**Vipac Engineers and Scientists Limited**
Level 2, 146 Leichhardt Street, Spring Hill, QLD 4000, Australia
PO Box 47, Spring Hill, Qld, 4000 Australia
**t.** +61 7 3377 0400 | **e.** brisbane@vipac.com.au
**w.** www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Mawsons

# Mawsons - Blue Hills Quarry Air Quality Assessment

## Air Quality Assessment

70B-22-0279-TRP-44787-2

24 February 2023

| | |
|---|---|
| **Job Title:** | Mawsons - Blue Hills Quarry Air Quality Assessment |
| **Report Title:** | Air Quality Assessment |
| **Document Reference:** | 70B-22-0279-TRP-44787-2 |

| **Prepared For:** | **Prepared By:** |
|---|---|
| Mawsons<br>141 King George St<br>Cohuna, Victoria, 3568, Australia<br><br>**Contact:** Cheryl Ward<br>**Tel:** 0437 335 747 | Vipac Engineers and Scientists Limited<br>Level 2, 146 Leichhardt Street,<br>Spring Hill, QLD 4000,<br>Australia<br><br>**Tel:** +61 7 3377 0400 |

| | | | |
|---|---|---|---|
| **Author:** | Stephen Thomas<br>24 Feb 2023 | [signature] | Air Quality Principal |
| **Reviewer:** | | | |
| **Issued By:** | Stephen Thomas | [signature] | Air Quality Principal |

**Revision History:**

| *Rev. #* | *Comments / Details of change(s) made* | *Date* | *Revised by:* |
|---|---|---|---|
| Rev. 00 | Original issue | 27 Oct 2022 | ST |
| Rev. 01 | Revised issue 1 | 29 Nov 2022 | ST |
| Rev. 02 | Revised issue 2 | 23 Feb 2023 | ST |

# Executive Summary

Vipac Engineers and Scientists Ltd was engaged by Mawsons to prepare an air quality assessment to support a Work Authority application to develop the Blue Hills Quarry (BLUQ) approximately 10km northwest of Maldon in the Mount Alexander Shire Council local government area. The proposed extraction area has an extraction capability of approximately 65 million tonnes of hornfels, and the site location was chosen due to the localised presence of this resource.

It is anticipated that at its peak that approximately 500tpa of product would be produced per annum at BLUQ. Despite the distance to the nearest to the nearest rural residence of 1.3km, a Level 2 assessment has been adopted which includes dispersion modelling to quantitatively assess predicted impacts against pre-defined air quality assessment criteria to understand risks.

The air quality impact assessment has been carried out as follows:

- An emissions inventory of PM10, PM2.5, TSP (for deposited dust) and respirable crystalline silica for the proposed quarry and existing quarry was compiled using National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 emissions estimation methodology for the Project.
- The emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of measured meteorological data from the closest BoM Station, The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the AERMOD dispersion model with reference to the requirements of the EPA Publication 1551 – 'Guidance notes for using the regulatory air pollution model AERMOD in Victoria.
- The atmospheric dispersion modelling results were assessed by comparison with the assessment criteria described in Guideline for Assessing and Minimising Air Pollution in Victoria and the National Environment Protection Measure.

Table ES-1 provides the maximum model predictions for PM10, PM2.5, dust deposition and RCS at the most affected sensitive receptors. As summarised in Table ES-1, the results of the modelling have shown that while a conservative approach has been adopted for the assessment, the modelled concentrations at all sensitive receptors are predicted to be below the criteria.

Air quality impacts should not therefore be a constraint to the proposed Work Authority application.

*Table ES-1: Summary of Results*

| Pollutant | Averaging Period | Criteria | Maximum predicted at any receptor | Compliant |
|---|---|---|---|---|
| RCS | 1-year | 3 µg/m³ | 0.07 µg/m³ | ✓ |
| $PM_{10}$ | 24-hour | 50 µg/m³ | 12.36 µg/m³ | ✓ |
| | Annual | 20 µg/m³ | 0.56 µg/m³ | ✓ |
| $PM_{2.5}$ | 24-hour | 25 µg/m³ | 5.19 µg/m³ | ✓ |
| | Annual | 8 µg/m³ | 0.22 µg/m³ | ✓ |
| Dust Deposition | 1-month | 2 g/m²/month | 0.12 g/m²/month | ✓ |
| | | 4 g/m²/month | 0.12 g/m²/month | ✓ |

# Table of Contents

# 1 Introduction

Vipac Engineers and Scientists Ltd was engaged by Mawsons to prepare an air quality assessment to support a Work Authority application to develop the Blue Hills Quarry (BLUQ) approximately 10km northwest of Maldon in the Mount Alexander Shire Council local government area. The proposed extraction area has an extraction capability of approximately 65 million tonnes of hornfels, and the site location was chosen due to the localised presence of this resource.

It is anticipated that at its peak that approximately 500tpa of product would be produced per annum at BLUQ. As the distance to the nearest to the nearest rural residence is greater than 500m (i.e. 1.3km), a Level 1 assessment as described in the EPAV Guideline for assessing and minimising air pollution (publication 1961) is sufficient to semi-quantitatively assess the risks of the proposed BLUQ. However, this report outlines the results of a Level 2 assessment which includes dispersion modelling to quantitatively assess predicted impacts against pre-defined air quality assessment criteria to understand risks.

# 2 Project Description

## 2.1 Site Location

BLUQ is located approximately 10km northwest of Maldon in the Mount Alexander Shire Council local government area. The Work Authority area will occupy approximately 50ha of land within a 560ha property owned by Mawsons as shown in Figure 2-1 which shows the Pit, the Mawsons property and locations of the nearest neighbours.

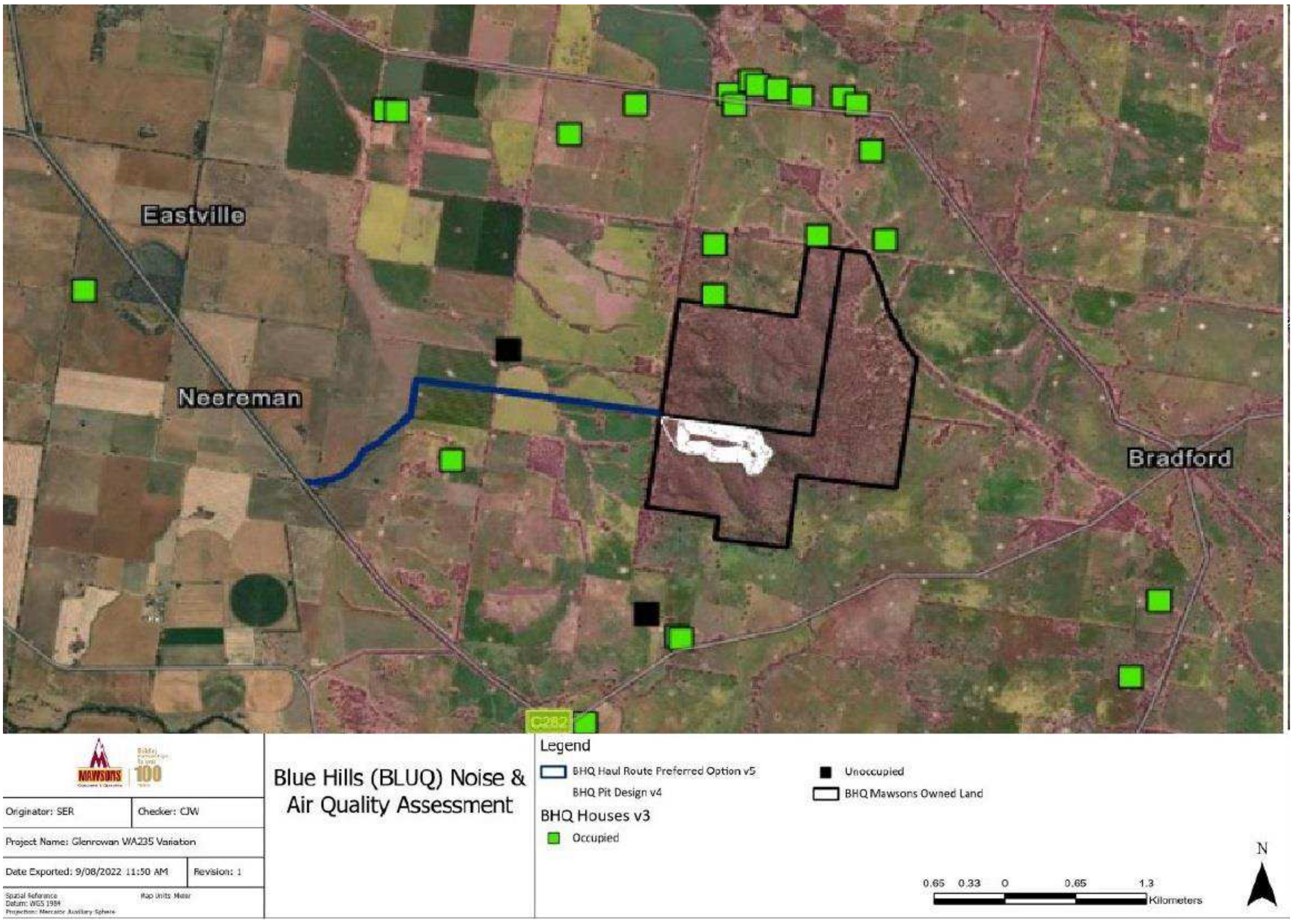



*Figure 2-1: Proposed Quarry Location*

## 2.2 Proposed Quarry Activities

The extraction of hard rock is proposed to be undertaken using conventional drill and blasting techniques. Shot rock is loaded from benches using front end loaders or excavators and subsequently hauled by dump truck to the fixed plant for processing.

