Eastern Creek Recycling Ecology Park

Recycling Infrastructure Optimisation Project

Appendix L
Human Health Risk Assessment

June 2022

Human Health Risk Assessment: Eastern Creek Recycling Ecology Park

Prepared for: Bingo Industries

3 March 2022

EnRiskS

Document History and Status

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Limitations

Environmental Risk Sciences Pty Ltd has prepared this report for the use of Bingo Industries in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in the **Section 1** of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information provided for use in this assessment was false.

This report was prepared in February and March 2022 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

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Table of Contents

Glossary of terms

AQIA	Air quality impact assessment
C&D	Construction and demolition
C&I	Commercial and industrial
CO	Carbon monoxide
DPIE	Department of Primary Industries and Environment
EIS	Environmental impact statement
EU	European Union
HHRA	Human health risk assessment
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NOx	Oxides of nitrogen
NO_2	Nitrogen dioxide
NSW EPA	New South Wales Environment Protection Authority
NHMRC	National Health and Medical Research Council
PM	Particulate matter
REP	Recycling Ecology Park
RR	Relative risk
SO_2	Sulfur dioxide
SSD	State Significant Development
tpa	Tonnes per annum
TSP	Total suspended particulates
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
WA Health	Western Australia Health
WHO	World Health Organization

Section 1. Introduction

1.1 Background

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Bingo Industries to conduct a human health risk assessment (HHRA) to address the potential for impacts on air quality at the Eastern Creek Recycling Ecology Park from activities following an expansion of the facility.

Currently, an Environmental Impact Statement (EIS) for a state significant development (SSD) project is being prepared for submission to NSW DPIE. The Proposal will allow an additional 950,000 tonnes of waste per annum to be processed through the facility. The Proposal also includes upgrades to internal roads and construction of new buildings and new exit roads.

As part of the EIS development, an air quality impact assessment (AQIA) has been prepared for the Proposal by EMM (EMM 2022). This assessment has assessed the potential for air quality impacts to occur in the surrounding community due to the increased activities at the Proposal Site both during construction (where appropriate) and operation.

Particulate matter was identified as the main pollutant of interest in the AQIA. This arises from release of dust during waste handling, storage, classification and transport. Background levels of PM_{10} and $PM_{2.5}$ in air around the facility are close to or above national guidelines for these parameters. Additional levels of particulate matter from these new activities requires more detailed assessment to fully inform the development application.

1.2 Objectives

The objectives of the HHRA presented in this report are:

- review available data and information for the Proposal
- undertake a HHRA to estimate the potential for health impacts are relevant receptor locations due to the changes in particulate matter concentrations predicted for the Proposal – commercial/industrial and residential receptor locations
- if elevated risks are identified, appropriate risk management measures that may need to be implemented to mitigate the identified risks will be discussed and/or control measures that are proposed for the Proposal to control dust will be reviewed.

The assessment has only addressed air emissions of particulate matter as modelled by EMM. This assessment has not addressed risks to the environment in on or off-site locations nor air quality impacts for other parameters as these have already been addressed by EMM in the AQIA.

It should be noted that the Secretary's Environmental Assessment Requirements (SEARs) issue for the Proposal did not include a requirement for the conduct of a HHRA. The HHRA has been conducted to support the outcomes of the AQIA.

1.3 Methodology and scope of works

- The methodology adopted for the conduct of this HHRA is in accordance with the relevant National protocols/ guidelines including:
- enHealth 2012. Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a)
- enHealth 2012. Australian Exposure Factor Guide (enHealth 2012b)

- NEPC 2021. National Environment Protection (Ambient Air Quality) Measure (NEPC 2021)
- NEPC 2011. National Environmental Protection (Air Toxics) Measure (NEPC 2011a)
- NSW EPA 2017. Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA 2017).

Where required, additional guidance has been obtained from relevant Australian and International guidance consistent with current industry best practice, such as that available from the USEPA and the World Health Organisation (WHO).

1.4 Available information

This assessment has been undertaken on the basis of the information and data provide in the following:

- EMM 2022, Air quality impact assessment, Eastern Creek REP – Recycling Infrastructure Optimisation Project. Report dated February 2022 and referred to as the AQIA.
- Publicly available information and documents relating to the Eastern Creek REP, available from https://www.bingoindustries.com.au/Policies/eastern-creek-policies-and-reporting

Section 2. Proposal description

2.1 General

Dial-A-Dump (EC) (DADEC) Pty Ltd, (the Applicant) (as owned by Bingo Industries Pty Ltd (Bingo) operate the Eastern Creek Recycling Ecology Park (REP), located at 1 Kangaroo Avenue, Eastern Creek (formerly known as the Genesis Waste Management Facility) ('the Proposal Site'). The current approval allows for a total throughput of two million tonnes per annum (Mtpa), of which up to 1 Mtpa may be landfilled (excluding residual chute waste) with the remaining 1 Mtpa processed for resource recovery. The Eastern Creek REP comprises of a number of resource recovery facilities and activities including:

- two materials processing centres known as Materials Processing Centre 1 (MPC1) and Materials Processing Centre 2 (MPC2) which predominantly process dry construction and demolition (C&D) and commercial and industrial (C&I) waste
- a Segregated Materials Area (SMA) which is principally used for the receipt, processing dispatch and stockpiling of inert construction and demolition materials, such as sand, dirt, aggregate, concrete, bricks and asphalt.

The Eastern Creek REP is approaching the current 2 Mtpa throughput limit, with this limit to be reached within the next few years. The Applicant is therefore proposing to increase the total throughput of the Eastern Creek REP by 950,000 tonnes per annum (tpa) and carry out minor infrastructure upgrades works across the Proposal Site (the Proposal). The Proposal aims to further unlock the potential of the strategically significant Eastern Creek REP, with benefits of scale and optimal location within the Sydney transport network to respond to market demand and the policies of both the NSW and Commonwealth governments for expanded and enhanced resource recovery infrastructure. The Proposal would consist of predominantly dry C&D and C&I waste, consistent with existing waste streams received at the Eastern Creek REP.

2.2 Overview of Proposal

Bingo are proposing to enhance resource recovery outcomes across the Greater Sydney area by increasing throughput at the Eastern Creek REP to capitalise on the underutilised state-of-the-art processing facilities (namely MPC2), and plant and equipment within the Eastern Creek REP. The Proposal would include the upgrade and construction of supporting infrastructure to optimise the current operation at Eastern Creek REP and facilitate the increased throughput proposed to be received at the Proposal Site. It is proposed to develop the Proposal Site in three stages

- **Stage 1: Initial throughput:** Stage 1 would comprise 500,000 tpa of additional throughput to be received at the Eastern Creek REP to enhance resource recovery outcomes by increasing utilisation of onsite processing capabilities.
- **Stage 2: Internal site optimisation:** Stage 2 would facilitate the remaining throughput increase (an additional 450,000 tpa of the total 950,000 tpa proposed) to be received and processed across the Eastern Creek REP and operation of one of two proposed new exit connections. Stage 2 would include:
    - the construction and operation of a new exit connection to the Honeycomb Drive extension and installation of two associated outbound weighbridges and a dedicated weighbridge office

- the construction and operation of a new exit connection to Kangaroo Avenue in the north east of the Proposal Site and the installation of two associated outbound weighbridges and a dedicated weighbridge office
    - upgrade of existing internal roads as required
    - earthworks for Stage 3 site establishment
    - additional carparking and amenities.
- **Stage 3: Installation of supporting infrastructure:** Stage 3 would comprise the redevelopment of the north-eastern corner of the Proposal Site. This would comprise: - construction and operation of a Site Workshop (relocating this activity from elsewhere within the Proposal Site to a dedicated enclosed facility):
    - construction and operation of a skip bin Maintenance and Manufacturing Workshop
    - installation of landscaping, signage, security fencing and finishing works.

2.3 Location and surrounding areas

The Proposal Site is located within the Eastern Creek industrial precinct / M7 business hub and is surrounded by a large range of industrial developments, primarily to the east. These industrial developments include Techtronic Industries, H&M distribution warehouse, Kuehne + Nagel (Australia) Pty Ltd warehouse, Kmart distribution centre, Bunnings distribution centre and DB Schenker warehouse. To the west of the Eastern Creek REP is the Fulton Hogan asphalt batching plant and a vacant area of undeveloped land.

