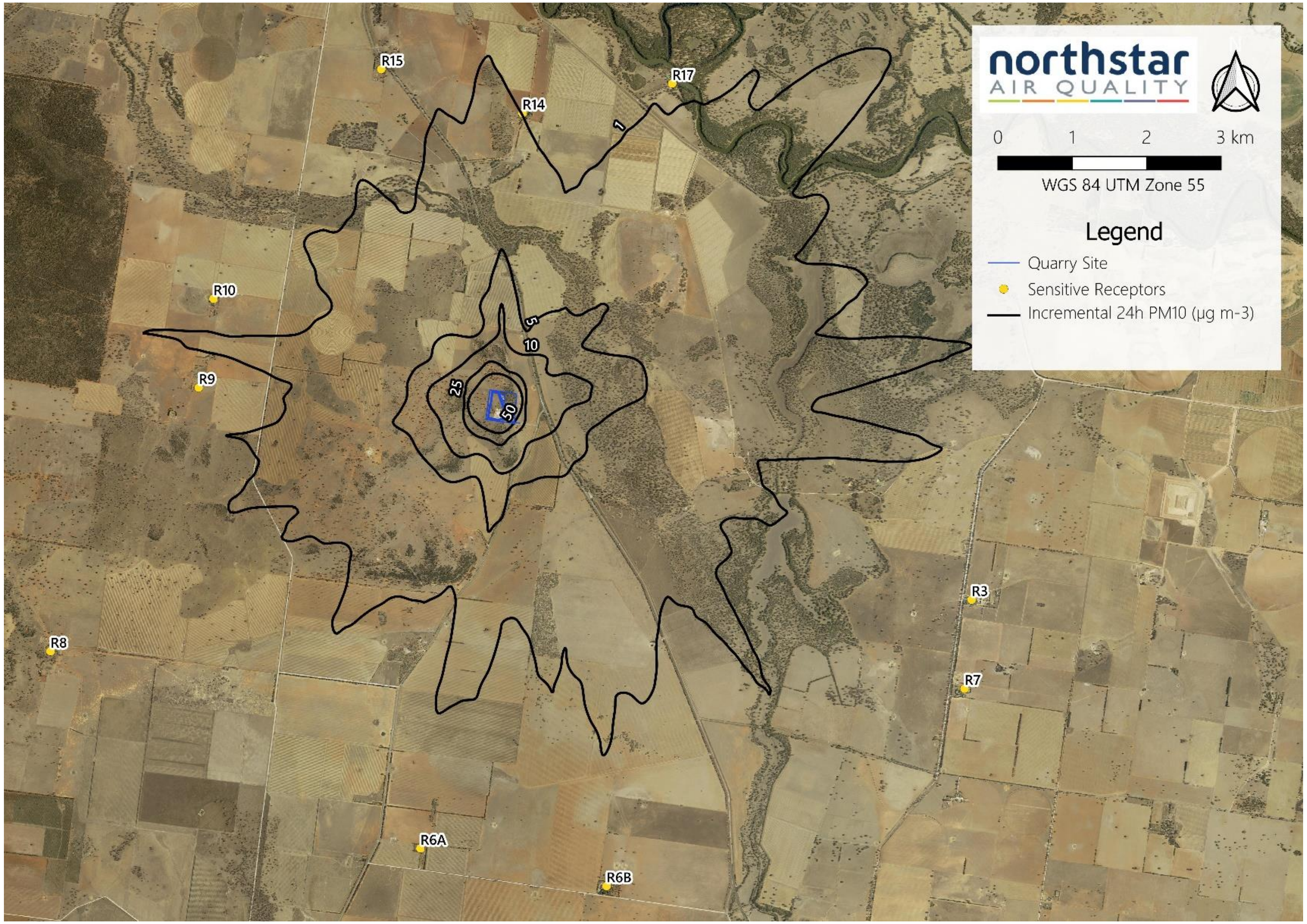
Table 21 Summary of contemporaneous impact and background – $PM_{2.5}$ Receptor 14 -Stage 1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
4/02/2014	<0.1	27.6	27.7	20/07/2014	0.2	17.6	17.8
9/06/2014	<0.1	26.7	26.8	22/07/2014	<0.1	11.8	11.9
10/02/2014	<0.1	24.1	24.2	4/09/2014	<0.1	10.4	10.5
10/06/2014	<0.1	20.2	20.3	19/08/2014	<0.1	7.6	7.7
15/01/2014	<0.1	19.0	19.1	27/04/2014	<0.1	8.9	9.0
20/07/2014	<0.1	17.6	17.7	6/04/2014	<0.1	1.5	1.6
16/05/2014	<0.1	17.2	17.3	24/03/2014	<0.1	6.8	6.9
3/08/2014	<0.1	16.5	16.6	25/01/2014	<0.1	8.5	8.6
23/02/2014	<0.1	15.2	15.3	22/02/2014	<0.1	8.3	8.4
8/06/2014	<0.1	14.6	14.7	6/06/2014	<0.1	9.0	9.1
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.			

Table 22 Summary of contemporaneous impact and background – $PM_{2.5}$ Receptor 14 – Stage 3

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
4/02/2014	<0.1	27.6	27.7	20/07/2014	0.2	17.6	17.8
9/06/2014	<0.1	26.7	26.8	4/09/2014	<0.1	10.4	10.5
10/02/2014	<0.1	24.1	24.2	22/07/2014	<0.1	11.8	11.9
10/06/2014	<0.1	20.2	20.3	19/08/2014	<0.1	7.6	7.7
15/01/2014	<0.1	19.0	19.1	27/04/2014	<0.1	8.9	9.0
20/07/2014	<0.1	17.6	17.7	6/04/2014	<0.1	1.5	1.6
16/05/2014	<0.1	17.2	17.3	24/03/2014	<0.1	6.8	6.9
3/08/2014	<0.1	16.5	16.6	22/02/2014	<0.1	8.3	8.4
23/02/2014	<0.1	15.2	15.3	25/01/2014	<0.1	8.5	8.6
8/06/2014	<0.1	14.6	14.7	6/06/2014	<0.1	9.0	9.1
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 12 Incremental 24-hour PM_{10} concentrations – Stage 1



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

6.4 Emissions Associated with Offsite Transportation

As required within the SEARs (refer **Section 1.1**), an assessment of the impact of road haulage is required to be provided. Impacts associated with road haulage have been assessed from onsite and offsite haulage, with those impacts being assessed to the junction of the Quarry access road and Strontian Road. The impacts of haulage within that boundary on the surrounding sensitive receptors is therefore an intrinsic component of the results presented in **Section 6.1** to **Section 6.3**.

As outlined in section 2.8 of the main EIS document, Quarry products would be transported north via Sturt Highway (approximately 60 % of loads), south via Strontian Road (approximately 15% of loads), or south via Sturt Highway (approximately 25 % of loads). The addition of a proposed maximum (total) 96 heavy vehicle movements per day (48 laden / 48 unladen) on those sealed roads is not anticipated to result in any measurable increase in air quality impacts at receptors in proximity to that haulage route.

7. GREENHOUSE GAS ASSESSMENT

This section presents the results of the GHG assessment, compares direct emissions totals with NSW and Australian totals, and provides a range of measures which might be considered to reduce GHG emissions.

7.1 Calculation of GHG Emissions

Based on the activity data for the operation of the Proposal and the emission factors outlined in **Section 5.2.4**, annual GHG emissions have been calculated and are presented in **Table 23**. The Proposal is calculated to result in direct (Scope 1) GHG emissions of 1 156.2 t CO_2-e per annum.