Fixed 'on-site' equipment consists of conventional hard rock processing equipment, including a double toggle primary crusher, primary scalping screen, secondary and tertiary crushers. Product from the fixed plant is to be discharged directly from overhead bins into trucks and then stockpiled within the quarry of directly despatched.

It is anticipated that at its peak that approximately 500tpa of product would be produced with approximately 14,705 truck movements occurring on an annual basis with an average of 60 loads per day along the preferred access route as shown in Figure 2-1.

Operations are proposed between 7am and 6pm, Monday to Friday and 7am to 1pm on Saturdays excluding public holidays. Blasting is allowed between 7:00 am and 5:00 pm Monday to Friday and is typically once per month.

Details of the plant and equipment proposed for use at BLUQ are provided in Table 2-1.

*Table 2-1: BLUQ Plant and Equipment*

| Description | No. of Units |
|---|---|
| Komatsu WA600 wheel loader (pit loader) | 1 |
| Caterpillar 773G dump truck | 1 |
| Komatsu HD405 Dump truck | 2 |
| Caterpillar 980 sales loaders | 3 |
| Komatsu HD325 watercart | 1 |
| Kenworth ridged tipper (bin truck) tertiary | 1 |
| Sterling ridged tipper (bin truck) ballast | 1 |
| Komatsu WA600 wheel loader (pit loader) | 1 |
| Caterpillar 773G dump truck | 1 |

## 2.3 Surrounding Environment

The proposed quarry is located on a roughly east to west trending ridge that rises to about RL 320 m (relative to Australian Height Datum) on the eastern side of the pit, while the Bridgewater-Maldon Road to the west is at an approximate elevation of RL220 m. The western slopes are typically gently sloping and approximately planar before the terrain becomes generally flat, near to the main road.

There are three sensitive receptors located within a 2 km radius as shown in Figure 2-1. The nearest resident is approximately 1.3km north of the proposed pit with several other residents nearby. The residents include long term landholders. Informal engagement with the local residents including leaseholders, occurs up to every 3 months in response to the proposed quarry.

The locations of the nearest potentially affected air sensitive receivers to BLUQ are provided in Appendix A.

# 3 Pollutants of Concern

The main emissions to air from quarrying operations are caused by wind-borne dust, vehicle usage, materials handling and transfers. Fugitive air emissions can be estimated using emission factors combined with site-specific information such as the silt and moisture content of material being handled.

Dust is a generic term used to describe fine particles that are suspended in the atmosphere. The dust emissions considered in this report are particulate matter in various sizes:

- Total Suspended Particles (TSP) - Particulate matter with a diameter up to 50 microns;
- $PM_{10}$ - Particulate matter less than 10 microns in size;
- $PM_{2.5}$ - Particulate matter less than 2.5 microns in size;
- Respirable Crystalline Silica (RCS); and
- Dust Deposition – deposited matter that falls out of the atmosphere.

Crystalline silica is a basic component of sand (soil, granite and many other minerals). Quartz is the most common form of crystalline silica. Cristobalite and tridymite are two other forms of crystalline silica. Only the respirable particles (<7 µm in aerodynamic diameter those which are capable of reaching the gas exchange region of the lungs) are considered when determining health effects of crystalline silica.

Repeated and prolonged exposure to relatively high concentrations of crystalline silica can cause the disease known as silicosis. This respiratory disease is characterised by scarring and hardening of the lung tissue and it reduces the ability of the lungs to extract oxygen from the air.

# 4 Legislative Requirements

## 4.1 National Environmental Protection Measure

Australia's first national ambient air quality standards were outlined in 1998 as part of the National Environment Protection Measure for Ambient Air Quality.

The Ambient Air Measure sets national standards for the key air pollutants; carbon monoxide, ozone, sulphur dioxide, nitrogen dioxide, lead and particles ($PM_{10}$ and $PM_{2.5}$). The Air NEPM requires the state governments to monitor air quality and to identify potential air quality problems.

## 4.2 Guideline for Assessing and Minimising Air Pollution in Victoria

The Guideline for Assessing and Minimising Air Pollution in Victoria provides a framework to assess and control risks associated with air pollution. It is a technical guideline for air quality practitioners and specialists with a role managing pollution discharges to air.

In Victoria, The Environment Protection Act, 2017 (the EP Act) provides the main legislative instrument for the protection of the environment within the State of Victoria. Under the EP Act all risks to human health and environment from pollution and waste must be minimised so far as reasonably practicable.

The contents of this guideline constitute guidance under this Act. This guideline provides duty holders with an approach to minimising risks in a proportionate way. The guideline aims to achieve this objective by providing:

- A clear framework for air pollution assessment and management that protects the environmental values of air (as defined in the Environment reference standards (ERS)) to ensure risks of harm to human health and the environment are minimised so far as reasonably practicable.
- Guidance on methods for assessing risk of harm from air pollution to human health and the environment. This includes a broad risk-based assessment framework, site-specific risk assessment methods, and risk-based air quality assessment criteria (AQACs).
- A conceptual framework for identifying and selecting risk management techniques and technologies to ensure that risks are minimised so far as reasonably practicable.
- Clarity on EPA’s expectations for the minimum reporting standards related to the assessment and management of air pollution in Victoria.

## 4.3 Air Quality Assessment Criteria

AQACs are concentrations of pollutants in air that provide a benchmark to understand potential risks to human health or the environment. They are risk-based concentrations that can help identify when or if an activity is likely to pose an unacceptable risk to the receiving environment.

AQACs are not intended to be concentrations one can 'pollute up to'. They are also not concentrations below which no action is required. This is because under the GED, anyone engaging in an activity that may give rise to risks of harm to human health or the environment due to discharges to air is required to minimise those risks so far as reasonably practicable. The criteria are outlined in Table 4-1.

*Table 4-1 - Air Quality Assessment Criteria*

| Pollutant | Basis | Criteria | Averaging Time |
|---|---|---|---|
| RCS | OEHHA | 3 μg/m$^3$ | 1-year |
| $PM_{10}$ | ERS | 50 μg/m$^3$ | 24-hour |
| | | 20 μg/m$^3$ | Annual |
| $PM_{2.5}$ | ERS | 25 μg/m$^3$ | 24-hour |
| | | 8 μg/m$^3$ | Annual |
| Dust Deposition | NSW Approved Methods | 2 g/m$^2$/month (project increment) | 1-year |
| | | 4 g/m$^2$/month (cumulative impact) | 1-year |

OEHHA - Californian Office of Environmental Health Hazard Assessment reference exposure levels (REL)
ERS - proposed final Environment Reference Standards 14 December 2020

# 5 Existing Environment

## 5.1 Dispersion Meteorology

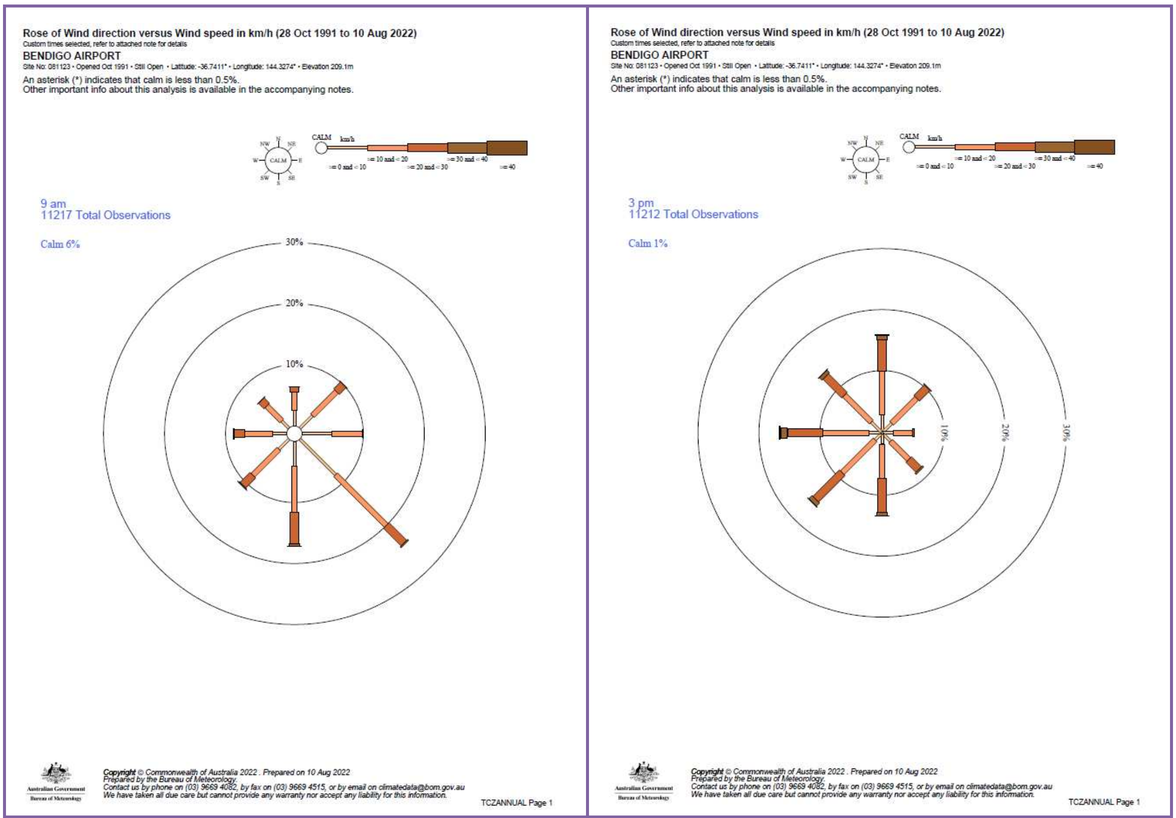
### 5.1.1 Regional Meteorology

Data recorded by the nearest Bureau of Meteorology (BoM) long term weather station at Bendigo Airport (located approximately 35 km north east of the BLUQ) was reviewed to describe the meteorological and climatic influences in the region. Long term weather data (1991 to 2022) obtained from the BOM weather station at Bendigo is presented in Table 5-1. The mean temperature range is between 2.7ºC and 30.3ºC with the coldest month being July and the hottest, January. The rainfall in the region is relatively consistent throughout the year. With a mean annual rainfall of 1,060 mm.

