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Proposed Bangus Quarry Landfill Development – Tumblong, NSW

Air Quality Impact Assessment

Addressee(s):	MH Earthmoving Pty Ltd
Report Reference:	19.1084.FR1V1
Date:	2 October 2019

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	GCG	MD
THE PROPOSAL	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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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 **2nd October 2019**

Non-Technical Summary

InSitu Advisory Pty Ltd on behalf of MH Earthmoving Pty Ltd has engaged Northstar Air Quality Pty Ltd to perform an air quality and odour impact assessment for the proposed repurposing of a quarry into a waste disposal facility. The waste disposal facility will be located at Lot 7004 DP 1028797 & Lot 7300 DP 1149008 on Tumblong Reserve Road, Tumblong, NSW.

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

The air quality and odour impact assessment presents an assessment of the impacts of the proposed construction and operational activities at the site which has been performed using a quantitative dispersion modelling approach, and in accordance with relevant NSW guidelines. The results of the assessment are presented as predicted incremental and cumulative impacts, accounting for prevailing background air quality conditions, where applicable.

In the case of particulate matter, the concurrent construction and operation of the waste disposal facility would not result in any additional exceedances of short term (24-hour) or longer term (annual average) deposition or concentration criteria.

In the case of odour, predicted impacts have been assessed assuming that odour emissions from the non-putrescible waste accepted would be similar to emissions from putrescible waste. Even under this highly conservative assumption, compliance with the NSW Environment Protection Authority odour criterion is easily achieved. Odour during actual operation of the landfill is anticipated to be significantly lower than that predicted.

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

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1. INTRODUCTION

InSitu Advisory Pty Ltd (InSitu) on behalf of MH Earthmoving Pty Ltd (MHE) has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality and odour impact assessment (AQIA) for the proposed repurposing of a quarry into a waste disposal facility (the Proposal). The Proposal will be located at Lot 7004 DP 1028797 & Lot 7300 DP 1149008 on Tumblong Reserve Road, Tumblong, NSW (the Proposal site).

The Proposal site was designated as a quarry reserve (Reserve 89508) in 1975 and after proposed design levels are achieved, the practical limits of extraction will be achieved at the quarry thereby requiring remediation and rehabilitation. The Proposal seeks to utilise the final quarry void as a waste disposal facility (landfill) receiving only waste materials from Visy Pulp and Paper (Visy) which is located in Tumut, NSW. The Visy manufacturing facility produces kraft linerboard from plantation grown radiata pine and recycled paper. During the manufacturing process by-products are generated which require landfilling in the absence of other resource recovery options.

The construction of the waste disposal facility at the Proposal site will require final excavation of the quarry, formation of the waste cells, lining and construction of leachate control facilities. The operation of the Proposal would be associated with the receipt and placement of up to 60 000 tonnes per annum (tpa) of by-products from the Visy paper and cardboard recycling process and the management of leachate generated in the landfill.

Given the nature and scale of the Proposal, and that the proposed sole-sourced waste is general solid waste (non-putrescible), the generation of landfill gases are anticipated to be negligible, and have not been considered within this AQIA.

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

The AQIA presents an assessment of the impacts of the proposed construction and operational activities at the Proposal site which has been performed using a quantitative dispersion modelling approach, and in accordance with relevant NSW guidelines. The results of the assessment are presented as predicted incremental and cumulative impacts, accounting for prevailing background air quality conditions as appropriate.

1.1 Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs 1321) have been provided for the Proposal by the NSW Department of Planning and Environment (DPE) (now Department of Planning, Industry and Environment [DPI&E]) on 2 April 2019. The SEARs relevant to this study, and the section of this AQIA report where they have been addressed, are presented in **Table 1**.

Table 1 SEARs 1321 requirements – air quality and odour

Requirement	Addressed in this report
a description of all potential sources of air, dust and odour emissions	Section 2.4
an air quality and odour impact assessment in accordance with relevant Environment Protection Authority guidelines	This AQIA
a description and appraisal of air quality impact mitigation and monitoring measures	Section 7

Further to the above, NSW EPA also provided requirements for the Proposal on 26 March 2019 which are presented in **Table 2**.

Further to the NSW DPI&E and EPA requirements, 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).
- Environmental Guidelines - Solid Waste Landfills (second edition) (NSW EPA, 2016)

Table 2 NSW EPA requirements – air quality and odour

Requirement	Addressed in this report
Details of all proposed construction activity and an assessment of the impacts. This is to include an assessment of noise, vibration and dust emissions for the establishment of the landfill cells, and the control of stormwater run-off.	Section 2.2, Section 2.4, Section 6.1
Details of the proposed management and mitigation measures that will be implemented to control all potential off-site impacts from the activity including potential amenity issues such as odour, dust, noise, litter and fire control, and vibration.	Section 7
General comments	
Demonstrate that the proposal will meet the required outcomes in the Landfill Guidelines, with justification for any proposed alternatives to the acceptable measures described in these guidelines. The application should be supported by a hydrogeological risk assessment, landfill gas risk assessment, air quality impact assessment, odour impact assessment, noise impact assessment, water balance calculations for leachate management, and proposed environmental monitoring programs.	This AQIA
Detail the mitigation and management options that will be used to prevent, control, abate or mitigate the identified potential environmental impacts associated with the project. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Section 5.4 Section 6 Section 7
Landfill development	
The environmental objective is for the minimisation of amenity impacts associated with the development of the landfill. The EIS should document the measures that will be implemented to achieve this objective, and include but not be limited to the following specific aspects. • Construction impacts – assess the impacts and detail the mitigation controls to minimise offsite dust, noise, vibration and water quality impacts in accordance with EPA guidelines. This should include details of any off-site work such as winning and importing clay liner material or graded rock for drainage layers.	Section 5.4 Section 6
Landfill operation – prevent degradation of local amenity	
The environmental objective in relation to local amenity is the prevention of impacts, and where not possible the mitigation of impacts on sensitive receptors in accordance with the EPA's guideline criteria for odour, dust, noise and facility management and operation.	Section 5.4 Section 6
All potentially impacted residential or sensitive locations likely to be impacted by the development must be identified and included in the assessment. The EIS should assess the impact and document the measures that will be implemented to achieve the amenity objectives, and should include but not be limited to the following specific aspects. • Odour - An odour assessment should be prepared based on the potential emissions from the waste disposal facility. The EIS should also detail the appropriate waste acceptance and screening steps and waste management steps that will be implemented to prevent the generation of odour. • Dust – The air quality impact assessment should include an assessment of dust impacts from the proposed construction and operation of the landfill and details of all mitigation measures.	Section 2.3.1 Section 6.1 Section 6.2 Section 7

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2. THE PROPOSAL

The following section provides a description of the Proposal and the potential emissions to air which would be anticipated to be associated with the construction and operational phases of the development.

Construction of the Proposal will be commenced upon final extraction from the quarry, and begin with the excavation of the first waste cell which is anticipated to take approximately two weeks to complete. Following the construction of the first waste cell (Cell 1), waste material will be delivered to site from Visy and placed within that prepared cell whilst the second waste cell is under construction. Given that construction and operational phase activities overlap, presentation of solely construction or operational activities would underestimate the impacts of the Proposal at surrounding receptors.

Further discussion of how the various construction and operational activities at the Proposal site have been characterised within the AQIA is presented in **Section 2.4**.

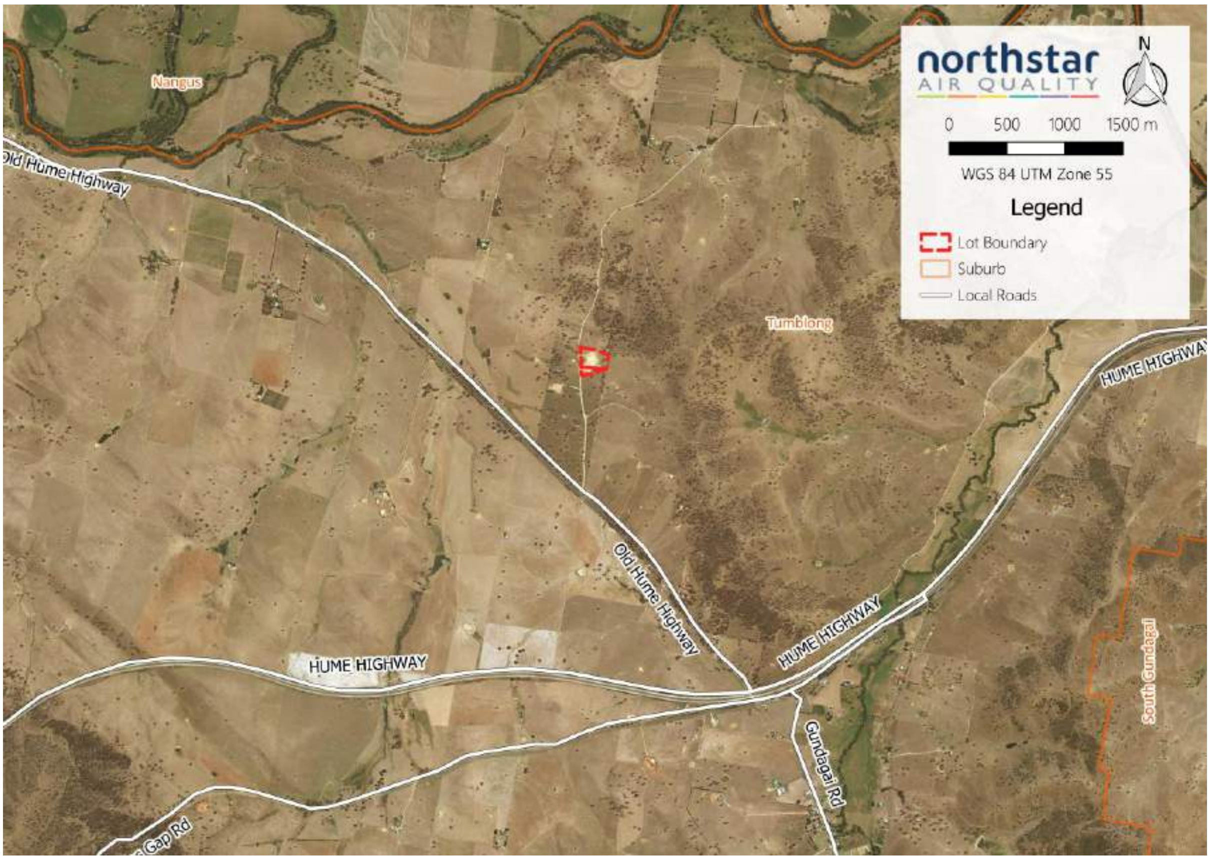
2.1 Environmental Setting

The Proposal site is located at Lot 7004 DP 1028797 & Lot 7300 DP 1149008 on Tumblong Reserve Road, Tumblong, NSW. The Proposal site is located within the Local Government Area (LGA) of Cootamundra-Gundagai Regional Council.

The Proposal site is situated in a predominantly rural area, which is zoned as RU1 (Primary Production). The nearest residential land use zone is over 11 kilometres (km) to the northeast of the Proposal site in the town of Gundagai.

A map illustrating the location of the Proposal site is presented in **Figure 1**.

Figure 1 Proposal site location



Source: Northstar Air Quality

2.2 Specific Construction Details

The Proposal is designed to include two waste cells which are largely formed around the current quarry void (the gravel pit). Additional excavation of the pit would be required to form both waste cells (Cell 1 and Cell 2) and this is activity is proposed to be performed in two stages.

Additional excavations required to form Cell 1 would be performed over a period of two. Excavated materials would be used to construct the perimeter bunds, Cell 1/Cell 2 intercell bund and basal sub-base layer (see below), with the remainder stored in Cell 2. Once construction of Cell 1 is completed, waste would begin to be accepted and emplaced within Cell 1.

A 1 metre (m) high clay bund will be constructed on the northern and western boundary of the landfill, utilising compacted clay fill, these bunds will be subsequently covered with geosynthetic clay liner (GCL) and HDPE geomembrane and protection geotextile. A sump area for leachate collection and extraction will be constructed within Cell 1 and Cell 2. A series of slotted HDPE pipes laid within an aggregate leachate drainage blanket will also be installed on the base of the landfill to collect and direct leachate into the sump area. Building of a small office structure will also be constructed for administration purposes.

Excavations in Cell 2 would commence after waste has begun to be accepted in Cell 1. These excavations would take approximately nine weeks to complete. A further four weeks would be required to construct the clay sub-base layer in Cell 2. The excavated materials from Cell 2 would be used partly for the clay sub-base layer, partial capping to the western lower flank of Cell 1 facing the road with the remainder hauled to a temporary stockpile in an adjacent Lot owned by MHE. This material would be used during the rehabilitation phase.