The Eastern Creek REP is bounded by the Western Motorway (M4) to the north, Kangaroo Avenue to the east and Honeycomb Drive to the south. The planned future Archbold Road extension will run parallel to the western boundary of the Proposal Site. The Eastern Creek REP is enclosed by commercial and industrial buildings to the immediate north, east and south. The closest residential premises are located across the M4 Motorway approximately 400 m to the north in the suburb of Minchinbury and approximately 1.2 km west in the suburb of Erskine Park.

The location of the Proposal Site and surrounding areas are shown on **Figure 1**[1].

[1] Figure 1 is obtained from the Environmental Management Strategy, Eastern Creek Recycling Ecology Park (& Landfill) prepared by Bingo Industries, dated 1 February 2021.

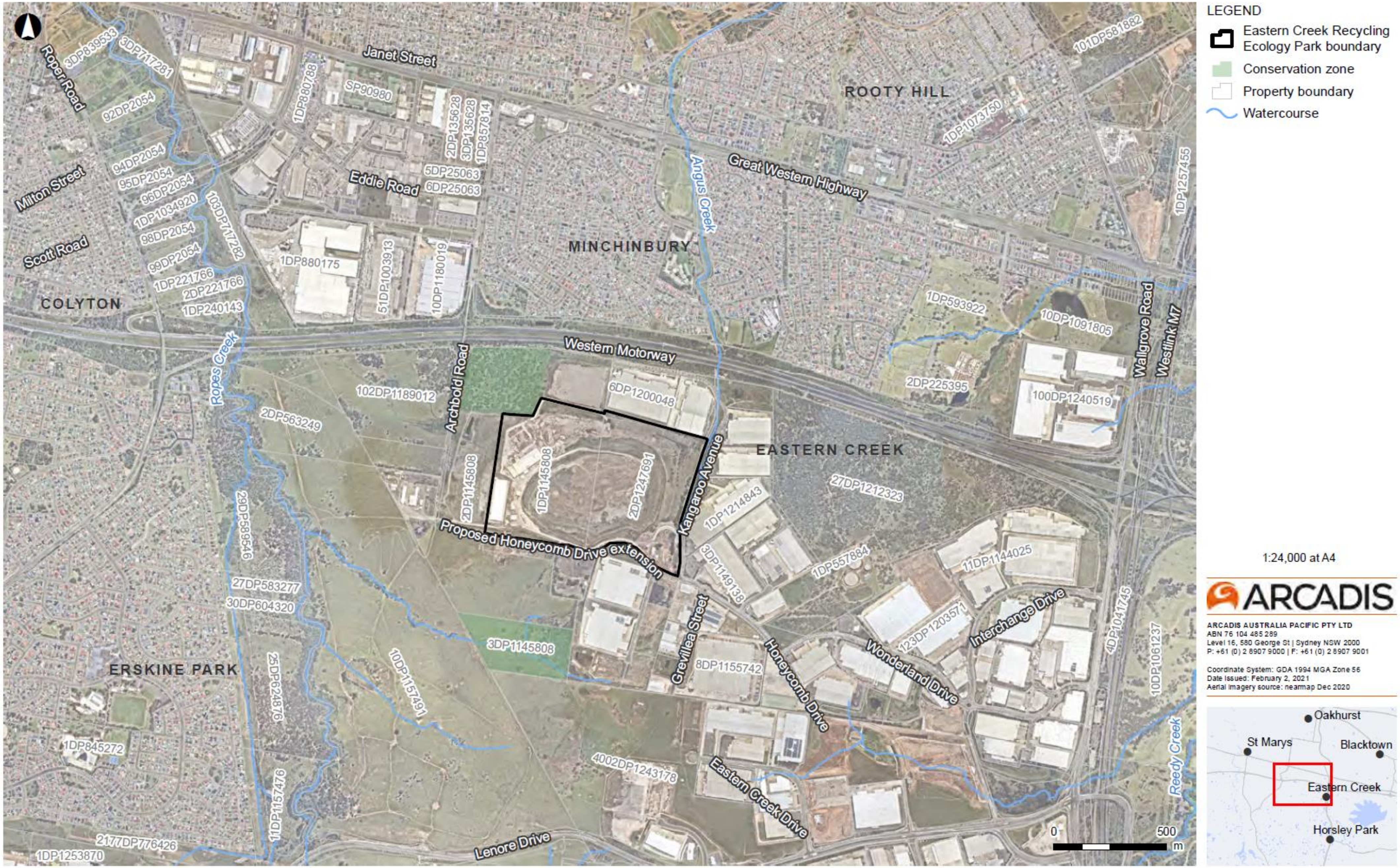


Figure 1: Facility location

Section 3. Particulate impacts predicted in AQIA

The AQIA presents an assessment of potential impacts on air quality associated with the Proposal. The AQIA identified key sources of emissions to air associated with the Proposal, which are as follows:

- Fugitive dust from waste and product handling and processing, movement of plant and equipment and wind erosion of exposed surfaces. Fugitive dust is evaluated on the basis of the particulate size fractions, where the following were assessed:
  - total suspended particulate matter (TSP)
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10})
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$).
- Diesel exhaust emissions from construction equipment, which include:
  - $PM_{2.5}$
  - oxides of nitrogen (NO_x) including nitrogen dioxide (NO_2)
  - sulphur dioxide (SO_2)
  - carbon monoxide (CO)
  - volatile organic compounds (VOCs).

The AQIA identified that apart from PM_{10} and $PM_{2.5}$, the other air emissions from construction equipment are very low, and would not result in significant off-site concentrations relative to ambient/existing air quality, and have not been further assessed. Hence the focus of the AQIA relates to emissions to air of dust or particulates.

For the purpose of evaluating impacts of the Proposal on existing air quality at commercial/industrial and residential areas surrounding the Proposal Site, the AQIA has identified the locations of the closest receptors. The location of the closet commercial/industrial and residential receptors evaluated in the AQIA are shown on **Figure 2**.

