INDEPENDENT REVIEW OF HUMAN HEALTH RISK ASSESSMENT

DOWE'S QUARRY, TENTERFIELD

Tenterfield Shire Council

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Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

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Dowe's Quarry, Tenterfield

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1 INTRODUCTION

Todoroski Air Sciences has been engaged by Tenterfield Shire Council to review and prepare independent advice in relation to the Human Health Risk Assessment (HHRA) prepared for the Dowe's Quarry Expansion near Tenterfield, New South Wales (NSW) (hereafter referred to as the Project).

This report reviews the *Human Health Risk Assessment for Respirable Crystalline Silica: Expansion of Dowe's Quarry* (**EnRisks 2020**), and also the relevant supporting documentation for the Project that the HHRA relies on, including the *Dowe's Quarry Air Quality Impact Assessment* (AQIA) (**Northstar, 2019**).

The Todoroski Air Sciences reviewer has over 30 years of experience in assessing and managing environmental dust, with specific expertise in mining and quarrying, including high risk toxic dusts, such as crystalline silica, various metals and more. The reviewer held senior roles at the NSW EPA for ten years and was responsible for environmental regulation of respirable crystalline silica during that time.

The reviewer declares that they have no conflicting company or private interests related to the Project, and are independent of the Project.

1.1 Scope of work

Our scope of work is as follows:

The independent review must be undertaken and reported to the panel by 31 March 2021 and must:

- *Consider the adequacy of the Human Health Risk Assessment and the proposed mitigation measures for emissions of respirable crystalline silica in the workplace and in the surrounding community.*
- *Identify any gaps in the documentation, analysis, assessment and recommendations.*
- *Propose any other measures that could reasonably be applied to manage and mitigate the emission of respirable crystalline silica.*

2 PROJECT OVERVIEW

The Dowe's Quarry is located approximately 8 kilometres (km) northeast of Tenterfield and has been operating at that site since 1987. It currently has approval to extract up to 150,000 tonnes per annum (tpa) of quartzose material from a disturbance area of approximately 6.7 hectares (ha) and to also store a range of fine materials generated through processing the raw materials. Processing is conducted at the processing plant located approximately 10km northwest of Tenterfield.

The Project involves the proposed continued operations and expansion of extraction activities within the quarry. This includes ongoing extraction within the existing extraction area and additional 4.4ha of area, an increase in production to 230,000tpa. Crushing and screening of extracted material at the quarry to be performed within the extraction area, and there would be ongoing transportation of the quarried material.

A site layout for the quarry is presented in **Figure 2-1**.

