17th June 2020

For the attention:
Hoagy Moscrop-Allison
Senior Planner – Major Assessment
City Development Branch
Council of City of Gold Coast

Dear **Hoagy Moscrop-Allison,**

Objection submission COM/2019/81 - Environmental Effects

Including dust and respirable dust and crystalline silica

Please find below further information that I think should be considered re this development Application and its Environmental Submission.

Respirable Crystalline Silica

If we look at the petrographic analysis supplied (Section 3.3.2 of the Noise and Dust assessment, Attachment A1). Firstly we note that it actually consists of only two paragraphs. With only the second paragraph actually containing any details in the rock samples make up as follows: "The sampled aggregate contains between 19% and 57% free silica as quartz crystal, with an average of 30% across all samples. For this assessment, a conservative assessment of the second highest percentage composition at 49% has been adopted for the assessment of potential crystalline silica impacts when assessed against an annual average exposure guideline."

There is absolutely no detailed analysis of the subject rock submitted other than a statement proclaiming: "the second highest percentage composition at 49% has been adopted for the assessment of potential crystalline silica impacts".

There is no details in the number of samples used. Whereabouts in the quarry they were sourced or the makeup of the rock or the date of the analysis which looks like it could be a 13 year old report from Attachment A1.

We would expect a reasonable PETROGRAPHIC ANALYSIS to contain details of the compound of the analysed samples. E.g. Primary Minerals followed by secondary minerals. All this very limited report tells us is there is apparently the "second highest percentage composition at 49% has been adopted" with no documentation to support this. Attachment A2 shows a more thorough example of rock analysis (from another Gold Coast quarry) that I believe should have been provided. This also shows the presence of 3% actinolite. Unfortunately this development application fails to highlight any further additional information. This, I believe, is a serious omission in allowing the planners to objectively identify the possible health risks of accepting this development application.

Modelling of Dust Data

A very important aspect of a quarry development application should be the consideration of the possible dangers of the dust emanating from the processes used on the site.

It is unfortunate that the development application, despite many years of actively quarrying the location, and thus knowing the rock constituents and the effect in their particular environment they unfortunately chose not to submit any actual data but only modelled data. And even this modelled data appears highly limited to what one would expect from a development application of this magnitude. Attachment B1 shows the very limited information that has been submitted whereas Attachment B2 shows Calpuff data (for another quarry) that I believe is far more open and should have been provided for a thorough and open analysis of the dust generated at the site.

The Nucrush submitted data consists of various Tables as per example in Attachment B3 where sensitive receptors R1 through to R18 have alleged results for the twelve month monitoring (as per requirements shown in Attachment B4). However, there is no further information available. We do not know the monitoring dates, what assumptions were made e.g. weather, wind, etc. the output at the time, the no. of haulage trucks, the vehicles operating within the site, the area allowed for wind erosion in the stockpiles, the position of the drills, etc. To be quite frank these values entered could be completely made up and no one would be any the wiser due to the lack of information provided in allowing this data to be collaborated. It really is a poor show in my opinion. And, importantly it should be remembered no blasting has been included despite the requirements stating: "Modelling is to be undertaken for a 12-month period under the worst-case scenario. Worst-case conditions are those for the periods when the maximum emissions are predicted to occur under normal operating conditions (for example when maximum earth moving activities are occurring or large areas of exposed land are expected on site) and/or where an expansion or development has maximum impact on sensitive receptors" (Attachment F2 and F3). The lack of blasting data is, in my opinion, a major oversight.

Also VicEPA standards state (Attachment F3): "For crystalline silica and other indicators that have long-term health effects annual average concentrations must be modelled with annual average background data included in the model". This has not been done.

Wind effects

Despite the complete lack of data to verify the figures submitted, it is apparent from a cursory glance that these figures are somewhat questionable. For instance observing the stage 7 Operations predicted PM2.5 annual average concentrations (Attachment B5) it can be clearly seen that the submitted data has far lower levels of PM2.5 values on the East of the site (where the separation buffers are at their narrowest). This is curious as there is normally a predominately western wind (i.e. blowing West to East) in the area (from my five years living here it has been very noticeable that the wind comes from the Tamborine Mountain direction, Westerly, towards my home). This would suggest the average reading would be higher on the East than on the West. Admittedly there is a slight ridge on the East (Attachment B6) however it is not substantial. On Attachment B5 I have marked the 5µg/m^3 distances to the East at Receptor R2 (Hopman Court) and to the West also. From this you can see the 5µg/m^3 dust boundary extends to approximately 170m to the East whilst to the west it extends approximately 680m. Therefore, with a predominately westerly wind you would assume the dust would spread further to the East. However, conversely, the results show the dust spreads four times as far to the West. This is ridiculous even allowing for the slight slope to the East. It is worrying that the more 'sensitive receptors' do not appear to have been modelled correctly. However, with insufficient data supplied this is impossible to ascertain. But, I do believe requires closer inspection.

Modelled Data Results are not worst case scenario

Modelled data results are presented in a number of tables within the Environmental part of the Noise and Dust assessment and stormwater document. Table 10, Stage 1 (Northern Haul Route) being typical (Reproduced in Attachment C1).

The first thing to note about these results is there is no evidence supplied to back these claims up. There is no input data such as Attachment B2. And also, and highly importantly, there is no blast conditions considered either. Clearly this is NOT the worst case scenario that it should be.

The Vic EPA standards, that this development application is referencing, (3.5 Modelling to be undertaken, reproduced in Attachment B4) states: "Modelling is to be undertaken for a 12-month period under the worst-case scenario. Worst-case conditions are those for the periods when the maximum emissions are predicted to occur under normal operating conditions (for example when maximum earth moving activities are occurring or large areas of exposed land are expected on site) and/or where an expansion or development has maximum impact on sensitive receptors". Clearly, and negligently in my opinion, this has not been done. The modelled data results are incorrect as they have not considered worst case scenarios.

Analysing submitted data

Given that the submitted data is, in my opinion, deficient, in not using worst case scenarios the analysis below is obviously based on the submitted data NOT the worst case data that has unfortunately not been submitted. Therefore the results will be artificially lower than could be realistically expected.

Attachment C1 shows the modelled data for Stage 1, Northern Haul Route, Table 10. It is interesting to note that the PM2.5 column shown for the Eastern receptor group is 4.9 µg/m³. Whereas the Silica component of this is only 0.09 µg/m³. Therefore, in Rock form the silica component was 49%. But, when crushed the PM2.5 component (<2.5 micrometres in diameter) only 1.84% is silica (100% / 4.9 * 0.09). This is shown graphically in Attachment C3. It is apparent a significant amount of silica has been lost between the rock extraction and the crushed result. Clearly something is very wrong in the analysis provided.

This is extremely concerning. Is there over 26 times more silica in the Nucrush dust than 'Table 10' appears to suggest?

A study of non-occupational exposure to silica dust, by the 'National Center for Biotechnolgy Information, National Library of Medicine, National Institute of health' (Attachment C5) confirms how the concentration of silica in the raw product is directly proportional to the concentration within PM10 dust: "concentrations for sites were 18.9 and 18.2 µg/m³, and mean silica concentrations were 1.33 and 1.11 µg/m³,respectively from 6-7% silica content in the PM-10 dust. Mean silica concentrations at the two sites is 1.22 2µg/m³". This, would appear to confirm my suspicions that the rock form with 49% silica cannot be reduced to a mere 1.84% silica concentration, for the PM2.5 particles, when it is crushed.

If my calculations are correct and there is still approx 49% silica in the PM2.5 portion then the Silica content would be 49% of the 4.9 µg/m³ i.e. 2.4 µg/m³ which is a lot higher that the 0.09 µg/m³ shown.

The figures just don't seem to stack up. Are we getting far more silica than claimed?

Further, according to Worksafe Queensland "It is the silica dusts, mostly smaller than 10 μm in diameter [PM10], that are potentially damaging to the lung. The size range cannot be seen by the naked eye in ordinary lighting. That fraction of the dust cloud which penetrates to the alveolar space to the lung is referred to as the respirable fraction. The respirable fraction of a dust cloud must be measured to assess the disease risk from dusts containing RCS [Repirable Crystalline Silica]. Size and surface area of particles are important determinants of their toxicity".

Therefore the development application should be measuring the silica content for silica dust particles smaller than PM10 (<10 μm in diameter) NOT PM2.5 (<2.5 μm in diameter). What is the percentage of the TSP column that is PM10? We need this information to calculate the respirable crystalline silica dust content. However, this information has, in my opinion, negligently not been provided.

To calculate the 'Annual Average μg/m³' of respirable dust I have modified Table 10 (Attachment C1) to more accurately reflect my findings (Attachment C4). I have modified the Silica Column at the guess estimate of 49% of the PM2.5 column for all particles.

I have also added an Annual Average to the PM10 (evaluated from the 'Maximum 24-hour average (μg/m³)' column. And added a silica column to this with a 49% of the total PM10. I note the Air quality objectives for Maximum 24-hour average doubled from PM2.5 to PM10 and have thus copied this to the PM10 columns for total dust and silica dust component also.

This has shown, for PM10, that the dust for all receptor groups (Eastern, Southern and Western) is an average of 20 μg/m³ whereas the assumed 'Air quality objective for PM10 is 16 μg/m³. Therefore, the respirable dust content (i.e. PM10 and below) of the Total Particulate Matter (TSP) is exceeded for the dust particles. Assuming silica is 49% of this gives an average Silica PM10 figure of 9.6 μg/m³ and thus **the silica dust 'Air Quality Objective' also clearly exceeded.**

Therefore, the respirable component of the TSP, in my opinion, exceeds the air quality objectives for both overall data and the silica component of this also.

This is extremely concerning it appears that the silica dust limit is exceeded at every single receptor group modelled all around the quarry.

Also, 'Worksafe Queensland' importantly also says: "It's toxic effect on cells (cytotoxicity) also appears to be dependent on the age of fractured crystalline silica, decreasing with time after cleavage". So our newly crushed silica is even more dangerous. And, as can be seen in Attachment C7, this report from a different source also highlights: "that freshly fractured silica is much more cytotoxic than aged quartz".

<u>Assessment of Emissions Cumulative effect</u>

This development application references the Vic EPA (SEPP AQM) Mining and Extractive Industries objective for respirable crystalline silica monitoring for all surrounding residences (Attachment C2).

In Section 3.2, Assessment Criteria of the Vic EPA (SEPP AQM) standard referenced (Attachment F1) it says "The assessment of emissions from the area sources must consider local air quality (i.e. existing air quality) in the vicinity of the mining or extractive operations. The assessment criteria are used to assess the total concentration of background plus emissions arising from activities on the site. Emissions from the mine or quarry must be managed to ensure the cumulative impacts of all sources (including the mine or quarry) in the local area do not pose a risk to the health and amenity of local residents and that the beneficial uses specified in the SEPP (AQM) are protected".

There is a significant Holcim concrete batching operation that generates lots of additional dust just across the road and within 200m (See Attachment G1). This has erroneously not been considered in the air quality assessment.

There is also an additional quarry across the road, within 400m, that is over 800m wide (Attachment G2) and, is again, an extremely dusty operation with mobile crushers screeners etc. and produces up to 100,000 tonnes of quarried product and additionally is recycling concrete also. This has erroneously not been considered in the air quality assessment.

Also, adjoining the Nucrush quarry is the 'JJ Richards & Sony Pty Ltd' Resource Recovery business at 241 Tamborine Oxenford Road (Attachment G3). The site is crushing and reusing concrete products and is yet another dusty operation. This has also erroneously not been considered in the air quality assessment.

Additionally, the Nucrush Hart Street Batching operation is only 1516m from the Nucrush quarry. This again is an extremely dusty facility (Attachment G4) that has been erroneously not considered in the air quality assessment.

In fact given the highly mobile nature of the respirable dust in the atmosphere the Nerang Hymix quarry should also be considered at 5km away (See Attachment C6, and discussed below).

The geographical locations with respect to the Nucrush site are shown in Attachment G5. From this aerial view it can be clearly seen that all five major sources of dust are required to be included in a cumulative dust assessment due to their close proximity to each other and the effect their accumulated dust nuisance to sensitive receptors all around the area.

The Vic EPA (SEPP AQM) standard referenced by this development application states: "Emissions from the mine or quarry must be managed to ensure the cumulative impacts of all sources (including the mine or quarry) in the local area do not pose a risk to the health and amenity of local residents". Clearly without considering the cumulative effect of the Holcim operation, the Bullrin Quarry, the Nucrush Hart Street, Upper Coomera and the 'JJ Richards' operation the statement: "do not pose a risk to the health and amenity of local residents" cannot be established and to ignore this highly important aspect of the standard is highly negligent in my humble opinion and shows a complete disregard for the health and welfare of the local residents and the environment once again.

This analysis must be complied with in order to ensure the correct level of dust, including respirable crystalline silica concentrations at all surrounding sensitive receptotrs are not above an appropriate air quality objective.

A cursory glance at any of the submitted Dust assessment diagrams (e.g. Attachment B5) will instantly show that this is clearly incorrect as the areas over the Holcim Concrete Batching operation, the Bullrin Quarry and the JJ Richards operation have no elevated predicted PM2.5 dust whatsoever, despite all having obvious elevated dust output. This diagram, along with all other diagrams of this type are clearly incorrect and culpably negligent, in my opinion, and should be disregarded.

