This document has been prepared on behalf of **Jackson Environment & Planning Pty Ltd** by:

Northstar Air Quality Pty Ltd,

Suite 1504, 275 Alfred Street, North Sydney, NSW 2060

www.northstarairquality.com | Tel: +61 (02) 9071 8600

Kariong Sand and Soil Supplies – Proposed Development

Air Quality Impact Assessment

Addressee(s):	Jackson Environment & Planning Pty Ltd
Report Reference:	18.1021.FR1V2
Date:	17 December 2018

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	GCG	MD
THE PROJECT	Final	Northstar Air Quality	GCG	MD
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar Air Quality	GCG	MD
EXISTING CONDITIONS	Final	Northstar Air Quality	GCG	MD
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CONSTRUCTION PHASE AIR QUALITY	Final	Northstar Air Quality	GCG	MD
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Final Authority

This report must by regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below.

Martin Doyle **17th December 2018**

Non-Technical Summary

Jackson Environment & Planning Pty Ltd has engaged Northstar Air Quality Pty Ltd on behalf of Mr and Mrs Ray and Sue Davis to perform an air quality impact assessment for the proposed development of the Kariong Sand and Soil Supplies site (the project) located at 90 Gindurra Road, Somersby NSW (the project site).

This air quality impact assessment forms part of the Environmental Impact Statement prepared to accompany the development application for the project under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The air quality impact assessment presents an assessment of the impacts of the proposed operations at the project site, associated with both the construction phase and operational phase of the development.

The assessment has been performed in accordance with the NSW EPA (2016) *Approved methods for the modelling and assessment of air pollutants in NSW*, and has been presented to provide confidence that the operations can be performed with no exceedances of the relevant air quality criteria.

A risk-based assessment of the potential construction phase air quality impacts indicates that the implementation of a range of mitigation measures would be required to ensure that the risks (both health and amenity) to the surrounding community would be low or not significant.

The dispersion model predictions associated with the operational phase of the project indicate that the existing and proposed operations can be performed without additional exceedances of the air quality criteria at any residential or non-residential receptor location surrounding the project site.

A range of emissions control measures would be implemented as part of the project operation and these are discussed in detail in the main body of the report. It is considered that the measures adopted represent best practice dust control, and although additional measures may be available (such as full enclosure), these have been respectfully considered to not be appropriate for use as part of the project. The measures which are adopted have been demonstrated to ensure that the environmental objectives are achieved.

It is further recommended that a campaign of fence-line air quality monitoring is performed to provide the EPA with assurance that the site can be operated with the best practice measures outlined in the report and without giving rise to unacceptable air quality impacts.

The results of the air quality impact assessment indicate that the granting of Development Consent for the project should not be rejected on the grounds of air quality.

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Units Used in the Report

All units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units. In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. For example:

- 50 micrograms per cubic metre is presented as 50 $\mu g{\cdot}m^{-3}$ and not 50 $\mu g/m^3$; and,
- 0.2 kilograms per hectare per hour is presented as 0.2 $kg{\cdot}ha^{-1}{\cdot}hr^{-1}$ and not 0.2 kg/ha/hr.

Common Abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
BoM	Bureau of Meteorology
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
kW	kilowatt
$mg\cdot m^{-3}$	milligram per cubic metre of air
$\mu g\cdot m^{-3}$	microgram per cubic metre of air
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
O_3	ozone
OEH	NSW Office of Environment and Heritage
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
SEE	Statement of Environmental Effects
TAPM	The Air Pollution Model
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
VKT	vehicle kilometre travelled
VOC	volatile organic compound

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1. INTRODUCTION

Jackson Environment & Planning Pty Ltd has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Mr and Mrs Ray and Sue Davis to perform an air quality impact assessment (AQIA) for the proposed development of the Kariong Sand and Soil Supplies site (the project) located at 90 Gindurra Road, Somersby NSW (the project site).

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the project under Part 4 of the *Environmental Planning and Assessment Act* 1979. The project will be assessed as a State Significant Development under Division 4.36 of the *Environmental Planning and Assessment Act* 1979 and Schedule 1 of the *State Environmental Planning Policy (State and Regional Development)* 2011.

The AQIA presents an assessment of the impacts of the proposed operations at the project site, associated with both the construction phase and operational phase of the development. Regarding potential construction impacts, this has been assessed using a risk-based assessment methodology, and appropriate construction control measures proposed to manage that risk. Regarding potential operational impacts, the assessment has used a quantitative dispersion modelling assessment, and the predicted incremental change in air quality in the area surrounding the project site is presented in addition to an assessment of compliance with relevant air quality criteria associated with cumulative impacts.

1.1 Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs 8660) have been provided for the project by the NSW Department of Planning and Environment (DPE). In relation to air quality and odour, the SEARs state that the EIS must provide:

- a quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant Environmental Protection Authority guidelines;
- the details of buildings and air handling systems and strong justification for any material handling, processing or stockpiling external to a building; and,
- details of proposed mitigation, management and monitoring measures.

Further to the above, NSW EPA has also provided a general list of requirements, and those broad requirements have been adopted as part of this assessment. These broad requirements are reproduced in **Table 1** and have been given due consideration within the performance of this assessment. The section of the report where each general requirement has been addressed is provided in **Table 1**.

Table 1 NSW Environment Protection Authority general requirements for an AQIA

Issue	Requirement	Addressed
The Project	• Identify all sources of air emissions from the development.	Section 2.4
	• Provide details of the project that are essential for predicting and assessing air impacts including:	
	– The quantities and physio-chemical parameters (eg concentration, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced or stored	Section 5.2.3, Appendix C
	– An outline of procedures for handling, transport, production and storage	Section 2
	– The management of solid, liquid and gaseous waste streams with potential for significant air impacts.	Section 2
The Location	• Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate provide a perspective view of the study area such as the terrain file used in dispersion models.	Section 4.1, Section 4.3
	• Describe surrounding buildings that may affect plume dispersion.	N/A
	• Provide and analyse site representative data on the following meteorological parameters: – Temperature and humidity – Rainfall, evaporation and cloud cover – Wind speed and direction – Atmospheric stability class – Mixing height – Katabatic air drainage – Air re-circulation	Appendix B

Issue	Requirement	Addressed
The Environmental Issues	Describe baseline conditions • Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data. This description should include the following parameters – TSP – PM_{10} – $PM_{2.5}$	Section 4.2
	Assess impacts • Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.	Section 2.4 Section 5
	• Estimate the resulting ground level concentrations of all pollutants. Where necessary (eg potentially significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the EPA.	Section 6 Section 7 NSW EPA (Jacqueline Ingham, Waste Operations) was contacted on 1 Nov 2017. No response other than receipt of communication has been received.
	• Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.	Section 7
	• Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations.	Section 7
	• For potentially odorous emissions provide the emission rates in terms of odour units (determined by techniques compatible with EPA procedures). Use sampling and analysis techniques for individual or complex odours and for point and diffuse sources, as appropriate.	Section 2.4
	Describe management and mitigation measures • Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes.	Section 5.2.4 Section 8

Further to the above, the policies, guidelines and plans which have been referenced during the performance of the AQIA include:

- Protection of the Environment Operations (Clean Air) Regulation 2002.
- Approved Methods for the Modelling and Assessment of Air Quality in NSW (NSW EPA, 2017).
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2006).
- Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006).
- Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006).

2. THE PROJECT

The following provides a description of the project and the emissions of air pollutants which would be anticipated as a result of the activities being performed at the project site during the construction and operational phases.

2.1 Project Background

The project site is currently operated as a soil and sand recycling business, located at 90 Gindurra Road, Somersby, NSW. Recycled sand and soil is sold for landscaping. The site's current development approval and infrastructure limits the amount of material that can be accepted and processed (screened and sorted) at the site. The site currently has development consent as a 'Sand and Metal Recycling Facility', which was originally approved under DA 15337 on 28 February 1992. The current consent permits the receiving of soil and sand, screening and landscaping material storage in outdoor concrete block bays and machinery parking at the front of the site. There are some structures on the site.

The site does not have an Environment Protection Licence under the *Protection of the Environment Operations Act* 1997.

The owner wishes to conduct site improvement works to allow a greater range of materials to be processed on the site, and to enable up to 200,000 tonnes per annum (tpa) to be received, processed and temporarily stored on the site. A summary of the relevant site design features is described in **Section 2.3**.

2.2 Environmental Setting

The project site is located in Lot 4 in deposited plan (DP) 227279. The location of the project site is illustrated in **Figure 1** and relates to the parcel of land that will be subject to the development consent.

The project site is located to the north of the suburb of Kariong, on the western edge of land zoned as IN1 (general industrial), with primary production (RU10) and rural lands (RU2), to the north and east, respectively. Lands zoned as infrastructure (SP2) and special infrastructure (SP1) are located to the immediate south. Land zoned as low density residential areas (R2) are located over 1 kilometre (km) from the project site boundary to the south and south east. The project site is located approximately 130 metres (m) from the M1 Pacific Motorway (F3 Freeway). A sandstone quarry operated by Gosford Quarries is located approximately 250 m to the east of the project site.

There are a number of residential properties located within a 1.5 km radius of the site in addition to a number of industrial and educational land uses. The closest privately-owned residence is located approximately 125 m to the east of the project site boundary. Further details of these 'sensitive receptor' locations are provided in **Section 4.1**.

Figure 1 Regional project setting

2.2 Overview and Purpose

The proposed development will allow a larger range and quantity of material to be received and processed at the project site. In addition to sand and soil products, such a virgin excavated natural materials (VENM) and excavated natural materials (ENM), the site will receive timber, metal and building waste. Concrete and bricks will be crushed to produce a recycled aggregate. Timber and woody stumps will be shredded to produce a landscaping mulch.

2.3 Specific Operational Details

2.3.1 Existing Operations

Current operations, which involves the receipt, storage and sale of up to 10,000 tpa of landscape supplies including items such as pebbles, bricklayers sand, plasterers sand, washed paving sand, soil mixes, pine mulches, timber mulches and other landscaping material, will be continued. It is noted that the 10,000 tpa is not included in the waste receival, processing and storage total of up to 200,000 tpa for which development consent is sought.

This assessment has considered the cumulative impact of these existing operations in addition to those of the waste receival, processing and storage operations.

2.3.2 The Project

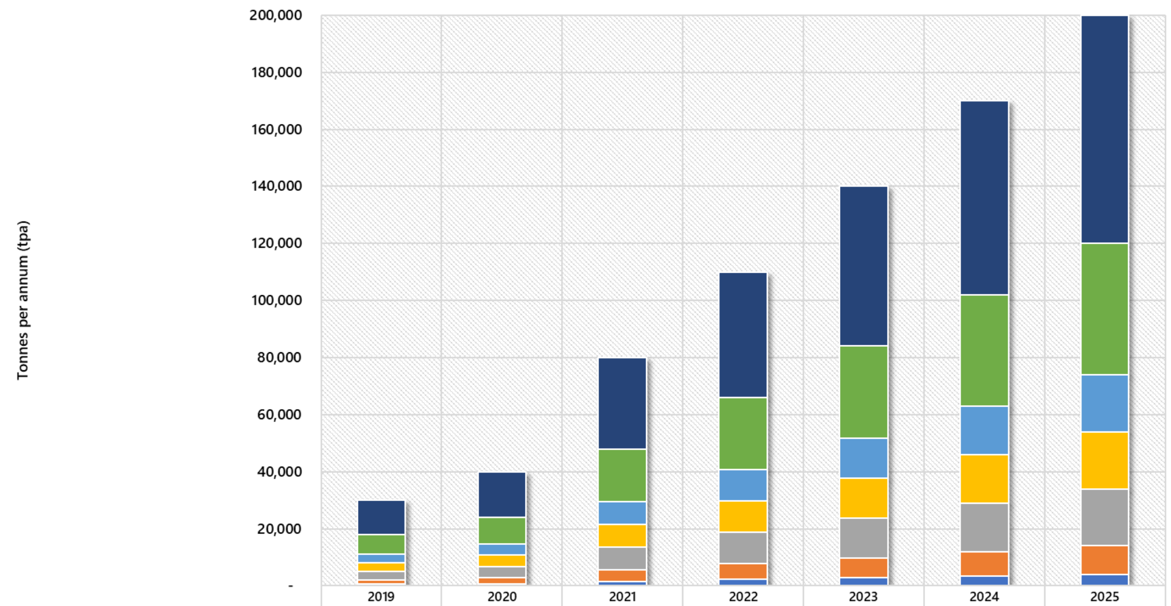
Waste

Waste received at the project site is envisaged to include a range of material types including:

- Virgin excavated natural material (VENM);
- Excavated natural material (ENM);
- Concrete, tiles and masonry;
- Timber (including rootballs and stumps);
- Mixed building waste;
- Metal; and,
- Asphalt.

The tonnages of each material type anticipated to be received over the first seven years of operation is presented in **Figure 2**. The maximum quantity of material to be received at the site in any year would be 200,000 tonnes (t).

Figure 2 Anticipated waste receipt – 2019 to 2025



	2019	2020	2021	2022	2023	2024	2025
Excavated Natural Material (soil)	12,000	16,000	32,000	44,000	56,000	68,000	80,000
Concrete / tiles / masonry	6,900	9,200	18,400	25,300	32,200	39,100	46,000
Timber	3,000	4,000	8,000	11,000	14,000	17,000	20,000
Asphalt	3,000	4,000	8,000	11,000	14,000	17,000	20,000
Virgin Excavated Natural Material (VENM) (soil)	3,000	4,000	8,000	11,000	14,000	17,000	20,000
Mixed building waste	1,500	2,000	4,000	5,500	7,000	8,500	10,000
Metal	600	800	1,600	2,200	2,800	3,400	4,000

Data source: (Jackson Environment and Planning, 2018)

Waste receival

Waste would be received in B-Doubles (except metal and timber), semi-trailers (except metal and timber) or rigid trucks which are weighed on the weighbridge. Materials would then tipped in the unloading bay associated with the 'waste receival area', visually inspected by trained staff with compliant material then moved by front end loader (FEL) to the storage bay associated with the relevant material. Concrete block storage bay walls will be 3 m in height and storage piles will be managed to not exceed the wall height. Clean building timbers may be separated and stored within the landscaping supplies area for sale, with no further processing.

A general concept layout is presented in **Figure 3** (for a more detailed overview see the main EIS documentation).

Processing

As required, material would be moved by FEL to the 'processing area' (refer **Figure 3**) where material would be sorted by an excavator, with clean materials free of contamination either stored or processed further (crushed, screened or chipped/shredded (timber)) and then transferred to the 'product blending area' as required.

Material which would require crushing is likely to include asphalt and concrete, tiles and masonry. Material to be screened would include ENM, VENM, crushed asphalt and crushed concrete, tiles and masonry.

Mixed building waste would be subject to a primary sorting process using a grab excavator with the recyclable material sent into the relevant waste stream. Any residual waste which requires further sorting to remove physical contamination to produce clean streams of recoverable materials would be transferred by FEL to the 'secondary sorting warehouse'.

The 'processing area' would be hardstand and constructed of recycled concrete aggregate and recycled asphalt. The area would need to accommodate the operation of a mobile crusher, mobile screening plant, mobile shredder and up to three FEL.

The 'secondary sorting warehouse' will be located at the north-eastern edge of the project site. FEL will enter the warehouse from the south, and deposit residual waste materials into a concrete block holding bay. Waste materials will be loaded to an electric feed hopper and conveyor which will screen fine soils in the loads. The recovered fines will be diverted to a hooklift bin. Remaining materials will pass through a trommel screen to separate small and coarser concrete and masonry aggregate followed by a magnet for the separation of ferrous metals and an elevated picking line will be used to remove timber, plastics, concrete/aggregate and non-ferrous metals by hand. A blower will be used to remove lighter material prior to entering the picking line. Once sorted, material will either be redirected back into the appropriate storage bay/area of the project site or stored for removal offsite to a licensed landfill facility.

Storage

Following processing / blending, materials would be moved by FEL to the relevant storage area within the 'landscape supplies area' or 'aggregate storage bays' of the project site (refer **Figure 3**). All storage areas (in both the 'waste receival area', 'landscape supplies area' and 'aggregate storage bays'), with the exception of storage piles of material which have been processed or blended immediately prior, would be constructed as 3-sided bins.

Waste and product transport

Vehicles containing waste materials would enter the site via Gindurra Road, access the weighbridge and continue along the eastern boundary of the site to the 'waste receival area'. Following tipping of the load, vehicles would continue around the road loop, back over the weighbridge and onto Gindurra Road. The length of the 'long' road loop from the gate to the 'waste receivals area' and back to the gate is approximately 750 m.

Generally, vehicles accessing the project site to pick up product would access the site via Gindurra Road, access the weighbridge and use the shorter road loop into, and around, the 'product supplies area'. The length of the 'short' road loop from the gate to the 'product supplies area' and back to the gate is approximately 400 m.

In some circumstances, vehicles accessing the project site to pick up loads of VENM, asphalt, ENM and concrete may pick up loads directly from the 'processing area' and utilise the 'long' road loop.

Products purchased and sold as part of the existing landscape supplies business (refer **Section 2.3.1**) would be delivered and removed from the project site using the 'short' road loop.

All roads would be constructed of recycled crushed concrete and crushed used asphalt and in accordance with the NSW EPA's *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010*.

Hours of operation

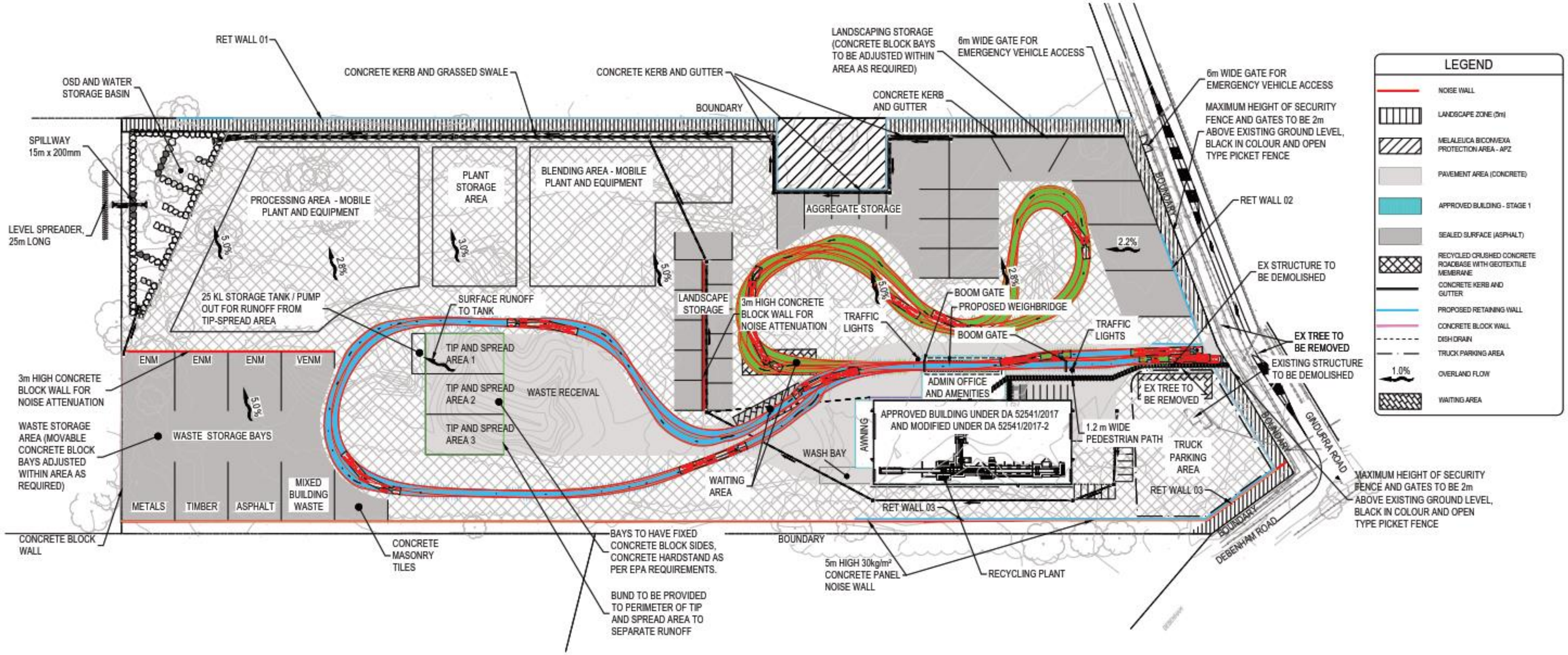
Deliveries of waste materials and product sales would be between the hours of 7:00 am and 6:00 pm on weekdays, and 8:00 am to 4:00 pm on Saturdays. No waste deliveries or product sales would occur on Sundays.

Processing of waste would be limited to weekdays between the hours of 8:00 am and 5:00 pm.

Workforce

Up to ten employees are anticipated to be required to service the project site after year seven, once 200,000 tpa of material is received, processed and sold.

Figure 3 General concept layout



Source: Cardno. Drawing number: 80518002-CI-106.

2.4 Identified Potential for Emissions to Air

2.4.1 Construction Phase

Construction of the project would involve the removal of existing structures and services on the Site, and the construction of new structures and services.

Jackson Environment and Planning (2017) *Kariong Sand and Soil Supplies – SEAR's Preliminary Environmental Assessment Report* (Jackson Environment and Planning, 2017) states the following:

> *"The complete development would require: installation of security fencing; construction of a hardstand area for processing material; construction of storage bays for processed material; construction of on-site roads suitable for large vehicles; construction of a truck parking area; construction of an office, maintenance workshop and weighbridge.*
>
> *The main operational area will be divided into two main areas; one for receiving and processing incoming material, and another area for storage of final product and sale of material to landscape supplies customers. It is anticipated that a total final area of the developed operational area on the site will be approximately 39,000 m^2.*
>
> *The update of the site will be conducted in two stages. The first stage will be construction work at the front of the site, involving demolition of the existing buildings, construction of a front office and workshop, front parking areas and install the security fencing. The second stage involves clearing of vegetation, earthworks to facilitate on-site drainage, construction of on-site roads, construction of a hardstand area, construction of a stormwater management system, construction of a noise barrier and construction of product storage bays."*

Correspondingly, an indicative list of plant and equipment that may be used during the construction of the project includes:

- Cranes.
- Earth moving vehicles.
- Pre-mixed concrete agitator trucks.
- Light vehicles.
- Drills.
- Pneumatic hand or power tools.
- Commercial vans.
- Cherry pickers.

The methodology used in the construction phase air quality assessment is discussed in **Section 5.1** and **Appendix E**, and the assessment of the potential impacts upon local air quality resulting from construction activities is presented in **Section 6**.

The construction phase activities to be performed as enabling works for the project are anticipated to have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and may typically be experienced by neighbours as amenity impacts, such as dust deposition and/or visible dust plumes, rather than associated with health-related impacts.

Localised engine exhaust emissions from construction machinery and vehicles may also be experienced, but given the scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts and construction vehicle emissions are not considered further in this AQIA, although the construction mitigation recommendations (see **Section 6.5**) includes measures to minimise these potential impacts.

2.4.2 Operational Phase

The processes which may result in the emission of pollutants to air include:

- Movement of vehicles around the project site on paved road surfaces;
- Unloading of waste materials (and purchased materials associated with the existing landscape supplies business);
- Movement of material around the site using front end loaders;
- Material processing (crushing/screening/shredding/blending) in the processing area and screening/sorting in the secondary sorting warehouse;
- Loading trucks with product material;
- Wind erosion of storage areas; and
- Emissions from vehicle and equipment exhaust.

All waste received at the project site would be classified as non-putrescible. Although timber would be received, processed (to mulch) and stored at the project site, it is not likely that the material would be retained at the project site for a sufficient period of time to decay and become odorous. Furthermore, the product is of no commercial value as a mulch product if it does begin to decay and therefore the material will be managed and stored to reduce the potential for decay. Importantly, no composting is proposed as part of the project site operations.

The odour from raw timber products and shredded / chipped material would be minor. A review of odour emissions data and hedonic tone descriptors associated with raw timber and shredded/chipped wood materials indicates that odour from these sources would generally be described as exhibiting neutral hedonics and by a standard odour descriptor as 'earthy'. The final product is often used as a medium in biofilters (used to reduce odour from odorous processes) and intrinsically has a residual and minor woodchip odour. For context, a well operated biofilter with odorous gas flowing through should not result in any discernible odour at around 10 m.

A minor odour may therefore be experienced in close proximity to the stockpiles of material, although given that the raw timber stockpile, the shredded material processing area and product stockpile are to be located approximately 200 m, 270 m and 185 m respectively from the nearest residence, the potential for odour impacts is considered to be insignificant.

Although no odour complaints would be anticipated to be received, an odour complaints log would be maintained within the site office and would form part of the ongoing environmental management of the site.

A number of air quality management measures are to be employed as part of the project to minimise the generation and off-site transport of particulate matter. A discussion of these measures, and how they relate to best practice, is presented in **Section 5.2.3**.