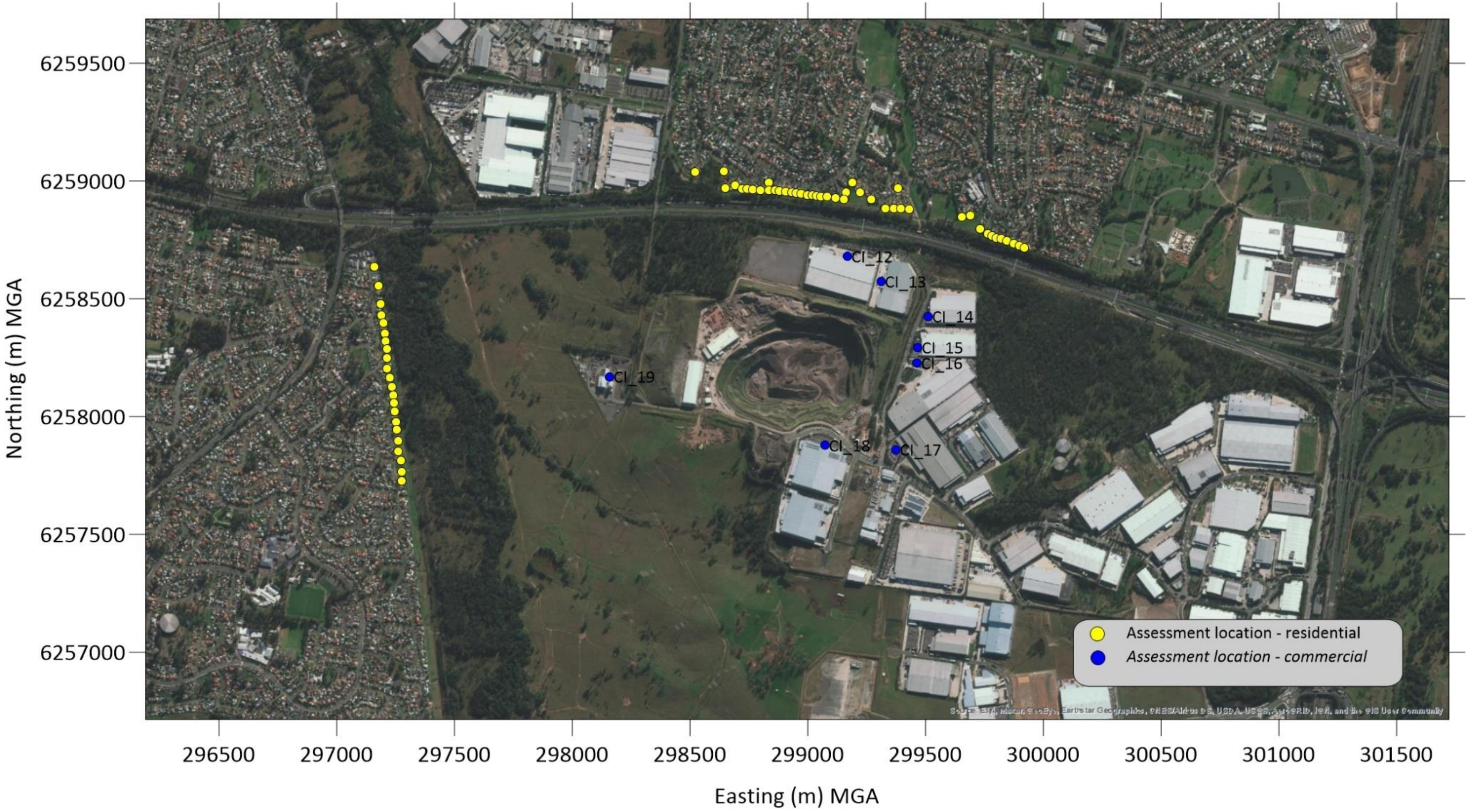


Figure 2: Locations of nearest commercial/industrial and residential receptors (from AQIA, EMM 2022)

Impacts of dust emissions on the surrounding community, at the closest receptors identified in **Figure 2**, were predicted on the basis of the following:

- Estimation of dust emissions rates during activities associated with approved operations as well as activities proposed during Stage 1, 2 and 3 construction and operations, noting that all significant site establishment activities occur during Stage 2 construction which coincides with Stage 1 operations (hence Stage 1 operations and Stage 2 construction are considered together)
- Incorporation of dust mitigation measures (existing and proposed) that reduce the emission rate of dust during various activities
- Use of an air dispersion model, that incorporates terrain and meteorology
- Consideration of existing air quality in the region:
    - $PM_{2.5}$ and PM_{10} data available from air quality monitoring stations located at Minchinbury (operated by Bingo since 2016 and reporting PM_{10}), St Marys and Prospect (operated by DPIE with data from 2016 to 2021 on $PM_{2.5}$ and PM_{10}). Background levels of $PM_{2.5}$ and PM_{10} were incorporated on the basis of daily varying concentrations from the DPIE Prospect data from 2016, which represented the most conservative background data for the area. This data included a number of days when the 24-hour average air quality guidelines for $PM_{2.5}$ and PM_{10} were exceeded. In addition, the annual average $PM_{2.5}$ and PM_{10} concentrations exceeded the air quality guidelines. The existing (i.e. background) air quality in relation to $PM_{2.5}$ and PM_{10}, including exceedances as noted, occur in the region regardless of the Proposal.
    - Dust deposition data from four locations on the Proposal Site, noting that deposited dust is an aesthetic issue rather than a health issue (refer to **Section 4** for further discussion).

The assessment of dust impacts requires consideration of an incremental impact from the Proposal as well as total or cumulative concentrations (incremental plus background).

Tables 1 and 2 presents a summary of the maximum impacts (incremental and cumulative) predicted in the AQIA for $PM_{2.5}$ and PM_{10} as 24-hour average and annual average concentrations at residential and commercial/industrial receptors surrounding the Proposal Site, and outcomes of the AQIA in relation to compliance with the guidelines adopted.

The modelled impacts as presented and discussed in the AQIA indicate the following:

- There are no additional exceedances or exceedances that would be measurable of the adopted guidelines at any of the off-site residential locations. Where this is the case there are no impacts of concern in the residential areas that require further assessment in relation to risks to human health.
- In relation to impacts predicated at commercial/industrial locations, the following is of note:
    - Stage 1 operations (including Stage 2 construction) have the potential to result in additional exceedances of the 24-hour average PM_{10} air guideline (over and above impacts related to approved operations). These impacts are considered to be short-

term and relate to the Stage 2 construction works which are expected to be completed over approximately 18 months.

- Impacts predicted during Stage 2 operations are considered representative of long-term operational impacts.
- Stage 2 operations result in a reduction in the maximum concentrations of $PM_{2.5}$ and PM_{10} at the closest commercial/industrial receptors (by comparison to approved operations) due to the reconfiguration/ optimisation of the Eastern Creek REP which acts to re-distribute dust emissions, particularly from trucks, by re-directing truck exit points to the Honeycomb Drive extension and Kangaroo Avenue in the northeast of the Proposal site.

Based on the above further assessment of health impacts reported in commercial/ industrial areas located adjacent to the Proposal Site is required and is presented in **Section 4**.

Table 1: Summary of predicted dust impacts as presented in the AQIA – Residential

Scenario	Maximum predicted concentrations $PM_{2.5}$ (µg/m^3)				Maximum predicted concentrations PM_{10} (µg/m^3)				Outcome of AQIA
	24-hour average		Annual average		24-hour average		Annual average		
	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	
Approved operations	1.8	24.9	0.2	8.8	16.8	43.3	1.4	20.3	PM_{10}: No additional exceedances of air guideline $PM_{2.5}$: No additional exceedances of air guideline
Stage 1 operations (plus Stage 2 construction)	3.1	25.1	0.3	9.0	27.6	44.6	2.2	21.4	PM_{10}: No additional exceedances of air guideline $PM_{2.5}$: One additional exceedance of 24 hour average guideline, however only where background is already elevated and incremental impact is negligible (~4% of guideline)*
Stage 2 operations	2.9	25.1	0.3	8.9	27.2	44.6	2.0	21.0	PM_{10}: No additional exceedances of air guideline $PM_{2.5}$: One additional exceedance of 24 hour average guideline, however only where background is already elevated and incremental impact is negligible (~4% of guideline)*
Stage 3 construction	Not assessed as works involve activities with low potential for dust emissions								
Stage 3 operations	No change from assessment presented for Stage 2 operations								

* An incremental impact that is 4% or less is considered negligible as this change would not be measurable using air quality monitoring equipment (EPA Victoria 2021)

Table 2: Summary of predicted dust impacts as presented in the AQIA – Commercial/industrial

Scenario	Maximum predicted concentrations $PM_{2.5}$ (µg/m^3)				Maximum predicted concentrations PM_{10} (µg/m^3)				Outcome of AQIA
	24-hour average		Annual average		24-hour average		Annual average		
	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	
Approved operations	6.8	27.1	1.3	10.0	42.9	62.0	8.4	27.3	PM_{10}: exceedance of 24 hour average air guideline on 15 days $PM_{2.5}$: exceedance of 24 hour average air guideline on 2 days
Stage 1 operations (plus Stage 2 construction) (duration of works ~ 18 months)	9.8	28.7	1.8	10.5	61.3	78.5	11.1	29.9	PM_{10}: exceedance of 24 hour average air guideline on 28 days $PM_{2.5}$: exceedance of 24 hour average air guideline on 3 days (not significantly different to approved operations)
Stage 2 operations	5.7	26.9	1.1	9.8	36.6	61.6	7.0	25.9	PM_{10}: exceedance of 24 hour average air guideline on 5 days $PM_{2.5}$: exceedance of 24 hour average air guideline on 2 days (no different to approved operations)
Stage 3 construction	Not assessed as works involve activities with low potential for dust emissions								
Stage 3 operations	No change from assessment presented for Stage 2 operations								

Section 4. Human health risk assessment – Particulate impacts

4.1 Background on particulate matter

Dust or Particulate Matter (PM) is a widespread air pollutant (that has and will always be present in air) with a mixture of physical and chemical characteristics that vary by location (and source). Unlike many other pollutants, particulates comprise a broad class of diverse materials and substances, with varying morphological, chemical, physical and thermodynamic properties, with sizes that vary from <0.005 micrometres (µm) to >100 µm. Particulates can be derived from natural sources such as crustal dust (soil), pollen and moulds, and other sources that include combustion and industrial processes. Secondary particulate matter is formed via atmospheric reactions of primary gaseous emissions. The gases that are the most significant contributors to formation of secondary particulates include: nitrogen oxides, ammonia, sulfur oxides, and certain organic gases (derived from vehicle exhaust; combustion sources; and agricultural, industrial and biogenic emissions).

The potential for particulate matter to result in adverse health effects is dependent on the size and composition of the particulate matter.

