# Appendix 7

## Air Quality Assessment

prepared by
Northstar Air Quality Pty Ltd

(Total No. of pages including blank pages = 108)

This page has intentionally been left blank

DARRYL MCCARTHY
CONSTRUCTIONS PTY LTD

ABN: 86 001 646 028

# Dowe's Quarry

## Air Quality Assessment

Prepared by

northstar
AIR QUALITY

September 2019

Appendix 7

This page has intentionally been left blank

# DARRYL MCCARTHY CONSTRUCTIONS PTY LTD

**ABN: 86 001 646 028**

# Air Quality Assessment


**Prepared for:** R.W. Corkery & Co. Pty Limited
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Email: brooklyn@rwcorkery.com

**On behalf of:** Darryl McCarthy Constructions Pty Ltd
ABN: 86 001 646 028
PO Box 246
TENTERFIELD NSW 2372

Tel: (02) 6736 1988
Fax: (02) 6736 1385
Email: dmccarthy@nqq.com.au

**Prepared by:** Northstar Air Quality Pty Ltd
Suite 1504, 275 Alfred Street
NORTH SYDNEY NSW 2069

Tel: (02) 9071 8600
Email: admin@northstarairquality.com


**September 2019**

# CONTENTS

**Page**

# CONTENTS

**Page**



## ANNEXURES



## FIGURES

# CONTENTS

**Page**

## TABLES

This page has intentionally been left blank

# COMMONLY USED ACRONYMS

| | |
|---|---|
| AADT | annual average daily traffic |
| ABS | Australian Bureau of Statistics |
| ACH | air changes per hour |
| AHD | Australian height datum |
| AQIA | air quality impact assessment |
| AQMS | air quality monitoring station |
| AWS | automated weather station |
| BoM | Bureau of Meteorology |
| °C | degrees Celsius |
| CO | carbon monoxide |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| DCP | Development Control Plan |
| DPE | NSW Department of Planning and Environment (from 1 July 2019 this body will form part of the 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 |
| GHG | greenhouse gas |
| GIS | geographical information system |
| K | kelvin (-273.15°C = 0 K, ±1°C = ±1 K) |
| kW | kilowatt |
| MGA | Map Grid of Australia |
| $mg \cdot m^{-3}$ | milligram per 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 |
| NO | nitric oxide |
| $NO_X$ | oxides of nitrogen |
| $NO_2$ | nitrogen dioxide |
| $O_3$ | ozone |
| OEH | NSW Office of Environment and Heritage (from 1 July 2019 this body will form part of the NSW Department of Planning, Industry and Environment) |
| Pa | pascal |
| 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 |
| SSD | State Significant Development |
| 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 |
| VOC | volatile organic compounds |

# EXECUTIVE SUMMARY

A detailed air quality impact assessment has been performed to assess the potential impacts of operations to be performed as part of the ongoing and expanded Dowe's Quarry operation.

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 with due reference to the Secretary's Environmental Assessment Requirements, and NSW Environment Protection Authority requirements.

The air quality criteria applicable to the assessment have been adopted from Commonwealth and State legislation and guidance, and approval conditions.

A modelling exercise has been performed to characterise the meteorological environment of the area surrounding the Quarry Site. A full description of the input data, modelling and validation of the outputs is presented in this report.

A detailed dispersion modelling exercise has been performed to characterise the predicted impacts from the proposed Quarry operation at a number of surrounding privately-owned receptors. A background air quality dataset has been adopted and added to those modelled impacts to determine a total, cumulative impact.

Details of the operations of the Quarry during two operational stages have been used to generate emissions inventories characterising the operation of the Quarry. Dust control measures for emissions sources have been identified and adopted where appropriate.

For the purposes of providing 'worst-case' assessment results, with which to compare against the long and short-term air quality criteria, processing operations at the Quarry Site have been assumed to operate at a throughput of 230 000 t per annum, or a maximum of 5,000 t per day. These activity rates are significantly greater than those which are likely to be experienced as part of ongoing Quarry operations.

These conservative assumptions provide confidence that the impacts of the Quarry operation are not likely to be greater than those presented within this assessment.

The dispersion modelling exercise indicates that the Quarry can operate across all three stages of development with no exceedances of adopted air quality criteria.

A greenhouse gas assessment has been performed to examine the potential impacts of the operation of the Quarry relating to emissions of GHG. A quantitative assessment of emissions has been performed with emissions compared with total national and NSW greenhouse gas emissions for context.

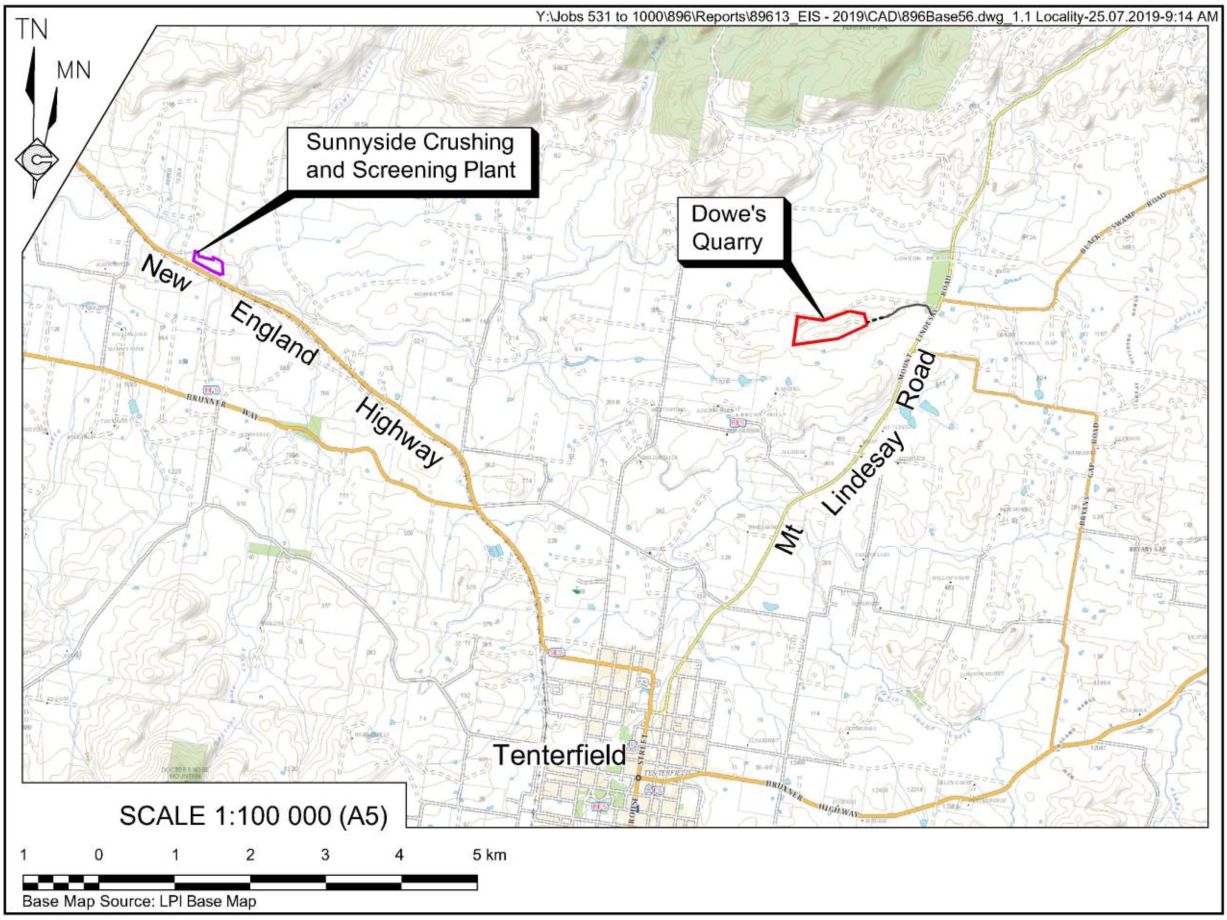
Emissions associated with the Proposal are anticipated to represent a negligible percentage of Australian and NSW emissions totals. Nonetheless, greenhouse gas emissions are proposed to be reduced through the implementation of a maintenance program for all plant and equipment, and the investigation into using B5 fuel where possible.

This page has intentionally been left blank

# 1. INTRODUCTION

Darryl McCarthy Constructions Pty Ltd (the Applicant) operates the Dowe's Quarry (the Quarry) located approximately 8 kilometres (km) northeast of Tenterfield, in the New England region of NSW (refer to **Figure 1**). The Quarry is operated to recover quartzose material used to produce a range of ivory-coloured stone products used in the manufacture of decorative concrete and landscaping products.

**Figure 1 Existing Locality Plan**




The Quarry originally commenced operations in 1987, and is currently operating under a development consent originally issued by the Joint Regional Planning Panel on 19 March 2015 and subsequently amended on 21 January 2016. The Quarry has approval to extract up to 150 000 tonnes per annum (tpa) of quartzose material, disturb a total area of 6.7 hectares (ha) and store a range of fine materials generated during the processing of the material at the Applicant's processing plant at Sunnyside, located approximately 10 km northwest of Tenterfield (refer to **Figure 1**). The existing development consent allows a maximum of 28 truck-loads of quartzose material to be transported daily (principally Monday to Friday) from the Quarry to Sunnyside with no more than 120 truck-loads per week.

The Applicant has identified a further 4.8 million tonnes (t) of quartzose material adjacent to and beneath the current approved extraction area for which they are seeking development consent to extract. Overall, the additional activities would increase the total area of disturbance to approximately 16.4 ha of which 6.5 ha is remnant native vegetation which would need to be progressively cleared.

In addition to the above activities, the Applicant intends to increase the range of products produced from the quarried quartzose material which would also involve a proportion of the quartzose material being processed on site prior to its despatch to Sunnyside or directly to customers.

R.W. Corkery & Co. Pty. Ltd (RWC) has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of the Applicant to perform an air quality impact assessment (AQIA) and greenhouse gas (GHG) assessment to support the continued operation and extension of Dowe's Quarry (the Proposal).

The AQIA presents an assessment of the impacts of the proposed operation of the Quarry and provides an assessment of the cumulative impacts of the Quarry with other relevant sources including general background conditions.

Of significance, the AQIA has been performed on the assumption that all 230 000 t of extracted material would be processed on-site, rather than being transported to Sunnyside for further processing. This represents a potential worst-case scenario and the actual long-term (annual average) air quality impacts are therefore likely to be significantly less than predicted.

Furthermore, in the assessment of short-term (24-hour) impacts, the processing plant has been assumed to be operating at full capacity (up to 5 000 t per day) which results in throughput being approximately 7 times greater than average. This assessment of campaign crushing at maximum possible rates provides confidence that the actual short-term particulate matter impacts are likely to be significantly less than predicted in this AQIA.

The GHG assessment provides an assessment of the potential GHG emissions during the operation of the Proposal.

## 1.1 ASSESSMENT REQUIREMENTS

The NSW Department of Planning and Environment (DP&E) (now Department of Planning, Industry and Environment [DPI&E]) has provided Secretary's Environmental Assessment Requirements (SEARs) for the Proposal (EAR number 1341), issue date 28 May 2019. The requirements of the SEARs in relation to air quality are presented in Table 1, with the relevant section(s) of this AQIA in which they have been addressed.

In the preparation of the SEARs, relevant government agencies have been consulted. The NSW Environment Protection Authority (EPA) responded on 22 May 2019 and has provided a list of requirements to be addressed in the preparation of the AQIA. These requirements are also listed in Table 1.

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.

No specific assessment requirements have been provided by the Tenterfield Shire Council (Council) for the AQIA or GHG Assessment.

**Table 1**
**Coverage of Issues Identified by Government Agencies for Consideration**

| Agency / Organisation | Paraphrased Relevant Requirement | Relevant Section(s) |
|---|---|---|
| Department of Planning & Environment (28/05/2019) | Include 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; | This assessment<br>Section 6 |
| Environment Protection Authority (22/05/2019) | Assess and quantify air quality issues including dust generation from the operation on the surrounding landscape and community; | Section 6 |
| | Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations (POEO) Act (1997) and the POEO (Clean Air) Regulation 2002. Particular consideration should be given to section 129 of the POEO Act concerning control of "offensive odour". | Section 3 |
| | Include an air quality impact assessment (AQIA) carried out in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005), | Section 6 |
| | Detail emission control techniques and practices that will be employed at the site and identify how the proposed control techniques and practices will meet the requirements of the POEO Act, POEO (Clean Air) Regulation and associated air quality limits or guideline criteria. | Section 6<br>Section 8<br>Annexure 3 |

## 1.2 PREVIOUS AQIA FOR THE QUARRY

A semi-quantitative AQIA was performed to support an EIS for a development application in 2014 (ENVIRON, 2014) for the continued operation and extension of the Quarry. At that time, the Applicant proposed to extend the (then) existing extraction area by approximately 1.4 ha to the west producing up to 100 000 t of rock per year (averaging 60 000 t per year).

The AQIA (ENVIRON, 2014) provided a quantification of likely particulate emissions resulting from a range of activities at the Quarry and compared these total annual emissions with other similar operations for which quantitative modelling results had previously been generated. Dispersion model predictions associated with the most similar development in terms of throughput and calculated annual emissions were then reviewed and conclusions drawn as to the likely incremental $PM_{10}$ and dust deposition levels which might be expected as a result of the ongoing Quarry operation and proposed extension.

Added to those derived concentrations was a regional background concentration which enabled conclusions to be drawn as to the likely cumulative particulate impacts which might be anticipated at surrounding non-Project related receptors. In conclusion (ENVIRON, 2014) determined that it was considered highly unlikely that cumulative impacts would exceed the NSW EPA 24-hour average $PM_{10}$ assessment criterion of 50 $\mu g \cdot m^{-3}$ and further that the proposed development would be unlikely to adversely impact upon the local air quality environment.

The development application was approved on 21 January 2016.

The AQIA presented within this report provides a full quantitative assessment of the likely incremental and cumulative impacts anticipated during the Quarry operation.

# 2. THE PROJECT

## 2.1 PROJECT BACKGROUND

The Quarry Site is located on rural land within Lots 308 and 309 DP 751540, Lots 3 and 4 DP 42044 and Lots 239 and 260 DP 751540. Under the Proposal the Quarry Site would extend into Lots 1 and 2 DP1092215 and Lot 244 DP751540. This land is owned by Mr Rod Dowe and leased by the Applicant.

The activities for which the Applicant is seeking development consent would involve the following (collectively, the Proposal):

- Ongoing extraction of quartzose rock within the existing extraction area and a 4.4 ha extension of the extraction area, producing up to 230 000 tpa.
- Campaign crushing and screening on site using mobile processing equipment. On-site processing would be undertaken in response to client requirements.
- Ongoing transportation of fragmented and crushed rock to the State road network, (i.e. the New England Highway), for delivery to the Sunnyside Crushing and Screening Plant, and other destinations. Material would also continue to be delivered locally within Tenterfield for Council-managed road and infrastructure activities and directly to the local community.
- Ongoing transportation of material directly to end points of use, where further processing at the Sunnyside Crushing and Screening Plant is not required.
- Ongoing backloading of clay fines and crusher fines from the Sunnyside Plant to the Quarry;
- Progressive emplacement of overburden and fines within and adjacent to the extraction area.
- Progressive and final rehabilitation of the Quarry to develop a landform suitable for native vegetation conservation.

The proposed Quarry layout is illustrated in **Figure 2**. The principal components and the respective approximate areas of disturbance within the Quarry Site are as follows:

- Extraction area (Stage 1 – 6.9 ha, Stage 2 – 10.1 ha, Stage 3 – 11.4 ha)

  The extraction area would be developed in three stages and would be centred on the quartzose material defined through the exploration drilling campaign undertaken by the Applicant.

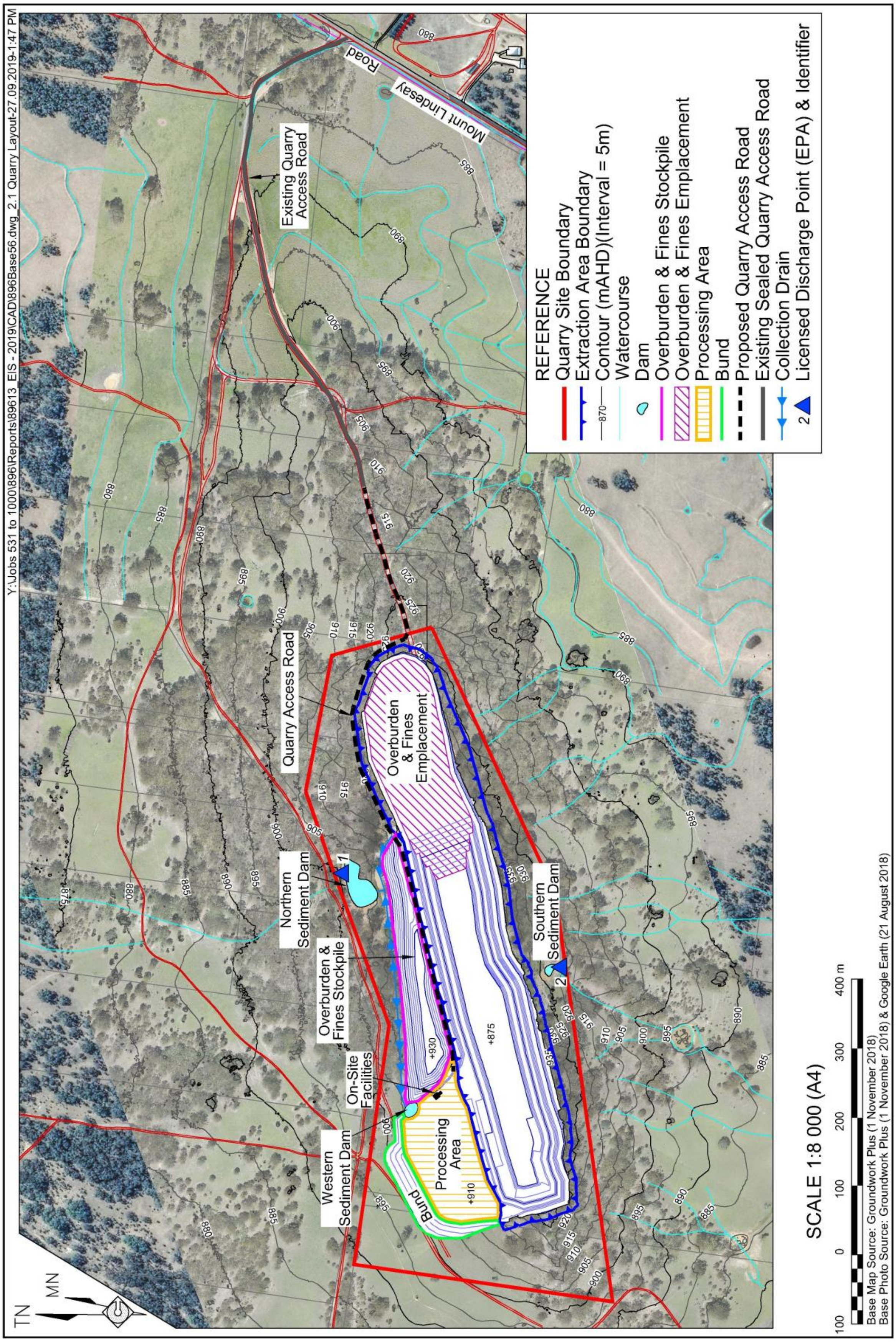
- Processing area (1.8 ha)

  The processing area would be located immediately to the northwest of the extraction area and would incorporate areas for the mobile crushing plant, raw feed stockpiles and product stockpiles.

- Bund (0.62 ha)

  A bund would be constructed to the north and west of the processing area principally to mitigate potential noise and visual impacts generated by the mobile crushing plant. The bund would be constructed using overburden and topsoil stripped during the development of other Quarry components.

**Figure 2 Proposed Quarry Layout**




**Source:** RWC

- Overburden and fines stockpile (Stage 1 – 3.2 ha, Stage 2 – 2.6 ha, Stage 3 – 1.6 ha)

  The overburden and fines stockpile would be progressively developed using overburden removed during extraction and fines backloaded from Sunnyside or produced on site. The overburden and fines stockpile would be located immediately to the north of the extraction area. No new material would be added to this area from midway through Stage 2 of operations. As the extraction area is developed to the north, material from the overburden and fines stockpile would be progressively relocated to the completed areas in the eastern section of the extraction area. This would to allow for the extension of the extraction area to the north and west.

- Overburden and fines emplacement (Stage 2 – 1.9 ha, Stage 3 – 2.9 ha)

  The overburden and fines emplacement would be developed in the eastern section of the extraction area from midway through Stage 2 using material moved from the overburden and fines stockpile and overburden generated during the extension of the extraction area. It would be developed to an ultimate height of approximately 920 m AHD (effectively ground level).

- Quarry access road (1.7 km)

  The Quarry access road would provide long-term vehicular access to the processing area. An approximately 750 m portion of this road is paved from Mt Lindesay Road.

- Sediment dams (0.2 ha)

  The northern sediment dam is located to the north of the overburden and fines stockpile and would contain all surface water runoff from the overburden and fines stockpile and other disturbed areas to the north of the extraction area.

  The southern sediment dam is located to the south of the extraction and would contain all surface water runoff from disturbed areas to the south of the extraction area.

The total area to be designated as the Quarry Site would be approximately 26.8 ha of which the maximum area of disturbance would be 16.4 ha. Approximately 6.5 ha of remnant native vegetation would be disturbed during the development of the Quarry Site.

## 2.2 OVERVIEW AND PURPOSE

The purpose of the AQIA is to identify and quantify the potential air quality risks to human health or the natural environment from the operation of the Proposal and identify potential mitigation measures that may be required, in order to manage those risks to acceptable levels.

An important consideration for any AQIA is to identify and quantify the discrete impacts from the Proposal being assessed and place those potential impacts in context of the prevailing conditions at that location. In terms of air quality studies, that requirement includes a consideration of the general background conditions on a regional scale (performed by examination of available sources of air quality monitoring that may reasonably be compared to the Quarry Site location) and more localised emissions to air from more proximate activities that need to be considered in aggregation to the anticipated Proposal impacts. This consideration is typically called a 'cumulative impact assessment' and is a requirement of the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA, 2017).

The geographical scale of the required cumulative impact assessment depends on the nature of proposed activities at the site under assessment and the likely impact footprint of those emissions. Further discussion relating to likely cumulative impacts is provided in Section 4.4.

The aim of the GHG assessment is to provide an assessment of the potential GHG emissions during the operation of the Proposal and identify how those emissions may be managed in accordance with best practice.

## 2.3 SPECIFIC OPERATIONAL DETAILS

The specific operational details are succinctly presented in **Table 2**. The indicative site layout is presented in **Figure 2**.

**Table 2**
**Indicative Key Proposal Components**

Page 1 of 2

| Project Component | Summary Description |
|---|---|
| Extraction Method | Drill and blast in a three-stage extraction area covering up to approximately 6.9 ha for Stage 1, 10.1 ha for Stage 2 and 11.4 ha for Stage 3. |
| Resource | Quartzose rock in a wide (25 m to 50 m) lens. |
| Disturbance Area | Disturbance of approximately 16.4 ha. |
| Total Recoverable Resource | Approximately 4.8 million tonnes of quartzose rock (conservative estimate). |
| Annual Production | Up to 230 000 tonnes per year of quartzose rock. |
| Project Life | Up to 30 years. |
| Processing | Crushing and screening either on-site at a rate up to 470 tonnes per hour, or at the Sunnyside Crushing and Screening Plant or other destinations. |
| Product Storage | Temporary stockpiling of products in the processing area prior to loading and despatch. Stockpiles would generally contain between 5 000 t and 10 000 t of material. |
| Waste Management | Overburden and fines generated to be stored in overburden and fines stockpile to the north of the extraction area (Stage 1, Stage 2 and Stage 3), or in the overburden and fines emplacement within the extraction area (Stage 2 and Stage 3) |
| Hours of Operation | Extraction and processing operations<br>7:00am – 5:00pm Monday to Saturday<br>Blasting<br>10:00am – 3:00pm Monday to Saturday<br>Transport operations<br>7:00am – 5:00pm Monday to Friday<br>Maintenance operations<br>24hrs Monday to Saturday |

**Table 2 (Cont'd)**
**Indicative Key Proposal Components**

Page 2 of 2

| Project Component | Summary Description |
|---|---|
| Equipment | Operations<br>1 x Hydraulic Drill Rig (Atlas Copco T35 or equivalent) – used typically one day per month for drilling blast holes.<br>2 x Excavator (Komatsu PC300 or equivalent) – permanently on site and used for loading trucks, clearing vegetation, soil removal, excavation of overburden and secondary breakage of oversize blasted rock.<br>1 x Haul Truck (22 $m^3$ / 40 t) – used periodically on site for transfer of raw material, soil and overburden.<br>Processing<br>1 x Jaw Crusher (Kleemann MC120Z PRO or equivalent)<br>1 x Cone Crusher (Kleemann MC011 PRO or equivalent)<br>1 x Mobile Screen (Kleemann MC953 EVO or equivalent) |

Processing is not currently undertaken within the Quarry Site with all quartzose rock extracted from the Quarry transported to the New England Highway and then principally to the Sunnyside Crushing and Screening Plant or other destinations. The Applicant intends to increase the range of products produced from the quartzose material, which would also involve a proportion of the quartzose material being processed on site prior to its despatch to Sunnyside or directly to customers. On-site processing would produce a range of 5 mm to 24 mm crushed rock products and crusher dust/fines for use in a variety of construction and infrastructure applications.

For the purposes of this AQIA, it has been assumed that all extracted material would be processed at the Quarry Site. The results of the assessment can therefore provide confidence that the operations can be performed at their maximum potential rates without resulting in adverse impacts on the surrounding environment.

## 2.4 IDENTIFIED POTENTIAL FOR EMISSIONS TO AIR

The key emissions to air during the operational phase are considered to include:

- Particulate emissions from the extraction, processing and storage of the resource and product;
- Wheel-generated particulate emissions from the haulage of recovered and product materials on unpaved and paved road surfaces;
- Blasting emissions of particulate and oxides of nitrogen; and,
- Wind erosion of exposed surfaces.
- Emissions of blast fume (including oxides of nitrogen) may also be anticipated, although given the distances between the Quarry Site and nearest receptors (minimum 600 m – refer Section 4.2), and the low frequency of blasting (once per month), impacts are likely to be minimal and have not been considered further.

- Emissions of greenhouse gases (GHG) would also be generated through the combustion of fuel in mobile plant and equipment during the operation of the Quarry. Emissions of GHG may also be generated through the off-site transport of product to markets and through employee vehicle use.