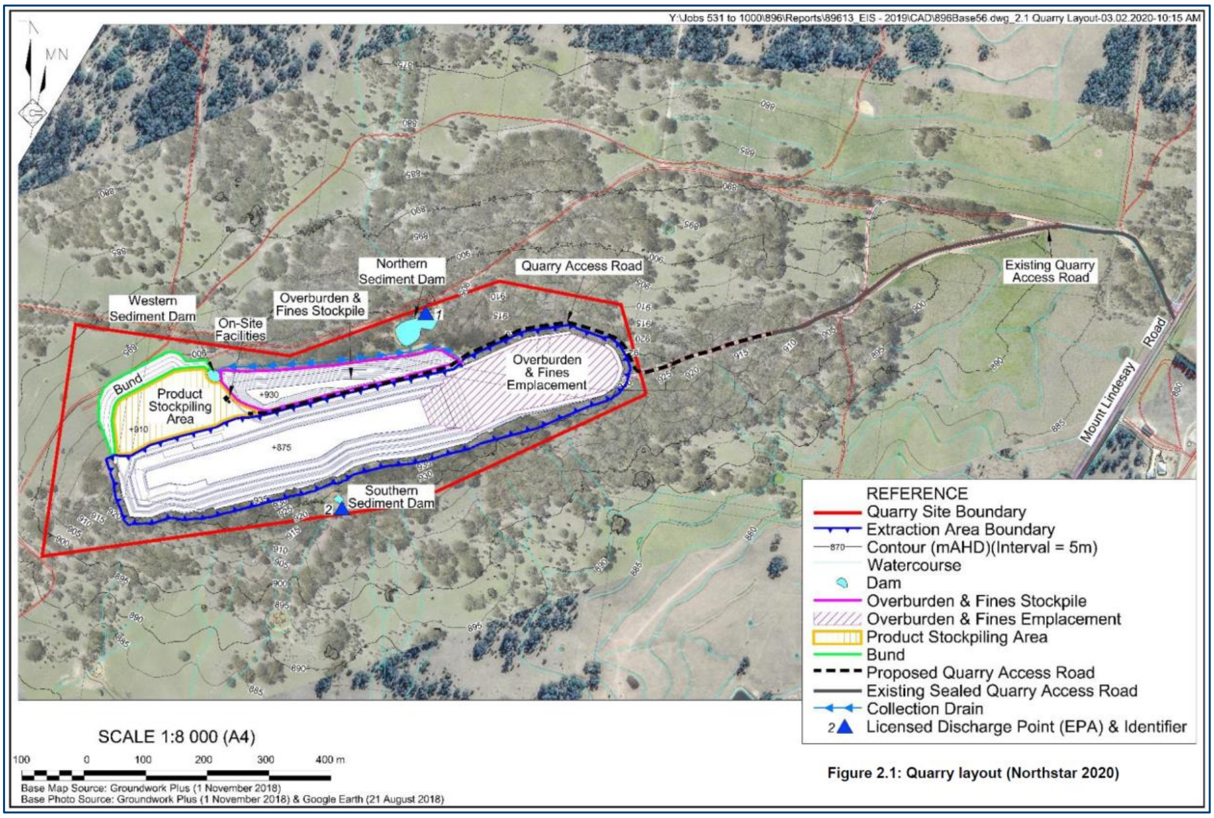


Figure 2-1: Site layout for the quarry

The Project would make the following key changes to the current operation:

- the inclusion of mobile crushing and screening plant at the quarry; and,
- an increase in production of 80,000tpa (which is an approximate 53% increase from existing approved operations of 150,000 taking them to 230,000tpa).

3 REVIEW OF THE HHRA

The key components of the HHRA have been examined and are discussed below.

The approach adopted by the HHRA follows the framework for risk assessment in the *Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards* (**enHealth, 2012a**) and utilises guidelines/protocols in *Australian Exposure Factor Guide* (**enHealth, 2012b**) and relevant National Environmental Protection Measure documents.

The HHRA considers other protocols and guidelines from overseas, insofar as they are consistent with Australian regulations and policies.

The HHRA considered the available information on respirable crystalline silica and provides a summary of this. A review of respirable crystalline silica toxicity on human health is made, and sets out the appropriate screening level guidelines. These guidelines were used as the basis of the HHRA's assessment of risks to human health. Uncertainties in the outcome were also considered reasonably.

Based on our review, the HHRA is comprehensive, and applies the correct Australian guidelines. The calculations it has made appear to be correct, and cover all of the key aspects required. The input data has been correctly taken from the AQIA.

The HHRA identifies the health risks associated with the Project, and concludes that *"…health risks to residents in existing properties adjacent to the Quarry are low and acceptable".*

The material produced at the Project is a graded fractured quartoze rock blend and comprises 99.5% silica. Silica is a commonly occurring mineral and exposure via inhalation is recognised as an important occupation inhalation hazard. Studies have indicated a positive association between worker exposure and health risk however there is limited data on the environmental exposure.

To assess the health risk associated with the Project, the HHRA relies significantly on air dispersion modelling predictions, which are presented in the AQIA. The AQIA assesses the activities proposed for the Project and, with appropriate emission factors, estimates the amount of dust generated. An air dispersion model was used to predict the extent of the dust impacts in the surrounding environment that would arise when all of the estimated dust is emitted from the Site. Further detail regarding the methodology of the AQIA is discussed in the following section.

It is important to note that the HHRA assumes that 100% of the predicted dust levels in the AQIA are comprised of respirable crystalline silica. This is conservative and will overestimate the likely actual amount of respirable crystalline silica. We note that the dust emissions from the Project would not be 100% respirable crystalline silica and will include a range of other particulate emissions, for example particles generated from the exhaust of equipment at the Project and from the handling of topsoil and overburden material. In general, the fraction of respirable crystalline silica in the dust from quartz processing facilities is low, and the highest estimates are that it can make up approximately half of the fine dust, e.g. per Texas Commission on Environmental Quality.