How far respirable dust can travel (PM10 & PM2.5)

An article from 'Nesilex' Silica Dust Supressant specialists shows how far respirable dust can actually travel (Attachment C6). It shows for a relatively low wind speed (3mph) the PM10 particles will travel approximately 880m. And for 6mph the PM10 respirable dust will travel 1.8km. Increasing to 7.3km for a 25mph wind.

The same article shows how far the highly respirable dust can actually travel for PM2.5 particles (Attachment C6). It shows for a relatively low wind speed (3mph) the PM2.5 particles will travel approximately 3.5km. And for 6mph the PM10 respirable dust will travel 7.2km. Increasing to 29km for a 25mph wind.

These figures are truly shocking and emphasise how much the respirable dust generated will enter the atmosphere and travel throughout areas around the Gold Coast.

Children and respirable dust

Attachment G6 gives an overview of the locations where children will congregate on a regular basis within the affected area. This shows schools starting at 350 metres away from extractive boundary (Oxenford State School) and Gaven state School 1000m, Highland Reserve State School at 1500m, Helensvale State School at 3000m, also Kindergartens at 650m, 800m and 100m, Children's council play park at 315m, Children's Aqua park at 270m, a wake park at 170m, a community Pony club at 160m, a fishing lake opposite at 60m and theme park at 670m (Paradise Country), Movie World at 1150m, Wet'n'Wild at 1745m, Australian Outback Spectacular at 1750m. In fact thousands of children on a daily basis will be within the fallout area of the dust including respirable crystalline silica dust.

Clearly the cumulative effect of all heavy industry emissions within the area need to be considered i.e Nucrush Quarry, Bullrin Quarry and recycling concrete entre, Holcim Concrete batching facility, 'JJ Richards' concrete recycling centre and Nucrush Hart Street batching operation.

And, as shown above, the respirable dust generated, as a result of quarrying such large amount of product will travel readily throughout all these locations where children live, attend school, play and exercise.

Can you risk exposing thousands of children to this much respirable dust on a daily basis? In fact 24 hour basis for the local children!

<u>Wind erosion of raw materials and product stockpiles (City Plan Specific Benchmark 9.4.4.3)</u>

In the Gold Coast City Plan, Specific benchmarks for assessment 9.4.4.3, Table 9.4.4-2 (Reproduced in Attachment D1) Amenity Protection PO1 states: "Development mitigates any negative effects to amenity, health and safety from existing surrounding activities having regard to: (f) wind effects"

And the applicants reply to: "Does the proposal meet the acceptable outcome" is "COMPLIES - The land use has functioned from the site circa 1992. Current management strategies will be carried to the continual operation of the extractive industry use."

However, the fact that the land use has functioned form 1992 is irrelevant. And, having studied the development application and an overview of the site I would argue that the applicant has not mitigated any negative effects to amenity, health and safety from existing surrounding activities having regard to: (f) wind effects. Attachment D2 clearly shows the extent of the uncovered stockpiles stretching far and wide within the quarry footprint. The development application says it mitigates any wind erosion by spraying with water (Attachment E1): "sprinklers to manage dust emission from stockpiles during high wind speed conditions" and Attachment E2: "Management of dust emissions from stockpiles during high wind speed conditions through appropriate use of sprinklers as required". However, there is no sprinkler system installed for the stockpiles. Thus, in windy conditions there will be nothing protecting the environment from the dust rising up from the stockpiles that are located throughout the quarry. These appear to be highly negligent empty claims.

I therefore believe this Performance Outcome (PO1) has not been met by simply claiming: "COMPLIES - The land use has functioned from the site circa 1992. Current management strategies will be carried to the continual operation of the extractive industry use." Thus, there is no attempts to add the sprinklers specified in the development application as claims the current management strategies are all compliant.

However, later in the development application their claims that: "sprinklers to manage dust emission from stockpiles during high wind speed conditions" is contradicting their reply to PO1. Either way this has been ill thought out and does not comply with PO1.

Further, Performance Outcome 2 (PO2) In the Gold Coast City Plan, Specific benchmarks for assessment 9.4.4.3, Table 9.4.4-2 (Reproduced in Attachment D1) Amenity Protection states: "The proposed development prevents loss of amenity and threats to health and safety, having regard to: (f) wind effects"

And the applicants reply to: "Does the proposal meet the acceptable outcome" is again: "COMPLIES - The land use has functioned from the site circa 1992. Current management strategies will be carried to the continual operation of the extractive industry use."

The comments above relating to PO1 are again pertinent for PO2. Thus, PO2 has not been complied with either.

<u>Wind erosion of raw materials and product stockpiles Environmental Authority EA0002207 (or EPPR00245613)</u>

Further, to non-compliancy to City Plan Specific Benchmark 9.4.4.3 PO1 and PO2. This also is reflected in Section B1 of the Environmental Authority EA0002207 (or EPPR00245613) which states: "You must take reasonable and practicable measures to minimise the releases of wind-blown dust to the atmosphere. Reasonable and practicable measures may include but are not limited to: (5) adoption of best practice environmental management for the extraction and processing (including crushing, screening and stockpiling)". I do not believe this has been adequately considered as it is clear from the aerial picture of the quarry (Attachment D2) that the stockpiles are merely piled throughout the site with no measures provided to limit wind erosion whatsoever. Thus, Schedule B, Air, Condition B1, of the Environmental Authority has not been complied with as discussed in 'Wind erosion of raw materials and product stockpiles (City Plan Specific Benchmark 9.4.4.3)' above.

Wind erosion of raw materials and product stockpiles - DES Code of practice for the concrete batching industry

https://environment.des.qld.gov.au/__data/assets/pdf_file/0021/88410/pr-cp-concrete-batching.pdf

The potential impacts on the environment and how those impacts can be mitigated is discussed within the concrete batching code of practice in order to comply with the Environmental Protection Act 1994.

"Performance outcomes are the end result that the operator needs to achieve to meet the environmental objectives. There are four performance outcomes in this code of practice. You may decide to use one or more of the suggested control measures to achieve the performance outcome or you may choose to use your own control measure. However, if you do not use the suggested control measures, you will not be able to rely on complying with the code as a defence if you cause unlawful environmental harm. You may still rely upon the defence of complying with your general environmental duty, but will have to show how you met your general environmental duty another way".

Attachment H1 shows 'Performance Outcome 1' i.e. "Dust and particulate emissions from all activities associated with the concrete batching process must be controlled in order to prevent or minimise nuisance at surrounding premises".

Also, a number of suggested control measures are listed in Attachment H1. These in general to not appear to have been adopted. Despite extensive stockpiles throughout the site (Attachment D2) there appears to be no attempt to enclose stockpiles e.g. "Enclose stockpiles on three sides ... measures such as screening or roofing to minimise dust emissions" or "Regularly water stockpiles to keep down dust omissions". Further: "All elevated hoppers, conveyors and dusty transfer points shall be sheltered from the wind" and "Roof and enclose truck loading bays" and "Use water sprays or filtered dust extraction systems around gob hoppers and across open sides of enclosures".

I do not believe Performance Outcome 1: "Dust and particulate emissions from all activities associated with the concrete batching process must be controlled in order to prevent or minimise nuisance at surrounding premises" is being addressed appropriately. The dust measures are not working at the Oxenford site as hundreds of dust complaints raised as objections will testify.

Silica Dust Limits

The development application specifies there is no limits for crystalline silica in Queensland and hence adopts the VicEPA (SEPP AQM) Mining and Extractive Industries objective for respirable crystalline silica. And goes on to say the Victorian PEM objective is based upon the Californian Office of Environmental Health assessment determination of "an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level" (Attachment C2).

The level adopted (as shown in Attachment C1) is 3µg/m^3 for PM2.5. However, this is not correct. The Californian limit is in fact 3µg/m^3 for PM4 i.e. for particles 4 micrometres and below; not 2.5 micrometres and below (Attachment I1). There is a significant difference and would skew the results in the Nucrush quarries favour significantly.

However, even this Californian enhanced level of silica dust protection has been criticized. The Environmental Working Group (EWG) concluded that the silica exposure limits adopted by California are insufficient to protect children and other vulnerable populations for several reasons:

- The exposure limits are based on epidemiologic studies of adult male miners (a population of typically healthy and robust workers).
- No studies included children or vulnerable populations
- Exacerbation of asthma (more severe in children than adults) is a known response to some respiratory irritants.

The agency added (Attachment I1): "Since children have smaller airways than adults and breathe more air on a body weight basis, penetration and deposition of particles in the airways and alveoli in children is likely greater than in adults exposed to the same concentration".

Clearly, given the significantly reduced separation buffers from the Queensland DES standard required of 1000m (down to a proposed 220m) for this quarries extractive boundary to sensitive receptors; the adopted level in this development application needs to be investigated as it is has clearly NOT based it's 'Air Quality Objective' (Attachment C2): "upon the Californian Office of Environmental Health assessment determination of "an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level" " as claimed otherwise its limit would be 3µg/m³ for PM4 not PM2.5.

Fine Dust Contamination

Throughout the modelled data no reference has been made to the 'Fine Road dust contamination'. Significant dust is carried from the site on a regular basis as the clouds of dust testify (Attachment J1).

This will be a significant source of respirable dust forever being churned as vehicles constantly drive through, and haulage vehicles add to, the dust along the haulage route. The particles are forever being lifted, redispersed and resettle in and around the haulage route.

As the development application infers in its Traffic Assessment submission that the haulage route terminates just before reaching the Tamborine Oxenford Road (i.e. 300m approx from their entrance) has the Fine Dust contamination been correctly modelled throughout its journey to the pacific motorway? There is once again insufficient data presented to determine this. However, it should be remembered that children waiting at school bus stops or walking through the area are more susceptible than adults to the 'Fine Road dust contamination' due to their general stature being lower to the ground (where there are higher levels of respirable dust concentrations) in and around the haulage route network.

Silica Facts

As the dust modelling is based on the "Californian Office of Environment Health" (attachment C2), I believe, it is pertinent to understand how some of these facts and figures where derived and problems associated with the monitoring of silica dust based on the Californian standards as shown below:

Silica Monitoring

Small silica dust is carcinogenic, and exposure to silica has been recognized an occupational health concern for decades. This size range of particle can travel long distances suspended in the atmosphere and particles smaller than 5 µm are easily lodged in the lungs.

In natural settings sand does not usually fracture this small, but under pressure in industrial operations and on roadways, silica can be ground to this respirable size. Road construction, non-metallic mining, glass grinding and sand-blasting are common sources of silica pollution (Attachment K1).

Silica Monitoring Regulation

Regulations on silica emissions and non-occupational exposures are fairly new, highly varied, and applicable only in a few states. Monitoring requirements and techniques are not yet standardized. No affordable, low-cost means of demonstrating regulatory exceedances of airborne silica concentrations currently exists (Attachment K2).

Exposure to silica in occupational and non-occupational settings (Attachment K3)

The concentrations of airborne particles that are likely to cause health effects in occupational settings are higher than concentrations of particles that are relevant to protect health in non-occupational exposure settings.

Only very small size-fractions of silica are transported and settle outside of occupational zones. Fine sand (~20-100 µm) can become airborne, but it settles nearby. Silica dust less than 10 µm is light enough and has enough surface area to stay airborne long enough to travel beyond occupational zones. A fraction of these smaller dust particles are also the most damaging to the lungs.

Silica dust less than 5 µm in diameter is **respirable**, meaning it can travel into the bronchial region and deposit in the gas-exchange zone of the lungs. There, they can cause scarring, swelling, and the growth of fibroids in alveoli, the deepest parts of the lungs. Silica dust less than 5 µm is of greatest concern in both occupational and non-occupational exposure. In occupational exposure, respirable silica is often correlated with larger particles, whereas in non-occupational settings respirable silica is not necessarily correlated with total coarse particulate matter. Occupational and non-occupational guidelines for silica exposure vary in whether they derive from estimates based on larger particle (PM10) monitoring data or respiratory-size specific data, but all non-occupational exposure limits are based on modifications of occupational exposure rules.

Non-occupational exposure (Attachment K4)

The concentration of particulate matter that is cause for concern in non-occupational exposure is much lower than in occupational exposure. A person is at work typically only one-third of the day, and usually spends more hours at home than work, including sleep. Also, the exposed population in a non-occupational setting includes more vulnerable people, such as children and the elderly, than the workforce (which is often estimated as healthy young-adult and middle-aged men in exposure risk studies). Children breathe more deeply than adults, and their smaller body mass means that their relative exposure to pollutants is much higher.

For all of these reasons, non-occupational exposure limits are set lower than occupational exposure limits to protect human health. For respirable crystalline silica, the difference between the two types of exposure limits can be orders of magnitude, as Occupational Safety and Health administration's (OSHA) occupational exposure guidelines are to avoid exposures above 10 *milligrams* per cubic meter, while Vermont's non-occupational exposure guideline is 0.12 *micrograms* per cubic meter.

Exposure Monitoring - Respirable Silica (Attachment K5)

Inhalation studies and studies of human cadavers have shown that crystalline silica particles less than 5 µm in diameter can travel deep into the lungs causing irritation and cancer. Respirable crystalline silica (silica particles that are less than 5 µm) has been identified as a human carcinogen by the International Agency for Research on Cancer (IARC). Non-occupational respirable silica emissions are not federally regulated, however six states have adopted ambient respirable silica exposure standards.