The long term wind roses recorded at the Bendigo Airport at 9am and 3pm are provided in Figure 5-1. Winds are shown to be more common from the south and south east at 9am. In addition, winds from the south, west and north directions dominate at 3pm. Stronger winds occur more frequently in the afternoon.

*Table 5-1: Mean Long-term Weather Data for Bendigo Airport*

| Month | Mean Temperature | | Rainfall (mm) | Highest rainfall (mm) | Lowest rainfall (mm) | Highest daily rainfall (mm) | Mean number of days of rain | Mean 9am wind speed (km/h) | Mean 3pm wind speed (km/h) |
|---|---|---|---|---|---|---|---|---|---|
| | Max (°C) | Min (°C) | | | | | | | |
| Jan | 30.3 | 14.4 | 35.6 | 177.8 | 0 | 64.2 | 6.1 | 15.9 | 19.1 |
| Feb | 29.6 | 14.4 | 29.1 | 152.2 | 0.2 | 66.4 | 5.1 | 15.1 | 17.6 |
| Mar | 26.1 | 11.9 | 32.1 | 116.4 | 1.4 | 64.6 | 5.4 | 13.7 | 16.8 |
| Apr | 21.4 | 8.1 | 35.6 | 133.6 | 3.2 | 47.2 | 6.8 | 12.4 | 15.9 |
| May | 16.6 | 5.3 | 46.9 | 121.3 | 6.6 | 45.6 | 11.9 | 10 | 14.3 |
| Jun | 13.4 | 3.6 | 50.7 | 127.4 | 2.4 | 45 | 13.7 | 9.9 | 14.8 |
| Jul | 12.7 | 2.7 | 53.3 | 99.2 | 11.4 | 30.2 | 16 | 9 | 15.4 |
| Aug | 14.2 | 2.9 | 52.6 | 139 | 9.6 | 36.2 | 14.1 | 11.1 | 17.5 |
| Sep | 17 | 4.6 | 52.9 | 153.4 | 7.4 | 50.6 | 11.9 | 14.3 | 18.8 |
| Oct | 20.9 | 6.8 | 40.5 | 137.6 | 1 | 65.6 | 8.8 | 15.6 | 19 |
| Nov | 24.7 | 9.9 | 45.9 | 115.2 | 6.4 | 43.6 | 7.7 | 15.3 | 18.9 |
| Dec | 27.6 | 12 | 38.2 | 138.6 | 0.4 | 60.8 | 6.8 | 16.1 | 19.2 |
| Annual | 21.2 | 8 | 510 | 1060.4 | 272.4 | 66.4 | 114.3 | 13.2 | 17.3 |




| | | |
|---|---|---|
| **Location:** Bendigo Airport BoM Station | **Data Period:** 1991 - 2022 | **Data Type:** Measured Data |

*Figure 5-1: Wind Roses for Bendigo Airport Weather Station (9am and 3pm)*

## 5.2 Local Meteorology

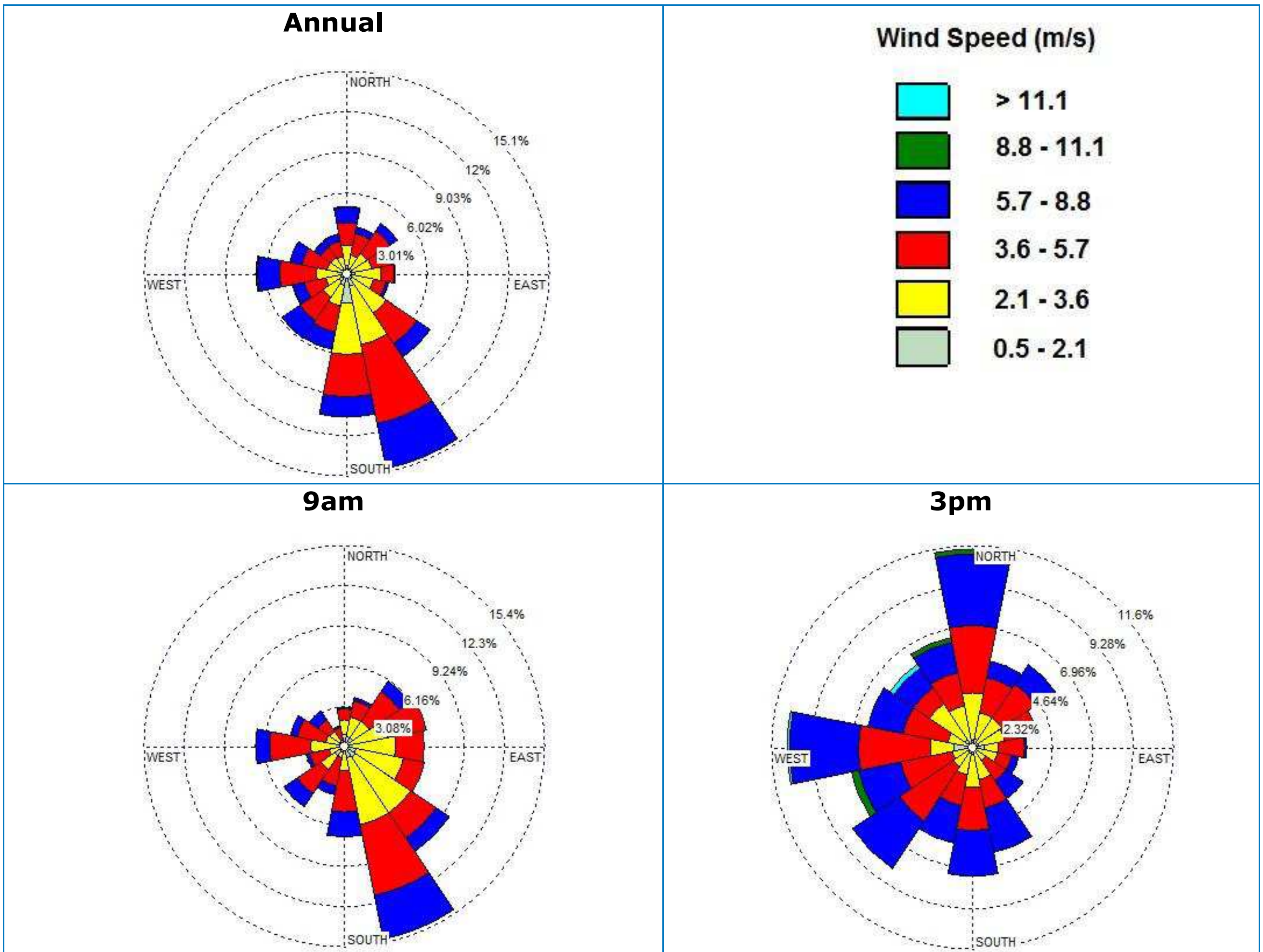
### 5.2.1 Introduction

A three dimensional meteorological field was required for the air dispersion modelling that includes a wind field generator accounting for slope flows, terrain effects and terrain blocking effects. The Air Pollution Model, or TAPM, is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research and can be used to develop meteorological input files for the AERMOD dispersion model for each hour of the modelling period (2017 to 2021). The TAPM derived dataset for 12 continuous months of hourly data from the year 2017 and approximately centred at the BLUQ has been used to provide further information on the local meteorological influences. Details of the modelling approach are provided in Section 6.2.