The assumptions made in the HHRA are supported by the review, and are considered to be conservative (overestimate impact).

Particulate respirable crystalline silica is investigated at three key residential properties surrounding the quarry in the HHRA, including:

- Property 12 (BL & JA Morrow);
- Property 13 (RM & S Ibbett); and
- Property 3A (RF & LL Tumbridge.

These nearest properties are located approximately 1300m from the boundary to the east and approximately 540m to the west. **Figure 3-1** presents the location of the properties relative to the Project. Note that property 1 is part of the Project.

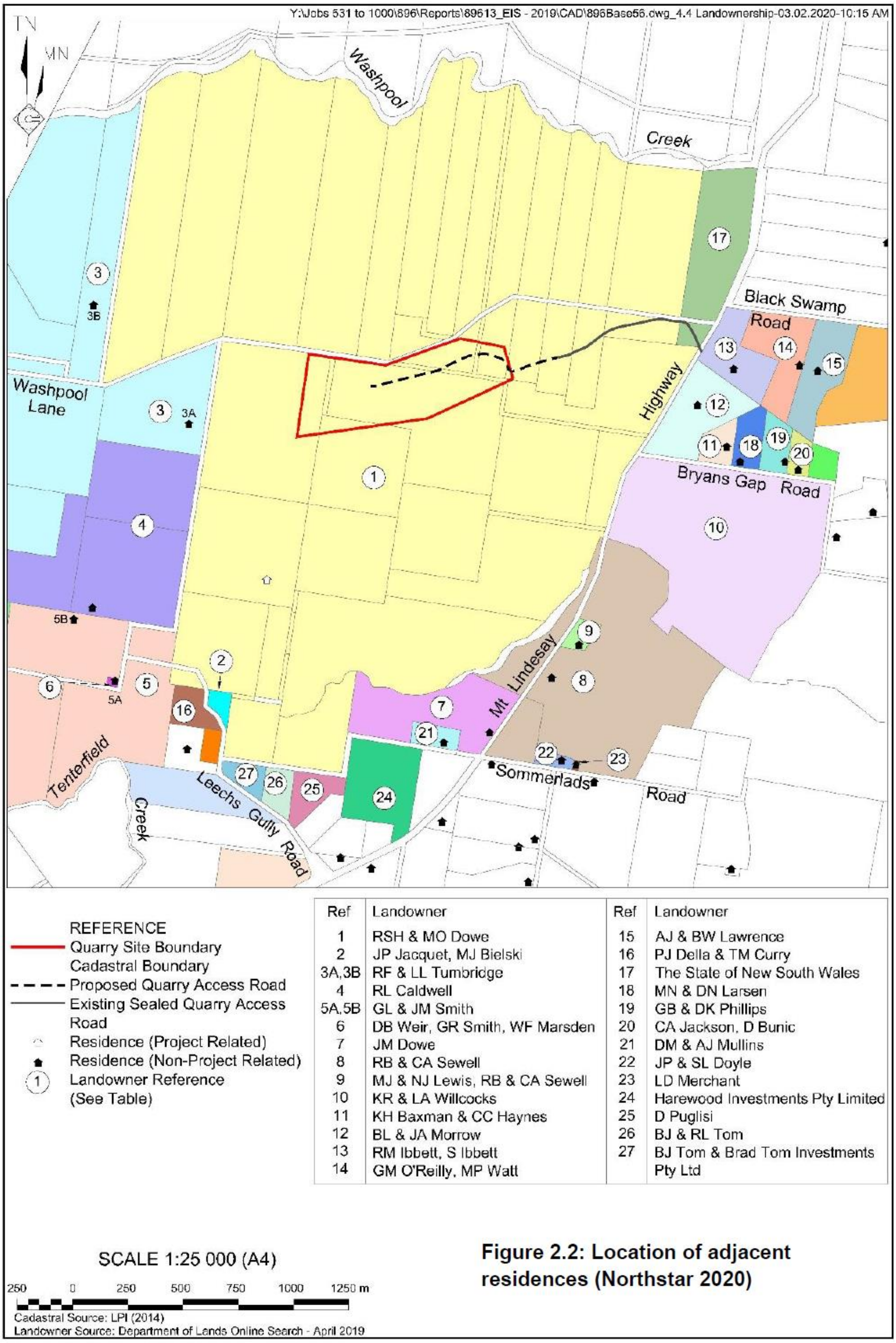


Figure 3-1: Residential receptor locations

Table 3-1 presents a summary of the predicted air quality levels at the receptors (taken from the AQIA and HHRA). These receptors are the closest identified receptors to the Project and would experience the highest dust levels.

Table 3-1: Summary of predicted air quality levels due to the Project

Receptor	$PM_{2.5}$		PM_{10}	
	24-hour average	Annual average	24-hour average	Annual average
Property 12	0.9	0.1	5.4	0.5
Property 13	0.8	0.1	7.5	0.4
Property 3A	2.9	0.2	19.9	1.3
Maximum	**2.9**	**0.2**	**19.9**	**1.3**

The toxicity reference values presented in Table 3.1 of the HHRA show occupational guidelines and community air guidelines. NSW does not have community air guidelines for respirable crystalline silica and the HHRA has adopted the Victoria (**VIC EPA, 2007**) guidelines for respirable crystalline silica, as $PM_{2.5}$ of 3µg/m^3.

The maximum off-site $PM_{2.5}$ concentration for all dust due to the Project is 0.2µg/m^3 and is predicted at the most impacted residential receptor. This is 15 times below the guideline level for respirable crystalline silica alone and shows that the Project would comply with criteria by a large margin.