Exposure Monitoring Occupational Safety and Health administration (Attachment K6)

The sampling techniques outlined by OSHA for occupational silica exposure would systematically underestimate silica exposure in non-occupational ambient settings. The stipulated performance (described above) methodically under-samples particles on the larger end of the range (1-5 µm), with only 25% of PM5 being entrained into the sample stream, so a relatively larger proportion of much smaller particles (e.g. 90% of 2 µm particles) constitute the final sample. In occupational settings such as sandblasting where more than 90% of particles will be silica, under-sampling particles on the large-end of the respirable fraction, will not appreciably change the percentage of silica in the air.

However, in ambient situations where a significant portion of fine particulates (2.5 µm and smaller) derive from other sources such as diesel combustion products or atmospheric reactions of sulfur dioxide, the disproportionately large representation of these smallest particles on the sample filter will not be truly representative of what is respirable in the air. This is extremely important in measuring for respirable silica because the percentage of total particles that is crystalline silica will be assessed based on the percent of particles on the sample filter that are silica. Non-silica particles would constitute a disproportionate (erroneously high) fraction of the total particulate matter, **and thus the calculated silica percentage would be erroneously low**.

Non-occupational exposure rules (Attachment K7)

Six states, California, Minnesota, New Jersey, New York, Texas, and Vermont, have adopted ambient air quality standards or guidance for ambient respirable crystalline silica (less than 5 µm in diameter) based on concerns about its health effects. Any inhaled particles of this size are dangerous, but silica can be especially detrimental to people's health.

In 2005, the California Office of Environmental Health Hazard Assessment (OEHHA) set forth a rule that chronic exposure (e.g. everyday exposure, at home or outside) to respirable crystalline silica should be less than 3 µg/m3. Minnesota – also a state facing potential frac sand mining like Wisconsin – and New Jersey have adopted California's health-based standard of respirable crystalline silica at 3 µg/m3, Texas and New York have set their guidance at 2 µg/m3 (though prior to 2014, New York had set theirs at 0.06 µg/m3), and Vermont has set their guidelines much lower at 0.12 µg/m3.

To determine ambient air guidelines for respirable crystalline silica, states used occupational health guidelines and adapted them to be suitable for chronic exposure. The typical population in occupational exposure studies are healthy adult males. This population's ability to deal with problematic exposures before experiencing negative health impacts is greater than any other population's. Thus, adequate concentration limits for non-occupational exposure need to be lower than occupational exposure limits.

California, and subsequently Minnesota and New Jersey, adjusted occupational exposure for the increased number of hours exposure would occur (i.e. hours not included in the 40-hour work week), and an "intraspecies uncertainty factor of 3" (MN DOH Respirable Silica Toxicological Summary), which is an estimated factor to account for the differences in susceptibility between healthy adult males and more vulnerable populations. Texas and New York used slightly higher adjustment factors, and Vermont followed adjustment guidelines for most known carcinogens, adjusting by an overall factor of 100.

The nonprofit organization Environmental Working Group wrote an expository piece on ambient airborne silica, in which they urged more states to adopt respirable silica regulations and make the standards no higher than 0.3 µm/m3 in order to protect vulnerable populations.

State measurement programs (Attachment K8)

California, Minnesota, New Jersey, New York, Texas, and Vermont have added respirable crystalline silica as a Hazardous Air Pollutants and thus adopted ambient guidelines, but respirable crystalline silica is not routinely measured. Rather, industries known to emit silica must use computer simulations to estimate their respirable crystalline silica emissions before they can obtain a permit to build or operate a facility.

These estimate emissions are based on empirical conversion factors from PM10 emissions estimates, followed by air dispersion models. If a proposed facility's emissions estimates indicate that they might emit an unacceptable amount of respirable silica, then the state would work with the proposed facility owner to discuss Best Available Control Technologies (BACT) to reduce their potential emissions. However, states may never actually monitor respirable crystalline silica. For example, in New York state, there has yet to be a case in which the state determined it must monitor respirable silica emissions based on emissions estimates and air dispersion models (personal communication).

Silica & PM10 (Attachment K9)

The U.S. does have National Ambient Air Quality Standards for particulate matter (find more information here), including standards for "coarse" and "fine" particulate matter. Coarse particulate matter (PM10) is composed of airborne particles that are less than 10 µm in diameter. Analyses from different regions of the U.S. determined that silica composed anywhere from 0-25% of the total particles (by mass) in daily PM10 samples, and proposed estimating 10% silica by mass in PM10 samples (US EPA 1996).

Since silica is not federally regulated separately from general particulate matter, and analyses to identify silica (such as XRD, discussed below) can be very expensive, agencies use this very rough estimate that 10% of PM10 is silica, though it is acknowledged that the percentage silica in a sample varies by location and nearby activities. At sand mining operations, the percentage of particulate matter that is silica can be upwards of 90% (based on EPA's emissions factor for sand and gravel processing), so the typical estimation of 10% may significantly underestimate the amount of airborne silica in areas near industrial sand mining.

"Inhalable" vs. "Respirable" (Attachment K10)

Coarse particulate matter is all "inhalable," meaning that it can enter the upper respiratory system, but it is not all "respirable," meaning it reaches the gas-exchange zone deep in the human lungs. Particulate matter that is less than 5 µm in diameter is considered respirable. Unfortunately, there have been few studies that have investigated what portion of PM10 is respirable, and it is likely to vary based on the composition of particulate matter in the sample.

This EPA study found an average of 20% PM4 (respirable fraction) in PM10 samples, but it ranged from 7 to 50%. Directly from PM10 measurements, it is difficult to ascertain the risk of respirable dust exposure. With the combined uncertainties of the portion of PM10 that is respirable and the percentage of PM10 that is silica, it is nearly impossible to adequately assess the risk of respirable silica exposure from PM10 measurements.

Silica and PM2.5 (Attachment K11)

The U.S. has National Ambient Air Quality Standards for fine particulate matter (read more here), which is less than 2.5 µm in diameter (PM2.5). Much respirable silica is larger than PM2.5 (though smaller than PM10), and is excluded from sampling for PM2.5. Up to 90% of PM2.5 may be comprised of combustion by-products and secondary particles. These make identification of respirable silica more challenging.

Visible Emissions (Attachment K12)

Visible emissions are also regulated throughout the United States. Visible emissions are quantified by a measure of opacity, which the degree of light-scattering by particles, and akin to the lack of transparency in the sky. The EPA has two primary methods that citizens can conduct to measure the opacity of emissions, EPA methods 9 and 22.

While visible emissions are not chemical-specific, monitoring and reporting visible emissions can be effective to bring enforcement for emissions violation. Emissions that are subject to opacity rules include primary emissions (e.g. through a smoke stack), and also fugitive emissions, such as leaky pipes, unpaved transport roads, or storage piles on industrial property. Often fugitive emissions are difficult to quantify or are neglected in permitting applications, so monitoring for visible fugitive emissions can be useful.

Conclusion

The modelled data required twelve months data and a detailed breakdown on information as to the data used (As per Attachment B2). There is no such disclosure (Attachment B1). Therefore, we can have no confidence in the derived figures as the supplied input data has not been disclosed.

Also, the modelled data does not include any blast data whatsoever. Therefore the modelled data is clearly incorrect and inadequate in not using the required 'worst case scenario'.

There is a clear question to be addressed as to how rock containing approximately 49% of silica can apparently produce only 1.84% of the PM2.5 particles as silica.

Also, the modelled data fails to include the cumulative effect of other emission sources within the area. Given, the four large and dusty operations of 'Bullrin quarry and concrete recyclers', 'Holcim' concrete batching facility', 'JJ Richards concrete recycling facility' and the 'Nucrush batching facility' in Hart Street , Upper Coomera (Attachment G5), to not include this is, in my opinion, despite being an obvious requirement, culpably negligent and produces dust results far lower than would realistically be seen. In fact given the highly mobile nature of the respirable dust in the atmosphere the Nerang Hymix quarry should also be considered (5km away).

Stockpiles within the quarry are widely spread in an apparent ad-hoc arrangement (Attachment D2). This leads me to believe the wind erosion effect of these raw materials would have made these results fairly damning if they had been accurately modelled correctly as there appears to be no method for dampening down these stockpiles in high winds as is required by: 'The Gold Coast City Plan', 'The Environmental Authority' and also the 'Queensland concrete batching guidelines'.

The petrographic analysis presented (Attachment A1) is clearly insufficient for the task at hand in establishing the effects of crushing up to a million tonnes of rock at such close planned proximity to sensitive receptors. In my humble opinion it would be negligent to make a decision based on the insufficient data that has been submitted.

The cumulative overall dust and the silica dust component that is witnessed at the sensitive receptors will be far higher than reported in this development application.

It has also incorrectly used a crystalline silica 'Air quality objective' of PM2.5 instead of PM4 despite its claims that this level is based on the Californian Office of Environmental Health. However, even this Californian enhanced level of respirable silica dust limit is itself being questioned due to its inability to include children and vulnerable adults in its generation of this limit.

It should also be remembered that these 'Air quality objectives' are based on a workers eight hour exposure and not the non-occupational 24 hour exposure that local residents will be submitted too.

It should be remembered that the Australian Cancer Council says: "Crystaline silica is found in stone, rock, gravel and clay etc. When these materials are worked on, the silica is released as a fine dust. This dust is respirable crystalline silica (commonly called silica dust). Silica dust is harmful when it's breathed in; it is a 100 times smaller than a grain of sand, so you can be breathing it in without knowing. This can lead to lung cancer, silicosis, chronic obstructive pulmonary disease and kidney disease" and "cancer risk increases with long term or repeated high level exposure" and "The mandatory limit for silica dust exposure in Australia is 0.1mg/m3 averaged over an eight-hour day. The ACGIH have recommended the threshold limit value be 0.025mg/m3 over an eight hour day. This limit was based on the prevention of lung cancer and silicosis. **However, there is currently no evidence to suggest a safe level of silica dust exposure**".

The evidence is clear. Can you possibly risk approving this development application when it is readily apparent that the required data analysis has not been as thorough as should be appropriate for a development application with such potentially devastating effects on quarry workers and local resident's health, including their children, and the vulnerable adults who are subjected to this risk twenty four hours a day seven days a week?

It should also be remembered that they have adopted a figure of 49% for the crystaline silica for their calculations i.e. "… a conservative assessment of the second highest percentage composition at 49% has been adopted for the assessment of potential crystalline silica impacts when assessed against an annual average exposure guideline" . However the Vic EPA standards referenced advise a worst case scenario should be adopted i.e.: "The sampled aggregate contains between 19% and 57% free silica as quartz crystal" and therefore it appears 57% should have been the criteria used. Is it appropriate not to use the worst case scenario when calculating the effect of crystalline silica? To underestimate the content is again, in my opinion, culpably negligent.

As the Australian Cancer Council says: "**there is currently no evidence to suggest a safe level of silica dust exposure**". A flawed submission, as this appears to be, would be culpably negligent when evaluating such a devastating effect that this might have in the longer term on the local residents, the quarry workers and the environment.

Thank you for considering my objection,

Attachment A1 - Petrographic Analysis

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MWA Environmental

3.3.2 PETROGRAPHIC ANALYSIS

Petrographic analysis has been undertaken of rock samples extracted at the subject site. MWA Environmental has reviewed the supplied petrographic reports dated between 2007 and 2016 to determine the composition of Crystalline Silica contained within the rock.

The sampled aggregate contains between 19% and 57% free silica as quartz crystal, with an average of 30% across all samples. For this assessment, a conservative assessment of the second highest percentage composition at 49% has been adopted for the assessment of potential crystalline silica impacts when assessed against an annual average exposure guideline.

Attachment A2 - Petrographic Analysis example from a sister Quarry

Table 1 – Modal analysis of minerals in Meta- greywacke

PRIMARY MINERALS	MODE (PER CENT)	COMMENTS
Unstrained Quartz	23	Anhedral, medium to fine grained
Moderately strained quartz	5	Anhedral, undulose extinction
Plagioclase	17	Minor alteration products
K-Feldspar	9	Minor alteration products
Groundmass contains quartz, biotite, muscovite, clay minerals	20	Fine grained
Volcanic rock fragment	5	Fine grained
Quartzite	5	Contains moderately strained composite quartz
Sedimentary rock fragments	4	Fine grained sandstone
Iron Oxides	1.1	Minor sulphides
Graphite	0.5	
Calcite	0.1	Vein
SECONDARY MINERALS		
Sericite, kaolinite, illite	5.5	Weak minerals, in matrix and feldspar grains
Actinolite	3	Acicular
Biotite	1	Weak minerals
Muscovite	0.3	Weak minerals
Chlorite	0.5	Weak mineral
Total	***100***	

Interpretation

This supplied rock is identified as meta-greywacke, a metamorphic rock formed by a process of low grade regional metamorphism. The original rock was moderately sorted, medium grained greywacke comprised of quartz, feldspar, clasts of rock fragments and silty clay matrix.

The rock generally has 37% free silica content and10% strained quartz (5% in single grains and 5% locked in quartzite) and is predicted to be innocuous in relation to alkali silica reactivity in concrete. Sulphides are present but do not exceed 1% in any provided sample. This concentration[3], taking into consideration the sample's low alkali silica reactivity,[4] is not predicted cause internal sulphide attack.

For engineering purposes the supplied rock is summarised as having the following characteristics:

- slightly weathered to unweathered meta greywacke
- hard and strong
- contains 1.1 % of iron oxides and trace sulphides
- contains 7.8% weak minerals (comprising 5.5% sericite, 1% biotite, 0.5% chlorite, 0.3% muscovite and 0.5% graphite)
- potential for mild to slow alkali silica reaction in concrete
- predicted to be suitable as a source for MRS 11.70 Coarse Concrete Aggregate, MRS 11.22 Cover Aggregates MRS 11.30/33/34/36 Dense Graded Asphalt Pavements, MRS 11.05 Unbound Pavements Types 1, 2 and 3 Rail Ballast CT147 and manufactured sand.