Emissions associated with the transport, unloading, handling, processing and storage of materials at the project site have been considered to be associated with potential emissions to air of particulate matter only. Assessment of the potential impacts upon local air quality resulting from those activities is presented in **Section 6**.

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3 LEGISLATION, REGULATION AND GUIDANCE

3.1 Federal Air Quality Standards

3.1.1 National Environment Protection (Ambient Air Quality) Measure

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

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

The Ambient Air Quality NEPM was varied in July 2003 to include advisory reporting standards for fine particulate matter with an aerodynamic equivalent diameter of 2.5 microns (µm) or less ($PM_{2.5}$) and in February 2016 (NEPC, 2016), introducing varied standards for PM_{10} and $PM_{2.5}$. The air quality standards and goals as set out in the (revised) Ambient Air Quality NEPM for the pollutants considered within this assessment are presented in **Table 2**.

Table 2 National Environment Protection (Ambient Air Quality) Measure standards and goals

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

3.1.2 National Clean Air Agreement

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

Regarding air quality standards with relevance to this report, the Initial Work Plan sets an objective to vary the Ambient Air Quality NEPM regarding PM_{10} and $PM_{2.5}$ standards.

Of relevance to the standards adopted as the relevant benchmarks for the performance of the project, the previous standards were augmented by an annual average PM_{10} concentration standard of 25 µg·m^{-3}, and the advisory reporting standards for $PM_{2.5}$ considered as standards. It is further likely that the 24-hour average PM_{10} concentration standard will be made more stringent from the current value of 50 µg·m^{-3} in time, although it is currently not possible to determine the revised standard for that metric.

3.2 NSW Air Quality Standards – Particulates

State air quality guidelines adopted by the NSW EPA are published in the *'Approved Methods for the Modelling and Assessment of Air Quality in NSW'* (the Approved Methods (NSW EPA, 2017)) which has been consulted during the preparation of this assessment report.

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the project.

The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE and WHO).

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW are presented in **Table 3**.

Table 3 NSW EPA air quality standards and goals

Pollutant	Averaging period	Criterion		Notes
		µg·m^{-3} (a)		
Particulates (as PM_{10})	24 hours	50		Numerically equivalent to the AAQ NEPM(b) standards and goals.
	1 year	25		
Particulates (as $PM_{2.5}$)	24 hours	25		
	1 year	8		
Particulates (as TSP)	1 year	90		
		g·m^{-2}·month^{-1}	g·m^{-2}·month^{-1}	
Deposited dust	1 year	2(c)	4(d)	Assessed as insoluble solids as defined by AS 3580.10.1

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

Based upon the above, the impact assessment criteria presented in **Table 4** have been applied to this AQIA.

Table 4 Impact assessment criteria adopted in this AQIA

Pollutant	Averaging period	Criterion
Particulates (as TSP)	1 year	90 $\mu g \cdot m^{-3}$
Particulates (as PM_{10})	24 hours	50 $\mu g \cdot m^{-3}$
	1 year	25 $\mu g \cdot m^{-3}$
Particulates (as $PM_{2.5}$)	24 hours	25 $\mu g \cdot m^{-3}$
	1 year	8 $\mu g \cdot m^{-3}$
Deposited dust	1 year (as monthly average)	2 $g \cdot m^{-2} \cdot month^{-1}$ (a) 4 $g \cdot m^{-2} \cdot month^{-1}$ (b)

Notes: (a): Maximum increase in deposited dust level

(b): Maximum total deposited dust level

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4. EXISTING CONDITIONS

4.1 Surrounding Land Sensitivity

4.1.1 Discrete Receptor Locations

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed (see also **Section 3.2** and **Table 4** for a discussion on how this consideration has been applied to the adopted impact assessment criteria). Typically, these locations are identified as residential properties although other sensitive land uses may include schools, medical centres, places of employment, recreational areas or ecologically sensitive locations.

It is important to note that the selection of discrete receptor locations is not intended to represent a fully inclusive selection of all sensitive receptors across the study area. The location selected should be considered to be representative of its location, and may be reasonably assumed to be representative of the immediate environs. In some instances, several viable receptor locations may be identified in a small area, for example a school neighbouring a medical centre. In this instance, the receptor closest to the potential sources to be modelled would generally be selected and would be used to assess the risk to other sensitive land uses in the area. It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see **Section 4.1.2**) that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location sensitive to changes in air quality does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the project site reside, population density data has been examined. Population density data based on the 2016 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km^2) grid, covering mainland Australia (ABS, 2017). Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities.

For clarity, the ABS use the following categories to analyse population density ($persons \cdot km^{-2}$):

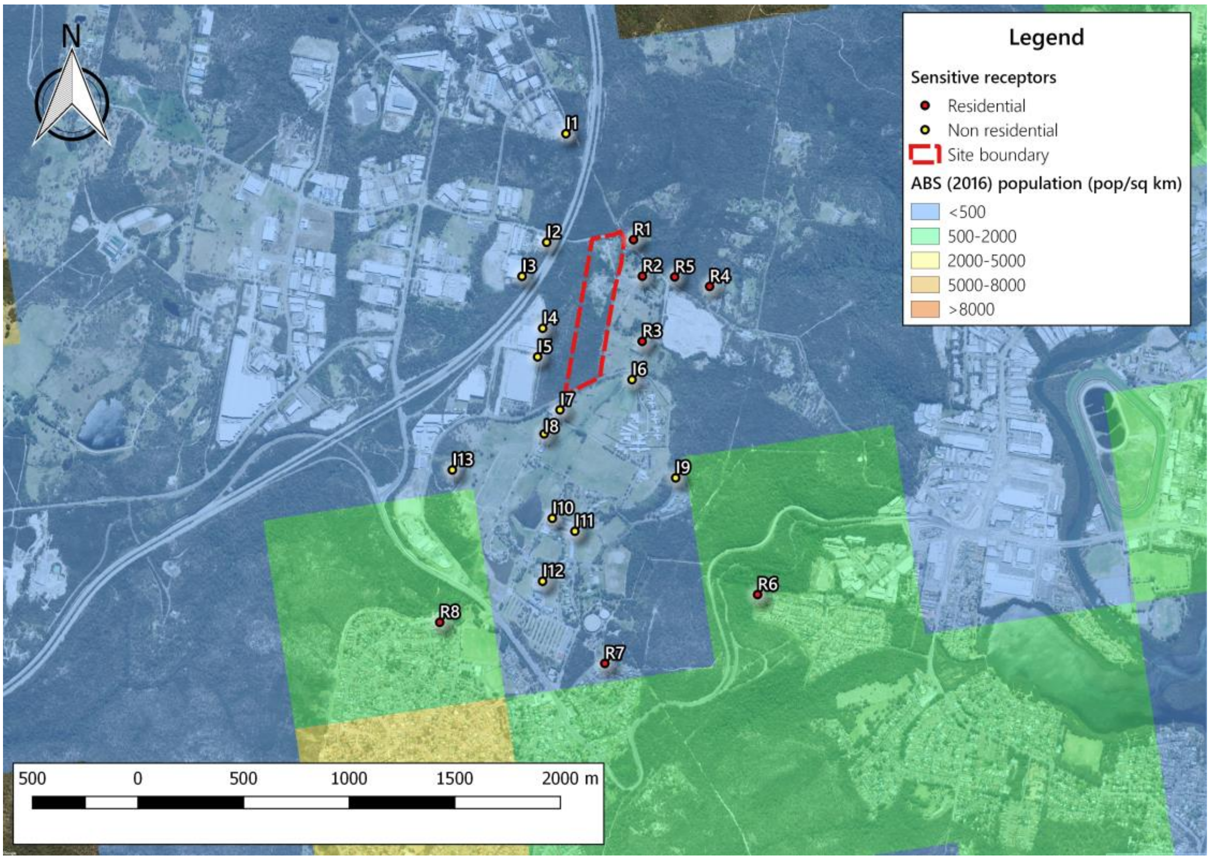
- Very high >8,000
- High >5,000
- Medium >2,000
- Low >500
- Very low <500
- No population 0

Using ABS data in a GIS, the population density of the area surrounding the project site are presented in **Figure 4**. The project site is located in an area of very low (<500 persons·km^{-2}), low (500 to 2000 persons·km^{-2}) and medium (2000 to 5000 persons·km^{-2}).

A number of residential locations, industrial locations and educational receptor location have been identified and these receptors adopted for use within this AQIA are presented in **Table 5**. **Figure 4** identifies that the receptors selected are located in directions which correspond to surrounding populated areas and are therefore appropriate.

The nearest identified schools to the project site are Parklands Community Preschool (I10) and Ngaruki Gulgul Central School (I13) which are located approximately 600 m from the project site boundary, and around 950 m from site activities. These sensitive receptor locations have been specifically included within the assessment.

Figure 4 Population density and sensitive receptors surrounding the project site



Note: Areas with no colour represents a 1 km^2 grid cell with zero population

Table 5 represents the discrete receptor locations that have been identified as part of this study (see **Figure 4**). The table is not intended to represent a definitive list of sensitive land uses, but a cross section of available locations that are used to characterise larger areas, or selected as they represent more sensitive locations which may represent people who are more susceptible to changes in air pollution than the general population.

Table 5 Discrete sensitive receptor locations used in the study

Rec	Location	Location (m, Australian Map Grid, zone 56)		Land Use	Land Use Zoning
		Easting	Northing		
Residential receptor locations					
R1	242 Debenham Road South, Somersby	342,001	6,301,422	Residential	Rural Landscape
R2	10 Acacia Road, Somersby	342,046	6,301,251	Residential	Primary Production
R3	32 Acacia Road, Somersby	342,050	6,300,944	Residential	Primary Production
R4	198 Debenham Road South, Somersby	342,365	6,301,208	Residential	Rural Landscape
R5	252 Debenham Road South, Somersby	342,199	6,301,250	Residential	Rural Landscape
R6	10 Singleton Point Road, Clare	342,616	6,299,761	Residential	Low Density Residential
R7	26 Old Mount Penang Road, Kariong	341,898	6,299,425	Residential	Low Density Residential
R8	95 Mitchell Drive, Kariong	341,113	6,299,606	Residential	Low Density Residential
Non-residential receptor locations					
I1	244 Debenham Road North, Somersby	341,673	6,301,916	Industrial	Rural Landscape
I2	58 Gindurra Road, Somersby	341,590	6,301,403	Industrial	General Industrial
I3	44 Gindurra Road, Somersby	341,476	6,301,241	Industrial	General Industrial
I4	2 Wella Way, Somersby	341,578	6,300,998	Industrial	General Industrial
I5	33 Kangoo Road, Somersby	341,556	6,300,863	Industrial	General Industrial
I6	3 Central Coast Highway, Kariong	342,005	6,300,763	Correctional Centre	Infrastructure
I7	3 Central Coast Highway, Kariong	341,666	6,300,615	Education	Infrastructure
I8	1A Central Coast Highway, Kariong	341,593	6,300,501	Education	Special Activities
I9	3 Central Coast Highway, Kariong	342,219	6,300,304	Correctional Centre	Infrastructure
I10	1A Central Coast Highway, Kariong	341,638	6,300,104	Education	Special Activities
I11	1A Central Coast Highway, Kariong	341,746	6,300,045	Education	Special Activities
I12	10 Festival Drive, Kariong	341,597	6,299,807	Education	Special Activities
I13	1A Central Coast Highway, Kariong	341,161	6,300,324	Education	Special Activities

4.1.2 Uniform Receptor Locations

Additional to the sensitive receptors identified in **Section 4.1.1**, a grid of uniform receptor locations has been used in the AQIA to allow presentation of contour plots of predicted impacts.

4.2 Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

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

A detailed description of the air quality environment surrounding the project site is presented in **Appendix A**.

A summary of the background air quality adopted for use within this AQIA is presented in **Table 6**.

Table 6 Background air quality data adopted for use within the AQIA

Pollutant	Averaging Period	Maximum Concentration	Criterion from Table 3	Source
TSP	Annual	32.8 $\mu g \cdot m^{-3}$	90 $\mu g \cdot m^{-3}$	Estimated on a TSP:PM_{10} ratio of 2.2 : 1 [1]
PM_{10}	24 hours	58.6 $\mu g \cdot m^{-3}$	50 $\mu g \cdot m^{-3}$	Wyong AQMS 2015 [1,2]
	Annual	14.9 $\mu g \cdot m^{-3}$	25 $\mu g \cdot m^{-3}$	
$PM_{2.5}$	24 hours	13.2 $\mu g \cdot m^{-3}$	25 $\mu g \cdot m^{-3}$	Wyong AQMS 2015 [1]
	Annual	5.2 $\mu g \cdot m^{-3}$	8 $\mu g \cdot m^{-3}$	
Dust deposition	Annual	2 $g \cdot m^{2} \cdot month^{-1}$	4 $g \cdot m^{2} \cdot month^{-1}$	Difference in NSW OEH maximum allowable and incremental impact criterion

Note: 1) Justification for the use of data from Wyong provided in **Appendix A**
2) Discussion of existing exceedance of criterion discussed in **Appendix A**

Table 6 indicates that concentrations of particulate matter (24-hour average PM_{10}) exceeded the relevant air quality criteria as detailed in **Table 3** in 2015 (on 6 May 2015). The NSW Air NEPM Compliance Report for 2015 (NSW OEH, 2015) indicated that the exceedance on 6 May 2015 was an 'exceptional' event and was due to a dust storm which affected PM_{10} concentrations at the Wyong site and in a wider area, from Albury to Sydney and to Tamworth.

The AQIA has been performed to assess the contribution of the project to the air quality of the surrounding area. A full discussion of how the project impacts upon the air quality, including the contribution during such 'exceptional events' is presented in **Section 6**.

4.3 Topography

The elevation of the project site is approximately 190 m to 210 m Australian Height Datum (AHD). No significant topographical features are present between the project site and the nearest sensitive receptor locations. The wider area does contain more significant features as shown in **Figure 5**, although these would not impact significantly upon the transport and dispersion of pollutants between the project site and receptors.

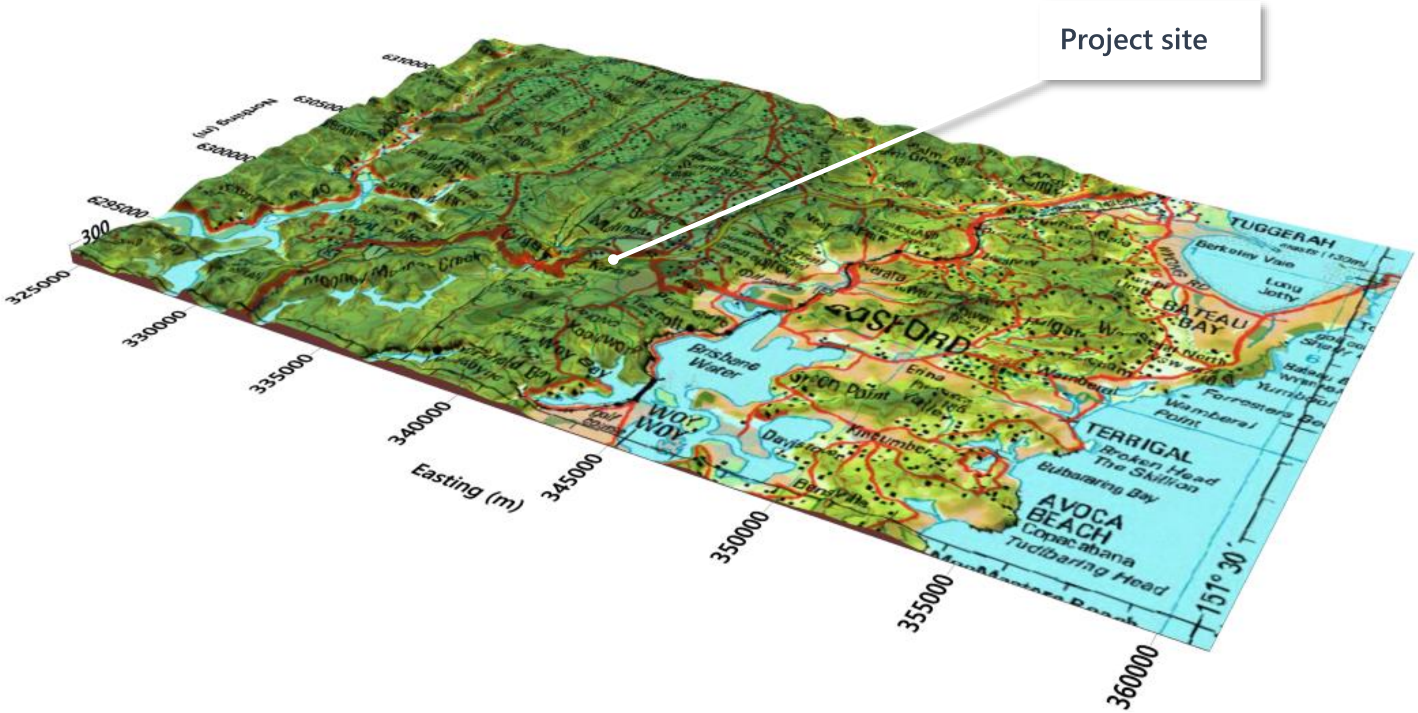
4.4 Meteorology

The meteorology experienced within an area can govern the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the project site have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at a number of surrounding Automatic Weather Stations (AWS).

To provide a characterisation of the meteorology which would be expected at the project site, a meteorological modelling exercise has also been performed.

A summary of the inputs and outputs of the meteorological modelling assessment, including validation, is presented in **Appendix B**.

Figure 5 3-dimensional representation of topography surrounding project site



5. METHODOLOGY

5.1 Construction Phase Activities

Construction phase activities have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and are typically experienced by neighbours as amenity impacts, such as dust deposition and visible dust plumes, rather than associated with health-related impacts. Localised engine exhaust emissions from construction machinery and vehicles may also be experienced, but given the scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts.

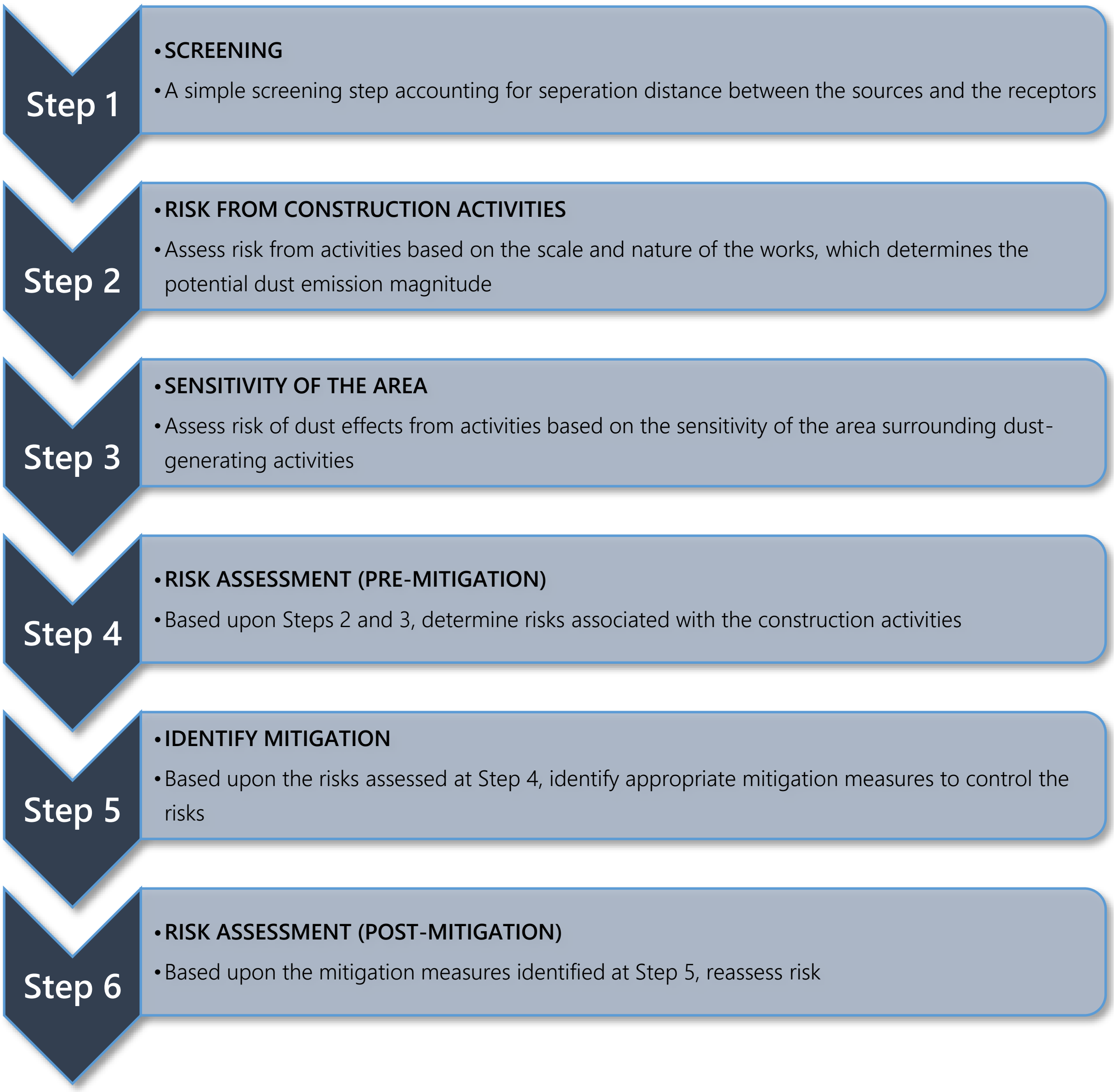
Modelling of dust from construction projects is generally not considered appropriate, as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly depending upon local conditions and the construction management practices employed. In lieu of a modelling assessment, the construction phase impacts associated with the project have been assessed using a risk-based assessment procedure. The advantage of this approach is that it determines the activities that pose the greatest risk, which allows the Construction Environmental Management Plan (CEMP) to focus controls to manage that risk appropriately, and reduce the impact through proactive management.

For this risk assessment, Northstar has adapted a methodology presented in the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (Institute of Air Quality Management, 2016)[1]. Reference should be made to **Appendix E** for the methodology.

Briefly, the adapted method uses a six-step process for assessing dust impact risks from construction activities, and to identify key activities for control, as illustrated in **Figure 6**.

[1] www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

Figure 6 Construction phase impact risk assessment methodology



5.2 Operational Phase Activities

5.2.1 Meteorological Modelling

Further to the description of prevailing meteorology discussed in **Section 4.4**, and discussed in more detail in **Appendix B**, the meteorology used in the AQIA has been processed using the TAPM meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 5.2.2**).

TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data.

As described fully in **Appendix B**, initial meteorological modelling indicated that the TAPM model did not provide an adequate representation of the meteorology when the output data were compared to observations collected at the Gosford AWS (data validation). A second TAPM model run, included (assimilated) the observations from Gosford AWS to 'nudge' the model predictions towards the observations, although the resulting wind roses extracted at the project site did not seem to be intuitively correct, based upon our experience. Therefore, to avoid criticism of preferential selection of data, both sets of TAPM model predictions have been used as input to the dispersion modelling exercise:

Input	Description	Reported
Input 1	TAPM modelling extracted at the project site with no data assimilation for the year 2015	**Section 7**
Input 2	Observations of wind speed and direction from Gosford AWS, using TAPM outputs for mixing height etc with data assimilation using Gosford AWS for the year 2015	**Appendix D**

This has been provided as a 'sensitivity test' (i.e. is the choice of meteorological data critical to the conclusions drawn from this report).

5.2.2 Dispersion Modelling

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 2-dimensional (2-D) mode. Given the relatively small distances between the sources and nearest receptors, the uncomplicated terrain between the sources and receptors and the characteristics of the emission sources (minimal buoyancy / vertical velocity), a detailed assessment using a 3-dimensional (3-D) meteorological dataset is not warranted.

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

The modelling scenarios provide an indication of the air quality impacts of the operation of activities at the project site. Added to these impacts are background air quality concentrations (where available and discussed in **Section 4.2** and **Appendix A**) which represent the air quality which may be expected within the area surrounding the project site, without the impacts of the project itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the operation of the project.

For clarity, emissions have been estimated for the proposed project (200,000 tpa) and includes a further 10,000 tpa of material deliveries and sales which occur as part of the existing operations at the site. All further references to a 200,000 tpa operations includes this existing 10,000 tpa operation which is not part of the current approval but has been modelled to provide an assessment of cumulative impacts.

5.2.3 Emissions Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. This assessment has adopted emission factors for materials handling processes, movement of trucks on paved site roads, crushing and screening and wind erosion contained within the US EPA AP-42 emission factor compendium (USEPA, 2006) to represent the emission of particulate matter resulting from the operations occurring at the project site as described in **Section 2.4**.

A full description of the emission sources included in the assessment for each scenario, and the emission factors and assumptions adopted are presented in **Appendix C**.