# 3. LEGISLATION, REGULATION AND GUIDANCE

As outlined in Section 2.4, the emissions of most concern during the operation of the Proposal will be particulate matter from vehicle movements, the operation of plant and machinery, and wind erosion. The following sections outline the Commonwealth and State air quality criteria relevant to those emissions. Also outlined are relevant legislation and guidance related to GHG emissions.

## 3.1 COMMONWEALTH AIR QUALITY STANDARDS AND REGULATIONS

### 3.1.1 National Environment Protection (Ambient Air Quality) Measure

The *National Environment Protection (Ambient Air Quality) Measure* (Ambient Air Quality NEPM) was promulgated in July 1998 and established ambient air quality standards for six key pollutants across Australia and provides a standard method for monitoring and reporting on air quality. Air quality standards and performance monitoring goals for the six key air pollutants include:

- Carbon monoxide (CO);
- Lead (Pb);
- Nitrogen dioxide ($NO_2$);
- Particles (particulate matter with an aerodynamic equivalent diameter of 10 microns (µm) or less ($PM_{10}$);
- Photochemical oxidants, as ozone ($O_3$); and,
- Sulphur dioxide ($SO_2$).

The Ambient Air Quality NEPM was varied in July 2003 to include advisory reporting standards for fine particulate matter with an aerodynamic equivalent diameter of 2.5 microns (µm) or less ($PM_{2.5}$) and in February 2016 (NEPC, 2016), introducing varied standards for $PM_{10}$ and $PM_{2.5}$.

The air quality standards and goals as set out in the (revised) Ambient Air Quality NEPM for the pollutants considered within this assessment are presented in **Table 3**.

**Table 3**
**National Environment Protection (Ambient Air Quality) Measure Standards and Goals**

| Pollutant | Averaging Period | Criterion | Allowable Exceedance per Year |
|---|---|---|---|
| Particulates (as $PM_{10}$) | 1 day | 50 $\mu g \cdot m^{-3}$ | None |
| | 1 year | 25 $\mu g \cdot m^{-3}$ | None |
| Particulates (as $PM_{2.5}$) | 1 day | 25 $\mu g \cdot m^{-3}$ | None |
| | 1 year | 8 $\mu g \cdot m^{-3}$ | None |

### 3.1.2 National Clean Air Agreement

The National Clean Air Agreement (NCAA) was agreed by Australia's Environment Ministers on 15 December 2015. The NCAA establishes a framework and work plans for the development and implementation of various policies aimed at improving air quality across Australia.

Regarding air quality standards with relevance to this report, the Work Plan 2018-2020 of the NCAA sets an objective to review scientific evidence in relation to annual average $PM_{10}$ standards.

The Work Plan 2015-2017 sought to strengthen particle reporting standards for $PM_{10}$ and $PM_{2.5}$ which came into effect on 4 February 2016. These standards have been adopted as part of this assessment.

## 3.2 NSW AIR QUALITY STANDARDS AND REGULATIONS

### 3.2.1 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 Pollutants in NSW*' (the Approved Methods (NSW EPA, 2017)) 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 for the project.

The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE and WHO) and 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 4** and these criteria have been applied within this AQIA.

**Table 4**
**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 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 TSP) | 1 year | $\mu g \cdot m^{-3}$ | 90 | |
| Particulates (as dust deposition) | 1 year(c) | $g \cdot m^{-2} \cdot month^{-1}$ | 2 | Assessed as insoluble solids as defined by AS 3580.10.1 |
| | 1 year(d) | $g \cdot m^{-2} \cdot month^{-1}$ | 4 | |

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

## 3.2.2 NSW Statutory Frameworks

### 3.2.2.1 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 Proposal be approved, an updated Environment Protection Licence (EPL) would be issued which would contain a range of requirements related to minimisation of emissions from the Quarry Site, operations at which would be defined as a scheduled activity under the POEO Act.

As required to be considered by NSW EPA (refer **Table 1**), the POEO Act emphasises the importance of preventing 'offensive odour'. For reference, "offensive odour" is defined within the POEO Act as:

*an odour:*

*(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:*

*(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*

*(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*

*(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.*

Operations at the Quarry Site have limited capacity to emit odour. Given the distances between the Quarry Site and nearest receptor locations (refer Section 4.2), any emitted odour is unlikely to cause adverse impact at those locations and odour has not been considered further within this AQIA.

### 3.2.2.2 Protection of the Environment (Clean Air) Regulation 2010

The Protection of the Environment (Clean Air) Regulation 2010 (POEO (Clean Air) Regulation) sets standards of concentration for emissions to air from both scheduled and non-scheduled activities. For the activities to be performed at the Quarry Site, the POEO (Clean Air) Regulation covers emissions from motor vehicles and motor vehicle fuels and also provides general standards of concentration for scheduled premises which are presented in **Table 5** for the pollutants of relevance to this assessment.

**Table 5**
**POEO (Clean Air) Regulation – Standards of Concentration**

| Air Impurity | Activity | Standard of Concentration (Group 6) |
|---|---|---|
| Solid particles (total) | Any activity or plant (except as listed below) | 50 $mg \cdot m^{-3}$ |
| | Any crushing, grinding, separating or materials handling activity | 20 $mg \cdot m^{-3}$ |

Further to the requirements in **Table 5**, 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.

As part of the Proposal operation, 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. No burning of materials would be performed as part of the ongoing operation of the Proposal.

## 3.3 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).

### 3.3.1 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.

### 3.3.2 Relevant NSW Legislation

There is no specific GHG legislation administered within NSW. The NGER scheme (and other identified Commonwealth schemes in Section 3.3.1) forms the applicable legislation within NSW.

### 3.3.3 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).

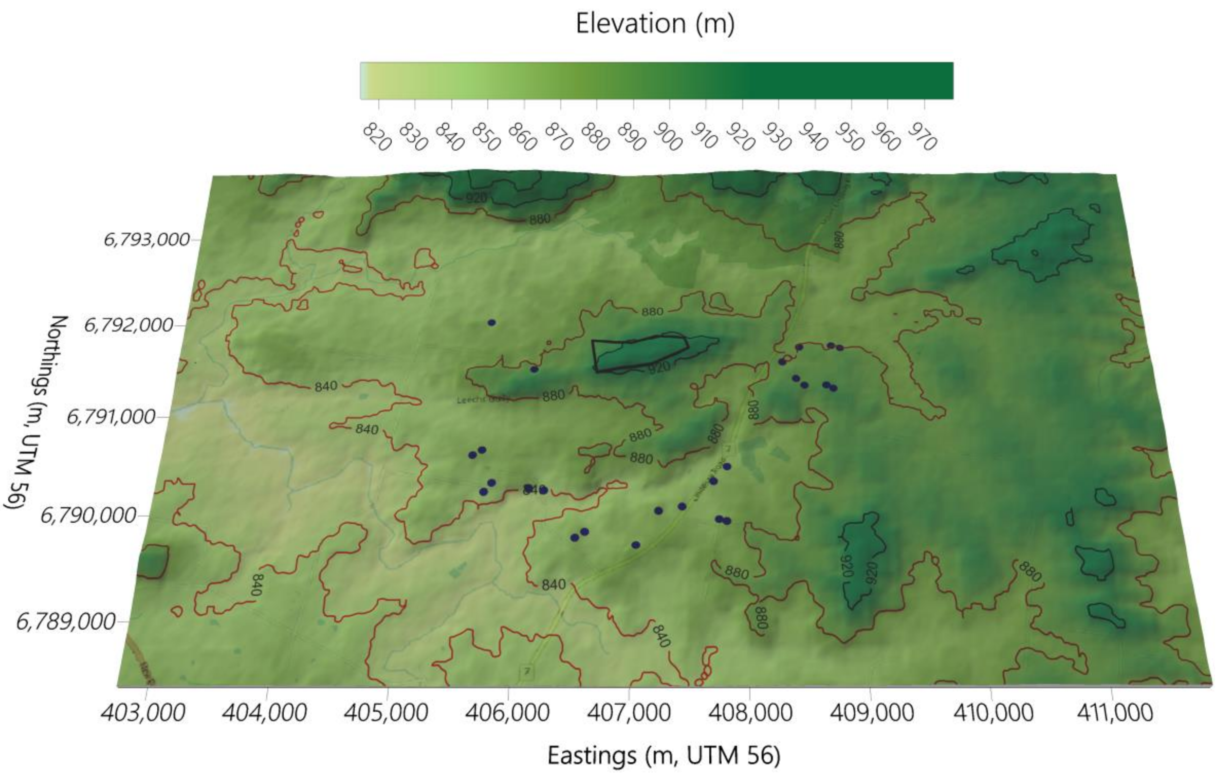
# 4. EXISTING CONDITIONS

This section provides an overview and description of the existing environment surrounding the Quarry Site.

## 4.1 TOPOGRAPHY

The Quarry Site is located in an area of relatively flat plain topography containing some ridge formations, as illustrated in **Figure 3**. The Quarry Site is located at an elevation of approximately 890 m to 945 m Australian Height Datum (AHD), however it is noted that the ridge that the Quarry Site occupies has been partially excavated by the Applicant and has since reduced in elevation.

**Figure 3 Topography Surrounding the Quarry Site**




**Source:** Northstar Air Quality, derived from NASA SRTM 1-arc second data

**Figure 3** additionally shows the relevant site boundary and sensitive receptor locations (see Section 4.2). These are illustrated in the figure to show how topography varies between the Quarry Site and the various sensitive receptor locations used in the AQIA, which is an important consideration in AQIA studies. The topography between the sensitive receptor locations and the Quarry Site can be considered 'uncomplicated' (in AQIA study terms).

## 4.2 SENSITIVE LAND USE AND LAND OWNERSHIP

AQIA studies typically use a desk-top mapping study to identify 'discrete receptor locations', or 'sensitive receptors', 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 important to note that the selection of discrete receptor locations is not intended to represent a fully inclusive selection of all sensitive receptors across the study area. The location selected should be considered to be representative of its location and may be reasonably assumed to be representative of the immediate environs.

It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations that are used to generate graphical plots of the predicted impacts, and as such the 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.

In accordance with the requirements of the Approved Methods (NSW EPA, 2017), a number of receptor locations representing surrounding residences have been identified and these receptors adopted for use within this AQIA are presented in **Table 6** and illustrated in **Figure 4**. **Figure 4** also presents the Lot boundaries associated with the relevant Lot owners.

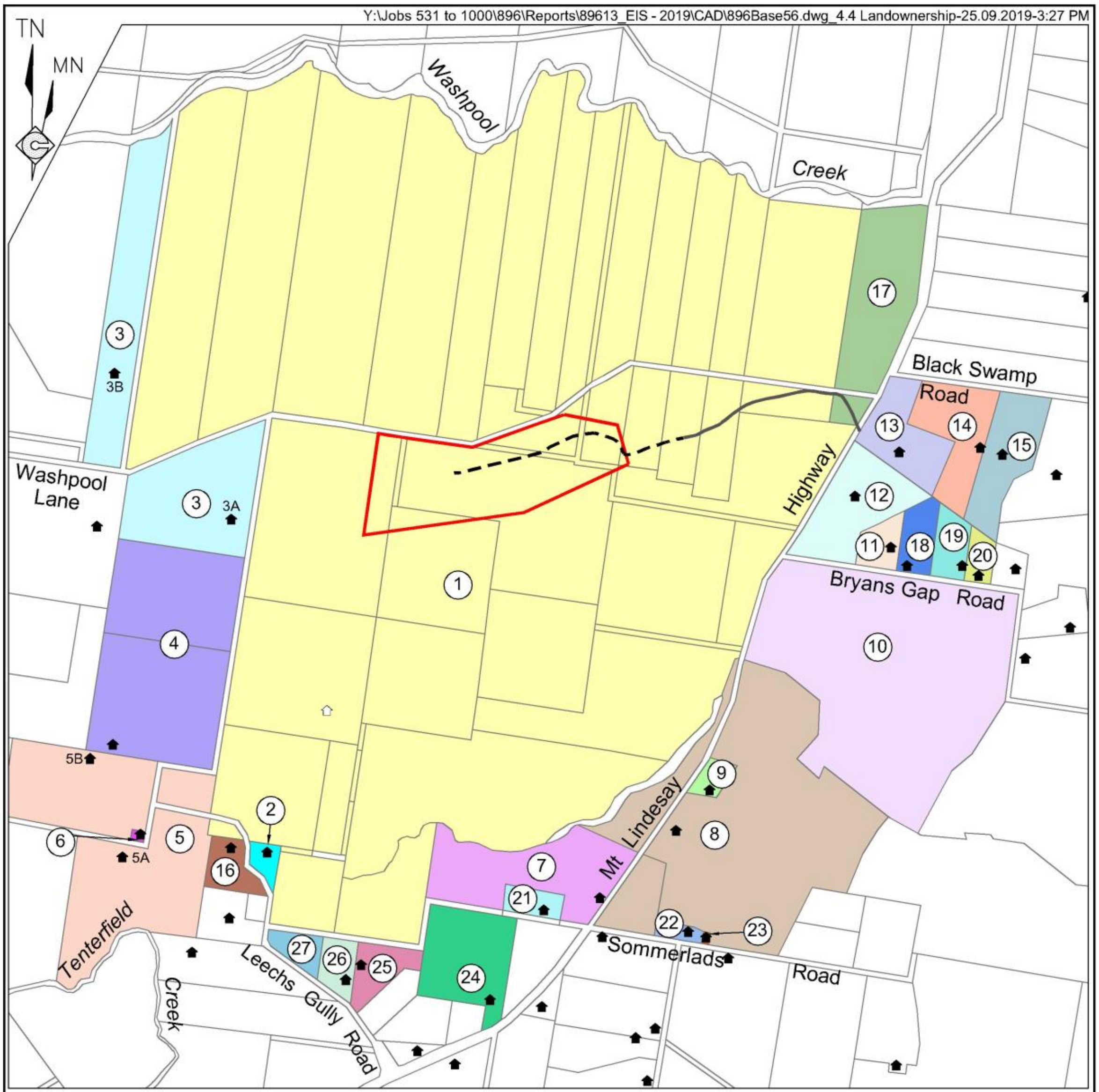
The land surrounding the Site is predominantly zoned as 'primary production' (RU1) in the Tenterfield Local Environmental Plan (2013). To the north-west of the Quarry the land is zoned as 'national parks and nature reserves' (E1) in the suburb of Boonoo Boonoo.

**Table 6**
**Sensitive Receptor Locations**

| Landowner Ref. No. | Landowner | Co-ordinates UTM | | Distance from Site boundary (km) |
|---|---|---|---|---|
| | | m E | m S | |
| 2 | JP Jacquet, MJ Bielski | 406 218 | 6 790 241 | 1.3 |
| 3A | RF & LL Tumbridge | 406 085 | 6 791 470 | 0.6 |
| 3B | RF & LL Tumbridge | 405 655 | 6 792 008 | 1.0 |
| 4 | RL Caldwell | 405 648 | 6 790 638 | 1.3 |
| 5A | GL & JM Smith | 405 684 | 6 790 223 | 1.6 |
| 5B | GL & JM Smith | 405 564 | 6 790 586 | 1.4 |
| 6 | DB Weir, GR Smith, WF Marsden | 405 750 | 6 790 308 | 1.4 |
| 7 | JM Dowe | 407 446 | 6 790 072 | 1.5 |
| 8 | RB & CA Sewell | 407 727 | 6 790 321 | 1.3 |
| 9 | MJ & NJ Lewis, RB & CA Sewell | 407 851 | 6 790 470 | 1.2 |
| 11 | KH Baxman & CC Haynes | 408 506 | 6 791 372 | 1.0 |
| 12 | BL & JA Morrow | 408 388 | 6 791 555 | 0.9 |
| 13 | RM Ibbett, S Ibbett | 408 551 | 6 791 718 | 1.0 |
| 14 | GM O'Reilley, MP Watt | 408 850 | 6 791 735 | 1.3 |
| 15 | AJ & BW Lawrence | 408 932 | 6 791 710 | 1.4 |
| 16 | PJ Della & TM Curry | 406 084 | 6 790 258 | 1.3 |
| 18 | MN & DN Larsen | 408 580 | 6 791 299 | 1.1 |
| 19 | GB & DK Phillips | 408 783 | 6 791 298 | 1.3 |
| 20 | CA Jackson, D Bunic | 408 844 | 6 791 262 | 1.4 |
| 21 | DM & AJ Mullins | 407 239 | 6 790 027 | 1.5 |
| 22 | JP & SL Doyle | 407 772 | 6 789 947 | 1.7 |
| 23 | LD Merchant | 407 838 | 6 789 927 | 1.7 |
| 24 | Harewood Investments Pty Limited | 407 041 | 6 789 697 | 1.8 |
| 25 | D Puglisi | 406 593 | 6 789 829 | 1.6 |
| 26 | BJ & RL Tom | 406 508 | 6 789 770 | 1.7 |

Source: RWC

**Figure 4 Land Ownership – Sensitive Receptor Locations**




REFERENCE
- Quarry Site Boundary
- Cadastral Boundary
- Proposed Quarry Access Road
- Existing Sealed Quarry Access Road
- Residence (Project Related)
- Residence (Non-Project Related)
- Landowner Reference (See Table)

| Ref | Landowner | Ref | Landowner |
|---|---|---|---|
| 1 | RSH & MO Dowe | 15 | AJ & BW Lawrence |
| 2 | JP Jacquet, MJ Bielski | 16 | PJ Della & TM Curry |
| 3A,3B | RF & LL Tumbridge | 17 | The State of New South Wales |
| 4 | RL Caldwell | 18 | MN & DN Larsen |
| 5A,5B | GL & JM Smith | 19 | GB & DK Phillips |
| 6 | DB Weir, GR Smith, WF Marsden | 20 | CA Jackson, D Bunic |
| 7 | JM Dowe | 21 | DM & AJ Mullins |
| 8 | RB & CA Sewell | 22 | JP & SL Doyle |
| 9 | MJ & NJ Lewis, RB & CA Sewell | 23 | LD Merchant |
| 10 | KR & LA Willcocks | 24 | Harewood Investments Pty Limited |
| 11 | KH Baxman & CC Haynes | 25 | D Puglisi |
| 12 | BL & JA Morrow | 26 | BJ & RL Tom |
| 13 | RM Ibbett, S Ibbett | 27 | BJ Tom & Brad Tom Investments Pty Ltd |
| 14 | GM O'Reilly, MP Watt | | |

SCALE 1:25 000 (A4)

250 0 250 500 750 1000 1250 m

Cadastral Source: LPI (2014)
Landowner Source: Department of Lands Online Search - April 2019

**Source:** RWC

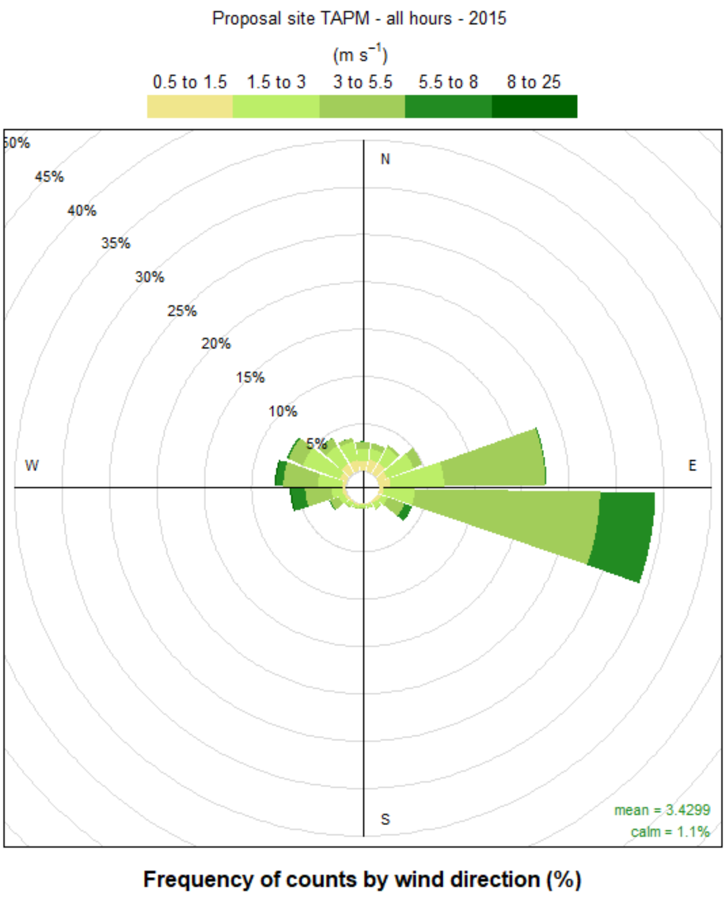
## 4.3 METEOROLOGY

The meteorology experienced within a given area can influence the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions in the area of the Quarry Site have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at surrounding Automatic Weather Stations (AWS). A full description and analysis are presented in **Annexure 1**.

To provide a characterisation of the meteorology which would be expected at the Quarry Site, a meteorological modelling exercise has been performed. A full description of the modelling exercise, methods and input data used, and a validation exercise using available observational data is also presented in **Annexure 1**.

A summary of the wind conditions predicted by the CSIRO TAPM model at the Quarry Site for 2015 is presented in **Figure 5**. These data have been used in the dispersion modelling exercise, as described in Section 5.1.

**Figure 5 TAPM Predicted Wind Conditions – Quarry Site, 2015**



## 4.4 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 given 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 generation, dispersion and fate of those emissions.

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

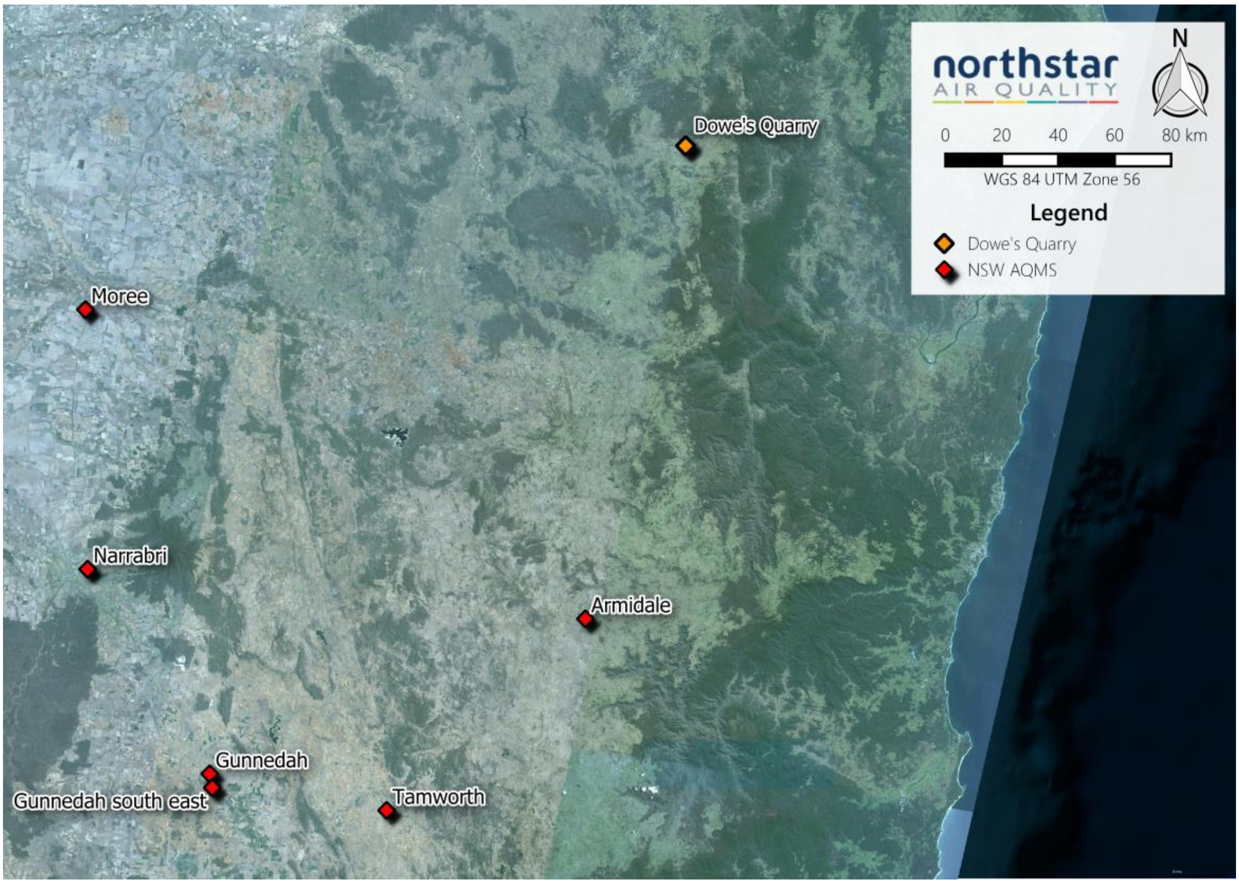
The NSW DPI&E operates air quality monitoring stations (AQMS) in regional centres and as part of the Rural Air Quality Monitoring Network. In regard to this AQIA study, the Quarry is not located in close proximity to any AQMS. The locations of the closest available sources of air quality monitoring data are presented in **Table 7** and in **Figure 6**. **Table 7** additionally provides a summary of the scope of monitoring performed at each AQMS and whether it was operating during 2015 (contemporaneous with the meteorological period used in the dispersion modelling component of this AQIA).

**Table 7**
**Closest DPI&E AQMS to the Quarry Site**

| AQMS Location | Distance to Site (km) | Screening Parameters | | | | |
|---|---|---|---|---|---|---|
| | | Network[(1)] | 2015 Data | Measurements | | |
| | | | | $PM_{10}$ | $PM_{2.5}$ | TSP |
| Armidale | 171.3 | RAQMN | × | × | × | ✓ |
| Moree | 220.5 | RAQMN | × | × | × | ✓ |
| Tamworth | 258.2 | Regional | ✓ | ✓ | × | × |
| Narrabri | 259.7 | Regional | ✓ | ✓ | × | × |
| Gunnedah | 579.2 | Regional | ✓ | ✓ | × | × |
| Gunnedah South East | 282.5 | RAQMN | × | × | × | ✓ |

**Note:** (1) RAQMN – Regional Air Quality Monitoring Network, Regional – Regional centre

**Figure 6 Air quality monitoring stations surrounding the Quarry Site**




**Source:** Northstar Air Quality Pty Ltd

The closest identified AQMS to the Quarry Site with continuous data which is able to be adopted for use in this AQIA is located at Tamworth. It is noted that the AQMS located at Armidale and Moree, both of which are more proximate to the Quarry, do not measure $PM_{10}$, which is of critical importance to this AQIA.