Free Silica Content

37% Free silica content.

Attachment B1 - Submitted Emission Source Information - Very limited data

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3.3.5 DUST EMISSION SOURCES

The following sources were represented in the CALPUFF Model:

- Haul Routes (unpaved) as a series of area sources;
- Access Roads (paved) as a series of area sources;
- Access Road (paved) as a series of area sources;
- Wind Erosion from stockpiles and unsealed areas as area sources;
- Drilling as an area source;
- Loading Truck at Pit as an area source;
- Processing Plant operation as an area source;
- Loading to Stockpiles as an area source;
- Loading from Stockpiles to trucks as an area source; and
- Concrete Batching Plant as an area source.

Dust emissions from each of these sources have been represented in the CALPUFF model as area sources with appropriate locations, sizes and initial dispersion parameters to represent the releases.

Attachment B2 - Typical emissions source table for Calpuff Modelled quarry

Quarry Stage 2 and Modification
Report No. 484/24

ENVIRONMENTAL ASSESSMENT
Appendix 5: Air Quality Assessment

Table 7
Calculated Annual TSP, PM_{10} and $PM_{2.5}$ Emissions - Scenario 1 and 2

Emissions Source	Calculated Annual TSP Emissions (kg/annum) by Source			Calculated Annual PM_{10} Emissions (kg/annum) by Source			Calculated Annual $PM_{2.5}$ Emissions (kg/annum) by Source		
	Scenario 1	Scenario 2	Difference	Scenario 1	Scenario 2	Difference	Scenario 1	Scenario 2	Difference
Weathered Rock Removal - Bulldozer	4,014.3	4,014.3	-	708.5	708.5	-	421.5	421.5	-
Truck Loading in Pit – Raw Material	336.5	701.1	364.6	159.2	331.6	172.4	24.1	50.2	26.1
Raw Material Haulage - Unsealed	4,028.9	8,393.4	4,364.6	1,145.7	2,386.8	1,241.1	114.6	238.7	124.1
Truck Unloading to Hopper	168.3	350.6	182.3	79.6	165.8	86.2	12.1	25.1	13.1
Raw material rehandle	16.8	35.1	18.2	8.0	16.6	8.6	1.2	2.5	1.3
Scalper	453.9	605.2	151.3	152.7	203.6	50.9	10.3	13.8	3.4
Screen 1	408.5	544.7	136.2	137.4	183.2	45.8	9.3	12.4	3.1
Screen 2	408.5	544.7	136.2	137.4	183.2	45.8	9.3	12.4	3.1
Screen 3	317.7	423.6	105.9	106.9	142.5	35.6	7.2	9.6	2.4
Jaw Crusher	1,002.7	1,336.9	334.2	445.6	594.2	148.5	82.5	110.0	27.5
No. 2 Crusher	947.0	1,262.6	315.7	420.9	561.2	140.3	77.9	103.9	26.0
No. 3 Crusher	724.1	965.5	241.4	321.8	429.1	107.3	59.6	79.5	19.9
No. 4 Crusher	779.9	1,039.8	260.0	346.6	462.1	115.5	64.2	85.6	21.4
Scalps Belt Conveyor	2.9	3.9	1.0	0.9	1.3	0.3	0.3	0.4	0.1
Jaw to Screen 1 Conveyer	26.0	34.7	8.7	8.5	11.4	2.8	2.4	3.2	0.8
No. 3 Belt Conveyor	1.4	1.9	0.5	0.5	0.6	0.1	0.1	0.2	0.1
No. 2 Crusher to Screen 2 Conveyor	24.6	32.7	8.2	8.1	10.8	2.7	2.3	3.0	0.8
No. 6 Belt Conveyor	4.3	5.8	1.4	1.4	1.9	0.5	0.4	0.5	0.1
Screen 2 to No. 2 Crusher Conveyor	24.6	32.7	8.2	8.1	10.8	2.7	2.3	3.0	0.8
Screen 2 to No. 3 Crusher Conveyor	18.8	25.0	6.3	6.2	8.2	2.1	1.7	2.3	0.6
No. 3 Crusher to Screen 2 Conveyor	18.8	25.0	6.3	6.2	8.2	2.1	1.7	2.3	0.6
Screen 2 to No. 4 Crusher Conveyor	20.2	27.0	6.7	6.6	8.9	2.2	1.9	2.5	0.6
No. 4 Crusher to Screen 3 Conveyor	20.2	27.0	6.7	6.6	8.9	2.2	1.9	2.5	0.6
Screen 3 to Product Conveyor	20.2	27.0	6.7	6.6	8.9	2.2	1.9	2.5	0.6
Scalps Pile Loading	2.9	3.9	1.0	0.9	1.3	0.3	0.3	0.4	0.1
No3 Belt Pile Loading	1.4	1.9	0.5	0.5	0.6	0.2	0.1	0.2	0.1
No6 Belt Pile Loading	4.3	5.8	1.4	1.4	1.9	0.5	0.4	0.5	0.1
Post Screen 3 Pile Loading	20.2	27.0	6.7	6.6	8.9	2.2	1.9	2.5	0.6
Loading to Trucks - product piles	182.3	182.3	-	86.2	86.2	-	13.1	13.1	-
Haulage to/from Pugmill	364.6	364.6	-	100.5	100.5	-	10.1	10.1	-
Loading to Hopper	91.1	91.1	-	43.1	43.1	-	6.5	6.5	-
Cement to Silo	58.5	58.5	-	31.2	31.2	-	4.7	4.7	-
Conveying to Pugmill	182.3	182.3	-	86.2	86.2	-	13.1	13.1	-
Pugmill Mixer	262.1	262.1	-	8.3	8.3	-	1.5	1.5	-
Loading to Stockpiles	182.3	182.3	-	86.2	86.2	-	13.1	13.1	-
Loading to Trucks	182.3	182.3	-	86.2	86.2	-	13.1	13.1	-
Loading to Trucks - product piles	39.3	39.3	-	18.6	18.6	-	2.8	2.8	-
Haulage to/from Asphalt Plant	314.2	314.2	-	86.6	86.6	-	8.7	8.7	-
Unloading to Storage Piles	39.3	39.3	-	18.6	18.6	-	2.8	2.8	-
Loading to aggregate bins	39.3	39.3	-	18.6	18.6	-	2.8	2.8	-
Conveying to Dryer	2.1	2.1	-	0.7	0.7	-	0.2	0.2	-
Asphalt Plant ducted sources	375.0	375.0	-	147.0	147.0	-	14.7	14.7	-
Truck Load Out	12.9	12.9	-	11.6	11.6	-	11.6	11.6	-
Loading to Product Trucks	336.5	701.1	364.6	159.2	331.6	172.4	24.1	50.2	26.1
Unsealed - Product Transportation	3,561.8	8,182.6	4,620.7	981.7	2,255.3	1,273.6	98.2	225.5	127.4
Sealed - Product Transportation	1,683.4	3,867.2	2,183.8	323.1	742.3	419.2	75.6	173.6	98.0
Drill	1,515.1	1,515.1	-	796.1	796.1	-	119.4	119.4	-
Blast	134.8	134.8	-	70.1	70.1	-	10.5	10.5	-
Wind Erosion - Exposed surfaces and stockpiles	10,880.0	10,880.0	-	5,440.0	5,440.0	-	816.0	816.0	-
Total	**34,257.0**	**48,106.8**	**13,849.8**	**12,839.2**	**16,925.7**	**4,086.4**	**2,175.8**	**2,705.2**	**529.4**

Attachment B3 - Typical submitted dust data Table

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Table A13.6: Model-Predicted Particulate Exposure (including ambient)
Stage 7 Operations (Northern Haul Route)

RECEPTOR	PM_{10}		$PM_{2.5}$		TSP	DUST DEPOSITION	Silica
	Maximum 24-hour average (µg/m³)	6th Highest 24-hour average (µg/m³)	Maximum 24-hour average (µg/m³)	Annual Average (µg/m³)	Annual Average (µg/m³)	Maximum Monthly Average (mg/m²/day)	Annual Average (µg/m³)
R1	32.1	22.5	8.7	4.8	27.4	59.6	0.06
R2	34.5	25.8	9.3	4.9	28.2	64.8	0.10
R3	44.5	28.6	10.5	4.9	28.4	63.5	0.11
R4	38.1	27.5	9.1	4.9	28.2	58.8	0.09
R5	30.0	26.2	8.3	4.9	28.3	56.7	0.09
R6	29.4	26.6	8.7	4.9	28.4	57.5	0.09
R7	22.5	20.3	7.1	4.8	27.2	47.6	0.04
R8	20.5	19.0	6.4	4.8	27.0	46.3	0.03
R9	19.9	18.3	6.0	4.8	26.9	46.0	0.03
R10	19.4	17.5	6.2	4.7	26.8	44.5	0.02
R11	21.5	17.9	6.4	4.8	26.9	45.3	0.03
R12	25.4	19.9	6.7	4.8	27.2	47.4	0.04
R13	33.0	19.7	7.7	4.8	27.3	48.5	0.04
R14	28.5	20.6	7.3	4.8	27.4	50.3	0.04
R15	24.0	19.5	6.7	4.8	27.4	50.9	0.04
R16	23.8	21.0	7.0	4.8	28.5	56.0	0.07
R17	29.4	26.0	10.0	5.2	32.0	59.6	0.24
R18	33.3	30.6	11.2	5.6	37.7	73.0	0.44
Air Quality Objective	**50 µg/m³**	**50 µg/m³**	**25 µg/m³**	**8 µg/m³**	**90 µg/m³**	**120 µg/m³**	**3 µg/m³**
Compliance?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Attachment B4 - Modelling Criteria

PEM Mining and Extractives v5.doc

3.5 Modelling to be undertaken

Results of any modelling are to be used for broad guidance as to the potential environmental impacts arising from any new or expanded development and to assist in the development of appropriate management strategies. The outputs from the model are highly dependent on the quality of the input data including emission estimates, meteorological data and background data. For mining and quarrying operations all of these inputs have a high level of uncertainty associated with them due to the nature of the activities being undertaken.

Modelling is to be undertaken for a 12-month period under the worst-case scenario. Worst-case conditions are those for the periods when the maximum emissions are predicted to occur under normal operating conditions (for example when maximum earth moving activities are occurring or large areas of exposed land are expected on site) and/or where an expansion or development has maximum impact on sensitive receptors. The modelling is required to be undertaken for a number of scenarios including,

- construction activities during the development of the site, and
- operational phases of the mine or quarry.

In conducting the modelling the emissions factors from the National Pollutant Inventory (NPI) Handbook for Mining and Extractives should be used. Where a proponent can show actual site-specific emission factors from trials/assessments then these factors would be preferred over literature-based factors providing that EPA is satisfied that the methodology used to determine the factors is sound. Advice should be sought from EPA prior to conducting the modelling if site-specific factors are to be used. For indicators not included in the NPI Handbook, the latest USEPA AP42 emission factors should be used. Other emission factors that may be considered to be more applicable for a specific site can be used with prior approval from EPA.

PM_{10} and $PM_{2.5}$ must be modelled as though they behave as a gas. Deposition for these size fractions is not included in the modelling. For TSP or deposited dust, dust deposition may be taken into account when deposition rates are known.

In conducting the modelling against the assessment criteria the impact of all sources of the indicator in the area must be included, as the assessment criteria have been established to account for cumulative impact of all sources.

This requires the inclusion of background data (this is discussed in more detail in the following sections).

If the impacts of bushfires, prescribed burning or dust storms are identified in background files they should not be excluded but clearly identified in the reporting of the results of the modelling (eg shown in the time series plots separate to the contribution from the mining or extractive operations and the combined emissions).

The results of the modelling must be reported for sensitive locations including houses, schools, kindergartens, recreation areas and sporting ovals. Any proposed developments, such as new housing developments, and identified future land uses (including zoning requirements) must be taken into account to ensure that developments planned closer to the sites than the current situation are considered in the assessment of potential impacts. The assessment at the selected locations must be done against the relevant assessment criteria listed in Table 2 of this PEM. Time-series plots showing the predicted concentrations for the pollutants being assessed for each day of the year should be presented for the sensitive locations that are predicted to be worst affected.

The assessment at the sensitive locations must be done against the relevant assessment criteria listed in Table 2 of this PEM. If the assessment criteria are exceeded then management practices on site should be reviewed to reduce emissions arising from the operations.

Level 1 assessments

The modelling for a Level 1 assessment requires 1 year of daily predictions for PM_{10} and $PM_{2.5}$ under worst-case scenarios. Time varying background files (24-hour averages) must be included for large operations in these locations.

For crystalline silica, arsenic and other indicators that have long-term health effects annual average concentrations must be modelled with annual average background data included in the model.

For Indicators such as NO_2 and CO that have averaging times less than 24-hours, the 70[th] percentile of the 1-hour average data is to be included. If background is not included for these indicators then the justification of the reason why must be included in the assessment report. For example, in a rural area with low traffic volumes or other sources in the vicinity.