The size of particulates is important as it determines how far from an emission source the particulates may be present in air (with larger particulates settling out close to the source and smaller particles remaining airborne for greater distances) and also the potential for adverse effects to occur as a result of exposure (how far the particles can infiltrate into the human respiratory system).

The common measures of particulate matter that are considered in the assessment of air quality and health risks are:

- **Total Suspended Particulates (TSP):** This refers to all particulates with an equivalent aerodynamic particle[2] size below 50 µm in diameter[3]. It is a gross indicator of the presence of dust with a wide range of sizes. The larger particles included in TSP (termed "inspirable", comprise particles around 10 µm and larger) are more of a nuisance as they will deposit out of the air (measured as deposited dust) close to the source and, if inhaled, are mostly trapped in the upper respiratory tract[4] and do not reach the lungs, hence, there is no potential for adverse health effects. Finer particles included in TSP (smaller than 10 µm, termed "respirable", as described below) tend to be transported further from the source and are of more concern with respect to human health as these particles can penetrate into the lungs. Not all of the dust characterised as TSP is relevant for the assessment of health impacts, and hence TSP as a measure of dust impact in the community, is difficult to directly include in this assessment. TSP can be used as a measure of dust that may give rise to nuisance impacts close to the source, where the heavier particles readily deposit out

[2] The term equivalent aerodynamic particle is used to reference the particle to a particle of spherical shape and density 1 gram per cubic centimetre (g/cm^3).

[3] The size, diameter, of dust particles is measured in micrometres.

[4] The upper respiratory tract comprises the mouth, nose, throat and trachea. Larger particles are mostly trapped by the cilia and mucosa and swept to the back of the throat and swallowed.

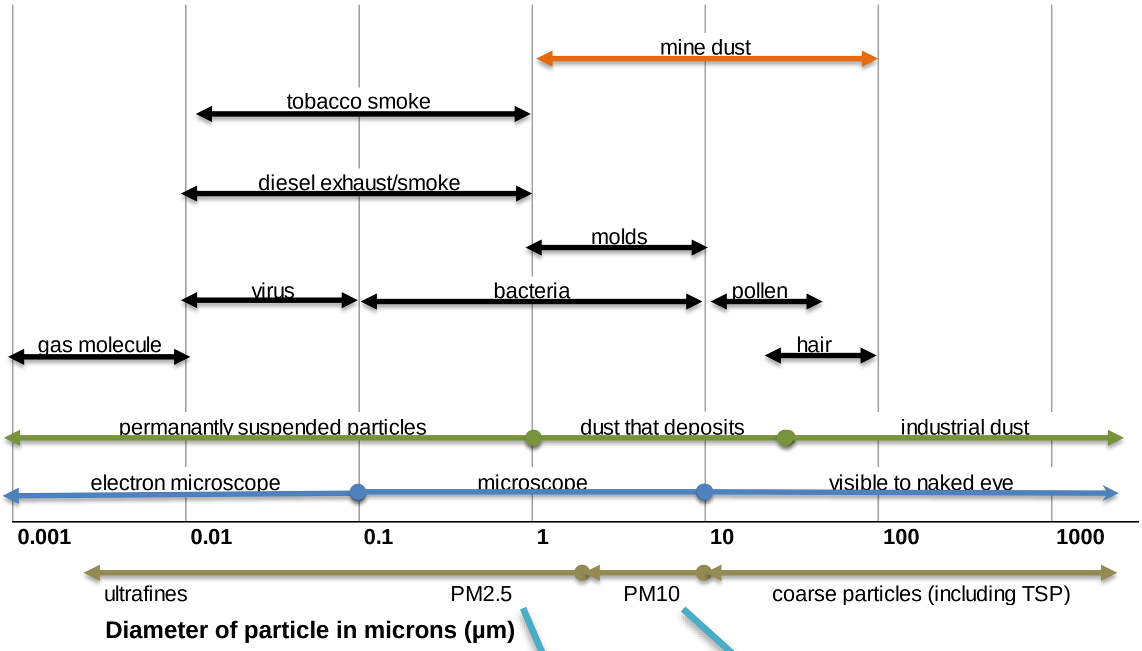
of the air causing dust to deposit onto surfaces (including vegetation and within homes). The deposition of dust is more often directly measured using dust deposition gauges, however, these data relate to an assessment of nuisance effects only. The assessment of potential health impacts relates to particles of a size where significant associations have been identified between exposure and adverse health effects.

- **PM_{10}, particulate matter below 10 µm in diameter, $PM_{2.5}$, particulate matter below 2.5 µm in diameter, PM_1, particulate matter below 1 µm in diameter and $PM_{0.1}$, particulate matter below 0.1 µm in diameter (PM_1 and $PM_{0.1}$ are termed ultrafine particles):** These particles are small and have the potential to penetrate beyond the body's natural filter mechanisms of cilia and mucous in the nose and upper respiratory system, with the smaller particles able to further penetrate into the lower respiratory tract[5] and lungs. Once in the lungs, adverse health effects may occur that include mortality and morbidity, which may be associated with a range of adverse cardiovascular and respiratory effects (OEHHA 2002)[6].

Figure 3 provides a general illustration to provide some context in relation to the size of different particles (discussed above) and relevance/importance for the assessment of inhalation exposures.

[5] The lower respiratory tract comprises the smaller bronchioles and alveoli, the area of the lungs where gaseous exchange takes place. The alveoli have a very large surface area and absorption of gases occurs rapidly with subsequent transport to the blood and the rest of the body. Small particles can reach these areas, be dissolved by fluids and absorbed.

[6] OEHHA – Office of Environmental Health Hazard Assessment.



1 Particulate matter enters our respiratory (lung) system through the nose and throat.

2|3 The larger particulate matter (PM_{10}) is eliminated from the respiratory system through coughing, sneezing and swallowing.

4 $PM_{2.5}$ can penetrate deep into the lungs. It can travel all the way to the alveoli, causing lung and heart problems, and delivering harmful chemicals (where present) to the blood system.

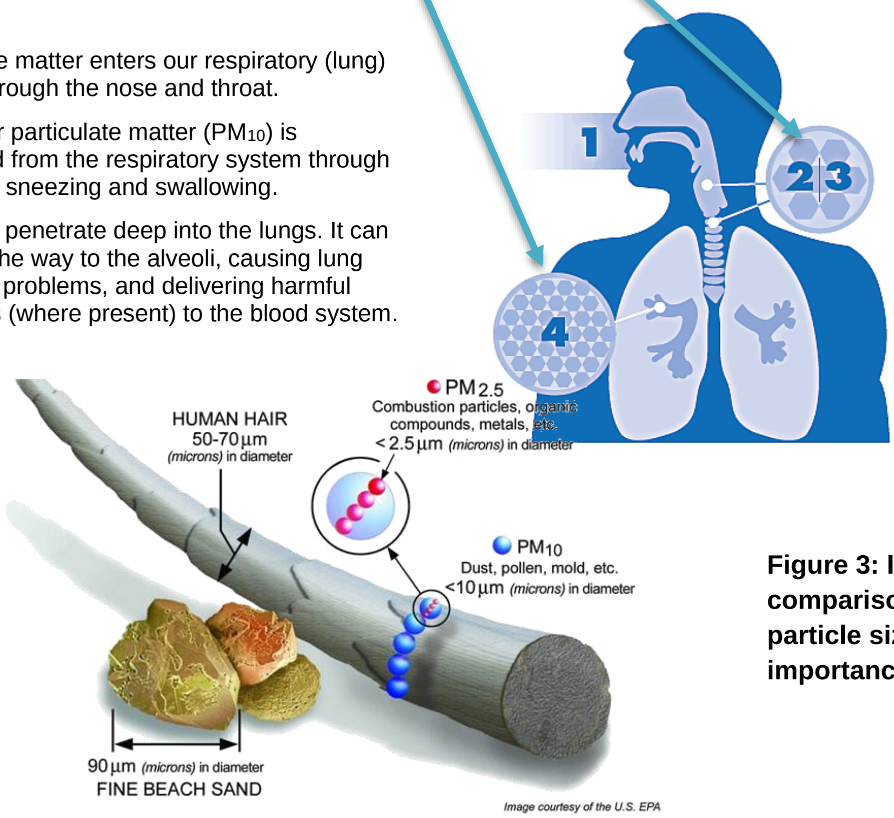


Figure 3: Illustrative comparison of relative particle sizes and importance for health

It is well accepted nationally and internationally that monitoring for PM_{10} is a good method of determining the community's exposure to potentially harmful dust (regardless of the source) and is most commonly measured in local and regional air quality monitoring programs. Reliable methods for the monitoring of PM_{10} concentrations have been available for a long time and hence these data are most widely available in urban and rural areas.