None of the identified AQMS measured $PM_{2.5}$ in 2015, and subsequently proxy data has been calculated from the ratio of measured $PM_{10}$ : $PM_{2.5}$ data from Tamworth in 2016. This ratio was then applied to the Tamworth $PM_{10}$ data from 2015 to determine the proxy $PM_{2.5}$ data for 2015.

**Annexure 2** provides a detailed assessment of the background air quality monitoring data collected at Tamworth AQMS.

It is noted that as part of the NSW DPI&E Regional Air Quality Monitoring Network there are AQMS that measure TSP, however access to that data is not available at the time of reporting. Based upon long-term historic monitoring data, a numerical relationship between TSP and $PM_{10}$ measurements has been established for the Lower Hunter, Sydney Metropolitan and Illawarra regions of NSW. Although not site specific, based upon the available data measured within the Lower Hunter region, a relationship between ambient concentrations of TSP : $PM_{10}$ of 2.3404 : 1 has been used to approximate background annual average TSP concentrations. This relationship is established and is used frequently in AQIA to approximate background annual average TSP concentrations (see **Annexure 2**).

A detailed summary of the background air quality is presented in **Annexure 2**, and a summary of the air quality monitoring data used in this assessment is presented in **Table 8**.

**Table 8**
**Summary of background air quality used in the AQIA**

| Pollutant | Averaging Period | Value | Data Source |
|---|---|---|---|
| $PM_{10}$ | 24-hour | Hourly varying | Tamworth 2015 |
| | Annual | 14.1 $\mu g \cdot m^{-3}$ | Tamworth 2015 |
| $PM_{2.5}$ | 24-hour | Hourly varying | Proxy calculated from Tamworth $PM_{10}$:$PM_{2.5}$ ratio 2016 |
| | Annual | 7.2 $\mu g \cdot m^{-3}$ | Proxy calculated from Tamworth $PM_{10}$:$PM_{2.5}$ ratio 2016 |
| TSP | Annual | 33.0 $\mu g \cdot m^{-3}$ | Estimated on TSP:$PM_{10}$ ratio of 2.3404:1 for Tamworth 2015 |
| Dust Deposition | Monthly | 2 $g \cdot m^{-2} \cdot month^{-1}$ | Approved Methods |

It is noted that the Approved Methods (NSW EPA, 2017) requires that background concentrations as provided above are added to dispersion model predictions to determine a 'cumulative' impact.

The AQIA has been performed to assess the contribution of the Proposal to the air quality of the surrounding area. A full discussion of how the Proposal impacts upon air quality is presented in Section 6.

## 4.5 POTENTIAL FOR CUMULATIVE IMPACTS

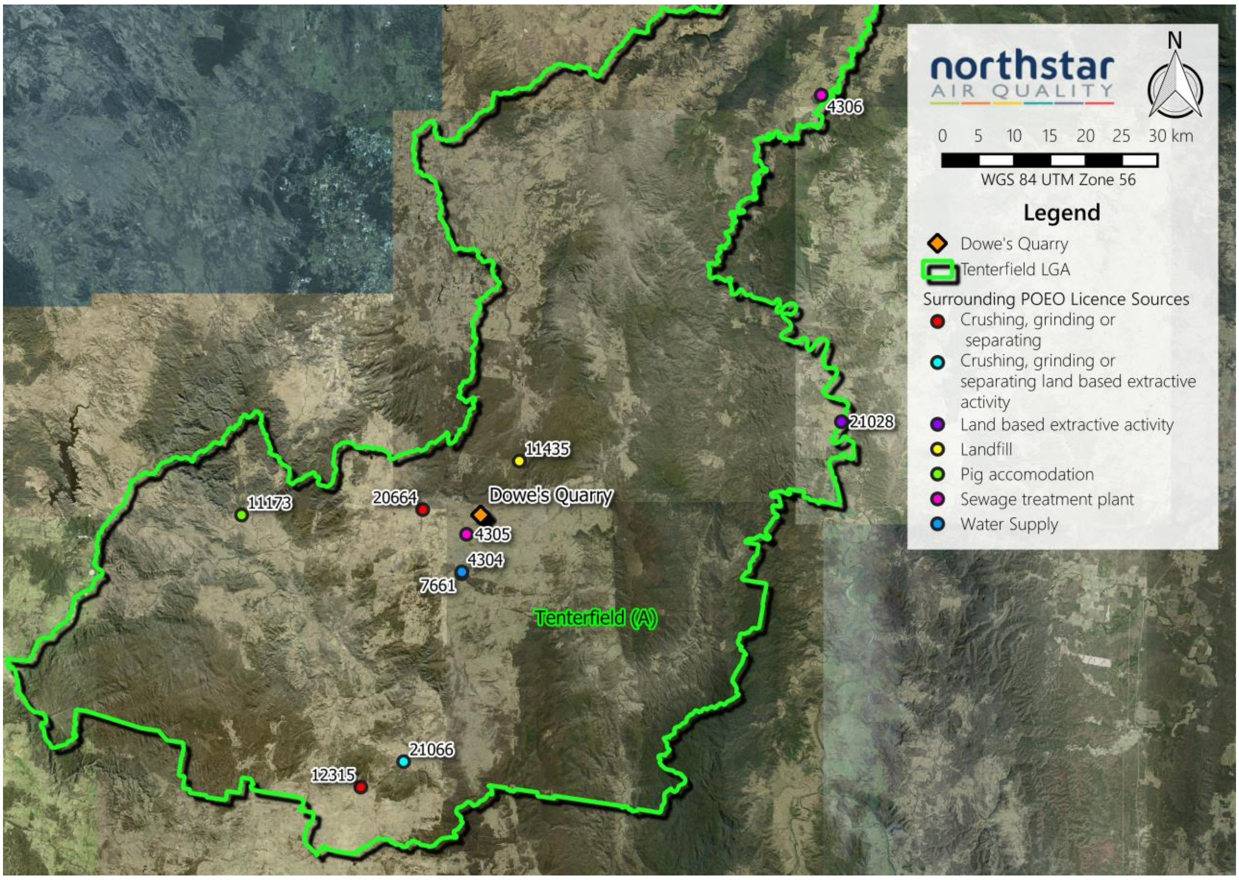
A desktop study has been performed to determine the potential for cumulative impacts from similar particulate generating operations conducted in proximity to the Quarry. Environment Protection Licences (EPL) currently in effect within the area of Tenterfield LGA have been reviewed[1] and ten operations with a current EPL (other than the Quarry) were identified as summarised in **Table 9** and shown in **Figure 7**.

[1] https://apps.epa.nsw.gov.au/prpoeoapp/

**Table 9**
**Summary of Activities in Tenterfield LGA Currently Licenced under the POEO Act**

| EPL Number | Licence Holder | Activity Type (as defined in the EPL) | Distance from Quarry (km) |
|---|---|---|---|
| 4305 | Tenterfield Shire Council | Sewage treatment processing - small plants | 2.9 |
| 4304 | Tenterfield Shire Council | Miscellaneous licensed discharge to waters (supply works) | 8.1 |
| 7661 | Tenterfield Shire Council | Other activities (water supply dam) | 8.3 |
| 11435 | Tenterfield Shire Council | Waste disposal by application to land | 8.9 |
| 11173 | John Parmjit Singh | Pig accommodation | 32.9 |
| 20664 | Darryl McCarthy Constructions Pty Ltd | Crushing, grinding or separating | 7.5 |
| 21066 | Georgiou Group Pty Ltd | Crushing, grinding or separating, land based extractive activity (including blasting) | 35.8 |
| 12315 | Wayne McCarthy Earthmoving Pty Ltd | Crushing, grinding or separating | 41.2 |
| 21028 | Delaney Civil Pty Ltd | Land based extractive activity | 51.5 |
| 4306 | Tenterfield Shire Council | Sewage treatment processing - small plants | 75.1 |

**Figure 7 Locations of Activities in Tenterfield LGA Currently Licenced under the POEO Act**




**Source:** Northstar Air Quality Pty Ltd

From review of **Table 9** and as shown in **Figure 7**, the closest activity to the Quarry Site which may result in cumulative impacts is the crushing and screening plant operated by the Applicant (Sunnyside, EPL number 20664) which is located approximately 7.5 km to the west. Given the large separation distance, cumulative impacts associated with this activity have been considered to be negligible.

As discussed in the previous AQIA performed for the Quarry (ENVIRON, 2014) emissions from industrial sources in the Tenterfield LGA would not likely cause significant direct cumulative impacts with emissions from the Quarry, but would contribute to regional air pollution levels. These have been considered through the adoption of background air quality data as discussed in Section 4.4.

## 4.6 GREENHOUSE GAS

Emissions of GHG are tracked by the Commonwealth of Australia via 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 each 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 2017 report for Australia (DEE, 2019a) and NSW (DEE, 2019b) 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 2017 across all economic sectors were 530.8 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 8.3 Mt $CO_2$-e, or 1.6 % of total emissions (DEE, 2019b).

State and Territory shares of national emissions (including emissions and removals from land use, land use change and forestry (LULCF) activities) comprised:

- 24.7 % from New South Wales;
- 30.3 % from Queensland;
- 20.7 % from Victoria;
- 16.6 % from Western Australia;
- 4.1 % from South Australia;
- 3.1 % from the Northern Territory
- 0.2 % from Tasmania;

- 0.2 % from the Australian Capital Territory (a partial estimate only, as some sectors are included within NSW); and,
- 0.01 % from External Territories.

GHG emissions in NSW in 2017 were 131.5 Mt $CO_2$-e with emissions from the mining sector (no information on quarrying available) being 17.2 Mt $CO_2$-e, or 13.1 % (DEE, 2019b).

# 5. APPROACH TO ASSESSMENT

## 5.1 AIR QUALITY ASSESSMENT

The following provides a brief description of the methodology used to assess the potential air quality impacts resulting from the operation of the Project.

As described in Section 2.4, the key emissions to air anticipated during the operation of the Project are:

- Particulate emissions from the clearance of vegetation;
- Particulate emissions from the extraction, processing and storage of the resource;
- Wheel-generated particulate emissions from the haulage of recovered and product materials on unpaved and paved road surfaces;
- Blasting emissions of particulate; and,
- Wind erosion of exposed surfaces.

The calculation of emissions of particulate matter from these processes is discussed in detail in **Annexure 3**.

A quantitative assessment has been performed to assess the impact of these emissions on surrounding sensitive receptor locations.

### 5.1.1 Modelling Approach

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 2-dimensional (2-D) mode. Given the uncomplicated terrain between the sources and receptors (refer Section 4.1), a detailed assessment using a 3-dimensional (3-D) meteorological dataset is not warranted.

The generation of appropriate meteorological data is discussed in detail in **Annexure 1**. Meteorological modelling using The Air Pollution Model (TAPM, v 4.0.5) has been performed to predict the meteorological parameters required for input to CALPUFF.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water 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.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources (refer **Annexure 3**), simulating dispersion and transformation processes along the way. The primary output files from CALPUFF contain either hourly concentrations or deposition fluxes evaluated at selected receptor locations.

CALPOST is used to process the CALPUFF output files, producing tabulations that summarise the results of the simulation (refer Section 6) (Scire, Strimaitis, & Yamartino, 2000).

In March 2011, NSW OEH (now part of DPI&E) published generic guidance and optimal settings associated with the CALPUFF modelling system for inclusion in the Approved Methods (Barclay & Scire, 2011). These guidelines and settings have been considered in the performance of this assessment.

### 5.1.2 Modelling Scenarios

An assessment of the impacts of the operation of activities at the Quarry Site has been performed which characterises the likely day-to-day operation of the Proposal, approximating average and likely maximum operational characteristics which are appropriate to assess against longer term (annual average) and shorter term (24-hour) criteria for particulate matter.

Two operational scenarios have been selected for dispersion modelling. Full emissions inventories for each modelled operation at each stage of operation are provided in **Annexure 3**.

No assessment of potential impacts associated with construction has been performed. Construction activities will be limited to the construction of the processing area pad and bund through cut and fill with material sourced from existing overburden stockpiles. Given that the long and short term impacts associated with particulate matter have been assessed on the assumption that the processing plant would be operating at a throughput of 230 000 tpa, or 5 000 t·day-1, respectively, it is considered that these scenarios appropriately cover any movement and placement of material used to construct the processing area.

The Quarry Site layout during both Stage 1 and Stage 2 of operations is presented in **Figure 8** and **Figure 9**, respectively. A further operational stage, Stage 3, is discussed within the main EIS. Operations during that stage have not been subject to quantitative assessment within this AQIA as it was determined that given the proposed layout, emissions are likely to be similar to those during Stage 1 and Stage 2. The results of the dispersion modelling exercise presented in Section 6 indicate very little difference in incremental impacts between Stage 1 and Stage 2 operations, and it would be anticipated that little change between those stages and Stage 3 operations would be observed.

The modelling scenarios provide an indication of the air quality impacts of the activities being performed as part of the Proposal. Added to these impacts are those associated with regional background air quality (refer Section 4.4) which together represent the air quality which may be expected within the area surrounding the Quarry Site.

**Figure 8 Stage 1 Operations**

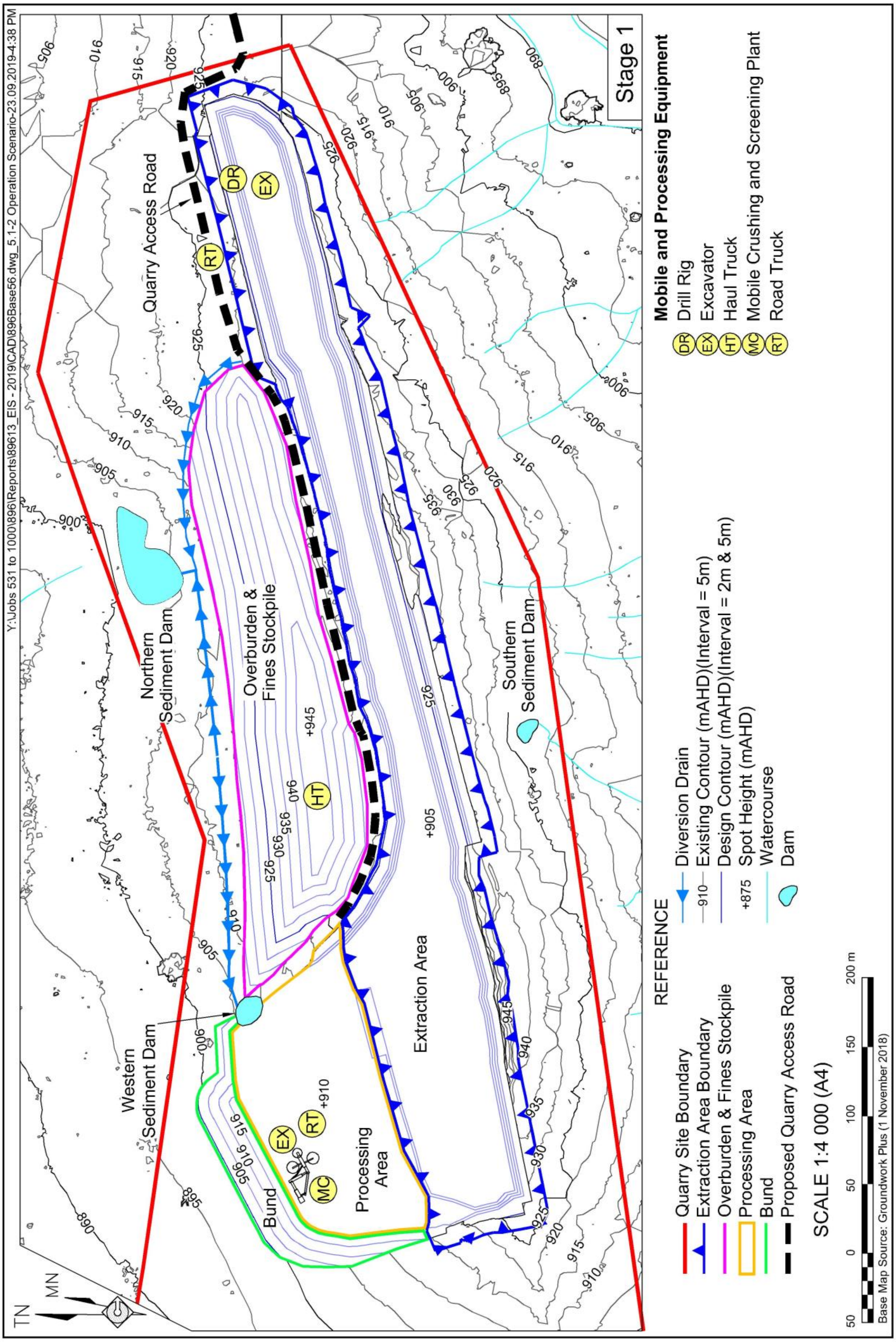
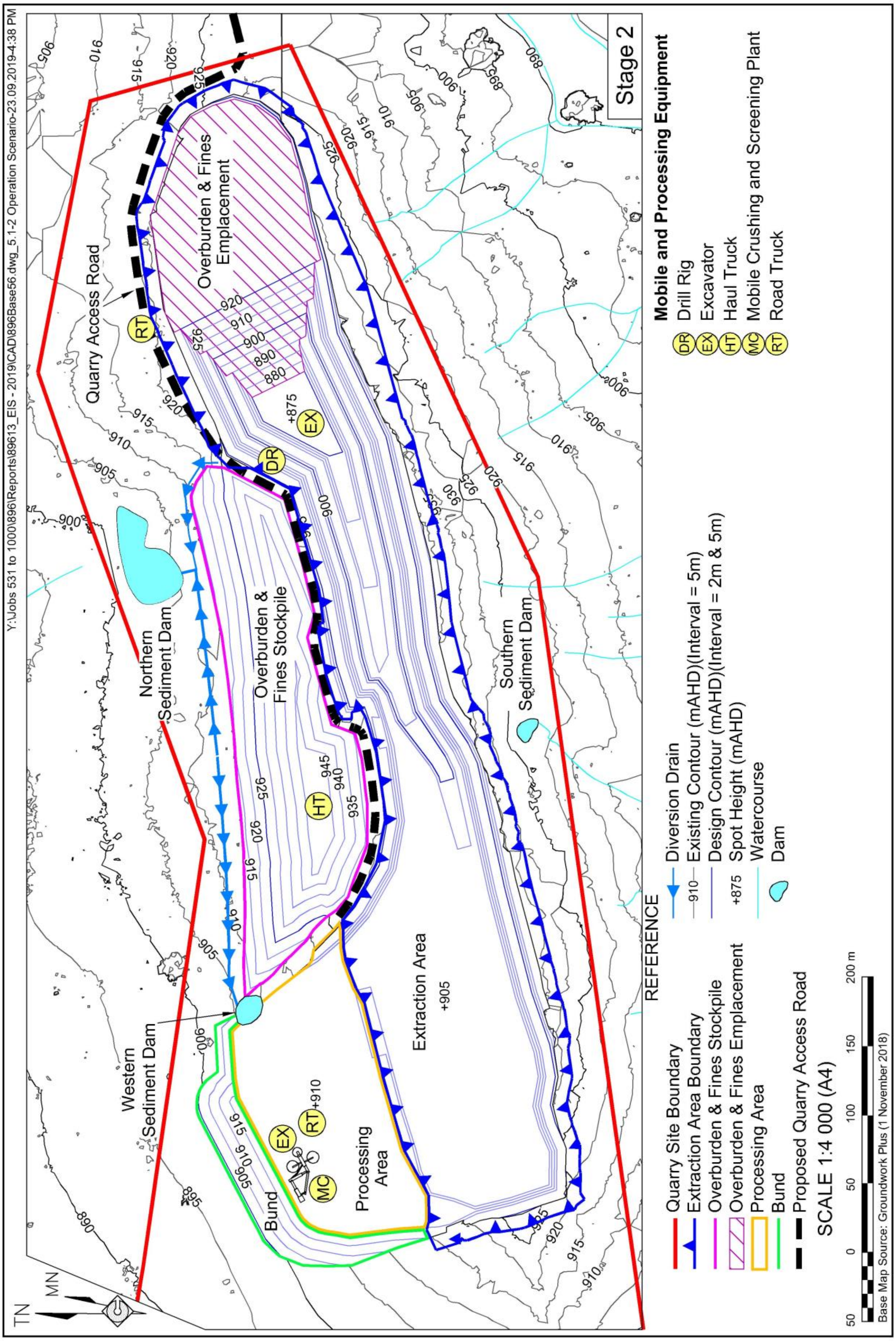


**Figure 9** **Stage 2 Operations**



### 5.1.3 Model Set Up

The following section outlines the dispersion model set-up and includes details of modelled source characteristics, source locations etcetera to provide full transparency in the modelling performed.

A detailed discussion of the generation and validation of meteorological data used in dispersion modelling is provided in **Annexure 1**.

In relation to the CALPUFF modelling performed as part of this AQIA, two of the three sources types have been used. Volume sources have been used to characterise emissions from drilling, blasting, materials handling, haulage routes, and materials processing. Area sources have been used to characterise emissions from sources of wind erosion such as the extraction area, overburden and fines emplacement area, overburden and fines stockpile and processing area (including product stockpiles). Point sources (i.e. stack emissions) have not been used as there are no such sources proposed at the Quarry Site during any stage of development.

Presented in **Table 10** are the source characteristics adopted for each source type across each modelling scenario. The *sigma y* and *sigma z* values provide an initial estimation of the horizontal and vertical spread of the modelled plume, respectively.

**Table 10**
**Source Characteristics – CALPUFF Modelling – All Scenarios**

| Source | Parameter | | |
|---|---|---|---|
| | Height (m AGL) | Sigma Y (m) | Sigma Z (m) |
| Volume:<br>Excavator, drilling, truck loading/unloading, crushing, screening | 2 | 1.16 | 2 |
| Volume:<br>Transport of materials around Quarry Site in haul trucks | 2 | 1.16 | 2 |
| Volume:<br>Transport of materials from Quarry Site in road trucks | 3.65 | 28.6 | 3.4 |
| Volume:<br>Blasting | 2 | 1.16 | 2 |
| Area:<br>Wind erosion | 0 | - | 0 |

## 5.2 GREENHOUSE GAS ASSESSMENT

The Greenhouse Gas Assessment has been performed with reference to:

- 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); and,
- ISO 14064-3:2006 (Greenhouse Gases – Part 3: Specification with guidance for the validation and verification of GHG assertions) guidelines (internationally accepted best practice).

The purpose of the GHG assessment is to examine the potential impacts of the operation of the Project 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 Proposal. This report does not provide a definitive quantification of GHG emissions arising from the Proposal 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) (DoE, 2018) defines two types of GHG emissions (see **Table 11**), namely 'direct' and 'indirect'. This assessment considers both direct emissions and indirect emissions resulting from the Proposal operation.

**Table 11**
**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 (DoE, 2018)

### 5.2.2 Emission Scopes

The NGA Factors (DoE, 2018) identifies two 'scopes' of emissions for GHG accounting and reporting purposes as shown in **Table 12**.

**Table 12**
**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 (DoE, 2018)

Electricity is to be generated at the Quarry Site through the use of a generator operated on diesel fuel and therefore Scope 2 emissions have not been considered further within this assessment.

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 to and from the Quarry Site are considered in this assessment as Scope 1 emissions as they are under the operational control of the Applicant.

### 5.2.3 Source Identification and Boundary Definition

The geographical boundary set for the GHG assessment covers the Quarry Site but also includes the transport of materials from the Quarry Site to and from Sunnyside.

All Scope 1 and Scope 3 emissions within the defined boundary have been identified and reported as far as possible.

### 5.2.4 Emission Source Identification

The GHG emission sources associated with the existing operations and the operation of the Project have been identified through review of the activities as described in Section 2.4.

The activities/operations being performed as part of the Proposal which have the potential to result in emissions of GHG are presented in **Table 13**. Emissions of GHG resulting from land clearance have not been estimated, given that the Quarry Site will be rehabilitated at the end of the extraction period.

**Table 13**
**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)<br>Emissions associated with 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)<br>Emissions associated with 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 fuels |

### 5.2.5 Emissions Estimation

Emissions of GHG from each of the sources identified in **Table 13** have been calculated using activity data for each source per annum (e.g. kL diesel fuel) and the relevant emission factor for each source.

The assumptions used in the calculation of activity data for each emissions source are presented below. Emission factors are presented in the following section.

#### 5.2.5.1 Activity Data

Information relating to the quantities of diesel and unleaded fuel used as part of the Proposal have been provided by the Applicant. In the calculation of certain values, assumptions have been made based on the levels of activity at the Quarry Site. These data and assumptions are outlined in **Table 14**.

**Table 14**
**Calculated Activity Data**

| Project Component | Assumptions | Activity | Units |
|---|---|---|---|
| Consumption of diesel fuel in mobile plant and equipment at the Quarry Site | Information provided by the Applicant indicates the diesel fuel use to be 20 000 L per month which includes diesel used in a camping style generator for power generation | 240 | kL·annum$^{-1}$ |
| Consumption of diesel fuel / unleaded fuel for employee transport purposes | Eight full-time equivalent positions to be generated by the Quarry (including 2 to 3 truck drivers).<br>Assume employees reside in Tenterfield (20 km as a two-way journey)<br>312 days per year<br>10.6 L per 100km fuel efficiency (ABS, 2017) | 5.3 | kL·annum$^{-1}$ |
| Consumption of diesel fuel / unleaded fuel for material transport purposes | Laden trucks to travel 15.15 km to Sunnyside and 13.6 km on return (28.75 km total)<br>Up to 4 600 return trips each year (230 000 / 50 t capacity)<br>56.3 L per 100 km fuel efficiency (ABS, 2017) | 74.5 | kL·annum$^{-1}$ |

### 5.2.6 Emission Factors

Emissions factors used for the assessment of GHG emissions associated with existing operations and the operation of the Project have been sourced from the NGA Factors (DoE, 2018) (refer to **Table 15**).

**Table 15**
**Greenhouse Gas Emission Factors**

| Emission Scope | Emission Source | Emission Factor | Energy Content Factor |
|---|---|---|---|
| Scope 1 | Diesel fuel for mobile plant and equipment | 70.2 kg $CO_2$-e GJ$^{-1}$ | 38.6 GJ·kL$^{-1}$ |
| | Diesel fuel for material transport | 70.5 kg $CO_2$-e GJ$^{-1}$ | 38.6 GJ·kL$^{-1}$ |
| Scope 3 | Diesel fuel for mobile plant and equipment | 3.6 kg $CO_2$-e GJ$^{-1}$ | 38.6 GJ·kL$^{-1}$ |
| | Unleaded fuel for employee transport | 3.6 kg $CO_2$-e GJ$^{-1}$ | 34.2 GJ·kL$^{-1}$ |
| | Diesel fuel for material transport | 3.6 kg $CO_2$-e GJ$^{-1}$ | 38.6 GJ·kL$^{-1}$ |

# 6. AIR QUALITY IMPACT ASSESSMENT

The following section provides the results of the dispersion modelling exercise described in Section 5.1, with all input data provided in **Annexure 3**. Results are provided as tables which provide the predicted concentrations at a particular point, and as isopleth (contour) plots which provide a visualisation of predicted impacts in the area around the Quarry Site.