The HHRA identifies that maintenance staff at the quarry would wear personal protective equipment (PPE) including personally fitted masks (P2 type). The review agrees that this is the correct type of PPE to use. It is generally not suitable for any permanent staff working in any dusty areas to use flimsy paper/ cloth masks, even those with a P2 rating. Personally fitted P2 masks will have soft rubber seals, one way air valves, and several sizes or types will be needed to adequately fit various workers. Any regular workers must wear PPE within 100m of the drill rigs or crusher must also be cleanly shaven, as a beard or stubble makes the P2 mask ineffective.

To directly respond to the questions asked in the scope of work regarding additional mitigation, the review considers that:

- mobile plant which handles materials containing silica should be fitted with sealed cabins, that have HEPA filtration installed;
- the site should pay most attention to minimising worker exposure to dust near the drill rigs and the crusher, including the wearing of PPE outdoors within 100m of these plant items.

Further recommendations for cleaning plant cabins, and blasting controls are set out in the summary and conclusions.

4 REVIEW OF AQIA

As the HHRA is based on the air dispersion modelling prediction in the AQIA, the key aspects of the AQIA (**Northstar Air Quality, 2019**) have also been examined and are discussed below.

The AQIA assesses potential air quality impacts associated with the Project using the CALPUFF air dispersion model. The CALPUFF air dispersion model is a regulatory air dispersion model endorsed by the NSW EPA for the use in impact assessments.

Air dispersion modelling comprises of essentially two key input elements – meteorology to drive the dispersion of air pollutants in the modelling domain and emission estimation to determine the amount of air pollution released into the air.

For the meteorological component, prognostic meteorological data were generated using TAPM. A comparison of the TAPM generated data is presented in Annexure 1 of the AQIA. The use of TAPM as an input into the CALPUFF model is an acceptable approach and generally follows the applicable guidelines. The results appear to be reasonable.

For the emission estimation, emission factors published by the US EPA were applied. These factors are coupled with the intensity of activity at the Project to estimate the total dust emissions. **Table 4-1** presents a summary of the estimated dust emissions.