Smaller particles such as $PM_{2.5}$, however, are seen as more significant with respect to evaluating health effects, as a higher proportion of these particles penetrate into the lungs. Very fine particles, specifically ultrafine particles (PM_1 or $PM_{0.1}$), are also considered to be of importance for the assessment of health effects as these particles penetrate the deepest into the respiratory system.

4.2 Health effects of exposure to particulates

Evaluation of size alone as a single factor in determining the potential for particulate toxicity is difficult since the potential health effects are not independent of chemical composition. There are certain particle size fractions that tend to contain certain chemical components, such as metals or other organic compounds.

There is strong evidence to conclude (USEPA 2012; WHO 2003, 2013) that fine particles (<2.5 µm, $PM_{2.5}$) are more hazardous than larger ones (coarse particles), primarily on the basis of studies conducted in urban air environments where there is a higher proportion (as a percentage of all particulates) of fine particles and other gaseous pollutants present from fuel combustion sources, as compared to particles derived from crustal origins. It should be noted that recent detailed review of the available studies in relation to the health effects of particulates (Hime, Marks & Cowie 2018) concluded that while there is some evidence that particulate matter from traffic and coal-fired power station emissions may elicit greater health effects compared to particulate matter from other sources (diesel exhaust, domestic wood combustion heaters and crustal materials), overall the evidence to date does not indicate a clear 'hierarchy' of harmfulness for particulate matter from different emission sources. Hime et al (Hime, Marks & Cowie 2018) identified that making such conclusions is limited by studies, many of which are not comparable. For this assessment, the health effects of exposure to particulate matter have been evaluated as being the same from all sources.

When undertaking any quantitative assessment of health impacts, it is important that the assessment considers health effects where there is sufficient evidence to demonstrate a causal link between exposure to particulates and the health outcome identified. There are numerous studies where statistical associations have been identified. Association does not mean causation; hence it is important that robust reviews are considered where the strength of the available data is fully evaluated and only health effects where there is strong causal evidence is evaluated. Such robust reviews are undertaken by key organisations such as the USEPA, WHO and Australian authorities (as noted below). Assessing health impacts based on associations only (not causation) would be misleading and inappropriate.

A significant amount of research, primarily from large epidemiology studies, has been conducted on the health effects of particulates with causal effects relationships identified for exposure to $PM_{2.5}$ (acting alone or in conjunction with other pollutants) (USEPA 2012, 2019). A more limited body of evidence suggests an association between exposure to larger particles, PM_{10} and adverse health effects (USEPA 2009, 2019; WHO 2003).

Adverse health effects associated with exposure to particulate matter have been well studied and reviewed by Australian and International agencies. Most of the studies and reviews have focused on population-based epidemiological studies in large urban areas in North America, Europe and Australia, where there have been clear associations determined between health effects and exposure to $PM_{2.5}$ and, to a lesser extent, PM_{10}. These studies are complemented by findings from other key investigations conducted in relation to the characteristics of inhaled particles; deposition and clearance of particles in the respiratory tract; animal and cellular toxicity studies; and studies on inhalation toxicity by human volunteers (NEPC 2010).

Particulate matter has been strongly linked to adverse health effects after both short term exposure (days to weeks) and long term exposure (months to years). The health effects vary widely (with the respiratory and cardiovascular systems most affected) and include mortality and morbidity effects.

In relation to mortality, for short term exposures in a population, this relates to the increase in the number of deaths due to pre-existing (underlying) respiratory or cardiovascular disease. For long term exposures in a population, this relates to mortality rates over a lifetime (i.e. shortening the lifespan), where long term exposure is considered to accelerate the progression of disease or even initiate disease.

In relation to morbidity effects, this refers to a wide range of health indicators used to define illness that have been associated with (or caused by) exposure to particulate matter. In relation to exposure to particulate matter, effects are primarily related to the respiratory and cardiovascular system and include (Morawska, Moore & Ristovski 2004; USEPA 2009, 2019):

- Aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits).
- Changes in cardiovascular risk factors such as blood pressure.
- Changes in lung function and increased respiratory symptoms (including asthma).
- Changes to lung tissues and structure.
- Altered respiratory defence mechanisms.

These effects are commonly used as measures of population exposure to particulate matter in community epidemiological studies (from which most of the available data in relation to health effects is derived) and are more often grouped (through the use of hospital codes) into the general categories of cardiovascular morbidity/effects and respiratory morbidity/effects. The available studies provide evidence for increased susceptibility for various populations, particularly older populations, children and those with underlying health conditions (USEPA 2009, 2019). The exposure-response relationships adopted incorporate (and are expected to be dominated by) data from these sensitive groups. This is important to note given the population in the off-site community may have some increased vulnerability to project related particulate exposures. The approach adopted for assessing risk is considered to address this increased vulnerability.

There is consensus in the available studies and detailed reviews that exposure to fine particulates, $PM_{2.5}$, is associated with, and causal to, cardiovascular and respiratory effects and mortality (all causes) (USEPA 2012). Similar relationships have also been determined for PM_{10}, however, the supporting studies do not show causal relationships as clear as those shown with $PM_{2.5}$ (USEPA 2012).

There are a number of studies that have been undertaken where other health effects have been evaluated. These studies have a large degree of uncertainty or a limited examination of the relationship and are generally only considered to be suggestive or inadequate (in some cases) of an association with exposure to $PM_{2.5}$ (USEPA 2018). A causal relationship has not been established for these health effects. This includes long term exposures and metabolic effects, male and female reproduction and fertility, pregnancy and birth outcomes; and short term exposures and nervous system effects (USEPA 2018).

4.3 Assessment of cumulative exposures to particulates

The assessment of cumulative exposures to $PM_{2.5}$ and PM_{10} is based on a comparison of the predicted cumulative concentrations to the current air quality standards and goals presented in the NEPM (NEPC 2021).

In relation to the current NEPM PM_{10} standard, the following is noted (NEPC 1998, 2010, 2014, 2021):

- The standard was derived through a review of appropriate health studies by a technical review panel of the NEPC where short term exposure-response relationships for PM_{10} and mortality and morbidity health endpoints were considered.
- Mortality health impacts were identified as the most significant and were the primary basis for the development of the standard.
- On the basis of the available data for key air sheds in Australia, the criterion of 50 micrograms per cubic metre ($\mu g/m^3$) was based on analysis of the number of premature deaths that would be avoided and associated cost savings to the health system (using data from the US). The development of the standard is not based on any acceptable level of risk and hence simply meeting the standard does not cover all aspects that need to be considered in terms of health impacts.
- The assessment undertaken considered exposures and issues relevant to urban air environments that are expected to also be managed through the PM_{10} standard. These issues included emissions from vehicles and wood heaters.

A similar approach has been adopted by NEPC (Burgers & Walsh 2002; NEPC 2002, 2014) in relation to the derivation of the $PM_{2.5}$ air quality standards, with specific studies related to $PM_{2.5}$ and mortality and morbidity indicators considered. Goals for lower $PM_{2.5}$ standards to be met by 2025 are also outlined by NEPC (NEPC 2021).

Table 3 presents a comparison of the current NEPC standards and goals with those established by the WHO (WHO 2021), the European Union (EU) (2015) and the USEPA (2012). The WHO (2021) update provided air quality goals along with interim targets for the reduction in concentrations over time. The WHO goals are not binding and are intended to serve as a reference for individual jurisdictions in establishing appropriate standards and policies. Review of the USEPA air quality standards in 2020 (USEPA 2020) recommended retaining the 2012 standards without revision for PM_{10} and $PM_{2.5}$.

The 2025 goals established by the NEPM for $PM_{2.5}$ (and adopted in this assessment) are similar to, but slightly more conservative (health protective) than, those provided by the EU and the USEPA. The 2025 goals are generally similar to the interim target 4 criteria established by the WHO (2021) but are higher than the WHO (2021) goals.

The NEPM PM_{10} guidelines are also similar to those established by the EU, however the 24-hour average guideline is significantly lower than the 24-hour average guideline of the USEPA. The NEPM guidelines are generally similar to the interim target 4 criteria established by the WHO

(2021), which are significantly more stringent that interim target levels 1 to 3, but are higher than the WHO (2021) goals.