Attachment B5 - Typical submitted dust data Map

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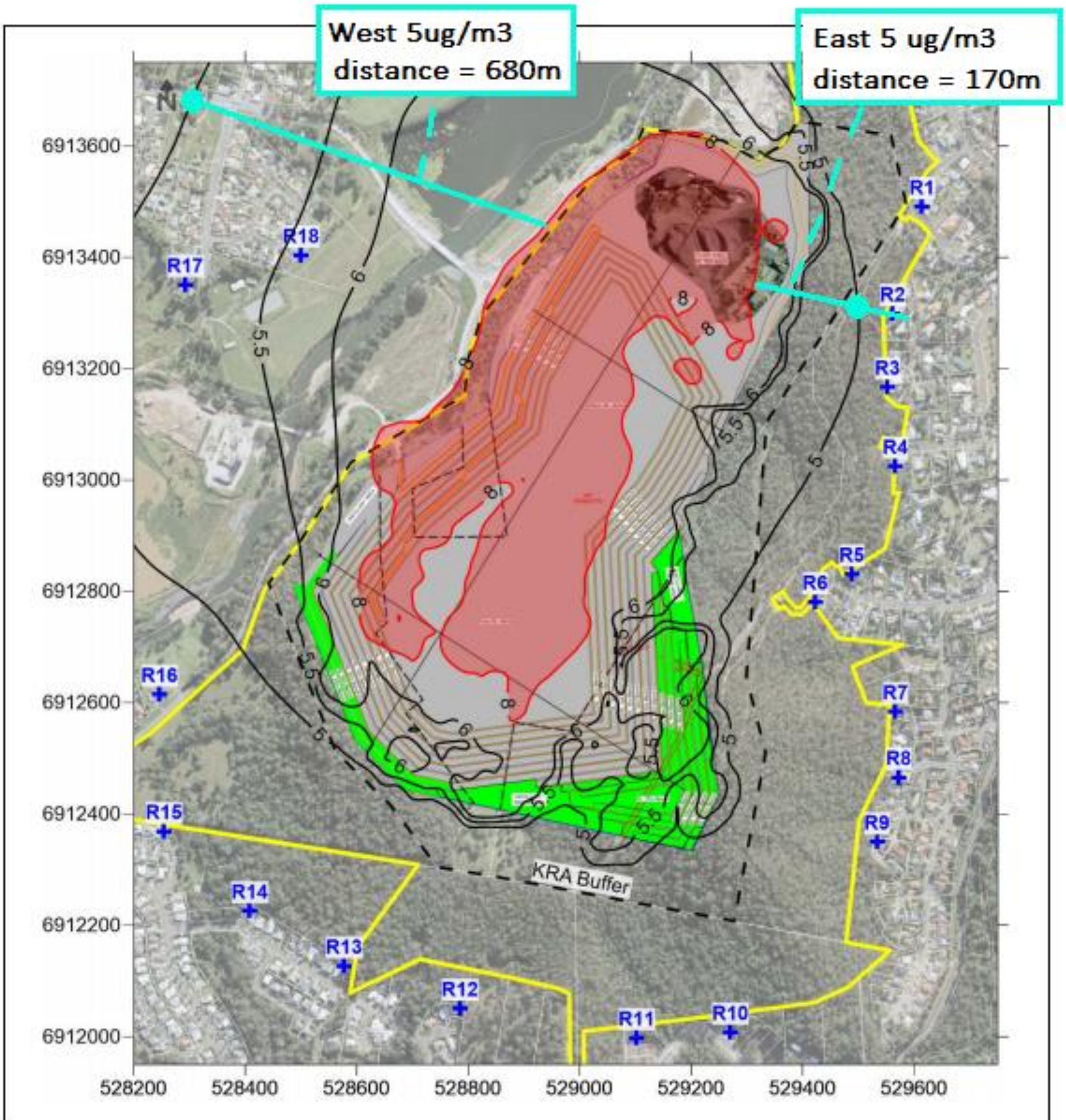
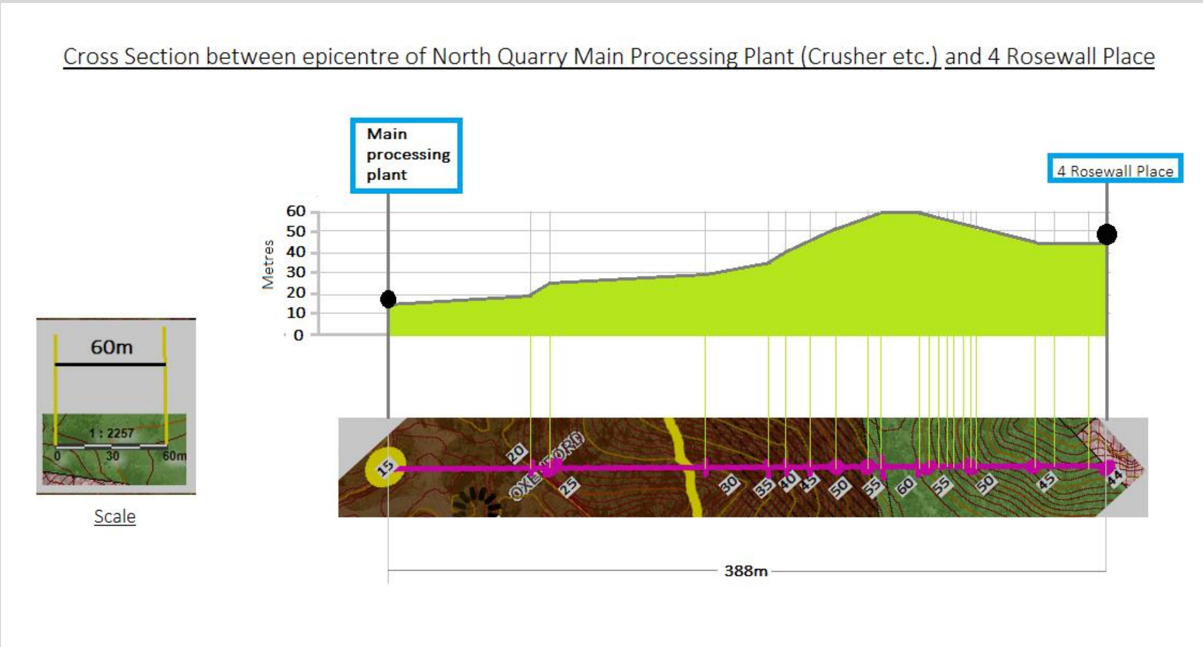


Stage 7 Operations plus Ambient
Predicted $PM_{2.5}$ annual average concentrations

Figure A12.4	Pollutant	Averaging Period	Ambient Concentration	EPP Objective	Date
mwa ENVIRONMENTAL	$PM_{2.5}$	Annual Average	4.9 µg/m³	8 µg/m³	2019-01-22

Attachment B6 - Contour diagram showing Rosewall Place - Receptor R2



Attachment C1 - Submitted Modelled data

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Table 10: Model-Predicted Particulate Exposure (including ambient) Stage 1 Operations (Northern Haul Route)

Daily Average

RECEPTOR GROUP	PM_{10}		$PM_{2.5}$		TSP	DUST DEPOSITION	Silica $PM_{2.5}$
	Maximum 24-hour average (µg/m³)	6th Highest 24-hour average (µg/m³)	Maximum 24-hour average (µg/m³)	Annual Average (µg/m³)	~~Annual~~ Average (µg/m³)	Maximum Monthly Average (mg/m²/day)	~~Annual~~ Average (µg/m³)
Eastern	37.8	28.6	8.8	4.9	29.6	72.0	0.09
Southern	36.4	22.4	8.1	4.8	27.9	56.5	0.06
Western	28.6	25.2	9.3	5.3	34.8	64.4	0.30
Air Quality Objective	**50 µg/m³**	**50 µg/m³**	**25 µg/m³**	**8 µg/m³**	**90 µg/m³**	**120 µg/m³**	**3 µg/m³**
Compliance?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Attachment C2 - Dust Modelling results

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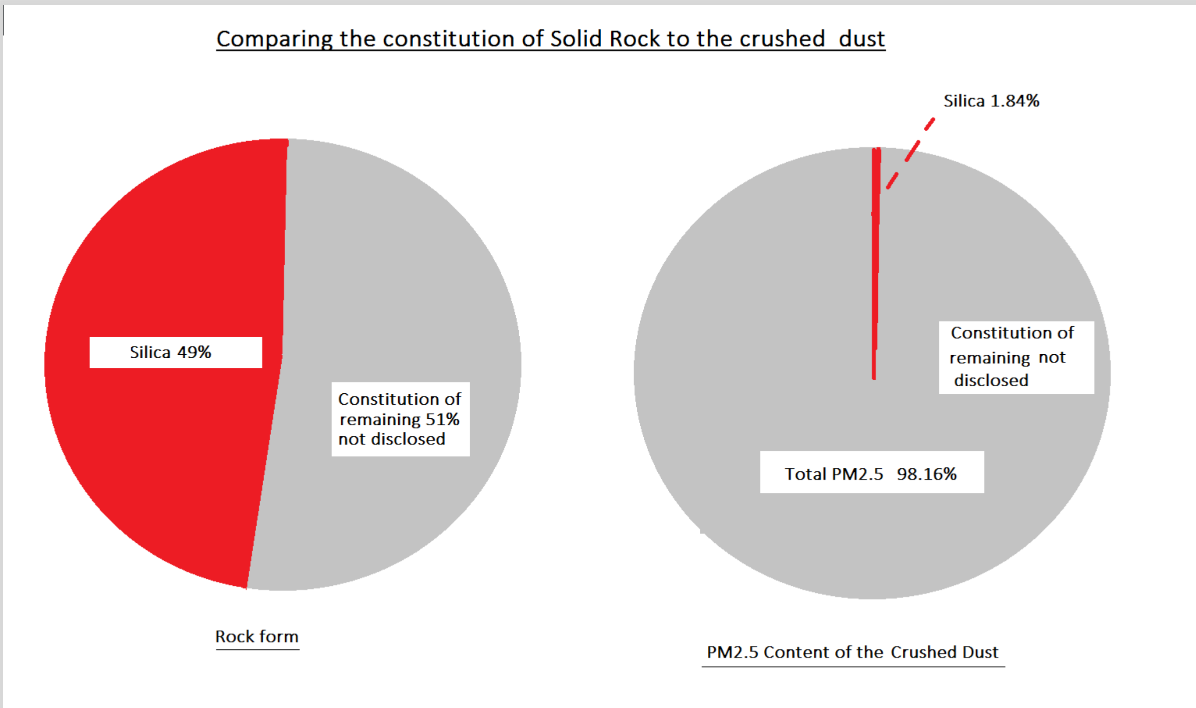
3.3.6 DUST MODELLING RESULTS

The predicted Crystalline Silica concentrations readily comply with the Vic EPA *(SEPP AQM) Mining and Extractive Industries* objective for respirable crystalline silica at all surrounding residences. The highest predicted annual average crystalline silica (as $PM_{2.5}$) concentration at a sensitive receptor is less than 15% of the adopted Victorian PEM objective. The Victorian PEM objective is based upon the Californian Office of Environmental Health Assessment determination of "*an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level*". On this basis it is considered that potential crystalline silica emissions from the quarry do not present a significant health risk to the local community.

Attachment C3 - Comparing constitution nof rock before and after crushing



Attachment C4 - Modified Table 10, Stage 1, predicted dust analysis

Table 10: **Model-Predicted Particulate Exposure (including ambient) Stage 1 Operations (Northern Haul Route)**

MODIFIED

MODIFIED

RECEPTOR GROUP	PM_{10}			Silica PM_{10}	$PM_{2.5}$		Silica $PM_{2.5}$
	Maximum 24-hour average (µg/m³)	6th Highest 24-hour average (µg/m³)	Annual Average (µg/m³)	Annual Average (µg/m³)	Maximum 24-hour average (µg/m³)	Annual Average (µg/m³)	Annual Average (µg/m³)
Eastern	37.8	28.6	21	10.29	8.8	4.9	2.4 ~~0.09~~
Southern	36.4	22.4	21.6	10.6	8.1	4.8	2.35 ~~0.06~~
Western	28.6	25.2	16.3	8.0	9.3	5.3	2.6 ~~0.30~~
Air Quality Objective	50 µg/m³	50 µg/m³	16 µg/m³	6 µg/m³	25 µg/m³	8 µg/m³	3 µg/m³
Compliance?	Yes	Yes	No	No	Yes	Yes	Yes

Modified to derive a PM10 annual average overall and for Silica content

Modified to show expected Silica PM2.5 @ 49% of rock

Attachment C5 - Non-Occupational exposure to silica dust from industrial sources

ncbi.nlm.nih.gov/pmc/articles/PMC3683189/

NON-OCCUPATIONAL EXPOSURE TO SILICA DUST FROM INDUSTRIAL SOURCES

As mentioned earlier, non-occupational exposure from industrial sources occurs when dust emitted from silica-based industries goes to the environment and people staying in the vicinity are affected. There have been very few studies in the vicinity of the industry where non-occupational exposures to crystalline silica and nonoccupational silicosis have been reported in slate pencil and agate industries.

Sand quarry, near California

It has been mentioned by Ruble and Goldsmith that Goldsmith reported particulate matter less than 10 µm (PM-10) and silica levels measured at two sites near a sand quarry, near California. Mean PM-10 concentrations for sites were 18.9 and 18.2 µg/m³, and mean silica concentrations were 1.33 and 1.11 µg/m³, respectively from 6–7% silica content in the PM-10 dust. Mean silica concentration at the two sites is 1.22 µg/m³ [Table 1].