Table 23 Calculated Proposal GHG emissions

Scope		Activity Rate	Units	Energy Content	Units	Emission Factor		CO_2 ($t \cdot yr^{-1}$)
1	Diesel fuel in plant and machinery on site	265.0	$kL \cdot year^{-1}$	38.6	$GJ \cdot kL^{-1}$	70.5	kg CO_2-e$\cdot GJ^{-1}$	721.2
	Material transport	159.8						435.0
							Scope 1 (subtotal)	1 156.2
3	Diesel fuel in plant and machinery on site	265.0	$kL \cdot year^{-1}$	38.6	$GJ \cdot kL^{-1}$	3.6	kg CO_2-e$\cdot GJ^{-1}$	36.8
	Material transport	159.8						22.2
	Employee travel	10.5		34.2				1.3
							Scope 3 (subtotal)	60.3

7.2 Greenhouse Gas Emissions in Context

A comparison of the calculated GHG emissions associated with the Proposal against Australian (DISER, 2020a) and NSW (DISER, 2020b) total emissions in 2018 and 2019, respectively is presented **Table 24**.

These data indicate that the operation of the Proposal, would contribute less than 0.0009 % of NSW total GHG emissions and less than 0.0002 % of Australian total GHG emissions in 2018.

Table 24 Proposal GHG emissions in context

Proposal Phase	Emissions (t CO_2-e per annum)		
	Proposal	NSW (2018)	Australia (2018)
		Total 131 685 000	Total 537 446 000
Operation	1 156.2	0.0009 %	0.0002 %

7.3 Management of GHG Emissions

The above assessment indicates that GHG emissions resulting from the operation of the Proposal are anticipated to be small, although emissions could be further reduced through the application of a number of measures:

- All vehicles/plant and machinery should be turned off when not in use and regularly serviced to ensure efficient operation, including the optimisation of tyre pressures;
- Truck routes and loading capacity should be designed to reduce the distance and effort required by the vehicles;
- Maintenance of roads in good condition to avoid meandering of vehicles;
- Reducing gradients around site where feasible;
- Where possible, B5 fuel should be used in plant and equipment.

8. MITIGATION AND MONITORING

8.1 Air Quality 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 more than sufficient to ensure that air quality impact at surrounding receptor locations are minimised.

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 25**.

Table 25 Summary of emission reduction methods adopted as part of Quarry operation

Emission control method	Control efficiency (%)
Fabric filters on drill rigs	99
Application of water on unsealed haulage routes (internal) < 2 $L \cdot m^{-2} \cdot hr^{-1}$	50
Reduction in vehicle speeds below 40 $km \cdot hr^{-1}$	44
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

The Environmental Management Plan for the Quarry site will include the measures identified above. The site manager will be responsible for ensuring that no operations are performed without the inclusion of the relevant controls.

8.2 Greenhouse Gas Mitigation

Emissions of GHG resulting from the Proposal operation would be minimised to the maximum extent practical by consideration of the following measures:

- All vehicles/plant and machinery should be turned off when not in use and regularly serviced to ensure efficient operation, including the optimisation of tyre pressures;
- Truck routes and loading capacity should be designed to reduce the distance and effort required by the vehicles;
- Maintenance of roads in good condition to avoid meandering of vehicles;
- Reducing gradients around site where feasible;
- Where possible, B5 fuel should be used in plant and equipment.

8.3 Monitoring

The predictions presented in this AQIA indicate that there would be no predicted exceedances of the adopted air quality criteria as a result of the Quarry operation. Additionally, given the distances between the Quarry and the receptor locations, the incremental impacts associated with the Proposal operation are predicted to be minimal. Therefore, it is not anticipated that any air quality monitoring would be required to be performed, although it is recommended that regular internal audits are performed to ensure that the Quarry site is implementing the air quality control measures appropriately, as outlined within this report.

9. CONCLUSION

R.W. Corkery & Co. Pty Limited has engaged Northstar Air Quality Pty Ltd on behalf of Milbrae Quarries Pty Ltd to perform an air quality impact assessment (AQIA) and greenhouse gas assessment (GHGA) for the proposed development of a quarry located off the Sturt Highway, Gillenbah NSW (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.

The AQIA has been performed in accordance with the NSW EPA Approved Methods document and includes a detailed description of the operations to be performed as part of the Proposal and includes a description of the management measures that will be employed to minimise particulate generation. The locations of surrounding sensitive receptor locations, a description of existing air quality and meteorology, and a description of the method used to assess potential impacts are also provided.

The results of the AQIA indicate that, during both stages assessed (Stage 1 and Stage 3), the impacts of the Proposal are predicted to be minimal at all surrounding receptor locations.

In relation to annual average criteria (PM_{10}, $PM_{2.5}$, dust deposition and silica), the addition of those minimal incremental impacts to existing background air quality results in the achievement of all criteria.

The Proposal is not predicted to result in any additional exceedances of the 24-hour maximum PM_{10} and $PM_{2.5}$ concentrations. Exceedances are identified in the air quality data adopted to represent the existing environment, and are likely due to grassfires, bushfires, or agricultural activities. For clarity, the Proposal is not anticipated to result in any increases in particulate concentrations which would result in additional exceedances of the criteria.

A range of management measures would be adopted as part of the Proposal, and their implementation would be a responsibility of the site manager.

GHG emissions anticipated as a result of the Proposal have been calculated in accordance with Australian Government methods. Emissions resulting from the Proposal are calculated to be insignificant, contributing less than 0.0009 % of NSW total GHG emissions and less than 0.0002 % of Australian total GHG emissions in 2018.

A range of management measures are to be considered which would result in further reductions in GHG emissions.

It is respectfully considered that the Proposal should not be rejected on the grounds of air quality

10. REFERENCES

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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
CO_2-e	carbon dioxide equivalent
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)

Abbreviation	Term
PM	particulate matter
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
Si	silica
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

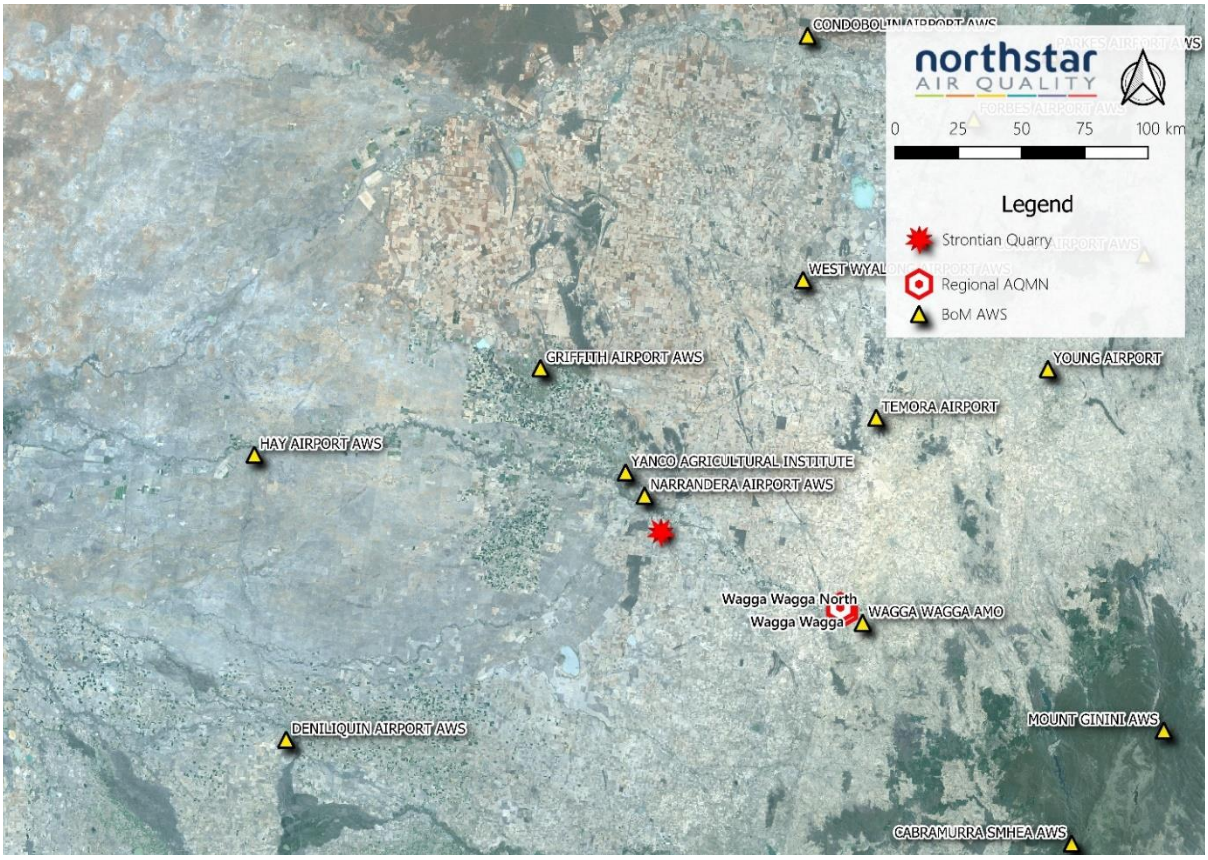
As discussed in **Section 4.2** a meteorological modelling exercise has been performed to characterise the meteorology of the Quarry site in the absence of site-specific measurements. The meteorological modelling has been based on measurements taken at a number of surrounding automatic weather stations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