### 5.2.2 Wind Speed and Direction

Figure 5-2 presents the annual, 9am and 3pm wind roses from the TAPM derived dataset for the year 2017 at the BLUQ location. Key features of the winds are:

- Winds are predominantly from the south and south east with average wind speed of 3.6 m/s;
- The strongest winds (>5.7m/s) occur in the afternoon; and
- The annual wind rose for the TAPM derived dataset is generally consistent with the long term measured data from the Bendigo Airport BoM Weather Station (Figure 5-1).




| **Location:** Site | **Data Period:** Jan 2017 to Dec 2017 | **Data Type:** TAPM extract |
|---|---|---|

*Figure 5-2: Annual and Seasonal Wind Roses for the TAPM Derived Dataset, 2017*

### 5.2.3 Atmospheric Stability

The Pasquill-Gifford stability classification scheme denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small. Figure 5-3 shows the stability class percentages from the TAPM derived meteorological data for the project site. The data identifies that Stability Classes D and F are most common; this stability class is indicative of neutral conditions neither enhancing nor impeding dispersion.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

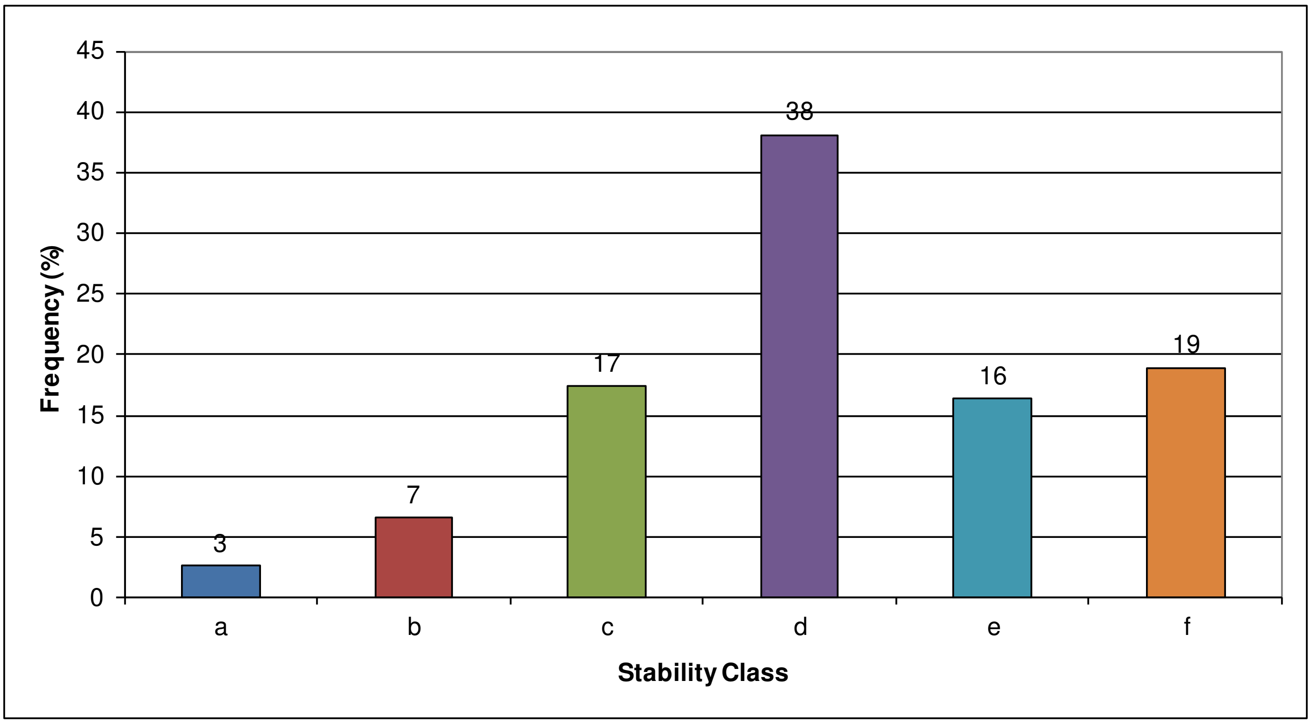



*Figure 5-3: Stability Class Percentages for the TAPM Derived Data, 2017*

### 5.2.4 Mixing Height

Mixing height is defined as the height of the layer adjacent to the ground over which an emitted or entrained inert non-buoyant tracer will be mixed (by turbulence) within a time scale of about one hour or less.

Diurnal variations in mixing depths are illustrated in Figure 5-4. As would be expected, an increase in the mixing depth 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 the growth of the convective mixing layer.

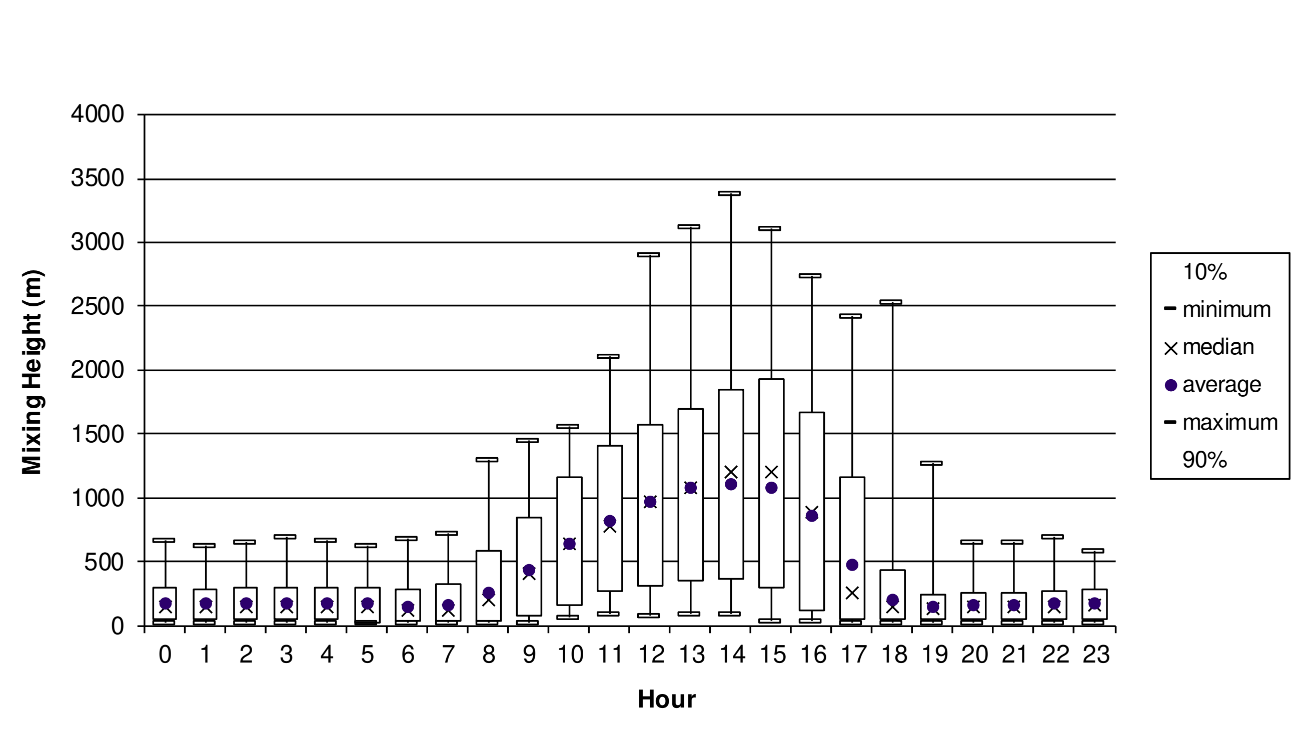



*Figure 5-4: Mixing Height of the TAPM Derived Data, 2017*

## 5.3 Existing Air Quality

The National Pollutant Inventory (NPI) database identifies no reporting sources of air pollution emissions in the surrounding 20 km from the BLUQ. Other sources that contribute to particulate matter concentrations in the vicinity of the proposed quarry may include:

- dust entrainment and tyre and break wear due to vehicle movements along public roads;
- petrol and diesel emission from vehicle movements along public roads;
- agricultural practices;
- wind generated dust from exposed areas within the surrounding region;
- seasonal emissions from household wood burning fires; and
- remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires.

Mawsons has been collecting continuous particulate matter data (approximating to TSP, PM10 and PM2.5) at the BLUQ site using a portable light-scattering instrument since March 2022. The data is collected to provide an understanding of baseline particulate matter concentrations and the influence of background dust sources. Figure 5-5 provides a time series plot of the 24 hour average particulate matter concentrations measured at the site from April to July 2022. As shown, with the exception of an episode in mid-April, the measured concentrations are very low of the order of < 5 μg/m$^3$ for each size fraction.