The hours of construction would be limited to:

- Monday to Friday - 7 am to 5 pm.
- Saturday - 7 am to 12 pm.
- Sunday and public holidays - no construction works.

The plant and equipment required during the construction activities in both Cell1 and Cell 2 would include:

- Excavator (Volvo EC360B, or similar);
- Bulldozers x 2 (Caterpillar D10, D7, or similar);
- Haul trucks x 2 (25 t Moxy, or similar);
- Water Truck (Hino 500, or similar); and,
- Vibrating pad foot roller.

2.3 Specific Operational Details

2.3.1 Waste Material

The Proposal site would accept general solid (non-putrescible) waste solely from the Visy Pulp and Paper Mill, Tumut NSW. Up to 60 000 tpa of waste material is proposed to be accepted at the Proposal site and includes residue from the paper and cardboard recycling process. The material to be accepted includes:

Paper Machine Rejects (PMR)

The main components of PMR are paper, plastic, raggers (a twisted agglomeration of rags and plastic wrapped around a wire) and metals. Improved recycled waste separation practices together with "pulping" technology would assist in the reduction of PMR. However, this technology is not yet available and the recent actions of China in banning the delivery of recycled paper has exacerbated issues in the Australian recycling market.

The plastic component of PMR includes 69.5 % rigid and 30.5 % soft / flexible plastics. The paper component consists of paper deemed to be too degraded to reprocess and is discarded. Metals include aluminium, foil and other forms of metal. Raggers consists of cloth and fibre that cannot be processed. No significant amounts of organic or earth-based material was accounted for in an analysis of this material performed at the request of Visy.

Dregs and Grits, Lime Mud

Dregs and grits are essentially a mixture of sodium and calcium carbonates (lime mud), and a small fraction of unburnt organic matter that is derived in the process of removing lignin from virgin fibre raw material in the kraft pulping process.

Lime mud is generated in the chemical recovery and recirculation process and, aside from dregs and grits, is the only waste product derived from the kraft pulping process.

Boiler Sand and Fly Ash

Sand of high quality is used as material to transport fuel in the bed of the "fluidised bed" power boiler. However, over time the bed material becomes contaminated and needs to be removed from the process.

Recrystallisation Plant Residue

Visy is a large generator of renewable energy and the majority of this energy is generated by the consumption of "black liquor" in the recovery boiler. The black liquor is generated in the pulping process which removes lignin from the timber raw material. During this process the Recrystallisation Plant also generates non–usable material.

The Visy Pulp and Paper annual Environment Protection Licence (EPL) return for year ending 30 June 2017 indicated that a total of 75 036 t of waste materials was produced. The percentage associated with each waste stream, and the likely quantity of each waste material type to be generated at 60 000 tpa waste generation rate is provided in **Table 3**.

Table 3 Details of non-recoverable material to be accepted at the Proposal site

Material type	% of total (w/w)	Anticipated quantity at 60 000 tpa receival rate
Paper machine rejects (PMR)	78.5	47 119
Dregs and grits, lime mud	14.4	8 657
Fly ash	4.2	2 516
Boiler sand	1.5	919
Recrystallisation plant residue	1.3	789

Source: Section 5.1.5 of the EIS (InSitu, 2019)

Waste material is stockpiled at the Visy facility at Tumut, where the material is prepared for loading. The waste material is screened to confirm and certify that the waste only contains the acceptable, non–putrescible materials, and then is then loaded into 30 t capacity trucks (truck and dog), which are then weighed for reporting purposes.

Waste leaving the Visy facility will be transported along the designated haulage route which will include the Snowy Mountain Highway, Gocup Road, Hume Highway, and Old Hume Highway before entering Tumblong Reserve Road, which will be sealed to appropriate standards. The transport vehicles will be regularly maintained and replaced, and all loads are enclosed to prevent any spillage or odour impacts during transportation.

Once the material arrives at the Proposal site, the waste vehicles will enter the site from the sealed Tumblong Reserve Road, and access the site over the weighbridge. On entering the site, waste vehicles will reverse to the active waste cell where the transported waste it is tipped from the trailer. The truck will then move forward, disengage the trailer, reverse back to the waste cell and the waste will then be tipped from the truck tipper into the active waste cell. The vehicles will then be cleaned and recoupled before leaving the waste cell.

The area of the active tip face will be no greater than 600 m^2, in accordance with the NSW Landfill Guidelines (NSW EPA, 2016).

The deposited waste will be spread evenly and compacted by a front end loader to form the appropriate shape of the waste cell. Daily cover material will then be applied to the waste. A stockpile of daily cover material will be retained on site, with adequate material to cover all waste to a depth of 150 millimetres (mm) at the end of every working day.

Staff will routinely conduct litter patrols to ensure that wind-blown waste material does not leave the operational waste cell.

Intermediate cover will be placed on non-active areas of the landfill and final cover will be placed upon rehabilitation of the landfill in accordance with (NSW EPA, 2016).

2.3.2 Leachate

Leachate can be defined as a liquid that passes through the landfill waste mass and has extracted some dissolved and suspended matter from the waste. The primary sources of leachate generation are:

- Surface water infiltration into the waste surface and surface runoff into the waste mass during periods of prolonged rainfall;
- Surface water shed from the landform; and
- Leachate generated by the moisture content, and degradation of the received emplaced waste.

Leachate is proposed to be stored within a leachate dam to the west of Cell 1.

Leachate shall be collected at the specially designed landfill sumps within Cell 1 and 2 by means of a series of slotted HDPE pipes laid within a minimum 300 mm aggregate leachate drainage blanket. Leachate will be pumped from the two landfill sumps via 400 mm ID HDPE side riser where it will be carried via surface laid pipework to the clay, GCL and HDPE lined leachate storage dam. The leachate storage dam has been designed to meet the requirements of design and storage capacity required by the NSW EPA Environmental Guidelines: Solid Waste Landfills 2016 (NSW EPA, 2016).

Leachate will be stored within the leachate storage dam and allowed to evaporate to assist in the reduction of leachate volume. Recirculation of leachate will be periodically undertaken back into the waste as and when required, subject to NSW EPA approvals. Should leachate levels rise within the dam that cannot be managed by evaporation or periodic re-injection, tankering will be undertaken to an authorised disposal facility.

2.3.3 Stormwater

Stormwater would be collected and stored within a storage dam to the west of Cell 1, located adjacent to the leachate storage area. Stormwater is not considered to represent a source of odour and has not been considered further within this AQIA.

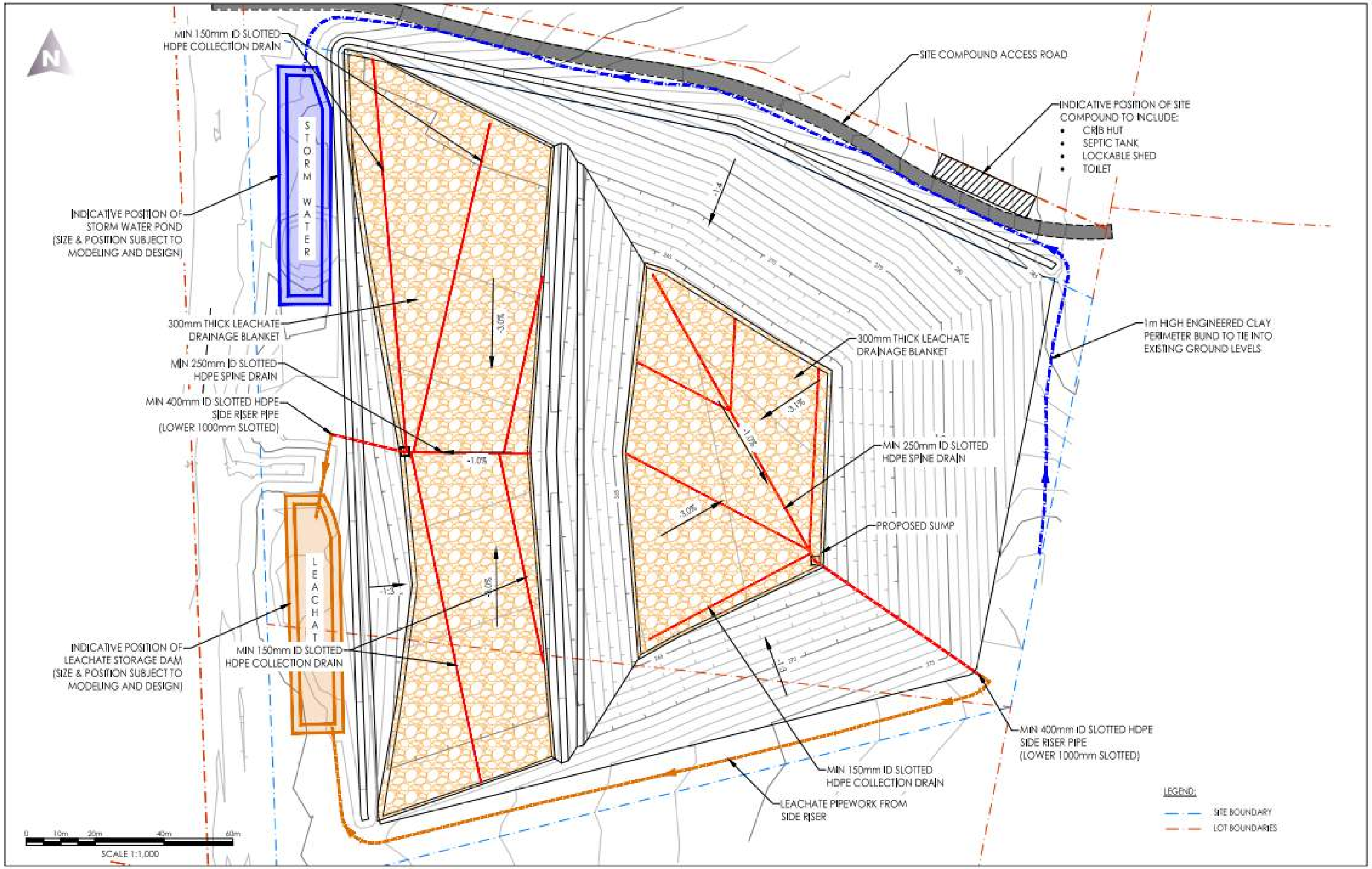
A general arrangement of the Proposal site is presented in **Figure 2**.

Details of the proposed operations at the Proposal site are presented in Table 4.

Table 4 Proposed operational details

Operation	Units	Value
Waste receival	tonnes·annum^{-1}	60 000
	tonnes·day^{-1} (average)	230
	tonnes·day^{-1} (maximum)	300
Waste truck movements	Number·annum^{-1}	2 000
	Number·day^{-1} (average)	8
	Number·day^{-1} (maximum)	10
Active tip face area	m^2 (maximum)	600
Daily cover depth	mm	150
Leachate storage	m^2	1 050
Stormwater storage	m^2	1 050
Employees	Number	8
Operational hours	Hours	7 am to 5 pm, Monday to Friday

Figure 2 Proposal site layout



Source: InSitu Advisory

2.4 Identified Potential for Emissions to Air

2.4.1 Construction Phase Activities

The construction phase activities described in **Section 2.2** are anticipated to have the potential to generate short-term emissions of particulates ('construction dust'). 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 and the distance to nearby sensitive receptors, 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.

2.4.2 Operational Phase Activities

Based on the description of operational phase activities outlined in **Section 2.3**, the processes which may result in the emission of pollutants to air include:

Particulate matter:

- Movement of vehicles around the Proposal site on paved and un-paved road surfaces;
- Placement of waste; and,
- Placement of cover material.

Odour:

- Active tip face;
- Intermediate waste cover; and,
- Leachate.

During the performance of the proposed construction and operation activities, a number of air quality management measures are to be employed to minimise the generation and off-site transport of pollutants. A discussion of these measures is presented in **Section 5.4**.

Assessment of the potential impacts upon local air quality resulting from the activities outlined above is presented in **Section 6**.

As previously discussed, construction phase and operational phase activities will be performed concurrently. As such, presentation of impacts solely associated with either phase would underestimate both the potential emissions and impacts of pollutants resulting from those activities. This is especially the case for particulate matter.

A scenario which reflects the activities being performed at the Proposal site resulting in maximum potential for emissions of particulate matter has been formulated which includes:

- Performance of construction activities within Cell 2 (including transportation of excavated material to the adjacent Lot and western flank);
- Transportation of waste material to the Proposal site from the Old Hume Highway, along Tumblong Road;
- Unloading and emplacement of waste material within Cell 1;
- Placement of daily cover on Cell 1; and,
- Wind erosion of excavated cells, stockpiled material and the surface of Cell 1 (the active cell).

This scenario has been termed the 'particulate matter scenario'.

In the case of odour, a scenario reflecting the potential for maximum emissions of odour has been considered, including:

- Deposition and emplacement of waste at the active tip face;
- Interim cover being present across the remainder of both Cells 1 and 2; and,
- Leachate storage.