Table 1

Non-occupational exposure to silica dust in vicinity of different industries

Industry	Location	PM-10 quartz concentration (µg/m³)	Mean quartz content (%)	Reference No.
Sand quarry	Exposed (vicinity)	1.22	6-7	27
Slate pencil industry	Exposed (vicinity)	49.15 (10)	15.00-18.79	7
	Control (away)	3.51 (5)	2.91	
Agate industry	Exposed (vicinity)	15.28 (20)	5.61	25, 26
	Control (away)	3.03 (14)	1.87	

Figures in the parenthesis indicate number of samples. PM-10: Particulate matter less than 10 µm

Attachment C6 - How far Can Respirable dust travel

nosilicadust.com/how-far-can-respirable-dust-actually-travel/

How Far Can Respirable Dust Actually Travel?

September 24, 2019

Respirable dust is invisible to the human eye but can pose serious health hazards. Exposure to respirable silica dust, which is fragmented crystalline silica, can lead to silicosis, lung cancer, and COPD. As a result, OSHA has instituted regulations to reduce the permissible exposure limit (PEL) of respirable silica dust on construction sites. These new reduced PELs have been in effect since September 23, 2017, however they only protect machine operators. There are no regulations for bystanders or enforced protections for surrounding civilians. Unfortunately, the nature of respirable dust particles can put bystanders at risk of inhalation exposure far beyond the confines of the construction site.

Dust size is important in determining potential associated health hazards. Dust particles need to be smaller than 200 microns to become airborne and smaller than 10 microns to be classified as "respirable." Respirable dust is able to penetrate the body's natural defenses and travels to the lungs which can lead to serious health hazards. Naturally, the size of the dust particle dictates how far it travels when airborne. Wind speed is another contributing factor to distance traveled: as wind speed increases, so does the distance traveled of the respirable dust particles.

The following tables demonstrate the relationship between particle size, wind speed, and distance traveled:[1]

Table 1: 10-micron particle

Wind Speed (mph)	Distance Traveled (miles)
3.1	.55
6.2	1.1
12.4	2.3
24.8	4.6
37.3	6.9
49.7	9.2

Table 2: 5-micron particle

Wind Speed (mph)	Distance Traveled (miles)
3.1	2.2
6.2	4.5
12.4	9
24.8	18
37.3	27
49.7	36.1

X = construction site

= area exposed to silica dust

Clearly, the smaller the particle the further the distance the dust particle travels, especially in an environment with stronger winds. While these are average distances, this phenomenon illustrates how pertinent it is for proper engineering controls to be in place when it comes to suppressing silica dust. Failing to properly control silica dust affects not only the construction crew, but people in the surrounding areas- in some cases as far as 50 miles from the site.

It's important to protect not only your workers, but they aren't the only ones at risk of respirable silica dust exposure. Civilians, bystanders, and neighborhoods in the vicinity of any construction site are at risk!

Attachment C7 - Freshly fractured silica is much more cytoxic than aged quartz

ncbi.nlm.nih.gov/pmc/articles/PMC3683189/

DISCUSSION

Go to:

Computation of cumulative risk is only an approximation because cumulative risk (%) depends on many factors such as silica particle size distribution in PM-10 dust, surface properties, and sources of quartz. EPA[6] derived the standard for ambient silica exposures by converting ambient exposures to occupational exposures. The curve for cumulative risk (%) versus cumulative silica exposure was used by EPA,[6] which was based upon respirable dust (≤5 µm). The concentration of silica in ambient dust is generally higher in large size fractions in the range of 2.5-15 µm and in dust fractions less than 2.5 µm.[1,6] Others like Buckman and Brandy,[34] and Ruble and Goldsmith[27] also reported that particulates greater than 10 µm contain more silica than particulates having diameters less than 10 µm. This may be so because quartz is harder than most minerals and does not disintegrate to fine particles easily as reported by Ayer.[35] This may be the reason why cases of silicosis are not reported from metropolitan cities of USA. But in the vicinity of silica-based industry; quartz comes from crushing, cutting, and grinding operations. The total airborne dust collected from work environment of agate industry was analyzed for particle size. It was found that 90% of the particles are having diameters less than 5 µm.[25,26] These particles get dispersed in the vicinity of agate industry. This is in contrast to the natural dust in which percentage of fine quartz particles is less. To certain extent, it justifies the conversion of ambient exposures to occupational exposures by EPA[6] in estimating risk in the vicinity of silica-based industry because cumulative occupational exposures are based upon respirable dust (≤5 µm). Secondly, airborne quartz in the vicinity of agate and slate pencil industry is freshly fractured. It has been reported that freshly fractured silica is much more cytotoxic than aged quartz.[6,36,37] Considering all these arguments, a question arises whether there should be separate silica standard for community environment (non-occupational exposure to silica dust from nonindustrial sources) and the environment in the vicinity of industry emitting silica particles (non-occupational exposure to silica dust from industrial sources).

Another question is whether the standard should be based on PM-10 dust or it should be based on respirable dust (less than 4 or 5 µm) or PM-2.5 because silicosis is the restrictive type of lung disease. Hearl[38] suggested the use of industrial hygiene techniques for measurement of crystalline silica in ambient environment. Bhagia[7] used PM-10 high volume samplers (1,100 liter per minute (LPM)) and vertical elutriators with median cutoff at 10 µm and a maximum cutoff at 15 µm (7.4 LPM) for measurement of silica in the vicinity of slate and agate industries. Davis *et al*.,[1] used dichotomous samplers with a maximum cutoff at 15 µm. The manual dichotomous sampler (16.7 LPM) is used for routine compliance monitoring in USA for PM-10 and PM-2.5. To answer all the questions discussed above, lot of field studies are required with simultaneous monitoring of PM-10, PM-2.5, and respirable dust (less than 4 or 5 µm) in the vicinity of silica-based industry as well as in the community environment. Our observations [Table 1] show that quartz concentrations (PM-10) in the vicinity of agate and slate pencil industries are more than 5 µg/m^3, while in control localities away from these industries are less than 5 µg/m^3. For the time being, an interim ambient air quality standard of 5 µg/m^3 for silica with PM-10 measurement with a cumulative risk of 0.33% appears reasonable.

Attachment D1 - City Plan 9.4.4.3 Specific Benchmarks for Assessment

Section 2 - The main application.pdf 165 / 354

9.4.4.3 Specific benchmarks for assessment

Table 9.4.4-2: General development provisions code – for assessable development

Performance outcomes	Acceptable outcomes	Does the proposal meet the acceptable outcome? If not, justify how the proposal meets either the performance outcome or overall outcome	Internal use
Amenity protection			
PO1 Development mitigates any negative effects to amenity, health and safety from existing surrounding activities having regard to: (a) noise; (b) hours of operation; (c) traffic; (d) signage; (e) visual amenity; (f) wind effects; (g) privacy; (h) vibration; (i) contaminated substances; (j) hazardous chemicals; (k) odour and emissions; and (l) safety.	**AO1** No acceptable outcome provided.	**COMPLIES** The land use has functioned from the site circa 1992. Current management strategies will be carried to the continual operation of the extractive industry use.	
PO2 The proposed development prevents loss of amenity and threats to health and safety, having regard to: (a) noise; (b) hours of operation; (c) traffic; (d) signage; (e) visual amenity; (f) wind effects; (g) privacy; (h) vibration; (i) contaminating substances; (j) hazardous chemicals; (k) odour and emissions; and (l) safety.	**AO2** No acceptable outcome provided.	**COMPLIES** THE LAND USE HAS FUNCTIONED FROM THE SITE CIRCA 1992. CURRENT MANAGEMENT STRATEGIES WILL BE CARRIED TO THE CONTINUAL OPERATION OF THE EXTRACTIVE INDUSTRY USE.	

Attachment D2 - Picture of the Site

Please note exposed raw materials and exposed stock piles extensive throughout the site

Attachment E1 - The main development application discussing sprinkler system for stockpiles

Section 2 - The main application.pdf 23 / 354

4.1 Noise & Dust Assessment – MWA Environmental

The Noise and Dust report addresses the potential impact of noise and dust emissions from the proposed quarrying activities on surrounding land uses with reference to the relevant regulatory noise limits and air quality objectives.

Nucrush propose to undertake appropriate actions to achieve minimal impacts.

The Noise and Dust report concludes that:

- The proposal will not change potential noise associated with haulage of material.
- With appropriate management measures and physical emission controls, compliance with noise criteria, noise limits and air quality objectives can continue to be achieved at surrounding sensitive land uses.
- Noise control measures include; acoustic treatment of primary crusher and screen to achieve a minimum 5dB(A) noise reduction and fitting mobile plants with broadband reversing alarms.
- Dust control measures include; watering of haul and access road, water sprays to fixed processing plant, rock drills for appropriate dust extraction and sprinklers to manage dust emission from stockpiles during high wind speed conditions.
- With appropriate dust management, as stipulated in Environmental Authority EPP0025613 Conditions B1 to B11, the proposed quarrying activities will comply with the relevant air quality objectives at all surrounding residences.

Attachment E2 - The Submitted MWA Environmental document discussing sprinkler system for stockpiles

Section 4 - Noise and Dust assessment and Stormwater.pdf 28 / 853

3.3.4 DUST CONTROL MEASURES

- Management of dust emissions from **stockpiles during high wind speed conditions** through appropriate use of sprinklers as required.

Attachment F1 - Vic EPA State Environment Protection Policy Air Quality Management (SEPP AQM) for Mining and Extractive Industries - Section 3.3 Assessment Criteria

PEM Mining and Extractives v5.doc

3.3 Assessment criteria

The assessment criteria are used to evaluate the impact of any residual emissions remaining after application of appropriate control practices, best practice or MEA, to ensure that emissions are managed in such a way that the beneficial uses of the air environment (as specified in SEPP (AQM)) are protected.

The assessment of emissions from area sources must consider local air quality (ie., existing air quality) in the vicinity of the mining or extractives operations. The assessment criteria are used to assess the total concentration of background plus emissions arising from activities on the site. Emissions from the mine or quarry must be managed to ensure that the cumulative impacts of all sources (including the mine or quarry) in the local area do not pose a risk to the health and amenity of local residents and that the beneficial uses specified in the SEPP (AQM) are protected.

Table 2 lists the assessment criteria applicable for the mining and extractive industries. These have been developed based on the protection of human health and for some indicators reflect the intervention levels in the SEPP (AQM).

It is important that emissions from industries, including mining and extractives, do not contribute to a deterioration of air quality in urban centres and regional towns and townships. .

Table 2: Assessment criteria for mining and extractive industries[2]

Indicator	Criteria	Averaging period
PM_{10}	60 µg/m³	24-hour average
$PM_{2.5}$	36 µg/m³	24-hour average
Respirable crystalline silica (as $PM_{2.5}$)	3µg/m³	Annual average
Arsenic (total inorganic)	0.003 µg/m³	Annual average
Hydrogen cyanide	340 µg/m³ 9 µg/m³	1-hour average Annual average
Nitrogen dioxide	0.14 ppm	1-hour average
Carbon monoxide	29 ppm	1-hour average
PAHs (as BaP)	0.3 ng/m³	Annual average
Asbestos	0.2 µg/m³ or 0.05 PCM fibres/m³	Annual average
[3]Radionuclides	As low as reasonably achievable	Annual average

Attachment F2 - Vic EPA State Environment Protection Policy Air Quality Management (SEPP AQM) for Mining and Extractive Industries - Section 3.4 Monitoring data required

PEM Mining and Extractives v5.doc

3.4 Monitoring data required prior to conducting air quality assessment

To enable an assessment of air quality impacts through modelling an understanding of existing air quality (ie., background) in the area is required. The data requirements for each level of assessment are:

- **Level 1** – Real time continuous 24-hour PM_{10} and $PM_{2.5}$ data for a 12-month period, analysis of crystalline silica ($PM_{2.5}$ fraction) and heavy metal content (PM_{10}) (where applicable)

When data is being collected or developed for modelling purposes meteorological data is required to be collected at the same location for the same period where practicable.

For Level 1 assessments data from the area where the operation is proposed needs to be collected. This must be done prior to the air quality assessment commencing. In some circumstances data may be available from EPA. Contact EPA to check availability of appropriate data.

Attachment F3 - Vic EPA State Environment Protection Policy Air Quality Management (SEPP AQM) for Mining and Extractive Industries - Section 3.4 Assessment Criteria

PEM Mining and Extractives v5.doc

3.5 Modelling to be undertaken

Results of any modelling are to be used for broad guidance as to the potential environmental impacts arising from any new or expanded development and to assist in the development of appropriate management strategies. The outputs from the model are highly dependent on the quality of the input data including emission estimates, meteorological data and background data. For mining and quarrying operations all of these inputs have a high level of uncertainty associated with them due to the nature of the activities being undertaken.

Level 1 assessments

The modelling for a Level 1 assessment requires 1 year of daily predictions for PM_{10} and $PM_{2.5}$ under worst-case scenarios. Time varying background files (24-hour averages) must be included for large operations in these locations.