It is important to note that dispersion modelling provides an assessment of risk, and includes an inherent uncertainty, no matter how accurate the modelling inputs may be. Barclay & Scire (2011) state:

*"The sources of uncertainty in model predictions can be significantly reduced by collecting the proper input data, preparing the input files correctly, checking and re-checking for errors, correcting for 'odd' model behaviour, insuring that errors in the measured data are minimised and applying the correct model to suit each application. As well as user 'error' inputs there is some 'inherent uncertainty' in model predictions which occurs in all dispersion models' due to the uncertainty of atmospheric behaviour.*

*Consider the following general statements on model performance which have been derived from the EPA 2003 and are to be considered in their totality, i.e., altogether.*

- Models are more reliable for estimating longer time averaged concentrations than for estimating short-term concentrations at specific locations
- Estimates of concentrations that occur at a specific time and site are poorly correlated with actual observed concentrations (paired in space and time) and are less reliable (mostly due to reducible uncertainty such as error in plume location due to a wind direction error).
- Models are reasonably reliable in estimating the highest concentrations occurring sometime, somewhere in an area. Model certainty is expected to be in the range of a factor of 2."

## 6.1 SUMMARY OF RESULTS

The dispersion modelling assessment indicates that all adopted air quality criteria are achieved at all sensitive receptor locations surrounding the Quarry Site during both operational stages modelled. One exceedance of the 24-hour average $PM_{10}$ criterion is predicted, although it is shown that the existing background conditions on that particular day are already in exceedance of the criterion, and the Proposal contributes a negligible impact.

It should be noted that the model predictions are based on worst case assumptions, most notably that the full 230 000 tpa of extracted material would be processed at the Quarry Site. In reality, a substantial amount of the material would be transported to Sunnyside and processed at that location.

In the case of the prediction of maximum 24-hour particulate impacts, it has been assumed that 5 000 $t \cdot day^{-1}$ of extracted material would be processed at the Quarry Site each and every day of the year.

The results can be viewed as worst-case and have been presented in this way to provide confidence that the Proposal can be operated in both modelled stages with minimal risk of exceedance of the relevant air quality criteria at all surrounding receptor locations.

## 6.2 ANNUAL AVERAGE TSP, $PM_{10}$, $PM_{2.5}$ AND DUST DEPOSITION

In the case of annual average predictions, all criteria are predicted to be met at surrounding residential locations during both Stage 1 and Stage 2 operations. Contributions from these activities are shown in all cases to result in minimal / negligible impact at all receptor locations.

Presented in **Table 16** are dispersion model predictions of annual average TSP concentrations. The maximum predicted increment resulting from Stage 1 and Stage 2 operations is 2.5 $\mu g \cdot m^{-3}$, at receptor 3A. This represents less than (<) 3 % of the annual average TSP criterion.

The addition of background air quality results in total cumulative impacts of TSP during both Stage 1 and Stage 2 operations being <40 % of the criterion at all surrounding receptor locations.

**Table 16**
**Predicted Annual Average TSP Concentrations**

| Receptor | Annual Average TSP Concentration ($\mu g \cdot m^{-3}$) | | | | | |
|---|---|---|---|---|---|---|
| | Stage 1 | | | Stage 2 | | |
| | Incremental Impact | Background | Cumulative Impact | Incremental Impact | Background | Cumulative Impact |
| 2 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 3A | 2.4 | 33.0 | 35.5 | 2.5 | 33.0 | 35.5 |
| 3B | 1.7 | 33.0 | 34.7 | 1.7 | 33.0 | 34.7 |
| 4 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 5A | 0.2 | 33.0 | 33.2 | 0.2 | 33.0 | 33.3 |
| 5B | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 6 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 7 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 8 | 0.5 | 33.0 | 33.5 | 0.5 | 33.0 | 33.5 |
| 9 | 0.6 | 33.0 | 33.6 | 0.6 | 33.0 | 33.6 |
| 11 | 1.1 | 33.0 | 34.1 | 1.0 | 33.0 | 34.0 |
| 12 | 1.5 | 33.0 | 34.5 | 1.4 | 33.0 | 34.4 |
| 13 | 1.2 | 33.0 | 34.2 | 1.1 | 33.0 | 34.2 |
| 14 | 0.8 | 33.0 | 33.8 | 0.7 | 33.0 | 33.7 |
| 15 | 0.7 | 33.0 | 33.7 | 0.7 | 33.0 | 33.7 |
| 16 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 18 | 0.9 | 33.0 | 33.9 | 0.9 | 33.0 | 33.9 |
| 19 | 0.7 | 33.0 | 33.7 | 0.7 | 33.0 | 33.7 |
| 20 | 0.7 | 33.0 | 33.7 | 0.7 | 33.0 | 33.7 |
| 21 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 22 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 23 | 0.3 | 33.0 | 33.3 | 0.3 | 33.0 | 33.3 |
| 24 | 0.2 | 33.0 | 33.2 | 0.2 | 33.0 | 33.2 |
| 25 | 0.2 | 33.0 | 33.2 | 0.2 | 33.0 | 33.2 |
| 26 | 0.2 | 33.0 | 33.2 | 0.2 | 33.0 | 33.2 |
| Criterion | - | - | 90 | - | - | 90 |

Presented in **Table 17** are dispersion model predictions of annual average $PM_{10}$ concentrations. The maximum predicted increment resulting from Stage 1 and Stage 2 operations is 1.6 $\mu g \cdot m^{-3}$ which represents <7 % of the annual average $PM_{10}$ criterion.

The addition of background air quality results in total cumulative impacts of $PM_{10}$ during Stage 1 and Stage 2 operations phase being <63 % of the criterion.

**Table 17**
**Predicted Annual Average $PM_{10}$ Concentrations**

| Receptor | Annual Average $PM_{10}$ Concentration ($\mu g \cdot m^{-3}$) | | | | | |
|---|---|---|---|---|---|---|
| | Stage 1 | | | Stage 2 | | |
| | Incremental Impact | Background | Cumulative Impact | Incremental Impact | Background | Cumulative Impact |
| 2 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.4 |
| 3A | 1.5 | 14.1 | 15.6 | 1.6 | 14.1 | 15.7 |
| 3B | 0.9 | 14.1 | 15.0 | 0.9 | 14.1 | 15.0 |
| 4 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 5A | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 5B | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 6 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 7 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 8 | 0.3 | 14.1 | 14.4 | 0.3 | 14.1 | 14.4 |
| 9 | 0.3 | 14.1 | 14.4 | 0.4 | 14.1 | 14.5 |
| 11 | 0.5 | 14.1 | 14.6 | 0.5 | 14.1 | 14.7 |
| 12 | 0.7 | 14.1 | 14.8 | 0.7 | 14.1 | 14.8 |
| 13 | 0.6 | 14.1 | 14.7 | 0.5 | 14.1 | 14.7 |
| 14 | 0.4 | 14.1 | 14.5 | 0.4 | 14.1 | 14.5 |
| 15 | 0.4 | 14.1 | 14.5 | 0.4 | 14.1 | 14.5 |
| 16 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 18 | 0.5 | 14.1 | 14.6 | 0.5 | 14.1 | 14.6 |
| 19 | 0.4 | 14.1 | 14.5 | 0.4 | 14.1 | 14.5 |
| 20 | 0.4 | 14.1 | 14.5 | 0.4 | 14.1 | 14.5 |
| 21 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 22 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 23 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 24 | 0.1 | 14.1 | 14.2 | 0.2 | 14.1 | 14.3 |
| 25 | 0.2 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| 26 | 0.1 | 14.1 | 14.3 | 0.2 | 14.1 | 14.3 |
| Criterion | - | - | 25 | - | - | 25 |

Presented in **Table 18** are dispersion model predictions of annual average $PM_{2.5}$ concentrations. The maximum predicted increment resulting from Stage 1 and Stage 2 operations is 0.2 µg·m$^{-3}$ which represents 2.5 % of the annual average $PM_{2.5}$ criterion.

The addition of background air quality results in total cumulative impacts of $PM_{2.5}$ during Stage 1 and Stage 2 operations being <93 % of the criterion.

**Table 18**
**Predicted Annual Average $PM_{2.5}$ Concentrations**

| Receptor | Annual Average $PM_{2.5}$ Concentration (µg·m$^{-3}$) | | | | | |
|---|---|---|---|---|---|---|
| | Stage 1 | | | Stage 2 | | |
| | Incremental Impact | Background | Cumulative Impact | Incremental Impact | Background | Cumulative Impact |
| 2 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 3A | 0.2 | 7.2 | 7.4 | 0.2 | 7.2 | 7.4 |
| 3B | 0.1 | 7.2 | 7.3 | 0.1 | 7.2 | 7.3 |
| 4 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 5A | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 5B | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 6 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 7 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 8 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 9 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 11 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 12 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 13 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 14 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 15 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 16 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 18 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 19 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 20 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 21 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 22 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 23 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 24 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 25 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| 26 | <0.1 | 7.2 | 7.3 | <0.1 | 7.2 | 7.3 |
| Criterion | - | - | 8 | - | - | 8 |

Presented in **Table 19** are dispersion model predictions of annual average dust deposition rates. The maximum predicted increment resulting from Stage 1 and Stage 2 operations is 0.2 $g \cdot m^{-2} \cdot month^{-1}$ which represents 10 % of the incremental annual average dust deposition criterion.

The addition of background air quality results in total cumulative impacts of dust deposition during Stage 1 and Stage 2 operations being 55 % of the cumulative criterion.

**Table 19**
**Predicted Annual Average Dust Deposition Rates**

| | **Annual Average Dust Deposition Rate ($g \cdot m^{-2} \cdot month^{-1}$)** | | | | | |
|---|---|---|---|---|---|---|
| | **Stage 1** | | | **Stage 2** | | |
| **Receptor** | **Incremental Impact** | **Background** | **Cumulative Impact** | **Incremental Impact** | **Background** | **Cumulative Impact** |
| 2 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 3A | 0.1 | 2.0 | 2.1 | 0.1 | 2.0 | 2.1 |
| 3B | 0.2 | 2.0 | 2.2 | 0.1 | 2.0 | 2.1 |
| 4 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 5A | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 5B | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 6 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 7 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 8 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 9 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 11 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 12 | 0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 13 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 14 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 15 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 16 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 18 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 19 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 20 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 21 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 22 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 23 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 24 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 25 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| 26 | <0.1 | 2.0 | 2.1 | <0.1 | 2.0 | 2.1 |
| Criterion | 2 | - | 4 | - | - | 8 |

Given the predicted low incremental annual average impacts of particulate matter, no concentration or deposition rate isopleth plots are provided.

## 6.3 MAXIMUM 24-HOUR AVERAGE $PM_{10}$ AND $PM_{2.5}$

The maximum predicted incremental 24-hour average $PM_{10}$ concentrations resulting from activities during Stage 1 and Stage 2 operations are presented in **Table 20**. These predictions indicate that the activities during operations could potentially result in incremental impacts up to 16.7 $\mu g \cdot m^{-3}$ at the modelled receptor locations, which represents <34 % of the relevant criterion.

Note that these predicted concentrations would only be reached during campaign crushing at peak rates.

**Table 20**
**Predicted Maximum 24-hour Average Incremental $PM_{10}$ Concentrations**

| Receptor | Maximum Incremental 24-hour $PM_{10}$ Concentration ($\mu g \cdot m^{-3}$) | |
|---|---|---|
| | **Stage 1** | **Stage 2** |
| 2 | 5.5 | 5.4 |
| 3A | 15.1 | 16.7 |
| 3B | 6.1 | 6.9 |
| 4 | 4.5 | 4.9 |
| 5A | 5.1 | 5.8 |
| 5B | 4.2 | 4.6 |
| 6 | 5.4 | 6.2 |
| 7 | 3.1 | 3.6 |
| 8 | 4.6 | 5.3 |
| 9 | 5.1 | 5.6 |
| 11 | 7.6 | 7.2 |
| 12 | 9.1 | 9.8 |
| 13 | 6.4 | 6.5 |
| 14 | 4.5 | 4.6 |
| 15 | 4.6 | 4.8 |
| 16 | 5.6 | 5.7 |
| 18 | 7.8 | 7.9 |
| 19 | 6.3 | 6.0 |
| 20 | 6.2 | 6.2 |
| 21 | 3.1 | 3.1 |
| 22 | 3.2 | 3.6 |
| 23 | 3.2 | 3.7 |
| 24 | 3.1 | 2.8 |
| 25 | 5.0 | 5.7 |
| 26 | 5.3 | 6.2 |
| Criterion | 50 | 50 |

The predicted maximum 24-hour average $PM_{10}$ concentrations resulting from the operation of Stage 1 and Stage 2 of the Project, with background included are presented in **Table 21** and **Table 22** respectively.

Results are presented for the receptor at which the highest incremental impacts have been predicted (receptor 3A). The left side of the tables show the predicted concentration on days with the highest background, and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations.

In both Stage 1 and Stage 2 operations, one exceedance of the 24-hour average impact assessment criterion for $PM_{10}$ is predicted although no additional exceedances are shown to eventuate because of the operation of the Project. The predicted exceedance (highlighted in **bold**) is driven by the background air quality (i.e. existing sources) and is not contributed to by the proposed operations at the Quarry Site.

**Table 21**
**Summary of Contemporaneous Impact and Background - 24-hour Average $PM_{10}$ – Stage 1**

| Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) | | | Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) | | |
|---|---|---|---|---|---|---|---|
| | Incr. | BG | Cumul. | | Incr. | BG | Cumul. |
| 06/05/2015 | <0.1 | **52.7** | **52.8** | 23/06/2015 | 15.1 | 18.0 | 33.1 |
| 26/11/2015 | <0.1 | 48.0 | 48.1 | 26/02/2015 | 14.0 | 10.9 | 24.9 |
| 21/08/2015 | 11.4 | 29.2 | 40.6 | 16/04/2015 | 13.1 | 24.3 | 37.3 |
| 17/04/2015 | 12.3 | 26.1 | 38.4 | 17/04/2015 | 12.3 | 26.1 | 38.4 |
| 08/03/2015 | 9.1 | 28.4 | 37.4 | 30/06/2015 | 11.4 | 20.5 | 31.9 |
| 16/04/2015 | 13.1 | 24.3 | 37.3 | 21/08/2015 | 11.4 | 29.2 | 40.6 |
| 06/10/2015 | 6.9 | 29.0 | 35.9 | 26/05/2015 | 11.3 | 22.1 | 33.4 |
| 27/11/2015 | 2.9 | 30.9 | 33.8 | 22/07/2015 | 11.3 | 13.9 | 25.3 |
| 26/05/2015 | 11.3 | 22.1 | 33.4 | 13/10/2015 | 11.1 | 15.6 | 26.7 |
| 15/04/2015 | 10.3 | 22.8 | 33.1 | 15/04/2015 | 10.3 | 22.8 | 33.1 |
| Criterion | 50 | | | Criterion | 50 | | |
| These data represent the highest cumulative impact 24-hour $PM_{10}$ predictions as a result of the operation of the project. | | | | These data represent the highest incremental impact 24-hour $PM_{10}$ predictions as a result of the operation of the project. | | | |

Note: Incr. = incremental impact, BG = background concentration, Cumul. = cumulative impact

**Table 22**
**Summary of Contemporaneous Impact and Background - 24-hour Average $PM_{10}$ – Stage 2**

| Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) | | | Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) | | |
|---|---|---|---|---|---|---|---|
| | Incr. | BG | Cumul. | | Incr. | BG | Cumul. |
| 06/05/2015 | <0.1 | **52.7** | **52.8** | 23/06/2015 | 16.7 | 18.0 | 34.7 |
| 26/11/2015 | <0.1 | 48.0 | 48.1 | 26/02/2015 | 16.6 | 10.9 | 27.5 |
| 21/08/2015 | 12.7 | 29.2 | 41.9 | 16/04/2015 | 15.3 | 24.3 | 39.5 |
| 17/04/2015 | 13.4 | 26.1 | 39.6 | 17/04/2015 | 13.6 | 13.9 | 27.5 |
| 16/04/2015 | 15.3 | 24.3 | 39.5 | 22/07/2015 | 13.4 | 26.1 | 39.6 |
| 08/03/2015 | 10.7 | 28.4 | 39.0 | 21/08/2015 | 12.7 | 20.5 | 33.2 |
| 06/10/2015 | 8.7 | 29.0 | 37.7 | 30/06/2015 | 12.7 | 29.2 | 41.9 |
| 23/06/2015 | 16.7 | 18.0 | 34.7 | 26/05/2015 | 12.4 | 22.1 | 34.5 |
| 26/05/2015 | 3.7 | 30.9 | 34.6 | 13/10/2015 | 11.6 | 15.6 | 27.2 |
| 27/11/2015 | 12.4 | 22.1 | 34.5 | 15/04/2015 | 11.3 | 22.8 | 34.1 |
| Criterion | 50 | | | Criterion | 50 | | |
| These data represent the highest cumulative impact 24-hour $PM_{10}$ predictions as a result of the operation of the project. | | | | These data represent the highest incremental impact 24-hour $PM_{10}$ predictions as a result of the operation of the project. | | | |

Note: Incr. = incremental impact, BG = background concentration, Cumul. = cumulative impact

**Figure 10** and **Figure 11** present the maximum predicted 24-hour average incremental $PM_{10}$ concentrations associated with Stage 1 and Stage 2 operations, respectively.

**Figure 10 Predicted Incremental Maximum 24-hour Average $PM_{10}$ Concentrations – Stage 1**

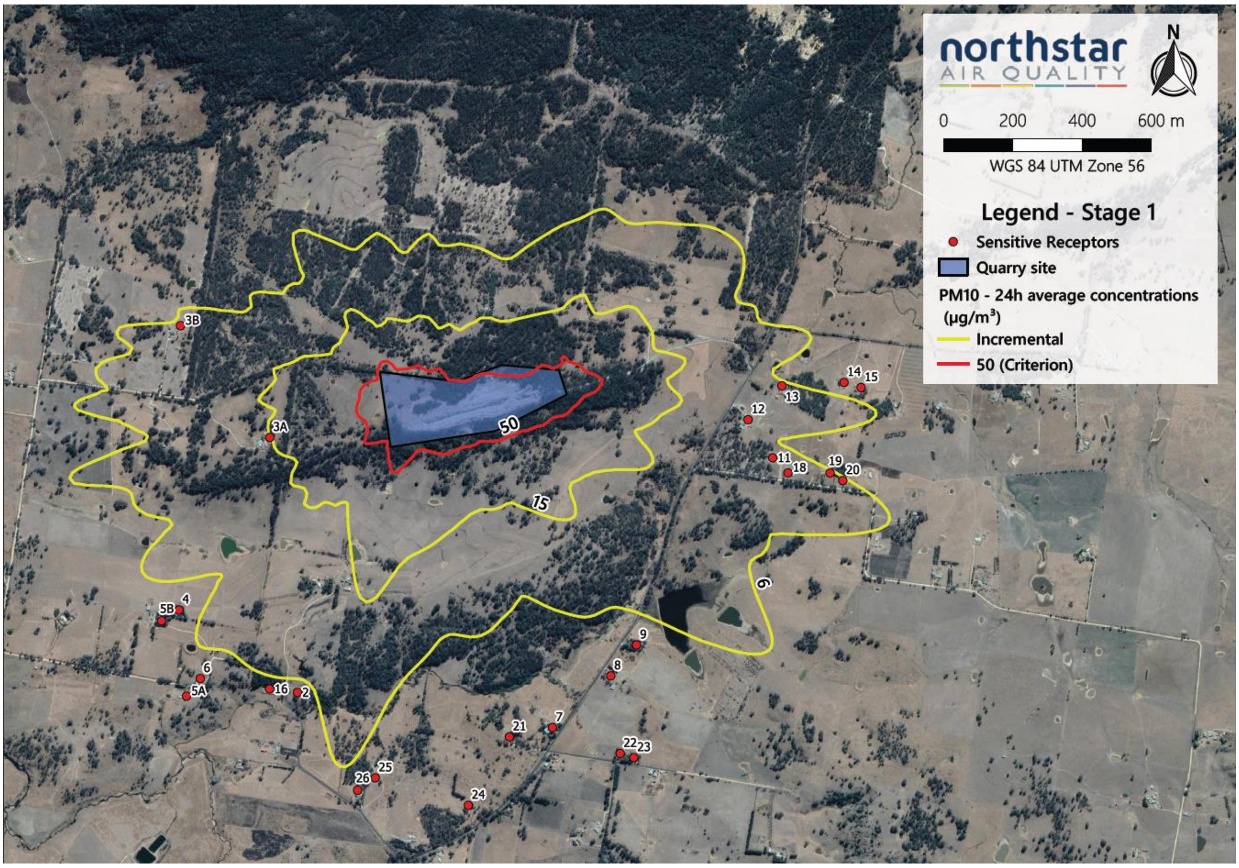
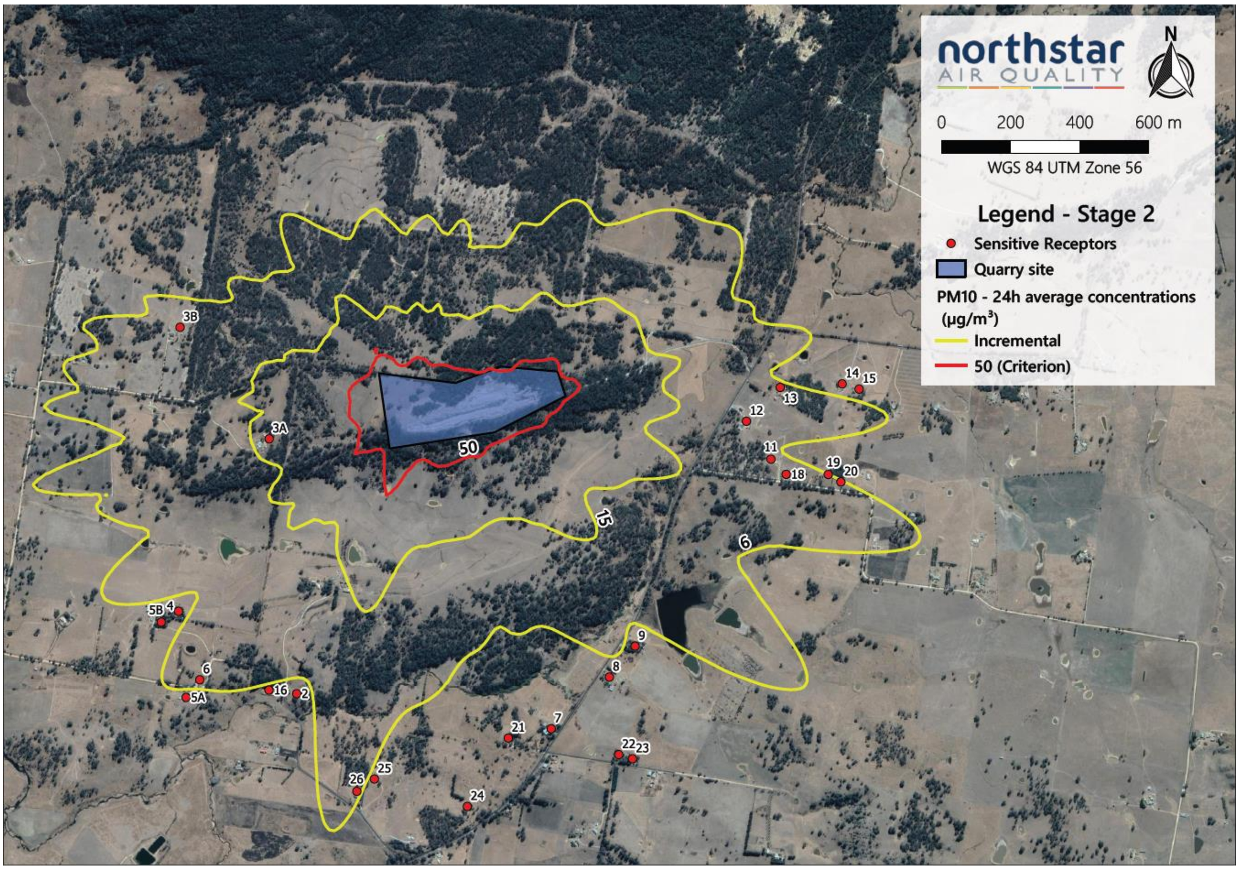



**Figure 11 Predicted Incremental Maximum 24-hour Average $PM_{10}$ Concentrations – Stage 2**



The maximum predicted incremental 24-hour average $PM_{2.5}$ concentrations resulting from activities during Stage 1 and Stage 2 operations are presented in **Table 23**. These predictions indicate that the activities during operations could potentially result in incremental impacts up to 2.3 $\mu g \cdot m^{-3}$ at the modelled receptor locations, which represents <10 % of the relevant criterion.

**Table 23**
**Predicted Maximum 24-hour Average Incremental $PM_{2.5}$ Concentrations**

| Receptor | Maximum Incremental 24-hour $PM_{2.5}$ Concentration ($\mu g \cdot m^{-3}$) | |
|---|---|---|
| | **Stage 1** | **Stage 2** |
| 2 | 0.7 | 0.7 |
| 3A | 2.0 | 2.3 |
| 3B | 0.9 | 1.0 |
| 4 | 0.6 | 0.7 |
| 5A | 0.6 | 0.7 |
| 5B | 0.5 | 0.6 |
| 6 | 0.7 | 0.8 |
| 7 | 0.4 | 0.5 |
| 8 | 0.6 | 0.7 |
| 9 | 0.6 | 0.7 |
| 11 | 0.8 | 0.8 |
| 12 | 1.1 | 1.2 |
| 13 | 0.7 | 0.8 |
| 14 | 0.5 | 0.6 |
| 15 | 0.5 | 0.6 |
| 16 | 0.7 | 0.7 |
| 18 | 0.9 | 0.9 |
| 19 | 0.7 | 0.7 |
| 20 | 0.7 | 0.7 |
| 21 | 0.4 | 0.4 |
| 22 | 0.4 | 0.5 |
| 23 | 0.4 | 0.5 |
| 24 | 0.3 | 0.4 |
| 25 | 0.7 | 0.8 |
| 26 | 0.7 | 0.9 |
| Criterion | 25 | 25 |

The predicted maximum 24-hour average $PM_{2.5}$ concentrations resulting from the operation of Stage 1 and Stage 2 of the Project, with background included are presented in **Table 24** and **Table 25** respectively.

Results are presented for the receptor at which the highest incremental impacts have been predicted (receptor 3A). Again, the left side of the tables show the predicted concentration on days with the highest background, and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations.