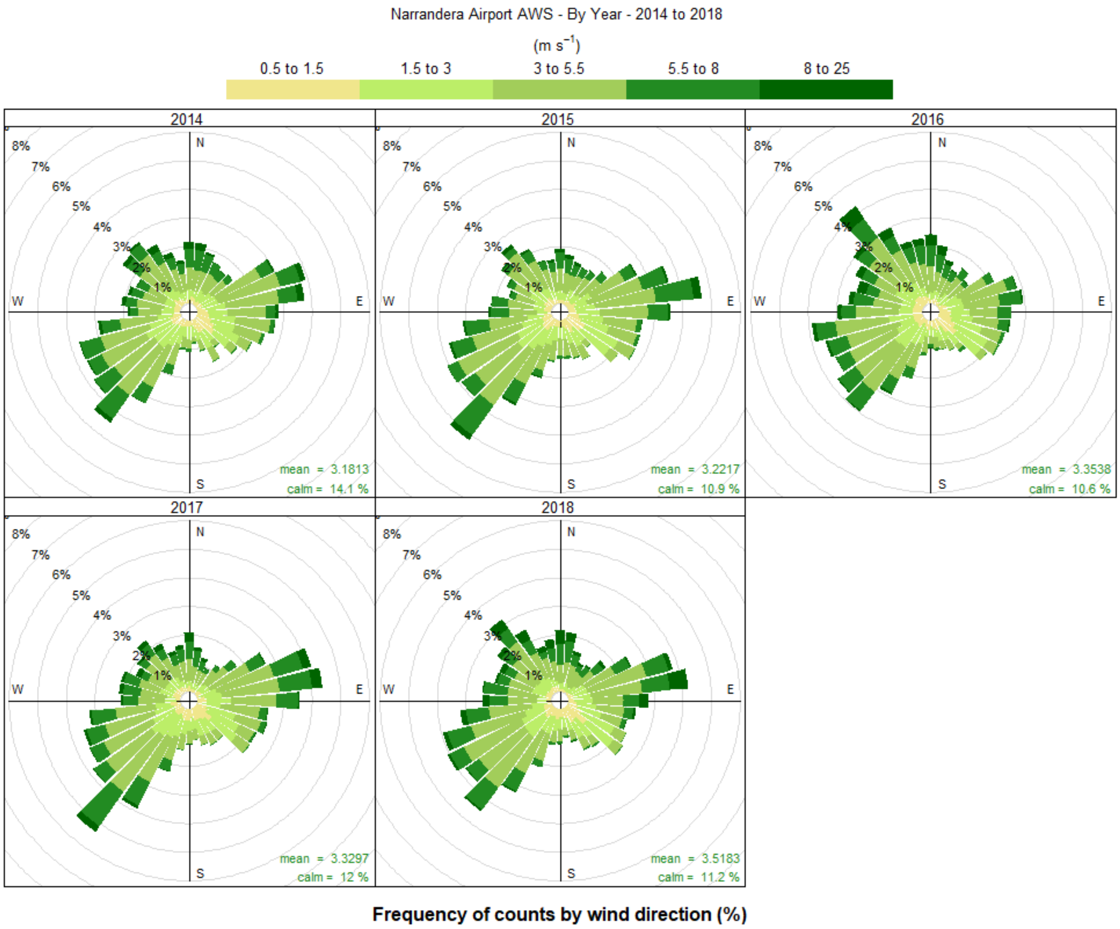
Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Narrandera Airport AWS #074148	BoM	455 493	6 159 563	15.9
Yanco Agricultural Institute AWS #074037	BoM	447 986	6 168 705	27.5
Wagga Wagga AMO AWS #072150	BoM	541 667	6 109 306	76.6
Griffith Airport AWS #075041	BoM	414 320	6 209 876	80.6
Temora Airport AWS #073151	BoM	547 016	6 190 290	96.2
West Wyalong Airport AWS #050017	BoM	518 132	6 244 679	114.1

Figure B1 Meteorological and air quality monitoring surrounding the Quarry site



Meteorological conditions at Narrandera 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 (2014 to 2018) are presented in **Figure B2**.

Figure B2 Annual wind roses 2014 to 2018, Narrandera Airport AWS



The wind roses indicate that from 2014 to 2018, winds at Narrandera Airport AWS shows a predominant east north-easterly and south-westerly component to the wind direction.

The majority of wind speeds experienced at Narrandera Airport AWS over the 5-year period, 2014 to 2018 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 north-westerly, north or north-easterly direction. Winds of this speed are not frequent, occurring during approximately 4% of the observed hours over the 5-year period at Narrandera Airport AWS. Calm winds (<0.5 $m{\cdot}s^{-1}$) occur during 11.8% of hours on average across the 5-year period.

Given the wind distributions across the years examined, data for the year 2014 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied. It is noted that wind direction data collected during the year 2016 shows a variation to average conditions, with an increased frequency of winds experienced from the northwest. Given this variation from average conditions, data collected during 2016 cannot be considered to be representative and has not been taken forward for further assessment.

Presented in **Figure B3** are the annual wind rose for the 2014 to 2018 period and the year 2014 and in **Figure B4** the annual wind speed distribution for Narrandera Airport AWS. These figures indicate that the distribution of wind speed and direction in 2014 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2014 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure B3 Annual wind roses 2014 to 2018, and 2014 Narrandera Airport AWS