Table 3: Comparison of particulate matter air quality goals

Pollutant	Averaging period	Criteria/guidelines/goals			
		NEPC (2021) – relevant to Australia	**WHO (2021) goals**	**EU #**	**USEPA (2012)**
PM_{10}	24-hour	50 µg/m³	Goal = 45 µg/m³ Interim target 4 = 50 µg/m³	50 µg/m³ as limit value to be met, with 35 exceedances permitted each year	150 µg/m³ (not to be exceeded more than once per year on average over 3 years)
	Annual	25 µg/m³	Goal = 15 µg/m³ Interim target 4 = 20 µg/m³	40 µg/m³ as limit value to be met	NA
$PM_{2.5}$	24-hour	25 µg/m³ 20 µg/m³ (goal for 2025)	Goal = 15 µg/m³ Interim target 4 = 25 µg/m³	NA	35 µg/m³ (98th percentile, averaged over 3 years)
	Annual	8 µg/m³ 7 µg/m³ (goal for 2025)	Goal = 5 µg/m³ Interim target 4 = 10 µg/m³	25 µg/m³ as target value to be met from 2010 and limit value to be met from 2015 20 µg/m³ as a 3-year average (average exposure indicator) from 2015 with requirements for ongoing percentage reduction and target of 18 µg/m³ as 3-year average to be attained by 2020	12 µg/m³ (annual mean averaged over 3 years)

Current EU Air Quality Standards (EU 2015) available from http://ec.europa.eu/environment/air/quality/standards.htm

In relation to the standards and goals presented in **Table 3**, the following should be noted:

- The NEPM standards (NEPC 2021) are the guidelines that apply in Australia. The guidelines apply to ambient air. They do not apply to the air environment inside buildings or structures. Application of the NEPM in NSW (NSW EPA 2017) does not provide any distinction in relation to occupational areas (commercial/industrial) compared with more sensitive areas such as residential (including school, childcare and aged care).
- The other guidelines and goals are included for comparison only where the following is of particular note:
  - The WHO (WHO 2021) goals do not apply to occupational settings
  - The EU guidelines apply to ambient air as outdoor air and exclude workplaces/occupational settings
  - The US guidelines relate to regional air quality, with no statements that preclude application in occupational settings.

The NEPM (NEPC 2021) air quality standards and goals for $PM_{2.5}$ and PM_{10} that apply in Australia relate to total concentrations in the air (from all sources including the Proposal) in regional airsheds. These criteria have then been considered in relation to the assessment of impacts from a specific source, the Proposal, as detailed within the AQIA, refer to **Section 3**. This review identified the following, in relation to cumulative impacts in relation to $PM_{2.5}$ and PM_{10}:

- Existing regional air quality includes exceedances of the AQIA guidelines for annual average $PM_{2.5}$ and PM_{10}, with the 24-hour average guidelines also exceeded on a number of days.
- There are no additional exceedances or exceedances that would be measurable of the AQIA guidelines at any of the off-site residential locations, where dust emissions from the Proposal are also considered. Where this is the case there are no health impacts of concern in the residential areas that require further assessment in relation to risks to human health.
- Stage 1 operations (including Stage 2 construction) have the potential to result in additional exceedances of the 24-hour average PM_{10} air guideline adopted in the AQIA (over and above impacts related to approved operations). These impacts principally relate to the Stage 2 construction works which are expected to be completed over approximately 18 months. These impacts are the focus of additional assessment presented in **Section 4.3.2**.
- Stage 2 operations result in a reduction in the maximum concentrations of $PM_{2.5}$ and PM_{10} at the closest commercial/industrial receptors (by comparison to approved operations) due to the reconfiguration/optimisation of the Eastern Creek REP and hence do not require any further assessment.

4.4 Assessing incremental exposures to particulates

4.4.1 General

In relation to the assessment of exposures to particulate matter, there is sufficient evidence to demonstrate that there is causal link between exposure to $PM_{2.5}$ (and to a lesser extent PM_{10}) and particular health effects. These health effects relate to exposures to $PM_{2.5}$ (or PM_{10}) alone (i.e. without co-exposures).

Where a causal link has been established in relation to exposure to changes in $PM_{2.5}$ or PM_{10} exposure and health effects, risks can be quantified using a mathematical relationship between an exposure concentration (i.e. concentration in air) and a response (namely a health effect). This relationship is termed an exposure-response relationship and is relevant to the range of health effects (or endpoints) identified as relevant (to the nature of the emissions assessed) and robust. An exposure-response relationship can have a threshold, where there is a safe level of exposure, below which there are no adverse effects; or the relationship can have no threshold (and is regarded as linear) where there is some potential for adverse effects at any level of exposure.

The available evidence does not suggest that there is a threshold below which health effects do not occur. Hence there are likely to be health effects associated with background levels of $PM_{2.5}$ and PM_{10}, even where the concentrations are below the current guidelines. Guidelines are currently available for the assessment of $PM_{2.5}$ and PM_{10} in Australia (NEPC 1998 amended 2016, 2002, 2021). These guidelines are not based on any acceptable level of risk, rather they are based on levels that are desirable in the community to balance background/urban sources with lowering impacts on health and cost savings in the health system.

The assessment of potential health impacts associated with localised impacts of $PM_{2.5}$ and PM_{10}, specifically in relation to impacts predicted during Stage 1 operations (and Stage 2 construction) has considered three approaches: community health impacts; localised incremental risks; and workplace exposures.

4.4.2 Community health impacts

Regional air quality

The quantification of health impacts related to exposure to $PM_{2.5}$ and PM_{10} is based on exposure-response relationships determined through large epidemiological studies. These studies relate regional air quality, measured as $PM_{2.5}$ and PM_{10} at regional air monitoring locations and short-term and long-term changes in health indicators, including mortality (all causes as well as respiratory and cardiovascular) and hospitalisations for a range of health end points including respiratory and cardiovascular effects. The population health data relate to all individuals living and working in the area where regional air quality is measured. Regional air quality relates to data collected at locations representative of air quality in a region which means the air monitoring is conducted away from specific sources (such as industry and roads).

However, within the population (to which the health data relates to) exposure to $PM_{2.5}$ and PM_{10} varies throughout the day and year as a result of where an individual may live or work in relation to specific sources in the region, where exposures for some or most of the day would be higher than reported at regional air monitoring stations, as well as other indoor or personal sources (e.g. wood fired heating, gas cooking, incense burning and smoking). While these individual exposures are not addressed in the air quality data used in the epidemiological studies, they are captured in the population health data (mortality and hospitalisation rates) as that data reflects all members of the population (exposed to variable levels). It is noted that the health data utilised also includes, and is likely to be dominated by, statistics relevant to sensitive populations such as the elderly, infants and those with pre-existing conditions. These populations are different to a healthy working population (principally in age, but also in health status). Hence the epidemiological studies that underpin the development of guidelines for regional air quality include individuals exposed to $PM_{2.5}$ and PM_{10} at a range of locations including working close so a specific source, and are expected to be conservative when considering impacts on working populations.

The NEPM guidelines do not relate to or apply to specifical localised sources. The NEPM air guidelines which are established to protect community health apply at regional air monitoring locations. Hence from a population or community health perspective, the increased concentrations at workplaces located very close to the Proposal are not of significance where no significant impacts on regional air quality is predicted to occur. The AQIA has not modelled regional air quality, rather it has focused on impacts at a number of receptor locations adjacent to the Proposal. This includes the closest residential areas, which have been considered to be representative of community air quality for the purpose of this review. As no significant/measurable impacts associated with the Proposal are predicted at these residential/community receptor locations, the Proposal (all stages) is not expected to change regional air quality. As there are no changes in regional air quality, there would not be expected to be any changes in overall population health risk for the region, including workers at locations close to specific sources such as the Proposal.

Community risks from crustal dust

It is noted that the studies that underpin the NEPM guidelines principally relate to particulate matter in urban environments, where these are principally sourced from combustion sources. Evaluating community exposures to particulate matter, where it is primarily derived from crustal materials, where the community includes residents and workers in a range of areas, has been undertaken for Port Hedland, where WA Health (WA Health 2016) established a 24-hour average guideline for

PM_{10} of 70 µg/m^3 (cumulative or total exposures) with 10 exceedances allowed that provides adequate protection of health and wellbeing, particularly for interim duration exposures of up to 5 years.