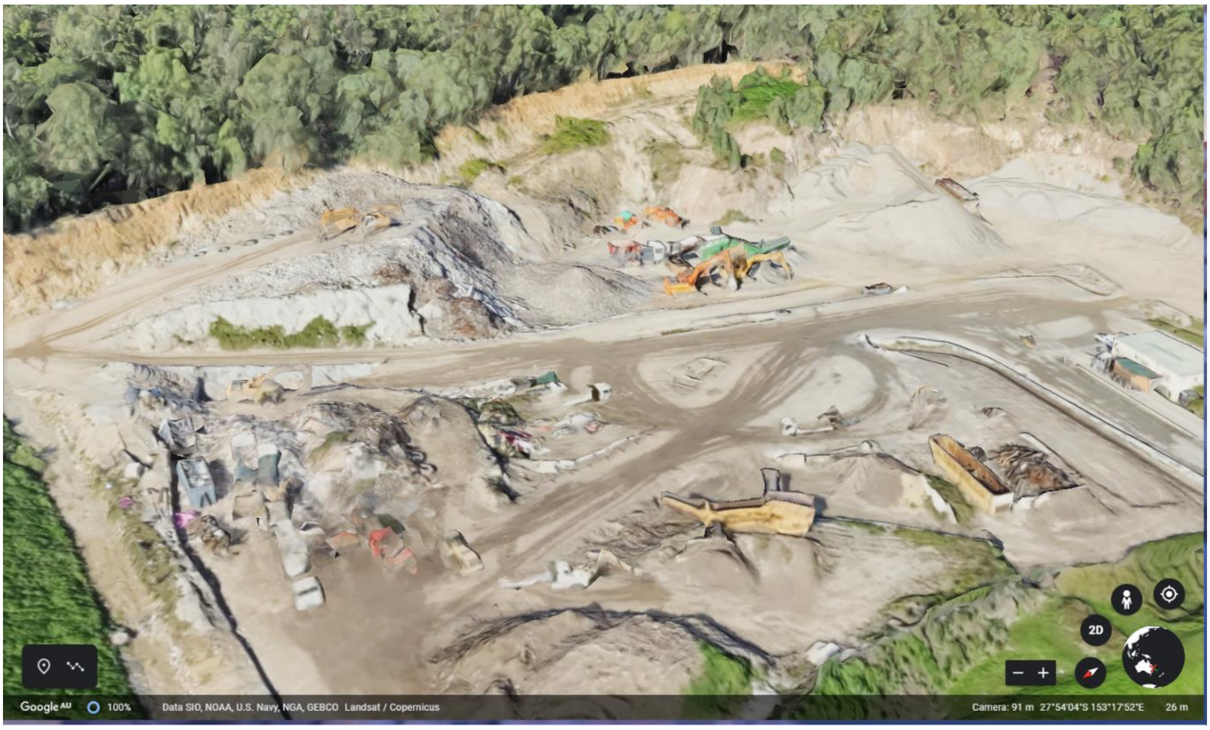
For crystalline silica, arsenic and other indicators that have long-term health effects annual average concentrations must be modelled with annual average background data included in the model.

For Indicators such as NO_2 and CO that have averaging times less than 24-hours, the 70th percentile of the 1-hour average data is to be included. If background is not included for these indicators then the justification of the reason why must be included in the assessment report. For example, in a rural area with low traffic volumes or other sources in the vicinity.

Attachment G1 - Holcim concrete batching facility (34 Maudsland Road, Oxenford) 3D view

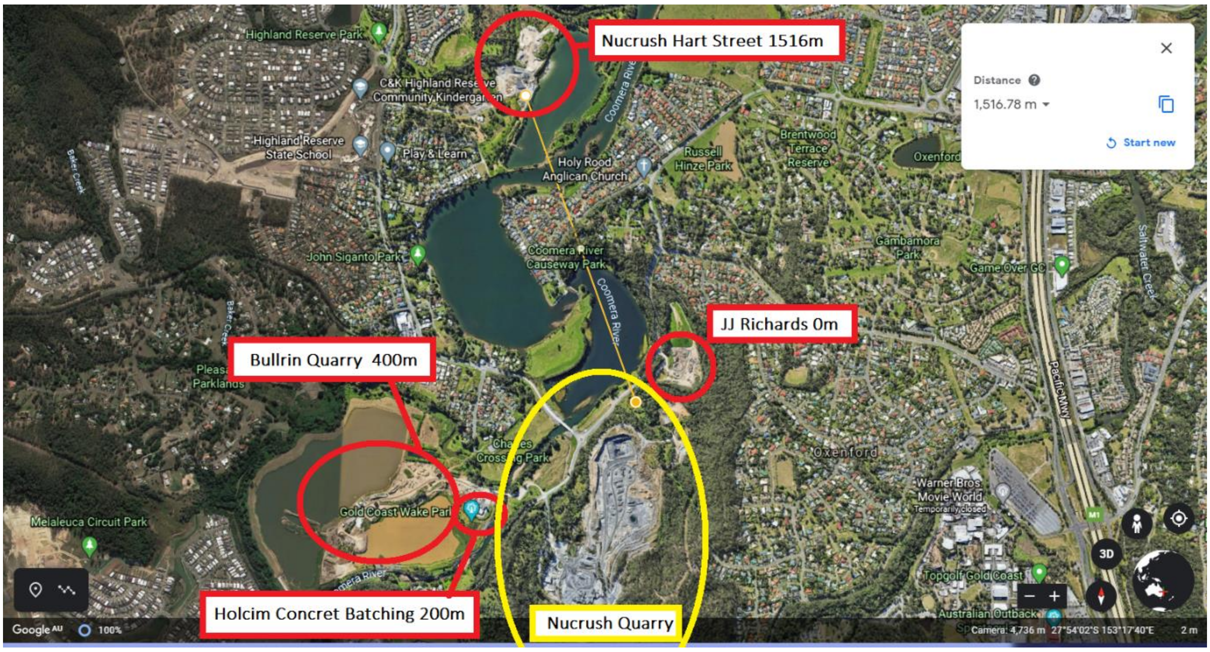
Attachment G2 - Bullrin Quarry operation (34 Maudsland Road, Oxenford) 3D View

Attachment G3 - JJ Richards quarry and recycling operation (241 Tamborine Oxenford Road), 3D view

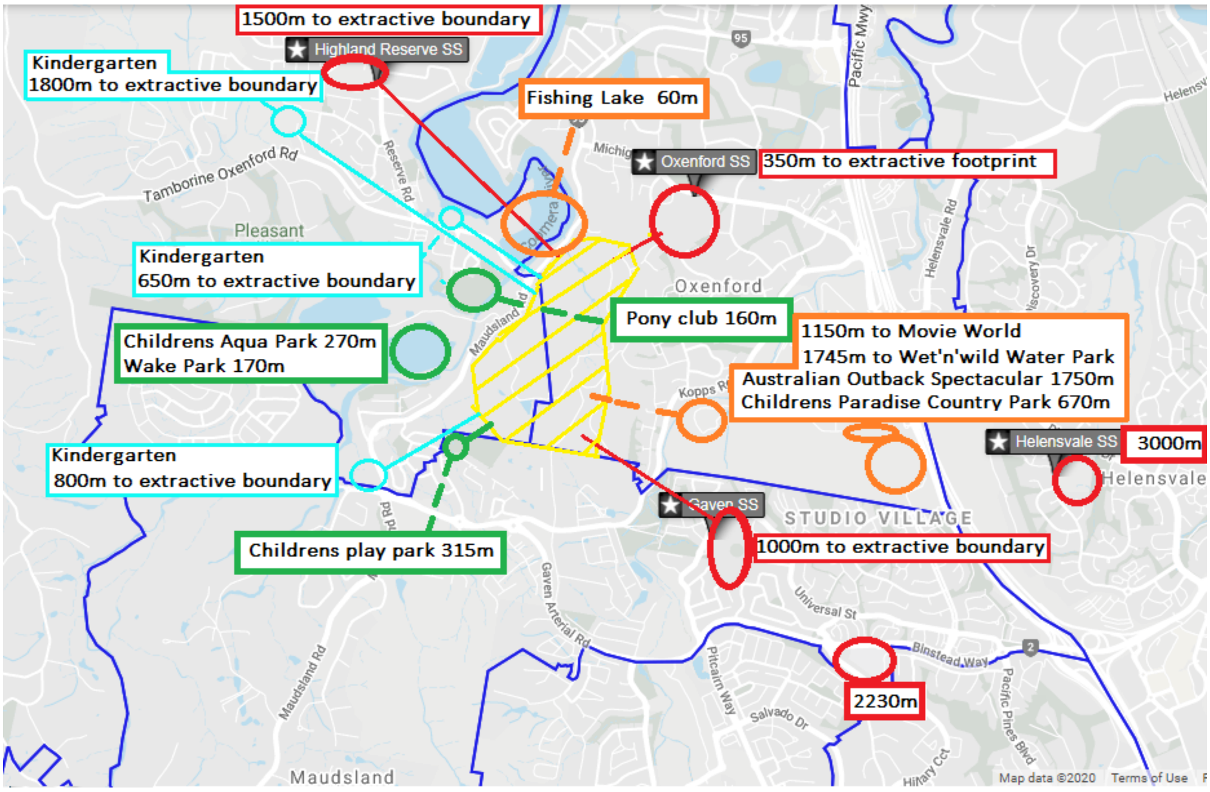


Attachment G4 - Nucrush Hart Street, Upper Coomera Concrete batching facility

Attachment G5 - Location of further dust pollutant sites to be considered



Attachment G6 - Location of Children (the most sensitive receptors) within the affected area



Attachment H1 - Concrete Batching 'Performance Outcome 1'

environment.des.qld.gov.au/__data/assets/pdf_file/0021/88410/pr-cp-concrete-batching.pdf

Code of practice for the concrete batching industry EM1305 7 / 15

Concrete batching processes

Dust from cement, sand and aggregates is generated by many activities, such as:

- loading and transport of materials
- storage of materials
- batching processes.

Performance outcome 1:

Dust and particulate emissions from all activities associated with the concrete batching process must be controlled in order to prevent or minimise nuisance at surrounding premises.

⚠ Dust from activities can enter neighbouring properties causing nuisance and lead to complaints. This may lead to an investigation by authorities regarding compliance of the activities being carried out.

✓ Suggested control measures

- ☐ Ensure that incoming and outgoing truckloads of sand, aggregate and concrete wash out are covered during transport if there is a possibility dust may be emitted.
- ☐ Ensure that trucks leaving the premises are clean, focusing on draw bar and tail gate, to prevent material causing dust nuisance and being tracked onto external roads.
- ☐ Regularly water sand and aggregate stockpiles to keep down dust emissions.
- ☐ Enclose stockpiles on three sides and keep storage levels at least 0.5 metres below the tops of the walls and at least 0.5 metres inside the open ends of the enclosures; or use other measures such as screening or roofing to minimise dust emissions.
- ☐ Ensure that cement and fly ash silos are fitted with overfill protection and dust filtration systems, and properly maintain the systems and filters.
- ☐ Use a burst bag detector system that has ducting to 1 m of ground level adjacent to the silo-filling pipe.
- ☐ All elevated hoppers, conveyors and dusty transfer points shall be sheltered from the wind.
- ☐ Prevent and clean up any spillages or dust accumulation on driveways or sealed roads.
- ☐ Regularly water or otherwise maintain unsealed roads to minimise dust emissions to prevent nuisance from traffic movements. Care should be taken to prevent material being tracked onto roadways.
- ☐ Roof and enclose truck loading bays.
- ☐ Use water sprays or filtered dust extraction systems around gob hoppers and across open sides of enclosures.
- ☐ Ensure any emission control equipment is regularly maintained.

- 👍 Install drive over in ground storage bins where practicable.
- 👍 Use Reverse Pulse filters rather than the 'green bag' type filters.
- 👍 Seal all internal roadways.
- 👍 Roof incline conveyors and enclose on at least one side.
- 👍 Consider screening at the boundary of the premises and / or around high dust generating activities. Screening may include shade cloth and / or vegetation.

Attachment I1 - Californian Standards

State exposure limits are inadequate to protect children's health

Silica exposure is a well-known danger for workers in mining and construction. With the spread of frac sand mining, however, silica air pollution has also become a danger for residents near sand mining and processing operations. Children, older adults and people with respiratory diseases are especially at risk. In the absence of a national air quality standard for silica outside the workplace, six states have developed their own standards or guidelines.

Table 3. State exposure limits for crystalline silica in air*

State	Calif.	Minn.	New Jersey	Texas	Vermont**	New York**
Limit (µg/m3)	3	3	3	2	0.12	0.06
Type of limit	chronic reference exposure level	chronic health-based value	long-term reference concentration	chronic reference value	hazardous ambient air standard (annual)	annual guideline concentration
Measured as	PM4	PM4	PM10	PM4	PM10	PM10

* Long-term exposure limits for general population based on the risk of silicosis.

** General population exposure limits derived by state agencies from occupational exposure values established by the American Conference of Governmental Industrial Hygienists (New York State Department of Environmental Conservation 1997; Vermont Department of Environmental Conservation 1998).

EWG's analysis concluded that the silica exposure limits adopted by California, Minnesota, New Jersey and Texas are insufficient to protect children and other vulnerable populations, for several reasons:

These exposure limits are based on epidemiologic studies of adult male miners, a population of typically healthy and robust workers. None of the studies included children or vulnerable populations, although they face unique risks. As the California Office of Environmental Health Hazard Assessment (OEHHA) noted, "exacerbation of asthma, which has a more severe impact on children than on adults, is a known response to some respiratory irritants" (OEHHA 2005). The agency added: "Since children have smaller airways than adults and breathe more air on a body weight basis, penetration and deposition of particles in the airways and alveoli in children is likely greater than that in adults exposed to the same concentration."

In setting their silica exposure values, California and Texas used epidemiological data from miner studies and applied a three-fold adjustment factor as a margin of safety to account for human variability. (Minnesota adopted the California standards.)