Table 4-1: Summary of estimated dust emissions for the Project

Modelling scenario	TSP	PM10	PM2.5	Units
Stage 1	51,372	17,800	2,078	kg/year
Stage 2	48,811	18,115	2,189	kg/year
Stage 1 – Peak daily	161.2	58.9	7.0	kg/day
Stage 2 – Peak daily	164.4	64.3	8.0	kg/day

It is noted that two sets of emissions inventories are produced, one is for annual average emissions, and the other for a peak day of activity which can have above average emission rates. Whilst the emissions estimated for the peak activity day are somewhat low, this is not important as the criteria we are interested in apply to the annual average results, which are (of course) based on the estimated annual average emissions.

Proposed dust mitigation measures are outlined in Section 2.3 of the HHRA and in Annexure 3 of the AQIA which indicate how they have been incorporated into the modelling.

The emission controls incorporated into the AQIA include:

- Dust collection on drill rig – 90% control
- Limited speed on site unpaved haul road – 44% control
- Water sprays on crushing – 77% control
- Water sprays on screening – 91.2% controls
- Water sprays on transfer points – 50% control
- Pit retention for activites in pit – 50% control for TSP, 5% for PM_{10} and $PM_{2.5}$
- Level 1 watering on unpaved haul roads – 50% control.

These control levels are reasonable, practical, and in some cases potentially lower emissions (by achieving higher control levels in practice) are likely. The indication from this is that there may be some overestimation in the predicted results, making them higher than may actually occur. This is especially the case for the single largest source of dust which is wheel generated dust on unpaved roads, where the high end of the range of likely dust control is applied. This is conservative, and thus acceptable to the review.

Overall, whilst it is normal for there to be minor differences in the modelling assumptions and preferences between experts, the review did not find any that are noteworthy, or that would lead to any tangible underestimations in the AQIA. The review thus considers that the results and conclusions of the AQIA, which directly affect the HHRA, are reliable, and that the AQIA and HHRA propose realistic and achievable control and mitigation measures that can be implemented to ensure no adverse impacts would arise off-site.

5 DISCUSSION

The material produced at the Project is a graded fractured quartoze rock blend and comprises 99.5% silica.

To the layperson this may appear to be alarming, especially as in recent years there have been more reports regarding health issues caused by respirable crystalline silica and the harm experienced by workers in the cement and kitchen benchtop industry.

It is therefore crucially important to understand that whilst almost all of the quarried product is silica, this does not mean that almost all of the dust generated is silica in a harmful from, which is respirable crystalline silica. Respirable crystalline silica will only be a small fraction of any dust emissions from the quarry, as verified by direct testing.

Respirable crystalline silica would be present as part of the typically less than 5% of microscopically small dust material that can be generated at the quarry.

However, the activities at the quarry that generate dust, including dust from the product, include general material handling activities using large plant items, and crushing and processing the material. These activities are all coarse mechanical activities and cannot physically generate significant amounts of the very fine material that is harmful.

All available studies which have measured the fraction of harmful fine material generated by mining and quarrying since the 1970's have found that only a small amount of the dust, less than approximately 5% is small enough to be in the harmful size range.

In this case, the AQIA emissions show that approximately 4 to 5% of the dust generated at the site would be in the fine $PM_{2.5}$ fraction. The HRA then assumes that all of this fine $PM_{2.5}$ dust is respirable crystalline silica, whereas in reality, it will be less.

The reason for this is that the equipment which will be used simply cannot break very much of the material down to such a small size. A direct analogy is attempting to break apart a grain of beach sand on an anvil with a hammer (noting that beach sand can be approximately 90% silica). Whilst it may be possible to strike the grain of sand hard enough break it into some smaller parts, striking it again and again cannot break very much of it down into particles which are small enough to be harmful. This is because both the face of the hammer and the anvil will flex and absorb the impact, and it is simply not possible to direct enough force into the particle to make it break down any further.