In both Stage 1 and Stage 2 operations, no exceedances of the 24-hour average impact assessment criterion for $PM_{2.5}$ are predicted. The maximum predicted cumulative impact at receptor 3A are likely to be <80 % of the relevant criterion.

**Table 24**
**Summary of Contemporaneous Impact and Background - 24-hour Average $PM_{2.5}$ – Stage 1**

| Date | 24-hour average $PM_{2.5}$ concentration (µg·m$^{-3}$) | | | Date | 24-hour average $PM_{2.5}$ concentration (µg·m$^{-3}$) | | |
|---|---|---|---|---|---|---|---|
| | Incr. | BG | Cumul. | | Incr. | BG | Cumul. |
| 06/05/2015 | <0.1 | 19.4 | 19.5 | 23/06/2015 | 2.0 | 8.4 | 10.5 |
| 26/11/2015 | <0.1 | 17.9 | 18.0 | 26/02/2015 | 1.9 | 6.2 | 8.1 |
| 21/08/2015 | 1.5 | 12.0 | 13.5 | 16/04/2015 | 1.8 | 10.4 | 12.3 |
| 27/11/2015 | 0.4 | 12.5 | 12.9 | 22/07/2015 | 1.6 | 7.2 | 8.8 |
| 08/03/2015 | 1.2 | 11.7 | 12.9 | 17/04/2015 | 1.6 | 11.0 | 12.6 |
| 06/10/2015 | 0.9 | 11.9 | 12.8 | 21/08/2015 | 1.5 | 12.0 | 13.5 |
| 07/05/2015 | <0.1 | 12.8 | 12.9 | 26/05/2015 | 1.5 | 9.7 | 11.3 |
| 17/04/2015 | 1.6 | 11.0 | 12.6 | 30/06/2015 | 1.5 | 9.2 | 10.7 |
| 21/11/2015 | <0.1 | 12.5 | 12.6 | 15/04/2015 | 1.5 | 10.0 | 11.4 |
| 16/04/2015 | 1.8 | 10.4 | 12.3 | 13/10/2015 | 1.4 | 7.7 | 9.1 |
| Criterion | 25 | | | Criterion | 25 | | |
| These data represent the highest cumulative impact 24-hour $PM_{2.5}$ predictions as a result of the operation of the project. | | | | These data represent the highest incremental impact 24-hour $PM_{2.5}$ predictions as a result of the operation of the project. | | | |

Note: Incr. = incremental impact, BG = background concentration, Cumul. = cumulative impact

**Table 25**
**Summary of Contemporaneous Impact and Background – 24-hour Average $PM_{2.5}$ – Stage 2**

| Date | 24-hour average $PM_{2.5}$ concentration (µg·m$^{-3}$) | | | Date | 24-hour average $PM_{2.5}$ concentration (µg·m$^{-3}$) | | |
|---|---|---|---|---|---|---|---|
| | Incr. | BG | Cumul. | | Incr. | BG | Cumul. |
| 06/05/2015 | <0.1 | 19.4 | 19.5 | 23/06/2015 | 2.3 | 6.2 | 8.5 |
| 26/11/2015 | <0.1 | 17.9 | 18.0 | 26/02/2015 | 2.3 | 8.4 | 10.7 |
| 21/08/2015 | 1.8 | 12.0 | 13.7 | 16/04/2015 | 2.2 | 10.4 | 12.6 |
| 08/03/2015 | 1.4 | 11.7 | 13.2 | 22/07/2015 | 2.0 | 7.2 | 9.1 |
| 06/10/2015 | 1.2 | 11.9 | 13.1 | 17/04/2015 | 1.8 | 11.0 | 12.8 |
| 27/11/2015 | 0.5 | 12.5 | 13.0 | 21/08/2015 | 1.8 | 12.0 | 13.7 |
| 17/04/2015 | 1.8 | 11.0 | 12.8 | 30/06/2015 | 1.7 | 9.2 | 11.0 |
| 07/05/2015 | <0.1 | 12.8 | 12.9 | 26/05/2015 | 1.7 | 9.7 | 11.5 |
| 16/04/2015 | 2.2 | 10.4 | 12.6 | 15/04/2015 | 1.6 | 10.0 | 11.6 |
| 21/11/2015 | <0.1 | 12.5 | 12.6 | 12/09/2015 | 1.5 | 8.0 | 9.5 |
| Criterion | 25 | | | Criterion | 25 | | |
| These data represent the highest cumulative impact 24-hour $PM_{2.5}$ predictions as a result of the operation of the project. | | | | These data represent the highest incremental impact 24-hour $PM_{2.5}$ predictions as a result of the operation of the project. | | | |

Note: Incr. = incremental impact, BG = background concentration, Cumul. = cumulative impact

**Figure 12** and **Figure 13** present the maximum predicted 24-hour average incremental $PM_{2.5}$ concentrations associated with Stage 1 and Stage 2 operations, respectively.

**Figure 12 Predicted Incremental Maximum 24-hour Average $PM_{2.5}$ Concentrations – Stage 1**

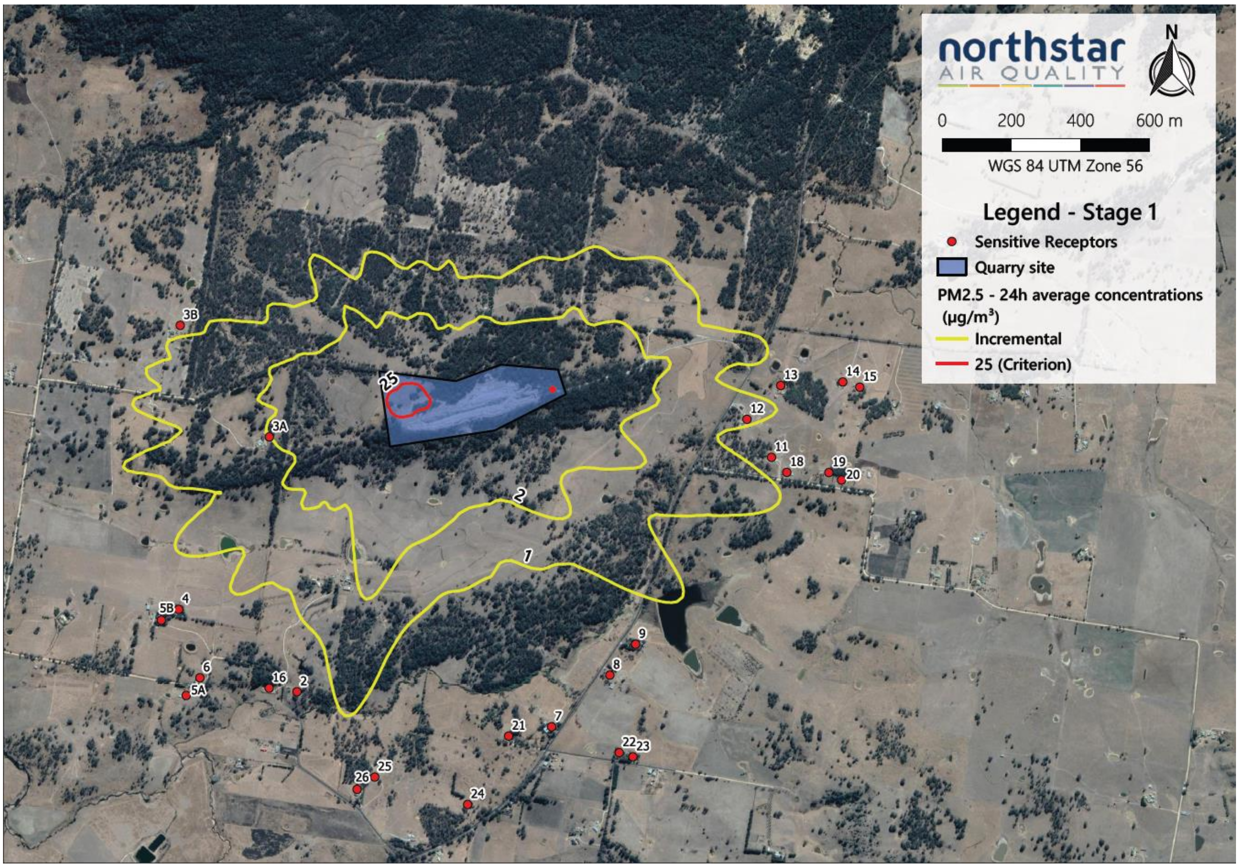
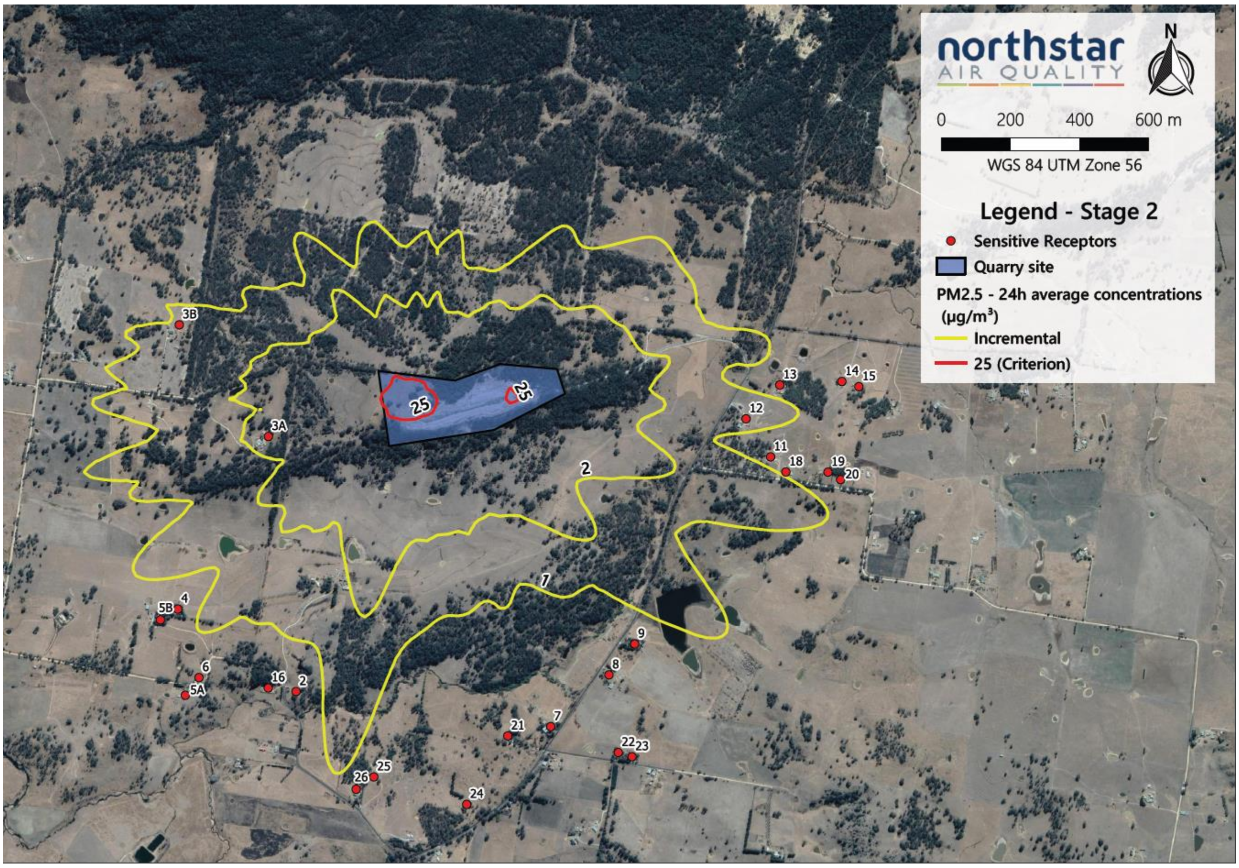



**Figure 13 Predicted Incremental Maximum 24-hour Average $PM_{2.5}$ Concentrations – Stage 2**



# 7. GREENHOUSE GAS ASSESSMENT

## 7.1 CALCULATION OF GHG EMISSIONS

Based on the activity data and emissions factors outlined in Section 5.2, **Table 26** presents the calculated Scope 1 and 3 GHG emissions associated with the Proposal. Note that no Scope 2 emissions have been calculated given that electricity is anticipated to be generated through a small diesel generator.

**Table 26**
**Greenhouse Gas Emissions**

| Emission Scope | Emission Source | Emission Factor | Energy Content Factor | Activity Rate | Emissions ($t\ CO_2\text{-}e \cdot yr^{-1}$) |
|---|---|---|---|---|---|
| Scope 1 | Diesel fuel for mobile plant and equipment | 70.2 kg $CO_2$-e $GJ^{-1}$ | 38.6 $GJ \cdot kL^{-1}$ | 240 $kL \cdot annum^{-1}$ | 650.3 |
| | Diesel fuel for material transport | 70.5 kg $CO_2$-e $GJ^{-1}$ | 38.6 $GJ \cdot kL^{-1}$ | 74.5 $kL \cdot annum^{-1}$ | 202.7 |
| | | | | **Total Scope 1** | **853.1** |
| Scope 2 | Electricity consumption | 0.82 kg $CO_2$-e $kWh^{-1}$ | - | 0 $kWh \cdot annum^{-1}$ | 0.0 |
| | | | | **Total Scope 2** | **0.0** |
| Scope 3 | Diesel fuel for mobile plant and equipment | 3.6 kg $CO_2$-e $GJ^{-1}$ | 38.6 $GJ \cdot kL^{-1}$ | 240 $kL \cdot annum^{-1}$ | 33.4 |
| | Unleaded fuel for employee transport | 3.6 kg $CO_2$-e $GJ^{-1}$ | 34.2 $GJ \cdot kL^{-1}$ | 5.3 $kL \cdot annum^{-1}$ | 0.7 |
| | Diesel fuel for material transport | 3.6 kg $CO_2$-e $GJ^{-1}$ | 38.6 $GJ \cdot kL^{-1}$ | 74.5 $kL \cdot annum^{-1}$ | 10.4 |
| | | | | **Total Scope 3** | **44.4** |

## 7.2 COMPARISON WITH NATIONAL TOTALS

A comparison of the calculated GHG emissions associated with the Proposal, and NSW and Australian emissions in 2017 is presented in **Table 27**.

**Table 27**
**Greenhouse Gas Emissions in Context**

| Emission Scope | Proposal total ($t\ CO_2\text{-}e \cdot yr^{-1}$) | Emissions ($Mt\ CO_2\text{-}e \cdot yr^{-1}$) | |
|---|---|---|---|
| | | Australia (2017) (excluding LULUCF) 530.8 Mt | NSW (2017) 131.5Mt |
| Scope 1 | 853.1 | 0.00016% | 0.00065% |

Note: LULUCF = Land Use Land Use Change and Forestry

This data indicate that the operation of the Proposal would contribute up to 0.00065% of NSW total GHG emissions and up to 0.00016% of Australian total GHG emissions in 2017.

## 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; and
- Where possible, B5 fuel should be used in plant and equipment.

# 8. AIR QUALITY MONITORING AND MANAGEMENT

The results of the air quality impact assessment presented in Section 6 indicate that the Proposal can be operated without resulting in exceedances of the relevant air quality criteria. It is noted that a number of conservative assumptions, particularly related to materials processing, result in predicted impacts being significantly greater than those likely during actual operation of the Proposal.

Ongoing air quality monitoring is not considered to be required as part of the Proposal. The Air Quality Management Plan (AQMP) (DMC, 2015) for the current operations at the Quarry includes a section relating to air quality monitoring and concludes that the need for implementation of air quality monitoring should arise only following a substantiated air quality complaint.

The AQMP would be updated to reflect the current air quality criteria applicable to the Proposal as outlined in Section 3.

# 9. CONCLUSIONS

## 9.1 AIR QUALITY

A detailed air quality impact assessment (AQIA) has been performed to assess the potential impacts of Stage 1 and Stage 2 operations to be performed as part of the ongoing and expanded Dowe's Quarry operation.

The AQIA has been performed in accordance with the NSW Environment Protection Authority (EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* document (NSW EPA, 2017), and with due reference to the Secretary's Environmental Assessment Requirements (SEARs), and NSW EPA requirements (refer Table 1).

The air quality criteria applicable to the AQIA have been adopted from Commonwealth and State legislation and guidance, and approval conditions and are presented in Section 3.

A modelling exercise has been performed to characterise the meteorological environment of the area surrounding the Quarry Site. A full description of the input data, modelling and validation of the outputs is presented in **Annexure 1**.

A detailed dispersion modelling exercise has been performed to characterise the predicted impacts from the Proposal at a number of surrounding privately-owned receptors. A background air quality dataset discussed in detail in **Annexure 2** has been adopted and added to those modelled impacts to determine a total, cumulative impact.

Details of the operations of the Proposal during both Stage 1 and Stage 2 have been used to generate emissions inventories characterising the operation of the Quarry. These are outlined in full in **Annexure 3**. Dust control measures for emissions sources have been identified and adopted where appropriate.

For the purposes of providing 'worst-case' assessment results, with which to compare against the long and short-term air quality criteria, processing operations at the Quarry Site have been assumed to operate at a throughput of 230 000 t per annum, or a maximum of 5,000 t per day. These activity rates are significantly greater than those which are likely to be experienced as part of ongoing Quarry operations.

These conservative assumptions provide confidence that the impacts of the Proposal are not likely to be greater than those presented within this assessment.

The dispersion modelling exercise indicates that the Proposal can operate across all three stages of development with no exceedances of adopted air quality criteria.

## 9.2 GREENHOUSE GAS

A greenhouse gas (GHG) assessment has been performed to examine the potential impacts of the operation of the Proposal relating to emissions of GHG. A quantitative assessment of emissions has been performed with emissions compared with total national and NSW GHG emissions for context.

Emissions associated with the Proposal are anticipated to represent 0.00065 % of Australian and 0.00016 % of NSW emissions totals for the year 2017.

Emissions are proposed to be reduced further through the implementation of a maintenance program for all plant and equipment, and the investigation into using B5 fuel where possible.

# 10. REFERENCES

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

BMT WBM Pty Ltd. (2011). *Teralba Quarry Extensions, Surface Water Assessment. Report prepared for Metromix Pty Ltd.*

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

DEE. (2017a). *Australian Government Department of the Environment and Energy, National Inventory by Economic Sector 2015. Australia's National Greenhouse Accounts, May 2017.*

DEE. (2019a). *Australian Government Department of the Environment and Energy. State and Territory Greenhouse Gas Inventories 2017. Australia's National Greenhouse Accounts, June 2019.*

DEE. (2019b). *Australian Government Department of the Environment and Energy, National Inventory by Economic Sector 2017. Australia's National Greenhouse Accounts, June 2019.*

DMC. (2015). *Air Quality Management Plan for Dowe's Quarry.*

DoE. (2018). *National Greenhouse Accounts Factors, Australian National Greenhouse Accounts, July 2017.* Australian Government Department of the Environment and Energy.

ENVIRON. (2014). *Dowe's Quarry, Air Quality Impact Assessment, prepared by ENVIRON Australia Pty Ltd.*

GHD. (2009). *Report for Proposed Gidgegannup Granite Quarry, Dust Assessment. Report prepared for Boral Resources (WA).*

GHD. (2016). *Wattle Vale Quarry, EIS Appendix G, Air Quality Impact Assessment. Report prepared for Glen Innes Severn Council.*

Heggies. (2008). *Albion Park Quarry, Proposed Expanded Operations, Air Quality Impact Assessment. Report prepared for Cleary Bros (Bombo) Pty Ltd.*

MRI. (2006). *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios used for AP-42 Fugitive Dust Emission Factors.*

NEPC. (2016, February 25). National Environment Protection (Ambient Air Quality) Measure as amended, National Environment Protection Council.

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

NSW EPA. (2011). *Coal Mine Particulate Matter Control Best Practice, Site-specific determination guideline.*

NSW EPA. (2017). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.* NSW Environment Protection Authority.

Pacific Environment Limited. (2017). *Eagleton Quarry Production Increase - Air Quality and Greenhouse Gas Assessment. Report prepared for Eagleton Rock Syndicate Pty Ltd.*

Scire, J. S., Strimaitis, D. G., & Yamartino, R. J. (2000). *A User's Guide for the CALPUFF Dispersion Model, January 2000.*

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

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

US EPA. (2006a). *AP-42 Emission Factors Section 13.2.2 Unpaved Roads.*

US EPA. (2006b). *AP-42 Emission Factors Section 13.2.4 Aggregate Handling and Storage Piles.*

US EPA. (2006c). *AP-42 Emission Factors Section 13.2.5 Industrial Wind Erosion.*

US EPA. (2011). *AP-42 Emission Factors Section 13.2.1 Paved Roads.*

WRI. (2004). A Corporate Accounting and Reporting Standard – Revised Edition. World Resources Institute / World Business Council for Sustainable World Business Council for Sustainable Development.

This page has intentionally been left blank

# Annexures

(Total No. of pages including blank pages = 42)

This page has intentionally been left blank

# Annexure 1

# Meteorology

(Total No. of pages including blank pages = 12)

This page has intentionally been left blank

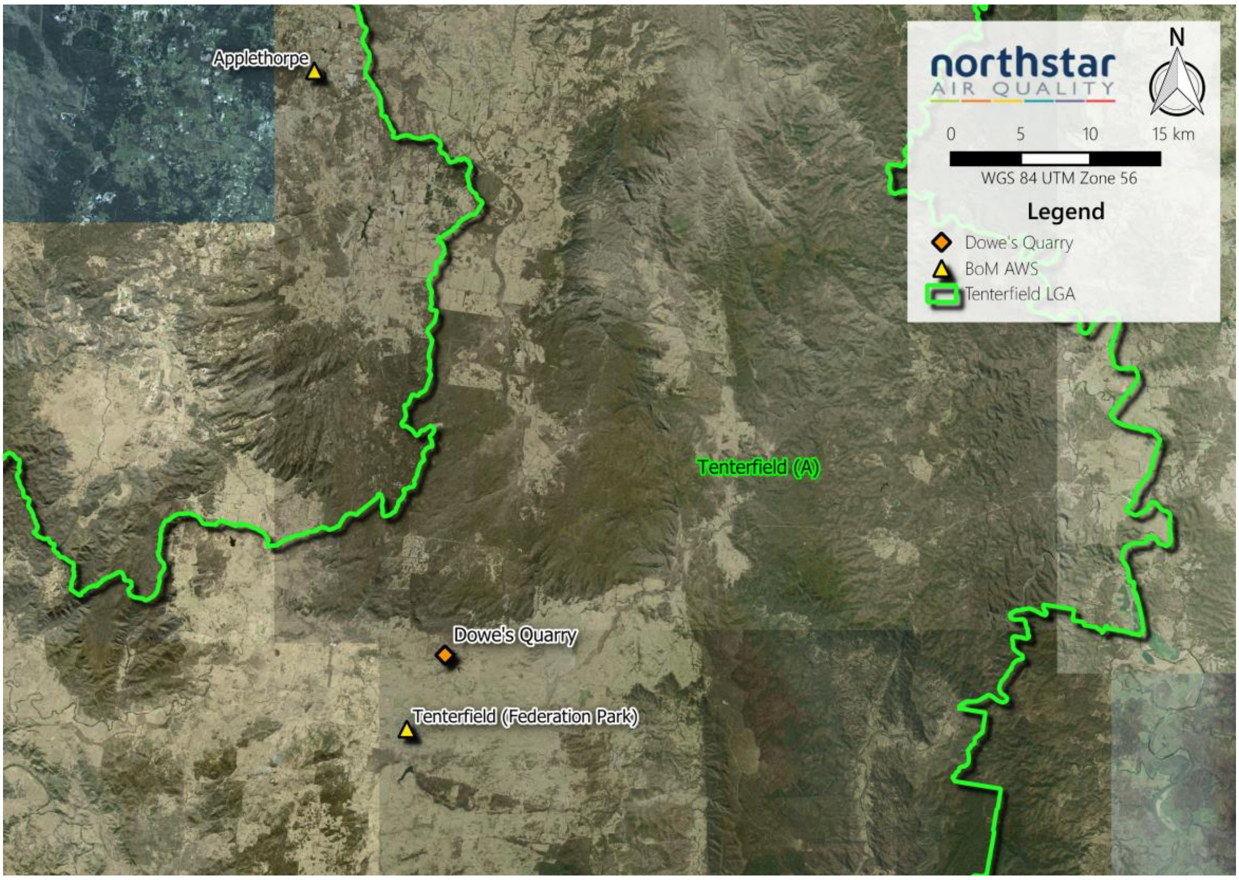
## METEOROLOGY

The meteorology experienced within a given area can govern the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. Dust generation is particularly dependent on wind speed and on the moisture budget, which is a function of evaporation and rainfall.

Meteorological parameters are not measured at the Quarry Site, and therefore data has been sourced from the Australian Government Bureau of Meteorology (BoM) to characterise the conditions which may be experienced at the Quarry Site. The closest automatic weather station (AWS) to the Quarry Site is located at Tenterfield (Federation Park) which is approximately 6.1 km to the southwest. The next closest AWS is located 42.8 km to the northwest at Applethorpe.

The location of the Tenterfield (Federation Park) and Applethorpe AWS are illustrated in **Figure 1-1**.

**Figure 1-1 Meteorological monitoring stations surrounding the Proposal site**




**Source:** Northstar Air Quality Pty Ltd

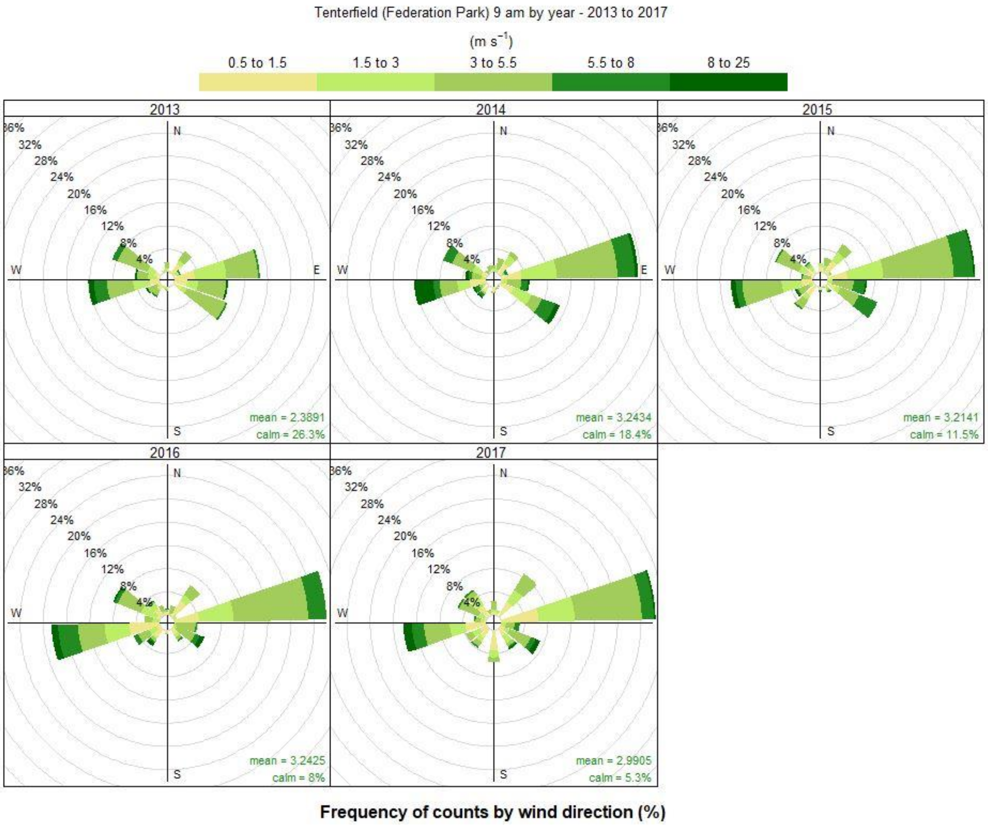
As discussed in **Section 4.3** a meteorological modelling exercise has been performed to characterise the meteorology of the Quarry Site in the absence of site-specific measurements. The meteorological modelling has been validated using measurements taken at Tenterfield (Federation Park) AWS.