This scenario has been termed the 'odour scenario'.

Full details of the sources and emissions considered in each of the particulate and odour scenarios is presented in **Section 5** and **Appendix D**.

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3. LEGISLATION, REGULATION AND GUIDANCE

3.1 NSW Air Quality Standards – Particulate Matter

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)).

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 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 5**.

Table 5 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units	Criterion
Particulates (as PM_{10})	24 hours	$\mu g{\cdot}m^{-3}$ (a)	50
	1 year	$\mu g{\cdot}m^{-3}$	25
Particulates (as $PM_{2.5}$)	24 hours	$\mu g{\cdot}m^{-3}$	25
	1 year	$\mu g{\cdot}m^{-3}$	8
Particulates (as Total Suspended Particulate [TSP])	1 year	$\mu g{\cdot}m^{-3}$	90
Deposited dust (d)	1 year	$g{\cdot}m^{-2}{\cdot}month^{-1}$ (b)	2
		$g{\cdot}m^{-2}{\cdot}month^{-1}$ (c)	4

Notes: (a): Micrograms per cubic metre of air; (b): Maximum increase in deposited dust level; (c): Maximum total deposited dust level; (d): Assessed as insoluble solids as defined by AS 3580.10.1

3.2 NSW Air Quality Standards – Odour

3.2.1 Definitions of Odour

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management but are generally not intended to achieve "no odour", but manage odour impacts to an acceptable level.

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour detection threshold (ODT) and defines one odour unit (OU). An odour goal of less than 1 OU would (by definition) result in no odour impact being detectable in laboratory conditions. In practice, the character of an odour can only be judged by the receiver's reaction to it, and preferably only compared to another odour under similar social and regional conditions.

Based on the literature available, the level at which an odour is perceived to be a nuisance can range from 2 OU to 10 OU (or greater) depending on a combination of the following factors:

- **Odour quality:** whether an odour results from a pure compound or from a mixture of compounds. Pure compounds tend to have a higher threshold (lower offensiveness) than a mixture of compounds.
- **Population sensitivity:** any given population contains individuals with a range of sensitivities to odour. The larger a population, the greater the number of sensitive individuals it contains.
- **Background level:** whether a given odour source, because of its location, is likely to contribute to a cumulative odour impact. In areas with more closely-located sources it may be necessary to apply a lower threshold to prevent offensive odour.
- **Public expectation:** whether a given community is tolerant of a particular type of odour and does not find it offensive, even at relatively high concentrations. For example, background agricultural odours may not be considered offensive until a higher threshold is reached than for odours from a landfill facility.
- **Source characteristics:** whether the odour is emitted from a stack (point source) or from an area (diffuse source). Generally, the components of point source emissions can be identified and treated more easily using control equipment than diffuse sources. Point sources tend to be located in urban areas, while diffuse sources are more prevalent in rural locations.
- **Health effects:** whether a particular odour is likely to be associated with adverse health effects. In general, odours from agricultural activities are less likely to present a health risk than emissions from industrial facilities.

3.2.2 Odour Assessment Criteria in NSW

Experience gained through odour assessments from proposed and existing facilities in NSW indicates that an odour performance goal of 7 OU is likely to represent the level below which "offensive" odours should not occur (for an individual with a 'standard sensitivity' to odours). Therefore, the Odour Technical Framework (DECC, 2006) recommends that, as a design goal, no individual be exposed to ambient odour levels of greater than 7 OU. In modelling and assessment terms, this is expressed as the 99th percentile value, as a nose response time average (approximately one second).

Odour assessment criteria need to consider the range in sensitivities to odours within the community to provide additional protection for individuals with a heightened response to odours. This is addressed in the Technical Framework (DECC, 2006) by setting a population dependant odour assessment criterion, and in this way, the odour assessment criterion allows for population size, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity. A summary of odour performance goals for various population densities, as referenced in the Odour Technical Notes (DECC, 2006) is shown in Table 6 This table shows that in situations where the population of the affected community lies between 125 and 500 people, an odour assessment criterion of 4 OU at the nearest residence (existing or any likely future residences) is to be used. For isolated residences, an odour assessment criterion of 7 OU is appropriate.

Table 6 NSW EPA Technical Framework odour criteria

Population of Affected Community	Impact Assessment Criteria for Complex Mixture of Odours (99^{th} percentile 1-second OU)
Urban area (≥2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10 – 30	6.0
Single residence (≤2)	7.0

Source: The Odour Technical Notes, DECC 2006

The area surrounding the Proposal site is largely rural in nature although as outlined in **Section 4.1**, five residences have been identified within a radius of approximately 2 km of the Proposal site boundary. The average household size in the Cootamundra-Gundagai LGA as reported in the 2016 census was 2.27 persons[1]. A population total within 2 km of the Proposal site is therefore calculated to be between 11 and 12 persons. The relevant odour criterion for a population of this size is 6 OU, applicable for a population between 10 and 30 residents, as shown in **Table 6**.

3.2.3 Regulation of Odour

It is noted that the odour assessment criteria (see **Section 3.2.2**) are a **design** tool rather than a **regulatory** tool. The benchmark for operational facilities is not the odour assessment criteria outlined above but whether the emission of odour is *'offensive'*, or being prevented or minimised using best management practices.

The *Protection of the Environment (Operations) Act* 1997 (POEO) is applicable to scheduled activities in NSW and emphasises the importance of preventing 'offensive odour'.

[1] https://profile.id.com.au/cgrc/household-size?WebID=10

The defining legislation applicable in NSW is provided under the *Protection of the Environment Operations Act* (1997) (POEO Act) and the *Protection of the Environment Operations (Clean Air) Regulation* (2010) (under the Act). The operations being performed at the landfill are considered a scheduled activity under the POEO Act, and therefore do require licencing by the NSW Environment Protection Authority. The POEO Act defines waste disposal (application to land) activities like this Proposal under Clause 39:

Waste disposal (application to land)

(1) This clause applies to waste disposal by application to land, meaning the application to land of waste received from off site, including (but not limited to) application by any of the following methods:

(a) spraying, spreading or depositing on the land,

(b) ploughing, injecting or mixing into the land,

(c) filling, raising, reclaiming or contouring the land.

(2) However, this clause does not apply to an activity that involves any of the following:

(a) sites inside the regulated area that, over any period of time, receive from off site a total of no more than 200 tonnes of the following waste (and no other waste):

(i) building and demolition waste only,

(ii) building and demolition waste mixed with virgin excavated natural material,

(b) sites outside the regulated area that, over any period of time, receive from off site a total of no more than 200 tonnes of the following waste (and no other waste):

(i) building and demolition waste only,

(ii) building and demolition waste mixed with virgin excavated natural material,

being waste generated inside the regulated area,

(c) sites outside the regulated area that, over any period of time, receive from off site a total of no more than 20,000 tonnes of the following waste (and no other waste):

(i) building and demolition waste only,

(ii) building and demolition waste mixed with virgin excavated natural material,

being waste generated outside the regulated area,

(d) sites that receive from off site no more than 5 tonnes of waste tyres per year or 500 waste tyres in total over any period (and no other waste),

(e) sites where only virgin excavated natural material is received from off site and applied to land,

(f) sites that are outside the regulated area, but only if:

(i) the site is owned by and operated by or on behalf of a local council, and

(ii) the site was in existence immediately before 28 April 2008 and was not required to be licensed before that date, and

(iii) details required under clause 47 of the Protection of the Environment Operations (Waste) Regulation 2005 were provided, in relation to the site, before 28 April 2008, and

(iv) the site receives from off site less than 5,000 tonnes per year of waste, and

(v) that waste has been generated outside the regulated area and consists only of general solid waste (putrescible), general solid waste (non-putrescible), clinical and related waste, asbestos waste, grease trap waste or waste tyres (or any combination of them).

(3) The activity to which this clause applies is declared to be a scheduled activity.

(4) For the purposes of this clause, 1 litre of waste is taken to weigh 1 kilogram.

The POEO Act is applicable to scheduled activities in NSW and emphasises the importance of preventing 'offensive odour'. For reference, 'offensive odour' is defined within the POEO Act as:

an odour:

(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.

Further to the discussion of factors that determine whether an odorous mixture may be determined to lead to a nuisance, and the impact assessment criterion determined in **Section 3.2** numerous papers and articles identify the disconnect between that two drivers that help regulate odour (as referenced in (Graham, Lawrence, & Doyle, 2013)). The description provided in the POEO Act may be summarised as a function of five broad factors, called the FIDOL factors, namely:

- **Frequency:** indicates how often an odour is experienced. Exposure to relatively pleasant odours (such as a bakery, for example) may be perceived to be a nuisance (or 'offensive odour') if it is experienced too frequently., and conversely, a more unpleasant odour may be tolerated if it is experienced hardly ever.
- **Intensity:** indicates the relative strength of the odour;
- **Duration:** in parallel to frequency, duration is an important factor representing the length of time of which an odour exposure is observed;
- **Offensiveness:** indicates how pleasant / unpleasant an odour is to the population. Whilst individuals may express a personal opinion of acceptance to specific odours, it is generally accepted that some odours are more unpleasant than others due to their chemical composition and also a hazard

identification function. The relative scale of typical pleasantness / unpleasantness is described as the odour's hedonic tone.

- **Location:** indicates the relationship between the odour experienced and the general perception of amenity that would be expected at that location. An odour that may be tolerated at an industrial site may be less tolerated at a healthcare centre, for example.

4. EXISTING CONDITIONS

4.1 Surrounding Land Sensitivity

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 **Section 3**). 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.

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 Proposal 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 ($persons{\cdot}km^{-2}$):

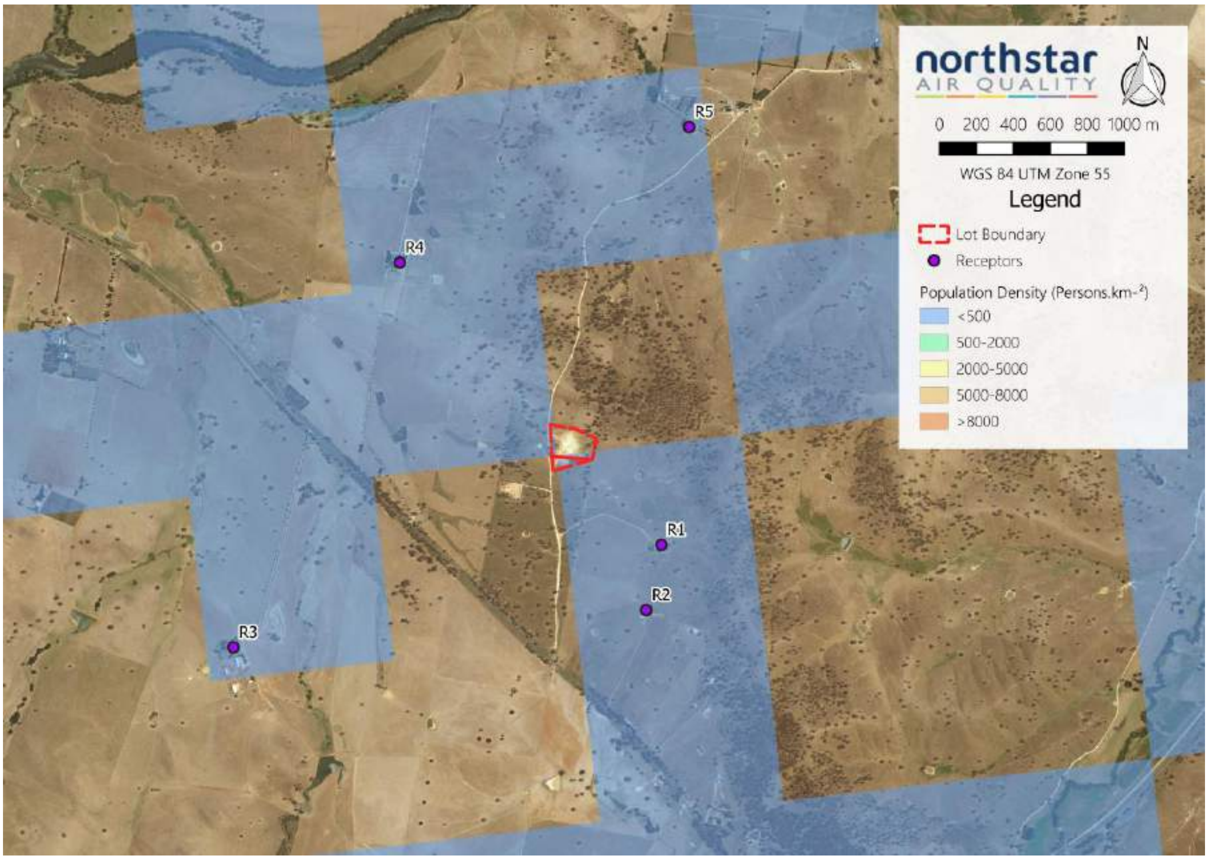
Very high	>8,000
High	>5,000
Medium	>2,000
Low	>500
Very low	<500
No population	0

The population density of the area surrounding the Proposal site is presented in **Figure 3**. The Proposal site is located in an area of very low population density (<500 $persons{\cdot}km^{-2}$).