5.2.4 Emissions Controls

Emissions controls will be employed at the project site. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the project operation.

The sources of emissions resulting from project operation are associated with road haulage, materials handling, materials processing and wind erosion. The emissions control measures proposed to be employed are discussed below, and where additional measures may be available but are not proposed to be implemented, these are discussed, and justification is provided.

It is noted that all the control measures which are available for a particular emissions source may not be suitable for implementation at the project site. Consideration has been given to factors which may constrain the implementation of each particulate control measure, namely the regulatory requirements, environmental impacts, safety implications and compatibility with current processes and future development (including economic viability). These factors have been considered in reference to the constraints evaluation adopted for the NSW EPA *DustStop* Pollution Reduction Program.

Road haulage

Options for the control of dust emissions from (unpaved) haul roads fall into the following three categories:

- Vehicle restrictions that limit the speed, weight or number of vehicles on the road.
- Surface improvement by measures such as (a) paving or (b) adding gravel or slag to a dirt road.
- Surface treatment such as watering or treatment with chemical dust suppressants.

By nature of the layout of the site, vehicles would generally be travelling at speeds well below those experienced on public roads. It is anticipated that the vehicle speed limit within the project site would be 30 $km{\cdot}hr^{-1}$ and as such, could result in an emission reduction of up to 85%, although this reduction factor is associated with unpaved roads (Katestone Environmental Pty Ltd, 2011). The predictive emission factor used in the quantification of particulate emissions from paved roads (USEPA, 2011) is applicable to vehicle speeds from 1 $km{\cdot}hr^{-1}$ to 88 $km{\cdot}hr^{-1}$ and no reduction factor for lower speeds is available. Lower vehicle speeds on paved roads would result in unquantifiably lower emissions.

All site roads would be constructed of recycled crushed concrete and crushed used asphalt and in accordance with the NSW EPA's *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010*.

All site roads would be subject to regular watering, with (USEPA, 2011) indicating that water flushing at a rate of 0.48 $gal{\cdot}yd^{-2}$ (2.2 $L{\cdot}m^{-2}$) would result in emissions reductions of between 30% and 70%. For the purposes of this assessment, the lower (conservative) reduction factor of 30% has been adopted.

In summary, three broad emission control strategies can be employed to minimise particulate emissions from road haulage operations. As discussed above, the project would implement control measures within each of those categories, by limiting the speed of vehicles, paving the road surface, and watering the road surface (refer **Table 7**).

Table 7 Emission reduction methods and particulate control efficiencies - haulage

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Vehicle restrictions that limit the speed of vehicles on the road.	☑	-	Not quantifiable
Surface improvement by paving	☑	-	Emissions reductions over unpaved roads calculated through emission factor
Surface treatment - watering	☑	30	(USEPA, 2011) - application rate of 2.2 $L \cdot m^{-2} \cdot hr^{-1}$ (0.48 $gal \cdot yd^{-2}$)

The project would employ best practice emission controls on haul roads

Materials handling

The handling of materials at the project site relates to materials being unloaded and loaded, and transferred by FEL from one area of the project site to another. Although the available information relating to best practice emission controls relates to the coal mining industry (Katestone Environmental Pty Ltd, 2011), the broad control techniques can generally be applied to any industry.

Options for the control of dust emissions from materials handling activities are as follows:

Loading / unloading

- Minimising the drop height from vehicles;
- Application of water;
- Modification of activities in windy conditions;
- Loading materials to a 3-sided enclosure;
- Covering loads with a tarpaulin;
- Limit load sizes to ensure material is not above the level of truck sidewalls; and,
- Enclosure with control device.

Operation of front end loader

- Minimising travel speeds and distances; and,
- Keep travel routes and materials moist.

The drop height of incoming material from vehicles would be minimised as far as possible, although the design of the various vehicles that would typically use the site (i.e. B-Doubles, tippers and semi-trailers) does not permit the implementation of a specified drop height of material from the vehicle (i.e. the tray and tip height of the vehicles is fixed). The drop height could be minimised by dropping material onto a built-up surface such as a stockpile, although stockpiles would likely be cleared as soon as practicable.

A visual assessment of dust lift-off during material handling activities would be undertaken whilst those activities are being performed. Where visible dust is generated as a result of those activities, additional control measures would be implemented (such as the application of water sprays), or the intensity of the activity would be reduced (reducing the particulate emission load). Non-critical site activities could also be ceased to reduce the overall site particulate emission and the hierarchy of the activities to be ceased would be determined by the site manager.

All raw materials are to be loaded to a 3-sided enclosure, as shown in **Figure 3**.

All product loads leaving the site would be covered, and with loads not above the level of the sidewalls in accordance with NSW Roads and Maritime Services requirements[2].

As discussed regarding road haulage (see **Road haulage** above), all site roads are to be paved and regularly watered which would reduce wheel-generated particulate emissions from FEL moving between parts of the project site. The FEL would also be required to adhere to mandatory site speed limits, although would likely be moving at a lower speed than trucks given the vehicle type and loads being carried.

The application of the above measures results in an emission reduction of PM_{10} of 14% (controlled versus uncontrolled).

Full enclosure of materials handling activities is not proposed. The area covered by the stockpiles (in which materials are to be deposited to, and loaded from [raw materials and product]) and the distance which FEL would be required to move materials to/from makes the use of full enclosure impractical. The area of land which would be required to be covered to enclose all stockpiles and transport routes between them (not including haul roads) would be greater than 10,000 m^2. The capital expenditure for such an enclosure would increase the overall cost of the project substantially. The emissions controls proposed for the project (refer **Table 8**) act to reduce particulate emissions, with some of these reductions being included within the dispersion modelling assessment. Some have not been included either due to the unquantifiable nature of the emission reduction (e.g. covering loads), or due to their 'as required' use (e.g. application of water).

2 http://www.rms.nsw.gov.au/roads/safety-rules/demerits-offences/uncovered-loads.html

Table 8 Emission reduction methods and particulate control efficiencies – materials handling

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Minimising the drop height from vehicles	☑	30	Adopted as far as practicable. Reduction associated with a drop height reduction from 3 m to 1.5 m (Katestone Environmental Pty Ltd, 2011)
Application of water	☑	50	Watering as required. Table 4 of (NPI, 2012)
Modification of activities in windy conditions	☑	-	As required. Not quantified
Loading materials to a 3-sided enclosure	☑	30	Table 4 of (NPI, 2012)
Covering loads with a tarpaulin	☑	-	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	☑	-	Not quantified
Enclosure with control device	☒	90-100	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Would increase the cost of the project substantially
Minimising travel speeds and distances	☑	-	Not quantified
Keep travel routes and materials moist	☑	50	Table 4 of (NPI, 2012)

Considering the relevant constraints, the project would employ best practice emission controls for materials handling

Materials processing

The processing of materials at the project site relates to the crushing, screening and shredding of material in the 'processing area' and sorting and screening in the 'secondary sorting warehouse'. Although the available information relating to best practice emission controls generally relates to the coal mining industry (Katestone Environmental Pty Ltd, 2011), the broad control techniques can generally be applied to any industry.

Options for the control of dust emissions from materials processing are as follows:

- Application of water;
- Modification of activities in windy conditions; and
- Enclosure, or enclosure with control device.

The application of water is proposed for all crushing, screening and shredding activities at the project site.

A visual assessment of dust lift-off during materials processing would be undertaken whilst those activities are being performed. Where visible dust is generated as a result of those activities, additional control measures would be implemented (such as the increased application of water sprays), or the intensity of the activity would be reduced (reducing the particulate emission load). Non-critical site activities could also be ceased to reduce the overall site particulate emission and the hierarchy of the activities to be ceased would be determined by the site manager.

The application of the above measures results in an emission reduction of PM_{10} of 63% (controlled versus uncontrolled).

Full enclosure of materials processing activities in the 'processing area' is not proposed. asthe area covered by the materials processing area makes the use of full enclosure impractical. The area of land which would be required to be covered to enclose all materials processing activities and ensure that FEL could access machinery to deposit loads would be greater than 3,000 m^2. The capital expenditure for such an enclosure would increase the overall cost of the project substantially.

The activities being performed within the 'secondary sorting warehouse' will be partially enclosed, as these operations are proposed to be performed within an existing building at the project site. The proponent has indicated that the doors on the 'secondary sorting warehouse' will be kept closed whenever possible, with the door on the northern side kept almost permanently closed and only opened for maintenance/emergencies. The door on the southern side will only be opened to allow the transport of material into and out of the building. Given that the process will not be fully enclosed, an emission control efficiency appropriate to the level of enclosure has been applied.

The emissions controls proposed for the project (refer **Table 9**) act to reduce particulate emissions, with some of these reductions being included within the dispersion modelling assessment. Some have not been included either due to the unquantifiable nature of the emission reduction (e.g. modification of activities).

Table 9 Emission reduction methods and particulate control efficiencies – material processing

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Application of water	☑	91.6 (screen) 77.7 (crush) 50 (shred)	Control efficiency adopted from (USEPA, 2006) Control efficiency adopted from (USEPA, 2006) Table 4 of (NPI, 2012)
Modification of activities in windy conditions	☑	-	As required. Not quantified
Enclosure	☑	70	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Only for activities within 'secondary sorting warehouse'
Enclosure with control device	☒	90-100	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Would increase the cost of the project substantially

Considering the relevant constraints, the project would employ best practice emission controls for materials processing

Wind erosion

Wind erosion at the project site would be associated with stockpiles of raw and processed materials. Although the available information relating to best practice emission controls generally relates to the coal mining industry (Katestone Environmental Pty Ltd, 2011), the broad control techniques can generally be applied to any industry.

Options for the control of dust emissions from wind erosion sources are as follows:

- Application of water;
- Application of chemical wetting agents;
- Surface crusting agents;
- Coverage of stockpiles with a tarp in high winds;
- Vegetative wind breaks or wind screens / fences;
- 3-sided enclosures around stockpiles;
- Reduction in stockpile heights;
- Pile shaping and orientation;
- Modification of activities in windy conditions; and
- Enclosure with control device.

All material which is brought to the project site would be unloaded within 3-sided bins to reduce wind erosion during unloading activities and also to reduce wind erosion during storage. No surface crusting agents or chemical wetting agents are proposed for any stockpile at the project site given that materials are not proposed to be stored over the long-term. Stockpile heights would be minimised to an extent as they would be limited by the height of the 3-sided bins. No material would be loaded above the height of the storage bins.

No vegetative wind-breaks or screens are proposed as these would hinder the movement of vehicles and FEL to the stockpiles. Piles cannot be effectively shaped or oriented, given that they would be 3-sided bins.

Transient stockpiles of material within the processing area would be kept to a minimum, and loaded to the relevant product stockpile in the landscape supplies area. Long-term storage of processed materials outside of 3-sided bins is not proposed.

As previously discussed, a visual assessment of dust lift-off during materials processing would be performed whilst those activities are being performed. Where visible dust is generated as a result of those activities, additional control measures would be implemented (such as the increased application of water sprays), or the intensity of the activity would be reduced (reducing the particulate emission load). This would result in the quantity of material being stockpiled outside of the 3-sided bins to be reduced.

Water sprays would also be implemented should visible dust lift-off be observed from materials storage bins and piles. Given that the 3-sided bins act to significantly reduce wind erosion (by up to 75% (Katestone Environmental Pty Ltd, 2011)), the constant application of water sprays is not considered to be required but would be available should circumstances require their use. Given their intermittent use, the application of water sprays has not been assumed as a control within the dispersion modelling exercise.

Full enclosure of materials storage areas is not proposed. The area covered by the materials stockpiles makes the use of full enclosure impractical. The area of land which would be required to be covered to enclose all stockpiles and ensure that FEL could access those piles to pick up / deposit loads would be greater than 3,000 m^2 (for 3-sided bins alone). The capital expenditure for such an enclosure would increase the overall cost of the project substantially. The emissions controls proposed for the project (refer **Table 10**) act to reduce particulate emissions, with some of these reductions being included within the dispersion modelling assessment. Some have not been included either due to the intermittent nature of the application.

Table 10 Emission reduction methods and particulate control efficiencies – wind erosion

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Application of water	✓	50	As required Table 4 of (NPI, 2012)
Application of chemical wetting agents	✗	80-99	Materials stored short-term (Katestone Environmental Pty Ltd, 2011)
Surface crusting agents	✗	95	Materials stored short-term (Katestone Environmental Pty Ltd, 2011)
Coverage of stockpiles with a tarp in high winds	✗	99	Area of >3,000 m^2 too large to cover (Katestone Environmental Pty Ltd, 2011)
Vegetative wind breaks or wind screens / fences	✗	30 - 80	Would hinder vehicle movements (Katestone Environmental Pty Ltd, 2011)
3-sided enclosures around stockpiles	✓	75	(Katestone Environmental Pty Ltd, 2011)
Reduction in stockpile heights	✗	30	Stockpiles limited in height (Katestone Environmental Pty Ltd, 2011)
Pile shaping and orientation	✗	<60	Materials stored in 3-sided bins (Katestone Environmental Pty Ltd, 2011)
Modification of activities in windy conditions	✓	-	As required. Not quantified
Enclosure with control device	✗	90-100	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Would increase the cost of the project substantially

Considering the relevant constraints, the project would employ best practice emission controls for sources of wind erosion

A summary of the emissions reductions measures that would be adopted as part of the project operation is presented in **Table 11**.

Table 11 Summary of emission reduction methods adopted as part of project operation

Emission control method	Control efficiency (%)
Road Haulage	
Vehicle restrictions that limit the speed of vehicles on the road.	Not quantified
Surface improvement by paving	Assessed through emission factor
Surface treatment - watering	30
Materials Handling	
Minimising the drop height from vehicles	30
Application of water	50
Modification of activities in windy conditions	Not quantified
Loading materials to a 3-sided enclosure	30
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified
Minimising travel speeds and distances	Not quantified
Keep travel routes and materials moist	50
Materials Processing	
Application of water	91.6 (screen) 77.7 (crush) 50 (shred)
Enclosure of activities within 'secondary sorting warehouse'	70
Modification of activities in windy conditions	Not quantified
Wind Erosion	
Application of water	50
3-sided enclosures around stockpiles	75
Modification of activities in windy conditions	Not quantified

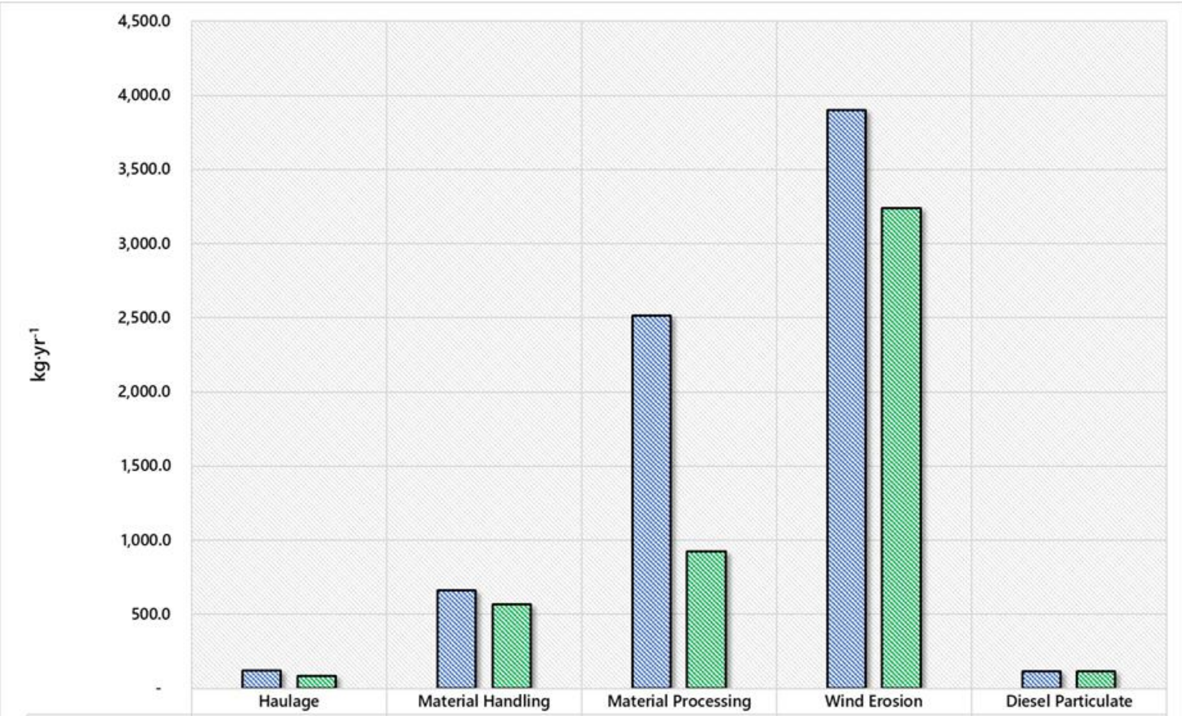
Based on the foregoing and the information provided in **Appendix C**, the distribution of controlled particulate emissions across broad emissions categories is presented in **Figure 7** for PM_{10}. Distributions for TSP and $PM_{2.5}$ are presented in **Appendix C**.

The approach adopted within this assessment in the assessment of wind erosion distributes emissions according to the wind speed across the site in each hour with zero wind erosion occurring during periods when the hourly wind speed is lower than the threshold wind velocity ($\leq$5.2 $m \cdot s^{-1}$) and emissions are increased by the cube of the wind speed during hours when the wind speed is greater than the threshold wind velocity (>5.2 $m \cdot s^{-1}$).

The USEPA (USEPA, 1998) approach assumes a constant emission across all hours, which in lower wind speeds (with associated poorer dispersion conditions) can result in unrealistic impacts at receptors.

The exposed areas adopted in the assessment which are available to be eroded by the wind have been assumed to be the full areas of the 3-sided bins and stockpile area. In reality, the area available for wind erosion at any one moment in time will be limited to those areas being, or having been recently disturbed. That is, fresh particulate matter does not generally become available due to the action of the wind itself, but is made available by activities being performed on an area. However, a worst-case assessment has been performed which assumes a constant supply of particles for wind erosion.

Figure 7 Calculated uncontrolled & controlled annual PM_{10} emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM10	120.7	661.5	2,517.0	3,900.8	115.5
Controlled PM10	84.5	565.5	922.4	3,239.8	115.5

Note: The emissions presented above (and in **Appendix C**) and associated results in **Section 6** reflect a 200 ktpa scenario. Wind erosion emissions are associated with meteorological input file 1 (refer **Appendix B**) which of the two input files generates higher emissions from wind erosion sources.

6. CONSTRUCTION PHASE AIR QUALITY ASSESSMENT

As described in (Jackson Environment and Planning, 2017) and (Jackson Environment and Planning, 2018) the construction and enabling works for the project would involve two stages:

- The first stage will be construction work at the front of the site, involving demolition of some of the existing buildings, construction of a front office and workshop, front parking areas and installation of the security fencing. This stage is the subject of a separate development application which is currently under assessment by Council. Only impacts associated with the second stage are considered within this AQIA.
- The second stage involves clearing of vegetation, earthworks to facilitate on-site drainage, construction of on-site roads, construction of a hardstand area, construction of a stormwater management system, construction of a noise barrier, construction of product storage bays and the installation of processing equipment in the processing area and secondary sorting warehouse.

The development and grading of the site will require both cut and fill, and the volumes have been derived from cut and fill estimates produced by Cardno, which are presented in **Table 12**

Table 12 Cut and fill estimates – construction phase

Activity	Cut volume (m^3)	Fill volume (m^3)	Balance volume (m^3)
Building pad	5	2,800	-2,795
Site roads	310	3,730	-3,420
Existing stockpiles	18,090	0	18,090
Total	18,405	6,530	11,875

The net balance equates to approximately 12,000 m^3 (rounded up) of material cut from the site as a result of the construction phase activities, and principally generated through the regrading of the existing stockpiles. That volume of cut material however will not be exported directly from the site and will be recycled as product (depending upon type and quality).

The footprint of the project site which is to be affected is estimated as: approximately 39,000 m^2, or 3.9 hectares (ha), in area.

The assumed supply route around the site during construction works may be up to 1 km as a loop to the southern extent of the processing area and back to the site entrance on Gindurra Road. It is anticipated that >50 heavy vehicle movements would be required each day to service the site, during peak periods of construction activities.

For the purposes of the assessment, the route for construction traffic to/from the site is assumed to be (i) along Gindurra Road to the right, then along Debenham Road South or (ii) along Gindurra Road, then along Wisemans Ferry Road to the Pacific Motorway or onto the Central Coast Highway.

6.1 Step 1: Screening Based on Separation Distance

The screening criteria applied to the identified sensitive receptors are whether they are located in excess of:

- 350 m from the boundary of the site.
- 500 m from the site entrance.
- 50 m from the route used by construction vehicles on public roads.
- Track-out is assumed to affect roads up to 100 m from the site entrance.

Table 13 presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table 13 Construction phase impact screening criteria distances

Rec	Location	Land Use	Screening Distance (m approx.)		
			Boundary (350m)	Site Entrance (500m)	Const. route (50m)
R1	242 Debenham Road South, Somersby	Residential	35	125	20
R2	10 Acacia Road, Somersby	Residential	80	190	20
R3	32 Acacia Road, Somersby	Residential	20	420	280
R4	198 Debenham Road South, Somersby	Residential	420	520	20
R5	252 Debenham Road South, Somersby	Residential	260	350	20
R6	10 Singleton Point Road, Clare	Residential	>1,000	>1,000	250
R7	26 Old Mount Penang Road, Kariong	Residential	>1,000	>1,000	255
R8	95 Mitchell Drive, Kariong	Residential	>1,000	>1,000	190
I1	244 Debenham Road North, Somersby	Industrial	500	500	20
I2	58 Gindurra Road, Somersby	Industrial	190	290	20
I3	44 Gindurra Road, Somersby	Industrial	260	440	140
I4	2 Wella Way, Somersby	Industrial	105	440	290
I5	33 Kangoo Road, Somersby	Industrial	105	640	540
I6	3 Central Coast Highway, Kariong	Correctional Centre	150	>1,000	40
I7	3 Central Coast Highway, Kariong	Education	55	>1,000	680
I8	1A Central Coast Highway, Kariong	Education	175	>1,000	660
I9	3 Central Coast Highway, Kariong	Correctional Centre	600	>1,000	750
I10	1A Central Coast Highway, Kariong	Education	600	>1,000	470
I11	1A Central Coast Highway, Kariong	Education	640	>1,000	490
I12	10 Festival Drive, Kariong	Education	>1,000	>1,000	180
I13	1A Central Coast Highway, Kariong	Education	600	>1,000	340

With reference to **Table 13**, a number of sensitive receptors are noted to be within the screening distance boundaries and therefore require further assessment as summarised in **Table 14**.

Table 14 Application of Step 1 screening

Construction Impact	Screening Criteria	Step 1 Screening	Comments
Demolition	350 m from boundary 500 m from site entrance	Screened	Demolition to occur in Stage 1 – not relevant to this AQIA
Earthworks	350 m from boundary 500 m from site entrance	Not screened	Receptors identified within the screening distance
Construction	350 m from boundary 500 m from site entrance	Not screened	
Track-out	100 m from site entrance	Screened	No receptors identified within the screening distance
Construction Traffic	50 m from roadside	Not screened	Receptors identified within the screening distance

6.2 Step 2: Risk from Construction Activities

Based upon the above assumptions and the assessment criteria presented in **Appendix E**, the dust emission magnitudes are as presented in **Table 15**.

Table 15 Construction phase impact categorisation of dust emission magnitude

Activity	Detail	Dust Emission Magnitude
Demolition	*screened at Step 1*	*screened at Step 1*
Earthworks and enabling works	>10,000 m^2 earthworks area	large
Construction	<25,000 m^3 building volume[(a)]	small
Track-out	*screened at Step 1*	*screened at Step 1*
Construction traffic routes	>10,000 m^2 earthworks area	large

Note (a) Includes construction of noise barrier and material storage bins. Secondary Processing Warehouse will be re-purposed and requires minor fit-out only.

6.3 Step 3: Sensitivity of an Area

6.3.1 Land Use Value

Based on the criteria listed in **Appendix E**, the land use value of the area surrounding the site is concluded to be *high* for health impacts and for dust soiling, based upon the following assumption:

- The receptor locations include residential properties where people may reasonably be expected to be present for eight to 24-hours.

Medium land use values are also identified in the area immediately surrounding the site in locations where people are anticipated to be employed (as opposed to residing).

Given that the highest sensitivity land uses would tend to define the level of control required to minimise impacts, it is considered that these sensitivity land uses are appropriately considered for both health and dust soiling effects. This value is used to derive *the sensitivity of the area*.

6.3.2 Sensitivity of an Area

Using the classifications shown in **Appendix E**, the sensitivity of the surrounding area to (i) health effects and (ii) dust soiling may be identified.