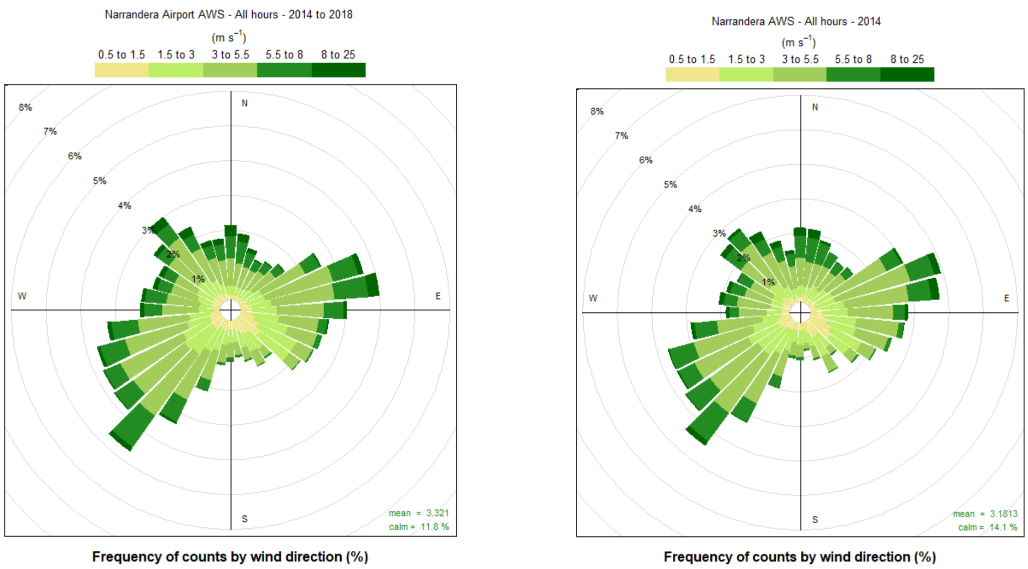
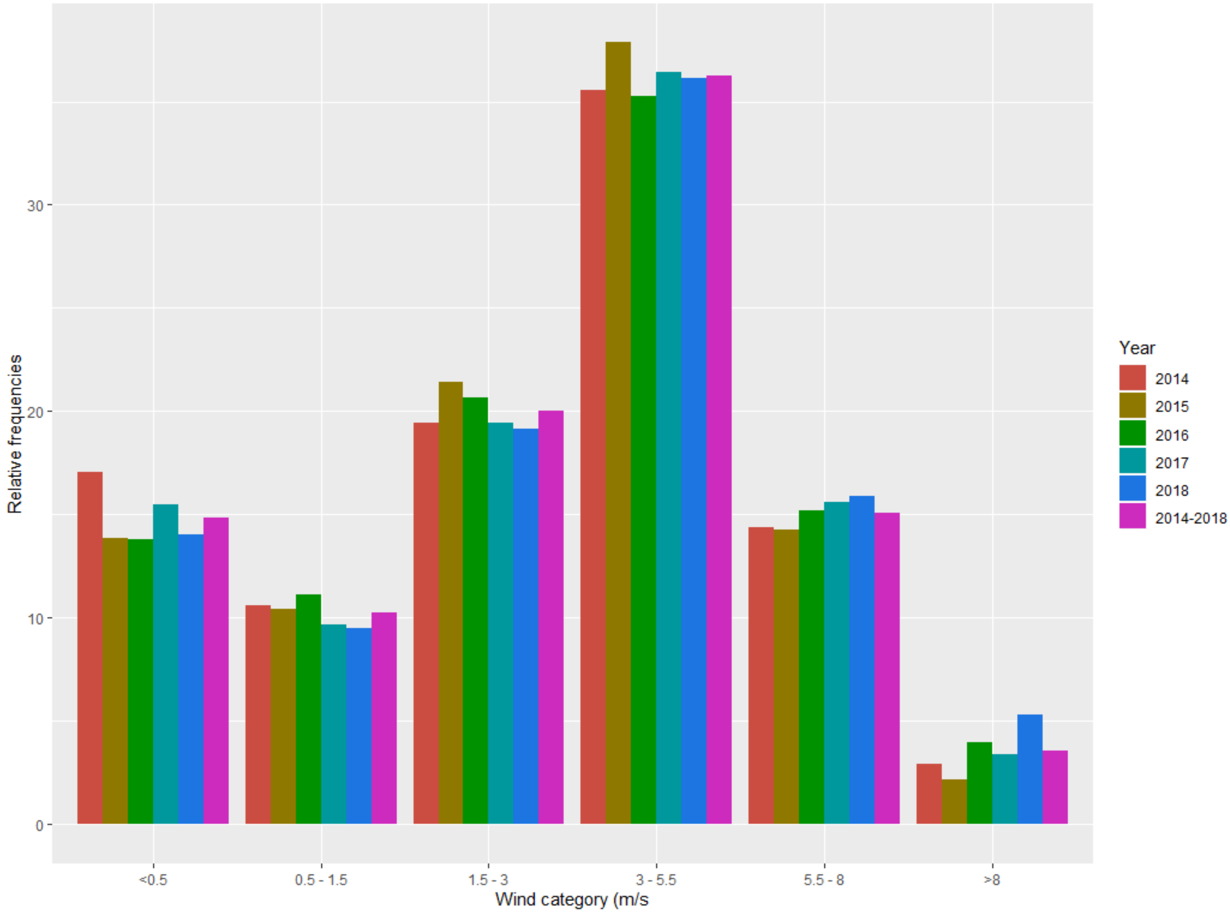


Figure B4 Annual wind speed distribution – Narrandera Airport AWS



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**. It is noted that an initial TAPM modelling run provided wind roses which did not validate well against observations at Narrandera Airport AWS. Given the poor validation, that initial TAPM modelling run has not been used in this AQIA. Subsequently, a second TAPM run was performed which used observations at Narrandera Airport AWS to 'nudge' model predictions towards those observations, and this has been used in this AQIA. However, in the absence of other AWS at appropriate distance from the model domain at which to validate model outputs, no validation has been able to be performed in this instance.

It is noted that a recent and approved AQIA for 'The Ranch' poultry farm complex odour assessment (SLR, 2017) adopted a similar meteorological modelling approach to that performed in this AQIA. That development is located in Tabbita, which is approximately 26 km north of Griffith. Meteorological observations from the Griffith Airport AWS were used in 'The Ranch' TAPM model, prior to using the 3-D output from TAPM in CALMET, which is directly comparable to the approach adopted in this AQIA. No validation of model outputs was provided in that approved assessment (SLR, 2017), presumably for the same reasons provided here.

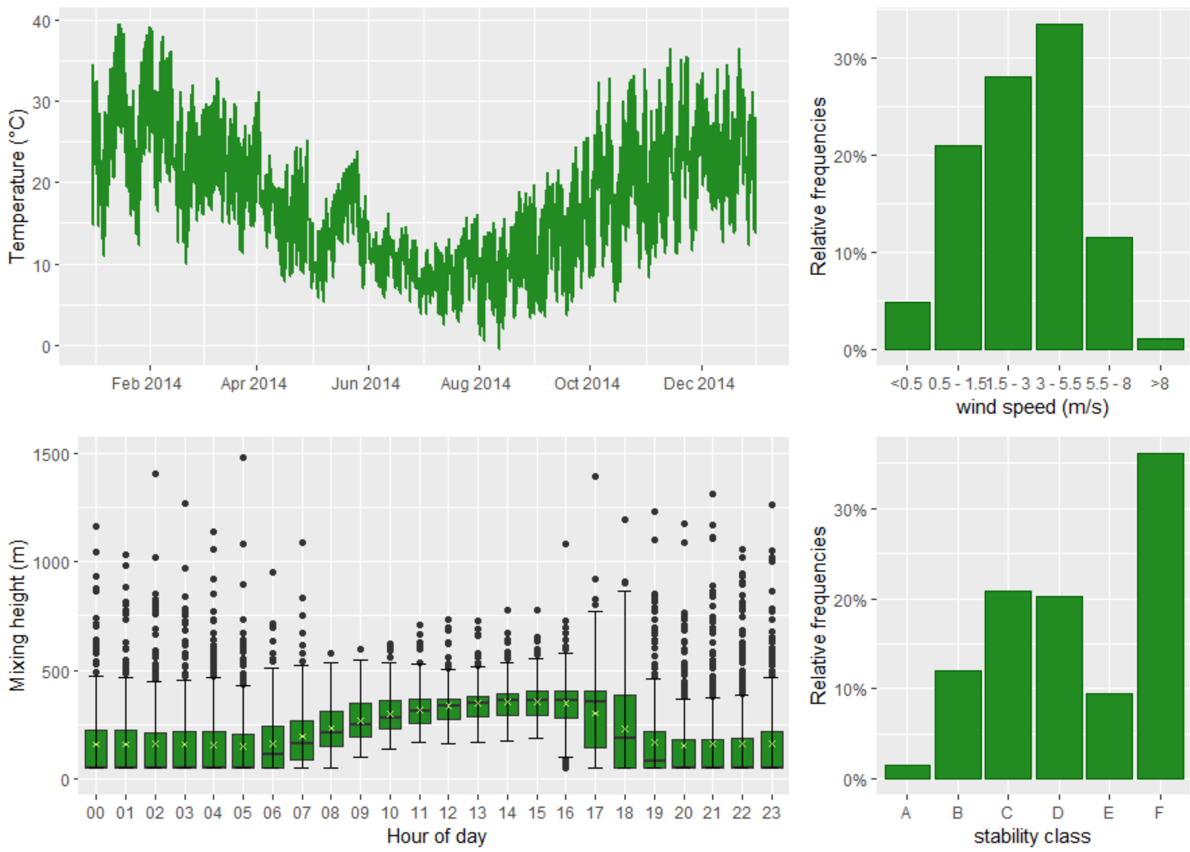
Table B2 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2014 to 31 December 2014
Centre of analysis	461 125 000 mE, 6 149 050 mN (UTM Coordinates)
Number of grid points	40 x 40 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	Narrandera Airport AWS
CALMET	
Modelling period	1 January 2014 to 31 December 2014
South-West corner of analysis	451 500 mS, 6 134 500 mN (UTM Coordinates)
Meteorological grid domain (resolution)	20 km x 20 km (0.2 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

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 B5**.