Five residential locations within an approximately 2 km radius of the Proposal site have been identified and these locations (termed as "sensitive receptors") have been adopted for use within this AQIA as presented in **Table 7**.

Figure 3 identifies that the sensitive receptors selected are located in all directions from the Proposal site, with the closest receptor (Receptor 1 [R1]) being approximately 600 m from the site boundary.

Figure 3 Population density and sensitive receptors surrounding the Proposal site



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

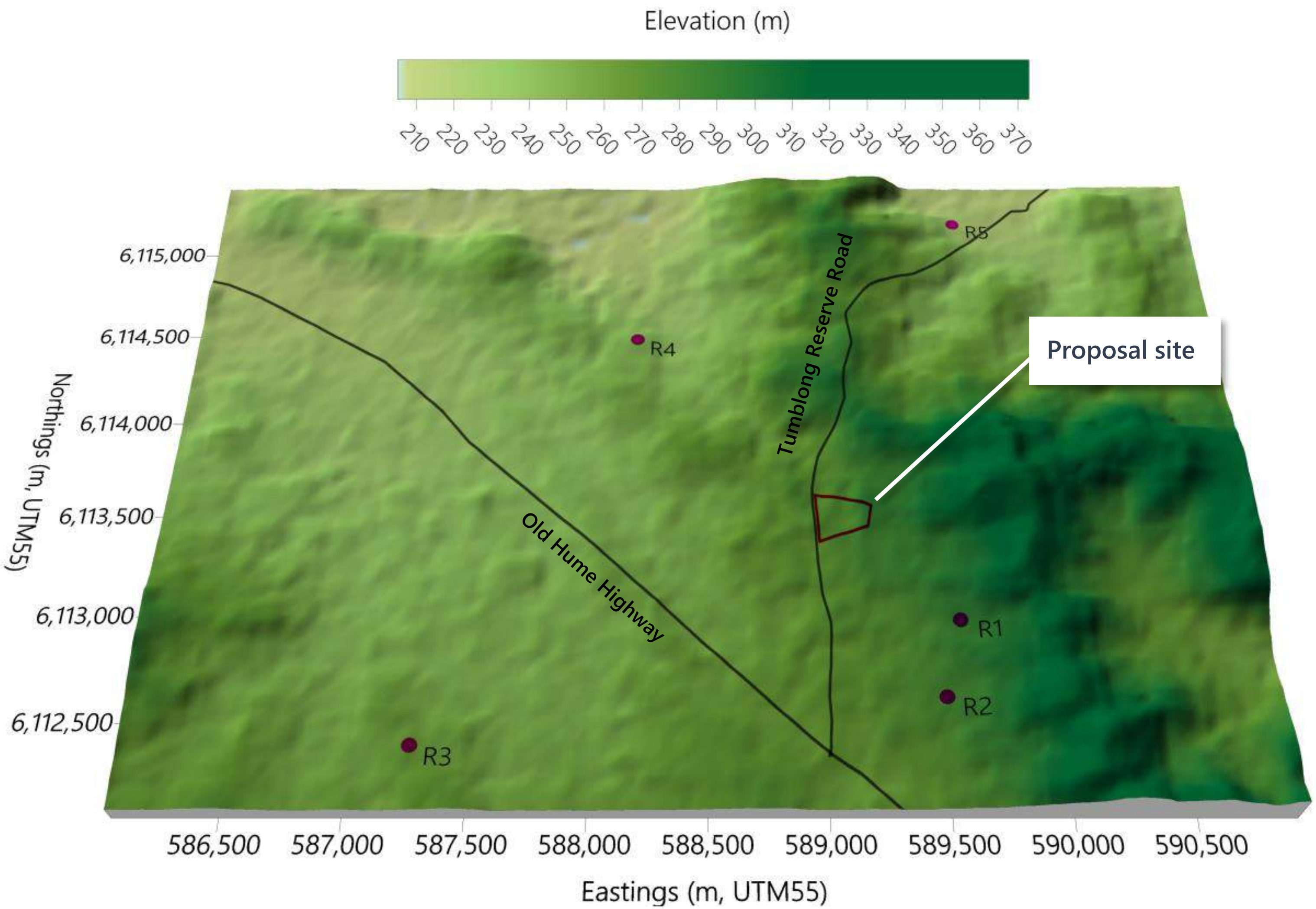
Table 7 Sensitive receptor locations used in the study

Rec. ID	Address	Land Use	Location (m, UTM 56)	
			Eastings	Northings
R1	68 Tumblong Reserve Road, Tumblong	Residential	589,581	6,112,920
R2	108 Old Hume Highway, Tumblong	Residential	589,499	6,112,568
R3	419 Old Hume Highway, Tumblong	Residential	587,265	6,112,366
R4	346 Old Hume Highway, Tumblong	Residential	588,165	6,114,446
R5	335 Tumblong Reserve Road, Tumblong	Residential	589,731	6,115,179

4.2 Topography

The elevation of the Proposal site is approximately 280 m Australian Height Datum (AHD). No significant topographical features are present between the Proposal site and the nearest sensitive receptor locations as shown in **Figure 4**. To the east of the Proposal site is a ridge line running from the north west to the south east. The ridge rises to approximately 360 m AHD within 600 m of the Proposal site.

Figure 4 3-dimensional representation of topography surrounding Proposal site



Source: Northstar Air Quality

4.3 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.

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

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

4.4 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 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.

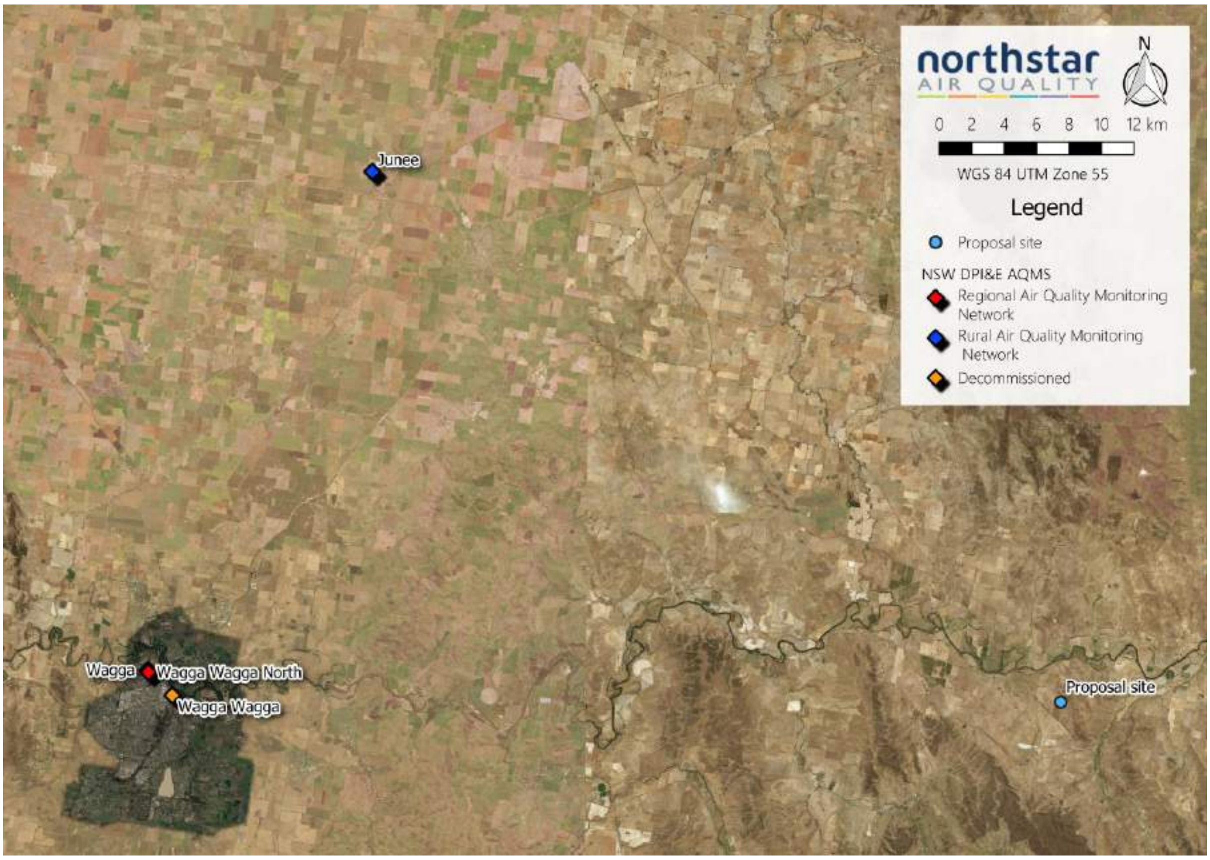
When assessing the impact of any particular source of emissions on the potential air quality at a location, the impact of all other sources of an individual pollutant should also be assessed. This 'background' (sometimes called 'baseline') air quality will vary depending on the pollutants to be assessed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

The NSW DPI&E operates air quality monitoring stations (AQMS) in regional centres, and as part of the Rural Air Quality Monitoring Network (RAQMN). The Proposal site is not located in close proximity to any AQMS, although four are located within a radius of 60 km. These locations (listed by proximity) are briefly summarised in **Table 8** and presented in **Figure 5**. The period of data being analysed is 2014 and has been selected to be contemporaneous with the meteorological modelling year (refer to **Appendix B**).

Table 8 Closest NSW DPI&E AQMS to the Proposal site

AQMS Location	Distance to Site (km)	Screening Parameters				
		Network	2014 Data	Measurements		
				TSP	PM_{10}	$PM_{2.5}$
Junee	53.6	RAQMN	×	✓	×	×
Wagga Wagga	54.8	Decommissioned	×	×	✓	×
Wagga Wagga North	56.3	Regional	✓	×	✓	✓
Wagga	56.4	RAQMN	×	✓	✓	✓

Figure 5 Air quality monitoring stations surrounding the Proposal site



Source: Northstar Air Quality

The closest representative AQMS is noted to be located at Wagga Wagga North and is considered to be the monitoring location most reflective of the conditions at the Proposal site.

Appendix C provides a detailed assessment of the background air quality monitoring data collected at the Wagga Wagga North AQMS.

The Proposal site is not located in close proximity to any other waste management facilities, or any facilities which may result in odour emissions of a similar nature. The existing odour environment surrounding the Proposal site can therefore be assumed to be negligible.

A detailed summary of the background air quality is presented in **Appendix C**, and a summary of the air quality monitoring data used in this assessment is presented in **Table 9**.

Table 9 Summary of background air quality used in the AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP)	Annual µg.m^{-3}	46.0	Estimated on a TSP:PM_{10} ratio of 2.222 : 1 (see **Appendix C**).
Particles (as PM_{10})	24-hour µg.m^{-3}	Daily Varying	The 24-hour maximum for PM_{10} in 2014 was 88.2 µg.m^{-3}
	Annual µg.m^{-3}	20.7	
Particles (as $PM_{2.5}$)	24-hour µg.m^{-3}	Daily Varying	The 24-hour maximum for $PM_{2.5}$ in 2014 was 27.6 µg.m^{-3}
	Annual µg.m^{-3}	7.5	
Dust deposition	Annual g·m^{-2}·month^{-1}	2	Difference in NSW OEH maximum allowable and incremental impact criterion
Odour	Nose response time (1-sec)	Negligible	No similar sources of odour in the surrounding area

Note: Reference should be made to **Appendix C**

It is noted that the Approved Methods (NSW EPA, 2017) requires that background concentrations as provided above are added to dispersion model predictions to determine a 'cumulative' impact.

The AQIA has been performed to assess the contribution of the Proposal to the air quality of the surrounding area. A full discussion of how the Proposal impacts upon air quality is presented in **Section 6**.

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5. METHODOLOGY

5.1 Modelling Approach

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 3-dimensional (3-D) mode. Given the nature of the topography between the sources and receptors, a detailed assessment using a 3-dimensional (3-D) meteorological dataset is considered to be warranted.

The generation of appropriate meteorological data is discussed in detail in **Appendix B**. Meteorological modelling using The Air Pollution Model (TAPM, v 4.0.5) has been performed to predict the meteorological parameters required for input to CALPUFF.

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.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources (refer **Appendix D**), simulating dispersion and transformation processes along the way. The primary output files from CALPUFF contain either hourly concentrations or deposition fluxes evaluated at selected receptor locations.