The assumed existing background annual average PM_{10} concentrations (as measured at Wyong in 2015) are reported in **Section 4.2**. As presented in **Table 6** the annual average PM_{10} concentration as measured at Wyong in 2015 was 14.9 µg m^{-3}, which provides the sensitivity of the area as *low* for dust health impacts.

The sensitivity of the area to dust soiling effects is assessed as a function of land use value, number of receptors and the distance to the site boundary. For this assessment, the sensitivity to dust soiling effects is assessed as being *high*, which seems intuitive given the proximity of receptors to the site boundary.

6.4 Step 4: Risk (Pre-Mitigation)

Given the dust emission magnitudes for the various construction phase activities as shown in **Section 6.2** (Step 2) and the sensitivity of the identified receptors as determined in **Section 6.3**, the resulting risk of air quality impacts (without mitigation) is as presented in **Table 16**.

Table 16 Risk of air quality impacts from construction activities

Impact	Sensitivity of Area	Dust Emission Magnitude					Preliminary Risk				
		Demolition	Earthworks	Construction	Track-out	Const. Traffic	Demolition	Earthworks	Construction	Track-out	Const. Traffic
Human Health	low	n/a	large	small	n/a	large	n/a	low	negl	n/a	low
Dust Soiling	high	n/a	large	small	n/a	large	n/a	high	low	n/a	high

The preliminary risk assessment summarised in **Table 16** indicates that with no mitigation measures there is a *low risk* of human health effects associated with construction phase activities. These are associated with emissions from earthworks and from construction traffic.

Table 15 indicates that there is a *high risk* of adverse dust soiling (amenity) impacts if no mitigation measures were to be applied to control emissions, in relation to earthworks and construction traffic. There is also a low impact associated with construction.

This preliminary risk assessment is used to identify appropriate construction-phase mitigation controls to be applied to those activities during the construction phase.

6.5 Step 5: Identified Mitigation

Table 17 lists the relevant mitigation measures identified, and have been presented as follows:

- **N** = not required (although they may be implemented voluntarily).
- **D** = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided).
- **H** = highly recommended (to be implemented as part of the CEMP, and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

The following measures are recommended as *highly recommended* (H) or *desirable* (D) by the IAQM methodology for a *low* risk site for earthworks, construction and construction traffic. A detailed review of the recommendations would be performed once details of the construction phase are available.

Table 17 Site-Specific Management Measures

Recommended Mitigation Measure		Risk & Recommendation
1	Communications	High
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	**H** to be implemented
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	**H** to be implemented
1.2	Display the head or regional office contact information.	**H** to be implemented
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	**H** to be implemented

	Recommended Mitigation Measure	Risk & Recommendation
2	Site Management	High
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	**H** to be implemented
2.2	Make the complaints log available to the local authority when asked.	**H** to be implemented
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	**H** to be implemented
2.4	Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.	**H** to be implemented
3	Monitoring	High
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	**H** to be implemented
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	**H** to be implemented
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	**H** to be implemented
3.4	Agree dust deposition, dust flux, or real-time continuous monitoring locations with the relevant regulatory bodies. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences.	**H** to be implemented
4	Preparing and Maintaining the Site	High
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	**H** to be implemented
4.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.	**H** to be implemented
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	**H** to be implemented
4.4	Avoid site runoff of water or mud.	**H** to be implemented
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	**H** to be implemented

Recommended Mitigation Measure		Risk & Recommendation
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	**H** to be implemented
4.7	Cover, seed or fence stockpiles to prevent wind erosion	**H** to be implemented
5	**Operating Vehicle/Machinery and Sustainable Travel**	**High**
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	**H** to be implemented
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	**H** to be implemented
5.3	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable	**H** to be implemented
5.4	Impose and signpost a maximum-speed-limit of 25 $km \cdot h^{-1}$ on surfaced and 15 $km \cdot h^{-1}$ on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	**H** to be implemented
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	**H** to be implemented
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	**H** to be implemented
6	**Operations**	**High**
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	**H** to be implemented
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	**H** to be implemented
6.3	Use enclosed chutes and conveyors and covered skips	**H** to be implemented
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	**H** to be implemented
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	**H** to be implemented
7	**Waste Management**	**High**
7.1	Avoid bonfires and burning of waste materials.	**H** to be implemented

Recommended Mitigation Measure		Risk & Recommendation
8	Measures Specific to Demolition	n/a
9	Measures Specific to Construction	Low
9.1	Avoid scabbling (roughening of concrete surfaces) if possible	**D** to be considered
9.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	**D** to be considered
10	Measures Specific to Track-Out	n/a
11	Specific Measures to Construction Traffic (adapted)	High
11.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	**H** to be implemented
11.2	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	**H** to be implemented
11.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	**H** to be implemented
11.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	**H** to be implemented
11.5	Record all inspections of haul routes and any subsequent action in a site log book.	**H** to be implemented

Notes D = desirable (to be considered), H = highly recommended (to be implemented), N = not required (although can be voluntarily implemented)

6.6 Step 6: Risk (Post-Mitigation)

For almost all construction activity, the adapted methodology notes that the aim should be to prevent significant effects on receptors through the use of effective mitigation and experience shows that this is normally possible.

Given the limited size of the site, residual impacts associated with fugitive dust emissions from the project construction activities would be anticipated to be '*low*' or '*not significant*'.

7. OPERATIONAL PHASE AIR QUALITY ASSESSMENT

The methodology used to assess operational phase impacts is discussed in **Section 5**. This section presents the results of the dispersion modelling assessment and uses the following terminology:

- Incremental impact – relates to the concentrations predicted as a result of the operation of the project in isolation.
- Cumulative impact – relates to the concentrations predicted as a result of the operation of the project PLUS the background air quality concentrations discussed in **Section 4.2**.

The results are presented in this manner to allow examination of the likely impact of the project in isolation and the contribution to air quality impacts in a broader sense.

In the presentation of results, the tables included shaded cells which represent the following:

Model prediction	Pollutant concentration / deposition rate less than the relevant criterion	**Pollutant concentration / deposition rate equal to, or greater than the relevant criterion**

As discussed in **Section 5.2.1** and **Appendix C**, two meteorological files have been used as input to dispersion modelling, given that an adequate validation of the data could not be performed. The results associated with the 'input 1' meteorological data file are presented within this section (TAPM modelling extracted at the project site with no data assimilation for the year 2015) with results associated with the 'input 2' meteorological data file (observations of wind speed and direction from Gosford AWS, using TAPM outputs for mixing height etc with data assimilation using Gosford AWS for the year 2015) presented in **Appendix D** as a 'sensitivity test' of those assumptions (i.e. is that assumption critical to the conclusions drawn from this report).

The results associated with 'input 1' meteorology have been selected for presentation within the main report given that when the results of modelling from 'input 1' and 'input 2' were compared, the results from 'input 1' resulted in the higher maximum 24-hour average concentrations at each receptor (in general but not exclusively). Reference should be made to **Appendix D** for the corresponding data and discussion. Essentially, the sensitivity test shows that the conclusions drawn from this AQIA are not materially affected by the assumptions used in the meteorological modelling.

7.1 Particulate Matter - Annual Average PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the proposed operations at the project site are presented in **Table 18**.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at receptor locations are low (<2% of the annual average TSP criterion, <3.2% of the annual average PM_{10} criterion and <2.5% of the $PM_{2.5}$ criterion).

The addition of existing background concentrations (refer **Section 4.2**) results in predicted concentrations of annual average TSP being less than 39%, annual average PM_{10} being less than 53% and annual average $PM_{2.5}$ being less than 68% of the relevant criteria at the nearest receptors.

Table 18 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

Receptor	Annual Average Concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	1.3	32.8	34.1	0.7	14.9	15.6	0.2	5.2	5.4
R2	1.8	32.8	34.6	1.0	14.9	15.9	0.2	5.2	5.4
R3	1.5	32.8	34.3	0.9	14.9	15.8	0.2	5.2	5.4
R4	0.3	32.8	33.1	0.2	14.9	15.1	0.1	5.2	5.3
R5	0.7	32.8	33.5	0.4	14.9	15.3	0.1	5.2	5.3
R6	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
R7	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
R8	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
I1	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
I2	0.6	32.8	33.4	0.4	14.9	15.3	0.1	5.2	5.3
I3	0.5	32.8	33.3	0.4	14.9	15.3	0.1	5.2	5.3
I4	1.1	32.8	33.9	0.7	14.9	15.6	0.1	5.2	5.3
I5	0.7	32.8	33.5	0.5	14.9	15.4	0.1	5.2	5.3
I6	0.4	32.8	33.2	0.3	14.9	15.2	0.1	5.2	5.3
I7	0.2	32.8	33.0	0.1	14.9	15.0	<0.1	5.2	5.3
I8	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
I9	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
I10	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
I11	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
I12	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
I13	0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
Criterion	-	90		-	25		-	8	

No contour plots of annual average PM_{10} or $PM_{2.5}$ are presented, given the minor predicted contribution from the operations at the project site at the nearest relevant sensitive receptors.

7.2 Particulate Matter – Annual Average Dust Deposition Rates

Table 19 presents the annual average dust deposition predicted as a result of the operations at the project site.

Table 19 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R1	0.3	2.0	2.3
R2	0.4	2.0	2.4
R3	0.4	2.0	2.4
R4	0.1	2.0	2.1
R5	0.2	2.0	2.2
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R8	<0.1	2.0	2.1
I1	<0.1	2.0	2.1
I2	0.1	2.0	2.1
I3	<0.1	2.0	2.1
I4	0.2	2.0	2.2
I5	0.1	2.0	2.1
I6	0.1	2.0	2.1
I7	<0.1	2.0	2.1
I8	<0.1	2.0	2.1
I9	<0.1	2.0	2.1
I10	<0.1	2.0	2.1
I11	<0.1	2.0	2.1
I12	<0.1	2.0	2.1
I13	<0.1	2.0	2.1
Criterion	2.0	-	4.0

An assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ is presented in **Table 19**, although comparison of the incremental concentration with the incremental criterion of 2 $g \cdot m^{-2} \cdot month^{-1}$ is also valid (as discussed within **Section 3**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the project site where the predicted impacts are <22% of the incremental criterion at receptor locations.

No contour plot of annual average dust deposition is presented, given the minor predicted contribution from the operations at the project site at the nearest sensitive receptors.

7.3 Particulate Matter - Maximum 24-hour Average

Table 20 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest residential receptors as a result of the operations at the project site only. No background concentrations are included within this table.

Table 20 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
R1	7.9	1.6
R2	9.8	1.5
R3	15.6	2.5
R4	4.7	1.5
R5	6.9	1.5
R6	0.5	0.1
R7	0.4	0.1
R8	0.3	0.1
I1	1.9	0.4
I2	5.7	0.8
I3	10.6	1.4
I4	12.3	1.7
I5	6.6	1.3
I6	5.4	1.1
I7	1.9	0.4
I8	1.0	0.3
I9	1.1	0.2
I10	0.7	0.2
I11	0.7	0.2
I12	0.5	0.1
I13	0.5	0.2

The predicted incremental concentration of PM_{10} and $PM_{2.5}$ are demonstrated to be small. At the receptor where the maximum impact is expected to occur (receptor R3, 32 Acacia Road, Somersby) operation of the project would contribute up to 32% of the 24-hour PM_{10} criterion and up to 10% of the 24-hour $PM_{2.5}$ criterion.

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the project, with background included are presented in **Table 21** and **Table 22** respectively.

Results are presented for the receptor at which the highest incremental impacts have been predicted (receptor R3 – refer **Table 20**). The left side of the tables show the predicted concentration on days with the highest background, and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations.

Table 21 Summary of contemporaneous impact and background – PM_{10} Receptor R3

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
06/05/2015	0.1	58.6	58.7	12/07/2015	15.6	3.1	18.7
26/11/2015	4.2	41.7	45.9	15/07/2015	13.0	12.6	25.6
17/10/2015	0.1	36.8	36.9	18/11/2015	9.6	16.3	25.9
06/10/2015	3.1	34.3	37.4	08/06/2015	9.5	11.6	21.1
27/11/2015	<0.1	33.7	33.8	12/10/2015	8.9	18.1	27.0
02/01/2015	<0.1	33.2	33.3	10/05/2015	8.5	10.0	18.5
19/11/2015	4.0	33.1	37.1	15/09/2015	8.3	14.9	23.2
25/11/2015	0.4	32.9	33.3	01/08/2015	7.8	11.0	18.8
12/12/2015	0.4	32.9	33.3	07/04/2015	7.5	7.6	15.1
07/10/2015	1.0	32.6	33.6	20/05/2015	7.5	7.1	14.6
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

One exceedance of the 24-hour average impact assessment criterion for PM_{10} is predicted although **no additional exceedances** are shown to eventuate because of the operation of the project. The predicted exceedance is driven by the background air quality (i.e. existing sources) and is not contributed to by the proposed operations at the project site.

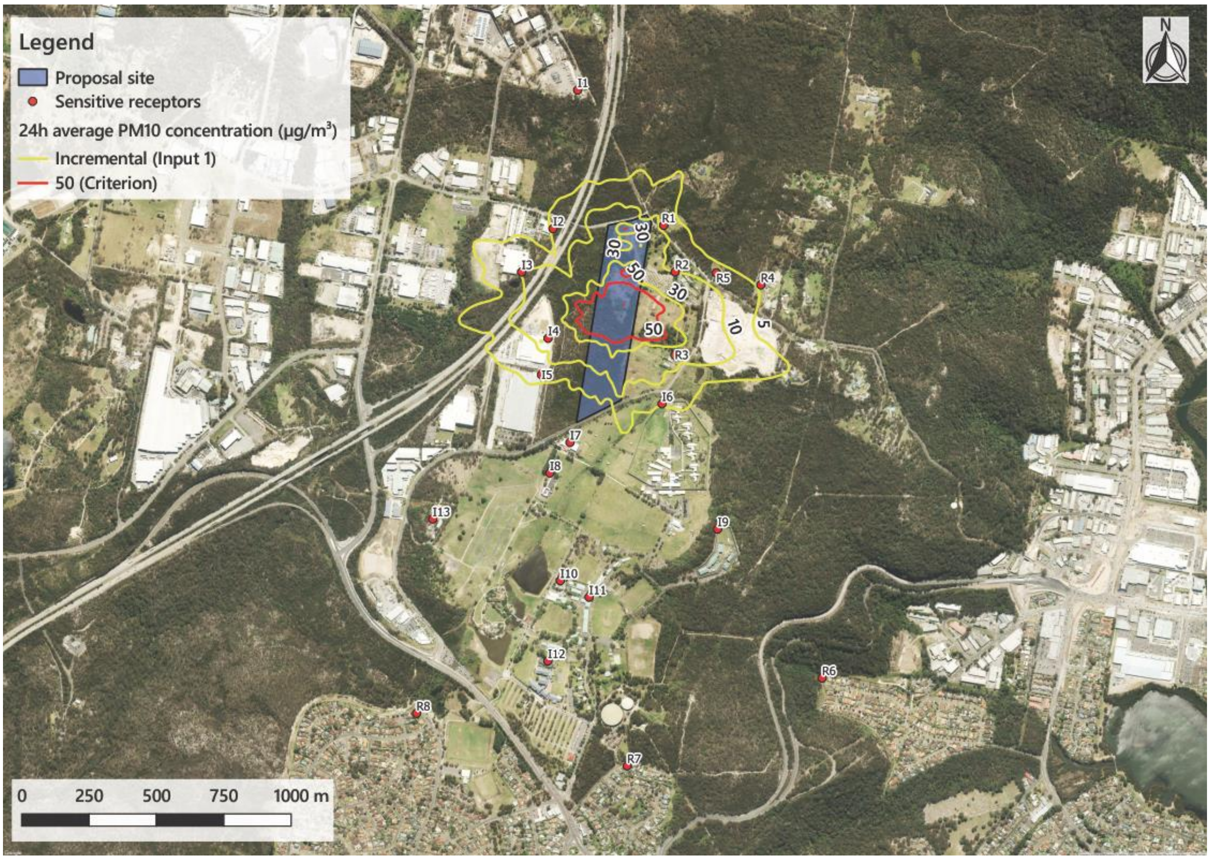
No exceedances of the 24-hour average $PM_{2.5}$ impact assessment criterion are predicted as a result of the project operations.

Table 22 Summary of contemporaneous impact and background – $PM_{2.5}$ Receptor R3

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
09/03/2015	<0.1	13.2	13.3	12/07/2015	2.5	1.7	4.2
20/11/2015	0.7	13.1	13.8	15/07/2015	1.9	5.5	7.4
12/03/2015	0.3	12.1	12.4	18/11/2015	1.7	4.2	5.9
21/08/2015	0.1	11.7	11.8	08/06/2015	1.6	7.6	9.2
01/01/2015	<0.1	11.2	11.3	12/10/2015	1.5	6.4	7.9
07/10/2015	0.1	10.8	10.9	15/09/2015	1.5	4.6	6.1
10/03/2015	<0.1	10.6	10.7	10/05/2015	1.4	0.0	1.4
20/12/2015	<0.1	10.6	10.7	07/04/2015	1.3	3.3	4.6
17/10/2015	<0.1	10.4	10.5	20/05/2015	1.3	2.9	4.2
14/12/2015	<0.1	10.4	10.5	01/08/2015	1.3	5.8	7.1
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

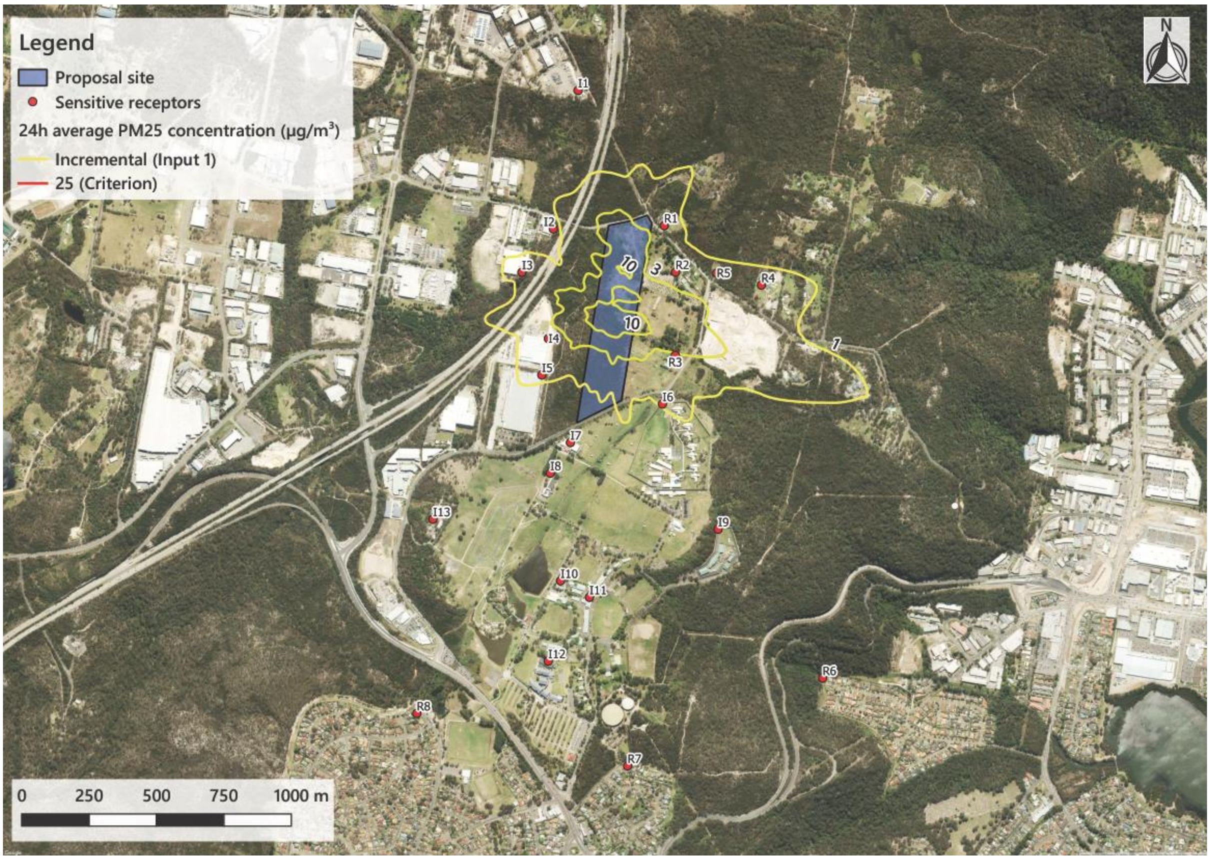
Contour plots of the incremental contribution of the proposed operations at the project site to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure 8** and **Figure 9**.

Figure 8 Incremental 24-hour PM_{10} concentrations



Note 1: Criterion = 50 µg·m^{-3} (cumulative)

Figure 9 Incremental 24-hour $PM_{2.5}$ concentrations



Note 1: Criterion = 25 µg·m^{-3} (cumulative)

8. MITIGATION AND MONITORING

8.1 Construction Phase

Based on the findings of the construction phase air quality assessment, even with no mitigation measures there is a *low risk* of human health effects associated with construction phase activities. These are associated with emissions from earthworks and from construction traffic.

There is a *high risk* of adverse dust soiling (amenity) impacts if no mitigation measures were to be applied to control emissions, in relation to earthworks and construction traffic. There is also a low impact associated with construction.

A range of mitigation and management measures are presented in **Section 6.5**, which would result in the risks associated with construction to be reduced to *'low'* or *'not significant'*.

8.2 Operational Phase

8.2.1 Mitigation

Based on the findings of the operational phase air quality impact assessment, it is considered that the particulate control measures proposed to be implemented will be sufficient to ensure that exceedances of all particulate criteria would not be experienced as a result of the project operation.

No additional exceedances of the 24-hour $PM_{2.5}$ or PM_{10} criteria are predicted as a result of the proposed activities at the project site. Whilst dispersion modelling predicts that one exceedance of the 24-hour PM_{10} criterion is likely at nearby residential locations, on that instance the incremental impact from the project operation resulting in the exceedance is very low with the background (non-project) concentration of 58.6 $\mu g \cdot m^{-3}$ already in exceedance of the 50 $\mu g \cdot m^{-3}$ criterion. The operations at the project site would not have contributed significantly during that day of exceedance.

A number of mitigation measures are proposed to be implemented as part of the project. Where defensible quantification of the control efficiencies afforded by these measures can be determined, these have been applied within the assessment. Additional measures may also be applied during certain wind conditions and although these measures have not been included within dispersion modelling, they would act to further reduce the generation of particulate.

It is important to note that this assessment does not rely on unquantified emissions control efficiencies to achieve compliance with the environmental objectives, rather these unquantified emissions control efficiencies would act to further reduce impacts and provide further assurances that the objectives will be complied with.

The mitigation measures which will be used as part of the project operation are summarised in **Table 23**.

Table 23 Summary of emission reduction methods adopted as part of project operation

Emission control method	Control efficiency (%)
Road Haulage	
Vehicle restrictions that limit the speed of vehicles on the road.	Not quantified
Surface improvement by paving	Assessed through emission factor
Surface treatment - watering	30
Materials Handling	
Minimising the drop height from vehicles	30
Application of water	50
Modification of activities in windy conditions	Not quantified
Loading materials to a 3-sided enclosure	30
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified
Minimising travel speeds and distances	Not quantified
Keep travel routes and materials moist	50
Materials Processing	
Application of water	91.6 (screen) 77.7 (crush) 50 (shred)
Enclosure of activities within 'secondary sorting warehouse'	70
Modification of activities in windy conditions	Not quantified
Wind Erosion	
Application of water	50
3-sided enclosures around stockpiles	75
Modification of activities in windy conditions	Not quantified

It is noted that the activities being performed within the 'secondary processing warehouse' will be enclosed within an existing building at the project site. Full enclosure of any other part of the process is not proposed, nor is it considered to be required. Results of the dispersion modelling exercise indicate that all air quality criteria can be achieved at all surrounding residential and non-residential land uses with the controls adopted, which are considered to represent best practice.

8.2.2 Monitoring

The predictions presented in this AQIA indicate that there would be no predicted exceedances of the adopted air quality criteria. However, given that the majority of the operations to be performed at the site are not proposed to be enclosed, it is recommended that a campaign of fence-line air quality monitoring is performed, to provide the EPA with assurance that the site can be operated with the best practice measures outlined in the report and without giving rise to unacceptable air quality impacts.

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9. CONCLUSION

Jackson Environment & Planning Pty Ltd has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Mr and Mrs Ray and Sue Davis to perform an air quality impact assessment (AQIA) for the proposed development of the Kariong Sand and Soil Supplies site (the project) located at 90 Gindurra Road, Somersby NSW (the project site).

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the project under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The AQIA presents an assessment of the impacts of the proposed operations at the project site, associated with both the construction phase and operational phase of the development. The incremental change in air quality in the area surrounding the project site is presented in addition to an assessment of compliance with relevant air quality criteria associated with cumulative impacts.

The assessment has been presented to provide confidence that the operations can be performed with no exceedances of the relevant air quality criteria.