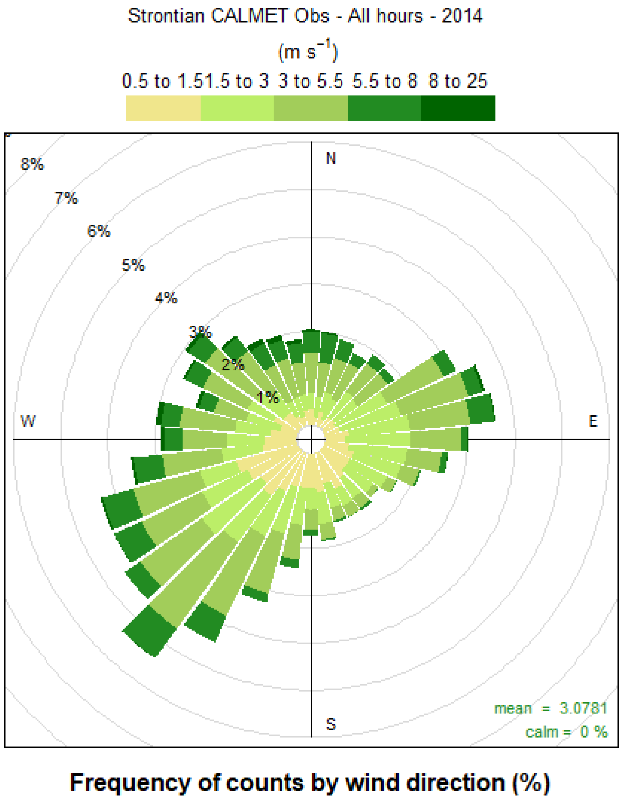
Diurnal variations in maximum and average mixing heights during the 2014 period shows that, as expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure B5 Predicted temperature, mixing height and wind speed frequency – Quarry site 2014



The modelled wind speed and direction at the Quarry site during 2014 are presented in **Figure B6**.

Figure B6 Predicted wind speed and direction – Quarry site 2014



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 320 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 2014 was selected for assessment based upon an analysis of meteorological and background air quality data.

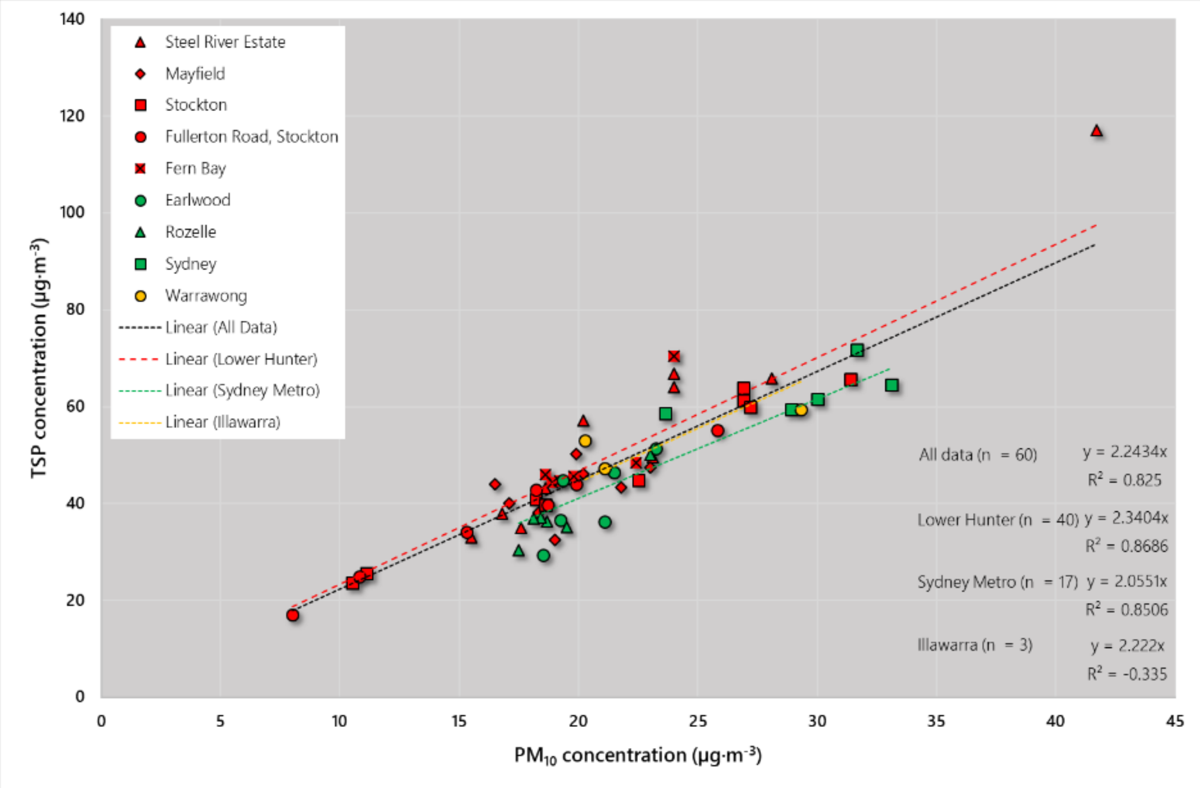
Table C1 Details of closest AQMS surrounding the Quarry

AQMS Location	Approximate distance to Quarry (km)	Screening Parameters			
		2014 Data	Measurements		
			PM_{10}	$PM_{2.5}$	TSP
Wagga Wagga North	77	✓	✓	✓	×
Wagga Wagga	79	×	×	×	×
Albury	140	✓	✓	×	×
Bathurst	318	✓	✓	×	×

Based on the sources of AQMS data available and their proximity to the Quarry, Wagga Wagga North 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, and the most conservative of all the relationships assessed. 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 48.4 $\mu g \cdot m^{-3}$ 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 $g \cdot m^{-2} \cdot month^{-1}$ as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of 2 $g \cdot m^{-2} \cdot month^{-1}$ (the total allowable deposition being 4 $g \cdot m^{-2} \cdot month^{-1}$).

Graphs presenting the daily varying PM_{10} and $PM_{2.5}$ data recorded at Wagga Wagga North in 2014 are presented in **Figure C2** and **Figure C3**, respectively.