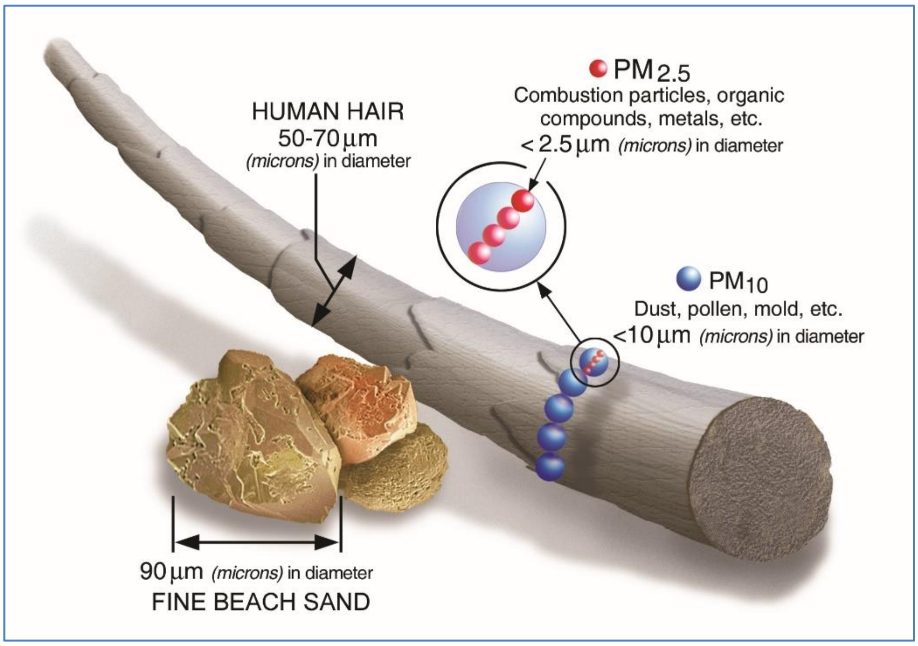
To break down particles further, high speed cutting and grinding tools are needed, not the heavy plant and crushers that would be used on site.

It is also important to understand that the dust generation at the quarry will be very different to that which occurs when cutting, grinding and polishing cement, or kitchen bench tips, or stone. These are precision industries and use very high speed, often diamond tipped cutting, grinding and polishing tools that generate a large fraction of the harmful, microscopically small particles in the dust created. Unlike mining, the dust from these industries is mostly generated by hand tools and within a metre of the workers mouth and nose. Some in these industries do not wear suitable personal protection equipment (PPE) such as a good quality dust masks, and there are documented instances of harm to workers in these industries.

It is also relevant to note the reviewer worked at the NSW EPA as the principal/ manager in the air branch, and investigated and reviewed whether NSW needed to develop environmental guidelines for crystalline silica in order to protect the community/ public. (Note that environmental guidelines are different to occupational health guidelines which protect workers in the workplace). The investigation found no need for specific criteria, as the current environmental dust criteria provides adequate protection.

That this is the case becomes evident when considering the Victorian EPA environmental criteria for crystalline silica, which is based on potential health impacts, and is for an annual average exposure level of 3.0µg/m^3 as $PM_{2.5}$.

The criterion of 3.0µg/m^3 means 3 millionths of one gram of $PM_{2.5}$ in a cubic metre of air, and $PM_{2.5}$ refers to all dust particles that are smaller than 2.5 millionths of a metre, or approximately 1/20th the diameter of a human hair, as illustrated in the diagram below from the US EPA.



Referring to. **Table 3-1** the highest predicted impact for total dust from the site is 0.2µg.m3, for annual average $PM_{2.5}$.

The review finds that the prediction is generally reliable. Only some part of this dust can be respirable crystalline silica, as part of the fine particles from the quarry will be from vehicle exhausts, and non silica dust components from the roads, and topsoil and overburden etc.

However, even if all of the dust from the quarry was 100% crystalline silica, there would need to be more than 15 times more dust, all year before the criteria are reached. Or in other words, the level of harmful crystalline silica at residences would be less than 7% of the criteria.

6 SUMMARY AND CONCLUSIONS

Todoroski Air Sciences have reviewed the HHRA, and also the key supporting information in the AQIA which is used in the HHRA.

We found that the HHRA and the AQIA are adequate and conclude that the Project would meet the relevant criteria, including for respirable crystalline silica, by a large margin.

We found that there is no valid reason to not approve the quarry expansion as it is presently proposed, and we recommend that the Project is approved.

Our response to the specific questions asked in the scope of work is set out below each question, as follows.