CALPOST is used to process the CALPUFF output files, producing tabulations that summarise the results of the simulation (refer **Section 6**) (Scire, Strimaitis, & Yamartino, 2000).

In March 2011, NSW OEH (now part of DPI&E) published generic guidance and optimal settings associated with the CALPUFF modelling system for inclusion in the Approved Methods (Barclay & Scire, 2011). These guidelines and settings have been considered in the performance of this assessment.

5.2 Modelling Scenarios

An assessment of the impacts of the operation of activities at the Proposal site has been performed which characterises the likely day-to-day operation of the Proposal site, approximating average operational characteristics which are appropriate to assess against longer term (annual average) and shorter term (1-hour and 24-hour) criteria.

As discussed in **Section 2.4**, modelling scenarios have been constructed to represent the activities which may be performed concurrently to result in the greatest potential for particulate matter and odour impacts. Added to these impacts are background air quality concentrations (where relevant and available as discussed in **Section 4.4** and **Appendix C**) which represent the air quality which may be expected within the area surrounding the Proposal site, without the impacts of the Proposal itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the activities being performed as part of the Proposal.

5.3 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 from the US EPA AP-42 emission factor compendium (US EPA, various) for particulate matter. For odour, referenced emission factors have been adopted which represent fresh waste and waste under intermediate cover.

It is noted that odour emissions from the non-putrescible waste material being deposited at the Proposal site are not likely to be significant. Measurement of odour generated by waste materials can often be limited to more odorous materials and therefore, emission factors adopted to support this AQIA represent putrescible waste sources, which would significantly over-estimate the predicted odour impacts. The predicted odour impacts associated with waste materials being deposited as part of the Proposal should be viewed in terms of compliance, rather than seeking to represent the likely odour environment surrounding the Proposal site.

A full description of the emission factors, adopted activity data, and estimated particulate matter and odour emission data are presented in **Appendix D**.

5.4 Emissions Controls

A number of emissions controls would be adopted during both Proposal construction and operation, to mitigate emissions of particulate matter and odour.

5.4.1 Particulate Matter

Emissions of particulate matter would be controlled during construction through:

- Minimisation of drop heights when loading haul trucks with excavated material, resulting in emissions reductions of 30%;
- The use of a water cart on unsealed site roads, resulting in emissions reductions of 50%; and,
- The limiting of vehicle speeds across unpaved areas of the site, resulting in emissions reductions of 50%.

During operation, particulate matter emissions would be controlled by:

- Paving the road between the site and Old Hume Highway, with the emission reduction calculated through the emission factor adopted (refer **Appendix D**);
- Minimisation of drop heights when placing waste and daily cover resulting in emissions reductions of 30%; and,
- The limiting of vehicle speeds across the site, resulting in emissions reductions of 50% on unpaved roads. Vehicle speeds would also be limited on the paved road between the Old Hume Highway and the Proposal site, although a quantifiable emissions reduction is not available to be applied to this emissions source.

5.4.2 Odour

As previously described, odour emissions resulting from the placement and storage of non-putrescible waste materials are likely to be minor. Emissions will be managed through the adoption of industry best practice as outlined in the NSW Landfill Guidelines (NSW EPA, 2016), including:

- Restriction of the active tip face to 600 m^2;
- Placement of daily cover on the active tip face at a depth of 150 mm at the close of business each day; and,
- The use of intermediate cover on areas awaiting final capping.

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6. AIR QUALITY IMPACT ASSESSMENT

The methodology used to assess air quality impacts associated with the Proposal 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 Proposal in isolation.
- Cumulative impact – relates to the concentrations predicted as a result of the operation of the Proposal PLUS the background air quality concentrations discussed in **Section 4.4**.

The results are presented in this manner to allow examination of the likely impact of the Proposal 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

6.1 Particulate Matter

6.1.1 Annual Average TSP, PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the activities being performed as part of the Proposal are presented in **Table 10**.

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

Receptor	Annual Average Concentration ($\mu g \cdot m^{-3}$)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	2.1	47.7	49.8	0.8	20.4	21.2	0.1	7.4	7.6
R2	1.2	47.7	48.9	0.5	20.4	20.8	<0.1	7.4	<7.5
R3	0.3	47.7	48.0	0.1	20.4	20.5	<0.1	7.4	<7.5
R4	0.3	47.7	48.0	0.2	20.4	20.5	<0.1	7.4	<7.5
R5	0.1	47.7	47.8	<0.1	20.4	<20.5	<0.1	7.4	<7.5
Criterion	-	90		-	25		-	8	

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at sensitive receptor locations are low, representing < (less than) 2.4 % of the annual average TSP criterion, < 3.2 % of the annual average PM_{10} criterion, and <1.3 % of the annual average $PM_{2.5}$ criterion.

The addition of existing background concentrations (refer **Section 4.3**) does not result in any predicted exceedances of the annual average criteria for TSP, PM_{10} or $PM_{2.5}$.

The performance of the Proposal does not result in any exceedances of the annual average particulate matter impact assessment criteria.

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

6.1.2 Annual Average Dust Deposition Rates

Table 11 below presents the annual average dust deposition predicted as a result of the activities being performed at the Proposal site.

Table 11 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R1	<0.1	2.0	<2.1
R2	<0.1	2.0	<2.1
R3	<0.1	2.0	<2.1
R4	<0.1	2.0	<2.1
R5	<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 11**, 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 4.3**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors where the predicted impacts are < 5 % of the incremental criterion at all receptor locations.

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

The performance of the Proposal does not result in any exceedances of the annual average dust deposition impact assessment criteria.

6.1.3 Maximum 24-Hour PM_{10} and $PM_{2.5}$

Table 12 below presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the identified sensitive receptors, as a result of the activities being performed at the Proposal site. No background concentrations are included within this table.

Table 12 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum 24-hour average concentration ($\mu g{\cdot}m^{-3}$)	
	PM_{10}	$PM_{2.5}$
R1	9.7	1.5
R2	5.4	0.8
R3	1.4	0.2
R4	4.0	0.6
R5	1.8	0.3
Criterion	50	25

The maximum increment predicted is at Receptor R1. The maximum predicted incremental concentration of PM_{10} and $PM_{2.5}$ at surrounding sensitive receptors is demonstrated to be 9.7 $\mu g{\cdot}m^{-3}$ and 1.5 $\mu g{\cdot}m^{-3}$ or 19.4 % and 6 % of the respective criteria (refer **Table 12** above).

The predicted maximum 24-hour average PM_{10} concentrations resulting from the activities proposed to be performed as part of the Proposal at Receptor 1 (greatest impacted receptor), with background included are presented in **Table 13**.

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

Table 13 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
31/01/2014	0.9	88.2	89.1	04/07/2014	9.7	18.3	28.0
10/02/2014	0.2	87.3	87.5	29/05/2014	9.5	12.9	22.4
08/02/2014	0.7	62.4	63.1	31/07/2014	9.5	20.0	29.5
15/01/2014	2.7	57.7	60.4	30/07/2014	8.9	18.0	26.9
29/12/2014	1.7	58.0	59.7	25/07/2014	7.0	20.4	27.4
18/01/2014	0.9	58.8	59.7	22/09/2014	6.1	26.1	32.2
14/11/2014	1.5	54.8	56.4	19/05/2014	5.9	33.6	39.5
17/03/2014	1.4	54.4	55.8	22/04/2014	5.9	27.6	33.5
09/02/2014	1.8	53.8	55.6	29/07/2014	5.8	24.1	29.9
20/01/2014	0.1	55.3	55.4	21/06/2014	5.7	13.6	19.3
20/11/2014	2.9	50.9	53.7	28/07/2014	5.4	11.8	17.3
29/01/2014	0.8	52.6	53.4	03/07/2014	5.3	16.0	21.3
18/03/2014	1.0	52.1	53.1	02/05/2014	5.2	39.5	44.7
22/01/2014	<0.1	50.0	<50.1	16/07/2014	5.0	7.9	12.9
21/03/2014	2.2	46.4	48.6	21/04/2014	4.4	26.4	30.8
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the Proposal.			

The analysis identifies a number of days that are predicted to exceed the maximum 24-hour average PM_{10} criterion, but these are driven by background concentrations already exceeding the criterion (50 µg·m^{-3}).

The analysis indicates that one additional exceedance of the maximum 24-hour average impact assessment criteria for PM_{10} could potentially occur as a result of the activities being performed as part of the Proposal at Receptor 1 (the greatest impacted receptor). Given that the incremental contribution from the Proposal on that day is predicted to be <0.1 µg·m^{-3}, and the background concentration is at the criterion of 50 µg·m^{-3}, no additional mitigation measures could be employed to remove this potential exceedance. Examination of the modelling files indicate that the predicted concentration on that day at R1 is 0.0 µg·m^{-3}. The predicted exceedance therefore results from the approach adopted in the presentation of results rather than Proposal activities/impacts.

Impacts at all other identified sensitive receptor locations are shown to result in no additional exceedances of the maximum 24-hour average PM_{10} criterion.

The performance of the Proposal does not result in any additional exceedances of the maximum 24-hour average PM_{10} impact assessment criteria at the identified sensitive receptor locations.

The predicted maximum 24-hour average $PM_{2.5}$ concentrations resulting from the activities being performed as part of the Proposal including and excluding background are presented in **Table 14**. Model predictions indicate that the maximum cumulative $PM_{2.5}$ impacts are likely to be experienced at receptor R4, with maximum incremental $PM_{2.5}$ impacts experienced at receptor R1. **Table 14** includes results for both of these receptor locations.

Table 14 Summary of contemporaneous impact and background – $PM_{2.5}$ Receptor R4 and R1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – R4			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – R1		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
04/02/2014	0.1	27.6	27.7	31/07/2014	1.5	8.1	9.6
09/06/2014	<0.1	26.7	26.8	04/07/2014	1.3	12.7	14.0
10/02/2014	<0.1	24.1	24.2	29/05/2014	1.3	7.7	9.0
10/06/2014	0.6	20.2	20.8	30/07/2014	1.2	8.1	9.3
15/01/2014	<0.1	19.0	19.1	25/07/2014	0.9	14.1	15.0
20/07/2014	0.3	17.6	17.9	29/07/2014	0.9	12.8	13.7
16/05/2014	<0.1	17.2	17.3	22/09/2014	0.8	7.4	8.2
03/08/2014	0.1	16.5	16.6	21/06/2014	0.8	12.8	13.6
23/02/2014	<0.1	15.2	15.3	22/04/2014	0.8	11.6	12.4
08/06/2014	<0.1	14.6	14.7	19/05/2014	0.7	11.3	12.0
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour PM2.5 predictions (outlined in blue) as a result of the operation of the Proposal.			

The analysis identifies a number of days that are predicted to exceed the maximum 24-hour average $PM_{2.5}$ criterion, but these are driven by background concentrations already exceeding the criterion (25 $\mu g \cdot m^{-3}$).

The analysis indicates that no additional exceedances of the maximum 24-hour average impact assessment criteria for $PM_{2.5}$ are likely to occur as a result of the activities being performed as part of the Proposal at the nearest sensitive receptor locations.

The performance of the Proposal does not result in any additional exceedances of the maximum 24-hour average $PM_{2.5}$ impact assessment criteria at the identified sensitive receptor locations.

Contour plots of the predicted incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations associated with the Proposal, are provided in **Figure 6** and **Figure 7**, respectively.