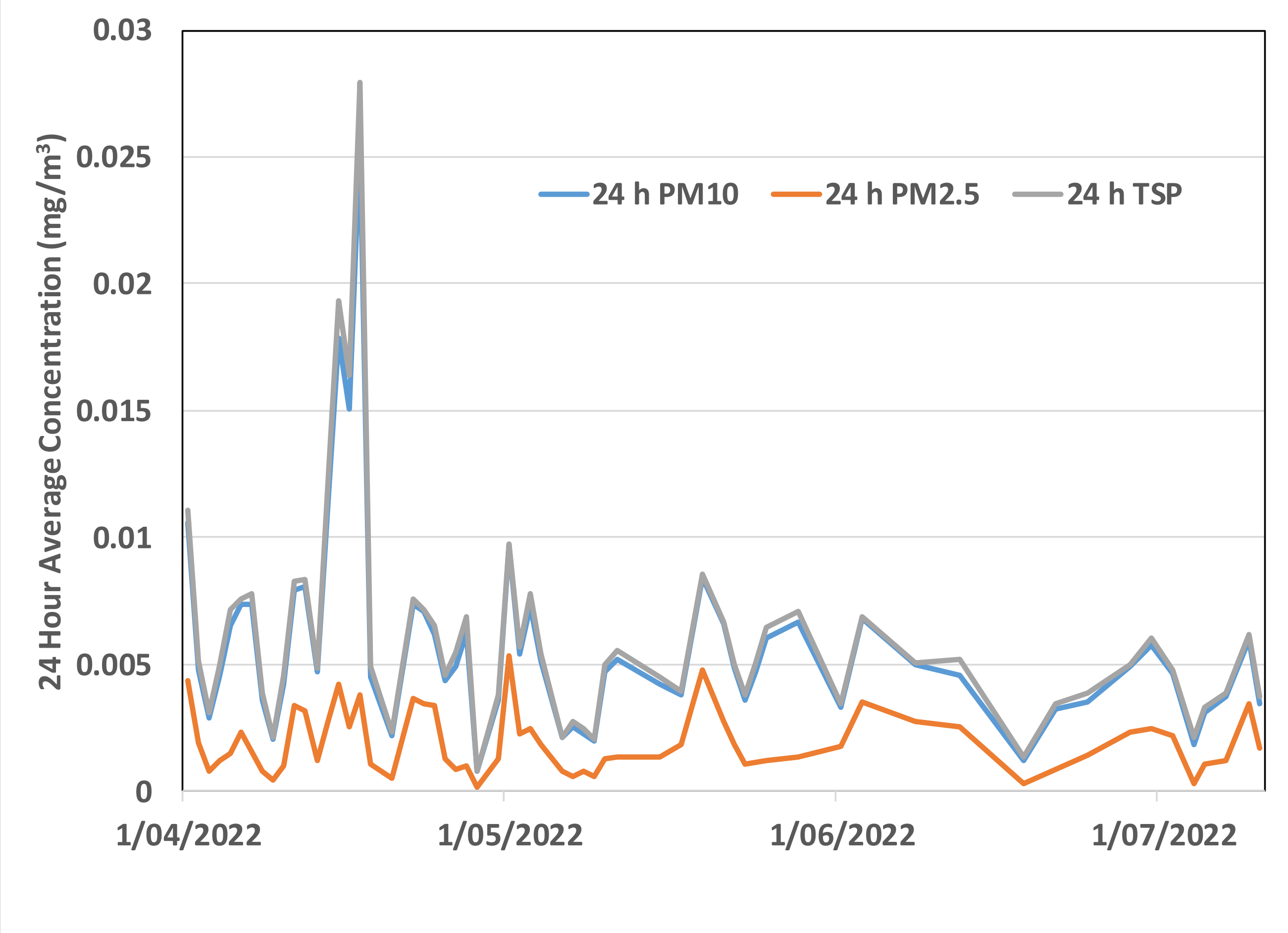



*Figure 5-5: BLUQ 24 Hour Average Particulate Matter Concentrations*

# 6 Methodology

The air quality impact assessment has been carried out as follows:

- An emissions inventory of TSP, PM10, PM2.5, and deposited dust for the proposed Project was compiled using National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 emissions estimation methodology for the Project (outlined in Section 6.1).
- The emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of measured meteorological data from the closest BoM Station, The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the AERMOD dispersion model with reference to the requirements of the EPA Publication 1551 – 'Guidance notes for using the regulatory air pollution model AERMOD in Victoria.
- The atmospheric dispersion modelling results were assessed by comparison between scenarios and the assessment criteria described in the Guideline for Assessing and Minimising Air Pollution in Victoria and the National Environment Protection Measure, described in Section 4.

## 6.1 Estimated Emissions

### 6.1.1 Emissions Sources

The air quality assessment takes into account dust generating activities from quarry activities and disturbed surfaces within the site boundaries. The main emissions to air are dust and particulate matter generated by the onsite activities which primarily occur as a result of the following activities:

- site clearance of areas including vegetation clearance, topsoil removal and storage, and earthworks
- excavation
- loading/unloading of haul trucks
- bulldozer and grader operations
- wind erosion from disturbed areas and stockpiles
- transfer points
- conveyors
- crushing and screening
- vehicle movements
- blasting and drilling

In addition, air pollutants from diesel combustion may release other air pollutants such as sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO) and trace quantities of volatile organic compounds. These substances are not considered to be emitted in sufficient quantities to affect air quality at sensitive receptors beyond the Project boundary; and have not been modelled in the air quality assessment.

### 6.1.2 Emission Estimation

Emission factors can be used to estimate emissions of TSP and $PM_{10}$ to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity.

Emission factors are used to estimate a facility's emissions by the general equation:

$$E_{i\,(kg/yr)} = \left[ A_{(t/h)} \times OP_{(h/yr)} \right] \times EF_{i\,l(kg/t)} \times \left[ 1 - \frac{CE_i}{100} \right]$$

Where:

$E_{i\,(kg/yr)}$ = Emission rate of pollutant

$A_{(t/h)}$ = Activity rate

$OP_{(h/yr)}$ = operating hours

$EF_{i\,l(kg/t)}$ = uncontrolled emission factor of pollutant

$CE_i$ = overall control efficiency for pollutant

The equations and activity rates are presented in ***Appendix A***.

### 6.1.3 Emissions Scenarios Modelled

The operational scenario representing maximum hourly activities for the BLUQ has been modelled for this assessment.

### 6.1.4 Emission Controls

Emissions controls for dust abatement were included in the emissions estimation, summarised in Table 6-2. These are consistent with dust control measures detailed in the generic Mawsons Air Quality Management Plan for the its quarries.

It should also be noted that some of the planned dust control measures are not easily quantifiable but will still serve to reduce dust emissions. The dispersion modelling study has taken a conservative approach and have not incorporated the effectiveness of these controls in the development of the emissions inventory.

- Routine visual monitoring and hazard minimisation.
- Planned activities will not occur during adverse weather conditions.
- Stockpile limits to 6m in height.
- Inherent moisture of material.
- Drill Rig fitted with engineered dust extraction / suppression as appropriate.
- Progressively establish vegetation on any topsoil/overburden stockpiles and rehabilitated landforms and in buffers.
- Material drop-height will be minimised during stockpile building.

*Table 6-1 – Project dust controls*

| Fugitive Source | Control | Emission Reduction (%) |
|---|---|---|
| Loaders on Stockpiles | Water sprays | 50 |
| Wind erosion of exposed areas (Pit & Stockpiles) | Water sprays | 50 |
| Wheel generated dust (Hauling internal and external) | Water sprays<br>Vehicle speed limits < 40km/h | 75<br>44 |
| Extraction activities (Pit) | Water sprays | 50 |
| Blasting (Pit) | - | - |
| Drilling (Pit) | Water sprays | 70 |
| Crushing | Water sprays | 50 |
| Screening | Water sprays | 50 |
| Loading trucks | Water sprays | 50 |

### 6.1.5 Emission Rates by Source

As discussed in Section 5.1, the emission estimation for individual activities has been derived from NPI Emission Estimation Technique manuals and US EPA AP42 documentation. The annual calculated emissions for TSP, $PM_{10}$ and $PM_{2.5}$ are presented in for each source type. It should be noted that all sources are classed as fugitive and there are no point sources associated with this project.

It is also noted that while blasting and drilling activities are proposed to occur at BLUQ on only a monthly basis, they are modelled between 7:00 am and 5:00 pm, Monday to Friday.

Furthermore, the maximum emission rates in g/s do not change between scenario.

*Table 6-2 - Calculated Annual Emissions by Source (g/s)*

| Fugitive Source | TSP | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| Extraction, loading and unloading activities | 2.21 | 1.03 | 0.34 |
| Wind erosion – Pits and stockpiles | 2.57 | 1.29 | 0.64 |
| Wheel generated dust | 6.09 | 1.67 | 0.16 |
| Blasting and drilling | 0.04 | 0.02 | 0.00 |
| Crushing | 2.32 | 0.89 | 0.05 |
| **Total** | **13.23** | **4.90** | **1.19** |

Emission rates for RCS were conservatively derived from a petrographic report prepared by Geochempet Services of a concrete aggregate mixed sample collected at the Mawsons site as 34% of the PM2.5 emissions.

## 6.2 Air Dispersion Modelling Methodology

The meteorological data used in the dispersion modelling was processed in two steps. Synoptic scale meteorological data were first processed in The Air Pollution Model (TAPM) for supplementary data and then further processed with reference to the EPA Victoria guidelines "Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD)" to produce the wind field and weather data suitable for dispersion modelling with AERMOD. The TAPM modelling methodology is discussed in Section 5.2.1.

### 6.2.1 TAPM

The Air Pollution Model, or TAPM, is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research. TAPM solves the fundamental fluid dynamics and scalar transport equations to predict meteorology and (optionally) pollutant concentrations. It consists of coupled prognostic meteorological and air pollution concentration components. The model predicts airflow important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses. TAPM's output for five consecutive years was exported as a surface and upper air station approximating to the site location.

TAPM was configured as follows:

- Centre coordinates – 36°55' S, 144°1' E;
- Dates modelled:
    - 30 December 2016 to 1 January 2018 (2 start-up days)
    - 30 December 2017 to 1 January 2019 (2 start-up days)
    - 30 December 2018 to 1 January 2020 (2 start-up days)
    - 30 December 2019 to 1 January 2021 (2 start-up days)
    - 30 December 2020 to 1 January 2022 (2 start-up days)
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
- 41 x 41 grid points for all modelling domains;
- 25 vertical levels from 10 m to an altitude of 8000 m above sea level; and
- The default TAPM databases for terrain, land use and meteorology were used in the model.