It is noted that the AWS at Tenterfield (Federation Park) only records 9am and 3pm wind speed and direction data. This is generally not considered appropriate for modelling validation, however, the nearest monitoring station measuring hourly wind data is over 82 km away at Glen Innes Airport AWS. Due to this distance it is not considered representative of the area where the Quarry resides, nor does it lie within an appropriate domain for meteorological modelling. Subsequently, in the absence of more suitable data, meteorological modelling has been performed against the 9 am and 3 pm data sets as measured at the Tenterfield AWS.

Furthermore, it is noted that the dataset measured at the Tenterfield AWS does not contain 3 pm wind speed and direction data for 2016 and 2017. Subsequently, only 9 am data has been adopted in the assessment of longer-term trends and for validation purposes.

Meteorological conditions at the Tenterfield (Federation Park) AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years at 9 am (2013 to 2017) are presented in **Figure 1-2**.

**Figure 1-2 Annual wind roses for 9 am, 2013 to 2017, Tenterfield (Federation Park) AWS**




The wind roses indicate that from 2013 to 2017 winds measured at the Tenterfield (Federation Park) AWS show a predominant easterly and westerly component at 9 am.

The majority of wind speeds experienced at the Tenterfield (Federation Park) AWS over the 5-year period at 9 am, are generally measured in the range of 0.5 metres per second (m·s$^{-1}$) to 5.5 m·s$^{-1}$ with the highest wind speeds (greater than 8 m·s$^{-1}$) occurring from a westerly direction. Winds of this speed are not very common, occurring during 3.2 % of the observed hours over the 5-year period at Tenterfield AWS. Calm winds (<0.5 m·s$^{-1}$) occur during 14.0 % of hours on average across the 5-year period.

Given the wind distribution across the years examined, data for the year 2015 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied.

Presented in **Figure 1-3** are the 9 am annual wind rose for the 2013 to 2017 period and the year 2015 and in **Figure 1-4** the annual wind speed distribution for the Tenterfield (Federation Park) AWS.

**Figure 1-3 Annual wind roses for 9am, 2013 to 2017, and 2015 Tenterfield (Federation Park) AWS**

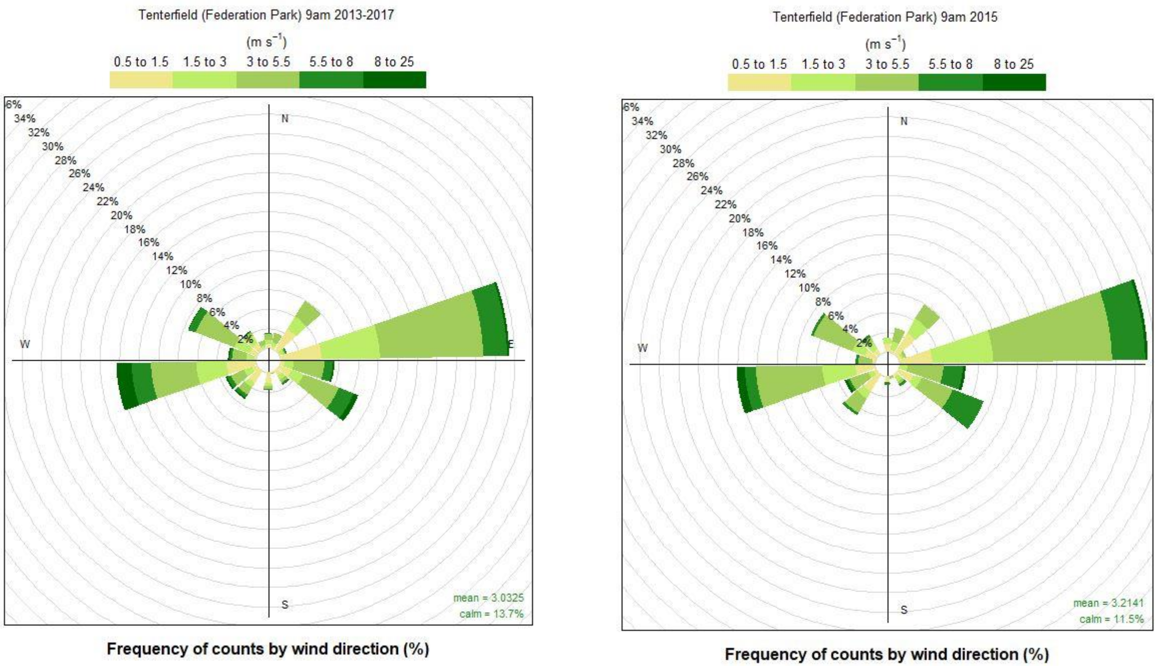
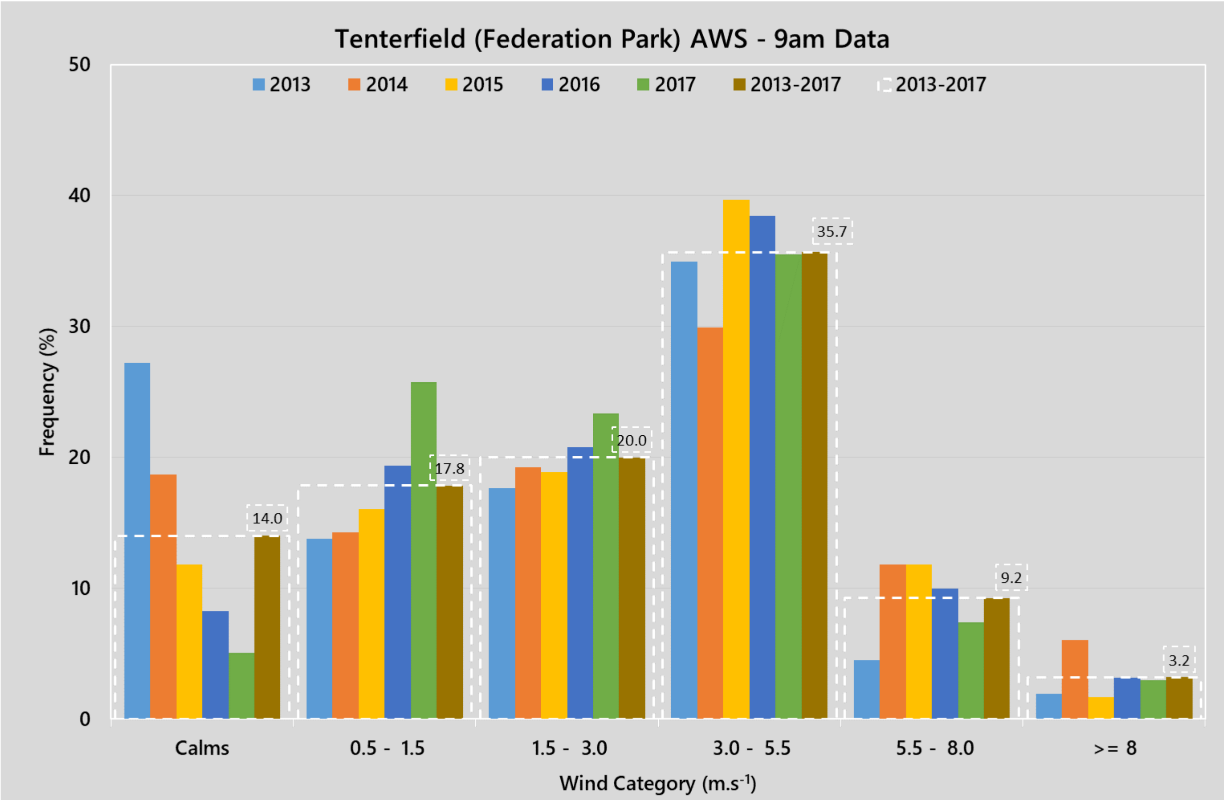


**Figure 1-4 Annual wind speed distribution for 9 am – Tenterfield (Federation Park)**



### 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 meteorology data has been performed.

In absence of any measured onsite meteorological data, site representative meteorological data for the Quarry site was generated using the TAPM meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 5.1**).

Meteorological modelling using The Air Pollution Model (TAPM, v 4.0.5) has been performed to predict the meteorological parameters required for CALPUFF. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water 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.

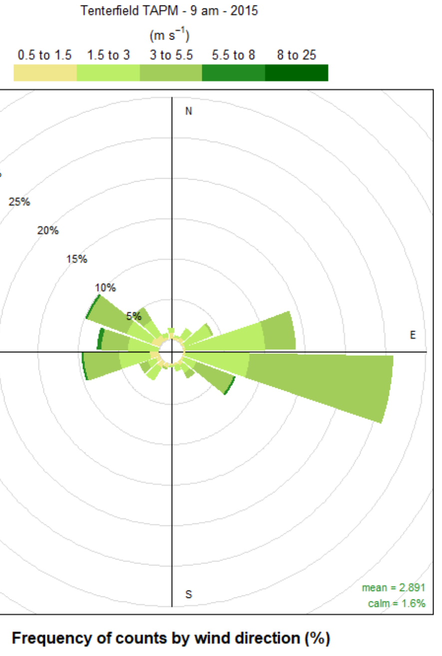
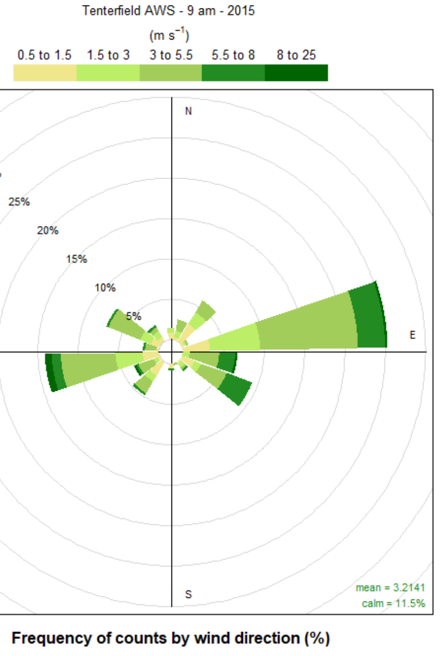
The parameters used in TAPM modelling are presented in **Table 1-1**.

**Table 1-1**
**Meteorological parameters used for this study**

| **TAPM v 4.0.5** | |
|---|---|
| Modelling period | 1 January 2015 to 31 December 2015 |
| Centre of analysis | 406 656 mS, 6 791 636 mN (UTM Coordinates) |
| Number of grid points | 25 x 25 x 25 |
| Number of grids (spacing) | 4 (30 km, 10 km, 3 km, 1 km) |
| Terrain | AUSLIG 9 second DEM |
| Data assimilation | No assimilation |

A comparison of the TAPM generated meteorological data, and that observed at the Tenterfield (Federation Park) AWS is presented in **Figure 1-5**.

**Figure 1-5 Modelled and observed meteorological data – Tenterfield (Federation Park) 9 am 2015**

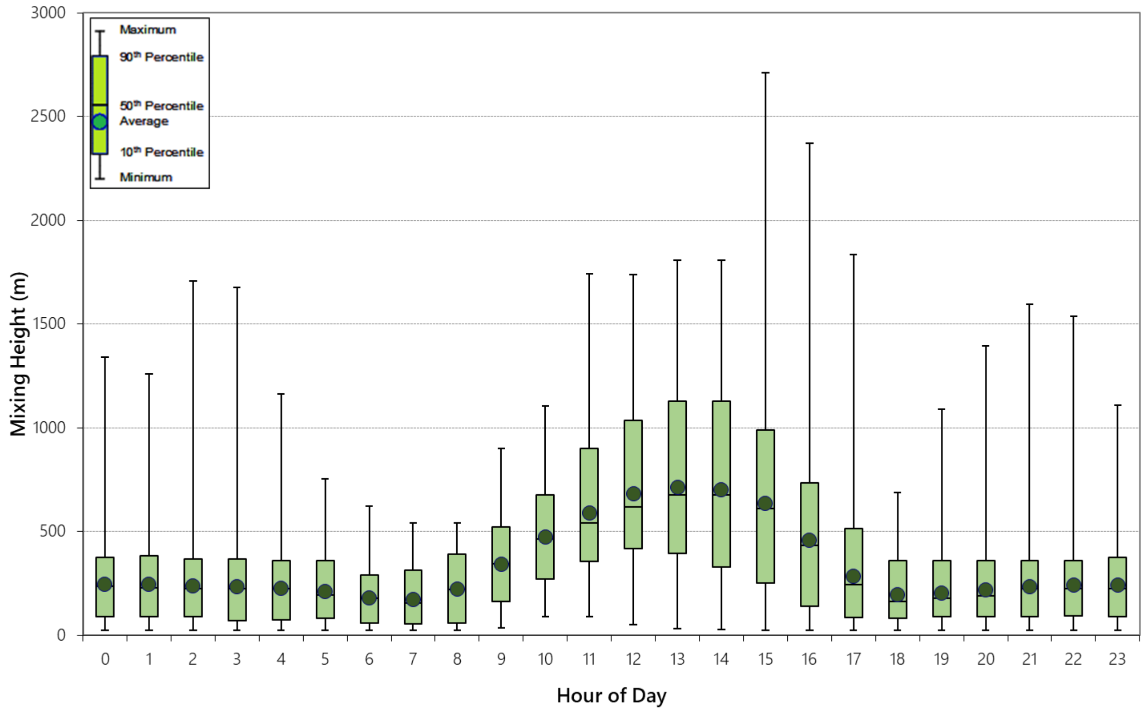
| Tenterfield TAPM generated wind rose | Observation at Tenterfield AWS |
|---|---|
|  |  |

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

Diurnal variations in maximum and average mixing heights predicted by TAPM at the Quarry Site during 2015 are illustrated in **Figure 1-6**.

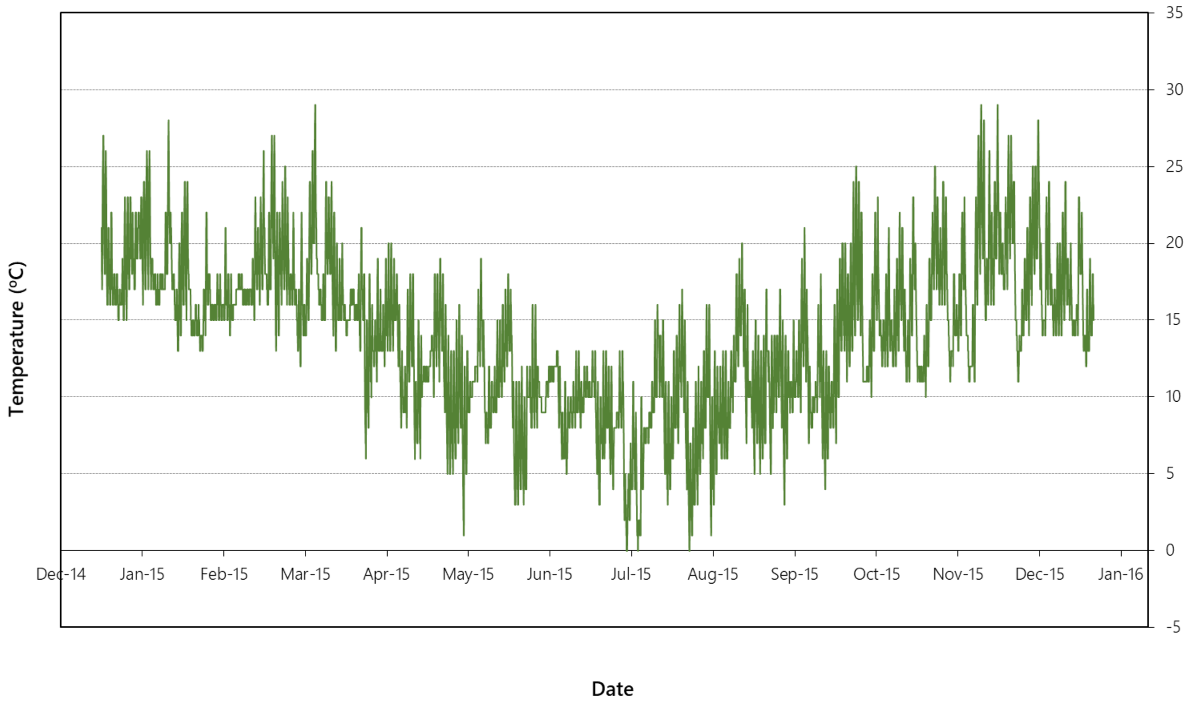
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer.

**Figure 1-6 Predicted mixing height – Quarry Site 2015**




The modelled temperature variations predicted at the Proposal site during 2015 are presented in **Figure 1-7**.

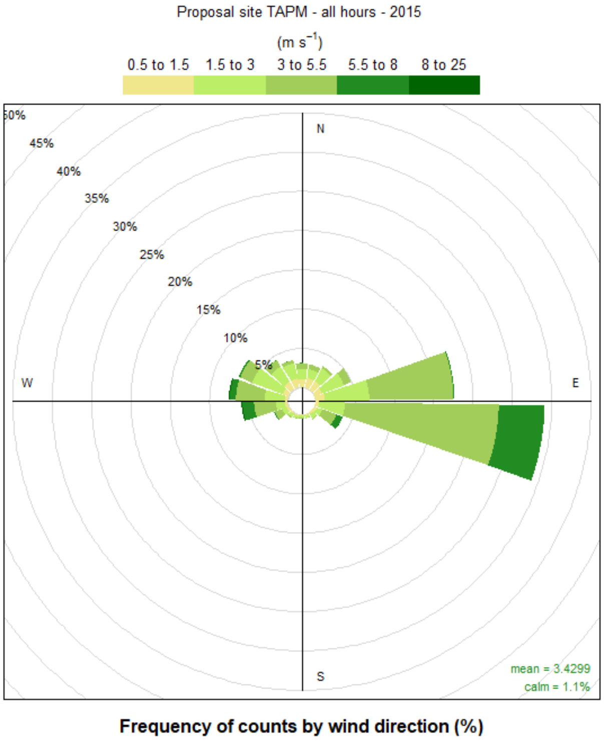
**Figure 1-7 Predicted temperature –Quarry Site 2015**




The maximum temperature of 29°C was predicted on the 20th March, and 26th November 2015 and the minimum temperature of 0°C was predicted on the 13th and 17th July and 5th August 2015.

The modelled wind speed and direction at the Quarry Site during 2015 are presented in **Figure 1-8**.

**Figure 1-8 Predicted wind speed and direction –Quarry Site 2015**



This page has intentionally been left blank

# Annexure 2

# Background Air Quality

(Total No. of pages including blank pages = 8)

This page has intentionally been left blank

Air quality data is not monitored at the Quarry Site and therefore air quality 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 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 (AQMS); and,
- The variability of particulate matter concentrations (often impacted by natural climate variability).

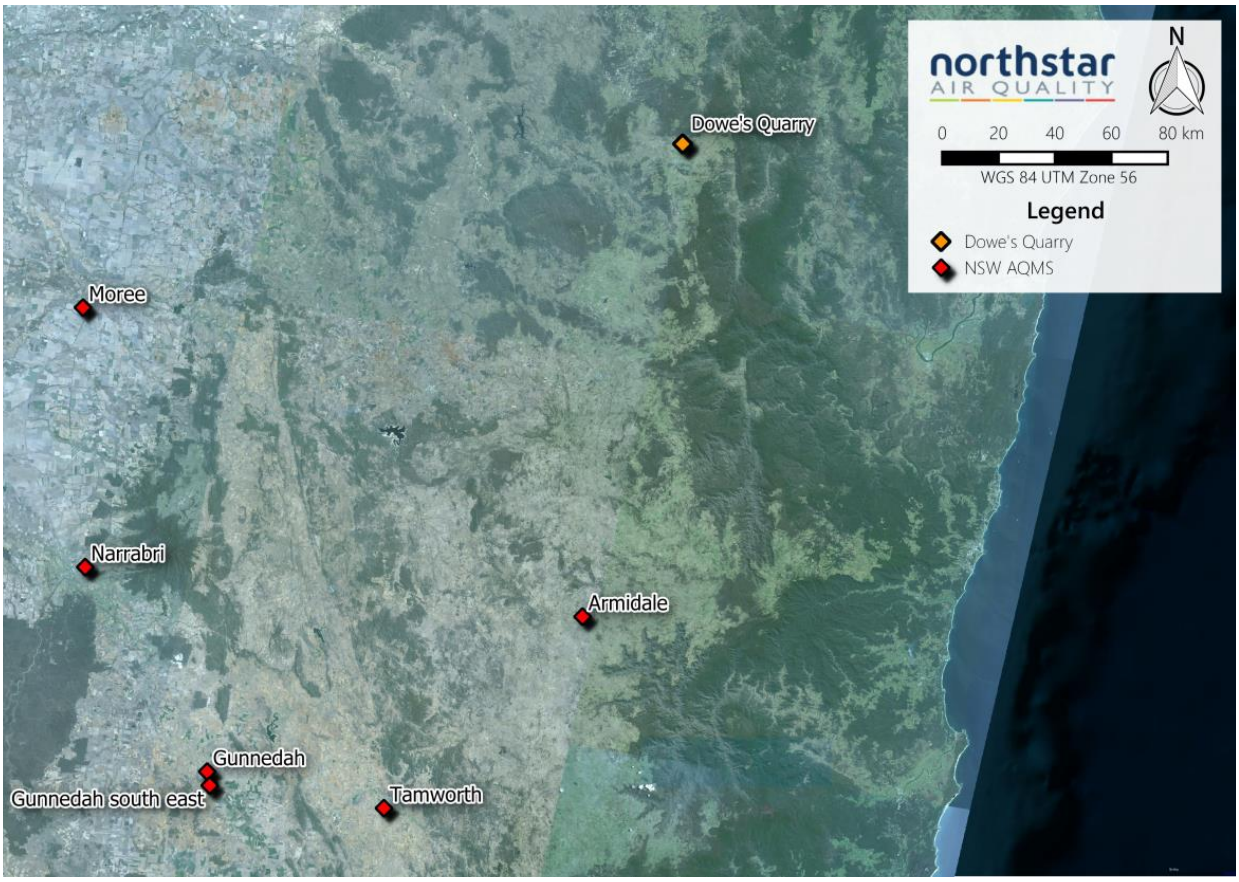
Air quality monitoring is performed by the NSW Department of Planning, Industry and Environment (DPI&E) at five AQMS in regional centres and as part of the Rural Air Quality Monitoring Network (RAQMN), within a 285 km radius of the Quarry Site. Details of the monitoring performed at these AQMS is presented in **Table 2-1** and **Figure 2-1**.

**Table 2-1**
**Closest DPI&E AQMS to the Quarry**

| AQMS Location | Distance to Site (km) | Screening Parameters | | | | |
|---|---|---|---|---|---|---|
| | | Network(1) | 2015 Data | Measurements | | |
| | | | | $PM_{10}$ | $PM_{2.5}$ | TSP |
| Armidale | 171.3 | RAQMN | ✗ | ✗ | ✗ | ✓ |
| Moree | 220.5 | RAQMN | ✗ | ✗ | ✗ | ✓ |
| Tamworth | 258.2 | AQMS | ✓ | ✓ | ✗ | ✗ |
| Narrabri | 259.7 | AQMS | ✓ | ✓ | ✗ | ✗ |
| Gunnedah | 579.2 | AQMS | ✓ | ✓ | ✗ | ✗ |
| Gunnedah South East | 282.5 | RAQMN | ✗ | ✗ | ✗ | ✓ |

**Note:** (1) RAQMN – Regional Air Quality Monitoring Network, Regional – Regional centre

**Figure 2-1 Air quality monitoring stations surrounding the Quarry Site**

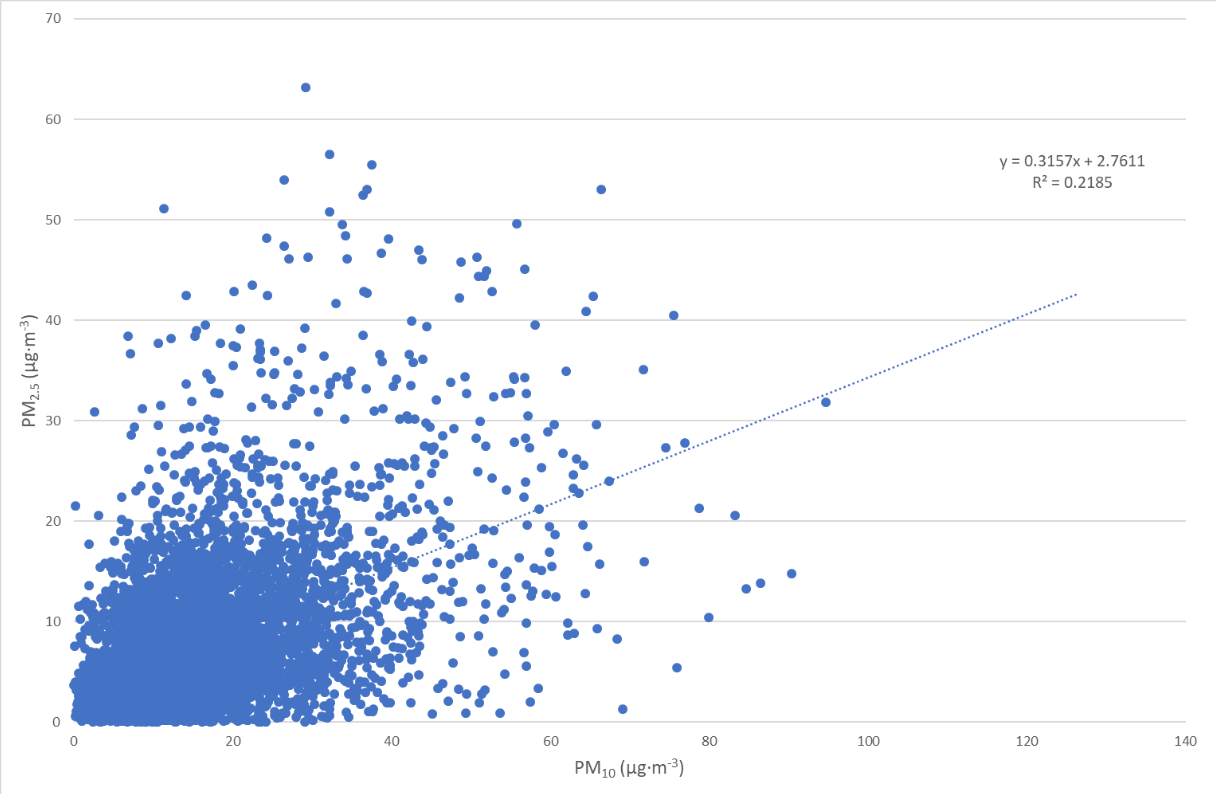



**Source:** Northstar Air Quality Pty Ltd

The closest identified AQMS to the Quarry Site with continuous data which is able to be adopted for use in this AQIA is located at Tamworth. It is noted that the AQMS located at Armidale and Moree, both of which are more proximate to the Quarry, do not measure $PM_{10}$, which is of critical importance to this AQIA.