Figure 6 Predicted maximum incremental 24-hour average PM_{10} concentrations resulting from Proposal activities

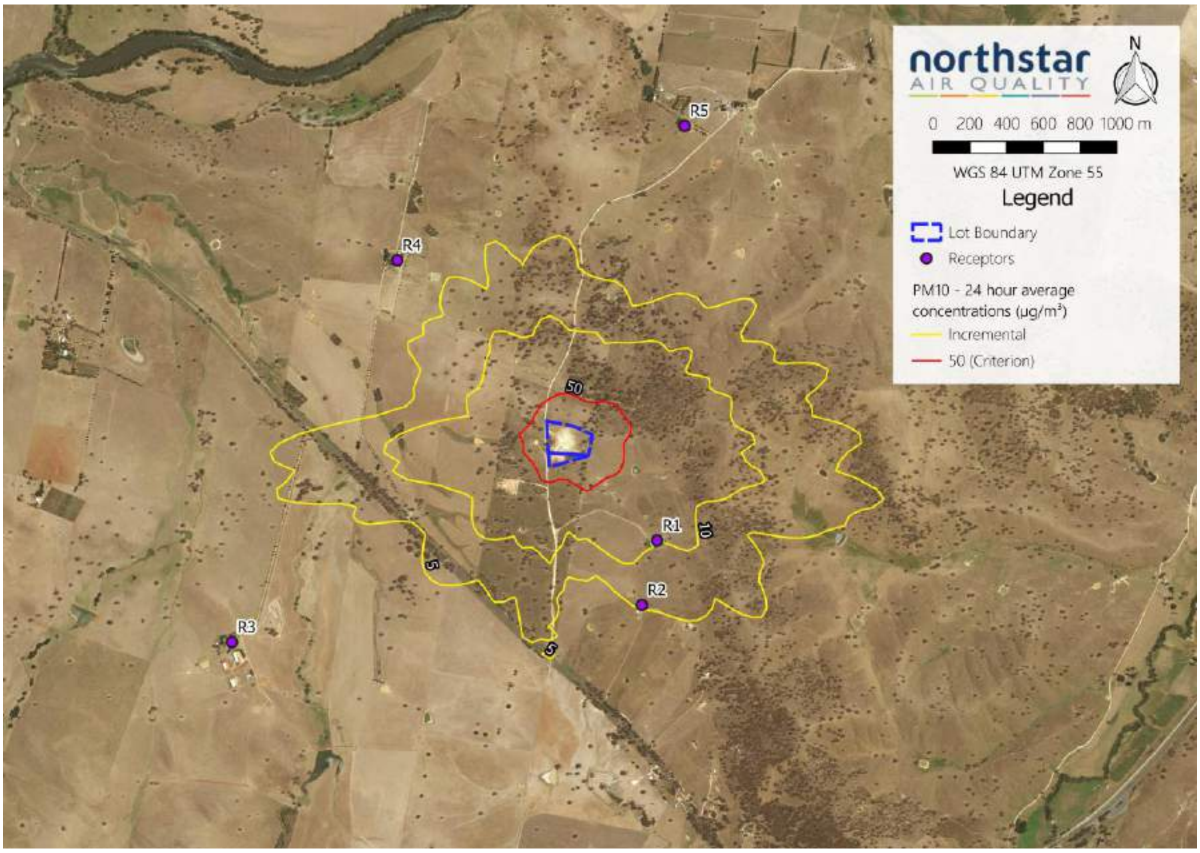
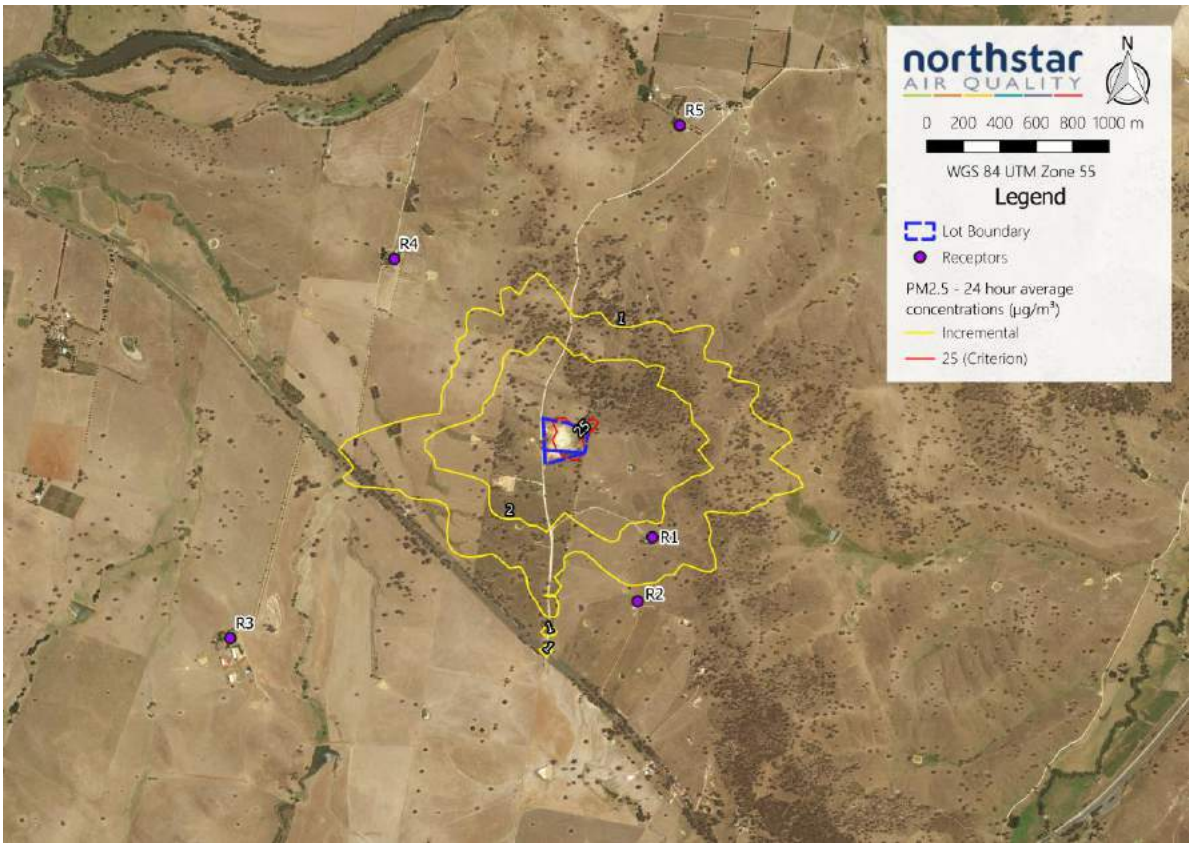


Figure 7 Predicted maximum incremental 24-hour average $PM_{2.5}$ concentrations resulting from Proposal activities



6.2 Odour

The predicted 1-hour average 99th percentile odour concentrations (OU) resulting from the operation of the Proposal are presented in **Table 15**. As discussed, these impacts represent the placement and storage of putrescible wastes, where the Proposal would only accept non-putrescible wastes which would be significantly less odorous. The results can therefore be viewed as highly conservative.

Table 15 Predicted 1-hour average 99^th percentile odour concentration

Receptor	99th percentile 1-second (nose response time) odour concentration (OU)
R1	1.0
R2	0.8
R3	0.2
R4	1.4
R5	0.2
Criterion	6.0

The results indicate that the operations can be performed without unacceptable odour impacts at the surrounding residential receptors. Predicted 1-odour concentrations at all receptors are below the adopted 6 OU criterion and as a maximum impact (1.4 OU at receptor R4), represent<24% of the criterion.

7. MITIGATION AND MONITORING

7.1 Mitigation

The mitigation measures to be employed as part of the Proposal are outlined in **Section 5.4** and reproduced below.

Emissions of particulate matter would be controlled during construction through:

- Minimisation of drop heights when loading haul trucks with excavated material.
- The use of a water cart on unsealed site roads; and,
- The limiting of vehicle speeds across unpaved areas of the site.

During operation, particulate matter emissions would be controlled by:

- Paving the road between the site and Old Hume Highway;
- Minimisation of drop heights when placing waste and daily cover; and,
- The limiting of vehicle speeds across the site, and on the paved road between the Old Hume Highway and the Proposal site.

Odour emissions resulting from the placement and storage of non-putrescible waste materials are likely to be minor. Emissions will be managed through the adoption of industry best practice as outlined in the NSW Landfill Guidelines (NSW EPA, 2016), including:

- Restriction of the active tip face to 600 m^2;
- Placement of daily cover on the active tip face at a depth of 150 mm at the close of business each day; and,
- The use of intermediate cover on areas awaiting final capping.

It is demonstrated within this AQIA that the measures above will be sufficient to ensure that no exceedances of the adopted air quality and odour criteria would be experienced during the performance of activities at the Proposal site.

The implementation of the mitigation measures outlined above would be managed through an Air Quality Management Plan (AQMP). The AQMP would detail the management procedures to be employed at the Proposal site, and how these measures would be reviewed and audited.

A complaints register would be maintained at the Proposal site to record any complaints relating to air quality (and odour). These records would be made available to NSW EPA and DP&E upon request.

7.2 Monitoring

Based on the activities being performed as part of the construction and operation of the Proposal, and based on the results of the AQIA, no air quality (or odour) monitoring is proposed to be performed during the construction or operation of the Proposal.

8. CONCLUSION

InSitu Advisory Pty Ltd (InSitu) on behalf of MH Earthmoving Pty Ltd (MHE) has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality and odour impact assessment (AQIA) for the proposed repurposing of a quarry into a waste disposal facility (the Proposal). The Proposal will be located at Lot 7004 DP 1028797 & Lot 7300 DP 1149008 on Tumblong Reserve Road, Tumblong, NSW (the Proposal site).

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

The AQIA presents an assessment of the impacts of the proposed construction and operational activities at the Proposal site which has been performed using a quantitative dispersion modelling approach, and in accordance with relevant NSW guidelines. The results of the assessment are presented as predicted incremental and cumulative impacts, accounting for prevailing background air quality conditions, where applicable.

In the case of particulate matter, the concurrent construction and operation of the Proposal would not result in any additional exceedances of short term (24-hour) or longer term (annual average) deposition or concentration criteria.

In the case of odour, predicted impacts have been assessed assuming that odour emissions from the non-putrescible waste accepted would be similar to emissions from putrescible waste. Even under this highly conservative assumption, compliance with the NSW EPA odour criterion is easily achieved. Odour during actual operation of the landfill is anticipated to be significantly lower than that predicted.

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

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9. REFERENCES

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APPENDIX A

Report Units and Common Abbreviations

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

Table A1 Common Abbreviations

Abbreviation	Term
AADT	annual average daily traffic
ABS	Australian Bureau of Statistics
ACH	air changes per hour
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AWS	automated weather station
BoM	Bureau of Meteorology
°C	degrees Celsius
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCP	Development Control Plan
DPE	NSW Department of Planning and Environment
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
F	fluoride
FEL	front end loader
GDA	Geocentric Datum of Australia
GHG	Greenhouse gas
GIS	geographical information system
HCl	hydrogen chloride
HF	hydrogen fluoride
K	kelvin (-273°C = 0 K, ±1°C = ±1 K)
kW	kilowatt
MGA	Map Grid of Australia

Abbreviation	Term
$mg \cdot m^{-3}$	milligram per cubic metre of air
$mg \cdot Nm^{-3}$	milligram per normalised 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
ODT	odour detection level
OEH	NSW Office of Environment and Heritage
OIA	odour impact assessment
OU	odour unit
Pa	Pascals
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
SEARs	Secretary’s Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEE	Statement of Environmental Effects
SO_X	oxides of sulphur
SO_2	sulphur dioxide
SSD	State Significant Development
STP	standard temperature and pressure (273.15 K, 101.3 kPa)
TAPM	The Air Pollution Model
TPM	total particulate matter
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VKT	vehicle kilometres travelled
VOC	volatile organic compounds

APPENDIX B

Meteorology

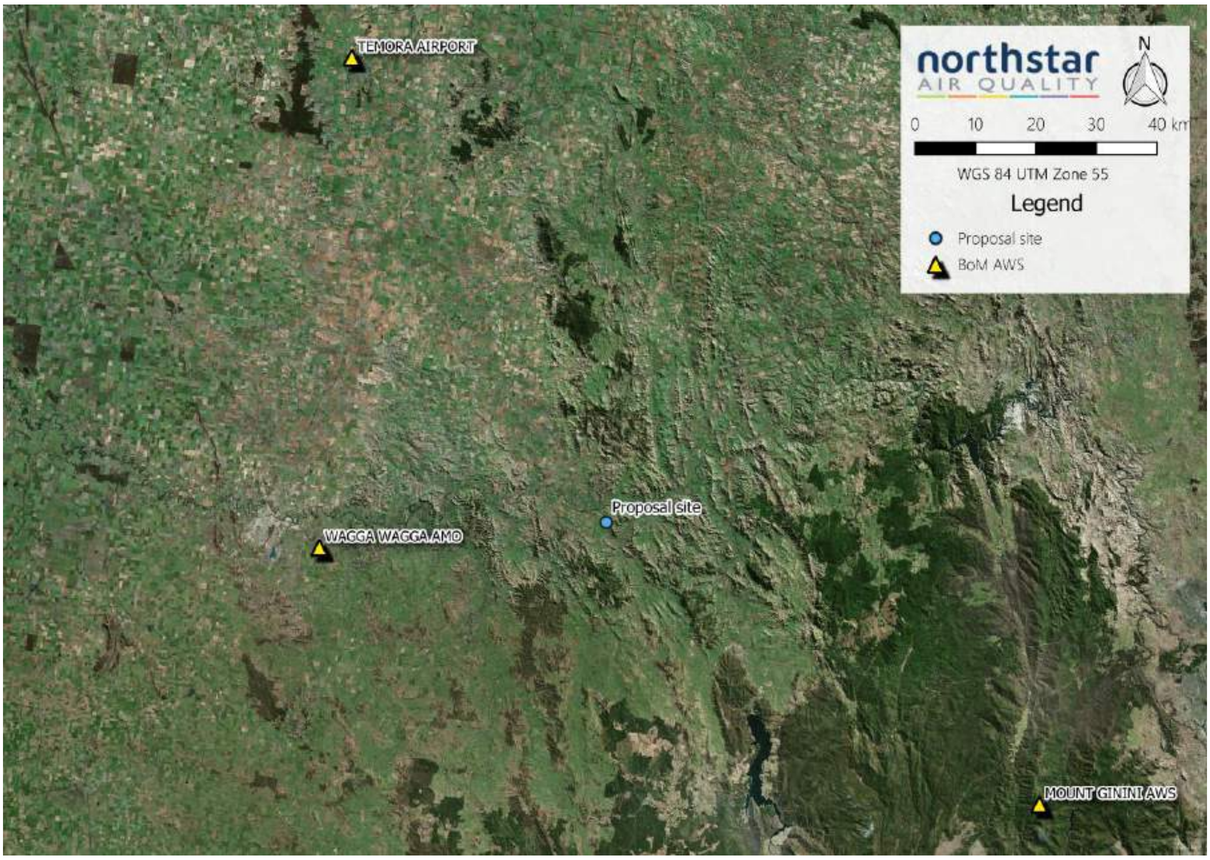
As discussed in **Section 4.3** a meteorological modelling exercise has been performed to characterise the meteorology of the Proposal site in the absence of site-specific measurements. The meteorological monitoring has been based on measurements taken at a number of surrounding automated weather stations (AWS) operated by the Bureau of Meteorology (BoM).