### 6.2.2 Measured Meteorological Data Inputs

Measured hourly meteorological data from the BoM Station at Bendigo was used for compilation of the 5 year dataset for modelling including:

- 10m wind direction and wind speed; and

- Ambient temperature

### 6.2.3 AERMOD

Dispersion modelling of the emission source parameters outlined in Section 5.1.4, was undertaken using the currently approved version of the regulatory model in Victoria AERMOD. The following sections discuss the key inputs adopted for the modelling.

#### 6.2.3.1 Receptor Grid

The AERMOD receptor grid was set with a total of 30,022 receptors with a southwest corner coordinates of 229425m E and 5906575m S using 50m resolution. The receptor grid also included 22 sensitive receptors representative of the closest residences to the BLUQ.

#### 6.2.3.2 Averaging Period

Post processing of the 1-hour, 24-hour and annual average predictions.

#### 6.2.3.3 Terrain

The terrain in the surrounding environment was derived from one-second (30m resolution) DEM.

#### 6.2.3.4 Background

As discussed in Section 5.3, the NPI database identifies no reporting sources of air pollution emissions in the surrounding 20 km from the BLUQ. Furthermore, baseline air quality data collected by Mawsons since March 2022 measured very low concentrations of particles of the order of < 5μg/m$^3$. Background air quality may therefore be primarily dust emissions from agricultural practices; wind generated from exposed areas, and remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. Therefore, given the remoteness of the BLUQ location and large distance to the nearest sensitive receptor combined with the measured low background concentrations of dust in the surrounding environment, a background dataset is not incorporated into the modelling assessment.

#### 6.2.3.5 Modelling Source Input Parameters

The particulate sources were modelled in accordance with the EPA Victoria recommendation with a volume source approximation used for cases when the key receptors are sufficiently distant from the source. Multiple volume sources were used to represent area sources such as wind erosion and haul roads.

As specified by EPA Victoria dry and wet deposition options for PM10 and PM2.5 were not modelled.

# 7 Results

Comparison of the modelled results to the assessment criteria is intended to provide an objective evaluation of the potential impact of the operations at the nearest sensitive receptors. Modelled ground-level concentrations for key air pollutants have been compared to the AQACs in the following sections to determine the potential impacts. Contour plots showing the spatial distribution of the maximum predictions are provided in ***Appendix B***.

As discussed in Section 4.2, AQACs are not intended to be concentrations one can 'pollute up to'. They are also not concentrations below which no action is required. The model results presented apply to the predicted incremental impact. Dust abatement controls that are currently adopted as standard practice at other Mawsons Quarries which can be quantified have been accounted for in the model.

## 7.1 PM10

The maximum predicted 24 hour and annual average PM10 concentrations at the 22 sensitive receptors are presented in Table 7-1.

The model predictions for 24 hour average PM10 and annual average PM10 are all below the criteria of 50 μg/m$^3$ and 20 μg/m$^3$.

*Table 7-1: Predicted 24 Hour and Annual Average PM10 Concentrations*

| ID | Predicted 24 Hour Average PM10 Concentrations (μg/m$^3$) | Predicted Annual Average PM10 Concentrations (μg/m$^3$) |
|---|---|---|
| R1 | 5.58 | 0.56 |
| R2 | 3.40 | 0.19 |
| R3 | 4.19 | 0.30 |
| R4 | 1.86 | 0.07 |
| R5 | 2.42 | 0.08 |
| R6 | 4.00 | 0.32 |
| R7 | 5.60 | 0.27 |
| R8 | 2.43 | 0.22 |
| R9 | 4.30 | 0.24 |
| R10 | 4.00 | 0.34 |
| R11 | 2.83 | 0.25 |
| R12 | 4.21 | 0.25 |
| R13 | 7.56 | 0.27 |
| R14 | 5.51 | 0.26 |
| R15 | 6.18 | 0.31 |
| R16 | 4.97 | 0.27 |
| R17 | 5.03 | 0.53 |
| R18 | 12.36 | 0.53 |
| R19 | 8.89 | 0.34 |
| R20 | 8.49 | 0.37 |
| R21 | 6.20 | 0.26 |
| R22 | 5.53 | 0.25 |
| **AQAC** | **50** | **20** |

## 7.2 PM2.5

The maximum predicted 24 hour and annual average PM2.5 at the 22 sensitive receptors are presented in Table 7-2.

The model predictions for 24 hour average PM2.5 and annual average PM2.5 are all below the criteria of 25 μg/m$^3$ and 8 μg/m$^3$.

*Table 7-2: Predicted 24 Hour and Annual Average PM2.5 Concentrations*

| ID | Predicted 24 Hour Average PM2.5 Concentrations (µg/m³) | Predicted Annual Average PM2.5 Concentrations (µg/m³) |
|---|---|---|
| R1 | 1.93 | 0.17 |
| R2 | 1.47 | 0.07 |
| R3 | 1.85 | 0.11 |
| R4 | 0.70 | 0.03 |
| R5 | 0.85 | 0.03 |
| R6 | 1.75 | 0.13 |
| R7 | 2.79 | 0.11 |
| R8 | 0.86 | 0.09 |
| R9 | 2.14 | 0.10 |
| R10 | 1.21 | 0.14 |
| R11 | 1.26 | 0.10 |
| R12 | 2.02 | 0.11 |
| R13 | 3.63 | 0.11 |
| R14 | 1.97 | 0.11 |
| R15 | 2.36 | 0.13 |
| R16 | 2.40 | 0.12 |
| R17 | 2.29 | 0.21 |
| R18 | 5.19 | 0.22 |
| R19 | 4.42 | 0.14 |
| R20 | 2.87 | 0.15 |
| R21 | 2.14 | 0.11 |
| R22 | 1.97 | 0.10 |
| **AQAC** | **25** | **8** |

## 7.3 Dust Deposition

The maximum predicted monthly average dust deposition at the 22 sensitive receptors are presented in *Table 7-3*

The model predictions for maximum monthly average dust deposition are well below the criteria of 2 g/m²/month and 4 g/m²/month.

*Table 7-3: Predicted Monthly Average Dust Deposition*

| ID | Predicted Monthly Average Dust Deposition (g/m²) |
|---|---|
| R1 | 0.12 |
| R2 | 0.03 |
| R3 | 0.07 |
| R4 | 0.01 |
| R5 | 0.03 |
| R6 | 0.04 |
| R7 | 0.03 |
| R8 | 0.03 |
| R9 | 0.03 |
| R10 | 0.06 |
| R11 | 0.03 |
| R12 | 0.03 |
| R13 | 0.03 |
| R14 | 0.03 |
| R15 | 0.03 |

| ID | Predicted Monthly Average Dust Deposition (g/m²) |
|---|---|
| R16 | 0.03 |
| R17 | 0.10 |
| R18 | 0.06 |
| R19 | 0.03 |
| R20 | 0.03 |
| R21 | 0.02 |
| R22 | 0.02 |
| **AQAC** | **2 & 4** |

## 7.4 Silica

The annual average RCS at the 22 sensitive receptors are presented in Table 7-4.

The model predictions for annual average RCS are well below the criteria of 3 μg/m³.

*Table 7-4: Predicted Annual Average RCS Concentrations*

| ID | Predicted Annual Average RCS (μg/m³) |
|---|---|
| R1 | 0.06 |
| R2 | 0.02 |
| R3 | 0.04 |
| R4 | 0.01 |
| R5 | 0.01 |
| R6 | 0.05 |
| R7 | 0.04 |
| R8 | 0.03 |
| R9 | 0.03 |
| R10 | 0.05 |
| R11 | 0.04 |
| R12 | 0.04 |
| R13 | 0.04 |
| R14 | 0.04 |
| R15 | 0.04 |
| R16 | 0.04 |
| R17 | 0.07 |
| R18 | 0.07 |
| R19 | 0.05 |
| R20 | 0.05 |
| R21 | 0.04 |
| R22 | 0.03 |
| **AQAC** | **3** |

# 8 Mitigation and Monitoring

## 8.1 General Dust Control Measures

As outlined in Section 6.1.4, the Mawsons Air Quality Management Plan sets out general dust control measures including:

- Minimise the potential for dust emissions from the product stockpile by either watering, where practical;
- Minimise the potential for dust emissions from the haul roads by paving haul road three and watering the haul roads when dust is visible especially during dry conditions;
- Routine visual monitoring and hazard minimisation.
- Planned activities will not occur during adverse weather conditions.
- Stockpile limits to 6m in height.
- Inherent moisture of material.
- Drill Rig fitted with engineered dust extraction / suppression as appropriate.
- Progressively establish vegetation on any topsoil/overburden stockpiles and rehabilitated landforms and in buffers.
- Material drop-height will be minimised during stockpile building.

## 8.2 Community Consultation

It is noted that Mawsons has undertaken community consultation of the closest receptors to inform potentially affected individuals about and steps being taken to minimize risks.

## 8.3 Air Monitoring Network

In the Guideline for Assessing and Minimising Air Pollution in Victoria, the EPA state that they are moving away from dust deposition monitoring due to a more proactive real-time data collection methods for $PM_{10}$. A cost/benefit analysis of Hi-Volume Sampling, Tapered Element Oscillating Microbalance (TEOM) and a light scattering particle measuring instrument (e.g. DustTrak) is undertaken, as shown in Table 8-1.