Figure C2 PM_{10} Measurements, Wagga Wagga North 2014

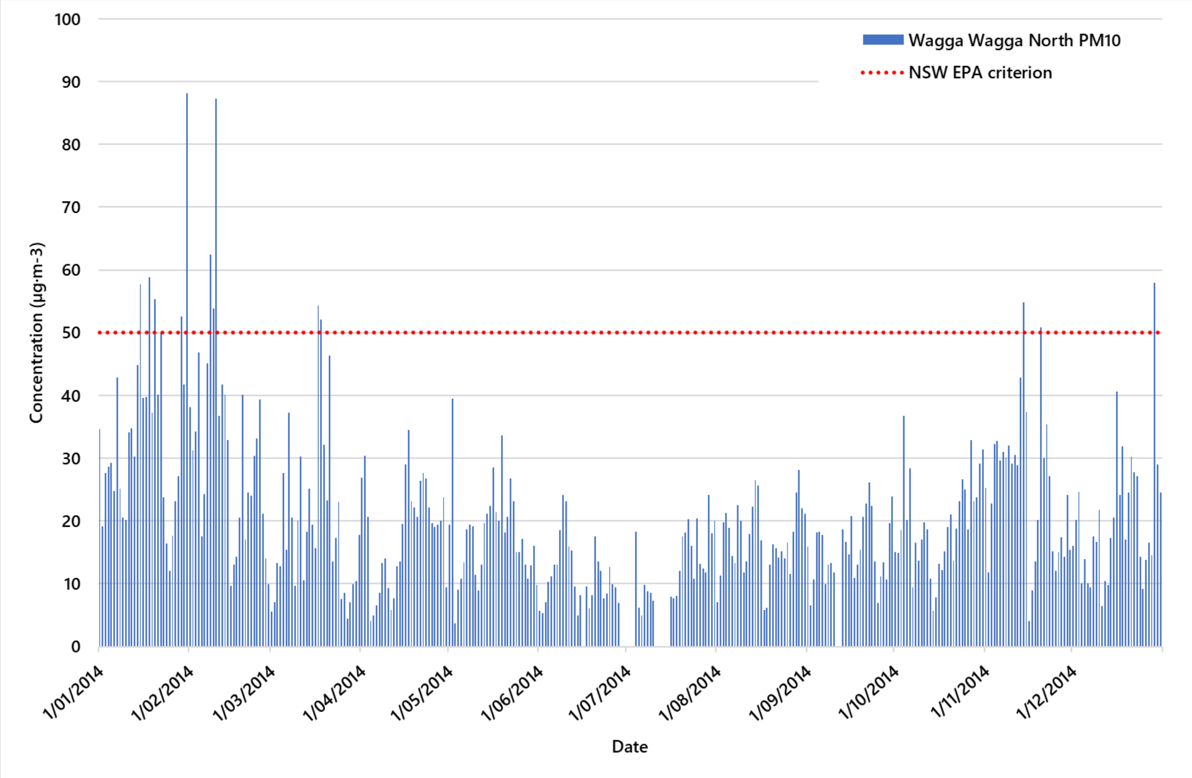
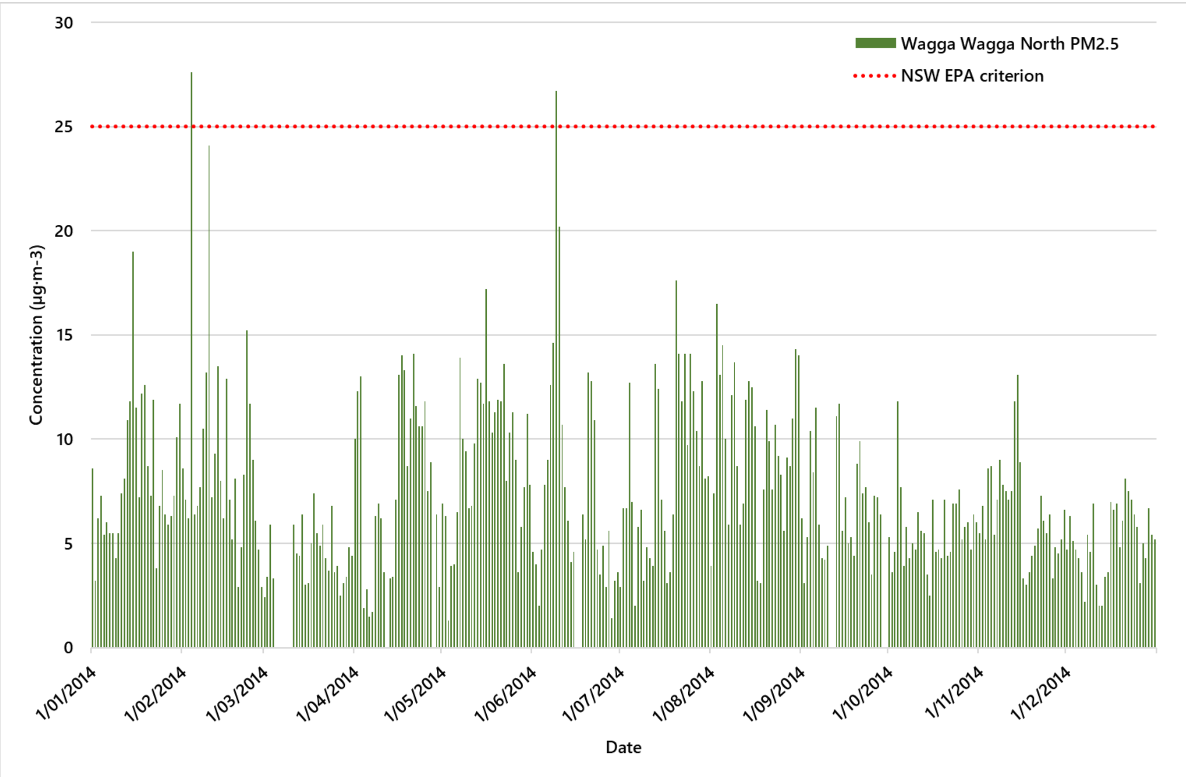


Figure C3 $PM_{2.5}$ Measurements, Wagga Wagga North 2014



Thirteen exceedances of the NSW EPA maximum 24-hour average PM_{10} criterion and two exceedances of the maximum 24-hour average $PM_{2.5}$ criterion were measured at the Wagga Wagga North AQMS in 2014. The NSW Annual Compliance Report for the National Environment Protection (Ambient Air Quality) Measure for 2014 (NSW OEH, 2016) provides commentary on the likely source of PM_{10} exceedances, reproduced below in **Table C2**. Exceedances of the $PM_{2.5}$ criterion are not discussed in (NSW OEH, 2016) but are included in **Table C2**.

Table C2 Calendar days in 2014 when 24-hour PM_{10} and $PM_{2.5}$ criterion was exceeded

Date	PM_{10} concentration ($\mu g{\cdot}m^{-3}$)	$PM_{2.5}$ concentration ($\mu g{\cdot}m^{-3}$)	Comments[1] on PM_{10} exceedance (from (NSW OEH, 2016))
15 January	57.7	19.0	24-ha grassfire, 4 km east of Wagga (Tasman Rd)
18 January	58.8	12.2	1-ha grassfire, 1.5 km SE of Wagga AQMS
20 January	55.3	8.7	
29 January	52.6	7.3	0.1 ha grassfire, 7 km NSW of Wagga AQMS
31 January	88.2	11.7	
4 February	46.8	27.6	
8 February	62.4	10.5	0.1 ha grassfire, midnight on 7 February at Tumbarumba Road x Eight Mile Road
9 February	53.8	13.2	
10 February	87.3	24.1	Victorian bushfires
17 March	54.4	5.0	
18 March	52.1	7.4	
9 June	24.2	26.7	
14 November	54.8	13.1	Two grass fires and one forest fire (up to 0.4 ha) within a 2 to 3 km radius of Wagga AQMS on 13 November and 14 November
20 November	50.8	4.9	10 ha grassfire 14 km SW of Wagga AQMS (Oxley, Uranquinty)
29 December	58.0	5.2	

Notes 1: Events that can be clearly identified as influencing pollution levels (NSW OEH, 2016)

PM_{10} concentrations show a seasonal trend at the Wagga Wagga North AQMS, with higher concentrations generally experienced in warmer months, and lower concentrations in cooler months. Higher concentrations are often due to bushfire activity (as shown in **Table C2**), but can also be influenced by dust storms, and impacts resulting from broadacre agricultural activity, especially in autumn months (DSEWPC, 2010).

$PM_{2.5}$ concentrations at the Wagga Wagga North AQMS show less seasonal trend, although elevated concentrations are experienced in the cooler months, most likely as a result of the use of wood-fired heaters.

Given the likely source of particulates which influence measurements of particulate matter at the Wagga Wagga North AQMS, it is likely that these sources may be similar in the area surrounding the Quarry site (i.e. broadacre agriculture, wood-fired heaters). The use of air quality data from Wagga Wagga North to characterise the air quality in the area surrounding Narrandera and the Quarry site is considered to be appropriate.

The AQIA considers all measured particulate concentrations within the background dataset (including exceedances) and provides discussion as to the potential impact of the Proposal on air quality. Impacts are discussed in terms of 'incremental' and 'cumulative' impact, and in relation to the number of 'additional exceedances' which may eventuate with the operation of the Proposal.

APPENDIX D

Emissions Inventory

As outlined in **Section 2.2**, a number of operations to be performed as part of the Quarry 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).