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

Table B1 Details of the meteorological monitoring surrounding the Proposal site

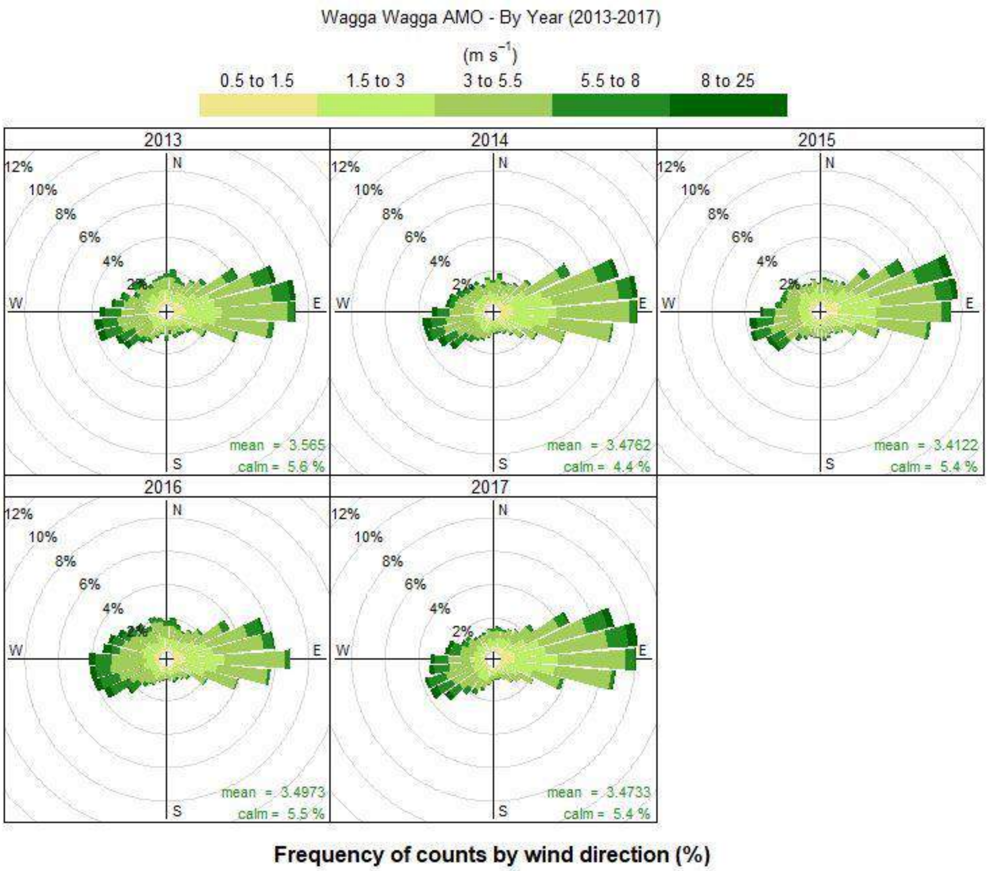
Site Name	Source	Approximate Location (UTM)		Approximate Distance to Site
		mE	mS	km
Wagga Wagga AMO – Station # 72150	BoM	541 667	6 109 306	47.6
Mount Ginni – Station # 70349	BoM	660 667	6 066 812	85.5
Temora Airport – Station # 73151	BoM	547 016	6 190 301	87.6

Figure B1 Meteorological and air quality monitoring surrounding the Proposal site



Meteorological conditions at Wagga Wagga AMO AWS (Wagga AWS) have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the recent years of data (2013 to 2017) are presented in **Figure B2**.

Figure B2 Annual wind roses 2013 to 2017, Wagga Wagga AMO AWS



The wind roses indicate that from 2013 to 2017, winds at Wagga AWS shows a predominant easterly component to the direction.

The majority of wind speeds experienced at Wagga AWS over the 5-year period, 2013 to 2017 are generally in the range of 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 a easterly direction. Winds of this speed are not uncommon, occurring during 3.6 % of the observed hours over the 5-year period at Wagga AWS. Calm winds (<0.5 $m \cdot s^{-1}$) occur during 5.3 % of hours on average across the 5-year period.

The annual distribution of PM_{10} has also been taken into account to determine the most suitable year for modelling, so that the meteorological data and background air quality data are contemporaneous. The PM_{10} distribution determines that 2014 is most representative of the 5-year period (2013-2017) at Wagga Wagga North AQMS (refer to **Appendix C**).

Given the wind distributions across the years examined, and the representative nature of the year 2014 in relation background air quality, data for the year 2014 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied.

Presented in **Figure B3** are the annual wind rose for the 2013 to 2017 period and the year 2014 and in **Figure B4** the annual wind speed distribution for Wagga AWS. These figures indicate that the distribution of wind speed and direction in 2014 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2014 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure B3 Annual wind roses 2013 to 2017, and 2014 Wagga Wagga AMO AWS

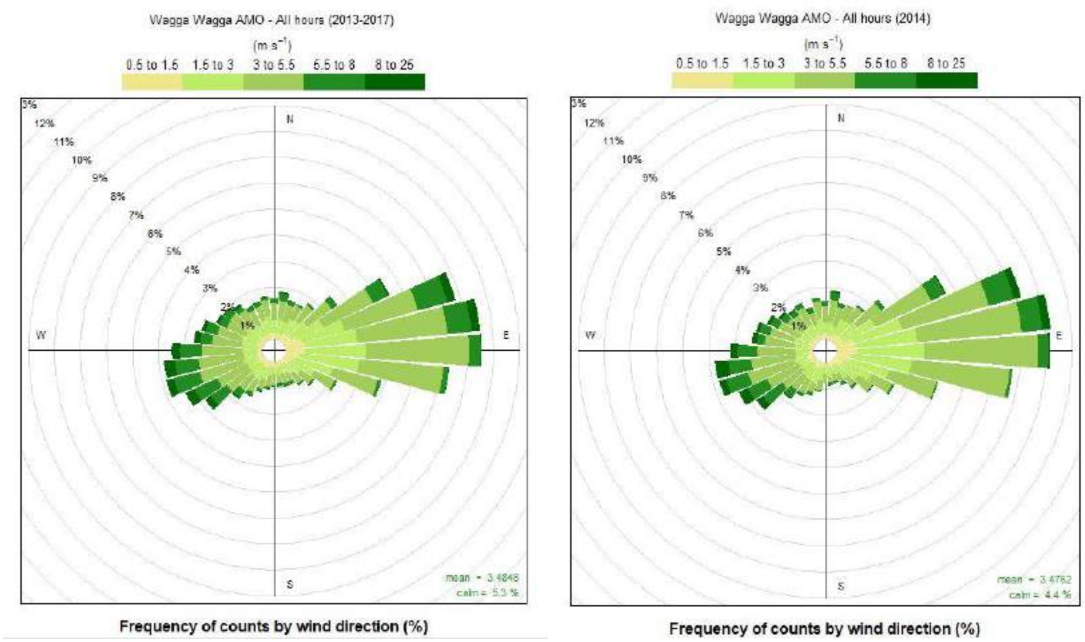
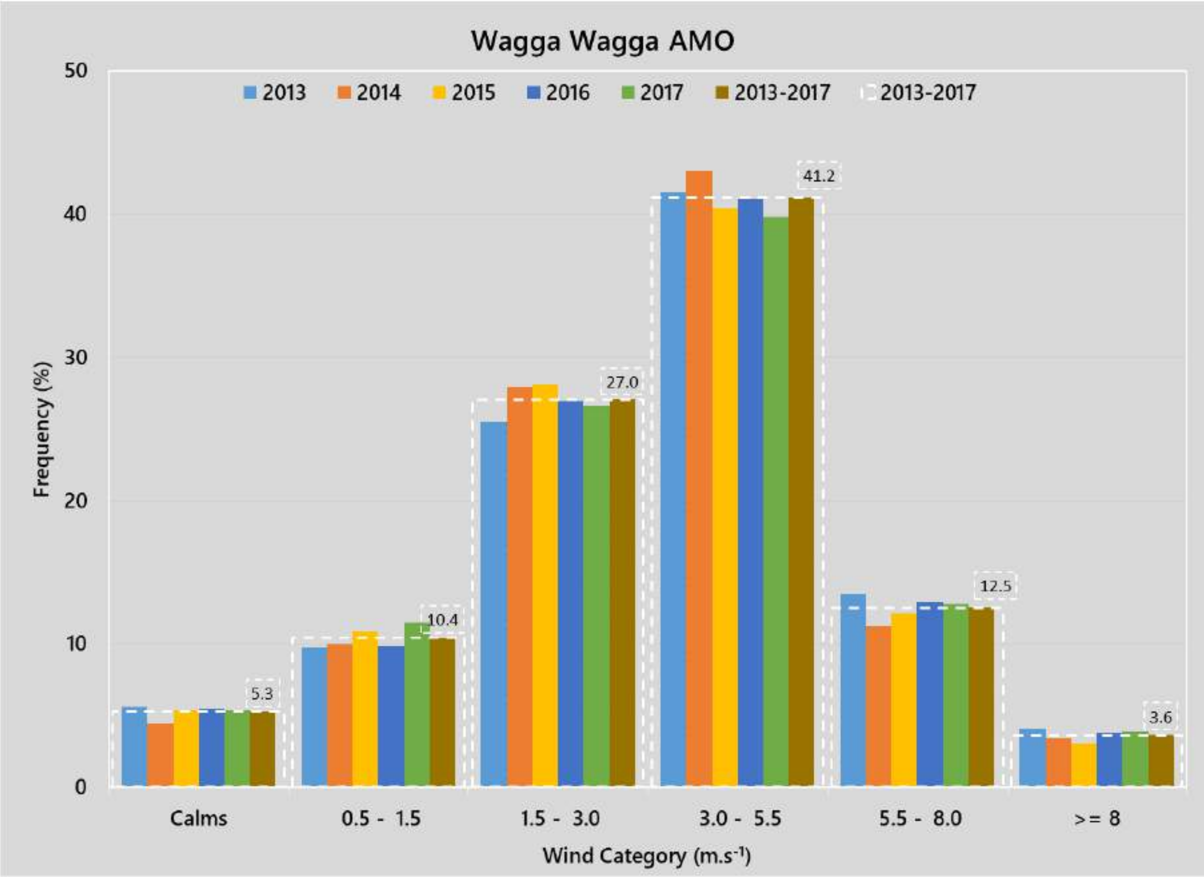


Figure B4 Annual wind speed distribution – Wagga Wagga AMO AWS



Meteorological Modelling

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

In absence of any measured onsite meteorological data, site representative meteorological data for this Proposal was generated using the CALMET meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 4.3)**.

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

In this study, CALMET has been run in no-observations (no-obs) mode using gridded prognostic data generated by The Air Pollution Model (TAPM, v 4.0.5), developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

TAPM is a prognostic model which 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.