The only exceedance of 70 µg/m^3 is predicted to occur at one industrial receptor (CI_18) during Stage 1 operations (and Stage 2 construction). The duration of these works is limited (approximately 18 months) and the number of exceedances of this guideline during this period is less than 10.

Hence based on the work relating to interim or limited duration exposures to PM_{10} from crustal dust presented by WA Health (WA Health 2016), the dust exposures predicted from the Proposal would not be expected to be of concern to the health and wellbeing of the community close to and surrounding the Proposal Site (including the maximum impacted industrial premises).

4.4.3 Localised risks

The discussion presented above relates to regional or community health. However further assessment has also been presented in relation to the assessment of incremental individual risks associated with changes in $PM_{2.5}$ and PM_{10} at industrial locations adjacent to the Proposal. These calculations relate to exposures by workers in these areas as a result of $PM_{2.5}$ and PM_{10} from the Proposal during Stage 1 operations (and Stage 2 construction) and do not consider any other exposures related to operations within the off-site workplaces (as a result of other localised sources)

Risk calculations relevant to exposures to $PM_{2.5}$ and PM_{10} by the community have been undertaken utilising exposure-response functions relevant to the most significant health effect associated with exposure for all members of the community, namely mortality (all cause and all ages). It is noted that there are more conservative exposure-response relationships for $PM_{2.5}$, however these relate to exposures by individuals aged 65 years and older (a sensitive sub-group of the population), which is not relevant to a working population (as is the case for the adjacent industrial premises). It is further noted that the exposure-response functions adopted to assess mortality relate to all ages, which include people aged over 65 years, which results in a conservative assessment for working populations.

The assessment of potential risks associated with exposure to particulate matter involves the calculation of a relative risk (RR). For the purpose of this assessment the shape of the exposure-response function used to calculate the relative risk is assumed to be linear[7]. The calculation of a relative risk based on the change in relative risk exposure concentration from baseline/existing (ie based on incremental impacts from the Proposal) can be calculated on the basis of the following equation (Ostro 2004):

7 Some reviews have identified that a log-linear exposure-response function may be more relevant for some of the health endpoints considered in this assessment. Review of outcomes where a log-linear exposure-response function has been adopted (Ostro 2004) for $PM_{2.5}$ identified that the log-linear relationship calculated slightly higher relative risks compared with the linear relationship within the range 10–30 micrograms per cubic metre (relevant for evaluating potential impacts associated with air quality goals or guidelines) but lower relative risks below and above this range. For this assessment (where impacts from a particular project are being evaluated) the impacts assessed relate to concentrations of PM_{10} and $PM_{2.5}$ where a linear relationship is expected to provide a more conservative estimate of relative risk.

$$RR = \exp[\beta(X-X0)]$$

Where:
X-X0 = the change in particulate matter concentration to which the population is exposed (μg/m³)
β = regression/slope coefficient, or the slope of the exposure-response function which can also be expressed as the per cent change in response per 1 μg/m³ increase in particulate matter exposure.

Based on this equation, where the published studies have derived relative risk values that are associated with a 10 micrograms per cubic metre increase in exposure, the β coefficient can be calculated using the following equation:

$$\beta = \frac{\ln(RR)}{10}$$

Where:
RR = relative risk for the relevant health endpoint as published (μg/m³)
10 = increase in particulate matter concentration associated with the RR (where the RR is associated with a 10 μg/m³ increase in concentration).

The assessment of health impacts for a particular population associated with exposure to particulate matter has been undertaken utilising the methodology presented by the WHO (Ostro 2004; WHO 2006) where the exposure-response relationships identified have been directly considered on the basis of the approach outlined below.

An additional risk can be calculated as:

$$Risk = \beta \times \Delta X \times B$$

Where:
β = slope coefficient relevant to the per cent change in response to a 1 μg/m³ change in exposure
ΔX = change (increment) in exposure concentration[8] in μg/m³ relevant to the project at the point of exposure (as relevant to the exposure being evaluated)
B = baseline incidence of a given health effect per person (eg annual mortality rate)

The calculation of the incremental individual risk for relevant health endpoints associated with exposure to particulate matter as outlined by the WHO (Ostro 2004) has considered the following four elements:

- Estimates of the changes in $PM_{2.5}$ and PM_{10} (i.e. incremental impacts) concentrations due to the Proposal – these have been modelled, with the maximum change at the adjacent

[8] Exposure concentration relates to the concentration at the point of exposure, with consideration of the period of time (as a fraction of continuous exposures), consistent with USEPA and enHealth guidance. Consideration of exposure time relevant to different activities or exposure locations (indoors, outdoors, work, transport etc) for evaluating exposure to $PM_{2.5}$ or PM_{10} is also established in the literature (Milner, J, Armstrong, B, Davies, M, Ridley, I, Chalabi, Z, Shrubsole, C, Vardoulakis, S & Wilkinson, P 2017) (Faria, T, Martins, V, Correia, C, Canha, N, Diapouli, E, Manousakas, M, Eleftheriadis, K & Almeida, SM 2020) (Adams, HS, Nieuwenhuijsen, MJ & Colvile, RN 2001)

industrial premises adopted. For this assessment the change in PM relates to the change in annual average air concentrations, where the following has been adopted (refer to **Table 2**):

  - Maximum incremental increase in PM_{10} = 11.1 µg/m^3
  - Maximum incremental increase in $PM_{2.5}$ = 1.8 µg/m^3

- A maximum exposure concentration has then been estimated for the industrial locations, assuming that the change in exposure at these locations as a result of the Proposal to $PM_{2.5}$ and PM_{10} occurs 8 hours per day, 5 days per week for 48 weeks of the year, with all other exposures consistent with regional air quality (which is unchanged). This results in the following incremental exposure concentrations:
  - Maximum incremental exposure concentration for PM_{10} (workers) = 2.4 µg/m^3
  - Maximum incremental exposure concentration for $PM_{2.5}$ (workers) = 0.4 µg/m^3
- Baseline incidence of the key health endpoints that are relevant to the population exposed – the assessment undertaken has considered the baseline mortality data (all cause, all ages) relevant to Western Sydney Local Health District (that covers the population relevant to the Proposal Site and surrounding areas), with the most recent data for 2019 indicating a rate of 488.7 per 100,000 (or 0.004887) as an age standardised rate[9]. It is noted that this baseline mortality rate is biased high (i.e., conservative) as it relates to all individuals and all ages, not a working population.
- Exposure-response relationships expressed as a percentage change in health endpoint per microgram per cubic metre change in particulate matter exposure, where a relative risk (RR) is determined. The exposure-response functions used in this assessment is based on the following:
  - PM_{10}: The exposure-response function adopted for the assessment of risks related to exposure to PM_{10} is based on analysis of data from European studies from 33 cities and includes panel studies of symptomatic children (asthmatics, chronic respiratory conditions) (Anderson et al. 2004). The study found a relative risk (RR) of all-cause mortality of 1.006 per 10 µg/m^3 change in PM_{10}. Based on a RR of 1.006 per 10 µg/m^3 change in PM_{10}, this results in a β = 0.0006. It is noted that this relationship is not as strong as for $PM_{2.5}$ and relates to short-term changes in PM_{10}. The relationship adopted is conservative as it includes young children and older adults, not relevant to a working population. The calculation of risk using this relationship based on a change in annual average concentration provides the same outcomes as calculating the daily risk and summing for the year.
  - $PM_{2.5}$: the exposure response function adopted is that recommended in a NEPC published report (Jalaudin & Cowie 2012). It was derived from a study in the United States which examined the health outcomes of hundreds of thousands of people living in cities all over the United States. These people were exposed to all different concentrations of $PM_{2.5}$ (Pope et al. 2002). The study found a relative risk (RR) of all-cause mortality of 1.06 per 10 µg/m^3 change in $PM_{2.5}$, and that this risk relationship was in the form of an exponential function. Based on a RR of 1.06 per 10 µg/m^3 change in $PM_{2.5}$, this results in a β = 0.0058. It is noted that the exposure response relationship established in this study was re-affirmed in a follow-up study (that

[9] Data available from NSW Health: https://www.healthstats.nsw.gov.au/#/home

included approximately 500,000 participants in the US) (Krewski et al. 2009) and is consistent with findings from California (Ostro et al. 2006). The relationship is also more conservative than a study undertaken in Australia and New Zealand (EPHC 2010). The relationship is also conservative as it includes older adults (in particular, not relevant to working populations).