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).

Paved Roads

Emissions of particulate matter resulting from the movement of vehicles on paved roads have been estimated using the emission factors presented in section 13.2.1 (Paved Roads) of AP-42, (US EPA, 2011).

The emission factor on page 13.2.1.3 of (US EPA, 2011) has been adopted for the operations of vehicles on paved roads:

$$EF_{(g.VKT^{-1})} = k(sL)^{0.91}(W \times 0.907185)^{1.02}$$

where:

$EF_{(g.VKT^{-1})}$= emission factor (g per vehicle kilometre travelled)

k = particle size multiplier (dimensionless)

sL = road surface silt loading (g·m^{-2})

W = average weight (tons) of vehicles travelling the road multiplied by 0.907185 to convert to metric tonnes

The particle size multipliers for TSP, PM_{10} and $PM_{2.5}$ (k) are provided in (US EPA, 2011) as 3.23, 0.62 and 0.15, respectively.

The quality rating for this emission factors are A for TSP, A for PM_{10}, D for $PM_{2.5}$.

The road surface silt loading of the paved haul road from the extraction area to the paved Quarry access road has been taken to be 8.2 g·m^{-2} which is the average value for a paved road at a quarry as outlined in Table 13.2.1-3 of (US EPA, 2011).

The mean weight of vehicles has been calculated based on the use of 30 t capacity Truck and Dog vehicles which would have a tare weight of 13.5 t and a loaded weight of 43.5 t. The average vehicle weight has therefore been calculated to be 28.5 t (metric).

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. $PM_{2.5}$ emission factors are not available for uncontrolled screening sources in AP-42 although have been taken to be 7% of PM_{10} 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 has been calculated based on the use of 30 t capacity Truck and Dog vehicles which would have a tare weight of 13.5 t and a loaded weight of 43.5 t. The average vehicle weight has therefore been calculated to be 28.5 t (metric).

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.

Stage 1 – annual average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg \cdot year^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59000	0.30680	0.01770	$kg \cdot hole^{-1}$	850	holes	Fabric filter (90)	5.0	2.6	0.2
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	6.95701	3.61765	0.20871	$kg \cdot blast^{-1}$	5	blasts		34.8	18.1	1.0
Excavator loading blasted material to HSI crusher and screen	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	25 000	t	Pit retention(A)	24.1	21.6	3.3
Crushing (HSI)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg \cdot t^{-1}$	25 000	t	Pit retention(A) Water spray (77.7)	7.5	6.4	1.1
Screening (HSI)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg \cdot t^{-1}$	25 000	t	Pit retention(A) Water spray (91.2)	13.8	9.0	0.6
Loading screen stockpiles (HSI)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	25 000	t	Pit retention(A)	24.1	21.6	3.3
FEL loading Crusher (PP)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	100 000	t	Pit retention(A)	96.3	86.5	13.1
Crushing (PP, Jaw AND Cone)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg \cdot t^{-1}$	200 000	t	Pit retention(A) Water spray (77.7)	60.2	50.8	9.2
Screening (PP)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg \cdot t^{-1}$	100 000	t	Pit retention(A) Water spray (91.2)	55.0	35.9	2.5
Loading stockpiles from screens	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	100 000	t	Pit retention(A)	96.3	86.5	13.1

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg{\cdot}year^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
FEL loading road trucks	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	125 000	t	Pit retention[(A)]	120.4	108.2	16.4
Dozer pushing overburden	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42589	0.36172	0.25472	$kg{\cdot}hr^{-1}$	90	hr		218.3	32.6	22.9
Dumping of concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention[(A)]	1.4	1.3	0.2
FEL loading crusher with concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention[(A)]	1.4	1.3	0.2
Crushing concrete and brick products (blended)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg{\cdot}t^{-1}$	1 500	t	Pit retention[(A)] Water spray (77.7)	0.5	0.4	0.1
Screening of concrete and brick products (blended)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg{\cdot}t^{-1}$	1 500	t	Pit retention[(A)] Water spray (91.2)	0.8	0.5	0.0
Loading of stockpiles with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention[(A)]	1.4	1.3	0.2
Loading trucks with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention[(A)]	1.4	1.3	0.2
50% of material in screen stockpiles moved to product stockpiles (load)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	62 500	t	Pit retention[(A)]	60.2	54.1	8.2
50% of material in screen stockpiles moved to product stockpiles (unload)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	62 500	t	Pit retention[(A)]	60.2	54.1	8.2
Paved road from Strontian Road to Quarry	AP-42 Paved roads - Section 13.2.1	0.66791	0.12820	0.03102	$kg{\cdot}VKT^{-1}$	3 500	VKT	Vehicle speed reduction (44)	1,309.0	251.3	60.8

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·year^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Unpaved road from Quarry entrance to HSI crusher	AP-42 Unpaved roads - Section 13.2.2	3.07066	0.87318	0.08732	kg·VKT^{-1}	4 107	VKT	Vehicle speed reduction (44) L1 watering (50) Pit retention(A)	1 765.6	953.9	95.4
Disturbed area (includes all stockpiles)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	7.6	ha	Pit retention(A)	3 230.0	3 068.5	460.3
								Total	**7 067.4**	**4 759.8**	**704.1**

Note: (A) 50% control for TSP, 5% control for PM_{10} and $PM_{2.5}$

Stage 3 – annual average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·year^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59000	0.30680	0.01770	kg·hole^{-1}	850	holes	Fabric filter (90)	5.0	2.6	0.2
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	6.95701	3.61765	0.20871	kg·blast^{-1}	5	blasts		34.8	18.1	1.0
Excavator loading blasted material to HSI crusher and screen	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	25 000	t	Pit retention(A)	24.1	21.6	3.3
Crushing (HSI)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	kg·t^{-1}	25 000	t	Pit retention(A) Water spray (77.7)	7.5	6.4	1.1
Screening (HSI)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	kg·t^{-1}	25 000	t	Pit retention(A) Water spray (91.2)	13.8	9.0	0.6
Loading screen stockpiles (HSI)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	25 000	t	Pit retention(A)	24.1	21.6	3.3
FEL loading Crusher (PP)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	100 000	t	Pit retention(A)	96.3	86.5	13.1
Crushing (PP, Jaw AND Cone)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	kg·t^{-1}	200 000	t	Pit retention(A) Water spray (77.7)	60.2	50.8	9.2
Screening (PP)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	kg·t^{-1}	100 000	t	Pit retention(A) Water spray (91.2)	55.0	35.9	2.5
Loading stockpiles from screens	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	100 000	t	Pit retention(A)	96.3	86.5	13.1

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg{\cdot}year^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
FEL loading road trucks	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	125 000	t	Pit retention(A)	120.4	108.2	16.4
Dozer pushing overburden	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42589	0.36172	0.25472	$kg{\cdot}hr^{-1}$	0	hr		0.0	0.0	0.0
Dumping of concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention(A)	1.4	1.3	0.2
FEL loading crusher with concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention(A)	1.4	1.3	0.2
Crushing concrete and brick products (blended)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg{\cdot}t^{-1}$	1 500	t	Pit retention(A) Water spray (77.7)	0.5	0.4	0.1
Screening of concrete and brick products (blended)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg{\cdot}t^{-1}$	1 500	t	Pit retention(A) Water spray (91.2)	0.8	0.5	0.0
Loading of stockpiles with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention(A)	1.4	1.3	0.2
Loading trucks with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	1 500	t	Pit retention(A)	1.4	1.3	0.2
50% of material in screen stockpiles moved to product stockpiles (load)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	62 500	t	Pit retention(A)	60.2	54.1	8.2
50% of material in screen stockpiles moved to product stockpiles (unload)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg{\cdot}t^{-1}$	62 500	t	Pit retention(A)	60.2	54.1	8.2
Paved road from Strontian Road to Quarry	AP-42 Paved roads - Section 13.2.1	0.66791	0.12820	0.03102	$kg{\cdot}VKT^{-1}$	3 500	VKT	Vehicle speed reduction (44)	1 309.0	251.3	60.8