*Table 8-1: $PM_{10}$ Measurement Technique Cost Benefit Analysis*

| Measurement Technique | Benefits | Disadvantages | Australian Standard |
|---|---|---|---|
| **Dust deposition sampling** | A dust deposition gauge consisting of a stainless steel fabricated stand and padded bottle holder, a 5L glass bottle, glass funnel and silicone bung is used to collect dust for 30±2 days and mass per unit area subsequently determined in a laboratory | Time resolution is limited to 1 month and the results are only available several weeks after the measurement. | AS/NZS 3580.10.1:2016 |
| **Hi-Volume Sampler** | The particulate concentration is calculated at a laboratory based on the total mass of the sample divided by the volume of air drawn through the filter paper. | Time resolution is limited to 24 hour and the results are only available several days/weeks after the measurement. Estimated precision - ±2 $\mu g/m^3$ | AS/NZS 3580.9.6:2003 |
| **TEOM** | Provide real-time data with short resolution (<1 hour) that can be used for proactive particulate control. Estimated precision - ±0.5 $\mu g/m^3$ | High capital costs. | AS/NZS 3580.9.8-2001 |

| | | | |
|---|---|---|---|
| **Portable Light Scattering** | Provide an approximation of real-time concentration data with short resolution (<1 hour) that can be used for proactive particulate control.<br>Estimated precision - ±0.5 µg/m$^3$ | Not Australian Standard | - |

Based on this assessment, consideration should be given to install and maintain a light scattering particle measuring instrument (e.g. DustTrak) at the fence-line of the proposed BLUQ. Additionally, the installation of a meteorological station would be beneficial to provide more accurate wind conditions.

The installation of these instruments will allow proactive dust management techniques to be employed to reduce the likelihood of complaints and exceedances.

It is noted that Mawsons is currently undertaking such a measurement program and it is recommended this is continued.

# 9 Conclusion

An Air Quality Impact Assessment has been carried out in support of a to support a Work Authority application to develop the Blue Hills Quarry (BLUQ) approximately 10km northwest of Maldon in the Mount Alexander Shire Council local government area.

As summarised in Table 9-1, the results of the modelling have shown that while a conservative approach has been adopted for the assessment, the modelled concentrations at all sensitive receptors are predicted to be below the criteria.

*Table 9-1 - Summary of Results*

| Pollutant | Averaging Period | Criteria | Maximum predicted at any receptor | Compliant |
|---|---|---|---|---|
| RCS | 1-year | 3 µg/m³ | 0.07 µg/m³ | ✓ |
| $PM_{10}$ | 24-hour | 50 µg/m³ | 12.36 µg/m³ | ✓ |
| | Annual | 20 µg/m³ | 0.56 µg/m³ | ✓ |
| $PM_{2.5}$ | 24-hour | 25 µg/m³ | 5.19 µg/m³ | ✓ |
| | Annual | 8 µg/m³ | 0.22 µg/m³ | ✓ |
| Dust Deposition | 1-month | 2 g/m²/month | 0.12 g/m²/month | ✓ |
| | | 4 g/m²/month | 0.12 g/m²/month | ✓ |

# Appendix A Sensitive Receptor Locations

| Air Sensitive Receiver | Coordinates | | Observation |
|---|---|---|---|
| R1 | 231418 | 5909864 | Approx. 2.2 km to the west |
| R2 | 232915 | 5907044 | Approx. 3.2 km to the south south-west |
| R3 | 233876 | 5907953 | Approx. 1.7 km to the south |
| R4 | 238584 | 5907745 | Approx. 4.3 km to the south-east |
| R5 | 238854 | 5908510 | Approx. 4.2 km to the east south-east |
| R6 | 235882 | 5912239 | Approx. 2.5 km to the north |
| R7 | 235744 | 5913169 | Approx. 3.1 km to the north |
| R8 | 235551 | 5913689 | Approx. 2.9 km to the north |
| R9 | 235341 | 5913801 | Approx. 2.9 km to the north |
| R10 | 235159 | 5912265 | Approx. 2.1 km to the north |
| R11 | 234994 | 5913685 | Approx. 3.6 km to the north |
| R12 | 234691 | 5913834 | Approx. 3.7 km to the north |
| R13 | 234486 | 5913748 | Approx. 3.7 km to the north |
| R14 | 234376 | 5913968 | Approx. 3.7 km to the north |
| R15 | 234309 | 5913612 | Approx. 3.5 km to the north |
| R16 | 234198 | 5913846 | Approx. 3.6 km to the north |
| R17 | 234126 | 5911597 | Approx. 1.9 km to the north |
| R18 | 234096 | 5912154 | Approx. 1.3 km to the north |
| R19 | 233272 | 5913581 | Approx. 3.3 km to the north |
| R20 | 232771 | 5913207 | Approx. 3.1 km to the north-north west |
| R21 | 230972 | 5913532 | Approx. 4.4 km to the north west |
| R22 | 230764 | 5913538 | Approx. 4.5 km to the north west |

# Appendix B Emissions Estimation

## Emission Estimation

The major air emission from extraction activities is fugitive dust. Emission factors can be used to estimate emissions of TSP, $PM_{10}$ and $PM_{2.5}$ to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity.

The National Pollutant Inventory Emission Estimation Technique Manual for Mining (January 2012) provide the equations and emission factors to determine the emissions of TSP and $PM_{10}$ from mining and quarrying activities. These emission factors incorporate emission factors published by the USEPA in their AP-42 documentation.

The default emission rates in the NPI EET for Mining and US EPA AP42 have been used for the estimation of emissions for all activities.

## Activity Overview

Tables A-1 and A-2 summarise the emission factors and key parameters applied in the emissions estimation.

*Table A 1 - Source Type Emission Factors applied*

| Source type | Default TSP Emission factor | Derived TSP Emission factor | $PM_{10}$/TSP ratio | $PM_{2.5}$/TSP ratio | Units |
|---|---|---|---|---|---|
| **Pit Activities** | | | | | |
| Excavator/FEL on Overburden | 0.025 | - | 0.47 | 0.105 | kg/t |
| Dumping overburden | 0.012 | - | 0.36 | 0.105 | kg/t |
| **Blasting/drilling:** | | | | | |
| Drilling | 0.59 | - | 0.52 | 0.052 | kg/hole |
| Blasting | - | 6.23 | 0.47 | 0.047 | kg/blast |
| **Wind erosion:** | | | | | |
| stockpiles/pits/haul roads | 0.4 | | 0.5 | 0.075 | kg/ha/h |
| **Processing & Handling:** | | | | | |
| Crushing | 0.0027 | - | 0.44 | 0.083 | kg/t |
| Loading trucks | 0.0004 | - | 0.42 | 0.105 | kg/t |
| **Wheel generated dust:** | | | | | |
| Unpaved roads | 4.23 | - | 0.3 | 0.02 | kg/VKT |

*Table A 2 - Parameters applied in emissions estimation*

| Parameter ID | Value | Units | Description | Data source |
|---|---|---|---|---|
| W | 37 and 61 | t | Truck capacity | client supplied |
| Holes | 100 | Holes/day | Holes drilled per day | Estimate |
| A | 930 | $m^2$/blast | Area blasted | Default |
| B | 1 | Blast/month[1] | Blast per month | Client supplied |
| t | 305 | t/hour | Maximum hourly extraction rate | Client supplied |
| t | 360 | t/hour | Maximum hourly primary crushing rate | Client supplied |
| t | 324 | t/hour | Maximum hourly secondary crushing rate | Client supplied |
| t | 131 | t/hour | Maximum hourly tertiary crushing rate | Client supplied |
| t | 3,660 | t/day | Maximum daily hauling | estimated |

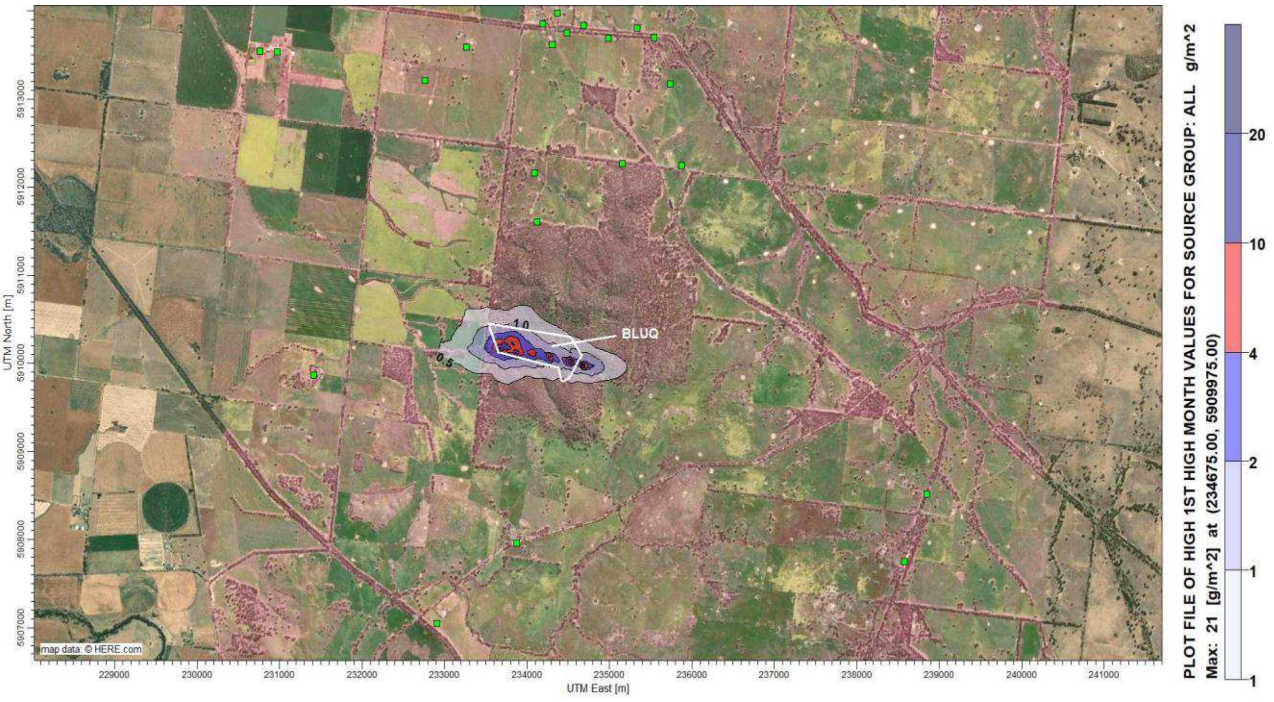
1 Note blasting was conservatively modelled as once per day between 7am and 5pm Monday to Friday