The above approach is consistent with that presented in Australia (Burgers & Walsh 2002), US (OEHHA 2002; USEPA 2005, 2010) and Europe.

Based on the above assumptions the Proposal's incremental risk associated with exposure to PM_{10} and $PM_{2.5}$ for the maximum predicted impacts in industrial premises located adjacent to the Proposal in Stage 1 operations (and Stage 2 construction) (rounded to 1 significant figure):

- PM_{10}: Risk=β x ΔX x B = 0.0006 x 2.4 x 0.004887 = 7 x 10^{-6}
- $PM_{2.5}$: Risk=β x ΔX x B = 0.0058 x 0.4 x 0.004887 = 1 x 10^{-5}

These risk levels are considered to be negligible or acceptable, as per guidance from enHealth and NEPC (enHealth 2012a; NEPC 2011b) and NSW EPA (NSW EPA 2017).

The calculated risks (above) relate to the maximum impacted offsite industrial location, assuming workers are at this location every workday of the year. Risks are lower at all other industrial locations adjacent to the Proposal Site.

It is noted that the maximum impacts predicted only occur during Stage 1 operations (and Stage 2 construction) which has a limited duration of approximately 18 months.

In addition, the assessment presented relates to impacts related to the Proposal, including activities associated with already approved operations. The additional impacts related to the Proposal (over and above the approved operations) are lower than evaluated above.

On the basis of the above, incremental changes in PM_{10} and $PM_{2.5}$ derived from the Proposal are not considered to be of significance in relation to health impacts in the off-site industrial areas.

4.4.4 Workplace exposures

When evaluating exposures in any workplace, it is also relevant to consider workplace exposure standards.

Workplace exposures to nuisance dust is addressed by Safework Australia, where a guideline of 10 mg/m^3 of inhalable dust is established. This relates to nuisance dust that does not contain hazards (such as elevated metals, silica or fibres) and would be applicable for worker exposures to dust on any industrial site (where exposures would relate to a range of sources at the industrial site and in industrial areas surrounding the Proposal Site). This guideline relates to an 8 hour average workday concentration, with inhalable dust essentially the same as TSP (i.e. all dust reactions in air that may be inhaled). The maximum TSP concentration (as a cumulative concentration in the adjacent industrial area, as detailed in the AQIA) for Stage 1 operations (and Stage 2 construction) is predicted to be 0.0895 mg/m^3 as an annual average. The AQIA has not predicted a 24-hour average or 8-hour average, however applying an averaging time conversion (Ontario MfE 2004) from annual average to 8 hours results in a maximum workday (8 hour average) concentration of TSP of 0.7 mg/m^3, which is well below the guideline of 10 mg/m^3.

In relation to respirable dust, ACGIH provides a workplace guideline (for an 8 hour workday) of 3 mg/m^3. Respirable dust may be considered more similar to PM_{10}. The maximum 24-hour average PM_{10} concentration is predicted to be 0.078 mg/m^3 (as cumulative concentration in the industrial area, refer to **Table 2**), which can be converted to a maximum 8 hour average concentration of 0.12 mg/m^3 (Ontario MfE 2004) which is well below 3 mg/m^3.

Based on the above, all exposures to dust, derived from the Proposal in workplaces surrounding the Proposal Site are below all relevant guidelines.

4.4.5 Overall

The above discussion provides multiple lines of evidence that support that Proposal related impacts on the health of workers at premises adjacent to the Proposal Site are not considered to be of significance. This outcome does not preclude the need for ongoing dust monitoring and management, as proposed (refer to **Section 4.4**).

4.5 Dust management

Consistent with the way in which dust emissions are managed during construction for all projects, dust mitigation and management measures are proposed to be implemented to minimise emissions relevant to the Proposal.

The AQIA outlines a range of dust mitigation measures to be implemented during construction as well as operations.

Activities proposed during construction are consistent with the Eastern Creek REP operations and hence existing dust controls for site operations would also apply to construction works. The existing dust-control measures at the Eastern Creek REP have been reviewed in the AQIA, including review of the existing monitoring data, and have been found to be consistent with Best Management Practice (BMP) as defined by Sustainability Victoria Guide to Best Practice at Resource Recovery Centres (Sustainability Victoria 2009)[10] and the requirements to manage dust as detailed in the NSW EPA Environmental Guidelines: Solid Waste Landfills (NSW EPA 2016)..

During construction the dust mitigation measures include:

- General measures
  - Erect screens or barriers to site fences around potentially dusty activities and material stockpiles where practicable
  - Provide an adequate water supply on the construction site for effective dust/particulate matter suppression/mitigation
  - Avoid site runoff of dirty water or mud
  - Temporary cessation of non-essential dust generating activities during high winds
  - Schedule activities to avoid adverse weather conditions by reviewing weather forecasts.
- Materials handling
  - Prevention of truck overloading to reduce spillage during loading/unloading and hauling

[10] Also refer to: https://www.sustainability.vic.gov.au/recycling-and-reducing-waste/for-councils-and-other-waste-recycling-operators/waste-and-recycling-facilities/best-practice-for-resource-recovery-centres

- Minimise drop heights from loading, unloading or handling equipment.

- Exposed areas
  - Minimise the disturbance area
  - Exposed areas will be stabilised as soon as practicable
  - Permanent soil stockpiles will be revegetated.
- Dust generation from vehicles
  - Watering of main haulage routes
  - Routes to be clearly marked and speed limits enforced (25km/hr on site)
  - Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport
  - All vehicles will pass through the wheel wash or shaker grid prior to existing the site.

During operations, the existing dust management measures are to continue, which have been determined to be consistent with BPM.

These management measures are appropriate, and consistent with dust management measures used to achieve best practice dust controls for construction and operations to minimise exposures and risks to health.

Section 6. Summary and conclusions

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Bingo Industries to conduct a HHRA to address the potential for impacts on air quality at the Eastern Creek Recycling Ecology Park from activities following an expansion of the facility.

Particulate matter was identified as the main pollutant of interest in the AQIA. This arises from release of dust during waste handling, storage, classification and transport. Background levels of PM_{10} and $PM_{2.5}$ in air around the facility are close to or above national guidelines for these parameters.

Additional levels of particulate matter associated with the Proposal have been modelled and assessed, as presented in the AQIA. The modelled impacts indicate the following:

- There are no additional exceedances or exceedances that would be measurable of the adopted guidelines at any of the off-site residential locations. Where this is the case there are no impacts of concern in the residential areas that require further assessment in relation to risks to human health.
- In relation to impacts predicated at commercial/industrial locations, the following is of note:
  - Stage 1 operations (including Stage 2 construction) have the potential to result in additional exceedances of the 24-hour average PM_{10} air guideline (over and above impacts related to approved operations). These impacts relate to the Stage 2 construction works which are expected to be completed over approximately 18 months.
  - Impacts predicted during Stage 2 operations are considered representative of long-term operational impacts.
  - Stage 2 operations result in a reduction in the maximum concentrations of $PM_{2.5}$ and PM_{10} at the closest commercial/industrial receptors due to the reconfiguration/ optimisation of the Eastern Creek REP. Hence there are no health risk issues of concern in relation to these operations.

Further assessment of potential impacts on health at adjacent industrial premises, during Stage 1 operations (and Stage 2 construction) has been undertaken. Based on the assessment undertaken there are no health risk issues of concern in relation to exposures to dust impacts in these areas, on the basis of the following lines of evidence:

- Where community health impacts are considered, there are no significance changes to regional air quality, relevant to overall community health and hence the variability in exposure that occurs throughout a region (where there are a range of sources) would not be expected to result in adverse community health outcomes, including for workers located adjacent to the Proposal.
- Where community health guidelines established for PM_{10} derived from crustal dust sources for interim exposure periods (less than 5 years), the predicted impacts throughout the off-site areas would comply with these guidelines.
- Calculated incremental individual risks at the maximum impacted industrial premises related to changes in $PM_{2.5}$ and PM_{10}, using conservative assumptions, has not identified health impacts that would be considered to be significant.

- Where workplace exposure guidelines are considered for exposures to nuisance dust in premises located adjacent to the Proposal, all concentrations remain well below the relevant guidelines.

To ensure that risks to health are minimised, dust management measures are proposed to be implemented during construction and operation (as detailed in the AQIA). These dust management measures are consistent with existing dust management measures implemented at the Proposal site which have been determined to represent Best Practice Management.

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