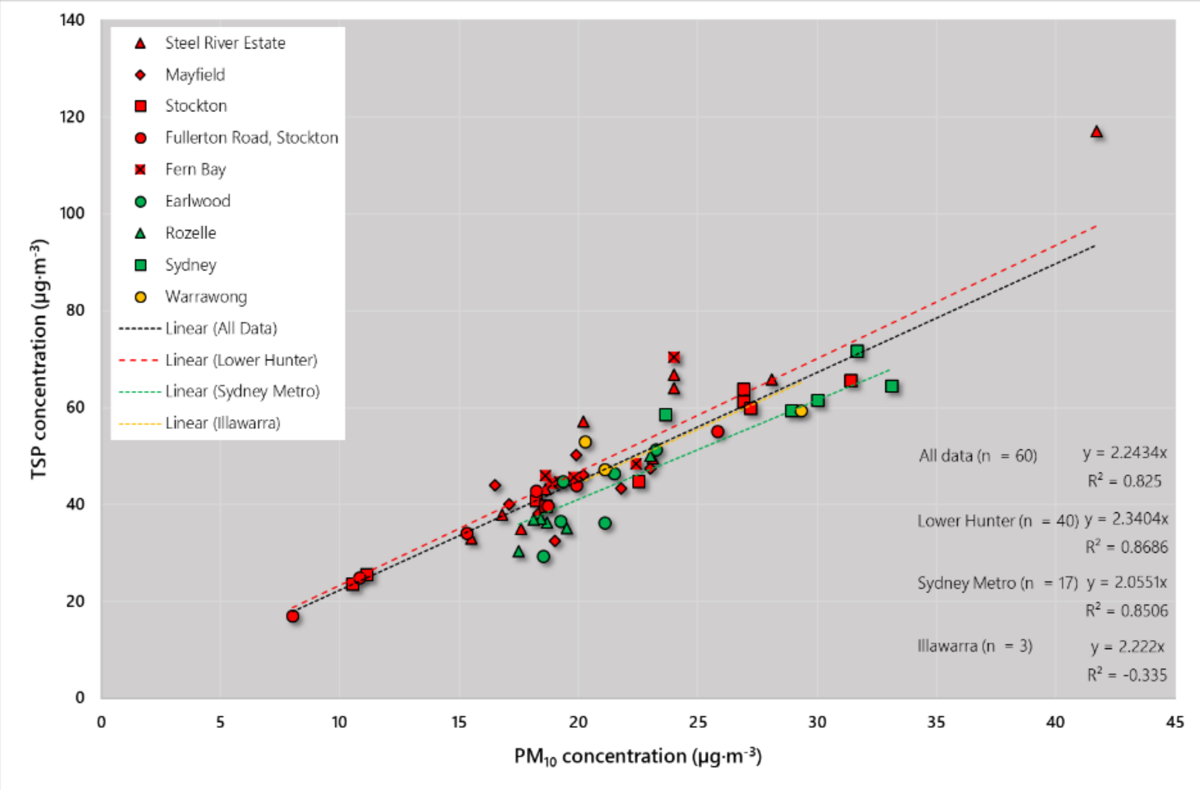
All identified monitoring stations did not measure $PM_{2.5}$ in 2015, and therefore a proxy measurement has been adopted/calculated. The proxy was calculated from the relationship between hourly $PM_{10}$ and $PM_{2.5}$ data measured at Tamworth AQMS in 2016. An X-Y plot is presented in **Figure 2-2** to illustrate the relationship between the $PM_{10}$ and $PM_{2.5}$ data as measured at Tamworth in 2016. The trendline equation ($PM_{2.5} = 0.3157 \times PM_{10} + 2.7611$) was used to calculate the proxy $PM_{2.5}$ using the $PM_{10}$ data measured at Tamworth in 2015 data as input.

**Figure 2-2 X-Y plot $PM_{10}$ and $PM_{2.5}$ Tamworth 2016**




It is noted that as part of the DPI&E Regional Air Quality Monitoring Network program there are AQMS that measure TSP, however access to that data is not available at the time of reporting. Based upon long-term historic monitoring data, an analysis of co-located measurements of TSP and $PM_{10}$ in the Lower Hunter (1999 to 2011), Sydney Metropolitan (1999 to 2004) and Illawarra (2002 to 2004) regions is presented in **Figure 2-3**. 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 region is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA, resulting in a background annual average TSP concentration of 33.0 µg·m$^{-3}$ being adopted.

**Figure 2-3 Co-located TSP and $PM_{10}$ measurements, Lower Hunter, Sydney Metro and Illawarra**




Summary statistics for TSP, $PM_{10}$ and $PM_{2.5}$ are presented in **Table 2-2**.

**Table 2-2**
**$PM_{10}$ and $PM_{2.5}$ statistics 2015 – Tamworth**

| Pollutant | TSP (µg·m$^{-3}$) | $PM_{10}$ (µg·m$^{-3}$) | Proxy $PM_{2.5}$ (µg·m$^{-3}$) |
|---|---|---|---|
| **Averaging Period** | **Annual** | **24-Hour** | **24-Hour** |
| Data Points (number) | 361 | 361 | 361 |
| Mean | 33.0 | 14.1 | 7.2 |
| Standard Deviation | - | 6.1 | 1.9 |
| Skew[1] | - | 1.6 | 1.6 |
| Kurtosis[2] | - | 6.1 | 6.1 |
| Minimum | - | 3.6 | 3.9 |
| **Percentiles (µg·m$^{-3}$)** | | | |
| 1 | - | 4.7 | 4.2 |
| 5 | - | 6.4 | 4.8 |
| 10 | - | 7.3 | 5.1 |
| 25 | - | 10.2 | 6.0 |
| 50 | - | 12.9 | 6.8 |
| 75 | - | 17.0 | 8.1 |
| 90 | - | 22.1 | 9.7 |
| 95 | - | 24.5 | 10.5 |

| Pollutant | TSP ($\mu g \cdot m^{-3}$) | $PM_{10}$ ($\mu g \cdot m^{-3}$) | Proxy $PM_{2.5}$ ($\mu g \cdot m^{-3}$) |
|---|---|---|---|
| 97 | - | 26.3 | 11.1 |
| 98 | - | 28.8 | 11.9 |
| 99 | - | 30.8 | 12.5 |
| Maximum | 33.0 | 52.7 | 19.4 |
| Data Capture (%) | 98.9 | 98.9 | 98.9 |

**Note:** 1 - Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2 - Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Graphs presenting the daily varying $PM_{10}$ and proxy $PM_{2.5}$ data recorded at Tamworth in 2015 are presented in **Figure 2-4** and **Figure 2-5**, respectively.

**Figure 2-4 $PM_{10}$ measurements, Tamworth 2015**

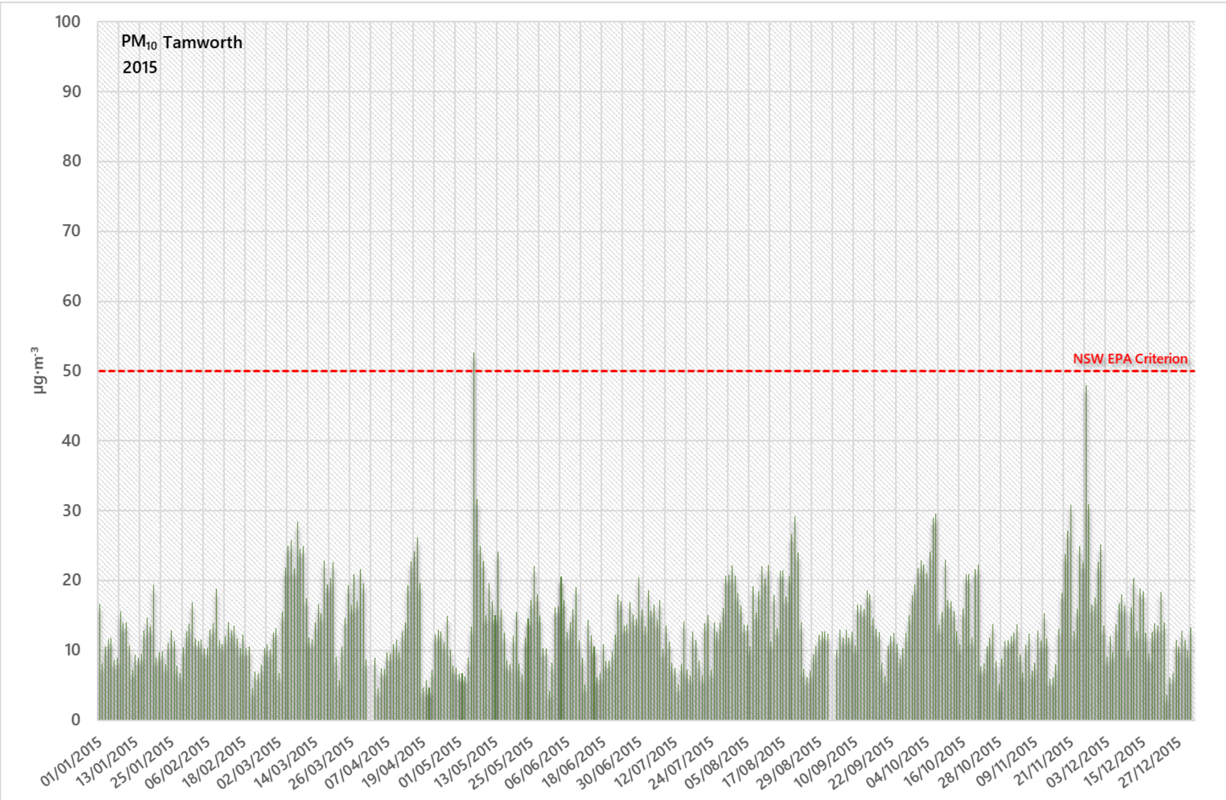
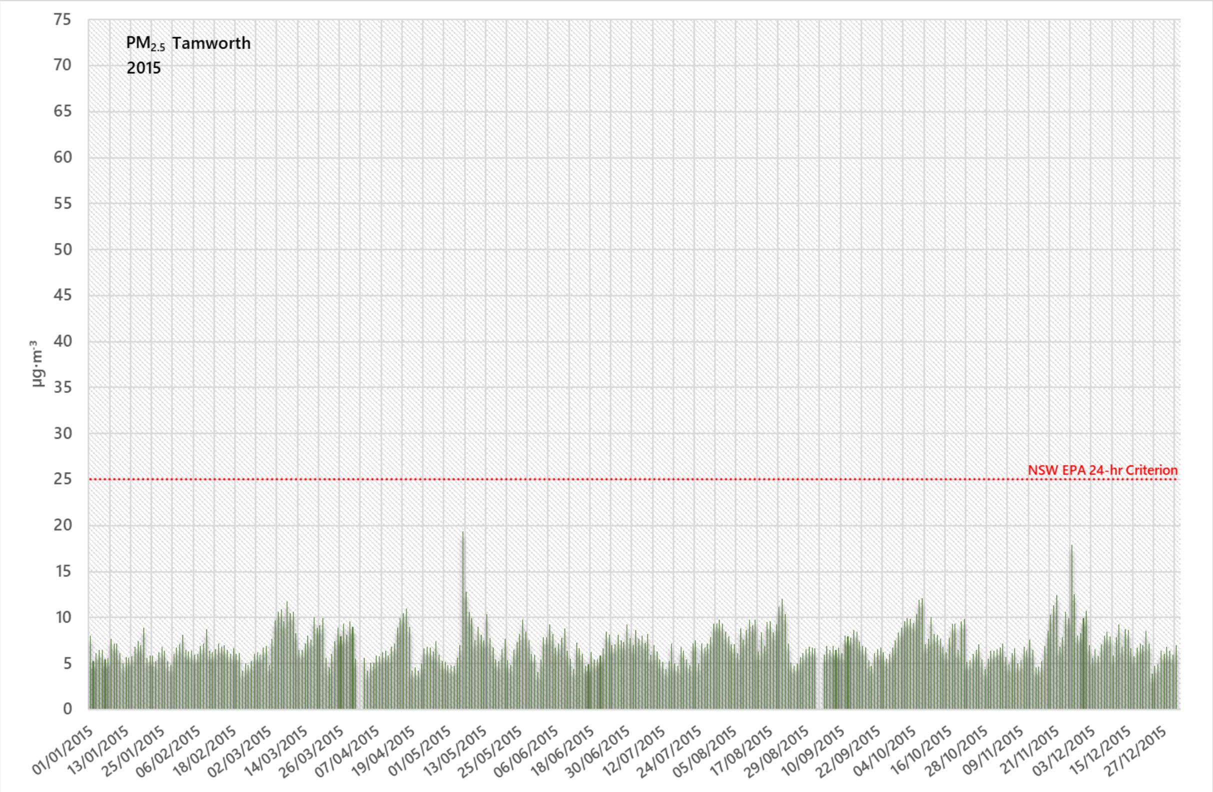


**Figure 2-5 Proxy $PM_{2.5}$ measurements, Tamworth 2015**




It is noted that the Approved Methods (NSW EPA, 2017) requires that background concentrations (as provided above) are added to dispersion model predictions to determine a 'cumulative' impact.

# Annexure 3

# Emissions Estimation

(Total No. of pages including blank pages = 20)

This page has intentionally been left blank

## EMISSIONS ESTIMATION – EMISSION FACTORS

As outlined in Section 2.4, a number of operations to be performed as part of the Proposal 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 in Section 2.4 are presented below.

Emission factors published by the US EPA in the Compilation of Air Pollutant Emission Factors (AP-42) have been adopted to allow estimation of particulate matter emissions (TSP, $PM_{10}$ and $PM_{2.5}$) from the Proposal operation. Several AP-42 sections have been consulted in the preparation of this assessment including:

- 11.9 Western Surface Coal Mining
- 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing
- 13.2.2 Unpaved Roads
- 13.2.1 Paved Roads
- 13.2.4 Aggregate Handling and Storage Piles

**Drilling and blasting**

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

The emission factor in Table 11.9-2 has been adopted for blasting:

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

where:

$A$ is the horizontal area ($m^2$) with blasting depth ≤ 12 m.

$PM_{10}$ and $PM_{2.5}$ emission factors are derived using the scaling factors outlined in Table 11.9.2 of (US EPA, 1998), which are 0.52 for $PM_{10}$ and 0.03 for $PM_{2.5}$ (applied to the TSP emission factor).

The emission factor in Table 11.9-4 has been adopted for drilling:

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

$PM_{10}$ and $PM_{2.5}$ emission factors have been derived using the same scaling factors as for blasting as outlined above in the absence of drilling specific factors.

On average, up to 20 000 t of material is anticipated to be removed by each blast. Assuming a 12 m drill holed depth, a 3 m by 3 m hole pattern and a material density of 2.4 t·m-3, and up to 12 blasts each year (approximately one per month), the annual blasting area (m2) in each of the modelled operational stages has been taken to be 4 167 m2.

Blasting has not been assumed to occur during the assessment of maximum 24-hour impacts, as the throughput of the processing operations would be limited should blasting occur.

### Loading and unloading, managing stockpiles

Emissions of particulate matter resulting from the loading of materials to trucks, and the unloading of materials at the raw feed, crusher hopper, overburden emplacement area and stockpiles, and the management of stockpiles at the processing plant have been estimated using the emission factor presented in Section 13.2.4 of AP-42 (Aggregate Handling and Storage Piles) (US EPA, 2006b).

The emission factor on page 13.2.4-4 has been adopted for the operations outlined above:

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

where:

$E$ = emission factor

$k$ = particle size multiplier (dimensionless)

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

$M$ = material moisture content (%)

The particle size multiplier for TSP, $PM_{10}$ and $PM_{2.5}$ are provided in (US EPA, 2006b) as 0.74, 0.35 and 0.2, respectively.

The value adopted for $U$ (mean wind speed) has been calculated from the output of the modelled meteorological file which is discussed in detail in **Annexure 1**. This value has been calculated to be 3.4 $m \cdot s^{-1}$.

The value adopted for $M$ (material moisture content) has been assumed to be 2 % for all materials handled at the Quarry Site. A review of several AQIA was performed which indicates that a range of values between 2 % and 5 % moisture content for materials handled at hard rock or aggregate quarries have been previously adopted:

- 2 % for soil as per page 17 of (GHD, 2016)
- 4 % for hard rock as per page 24 of (GHD, 2009)
- 3 % for rock and 5% for overburden as per page 25 of (Heggies, 2008)
- 2 % for aggregate as per page B-4 of (Pacific Environment Limited, 2017)
- 5 % for hard rock and 4% for product as per page 3-38 of (BMT WBM Pty Ltd, 2011)

In the case of the AQIA reviewed, no source data for those moisture content values are provided. For the purposes of this assessment, a value of 2 % has been adopted for all materials to be handled as part of Proposal operations. This is the lowest value of those reviewed and is conservative.

### Processing

Emissions of particulate matter resulting from the processing of materials (crushing and screening) 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).

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

$$\text{TSP } (kg \cdot tonne^{-1}) = 0.0027$$

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

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

$PM_{2.5}$ emission factors are not available in AP42 although have been taken to be 10% of $PM_{10}$ as per aggregate handling sources (MRI, 2006).

For uncontrolled screening:

$$\text{TSP } (kg \cdot tonne^{-1}) = 0.0125$$

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

$$PM_{2.5} \ (kg \cdot tonne^{-1}) = 0.00043$$

$PM_{2.5}$ emission factors are not available in AP42 although taken to be 10 % of $PM_{10}$ as per aggregate handling sources (MRI, 2006).

### Transportation

Emissions of particulate matter resulting from the movement of materials on unpaved and paved roads have been estimated using the emission factors presented in Section 13.2.2 (Unpaved Roads) and 13.2.1 (Paved Roads) of AP-42, respectively (US EPA, 2006a), (US EPA, 2011).

The emission factor on page 13.2.2-4 of (US EPA, 2006a) has been adopted for the operations of vehicles on unpaved roads:

$$E \ (kg \cdot VKT^{-1}) = 0.2819 \ \times k(s/12)^a (W \ \times \ 0.907185/3)^b$$

where:

$E$ = 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 to 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 silt content ($s$) of unpaved haul roads at the Quarry Site has been taken to be 8.3 % which equates to a haul road to/from pit at a stone quarrying and processing facility (Table 13.2.2-1 of (US EPA, 2006a)). This is considered to most appropriately reflect the proposed operations.

The mean weight ($W$) of vehicles has been calculated based on the use of '40 t' dump trucks, such as the CAT 771D (or similar) which has a payload of 41 t, tare weight of 34.7 t and a loaded weight of 75.7 t (ritchiespecs.com). The average vehicle weight has therefore been calculated to be 55.2 t (metric).

The emission factor on page 13.2.1-4 of (US EPA, 2011) has been adopted for the operations of vehicles on paved roads:

$$E\ (kg \cdot VKT^{-1}) = k(sL)^{0.91}(W\ \times\ 0.907185)^{1.02}$$

where:

$E$ = emission factor (kg per vehicle kilometre travelled)

$k$ = particle size multiplier (dimensionless)

$sL$ = road surface silt loading ($g \cdot m^{-2}$)

$W$ = 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 road surface silt loading ($sL$) of the paved haul road between Mt Lindesay Rd and the unpaved section of access road has been taken to be 0.6 $g \cdot m^{-2}$. This value is considered to represent a potential worst-case. (US EPA, 2011) provides discussion regarding limited access roadways with the recommendation that a silt loading value of 0.015 $g \cdot m^{-2}$ be adopted. The value of 0.6 $g \cdot m^{-2}$ is therefore considered to be conservative. It is noted that this value is consistent with that adopted in the previous AQIA for the Quarry (ENVIRON, 2014).

The mean weight of vehicles ($W$) has been calculated based on the use of 50 t capacity B-Double vehicles, which would have a payload of 50 t, tare weight of 13.5 t and a loaded weight of 63.5 t. The average vehicle weight has therefore been calculated to be 38.5 t (metric).

**Wind Erosion**

Emissions of particulate matter resulting from the wind erosion of materials from the extraction area, overburden emplacement, processing area (including material stockpiles) have been estimated using the emission factor presented in Section 11.9 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The emission factor in Table 11.9-4 of (US EPA, 1998) has been adopted for the action of wind erosion:

$$\text{TSP } (tonne \cdot ha^{-1} \cdot yr^{-1}) = 0.85$$

$$\text{PM}_{10} \ (tonne \cdot ha^{-1} \cdot yr^{-1}) = 0.425$$

$$\text{PM}_{2.5} \ (tonne \cdot ha^{-1} \cdot yr^{-1}) = 0.06375$$

To determine $PM_{10}$ and $PM_{2.5}$ emissions, the particle size multipliers in Section 13.2.5 (Industrial Wind Erosion) of AP-42 have been applied to TSP emissions, specifically 0.5 for $PM_{10}$ and 0.075 for $PM_{2.5}$ (US EPA, 2006c).

## ACTIVITY DATA

Activity data for each modelled phase of the operations to be performed as part of the Proposal are presented in **Table 3-1** overleaf. Notes on the assumptions adopted in the calculation of those data are outlined below.

Note A: Quantity also reflects loading to trucks by excavator and unloading at final location
Note B: No overburden removal or transport assumed during peak daily activities
Note C: Assumed maximum fresh material transported from pit to processing plant during peak daily activities 1 400 t which equates to 35 truck loads, or approximately twice the daily average
Note D: No blasting assumed during peak daily activities
Note E: Assumed 95% through jaw crusher
Note F: Maximum daily transport of material off site limited by approvals – maximum of 28 trucks per day
Note G: Processing in daily peak activities limited by capacity of equipment = 470 $t \cdot hr^{-1}$. Processing rate during daily peak activities assumed to be approximately 7 times greater than the average required.
Note H: Area of materials stockpiles shown for information. Wind erosion covered in area of 'processing area'
Note J: Area of overburden and fines emplacement shown for information. Wind erosion covered in area of 'extraction area'

Length of transport routes in each Stage:

Stage 1:

Overburden transport route – 0.78 km
Fresh rock transport route – 0.78 km
Fines to overburden transport route – 0.29 km
Product transport route (unpaved) – 0.91 km
Product transport route (paved) – 0.77 km

Stage 2:

Overburden transport route – 0.61 km
Fresh rock transport route – 0.6 km
Fines to overburden transport route – 0.29 km
Product transport route (unpaved) – 0.96 km
Product transport route (paved) – 0.77 km

**Table 3-1**
**Adopted Activity Data**

| Parameter | Units | Stage 1 | | Stage 2 | |
|---|---|---|---|---|---|
| Period | - | 1 year | 24-hour | 1 year | 24-hour |
| Overburden removal[A,B] | tonnes | 60 000 | 0 | 60 000 | 0 |
| Overburden transport route | kilometres | 2 286 | 0 | 1 788 | 0 |
| Fresh rock removal[A,C] | tonnes | 230 000 | 1 400 | 230 000 | 1 400 |
| Fresh rock transport route to processing area | kilometres | 8 537 | 52 | 6 740 | 41 |
| Drilling | holes | 926 | 77 | 926 | 77 |
| Blasting[D] | $m^2$ | 7 896 | 0 | 7 896 | 0 |
| Primary crushing (Jaw)[E,G] | tonnes | 218 500 | 4 750 | 218 500 | 4 750 |
| Secondary crushing (Cone)[G] | tonnes | 230 000 | 5 000 | 230 000 | 5 000 |
| Screening[G] | tonnes | 230 000 | 5 000 | 230 000 | 5 000 |
| Product transported off site | tonnes | 230 000 | 1 400 | 230 000 | 1 400 |
| Removal of fines[A] | tonnes | 10 000 | 87 | 10 000 | 87 |
| Transport of fines to overburden stockpile | kilometres | 142 | 1.2 | 142 | 1.2 |
| Product transport route (unpaved on site)[F] | kilometres | 8 372 | 51 | 8 832 | 54 |
| Product transport route (paved)[F] | kilometres | 7 084 | 43 | 7 084 | 43 |
| Extraction area | hectares | 6.9 | 6.9 | 10.1 | 10.1 |
| Processing area | hectares | 1.8 | 1.8 | 1.8 | 1.8 |
| Overburden and fines stockpile | hectares | 3.2 | 3.2 | 2.6 | 2.6 |
| Overburden and fines emplacement[J] | hectares | | | 1.9 | 1.9 |
| Product stockpiles[H] | hectares | 0.027 | 0.027 | 0.027 | 0.027 |

## Emissions Controls

The Quarry operates an air Quality Management Plan (AQMP) (DMC, 2015) which outlines air quality control measures adopted by the Applicant at the Quarry Site. As per section 5 of the AQMP:

- The dust collection system on the drill rig is regularly serviced to ensure it remains effective.
- Blasting and secondary rock breakage is limited during periods of high winds or extremely dry weather, where it is practical to do so.
- A bitumen seal will be applied to a 600 m section of the quarry access road to from its intersection with the Mount Lindesay Road.
- All other internal roads are surfaced with appropriate materials to limit dust lift-off and graded, where necessary.
- Road watering is undertaken on the remaining unsealed roads, if dust becomes a nuisance during periods of westerly winds.
- Appropriate care is taken to avoid spillage during loading.
- Load size is limited, as appropriate, to ensure materials do not extend above truck sidewalls.
- Each truck cover is fully extended on laden vehicles before each truck leaves the Quarry.
- All vehicles travelling on the quarry access road are limited to a speed no greater than $30 km \cdot hr^{-1}$.
- All vehicles travelling on internal unsealed roads within the Quarry Site are limited to a speed no greater than $10 km \cdot hr^{-1}$.
- DMcC's complaints management system would continue to be maintained to ensure that all complaints are dealt with through investigation and implementation of corrective treatments.