- *Consider the adequacy of the Human Health Risk Assessment and the proposed mitigation measures for emissions of respirable crystalline silica in the workplace and in the surrounding community.*

Our review finds that the HHRA adequately considers the risks and correctly applies the information from the AQIA. We have also reviewed the AQIA and find that it also adequately represents the potential dust levels. The HHRA assumes that 100% of the dust is crystalline silica, which is conservative and is an overestimate of any actual crystalline silica levels and the assessed risks.

In terms of proposed mitigation measures, the following is noted:

Environmental (community) mitigation measures.

The AQIA sets out specific dust control measures that will be used at the quarry, as listed in **Section 4** of this report and as proposed in the HHRA and AQIA. These measures should be implemented to minimise dust generated at the site as may then disperse into the surrounding environment where the community reside.

The relevant proposed mitigation measures are listed below, but have been adapted to a form suitable to be included as part of any approval conditions for the quarry:

- Dust collection equipment on drill rigs that prevent the release of 90% or more of the dust generated from drilling must be installed on the drill rigs, and must be used when drilling.

- The quarry access road is to be sealed with bitumen for at least 600m from the intersection with the Mount Lindesay Road.
- A maximum speed of 30km/hr must be observed for heavy vehicles travelling on the quarry access road, and a maximum speed of 10km/hr when travelling on any unpaved roads.
- Water sprays must be used when crushing - and be suitable to achieve at least 77% control relative to not using water sprays.
- Water sprays must also be used when screening – and be suitable to achieve at least 91.2% control relative to not using water sprays.
- Water sprays must be used on transfer points – and be suitable to achieve at least 91.2% control relative to not using water sprays.
- As a minimum, Level 1 watering (which means applying 1 litre of water per square metre of road surface) must be used on any dry or visibly dusty unpaved haul roads when in use - and be suitable to achieve at least 50% control relative to not watering.
- Provided that they are at least as effective or more effective, alternative dust controls may be used with written approval from the EPA, as documented in any Environmental Protection Licence (EPL).
- Additional controls, over and above those listed here or in the EPL, may be used at any time.

Occupational (worker) mitigation measures

The HHRA identifies that maintenance staff at the quarry would wear personal protective equipment (PPE) including personally fitted masks (P2 type).

- *Identify any gaps in the documentation, analysis, assessment and recommendations.*

No gaps are identified in the AQIA, HHRA or in their assessment and analysis. However, some gaps are identified in the documented/ recommended worker mitigation measures and for blasting. These are set out the next section as recommended additional mitigation measures.

- *Propose any other measures that could reasonably be applied to manage and mitigate the emission of respirable crystalline silica.*

It is recommended that the following additional mitigation measures be applied at some parts of the Project to better protect workers. It is noted that many of these measures may already be done, but this was not documented.

- All drill rigs, and any mobile plant that handles or transports silica containing materials is to have an air-tight cabin with air filtration (and air conditioning so that there is no need to open any window). The cabin air filtration must use HEPA rated filters.
- All cabins with HEPA filtration must be cleaned at least weekly, along with the mating cabin and rubber seal surfaces for doors (and openable windows if applicable), which must be inspected weekly to ensure an air-tight fit. Wiping with damp microfibre towel is adequate.

- For drill rigs, cabins and door and window seals must be cleaned, and door and window seals inspected for leaks and deterioration at the end of each shift. Wiping with damp microfibre towel is adequate. The drill rig cabin interior must be kept free of dust, and the door and window seals must be air-tight.
- A spare set of door seal rubbers must be kept on hand for any site owned drill rigs and installed immediately if any break is found during a daily inspection. Contractors must not use drill rigs with ineffective, non air-tight door or window seals at any time.
- All HEPA cabin filters must be inspected and replaced as per manufacturer's recommendations. This is especially important for the drill rigs.
- Personally fitted masks (P2 type) must be worn outdoors within 100m of any drill rig when drilling or the crusher when it is operating.

It is recommended that the following additional mitigation measures be applied for blasting at the Project to better protect workers and the environment;

- Wherever possible, blasting should be conducted between 10 am and 3 pm when the wind is not blowing towards any off-site dwelling. Blasting should be avoided when the 1-hour average wind speed is above 6m/s.

7 REFERENCES

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