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·year^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Unpaved road from Quarry entrance to HSI crusher	AP-42 Unpaved roads - Section 13.2.2	3.07066	0.87318	0.08732	kg·VKT^{-1}	5 617	VKT	Vehicle speed reduction (44) L1 watering (50) Pit retention[(A)]	2 414.5	1 304.6	130.5
Disturbed area (includes all stockpiles)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	5.8	ha	Pit retention[(A)]	2 465.0	2 341.8	351.3
								Total	**6 733.1**	**4 351.1**	**607.2**

Note: (A) 50% control for TSP, 5% control for PM_{10} and $PM_{2.5}$

Stage 1 – maximum 24-hour

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 blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59000	0.30680	0.01770	$kg \cdot hole^{-1}$	260	holes	Fabric filter (90)	1.53	0.80	0.05
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	6.95701	3.61765	0.20871	$kg \cdot blast^{-1}$	1	blasts		13.27	6.90	0.40
Excavator loading blasted material to HSI crusher and screen	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	2 700	t	Pit retention[(A)]	2.60	2.34	0.35
Crushing (HSI)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg \cdot t^{-1}$	2 700	t	Pit retention[(A)] Water spray (77.7)	0.81	0.69	0.12
Screening (HSI)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg \cdot t^{-1}$	2 700	t	Pit retention[(A)] Water spray (91.2)	1.49	0.97	0.07
Loading screen stockpiles (HSI)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	2 700	t	Pit retention[(A)]	2.60	2.34	0.35
FEL loading Crusher (PP)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	2 400	t	Pit retention[(A)]	2.31	2.08	0.31
Crushing (PP, Jaw AND Cone)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg \cdot t^{-1}$	4 800	t	Pit retention[(A)] Water spray (77.7)	1.45	1.22	0.22
Screening (PP)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg \cdot t^{-1}$	2 400	t	Pit retention[(A)] Water spray (91.2)	1.32	0.86	0.06
Loading stockpiles from screens	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	2 400	t	Pit retention[(A)]	2.31	2.08	0.31

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}	$PM_{2.5}$
FEL loading road trucks	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	1 440	t	Pit retention$^{(A)}$	1.39	1.25	0.19
Dozer pushing overburden (would not occur during peak Quarry activity)	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42589	0.36172	0.25472	kg·hr^{-1}	0	hr		0.0	0.0	0.0
Dumping of concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	30	t	Pit retention$^{(A)}$	0.03	0.03	0.00
FEL loading crusher with concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	30	t	Pit retention$^{(A)}$	0.03	0.03	0.00
Crushing concrete and brick products (blended)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	kg·t^{-1}	30	t	Pit retention$^{(A)}$ Water spray (77.7)	0.01	0.01	0.00
Screening of concrete and brick products (blended)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	kg·t^{-1}	30	t	Pit retention$^{(A)}$ Water spray (91.2)	0.02	0.01	0.00
Loading of stockpiles with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	30	t	Pit retention$^{(A)}$	0.03	0.03	0.00
Loading trucks with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	30	t	Pit retention$^{(A)}$	0.03	0.03	0.00
50% of material in screen stockpiles moved to product stockpiles (load)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	2 550	t	Pit retention$^{(A)}$	2.46	2.21	0.33
50% of material in screen stockpiles moved to product stockpiles (unload)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	2 550	t	Pit retention$^{(A)}$	2.46	2.21	0.33
Paved road from Strontian Road to Quarry	AP-42 Paved roads - Section 13.2.1	0.66791	0.12820	0.03102	kg·VKT^{-1}	41	VKT	Vehicle speed reduction (44)	15.2	2.9	0.7

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}	$PM_{2.5}$
Unpaved road from Quarry entrance to HSI crusher	AP-42 Unpaved roads - Section 13.2.2	3.07066	0.87318	0.08732	$kg \cdot VKT^{-1}$	48	VKT	Vehicle speed reduction (44) L1 watering (50) Pit retention(A)	20.5	11.1	1.1
Disturbed area (includes all stockpiles)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	$kg \cdot ha^{-1} \cdot yr^{-1}$	7.6	ha	Pit retention(A)	8.8	8.4	1.3
								Total	**75.8**	**44.0**	**5.5**

Note: (A) 50% control for TSP, 5% control for PM_{10} and $PM_{2.5}$

Stage 3 – maximum 24-hour

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 blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	0.59000	0.30680	0.01770	kg·hole^{-1}	260	holes	Fabric filter (90)	1.53	0.80	0.05
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	6.95701	3.61765	0.20871	kg·blast^{-1}	1	blasts		13.27	6.90	0.40
Excavator loading blasted material to HSI crusher and screen	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	2 700	t	Pit retention(A)	2.60	2.34	0.35
Crushing (HSI)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	kg·t^{-1}	2 700	t	Pit retention(A) Water spray (77.7)	0.81	0.69	0.12
Screening (HSI)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	kg·t^{-1}	2 700	t	Pit retention(A) Water spray (91.2)	1.49	0.97	0.07
Loading screen stockpiles (HSI)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	2 700	t	Pit retention(A)	2.60	2.34	0.35
FEL loading Crusher (PP)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	2 400	t	Pit retention(A)	2.31	2.08	0.31
Crushing (PP, Jaw AND Cone)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	kg·t^{-1}	4 800	t	Pit retention(A) Water spray (77.7)	1.45	1.22	0.22
Screening (PP)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	kg·t^{-1}	2 400	t	Pit retention(A) Water spray (91.2)	1.32	0.86	0.06
Loading stockpiles from screens	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	kg·t^{-1}	2 400	t	Pit retention(A)	2.31	2.08	0.31

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}	$PM_{2.5}$
FEL loading road trucks	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	1 440	t	Pit retention(A)	1.39	1.25	0.19
Dozer pushing overburden (would not occur during peak Quarry activity)	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42589	0.36172	0.25472	$kg \cdot hr^{-1}$	0	hr		0.0	0.0	0.0
Dumping of concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	30	t	Pit retention(A)	0.03	0.03	0.00
FEL loading crusher with concrete and brick products	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	30	t	Pit retention(A)	0.03	0.03	0.00
Crushing concrete and brick products (blended)	AP-42 - Primary crushing - Table 11.19.2.1	0.00270	0.00120	0.00022	$kg \cdot t^{-1}$	30	t	Pit retention(A) Water spray (77.7)	0.01	0.01	0.00
Screening of concrete and brick products (blended)	AP-42 - Screening - Table 11.19.2.1	0.01250	0.00430	0.00030	$kg \cdot t^{-1}$	30	t	Pit retention(A) Water spray (91.2)	0.02	0.01	0.00
Loading of stockpiles with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	30	t	Pit retention(A)	0.03	0.03	0.00
Loading trucks with concrete and brick products (blended)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	30	t	Pit retention(A)	0.03	0.03	0.00
50% of material in screen stockpiles moved to product stockpiles (load)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	2 550	t	Pit retention(A)	2.46	2.21	0.33
50% of material in screen stockpiles moved to product stockpiles (unload)	AP-42 - Batch drop - Section 13.2.4.3	0.00193	0.00091	0.00014	$kg \cdot t^{-1}$	2 550	t	Pit retention(A)	2.46	2.21	0.33
Paved road from Strontian Road to Quarry	AP-42 Paved roads - Section 13.2.1	0.66791	0.12820	0.03102	$kg \cdot VKT^{-1}$	41	VKT	Vehicle speed reduction (44)	15.2	2.9	0.7

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}	$PM_{2.5}$
Unpaved road from Quarry entrance to HSI crusher	AP-42 Unpaved roads - Section 13.2.2	3.07066	0.87318	0.08732	kg·VKT^{-1}	65	VKT	Vehicle speed reduction (44) L1 watering (50) Pit retention$^{(A)}$	28.1	15.2	1.5
Disturbed area (includes all stockpiles)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	5.8	ha	Pit retention$^{(A)}$	6.7	6.4	1.0
								Total	**81.2**	**46.1**	**5.6**

Note: (A) 50% control for TSP, 5% control for PM_{10} and $PM_{2.5}$

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