A number of the above measures have been implemented through a Driver's Code of Conduct.

Based on review of the above, emissions controls applied during each stage of operation are as follows:

- Dust collection on drill rig – 90 % control (NPI, 2012)
- Limited speed on site unpaved haul road – 44 % control (Countess Environmental , 2006)
- Water sprays on crushing – 77.7 % control (US EPA, 2004)
- Water sprays on screening- 91.2 % control (US EPA, 2004)
- Water sprays on transfer points – 50 % control (NPI, 2012)
- Pit retention for activities in pit – 50 % control for TSP, 5 % for $PM_{10}$ and $PM_{2.5}$ (NPI, 2012)
- During peak daily operations, watering of all haul roads will also occur:
- Level 1 watering on unpaved haul roads – 50 % control (NPI, 2012)

## Emissions Totals

Based on the above emission factors, activity rates and emission controls employed as part of the Proposal, the following tables outline the calculated emissions totals for each stage of operation and for annual average and peak daily activity rates:

**Table 3-2** – Stage 1 Annual Particulate Emissions ($kg \cdot annum^{-1}$)

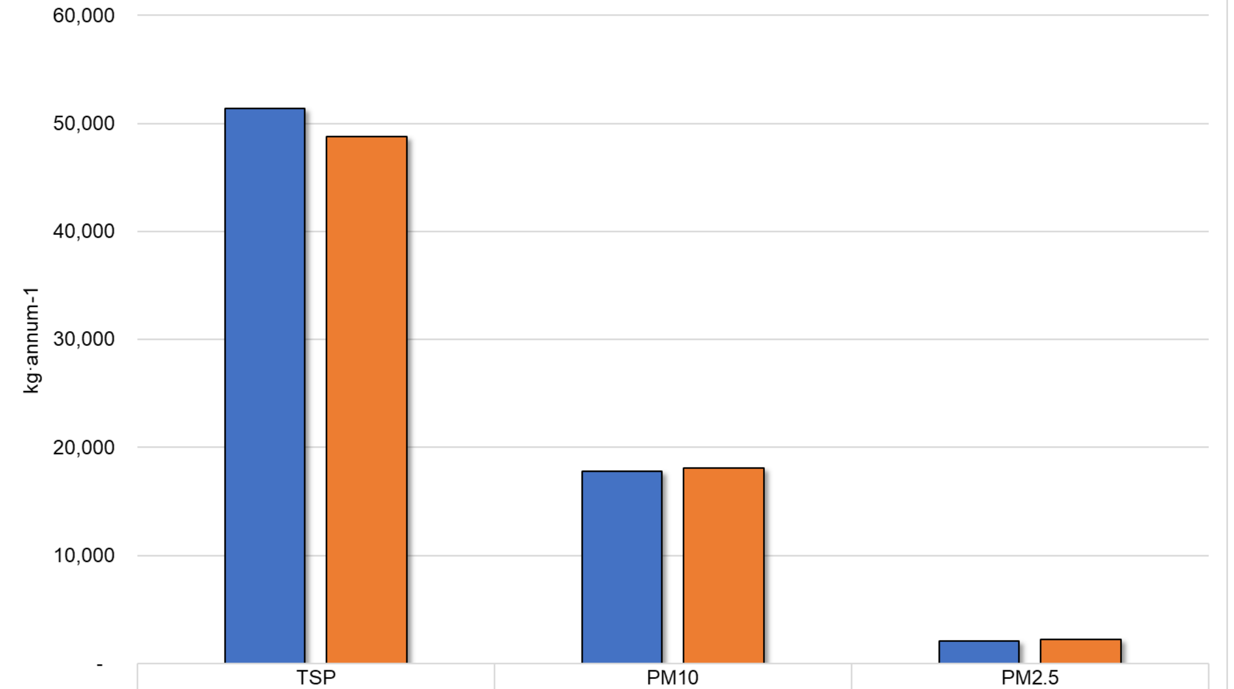
**Table 3-3** – Stage 2 Annual Particulate Emissions ($kg \cdot annum^{-1}$)

**Table 3-4** – Stage 1 Peak Daily Particulate Emissions ($kg \cdot day^{-1}$)

**Table 3-5** – Stage 2 Peak Daily Particulate Emissions ($kg \cdot day^{-1}$)

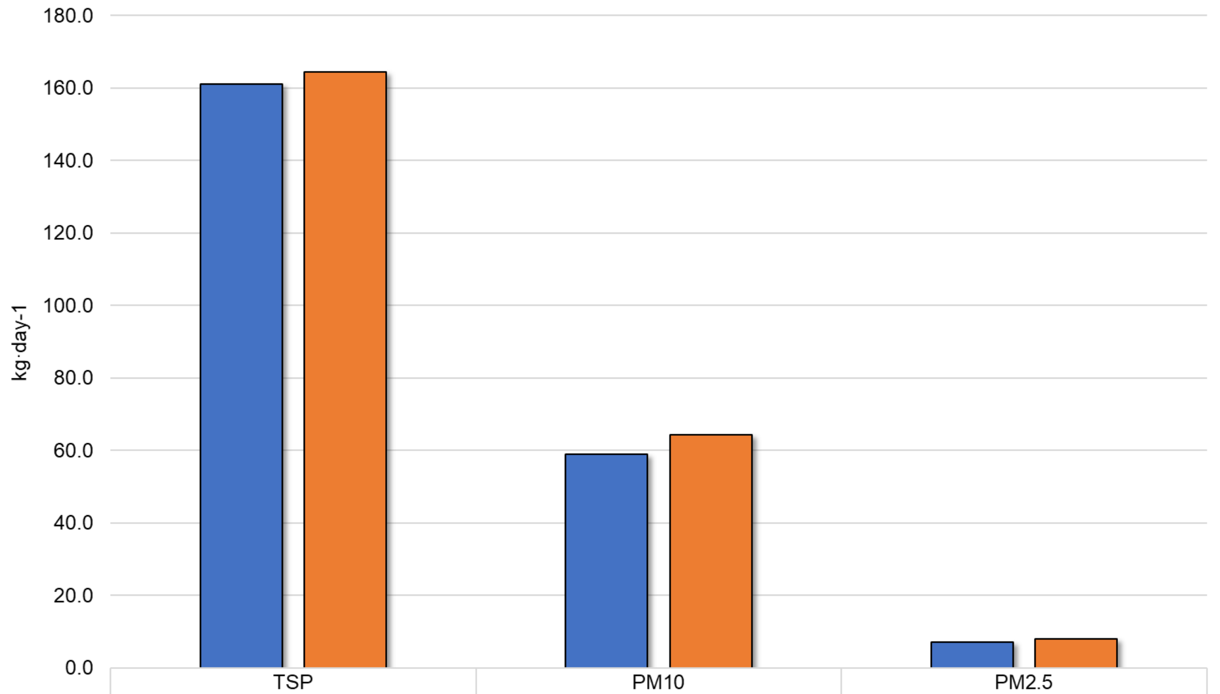
**Figure 3-1** and **Figure 3-2** also show these calculated emissions totals.

**Figure 3-1 Annual Particulate Emission, Stage 1 and Stage 2**




| | TSP | PM10 | PM2.5 |
|---|---|---|---|
| Stage 1 | 51,372 | 17,800 | 2,078 |
| Stage 2 | 48,811 | 18,115 | 2,189 |

**Figure 3-2 Peak Daily Particulate Emission, Stage 1 and Stage 2**




| | TSP | PM10 | PM2.5 |
|---|---|---|---|
| Stage 1 | 161.2 | 58.9 | 7.0 |
| Stage 2 | 164.4 | 64.3 | 8.0 |

## Table 3-2
## Stage 1 – Annual Emissions Totals

| Description | Emission Factor | | | | Units | Activity Rate | Units | Controls | Controlled Emissions ($kg{\cdot}yr^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | TSP | $PM_{10}$ | $PM_{2.5}$ | | | | | TSP | $PM_{10}$ | $PM_{2.5}$ |
| Drilling of blast holes | AP-42 - Drilling (Overburden) - Table 11.9-4 | 0.59000 | 0.30680 | 0.01770 | $kg{\cdot}hole^{-1}$ | 887 | holes | Dust collection (90%) Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 26.2 | 25.9 | 1.5 |
| Blasting of fresh rock | AP-42 - Blasting (Coal or Overburden) - Table 11.9-2 | 1.42342 | 0.74018 | 0.04270 | $kg{\cdot}blast^{-1}$ | 12 | blasts | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 22.7 | 22.4 | 1.3 |
| Loading of haul truck (rock) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 230 000 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 128.2 | 115.2 | 17.4 |
| Loading of haul truck (overburden) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 60 000 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 33.4 | 30.0 | 4.5 |
| Hauling rock to 'Processing Area' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg{\cdot}VKT^{-1}$ | 8 537.24 | VKT | Limited speed (44%) | 19 770.5 | 5 622.0 | 562.2 |
| Haul overburden to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg{\cdot}VKT^{-1}$ | 2 285.71 | VKT | Limited speed (44%) | 5 293.2 | 1 505.2 | 150.5 |
| Unloading of rock at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 230 000 | t | - | 256.3 | 121.2 | 18.4 |
| Unloading of overburden at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 60 000 | t | - | 66.9 | 31.6 | 4.8 |
| Excavator loading Jaw Crusher at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 230 000 | t | - | 256.3 | 121.2 | 18.4 |
| Crushing of rock in Jaw Crusher | AP-42 - Primary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | $kg{\cdot}t^{-1}$ | 218 500 | tonnes | Controlled (77.7%) | 131.6 | 58.5 | 10.5 |
| Crushing of rock in Cone Crusher | AP-42 - Secondary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | $kg{\cdot}t^{-1}$ | 230 000 | tonnes | Controlled (77.7%) | 138.5 | 61.5 | 11.1 |
| Screening of rock | AP-42 - Screening - Table 11.19.2.1 | 0.01250 | 0.00430 | 0.00030 | $kg{\cdot}t^{-1}$ | 230 000 | tonnes | Controlled (91.2%) | 253.0 | 87.0 | 6.1 |
| Loading material stockpiles from processing | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 230 000 | t | Water sprays (50%) | 128.2 | 60.6 | 9.2 |

| Description | Emission Factor | | | | Units | Activity Rate | Units | Controls | Controlled Emissions ($kg{\cdot}yr^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | TSP | $PM_{10}$ | $PM_{2.5}$ | | | | | TSP | $PM_{10}$ | $PM_{2.5}$ |
| Loading road trucks with product | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 230 000 | t | - | 256.3 | 121.2 | 18.4 |
| Hauling of product from 'Processing Area' to paved road | AP-42 Unpaved roads - Section 13.2.2 | 3.51567 | 0.99973 | 0.09997 | $kg{\cdot}VKT^{-1}$ | 8 372 | VKT | Limited speed (44%) | 16 482.6 | 4 687.1 | 468.7 |
| Hauling of product from paved road to Mt Lindesay Rd | AP-42 Paved roads - Section 13.2.1 | 0.08404 | 0.01613 | 0.00390 | $kg{\cdot}VKT^{-1}$ | 7 084 | VKT | - | 595.3 | 114.3 | 27.6 |
| Wind erosion of Material Stockpiles | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | $kg{\cdot}ha^{-1}{\cdot}yr^{-1}$ | 0.0 | ha | - | - | - | - |
| Wind erosion of 'Extraction Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | $kg{\cdot}ha^{-1}{\cdot}yr^{-1}$ | 6.9 | ha | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 2 932.5 | 2 785.9 | 417.9 |
| Wind erosion of 'Overburden and Fines Stockpile' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | $kg{\cdot}ha^{-1}{\cdot}yr^{-1}$ | 3.2 | ha | - | 2 720.0 | 1 360.0 | 204.0 |
| Wind erosion of 'Processing Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | $kg{\cdot}ha^{-1}{\cdot}yr^{-1}$ | 1.8 | ha | - | 1 530.0 | 765.0 | 114.8 |
| Loading of fines at 'Processing Area' to haul truck | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg/t | 10 000 | t | - | 11.1 | 5.3 | 0.8 |
| Transport of fines to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg{\cdot}VKT^{-1}$ | 141.64 | VKT | Limited speed (44%) | 328.0 | 93.3 | 9.3 |
| Unloading of fines at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 10 000 | t | - | 11.1 | 5.3 | 0.8 |
| **Total** | | | | | | | | | **51 372** | **17 800** | **2 078** |

**Table 3-3**
**Stage 2 – Annual Emissions Totals**

| Description | Emission Factor | | | | Units | Activity Rate | Units | Controls | Controlled Emissions ($kg \cdot yr^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | TSP | $PM_{10}$ | $PM_{2.5}$ | | | | | TSP | $PM_{10}$ | $PM_{2.5}$ |
| Drilling of blast holes | AP-42 - Drilling (Overburden) - Table 11.9-4 | 0.59000 | 0.30680 | 0.01770 | $kg \cdot hole^{-1}$ | 887 | holes | Dust collection (90%) Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 26.2 | 25.9 | 1.5 |
| Blasting of fresh rock | AP-42 - Blasting (Coal or Overburden) - Table 11.9-2 | 1.42342 | 0.74018 | 0.04270 | $kg \cdot blast^{-1}$ | 12 | blasts | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 22.7 | 22.4 | 1.3 |
| Loading of haul truck (rock) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg \cdot t^{-1}$ | 230 000 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 239.8 | 215.5 | 32.6 |
| Loading of haul truck (overburden) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg \cdot t^{-1}$ | 60 000 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 62.6 | 56.2 | 8.5 |
| Hauling rock to 'Processing Area' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg \cdot VKT^{-1}$ | 6 739.93 | VKT | Limited speed (44%) | 15 608.3 | 4 438.4 | 443.8 |
| Haul overburden to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg \cdot VKT^{-1}$ | 1 787.55 | VKT | Limited speed (44%) | 4 139.6 | 1 177.2 | 117.7 |
| Unloading of rock at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg \cdot t^{-1}$ | 230 000 | t | - | 479.6 | 226.8 | 34.3 |
| Unloading of overburden at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg \cdot t^{-1}$ | 60 000 | t | - | 125.1 | 59.2 | 9.0 |
| Excavator loading Jaw Crusher at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg \cdot t^{-1}$ | 230 000 | t | - | 479.6 | 226.8 | 34.3 |
| Crushing of rock in Jaw Crusher | AP-42 - Primary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | $kg \cdot t^{-1}$ | 218 500 | tonnes | Controlled (77.7%) | 131.6 | 58.5 | 10.5 |
| Crushing of rock in Cone Crusher | AP-42 - Secondary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | $kg \cdot t^{-1}$ | 230 000 | tonnes | Controlled (77.7%) | 138.5 | 61.5 | 11.1 |
| Screening of rock | AP-42 - Screening - Table 11.19.2.1 | 0.01250 | 0.00430 | 0.00030 | $kg \cdot t^{-1}$ | 230 000 | tonnes | Controlled (91.2%) | 253.0 | 87.0 | 6.1 |
| Loading material stockpiles from processing | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg \cdot t^{-1}$ | 230 000 | t | Water sprays (50%) | 239.8 | 113.4 | 17.2 |

| **Description** | **Emission Factor** | | | | **Units** | **Activity Rate** | **Units** | **Controls** | **Controlled Emissions (kg·yr$^{-1}$)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Source** | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** | | | | | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** |
| Loading road trucks with product | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 230 000 | t | - | 479.6 | 226.8 | 34.3 |
| Hauling of product from 'Processing Area' to paved road | AP-42 Unpaved roads - Section 13.2.2 | 3.51567 | 0.99973 | 0.09997 | kg·VKT$^{-1}$ | 8 832 | VKT | Limited speed (44%) | 17 388.2 | 4 944.6 | 494.5 |
| Hauling of product from paved road to Mt Lindesay Rd | AP-42 Paved roads - Section 13.2.1 | 0.08404 | 0.01613 | 0.00390 | kg·VKT$^{-1}$ | 7 084 | VKT | - | 595.3 | 114.3 | 27.6 |
| Wind erosion of Material Stockpiles | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg.ha$^{-1}$·yr$^{-1}$ | - | ha | - | - | - | - |
| Wind erosion of 'Extraction Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg.ha$^{-1}$·yr$^{-1}$ | 10.1 | ha | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 4 292.5 | 4 077.9 | 611.7 |
| Wind erosion of 'Overburden and Fines Stockpile' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg.ha$^{-1}$·yr$^{-1}$ | 2.6 | ha | - | 2 210.0 | 1 105.0 | 165.8 |
| Wind erosion of 'Processing Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg.ha$^{-1}$·yr$^{-1}$ | 1.8 | ha | - | 1 530.0 | 765.0 | 114.8 |
| Wind erosion of 'Overburden and Fines Emplacement' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg.ha$^{-1}$·yr$^{-1}$ | - | | | - | - | - |
| Loading of fines at 'Processing Area' to haul truck | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 10 000 | t | - | 20.9 | 9.9 | 1.5 |
| Transport of fines to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | kg·VKT$^{-1}$ | 141.64 | VKT | Limited speed (44%) | 328.0 | 93.3 | 9.3 |
| Unloading of fines at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 10 000 | t | - | 20.9 | 9.9 | 1.5 |
| **Total** | | | | | | | | | **48 811** | **18 115** | **2 189** |

**Table 3-4**
**Stage 1 – Peak Daily Emissions Totals**

| Description | Emission Factor | | | | Units | Activity Rate | Units | Controls | Controlled Emissions (kg·day$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | TSP | $PM_{10}$ | $PM_{2.5}$ | | | | | TSP | $PM_{10}$ | $PM_{2.5}$ |
| Drilling of blast holes | AP-42 - Drilling (Overburden) - Table 11.9-4 | 0.59000 | 0.30680 | 0.01770 | kg·hole$^{-1}$ | 77 | holes | Dust collection (90%) Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 2.28 | 2.25 | 0.13 |
| Blasting of fresh rock | AP-42 - Blasting (Coal or Overburden) - Table 11.9-2 | 4.02605 | 2.09354 | 0.12078 | kg·blast$^{-1}$ | 0 | blasts | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | - | - | - |
| Loading of haul truck (rock) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 1 400 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 0.78 | 0.70 | 0.11 |
| Loading of haul truck (overburden) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 0 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | - | - | - |
| Hauling rock to 'Processing Area' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | kg·VKT$^{-1}$ | 51.9 | VKT | Limited speed (44%) Watering (50%) | 60.17 | 17.11 | 1.71 |
| Haul overburden to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | kg·VKT$^{-1}$ | 0 | VKT | Limited speed (44%) Watering (50%) | - | - | - |
| Unloading of rock at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 1 400 | t | - | 1.56 | 0.74 | 0.11 |
| Unloading of overburden at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 0 | t | - | - | - | - |
| Excavator loading Jaw Crusher at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 5 000 | t | - | 5.57 | 2.64 | 0.40 |
| Crushing of rock in Jaw Crusher | AP-42 - Primary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | kg·t$^{-1}$ | 4 750 | tonnes | Controlled (77.7%) | 2.86 | 1.27 | 0.23 |
| Crushing of rock in Cone Crusher | AP-42 - Secondary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | kg·t$^{-1}$ | 5 000 | tonnes | Controlled (77.7%) | 3.01 | 1.34 | 0.24 |
| Screening of rock | AP-42 - Screening - Table 11.19.2.1 | 0.01250 | 0.00430 | 0.00030 | kg·t$^{-1}$ | 5 000 | tonnes | Controlled (91.2%) | 5.50 | 1.89 | 0.13 |
| Loading material stockpiles from processing | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 5 000 | t | Water sprays (50%) | 2.79 | 1.32 | 0.20 |

| **Description** | **Emission Factor** | | | | **Units** | **Activity Rate** | **Units** | **Controls** | **Controlled Emissions (kg·day$^{-1}$)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Source** | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** | | | | | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** |
| Loading road trucks with product | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 1,400 | t | - | 1.56 | 0.74 | 0.11 |
| Hauling of product from 'Processing Area' to paved road | AP-42 Unpaved roads - Section 13.2.2 | 3.51567 | 0.99973 | 0.09997 | kg·VKT$^{-1}$ | 51 | VKT | Limited speed (44%) Watering (50%) | 50.16 | 14.26 | 1.43 |
| Hauling of product from paved road to Mt Lindesay Rd | AP-42 Paved roads - Section 13.2.1 | 0.08404 | 0.01613 | 0.00390 | kg·VKT$^{-1}$ | 43 | VKT | - | 3.62 | 0.70 | 0.17 |
| Wind erosion of Material Stockpiles | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 0.0 | ha | - | - | - | - |
| Wind erosion of 'Extraction Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 6.9 | ha | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 8.03 | 7.63 | 1.14 |
| Wind erosion of 'Overburden and Fines Stockpile' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 3.2 | ha | - | 7.45 | 3.73 | 0.56 |
| Wind erosion of 'Processing Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 1.8 | ha | - | 4.19 | 2.10 | 0.31 |
| Loading of fines at 'Processing Area' to haul truck | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 87 | t | - | 0.10 | 0.05 | 0.01 |
| Transport of fines to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | kg·VKT$^{-1}$ | 1.23 | VKT | Limited speed (44%) Watering (50%) | 1.43 | 0.41 | 0.04 |
| Unloading of fines at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 87 | t | - | 0.10 | 0.05 | 0.01 |
| **Total** | | | | | | | | | **161.2** | **58.9** | **7.0** |

**Table 3-5**
**Stage 2 – Peak Daily Emissions Totals**

| Description | Emission Factor | | | | Units | Activity Rate | Units | Controls | Controlled Emissions ($kg{\cdot}day^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | TSP | $PM_{10}$ | $PM_{2.5}$ | | | | | TSP | $PM_{10}$ | $PM_{2.5}$ |
| Drilling of blast holes | AP-42 - Drilling (Overburden) - Table 11.9-4 | 0.59000 | 0.30680 | 0.01770 | $kg{\cdot}hole^{-1}$ | 77 | holes | Dust collection (90%) Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 2.27 | 2.24 | 0.13 |
| Blasting of fresh rock | AP-42 - Blasting (Coal or Overburden) - Table 11.9-2 | 4.02605 | 2.09354 | 0.12078 | $kg{\cdot}blast^{-1}$ | 0 | blasts | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | - | - | - |
| Loading of haul truck (rock) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 1 400 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 1.46 | 1.31 | 0.20 |
| Loading of haul truck (overburden) | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 0 | t | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | - | - | - |
| Hauling rock to 'Processing Area' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg{\cdot}VKT^{-1}$ | 41 | VKT | Limited speed (44%) Watering (50%) | 47.50 | 13.51 | 1.35 |
| Haul overburden to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | $kg{\cdot}VKT^{-1}$ | 0 | VKT | Limited speed (44%) Watering (50%) | - | - | - |
| Unloading of rock at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 1 400 | t | - | 2.92 | 1.38 | 0.21 |
| Unloading of overburden at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 0 | t | - | - | - | - |
| Excavator loading Jaw Crusher at 'Processing Area' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 5 000 | t | - | 10.43 | 4.93 | 0.75 |
| Crushing of rock in Jaw Crusher | AP-42 - Primary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | $kg{\cdot}t^{-1}$ | 4 750 | tonnes | Controlled (77.7%) | 2.86 | 1.27 | 0.23 |
| Crushing of rock in Cone Crusher | AP-42 - Secondary crushing - Table 11.19.2.1 | 0.00270 | 0.00120 | 0.00022 | $kg{\cdot}t^{-1}$ | 5 000 | tonnes | Controlled (77.7%) | 3.01 | 1.34 | 0.24 |
| Screening of rock | AP-42 - Screening - Table 11.19.2.1 | 0.01250 | 0.00430 | 0.00030 | $kg{\cdot}t^{-1}$ | 5 000 | tonnes | Controlled (91.2%) | 5.50 | 1.89 | 0.13 |
| Loading material stockpiles from processing | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | $kg{\cdot}t^{-1}$ | 5 000 | t | Water sprays (50%) | 5.21 | 2.47 | 0.37 |

| **Description** | **Emission Factor** | | | | **Units** | **Activity Rate** | **Units** | **Controls** | **Controlled Emissions (kg·day$^{-1}$)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Source** | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** | | | | | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** |
| Loading road trucks with product | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 1 400 | t | - | 2.92 | 1.38 | 0.21 |
| Hauling of product from 'Processing Area' to paved road | AP-42 Unpaved roads - Section 13.2.2 | 3.51567 | 0.99973 | 0.09997 | kg·VKT$^{-1}$ | 54 | VKT | Limited speed (44%) Watering (50%) | 52.92 | 15.05 | 1.50 |
| Hauling of product from paved road to Mt Lindesay Rd | AP-42 Paved roads - Section 13.2.1 | 0.08404 | 0.01613 | 0.00390 | kg·VKT$^{-1}$ | 43 | VKT | - | 3.62 | 0.70 | 0.17 |
| Wind erosion of Material Stockpiles | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | - | ha | - | - | - | - |
| Wind erosion of 'Extraction Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 10.1 | ha | Pit retention (50% TSP, 5% $PM_{10}$, $PM_{2.5}$) | 11.76 | 11.17 | 1.68 |
| Wind erosion of 'Overburden and Fines Stockpile' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 2.6 | ha | - | 6.05 | 3.03 | 0.45 |
| Wind erosion of 'Processing Area' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | 1.8 | ha | - | 4.19 | 2.10 | 0.31 |
| Wind erosion of 'Overburden and Fines Emplacement' | AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4 | 850.0 | 425.0 | 63.8 | kg·ha$^{-1}$·yr$^{-1}$ | - | | | - | - | - |
| Loading of fines at 'Processing Area' to haul truck | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 87 | t | - | 0.18 | 0.09 | 0.01 |
| Transport of fines to 'Overburden and Fines Stockpile' | AP-42 Unpaved roads - Section 13.2.2 | 4.13535 | 1.17594 | 0.11759 | kg·VKT$^{-1}$ | 1.23 | VKT | Limited speed (44%) Watering (50%) | 1.43 | 0.41 | 0.04 |
| Unloading of fines at 'Overburden and Fines Stockpile' | AP-42 - Batch drop - Section 13.2.4.3 | 0.00111 | 0.00053 | 0.00008 | kg·t$^{-1}$ | 87 | t | - | 0.18 | 0.09 | 0.01 |
| **Total** | | | | | | | | | **164.4** | **64.3** | **8.0** |