EWG strongly disagrees with this approach. A three-fold margin of safety is insufficient to account for the potentially elevated sensitivity to silica among children, the elderly and people with respiratory diseases. The California agency's own guidelines for the Derivation of Non-cancer Reference Exposure Levels, finalized in 2008 – three years after it adopted its silica exposure limit – call for a higher adjustment factor to protect children's health from air pollutants (OEHHA 2008). In fact, in the draft risk assessment for benzene the Office of Environmental Health Hazard Assessment published in January 2014, it called a 10-fold adjustment a "default" factor for air toxics to allow for the differences among infants, children and adults (OEHHA 2014). Similarly, the U.S. EPA also typically uses an additional safety factor of 10 in its risk assessments for certain exposures during vulnerable periods of development. In the case of pesticides, the Food Quality Protection Act of 1996 specifically requires consideration of children's exposure (U.S. EPA 2002a; U.S. EPA 2002b).

Attachment J1 - Fine Road Dust Contamination

Attachment K1

publiclab.org/wiki/silica-monitoring

Public Lab

Silica Monitoring

Small silica dust is carcinogenic, and exposure to silica has been recognized an occupational health concern for decades. This size range of particle can travel long distances suspended in the atmosphere and particles smaller than 5 µm are easily lodged in the lungs.

In natural settings sand does not usually fracture this small, but under pressure in industrial operations and on roadways, silica can be ground to this respirable size. Road construction, non-metallic mining, glass grinding and sand-blasting are common sources of silica pollution.

Attachment K2

publiclab.org/wiki/silica-monitoring

Public Lab

Regulation

Regulations on silica emissions and non-occupational exposures are fairly new, highly varied, and applicable only in a few states. Monitoring requirements and techniques are not yet standardized. No affordable, low-cost means of demonstrating regulatory exceedances of airborne silica concentrations currently exists.

While there are few direct means of proving or registering non-occupational silica exposures, concerned communities can take a variety of actions to address sources of silica particles and advocate for stricter silica regulations.

The following sections discuss regulations around silica and how they relate to existing occupational exposure and overall particulate matter regulations that do exist. It also highlights where current regulations on non-occupational exposure to silica do exist, and their approaches differ.

Attachment K3

publiclab.org/wiki/silica-monitoring

Public Lab

Exposure to silica in occupational and non-occupational settings

Efforts to measure and regulate non-occupational exposure to silica are fairly recent. Occupational regulations around silica exposure, which started in the 1920s for the U.S. (OSHA 2008), are based on scientific findings that there are correlations between total airborne particles and lung damage. However, the concentrations of airborne particles that are likely to cause health effects in occupational settings are higher than concentrations of particles that are relevant to protect health in non-occupational exposure settings.

Only very small size-fractions of silica are transported and settle outside of occupational zones. Fine sand (~20-100 µm) can become airborne, but it settles nearby. Silica dust less than 10 µm is light enough and has enough surface area to stay airborne long enough to travel beyond occupational zones. A fraction of these smaller dust particles are also the most damaging to the lungs.

Silica dust less than 5 µm in diameter is **respirable**, meaning it can travel into the bronchial region and deposit in the gas-exchange zone of the lungs. There, they can cause scarring, swelling, and the growth of fibroids in alveoli, the deepest parts of the lungs. Silica dust less than 5 µm is of greatest concern in both occupational and non-occupational exposure. In occupational exposure, respirable silica is often correlated with larger particles, whereas in non-occupational settings respirable silica is not necessarily correlated with total coarse particulate matter. Occupational and non-occupational guidelines for silica exposure vary in whether they derive from estimates based on larger particle (PM10) monitoring data or respiratory-size specific data, but all non-occupational exposure limits are based on modifications of occupational exposure rules.

Attachment K4

publiclab.org/wiki/silica-monitoring

Public Lab

Non-occupational exposure

The concentration of particulate matter that is cause for concern in non-occupational exposure is much lower than in occupational exposure. A person is at work typically only one-third of the day, and usually spends more hours at home than work, including sleep.

Also, the exposed population in a non-occupational setting includes more vulnerable people, such as children and the elderly, than the workforce (which is often estimated as healthy young-adult and middle-aged men in exposure risk studies).

Children breathe more deeply than adults, and their smaller body mass means that their relative exposure to pollutants is much higher.

For all of these reasons, non-occupational exposure limits are set lower than occupational exposure limits to protect human health. For respirable crystalline silica, the difference between the two types of exposure limits can be orders of magnitude, The Occupational Safety and Health Administration's (OSHA) occupational exposure guidelines are to avoid exposures above 10 *milligrams* per cubic meter, while the state of Vermont's non-occupational exposure guideline is 0.12 *micrograms* per cubic meter.

Attachment K5

publiclab.org/wiki/silica-monitoring

Public Lab

Exposure Monitoring

Respirable silica

Inhalation studies and studies of human cadavers have shown that crystalline silica particles less than 5 µm in diameter can travel deep into the lungs causing irritation and cancer. Respirable crystalline silica (silica particles that are less than 5 µm) has been identified as a human carcinogen by the International Agency for Research on Cancer (IARC). Non-occupational respirable silica emissions are not federally regulated, however six states have adopted ambient respirable silica exposure standards.

The Occupational Safety and Health Administration's (OSHA) PM4 monitoring standard is a federal standard that state-level OSHA agencies implement and enforce.

Attachment K6

publiclab.org/wiki/silica-monitoring

Public Lab

OSHA's PM4

OSHA's current rules necessitate air sampling using a size-shearing pump to draw air onto a filter, and then analyze the filter for the concentration of crystalline silica. The methods that OSHA promotes are more performance-based than based on specific technology (whereas EPA methods are specific to certain technologies/instruments), but require using a devise (usually a cyclone) that can collect and retain 0% of particles that are 10 µm or larger, 25% of particles that are 5 µm, 50% of particles that are 3.5 µm, 75% of particles that are 2.5 µm, and 90% of particles that are 2.0 µm (OSHA Technical Manual, Section II, Chapter 1, Part III). The method is generally referred to as a method for "PM4" or particulate matter that is 4 µm, because size-shearing methods are often distinguished by their "50% cut point," or the diameter of particle for which 50% are entrained into the cyclone and 50% impact the walls. The OSHA method is labeled for PM4 as short-hand rounding for a PM3.5 method. After the appropriately sized particles are collected on the filter, they are analyzed using X-ray diffraction (XRD) techniques, described below.

OSHA sampling

The sampling techniques outlined by OSHA for occupational silica exposure would systematically underestimate silica exposure in non-occupational ambient settings. The stipulated performance (described above) methodically under-samples particles on the larger end of the range (1-5 µm), with only 25% of PM5 being entrained into the sample stream, so a relatively larger proportion of much smaller particles (e.g. 90% of 2 µm particles) constitute the final sample. In occupational settings such as sandblasting where more than 90% of particles will be silica, under-sampling particles on the large-end of the respirable fraction, will not appreciably change the percentage of silica in the air.

However, in ambient situations where a significant portion of fine particulates (2.5 µm and smaller) derive from other sources such as diesel combustion products or atmospheric reactions of sulfur dioxide, the disproportionately large representation of these smallest particles on the sample filter will not be truly representative of what is respirable in the air. This is extremely important in measuring for respirable silica because the percentage of total particles that is crystalline silica will be assessed based on the percent of particles on the sample filter that are silica. Non-silica particles would constitute a disproportionate (erroneously high) fraction of the total particulate matter, **and thus the calculated silica percentage would be erroneously low**.

Attachment K7

publiclab.org/wiki/silica-monitoring

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State non-occupational exposure rules

Six states, California, Minnesota, New Jersey, New York, Texas, and Vermont, have adopted ambient air quality standards or guidance for ambient respirable crystalline silica (less than 5 µm in diameter) based on concerns about its health effects. Any inhaled particles of this size are dangerous, but silica can be especially detrimental to people's health.

In 2005, the California Office of Environmental Health Hazard Assessment (OEHHA) set forth a rule that chronic exposure (e.g. everyday exposure, at home or outside) to respirable crystalline silica should be less than 3 µg/m3. Minnesota – also a state facing potential frac sand mining like Wisconsin – and New Jersey have adopted California's health-based standard of respirable crystalline silica at 3 µg/m3, Texas and New York have set their guidance at 2 µg/m3 (though prior to 2014, New York had set theirs at 0.06 µg/m3), and Vermont has set their guidelines much lower at 0.12 µg/m3.

To determine ambient air guidelines for respirable crystalline silica, states used occupational health guidelines and adapted them to be suitable for chronic exposure. The typical population in occupational exposure studies are healthy adult males. This population's ability to deal with problematic exposures before experiencing negative health impacts is greater than any other population's. Thus, adequate concentration limits for non-occupational exposure need to be lower than occupational exposure limits.

California, and subsequently Minnesota and New Jersey, adjusted occupational exposure for the increased number of hours exposure would occur (i.e. hours not included in the 40-hour work week), and an "intraspecies uncertainty factor of 3" (MN DOH Respirable Silica Toxicological Summary), which is an estimated factor to account for the differences in susceptibility between healthy adult males and more vulnerable populations. Texas and New York used slightly higher adjustment factors, and Vermont followed adjustment guidelines for most known carcinogens, adjusting by an overall factor of 100.

The nonprofit organization Environmental Working Group wrote an expository piece on ambient airborne silica, in which they urged more states to adopt respirable silica regulations and make the standards no higher than 0.3 µm/m3 in order to protect vulnerable populations.

Attachment K8

publiclab.org/wiki/silica-monitoring

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State measurement programs

California, Minnesota, New Jersey, New York, Texas, and Vermont have added respirable crystalline silica as a Hazardous Air Pollutants and thus adopted ambient guidelines, but respirable crystalline silica is not routinely measured. Rather, industries known to emit silica must use computer simulations to estimate their respirable crystalline silica emissions before they can obtain a permit to build or operate a facility.

These estimate emissions are based on empirical conversion factors from PM10 emissions estimates, followed by air dispersion models. If a proposed facility's emissions estimates indicate that they might emit an unacceptable amount of respirable silica, then the state would work with the proposed facility owner to discuss Best Available Control Technologies (BACT) to reduce their potential emissions. However, states may never actually monitor respirable crystalline silica. For example, in New York state, there has yet to be a case in which the state determined it must monitor respirable silica emissions based on emissions estimates and air dispersion models (personal communication).

Attachment K9

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Silica & PM10

The U.S. does have National Ambient Air Quality Standards for particulate matter (find more information here), including standards for "coarse" and "fine" particulate matter. Coarse particulate matter (PM10) is composed of airborne particles that are less than 10 µm in diameter. Analyses from different regions of the U.S. determined that silica composed anywhere from 0-25% of the total particles (by mass) in daily PM10 samples, and proposed estimating 10% silica by mass in PM10 samples (US EPA 1996).

Since silica is not federally regulated separately from general particulate matter, and analyses to identify silica (such as XRD, discussed below) can be very expensive, agencies use this very rough estimate that 10% of PM10 is silica, though it is acknowledged that the percentage silica in a sample varies by location and nearby activities. At sand mining operations, the percentage of particulate matter that is silica can be upwards of 90% (based on EPA's emissions factor for sand and gravel processing), so the typical estimation of 10% may significantly underestimate the amount of airborne silica in areas near industrial sand mining.

Attachment K10

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"Inhalable" vs. "Respirable"

Coarse particulate matter is all "inhalable," meaning that it can enter the upper respiratory system, but it is not all "respirable," meaning it reaches the gas-exchange zone deep in the human lungs. Particulate matter that is less than 5 µm in diameter is considered respirable. Unfortunately, there have been few studies that have investigated what portion of PM10 is respirable, and it is likely to vary based on the composition of particulate matter in the sample.

This EPA study found an average of 20% PM4 (respirable fraction) in PM10 samples, but it ranged from 7 to 50%. Directly from PM10 measurements, it is difficult to ascertain the risk of respirable dust exposure. With the combined uncertainties of the portion of PM10 that is respirable and the percentage of PM10 that is silica, it is nearly impossible to adequately assess the risk of respirable silica exposure from PM10 measurements.

Attachment K11

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Silica & PM2.5

The U.S. has National Ambient Air Quality Standards for fine particulate matter (read more here), which is less than 2.5 μm in diameter (PM2.5). Much respirable silica is larger than PM2.5 (though smaller than PM10), and is excluded from sampling for PM2.5. Up to 90% of PM2.5 may be comprised of combustion byproducts and secondary particles. These make identification of respirable silica more challenging.

Particles this small are composed of "primary" and "secondary" particles, meaning particles that are directly emitted from a source and particles that are formed through reactions in the atmosphere, respectively. Chemicals that can react to create PM2.5 include nitrogen dioxide (NO2) and sulfur dioxide (SO2), which are hydroscopic and react with water droplets (read more on droplet formation).

Attachment K12

publiclab.org/wiki/silica-monitoring

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Visible emissions

Visible emissions are also regulated throughout the United States. Visible emissions are quantified by a measure of opacity, which the degree of light-scattering by particles, and akin to the lack of transparency in the sky. The EPA has two primary methods that citizens can conduct to measure the opacity of emissions, EPA methods 9 and 22. Read more about these methods here.

While visible emissions are not chemical-specific, monitoring and reporting visible emissions can be effective to bring enforcement for emissions violation. Emissions that are subject to opacity rules include primary emissions (e.g. through a smoke stack), and also fugitive emissions, such as leaky pipes, unpaved transport roads, or storage piles on industrial property. Often fugitive emissions are difficult to quantify or are neglected in permitting applications, so monitoring for visible fugitive emissions can be useful.