A risk-based assessment of the potential construction phase air quality impacts indicates that the implementation of a range of mitigation measures would be required to ensure that the risks (both health and amenity) to the surrounding community would be low or not significant.

The dispersion model predictions associated with the operational phase of the project indicate that the existing and proposed operations can be performed without additional exceedances of the air quality criteria at any residential or non-residential receptor location surrounding the project site.

To adequately account for a potential uncertainty in the modelled meteorological conditions, a second meteorological file was used as input to the dispersion model. The results of that sensitivity assessment indicate that the existing and proposed operations can be performed without additional exceedances of the air quality criteria at any residential or non-residential receptor location surrounding the project site.

One exceedance of the 24 hr PM_{10} criterion is noted, although this was due to an 'exceptional' event (a dust storm which affected PM_{10} concentrations at the Wyong site and in a wider area, from Albury to Sydney and to Tamworth). Significantly, the project is demonstrated not to contribute to any additional exceedances of the air quality criteria.

A range of emissions control measures would be implemented as part of the project operation and these are discussed in detail in the main body of the report. It is considered that the measures adopted represent best practice dust control, and although additional measures may be available (such as full enclosure), these have been respectfully considered to not be appropriate for use in some parts of the project. The measures which are adopted have been demonstrated to ensure that the environmental objectives are achieved.

It is further recommended that a campaign of fence-line air quality monitoring is performed to provide the EPA with assurance that the site can be operated with the best practice measures outlined in the report and without giving rise to unacceptable air quality impacts.

The results of the air quality impact assessment indicate that the granting of Development Consent for the project should not be rejected on the grounds of air quality.

10. REFERENCES

ABS. (2017). *Australian Bureau of Statistics*. Retrieved from 3101.0 - Australian Demographic Statistics: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Jun%202015?OpenDocument

DEC. (2006). *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW*. NSW Environment Protection Authority.

DSEWPC. (2012). *National Pollutant Inventory Emission Estimation Technique Manual for Mining Version 3.1.* Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Environment and Climate Change Canada. (2015). *Emission Estimation Calculators - Wood Products Operation.*

Government of Newfoundland and Labrador. (2012). *Guideline for Plume Dispersion Modelling.*

Institute of Air Quality Management. (2016). *Guidance on the assessment of dust from demolition and construction version 1.1.*

Jackson Environment and Planning. (2017). *Kariong Sand and Soil Supplies - SEARs Preliminary Environmental Assessment Report.*

Jackson Environment and Planning. (2018). *Kariong Sand and Soil Supplies - Environmental Impact Statement.*

Katestone Environmental Pty Ltd. (2011). *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining.*

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

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

NSW DEC. (2006). Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW.

NSW DEC. (2006). Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW.

NSW EPA. (2013). *Technical Report No.7, Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year.*

NSW EPA. (2014). *Reducing Emissions from Non-Road Diesel Engines*. Prepared by ENVIORN Australia Pty Ltd.

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

NSW OEH. (2015). *NSW Annual Compliance Report 2015, National Environment Protection (Ambient Air Quality) Measure.*

USEPA. (1998). *AP-42 Compilation of Air Pollutant Emission Factors, Chapter 11.9 Western Surface Coal Mining.*

USEPA. (2006). *AP42 Compilation of Air Pollutant Emission Factors, Chapter 13.2.2 Unpaved Roads.*

USEPA. (2006). *AP-42 Compilation of Air Pollutant Emission Factors, Chapter 13.2.4 Aggregate Handling and Storage Piles.*

USEPA. (2006). *AP-42 Compliation of Air Pollutant Emission Factors, Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.*

USEPA. (2011). *AP-42 Compilation of Air Pollutant Emission Factors, Chapter 13.2.1 Paved Roads.*

USEPA. (2011). *Emission Factor Documentation for AP-42, Section 13.2.1 Paved Roads.*

APPENDIX A

Background Air Quality

Air quality monitoring is performed by the NSW Office of Environment and Heritage (OEH) at three air quality monitoring station (AQMS) within a 50 km radius of the project site. Details of the monitoring performed at these AQMS is presented in **Table A1** with the location of the stations being illustrated in **Figure A1**.

Table A1 Details of closest AQMS surrounding the project site

Site Name	Distance from Project site (km)	Commissioned	Particulate measurements performed
Wyong	19.8	2012	PM_{10}, $PM_{2.5}$
Macquarie Park	41.9	2017	PM_{10}, $PM_{2.5}$
Lindfield	42.6	1994	PM_{10}

Air quality is not monitored at the project site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this assessment.

Given that concentrations of PM_{10} and $PM_{2.5}$ are measured at the Wyong AQMS since 2012, and that AQMS is the closest to the project site, the use of air quality data collected as Wyong has been used for the purposes of this assessment. Data collected at Macquarie Park does not cover a sufficient time period, and data collected at Lindfield does not include $PM_{2.5}$ data. Furthermore, the environment surrounding the Wyong AQMS is similar to that surrounding the project site (non-urban, away from major sources of particulate emissions, similar population density).

Figure A1 Meteorological and air quality monitoring surrounding the project site

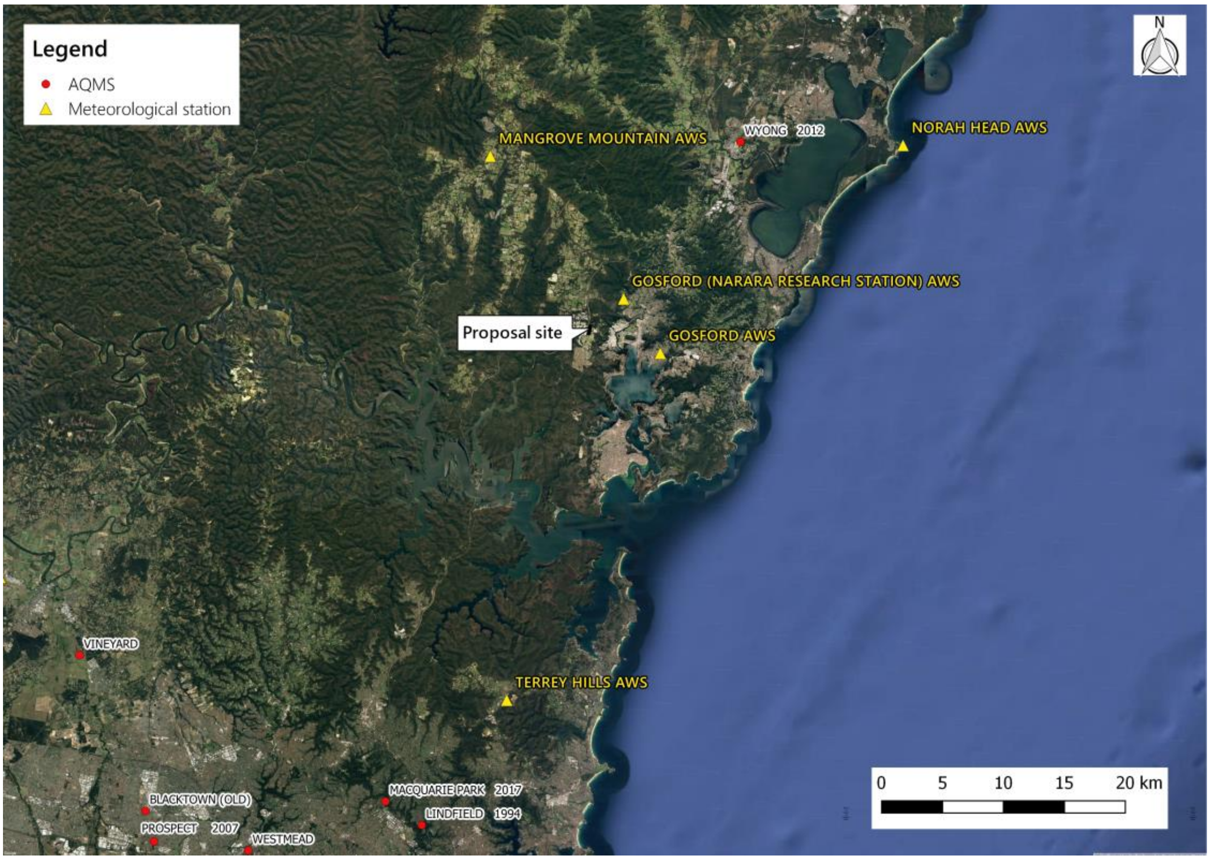


Table A2 presents statistics for PM_{10} and $PM_{2.5}$ monitoring at the Wyong AQMS in 2015.

For the reasons discussed above, PM_{10} and $PM_{2.5}$ monitoring data from the Wyong AQMS for the year 2015 have been used as a representation of the background conditions at the project site.

Table A2 PM_{10} and $PM_{2.5}$ statistics for Wyong AQMS, 2015

Year	2015	2015
Pollutant	PM_{10}	$PM_{2.5}$
Averaging Period	24-hour	24-hour
Data Points (number)	361	355
Mean (µg·m^{-3})	14.9	5.2
Standard Deviation (µg·m^{-3})	6.8	2.1
Skew[1]	*+1.6*	*+0.9*
Kurtosis[2]	*+5.0*	*+0.9*
Minimum (µg·m^{-3})	3.1	1.4
Percentiles (µg·m^{-3})		
1	4.7	1.7
2	5.7	2.0
3	6.3	2.2
5	7.3	2.4
10	8.2	2.8
25	10.2	3.7
50	13.0	4.8
75	18.3	6.4
90	24.4	8.0
95	26.8	9.1
97	29.3	9.7
98	32.9	10.6
99	33.9	11.4
Maximum 1 (µg·m^{-3})	58.6	13.2
Maximum 2 (µg·m^{-3})	41.7	13.1
Maximum 3 (µg·m^{-3})	36.8	12.1
Data Capture (%)	98.9	97.3

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

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

Figure A2 24-hour average PM_{10} measurements, Wyong 2015

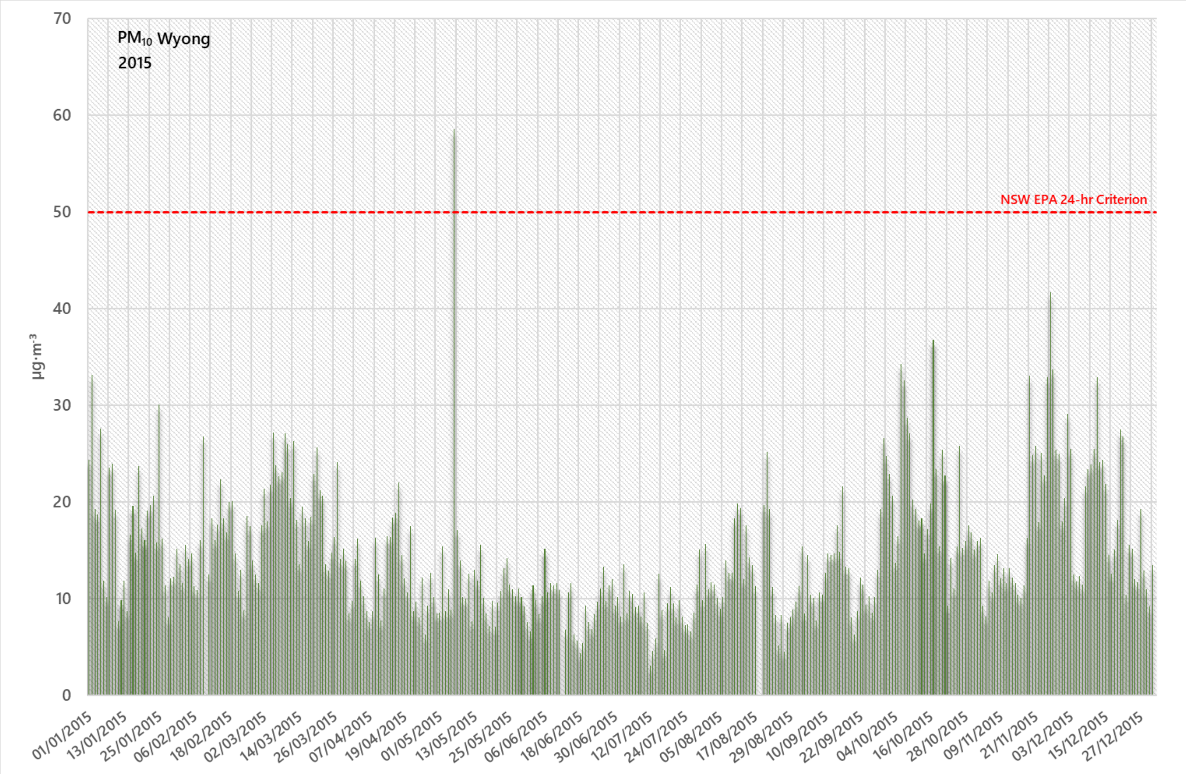
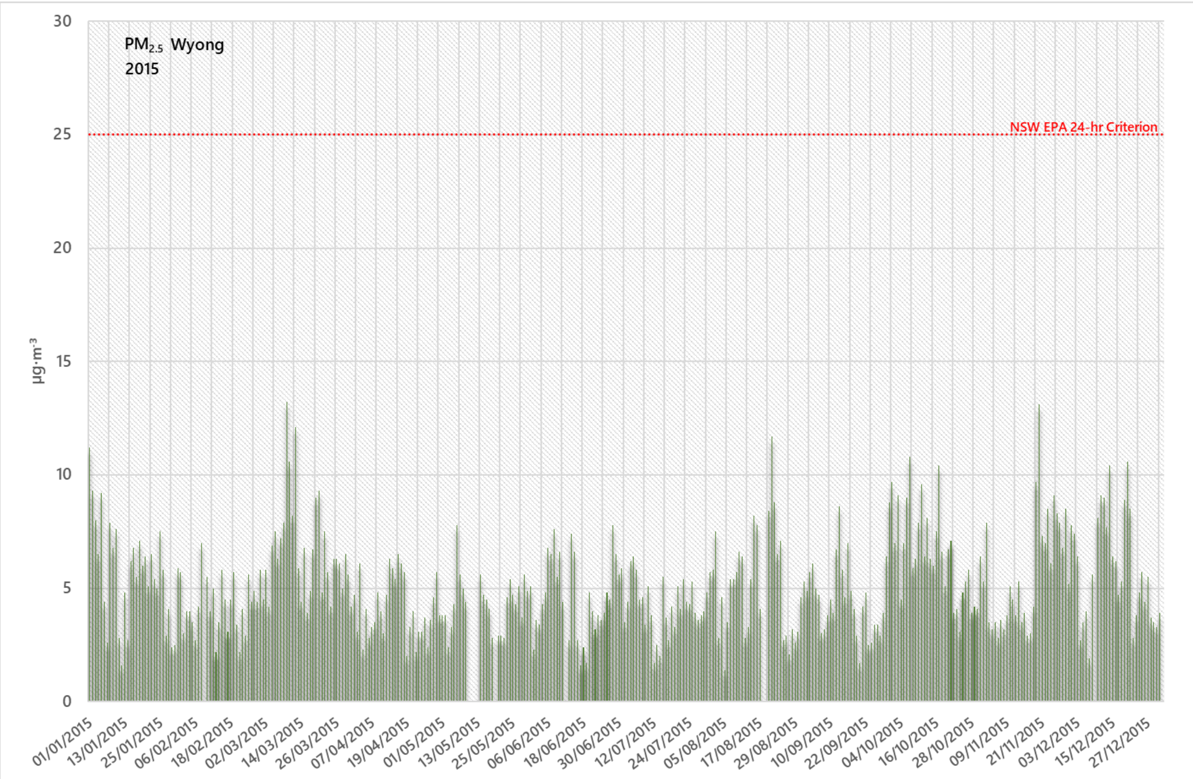
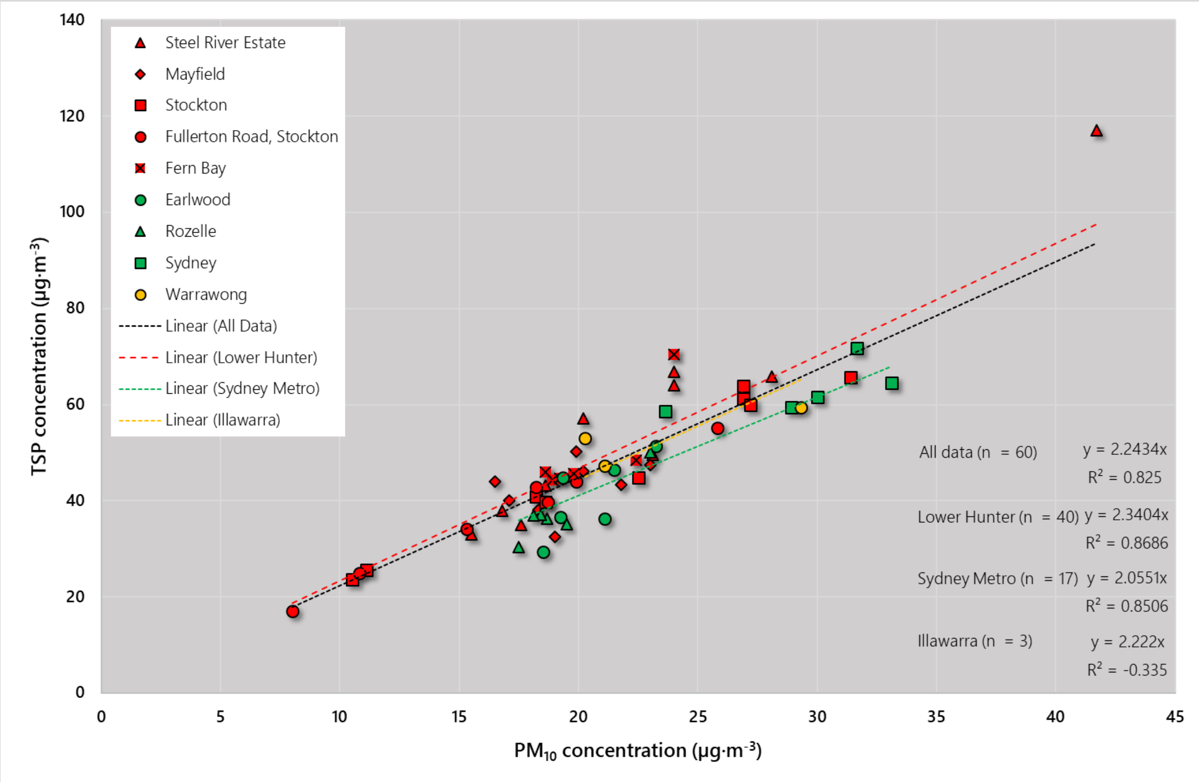


Figure A3 24-hour average $PM_{2.5}$ measurements, Wyong 2015



Concentrations of TSP are not measured by the NSW OEH at any AQMS surrounding the project site. An analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure A4**. The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.2 : 1 (i.e. PM_{10} represents ~45% of TSP) is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA.

Figure A4 Co-located TSP and PM_{10} measurements, Lower Hunter, Sydney Metro and Illawarra



Similarly, no dust deposition data is available for the area surrounding the project site. The incremental impact criterion of 2 $g{\cdot}m^{-2}{\cdot}month^{-1}$ as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of 2 $g{\cdot}m^{-2}{\cdot}month^{-1}$ (the total allowable deposition being 4 $g{\cdot}m^{-2}{\cdot}month^{-1}$).

APPENDIX B

Meteorological Data Analysis

A summary of the relevant monitoring sites is provided in **Table B1** and also displayed in **Figure A1**.

Table B1 Details of the meteorological monitoring surrounding the project site

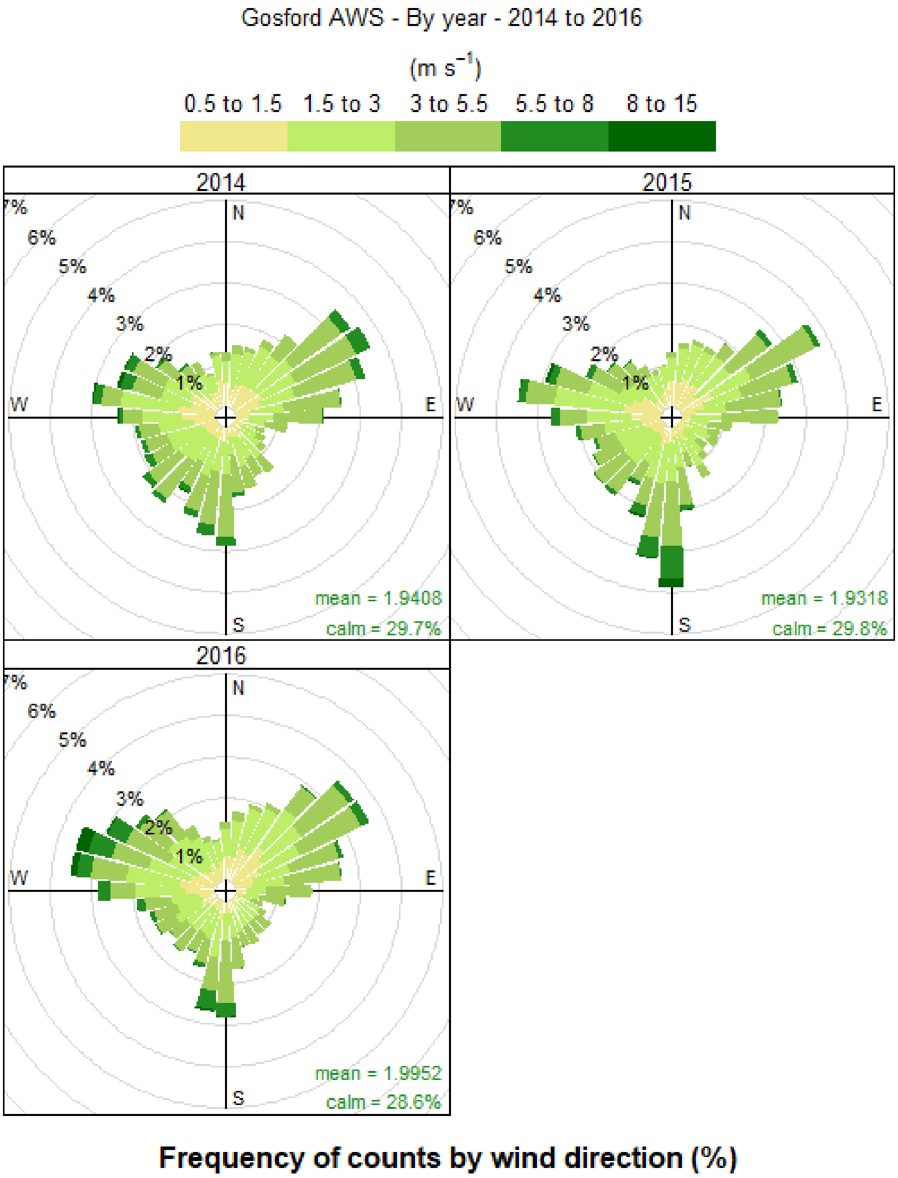
Site Name	Approximate Location (Latitude, Longitude)	
	˚S	˚E
Gosford AWS – Station # 61425	33.44	151.36
Gosford Narara AWS – Station # 61087	33.39	151.33
Mangrove Mountain AWS – Station # 61375	33.29	151.21

Meteorological conditions at Gosford AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2014 to 2016) are presented in **Figure B1**. It is noted that Gosford AWS began monitoring in 2013.

The wind roses indicate that from 2014 to 2016, winds at Gosford AWS show northwesterly, northeasterly and southerly components to the wind direction.

The majority of wind speeds experienced at the Gosford AWS between 2014 and 2016 are generally in the range 1.5 metres per second ($m{\cdot}s^{-1}$) to 5.5 $m{\cdot}s^{-1}$ with the highest wind speeds (greater than 8 $m{\cdot}s^{-1}$) occurring from southerly and northwesterly directions. Winds of this speed are rare and occur during 0.4% of the observed hours during the years. Calm winds (<0.5 $m{\cdot}s^{-1}$) prevail and occur more than 29% of hours across the years.