**Haul Roads**

Haul road parameters estimated and incorporated into the model are summarised below.

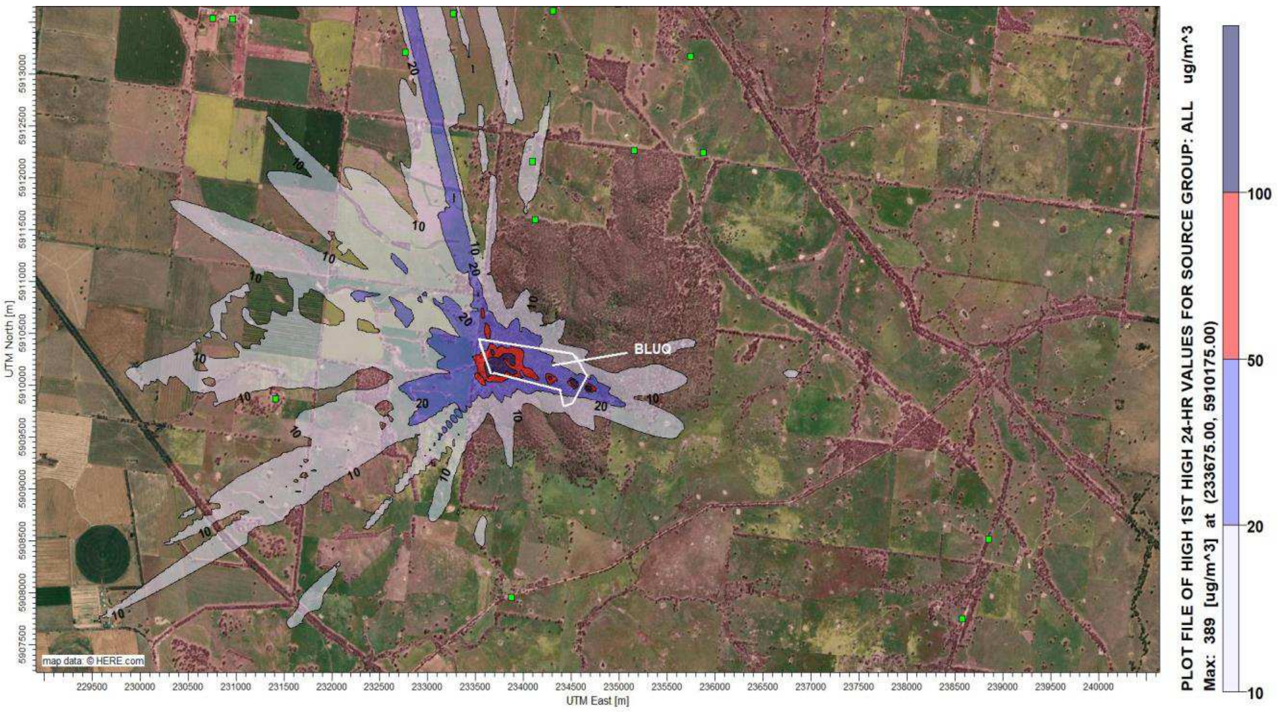
| Site | Total Haul Road Length (km) | VKT/hr |
|---|---|---|
| For external | 4.2 | 42 |
| Internal | 1.5 | 25 |

# APPENDIX B Isopleth Plots



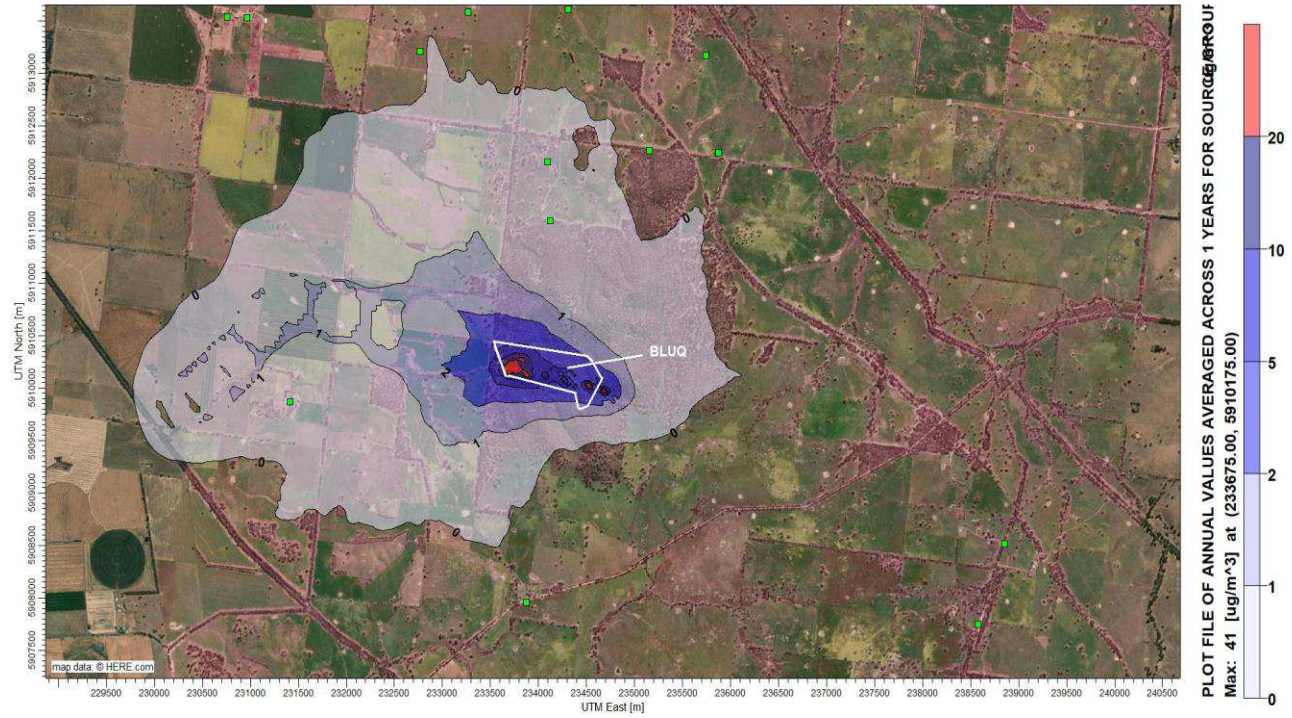

| **Pollutant:** Dust Deposition | **Averaging Period:** 1-month | **Percentile:** MAX | **Criteria:** 2 & 4 g/m$^2$/month |
|---|---|---|---|

*Figure B 1 - Predicted maximum 1-month average deposition – Dust Deposition*




| Pollutant: | Averaging Period: | Percentile: | Criteria: |
|---|---|---|---|
| $PM_{10}$ | 24-hour | MAX | 50 µg/m$^3$ |

*Figure B 2 - Predicted maximum 24-hour average concentrations – $PM_{10}$*




| Pollutant: | Averaging Period: | Percentile: | Criteria: |
|---|---|---|---|
| $PM_{10}$ | Annual | Average | 20 µg/m$^3$ |

*Figure B 3 - Predicted maximum annual average concentrations – $PM_{10}$*


| Pollutant: | Averaging Period: | Percentile: | Criteria: |
|---|---|---|---|
| RCS | 1-year | AVERAGE | 3 µg/m$^3$ |

*Figure B 4 - Predicted 1-year average concentrations – RCS*


| Pollutant: | Averaging Period: | Percentile: | Criteria: |
|---|---|---|---|
| $PM_{2.5}$ | 24-hour | MAX | 25 µg/m$^3$ |

*Figure B 5 - Predicted maximum 24-hour average concentrations – $PM_{2.5}$*


| Pollutant:<br>$PM_{2.5}$ | Averaging Period:<br>Annual | Percentile:<br>Average | Criteria:<br>8 µg/m$^3$ |
|---|---|---|---|

*Figure B 6 - Predicted maximum annual average $PM_{2.5}$ concentration*