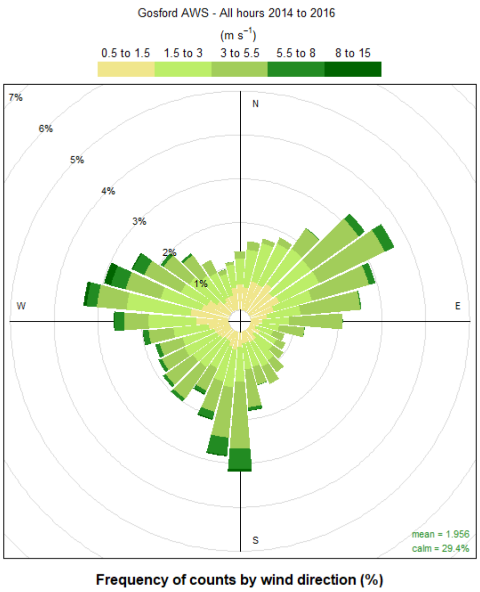
Figure B1 Annual wind roses 2014 to 2016, Gosford AWS



Given the similarities in the wind distribution across the years examined, data for the year 2015 has been selected for further assessment. Presented in **Figure B2** are the annual wind rose for the 2014 to 2016 period and the year 2015 and in **Figure B3** the annual wind speed distribution for Gosford AWS. These figures indicate that the distribution of wind speed and direction in 2015 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2015 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure B2 Annual wind roses 2014 to 2016, and 2015 Gosford AWS



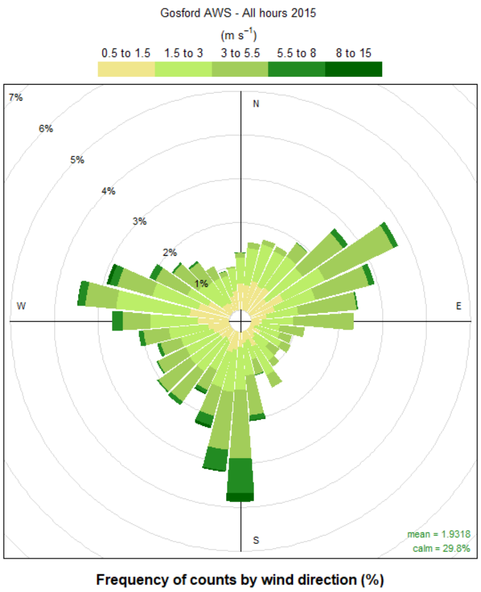
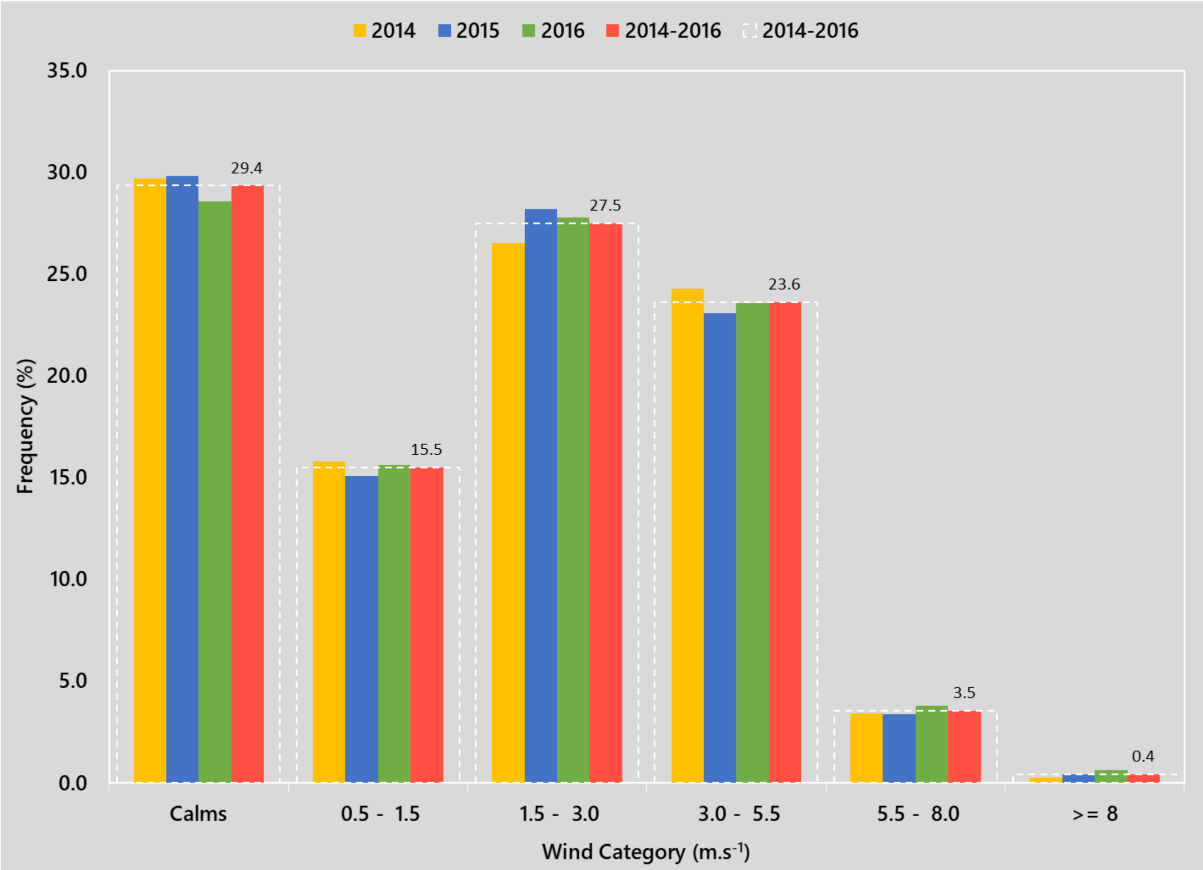


Figure B3 Annual wind speed distribution Gosford AWS



Meteorological Processing

The BoM data adequately covers the issues of data quality assurance, however it is limited by its location compared to the project site. To address these uncertainties, a multi-phased assessment of the meteorological data has been performed.

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

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

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

The parameters used in TAPM modelling are presented in **Table B2**.

Table B2 Meteorological parameters used for this study (TAPM v 4.0.5)

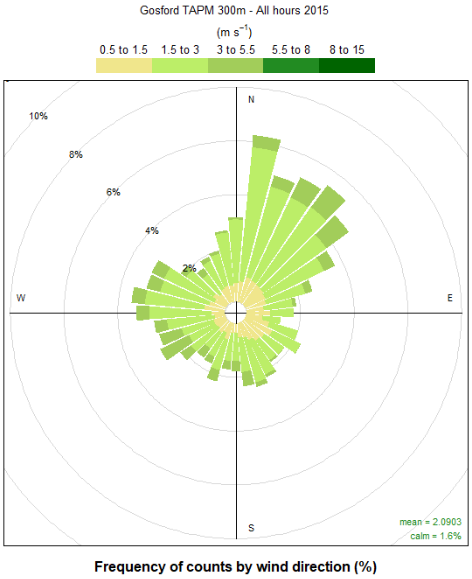
Modelling period	1 January 2015 to 31 December 2015
Centre of analysis	341,815 mS , 6,301,121 mN (UTM Coordinates)
Number of grid points	40 × 40 × 25
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 0.3 km)
Terrain	AUSLIG 9 second DEM
Data assimilation[(a)]	1) None 2) Gosford AWS

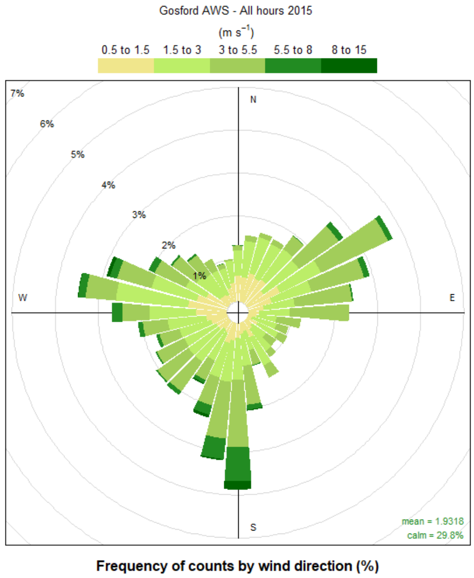
Note: (a) Sensitivity test performed using 2 sets of modelled TAPM data

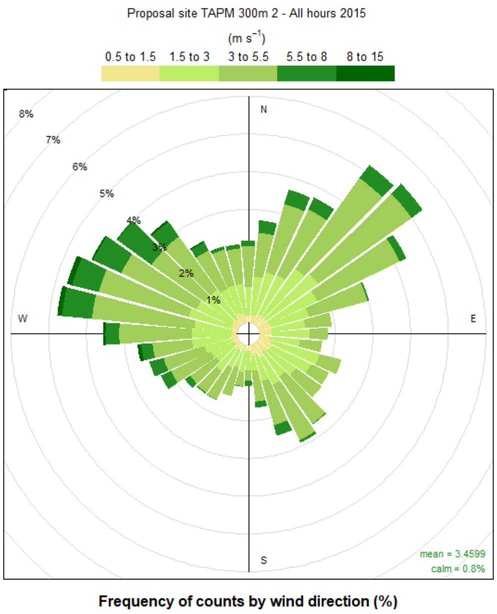
No further processing of meteorological data has been performed. The dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 2-dimensional mode. Given the relatively small distances and the uncomplicated terrain between the sources and receptors and the characteristics of the emission sources (minimal buoyancy / vertical velocity), a detailed assessment using a 3-dimensional meteorological dataset is not warranted. A comparison of the TAPM generated meteorological data (project site and Gosford AWS), and that observed at the Gosford AWS is presented in **Figure B4** for TAPM run 1 and **Figure B5** for TAPM run 2 (see **Table B2**).

Figure B4 Modelled and observed meteorological data – Gosford AWS, 2015 - Run 1

TAPM generated windrose	Observations at Gosford AWS



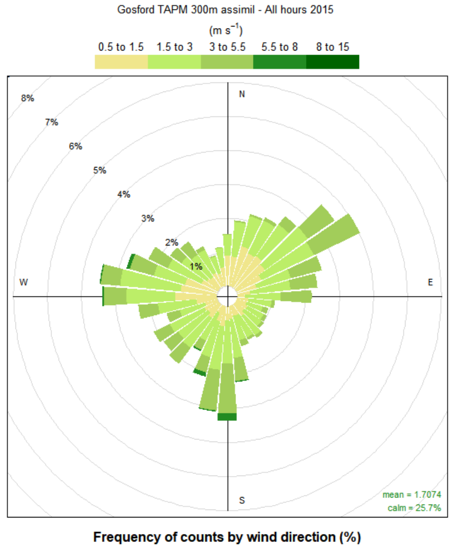


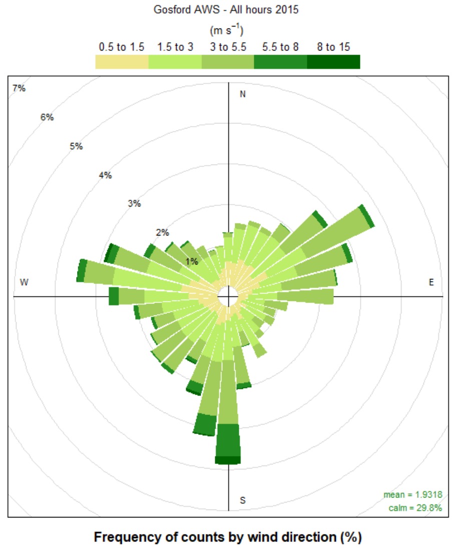


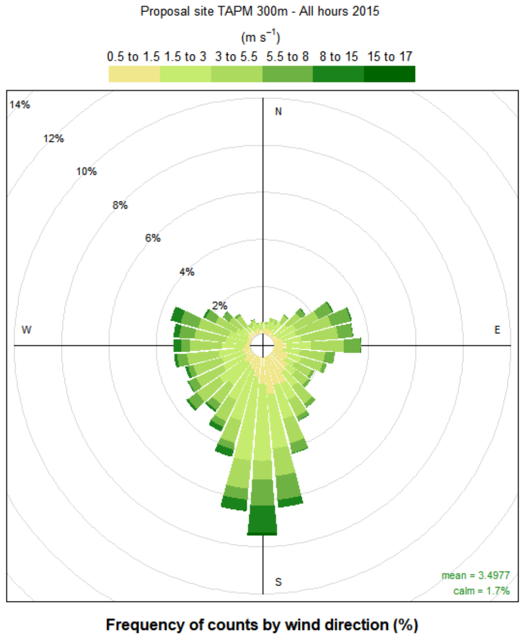
Note: No data assimilation

Figure B5 Modelled and observed meteorological data – Gosford AWS, 2015 - Run 2

TAPM generated windrose	Observations at Gosford AWS







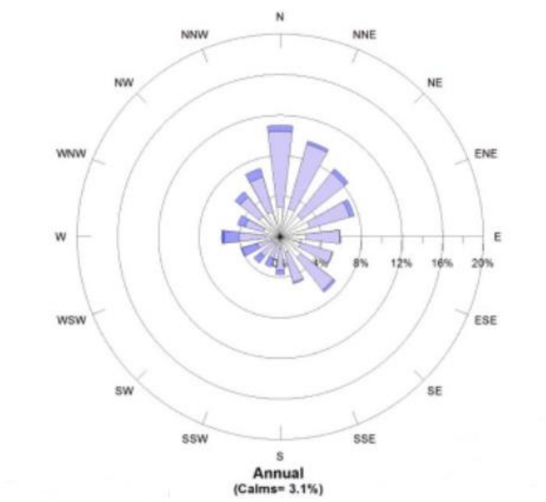
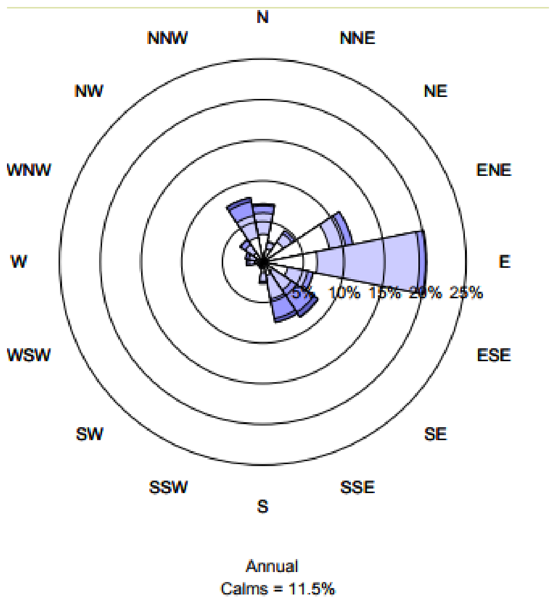
Note: Data assimilated from Gosford AWS

It can be seen that, as would be expected, observations at Gosford AWS are more accurately modelled when Gosford AWS observations are used within the model to 'nudge' the predicted data (TAPM run 2). However, when data is extracted at the project site, the predicted wind rose is shown to be dominated by southerly winds and a lack of winds from the northeast and northwest, winds of which direction would be expected from examination of the observations, measured only approximately 4 km away.

The data extracted at the project site when no observational data is included (TAPM run 1) seems to provide a more sensible output, with an intuitively better distribution of winds although the validation between the Gosford AWS observations and model output is poor which does not provide much confidence in the model output at the project site.

No site specific data is available to confirm which of the wind roses is most correct. A review of two recent AQIA performed in the surrounding area has been completed to examine the modelled meteorological data adopted for those assessments. A summary of the annual wind roses for those AQIA is presented in **Figure B6**.

Figure B6 Meteorological data used in recent AQIA near the project site

Annual Wind Rose	Comments
	Hanson Somersby Quarry Extension AQIA (SLR Consulting, 2013) Project site 4.5 km NW from Kariong Sand and Soil Supplies site Modelled 2008 data using TAPM with no data assimilation No validation of model performance provided
	Grants Road Sand Quarry Extension AQIA (PAEHolmes, 2013) Project site 4.0 km NW from Kariong Sand and Soil Supplies site Modelled 2007 data using TAPM/CALMET with data assimilated from Gosford (Narara Research Station) AWS No validation of model performance provided in AQIA but comparison of modelled data at project site with observations at nearby AWS provided

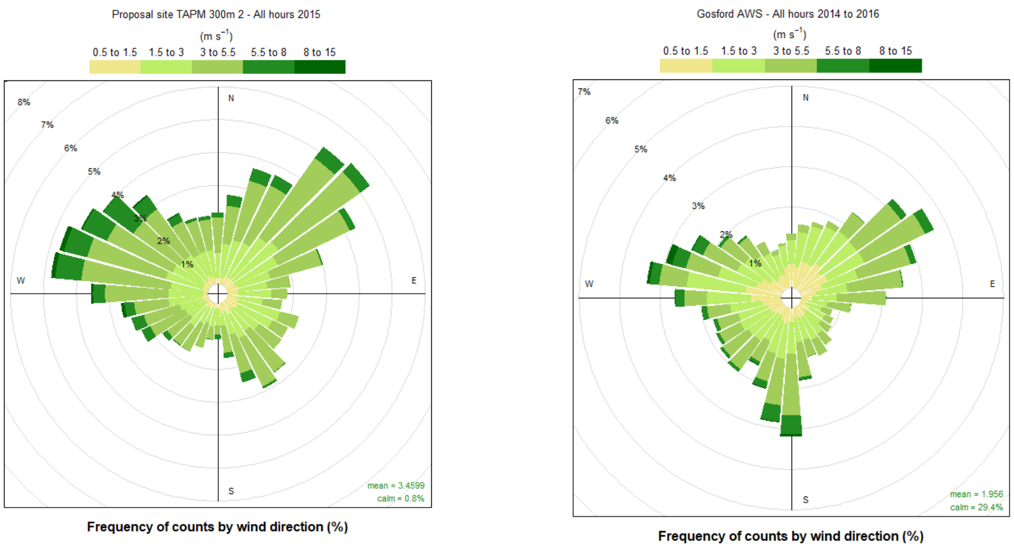
Clearly, the adequate characterisation of meteorology at the project site and surrounding area through the use of modelling techniques provides a range of results as shown above and in **Figure B6**. To avoid criticism of preferentially selecting data, an assessment of the sensitivity of the results of the modelling assessment to meteorological data has been performed.

The sensitivity assessment has used two meteorological input files:

- The results of the TAPM modelling extracted at the project site with no data assimilation for the year 2015 (Input 1 in **Figure B7**); and
- Observations of wind speed and direction from Gosford AWS, using TAPM outputs for mixing height etc with data assimilation using Gosford AWS for the year 2015 (Input 2 in **Figure B7**).

Figure B7 Meteorological data used in the assessment

Meteorological Input 1	Meteorological Input 2



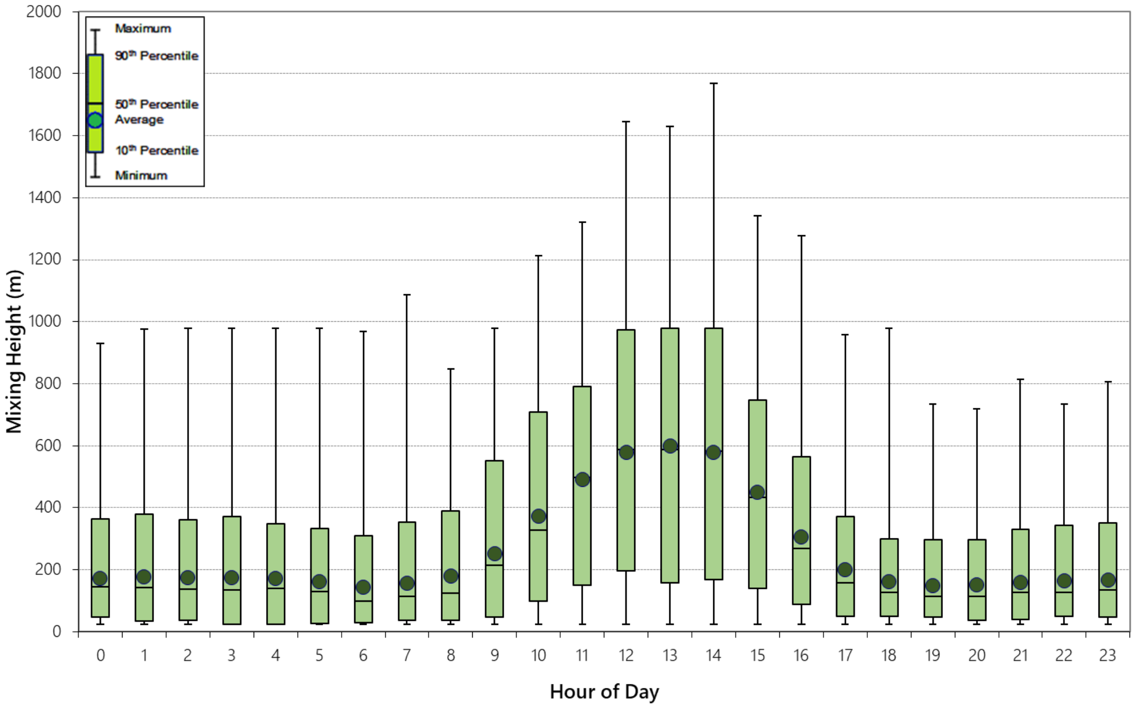
It is considered that by using these two datasets, the sensitivity of the results to meteorological input data can be examined.

As generally required by the NSW EPA (refer **Section 1.1**) the following provides a summary of the modelled meteorological dataset (Input 1). Given the nature of the pollutant emission sources at the project site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirulation potential of the project site has not been provided. Details of the predictions of wind speed and direction, mixing height and temperature at the project site are provided below.

Diurnal variations in maximum and average mixing heights predicted by TAPM at the project site during 2015 period are illustrated in **Figure B8**.

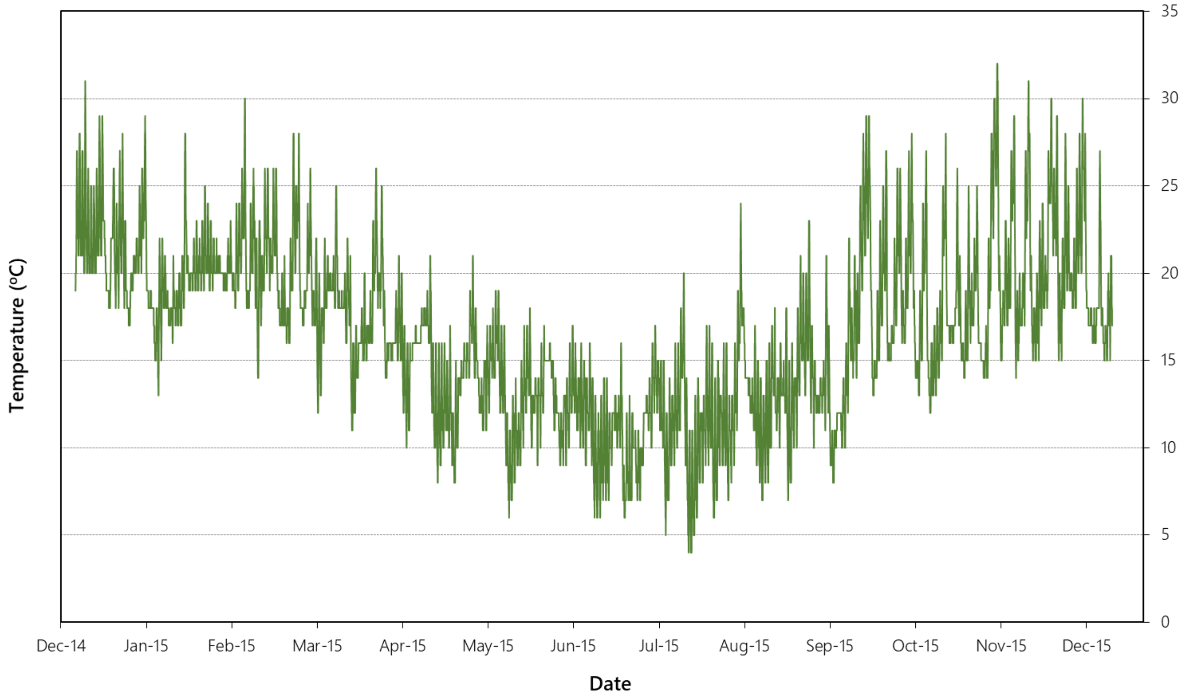
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure B8 Predicted mixing height – project site 2015



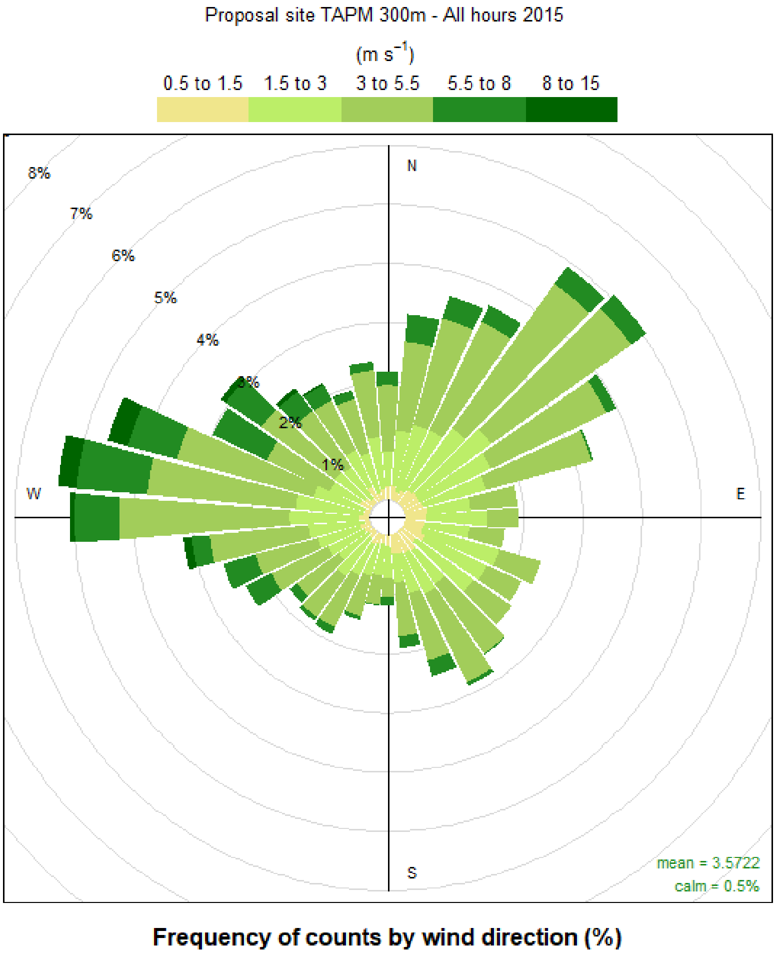
The modelled temperature variations predicted at the project site during 2013 are presented in **Figure B9**. The maximum temperature of 32°C was predicted on 20 November 2015 and the minimum temperature of 4°C was predicted on 5 August 2013.

Figure B9 Predicted temperature – project site 2015



The modelled wind speed and direction at the project site during 2015 are presented in **Figure B10**.

Figure B10 Predicted wind speed and direction – project site 2015



APPENDIX C

Emissions Estimation

The assumptions outlined in **Table C1** have been used in the development of the particulate emissions inventory for the project.

Table C1 Assumptions adopted within the particulate matter assessment

Parameter[4]	Units	Annual average	Peak maximum
Material receival rate	tonnes	200,000 (per annum)	641.0(per day)[1]
Material processing rate	tonnes	200,000 (per annum)	769.2 (per day)[2]
Material despatch rate	tonnes	200,000 (per annum)	641.0 (per day)[1]
Existing landscape supplies business – receivals and sales	Tonnes	10,000 (per annum)	32.1 (per day)[1]
Silt loading of paved roads	$g \cdot m^{-2}$	0.6[3]	

Notes: 1: Peak daily maximum taken to be the average daily throughput (365 days minus Sundays per annum = 312 days per year)

2: Peak daily maximum taken to be the average daily throughput (365 days minus Saturdays and Sundays per annum = 260 days per year)

3: Ubiquitous baseline for normal conditions on roads with <500 annual average daily traffic flow (USEPA, 2011)

4: No values for material moisture content, silt content or wind speed required as default values used within the assessment.

Emissions resulting from the loading of materials, transfer of materials (except for road transport), and the loading of crushers, screens and the shredder have been estimated using the US EPA AP-42 emission factor for material transfer in crushed stone processing and mineral processing industries (USEPA, 2006) with emission factors of:

- 0.0015 $kg \cdot t^{-1}$ for TSP;
- 0.00055 $kg \cdot t^{-1}$ for PM_{10}; and,
- 0.00008 $kg \cdot t^{-1}$ for $PM_{2.5}$.

The $PM_{2.5}$ emission factor assumes a $PM_{2.5}/PM_{10}$ ratio of 0.14 which is taken from similar activities within the USEPA AP-42 for Crushed Stone Processing (USEPA, 2006).

Emissions arising from the movement of heavy vehicles on unpaved site roads have been estimated using the US EPA AP-42 emission factor for paved roads (USEPA, 2011) as outlined below.

$$E = k\,(sL)^{0.91} \times (W)^{1.02}$$

Where:

E = Emission factor ($g \cdot VKT^{-1}$)

k = particle size multiplier (dimensionless) for TSP = 3.23, for PM_{10} = 0.62, for $PM_{2.5}$ = 0.15

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

W = Mean vehicle weight (tonnes)

Emissions resulting from the crushing and screening of materials at the project site have been estimated using the US EPA AP-42 emission factor for crushed stone processing (USEPA, 2006). The emission factor for uncontrolled tertiary crushing:

- 0.0027 $kg{\cdot}t^{-1}$ for TSP
- 0.0012 $kg{\cdot}t^{-1}$ for PM_{10} and
- 0.00012 $kg{\cdot}t^{-1}$ for $PM_{2.5}$

have been adopted. Application of emissions controls (watering) result in these emissions being controlled by 77.7% (USEPA, 2006) with controlled emissions being:

- 0.0006 $kg{\cdot}t^{-1}$ for TSP
- 0.00027 $kg{\cdot}t^{-1}$ for PM_{10} and
- 0.00005 $kg{\cdot}t^{-1}$ for $PM_{2.5}$

For screening uncontrolled emissions rates of:

- 0.0125 $kg{\cdot}t^{-1}$ for TSP
- 0.0043 $kg{\cdot}t^{-1}$ for PM_{10} and
- 0.00043 $kg{\cdot}t^{-1}$ for $PM_{2.5}$

have been adopted. Application of emissions controls (watering, or throughput of wetted material from the crusher) result in these emissions being controlled by 91.6% (USEPA, 2006) with controlled emissions being:

- 0.0011 $kg{\cdot}t^{-1}$ for TSP
- 0.00037 $kg{\cdot}t^{-1}$ for PM_{10} and
- 0.000025 $kg{\cdot}t^{-1}$ for $PM_{2.5}$

Emissions resulting from the shredding of timber have been estimated using an emission factor from the Government of Canada, emissions estimation calculator for wood products operation (Environment and Climate Change Canada, 2015). The adopted uncontrolled emission factors are:

- 0.118 $kg{\cdot}ODT^{-1}$ for TSP
- 0.091 $kg{\cdot}ODT^{-1}$ for PM_{10} and
- 0.008 $kg{\cdot}ODT^{-1}$ for $PM_{2.5}$

with ODT being Oven Dry Tonne (0% moisture). Given that seasoned timber to be received at the site would be higher than 0% moisture content (seasoned timber has typically 9% to 14% moisture content), no adjustment for the dry weight has been performed, which represents a worst case.

The NPI mining manual EET specifies a value of 0.2 kg·ha^{-1}·hr^{-1} (PM_{10}) for wind erosion for all sources excepting coal stockpiles. This factor is considered approximate as it does not take into account variations in the climate of an area or the soil or ore type. Within this assessment, PM_{10} emissions for all stockpiles and exposed areas were parameterised using the form of Shao (2000) as:

$$Ewind = 5.2 \times 10^{-7}\, WS^3 \left(1 - \left(\frac{WS_T}{WS_{10}}\right)^2\right) \quad \text{for } WS_T > WS_{10}$$

$$Ewind = 0 \quad \text{for } WS_T \leq WS_{10}$$

Where:

WS_T is the threshold for wind erosion in m·s^{-1}, taken to be 5.2 m·s^{-1};

WS_{10} is the wind speed at 10 m height; and,

$Ewind$ is the PM_{10} emissions (g·m^{-2}·s^{-1})

Using this equation with hourly modelled wind speeds for the project site (refer **Appendix B**, varied according to the meteorological input file used) an annual PM_{10} emission of 2,654.1 kg·ha^{-1}·yr^{-1} is obtained using meteorological input file 1 and 905.6 kg·ha^{-1}·yr^{-1} obtained using meteorological input file 2. For meteorological input file 2 this is significantly higher than the US EPA AP-42 emission factor for Western surface coal mining of 425 kg·ha^{-1}·yr^{-1} (assuming PM_{10} is 50% of TSP). However, the adopted factor allows variability in emissions within the dispersion model, avoiding emissions during periods of low dispersion when winds would not be strong enough to result in wind erosion, and including emissions during stronger winds when wind erosion would occur and dispersion would be greater.

TSP emissions have been calculated assuming that PM_{10} represents 50% of TSP and $PM_{2.5}$ emissions have been calculated assuming that they represent 10% of PM_{10} emissions.

In addition to the emissions of process related particulate matter, recent studies have shown that emissions of fine particulate matter resulting from diesel combustion can significantly contribute to the fine particulate matter emissions profile of a site. To appropriately quantify these emissions, information contained within the NSW EPA report "*Reducing Emissions from Non-road Diesel Engines*" (NSW EPA, 2014) has been reviewed. It has been assumed that all emissions from diesel combustion are fine particulate (i.e. $PM_{2.5}$) emissions. The assumptions adopted within the assessment, including the emission factors is presented in **Table C2**. The full emissions inventory is presented below.

Table C2 Assumptions adopted within the diesel particulate matter assessment

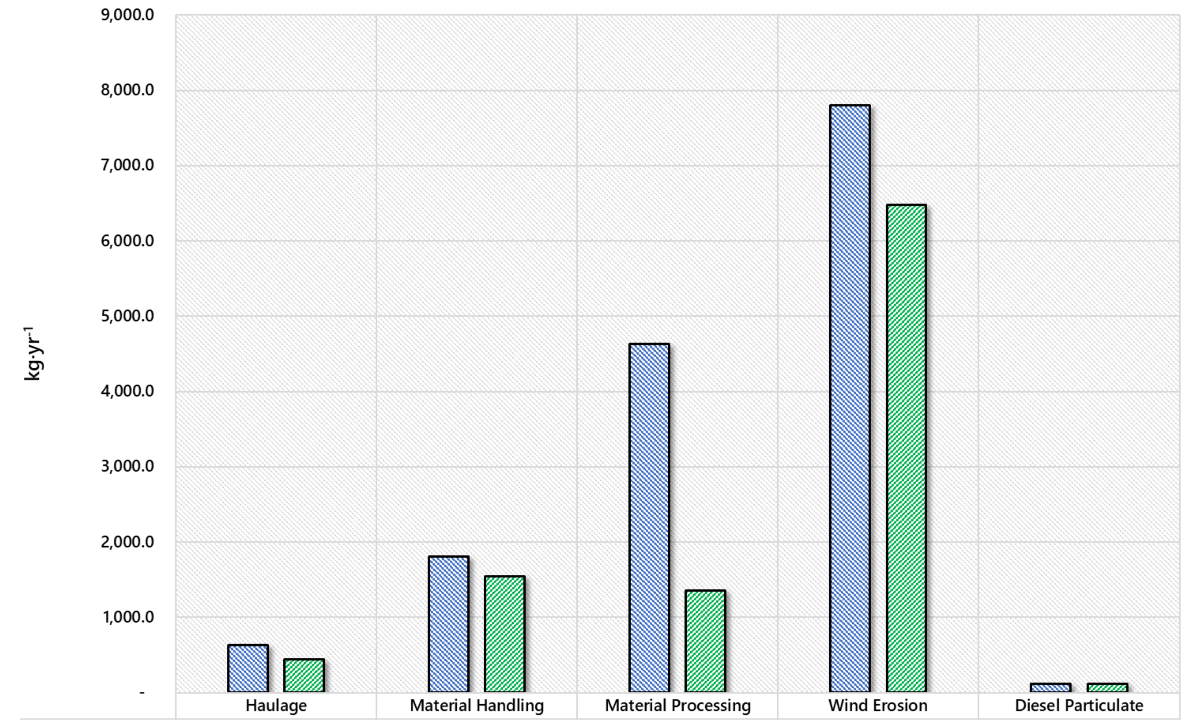
Equipment	kW rating	Operating hours	Load factor[1]	$PM_{2.5}$ emission factor ($g \cdot kWh^{-1}$)[2]
Crusher	140	500	0.59	0.2
Screen x2	151	2,000	0.59	0.2
Shredder	37	1,000	0.59	0.2
Front end loader 1	143	1,000	0.59	0.2
Front end loader 2	143	1,000	0.59	0.2
Front end loader 3	143	1,000	0.59	0.2
Front end loader 4	143	1,000	0.59	0.2
Excavator	143	1,500	0.59	0.2
Vehicle	**$VKT \cdot year^{-1}$**		**$PM_{2.5}$ emission factor ($g \cdot VKT^{-1}$)[3]**	
All haulage vehicles	15,694		0.584	

Notes: 1: From Table D1 of (NSW EPA, 2014)
2: From Table 5 of (NSW EPA, 2014)
3: 1996 Australian Design Rule (ADR) 70/00 in (NSW EPA, 2013)

Emissions controls will be employed at the project site as discussed in **Section 5.2.3**. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the project operation. A description of each emission reduction method to be employed as part of the project is presented in **Section 8**.

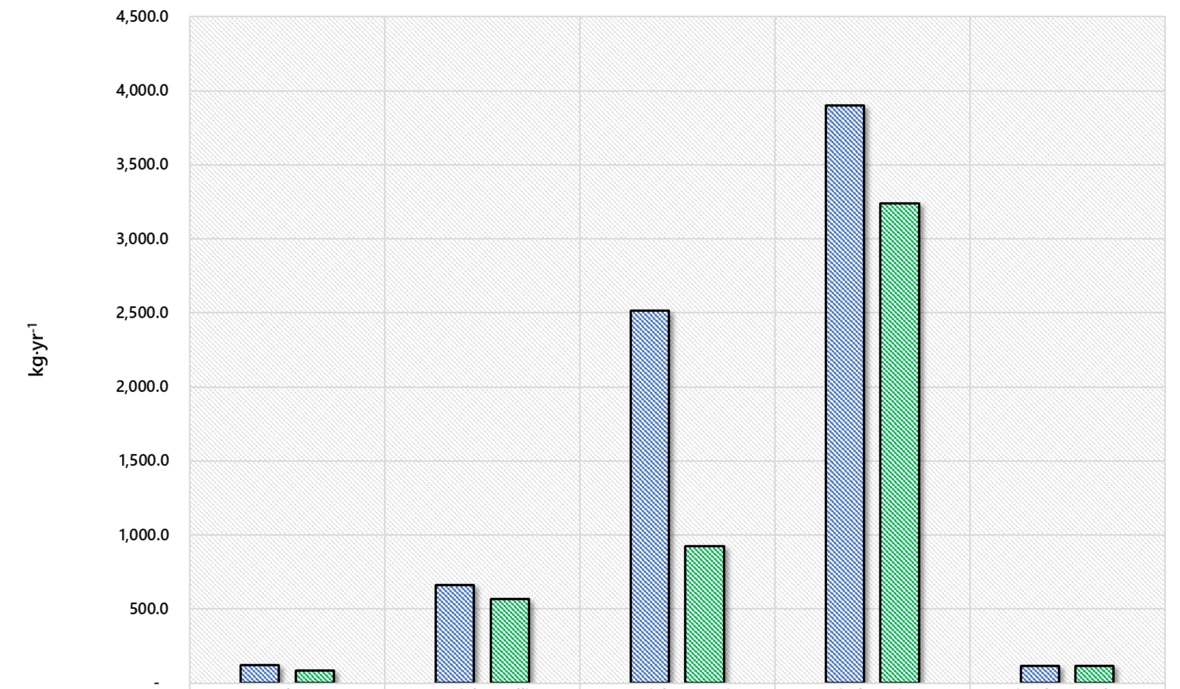
Based on the foregoing, the distribution of particulate emission across broad emissions categories is presented in **Figure C1** (TSP) **Figure C2** (PM_{10}) and **Figure C3** ($PM_{2.5}$). The results are presented for the inventory associated with wind erosion calculated using meteorological input file 1 which provides the greatest emissions from wind erosion. Note that the emissions from wind erosion sources are shown to dominate the site emissions inventory, due to the basis on which these emissions have been calculated. As discussed above these are highly conservative.

Figure C1 Calculated uncontrolled & controlled annual TSP emissions



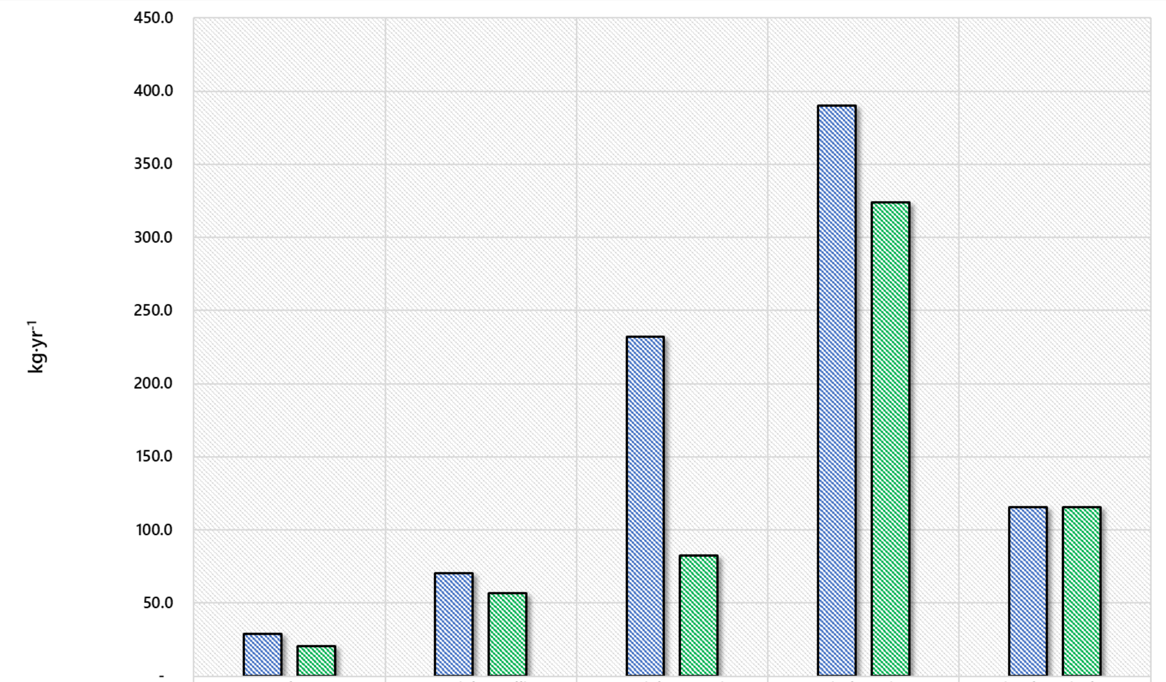
	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled TSP	628.8	1,804.2	4,627.2	7,801.4	115.5
Controlled TSP	440.2	1,542.2	1,351.0	6,479.4	115.5

Figure C2 Calculated uncontrolled & controlled annual PM_{10} emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM10	120.7	661.5	2,517.0	3,900.8	115.5
Controlled PM10	84.5	565.5	922.4	3,239.8	115.5

Figure C3 Calculated uncontrolled & controlled annual $PM_{2.5}$ emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM2.5	29.2	70.5	231.9	390.1	115.5
Controlled PM2.5	20.4	56.9	82.3	324.0	115.5

Particulate emissions have been modelled based on the groupings outlined in **Table C3** below:

Table C3 Modelled particulate fractions

Fraction	Representing	Geometric mass mean diameter (microns)	Geometric standard deviation (microns)
Coarse	TSP minus PM_{10} fraction	1.25	1.24
Intermediate	PM_{10} minus $PM_{2.5}$ fraction	5	1.24
Fine	$PM_{2.5}$ fraction	20	1.24

Source: (Government of Newfoundland and Labrador, 2012)

By adopting this approach, the dispersion model separates out the larger particulates which are more rapidly deposited from the atmosphere, closer to the site. This is a more realistic approach than the default adopted in CALPUFF (geometric mass mean diameter of 0.48 microns for all particulate size fractions) and results in the predicted off-site suspended and deposited particulate levels decreasing more rapidly with increasing distance from the source.

Emissions Inventory

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
ENM												
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	2,758	VKT	Watering at 2.2 L·m^{-2}	30	93.0	17.9	4.3
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	80,000	t			120.0	44.0	4.4
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	80,000	t			120.0	44.0	4.4
Material loaded to screen	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	80,000	t			120.0	44.0	4.4
Screening	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	80,000	t	Watering	91.6	84.0	28.9	2.9
Material stacked to storage pile	0.0015	0.00055	0.00008	kg·t^{-1}	AP42 - 11.19.2 Conveyor Transfer	76,000	t	Watering	91.6	9.6	3.5	0.5
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	76,000	t			114.0	41.8	4.2
Material loaded to vehicles	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	76,000	t			114.0	41.8	4.2
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	2,025	VKT	Watering at 2.2 L·m^{-2}	30	65.1	12.5	3.0
VENM												
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	690	VKT	Watering at 2.2 L·m^{-2}	30	23.3	4.5	1.1

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material loaded to screen	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	20,000	t	Watering	91.6	21.0	7.2	0.7
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	20,000	t	Watering	91.6	2.5	0.9	0.1
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	506	VKT	Watering at 2.2 $L \cdot m^{-2}$	30	16.3	3.1	0.8
Asphalt												
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	690	VKT	Watering at 2.2 $L \cdot m^{-2}$	30	23.3	4.5	1.1
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material loaded to crusher	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Crushing	0.0027	0.0012	0.00012	kg·t^{-1}	AP42 -11.19.2 Tertiary Crushing	20,000	t	Watering	77.7	12.0	5.4	0.5
Screening	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	20,000	t	Watering	91.6	21.0	7.2	0.7
Material stacked to storage pile	0.0015	0.00055	0.00008	kg·t^{-1}	AP42 - 11.19.2 Conveyor Transfer	20,000	t	Watering	91.6	2.5	0.9	0.1
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material loaded to vehicles	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	506	VKT	Watering at 2.2 L·m^{-2}	30	16.3	3.1	0.8
Metal												
Receival of loads (rigid trucks)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	247	VKT	Watering at 2.2 L·m^{-2}	30	6.3	1.2	0.3
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	4,000	t			6.0	2.2	0.2

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	4,000	t			6.0	2.2	0.2
Material loaded to vehicles	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	4,000	t			6.0	2.2	0.2
Material picked up and taken offsite for recycling	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	44	VKT	Watering at 2.2 L·m^{-2}	30	2.6	0.5	0.1
Timber etc												
Receival of loads (rigid trucks)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	1,235	VKT	Watering at 2.2 L·m^{-2}	30	31.6	6.1	1.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t			30.0	11.0	1.1
Material chipped by shredder	0.12	0.09	0.01	kg·ODT^{-1}	https://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=2101C0ED-1&offset=15&toc=hide	18,000	t	Watering	50	1062.0	819.0	72.0
Material stacked to storage pile	0.0015	0.00055	0.00008	kg·t^{-1}	AP42 - 11.19.2 Conveyor Transfer	18,000	t	Watering	91.6	2.3	0.8	0.1
Chipped material moved by FEL to storage area in Landscape supplies area	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	18,000	t			27.0	9.9	1.0

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Material loaded to vehicles	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	18,000	t			27.0	9.9	1.0
SALE and offsite by tipper truck	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	657	VKT	Watering at 2.2 L·m^{-2}	30	16.8	3.2	0.8
Concrete / tiles / masonry												
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	1,586	VKT	Watering at 2.2 L·m^{-2}	30	53.5	10.3	2.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	46,000	t			69.0	25.3	2.5
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	46,000	t			69.0	25.3	2.5
Material loaded to crusher	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	46,000	t			69.0	25.3	2.5
Crushing	0.0027	0.0012	0.00012	kg·t^{-1}	AP42 -11.19.2 Tertiary Crushing	46,000	t	Watering	77.7	27.7	12.3	1.2
Screening	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	46,000	t	Watering	91.6	48.3	16.6	1.7
Material stacked to storage pile	0.0015	0.00055	0.00008	kg·t^{-1}	AP42 - 11.19.2 Conveyor Transfer	41,400	t	Watering	91.6	5.2	1.9	0.3
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	41,400	t			62.1	22.8	2.3

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	41,400	t			62.1	22.8	2.3
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	1,147	VKT	Watering at 2.2 $L \cdot m^{-2}$	30	36.9	7.1	1.7
Mixed building waste												
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	345	VKT	Watering at 2.2 $L \cdot m^{-2}$	30	11.6	2.2	0.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
Primary sorting with grab excavator	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
Back into other waste streams	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	4,600	t			6.9	2.5	0.3
Residual waste stored in separate bunker	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	16,000	t			24.0	8.8	0.9
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	16,000	t			24.0	8.8	0.9

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Residual picked up and taken offsite for disposal by B-Double	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	175	VKT	Watering at 2.2 L/m2	30	10.4	2.0	0.5
Landscape supplies business												
Landscape supplies business (add. 10,000 tpa IN, 10,000tpa OUT)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	3,084	VKT			33.2	6.4	1.5
Unload - existing landscape supplies business	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
Load - existing landscape supplies business	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
Secondary Processing Warehouse (and associated activities)												
Front end loader on residual waste for transfer to warehouse	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
Unloading to hopper	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	Enclosure	70	4.5	1.7	0.2
Screening	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	10,000	t	Enclosure	70	37.5	12.9	1.3
Trommel	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	10,000	t	Enclosure	70	37.5	12.9	1.3
Loading to hooklift bins	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	Enclosure	70	4.5	1.7	0.2

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit						TSP	PM_{10}	$PM_{2.5}$
Transfer back to main site	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t			15.0	5.5	0.6
WIND EROSION												
Wind erosion	5,308	2,654	265	kg·ha^{-1} ·yr^{-1}	Shao (2000)	1.47 0.99 (c) 0.48 (u/c)	ha	3-sided enclosure	75	6,479.4	3,239.8	323.9
DIESEL EMISSIONS												
Diesel emissions (total)	Various (see **Table C2**) and **Section 5.2.3**									115.5	115.5	115.5

Note: Paved roads emission factor represents a site average.

3-sided enclosure not included on stockpiles in processing area

(c) = controlled, (u/c) = uncontrolled

APPENDIX D

Results of Sensitivity Assessment

As discussed in **Section 4.4**, **Section 6** and **Appendix C**, two meteorological files have been used as input to dispersion modelling, given that an adequate validation of the data could not be performed. The results associated with the 'input 1' meteorological data file are presented within **Section 6** (TAPM modelling extracted at the project site with no data assimilation for the year 2015) with results associated with the 'input 2' meteorological data file (observations of wind speed and direction from Gosford AWS, using TAPM outputs for mixing height etc with data assimilation using Gosford AWS for the year 2015) presented overleaf.

Particulate Matter - Annual Average PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the proposed operations at the project site are presented in **Table D1**.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at receptor locations are low (<3% of the annual average TSP criterion, <4% of the annual average PM_{10} criterion and <3.5% of the annual average $PM_{2.5}$ criterion).

The addition of existing background concentrations (refer **Section 4.2**) results in predicted concentrations of annual average TSP being less than 39%, annual average PM_{10} being less than 54% and annual average $PM_{2.5}$ being less than 69% of the relevant criteria at the nearest receptors.

Table D1 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

Receptor	Annual Average Concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	1.9	32.8	34.7	1.0	14.9	15.9	0.2	5.2	5.4
R2	2.1	32.8	34.9	1.1	14.9	16.0	0.3	5.2	5.5
R3	1.5	32.8	34.3	0.9	14.9	15.8	0.2	5.2	5.4
R4	0.5	32.8	33.3	0.3	14.9	15.2	0.1	5.2	5.3
R5	1.0	32.8	33.8	0.6	14.9	15.5	0.1	5.2	5.3
R6	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
R7	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
R8	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
I1	0.2	32.8	33.0	0.1	14.9	15.0	<0.1	5.2	<5.3
I2	0.9	32.8	33.7	0.5	14.9	15.4	0.1	5.2	5.3
I3	0.8	32.8	33.6	0.5	14.9	15.4	0.1	5.2	5.3
I4	1.5	32.8	34.3	1.0	14.9	15.9	0.2	5.2	5.4
I5	0.8	32.8	33.6	0.6	14.9	15.5	0.1	5.2	5.3
I6	0.7	32.8	33.5	0.5	14.9	15.4	0.1	5.2	5.3
I7	0.4	32.8	33.2	0.3	14.9	15.2	0.1	5.2	5.3
I8	0.3	32.8	33.1	0.2	14.9	15.1	<0.1	5.2	5.3
I9	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
I10	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
I11	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
I12	<0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
I13	0.1	32.8	32.9	0.1	14.9	15.0	<0.1	5.2	5.3
Criterion	-	90		-	25		-	8	

No contour plots of annual average PM_{10} or $PM_{2.5}$ are presented, given the minor predicted contribution from the operations at the project site at the nearest relevant sensitive receptors.

Particulate Matter – Annual Average Dust Deposition Rates

Table D2 presents the annual average dust deposition predicted as a result of the operations at the project site. An assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ is presented in **Table D2**, although comparison of the incremental concentration with the incremental criterion of 2 $g \cdot m^{-2} \cdot month^{-1}$ is also valid (as discussed within **Section 3**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the project site where the predicted impacts are <10% of the incremental criterion at receptor locations.

No contour plot of annual average dust deposition is presented, given the minor predicted contribution from the operations at the project site at the nearest sensitive receptors.

Table D2 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R1	0.2	2.0	2.2
R2	0.2	2.0	2.2
R3	0.1	2.0	2.1
R4	<0.1	2.0	2.1
R5	<0.1	2.0	2.1
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R8	<0.1	2.0	2.1
I1	<0.1	2.0	2.1
I2	<0.1	2.0	2.1
I3	<0.1	2.0	2.1
I4	0.1	2.0	2.1
I5	<0.1	2.0	2.1
I6	<0.1	2.0	2.1
I7	<0.1	2.0	2.1
I8	<0.1	2.0	2.1
I9	<0.1	2.0	2.1
I10	<0.1	2.0	2.1
I11	<0.1	2.0	2.1
I12	<0.1	2.0	2.1
I13	<0.1	2.0	2.1
Criterion	2.0	-	4.0

Particulate Matter - Maximum 24-hour Average

Table D3 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest residential receptors as a result of the operations at the project site only. No background concentrations are included within this table.

The predicted incremental concentration of PM_{10} and $PM_{2.5}$ are demonstrated to be small. At the receptor where the maximum impact is expected to occur (receptor R1, 242 Debenham Road South, Somersby) operation of the project would contribute up to 14% of the 24-hour PM_{10} criterion and up to 6% of the 24-hour $PM_{2.5}$ criterion.

Table D3 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
R1	7.0	1.4
R2	5.1	1.1
R3	5.4	0.9
R4	1.7	0.4
R5	3.2	0.7
R6	0.3	0.1
R7	0.8	0.1
R8	0.5	0.1
I1	0.9	0.3
I2	3.4	0.7
I3	3.3	0.7
I4	7.0	1.0
I5	4.0	0.7
I6	3.7	0.6
I7	3.1	0.5
I8	1.8	0.3
I9	0.9	0.2
I10	1.1	0.2
I11	1.6	0.3
I12	1.0	0.2
I13	1.0	0.2

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the project, with background included are presented in **Table D4** and **Table D5** respectively.

Results are presented for the receptor at which the highest incremental impacts have been predicted (receptor R3 – refer **Table 20**).

The left side of the tables show the predicted concentration on days with the highest background, and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations.

Table D4 Summary of contemporaneous impact and background – PM_{10} Receptor R1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
06/05/2015	0.1	58.6	58.7	21/04/2015	7.0	17.5	24.5
26/11/2015	0.1	41.7	41.8	15/06/2015	5.5	11.6	17.1
17/10/2015	0.4	36.8	37.2	23/09/2015	4.7	11.5	16.2
06/10/2015	1.7	34.3	36.0	28/06/2015	3.7	11.4	15.1
27/11/2015	0.1	33.7	33.8	14/06/2015	3.6	10.7	14.3
02/01/2015	0.6	33.2	33.8	27/05/2015	3.3	10.3	13.6
19/11/2015	0.6	33.1	33.7	31/05/2015	3.3	7.6	10.9
25/11/2015	0.7	32.9	33.6	29/04/2015	3.1	10.2	13.3
12/12/2015	0.7	32.9	33.6	26/06/2015	2.9	13.3	16.2
07/10/2015	0.0	32.6	32.6	31/03/2015	2.8	8.5	11.3
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

One exceedance of the 24-hour average impact assessment criterion for PM_{10} is predicted although no additional exceedances are shown to eventuate because of the operation of the project. The predicted exceedance is driven by the background air quality (i.e. existing sources) and is not contributed to by the proposed operations at the project site.

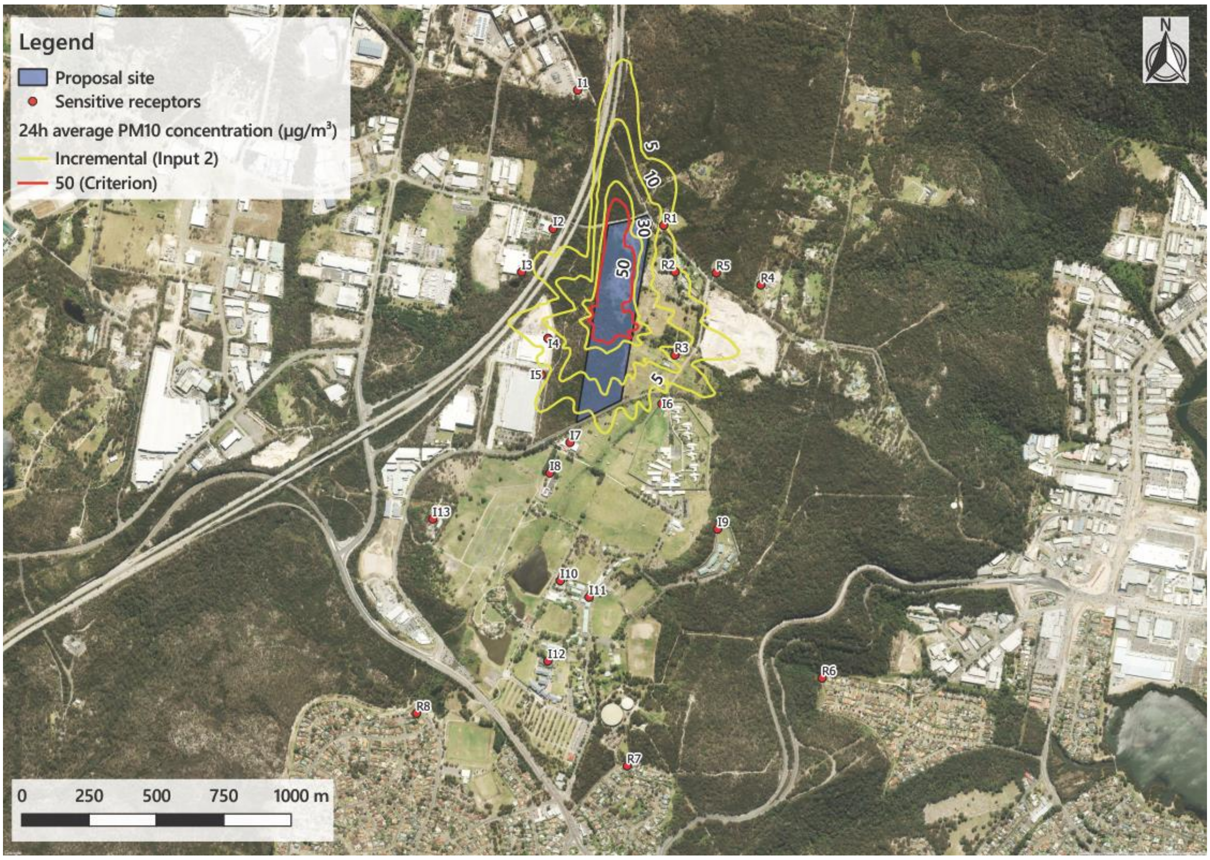
No exceedances of the 24 hour average $PM_{2.5}$ impact assessment criterion are predicted as a result of the project operations.

Table D5 Summary of contemporaneous impact and background – $PM_{2.5}$ Receptor R1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
09/03/2015	0.3	13.2	13.5	21/04/2015	1.4	4.0	5.4
20/11/2015	0.4	13.1	13.5	15/06/2015	1.1	6.6	7.7
12/03/2015	0.4	12.1	12.5	28/06/2015	1.0	7.8	8.8
21/08/2015	0.4	11.7	12.1	23/09/2015	0.9	2.5	3.4
01/01/2015	0.1	11.2	11.3	14/06/2015	0.9	7.4	8.3
07/10/2015	<0.1	10.8	10.9	31/05/2015	0.8	5.1	5.9
10/03/2015	0.1	10.6	10.7	18/06/2015	0.8	2.4	3.2
20/12/2015	0.1	10.6	10.7	29/04/2015	0.8	5.7	6.5
17/10/2015	0.1	10.4	10.5	27/05/2015	0.7	5.1	5.8
14/12/2015	0.1	10.4	10.5	09/07/2015	0.7	3.4	4.1
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

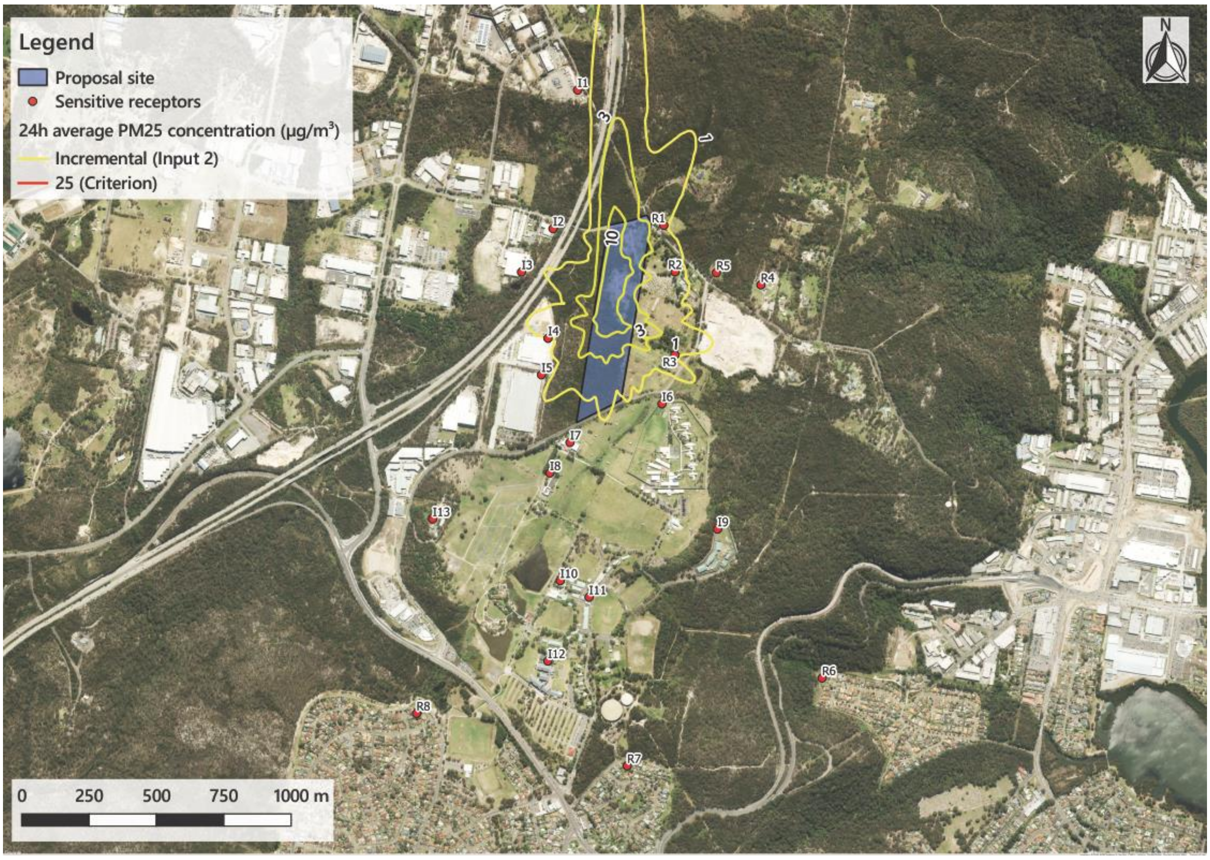
Contour plots of the incremental contribution of the proposed operations at the project site to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure D1** and **Figure D2**.

Figure D1 Incremental 24-hour PM_{10} concentrations



Note 1: Criterion = 50 $\mu g{\cdot}m^{-3}$ (cumulative)

Figure D2 Incremental 24-hour $PM_{2.5}$ concentrations



Note 1: Criterion = 25 µg·m^{-3} (cumulative)

APPENDIX E

Construction Phase Risk Assessment Methodology

Provided below is a summary of the risk assessment methodology used in this assessment. It is based upon IAQM (2016) *Guidance on the assessment of dust from demolition and construction* (version 1.1), and adapted by Northstar Air Quality.

Adaptions to the Published Methodology Made by Northstar Air Quality

The adaptions made by Northstar Air Quality from the IAQM published methodology are:

- **PM_{10} criterion:** an amended criterion representing the annual average PM_{10} criterion relevant to Australia rather than the UK;
- **Nomenclature:** a change in nomenclature from "receptor sensitivity" to "land use value" to avoid misinterpretation of values attributed to "receptor sensitivity" and "sensitivity of the area" which may be assessed as having different values;
- **Construction traffic:** the separation of construction vehicle movements as a discrete risk assessment profile from those associated with the 'on-site' activities of demolition, earthworks and construction. The IAQM methodology considers five risk profiles of: "demolition", "earthworks", "construction" and "track-out". The adaption by Northstar Air Quality introduces a fifth risk assessment profile of "construction traffic" to the existing four risk profiles; and,
- **Tables:** minor adjustments in the visualisation of some tables.

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located:

- more than 350 m from the boundary of the site;
- more than 50 m from the route used by construction vehicles on public roads; and,
- more than 500 m from the site entrance.

This step is noted as having deliberately been chosen to be conservative, and would require assessments for most developments.

Step 2 – Risk from Construction Activities

Step 2 of the assessment provides "dust emissions magnitudes" for each of the dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles) and construction traffic.

The magnitudes are: Large; Medium; or Small, with suggested definitions for each category as follows:

Dust Emission Magnitude Activities

Activity	Large	Medium	Small
Demolition			
- total building volume*	• >50,000 m^3	• 20,000 m^3 to 50,000 m^3	• <20,000 m^3
- demolition height	• > 20m AGL	• 10 m and 20 m AGL	• <10 m AGL
- onsite crushing	• yes	• no	• no
- onsite screening	• yes	• no	• no
- demolition of materials with high dust potential	• yes	• yes	• no
- demolition timing	• any time of the year	• any time of the year	• wet months only
Earthworks			
- total area	• >10,000 m^2	• 2,500 m^2 to 10,000 m^2	• <2,500 m^2
- soil types	• potentially dusty soil type (e.g., clay, which would be prone to suspension when dry due to small particle size	• moderately dusty soil type (e.g., silt),	• soil type with large grain size (e.g., sand
- heavy earth moving vehicles	• >10 heavy earth moving vehicles active at any time	• 5 to 10 heavy earth moving vehicles active at any one time	• <5 heavy earth moving vehicles active at any one time
- formation of bunds	• >8m AGL	• 4m to 8m AGL	• <4m AGL
- material moved	• >100,000 t	• 20,000 t to 100,000 t	• <20,000 t
- earthworks timing	• any time of the year	• any time of the year	• wet months only
Construction			
- total building volume	• 100,000 m^3	• 25,000 m^3 to 100,000 m^3	• <25,000 m^3
- piling	• yes	• yes	• no
- concrete batching	• yes	• yes	• no
- sandblasting	• yes	• no	• no
- materials	• concrete	• concrete	• metal cladding or timber
Track-out (within 100 m of construction site entrance)			
- outward heavy vehicles movements per day	• >50	• 10 to 50	• <10
- surface materials	• high potential	• moderate potential	• low potential
- unpaved road length	• >100m	• 50m to 100m	• <50m

Activity	Large	Medium	Small
Construction Traffic (from construction site entrance to construction vehicle origin)			
Demolition traffic - total building volume	• >50,000 m^3	• 20,000 m^3 to 50,000 m^3	• <10,000 m^3
Earthworks traffic - total area	• >10,000 m^2	• 2,500 m^2 to 10,000 m^2	• <2,500 m^2
Earthworks traffic - soil types	• potentially dusty soil type (e.g., clay, which would be prone to suspension when dry due to small particle size	• moderately dusty soil type (e.g., silt),	• soil type with large grain size (e.g., sand
Earthworks traffic - material moved	• >100,000 t	• 20,000 t to 100,000 t	• <20,000 t
Construction traffic - total building volume	• 100,000 m^3	• 25,000 m^3 to 100,000 m^3	• <25,000 m^3
Total traffic - heavy vehicles movements per day when compared to existing heavy vehicle traffic	• >50% of heavy vehicle movement contribution by Proposal	• 10% to 50% of heavy vehicle movement contribution by Proposal	• <10% of heavy vehicle movement contribution by Proposal

Step 3 – Sensitivity of the Area

Step 3 of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:

- The specific sensitivities that identified land use values have to dust deposition and human health impacts;
- The proximity and number of those receptors locations;
- In the case of PM_{10}, the local background concentration; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Land Use Value

Individual receptor locations may be attributed different land use values based on the land use of the land, and may be classified as having high, medium or low values relative to dust deposition and human health impacts (ecological receptors are not addressed using this approach).

Essentially, land use value is a metric of the level of amenity expectations for that land use.

The IAQM method provides guidance on the land use value with regard to dust soiling and health effects and is shown in the table below. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

IAQM Guidance for Categorising Land Use Value

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Health effects	• Locations where the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: Residential properties, hospitals, schools and residential care homes.*	• Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: Office and shop workers, but would generally not include workers occupationally exposed to PM_{10}.*	• Locations where human exposure is transient. *Examples: Public footpaths, playing fields, parks and shopping street.*

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Dust soiling	• Users can reasonably expect a high level of amenity; or • The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land. *Examples: Dwellings, museums, medium and long term car parks and car showrooms.*	• Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or • The appearance, aesthetics or value of their property could be diminished by soiling; or • The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. *Examples: Parks and places of work.*	• The enjoyment of amenity would not reasonably be expected; or • Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or • There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. *Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.*

Sensitivity of the Area

The assessed land use value (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors.

Additional factors to consider when determining the sensitivity of the area include:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant, the season during which the works would take place;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document

Sensitivity of the Area - Health Impacts

For high land use values, the method takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account, and professional judgement may be used to determine alternative sensitivity categories, taking into account the following:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local / seasonal meteorological data;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Land Use Value	Annual Mean PM_{10} Concentration ($\mu g \cdot m^{-3}$)	Number of Receptors[a]	Distance from the Source (m)[b]				
			<20	<50	<100	<200	<350
High	>30	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	26 – 30	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	22 – 26	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	≤22	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Note: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m), noting that only the highest level of area sensitivity from the table needs to be considered. In the case of high sensitivity areas with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of <20m and <50m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Sensitivity of the Area - Dust Soiling

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in the table below

IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

Land Use Values	Number of receptors[a]	Distance from the source (m)[b]			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: (a) Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of <20m and <50m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Step 4 - Risk Assessment (Pre-Mitigation)

The matrices shown for each activity determine the risk category with no mitigation applied.

Risk of dust impacts from earthworks

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Earthworks**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from construction activities

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Construction**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from demolition activities

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Demolition**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Risk of dust impacts from trackout (within 100m of construction site entrance)

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Trackout**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from construction traffic (from construction site entrance to origin)

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Construction Traffic**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 5 – Identify Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the site is a low, medium or high risk site.

The identified mitigation measures are presented as follows:

- **N** = not required (although they may be implemented voluntarily)
- **D** = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided);
- **H** = highly recommended (to be implemented as part of the CEMP, and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

The table below presents the complete mitigation table, not that assessed as required for any specific project or activity:

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
1	Communications			
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	N	H	H
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H	H	H
1.2	Display the head or regional office contact information.	H	H	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	D	H	H
2	Site Management			
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	H	H	H
2.2	Make the complaints log available to the local authority when asked.	H	H	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H	H	H
2.4	Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.	N	N	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
3	Monitoring			
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	D	D	H
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	H	H	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H	H	H
3.4	Agree dust deposition, dust flux, or real-time continuous monitoring locations with the relevant regulatory bodies. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences.	N	H	H
4	Preparing and Maintaining the Site			
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H	H	H
4.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.	H	H	H
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	D	H	H
4.4	Avoid site runoff of water or mud.	H	H	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	D	H	H
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	D	H	H
4.7	Cover, seed or fence stockpiles to prevent wind erosion	D	H	H
5	Operating Vehicle/Machinery and Sustainable Travel			
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	H	H	H
5.3	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
5.4	Impose and signpost a maximum-speed-limit of 25 km·h^{-1} on surfaced and 15 km·h^{-1} on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	D	D	H
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N	H	H
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	N	D	H
6	Operations			
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	H	H	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	H	H	H
6.3	Use enclosed chutes and conveyors and covered skips	H	H	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H	H	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	D	H	H
7	Waste Management			
7.1	Avoid bonfires and burning of waste materials.	H	H	H
8	Measures Specific to Demolition			
8.1	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	D	D	H
8.2	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	H	H	H
8.3	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H	H	H
8.4	Bag and remove any biological debris or damp down such material before demolition.	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	N	D	H
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	N	D	H
8.7	Only remove the cover in small areas during work and not all at once	N	D	H
9	Measures Specific to Construction			
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D	D	H
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	D	H	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N	D	H
8.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	N	D	D
10	Measures Specific to Track-Out			
10.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D	H	H
10.2	Avoid dry sweeping of large areas.	D	H	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D	H	H
10.6	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	N	H	H
10.7	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D	H	H
10.8	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	N	H	H
10.9	Access gates to be located at least 10 m from receptors where possible.	N	H	H
11	Specific Measures to Construction Traffic (adapted)			
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N	D	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D	H	H

Step 6 – Risk Assessment (post-mitigation)

Following Step 5, the residual impact is then determined.

The objective of the mitigation is to manage the construction phase risks to an acceptable level, and therefore it is assumed that application of the identified mitigation would result in a *low* or *negligible* residual risk (post mitigation).