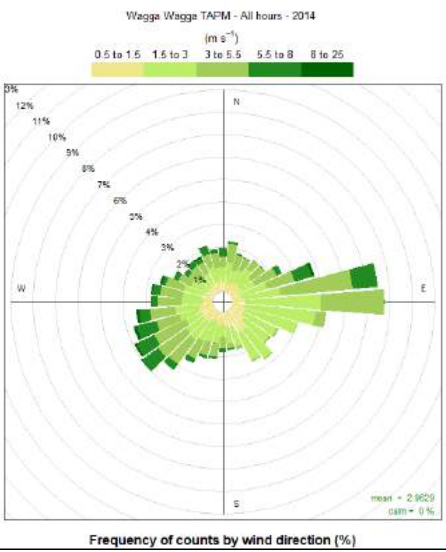
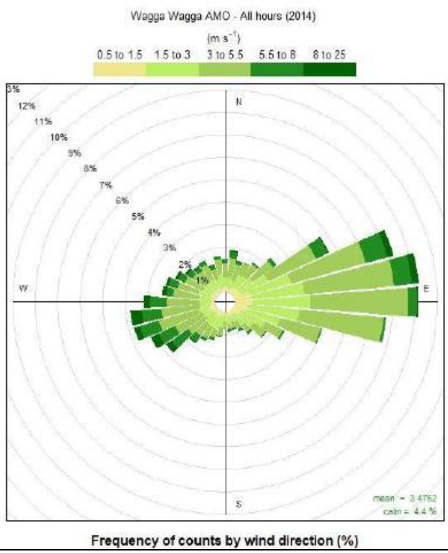
The parameters used in TAPM and CALMET modelling are presented in **Table B2**.

Table B2 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2014 to 31 December 2014
Centre of analysis	565 300 mS, 6 112 860 mN (UTM Coordinates)
Number of grid points	60 x 60 x 25
Number of grids (spacing)	4 (25 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	N/A
CALMET	
Modelling period	1 January 2014 to 31 December 2014
South-West corner of analysis	584 000 mS, 6 108 500 mN (UTM Coordinates)
Meteorological grid domain (resolution)	10 km x 10 km (0.2 km)
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data assimilation	No-obs approach using TAPM – 3D.DAT file

A comparison of the TAPM generated meteorological data, and that observed at the Wagga AWS, is presented in **Figure B5**. These data generally compare well which provides confidence that the data being input to CALMET for further modelling are appropriate. Comparison of the CALMET modelled data and the observations at Wagga AWS is not possible due to the large separation distances between the Proposal site and that AWS.

Figure B5 Modelled and observed meteorological data – Wagga Wagga AMO AWS, 2014

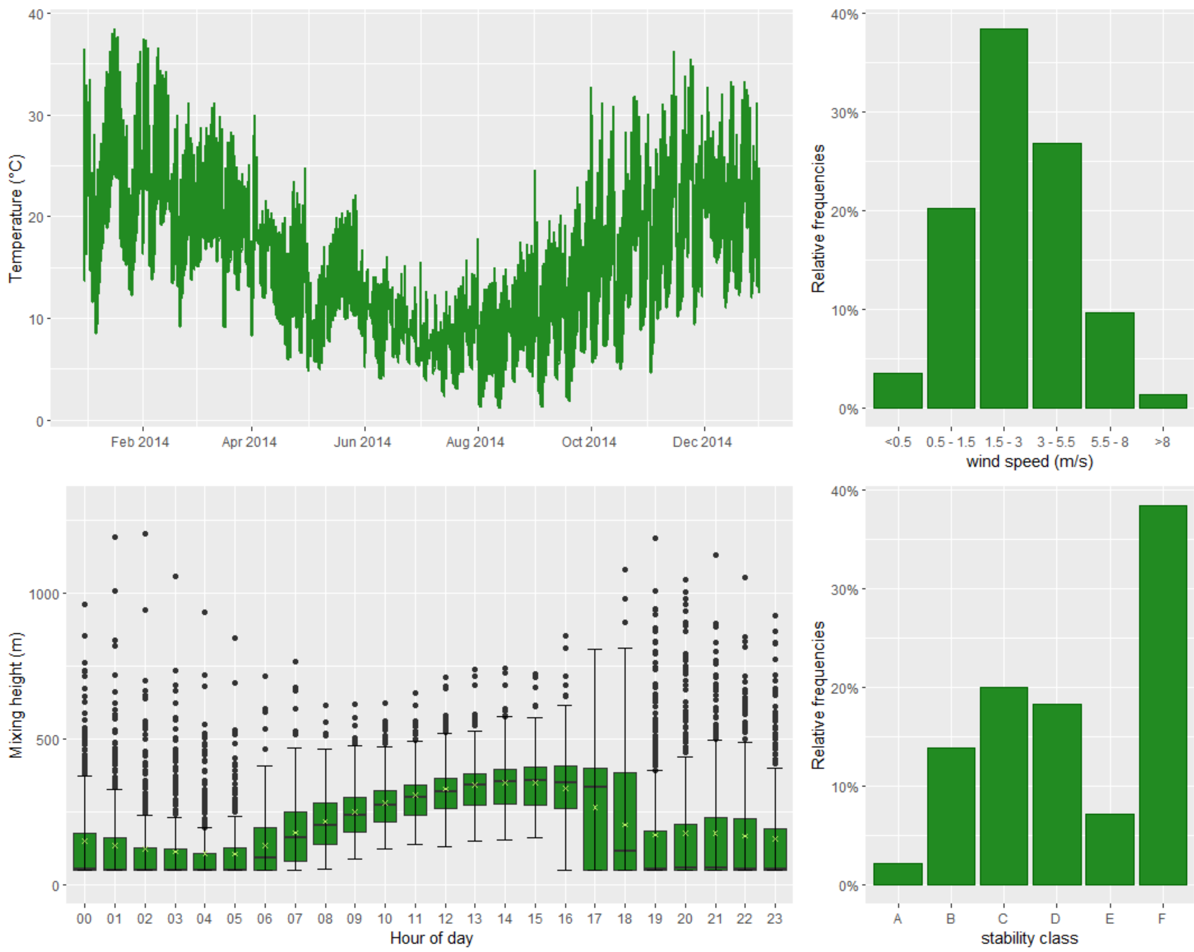
Wagga Wagga TAPM generated windrose	Observations at Wagga AWS
	

As generally required by the NSW EPA the following provides a summary of the modelled meteorological dataset. Given the nature of the pollutant emission sources at the Proposal site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirulation potential of the Proposal site has not been provided. Details of the CALMET predictions of wind speed and direction, mixing height, temperature and stability class at the Proposal site are provided in **Figure B6**.

The modelled temperature variations at the Proposal site during 2014 predicted a maximum temperature of 39°C on the 17th January 2014 and a minimum temperature of 1°C on the 13th August 2014.

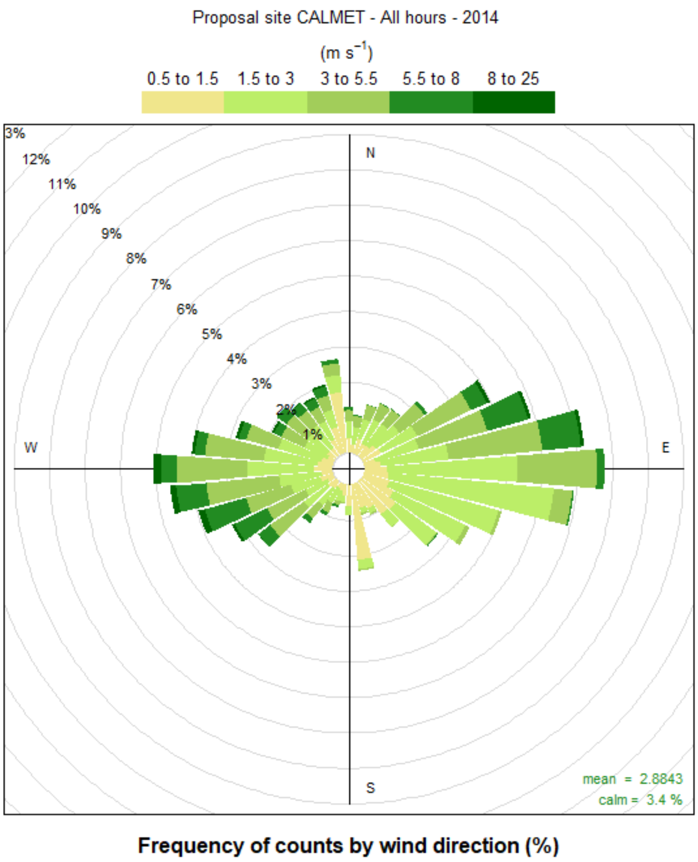
Diurnal variations in maximum and average mixing heights during the 2014 period shows that, as expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure B6 Predicted temperature, mixing height, wind speed and stability class frequencies – Proposal site 2014



The modelled wind speed and direction at the Proposal site during 2014 is presented in **Figure B7**.

Figure B7 Predicted wind speed and direction – Proposal site 2014



APPENDIX C

Background Air Quality Data

Air quality is not monitored at the Proposal site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this assessment. Determination of data to be used as a location representative of the Proposal site and during a representative year can be complicated by factors which include:

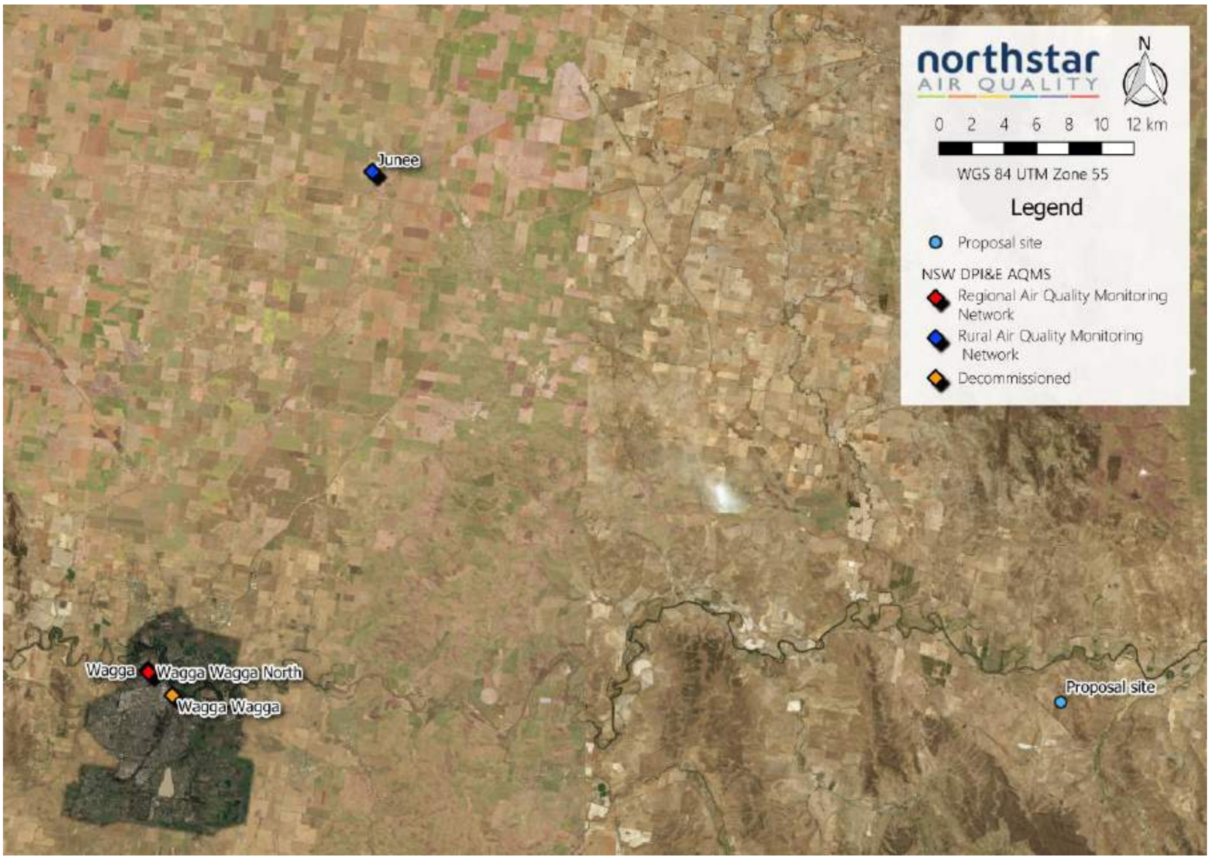
- the sources of air pollutant emissions around the Proposal site and representative AQMS; and,
- the variability of particulate matter concentrations (often impacted by natural climate variability).

Air quality monitoring is performed by the NSW Department of Planning, Industry and Environment (DPI&E) at four air quality monitoring station (AQMS) within a 60 km radius of the Proposal site, in regional centres and as part of the Rural Air Quality Monitoring Network (RAQMN). Details of the monitoring performed at these AQMS is presented in **Table C1** and **Figure C1**. The period of data being analysed is 2014 and has been selected to be contemporaneous with the meteorological modelling year (refer to **Appendix B**) and based upon the annual distribution of PM_{10} measured at Wagga Wagga North AQMS (see below).

Table C1 Details of Closest AQMS Surrounding the Proposal site

AQMS Location	Distance to Site (km)	Screening Parameters				
		Network	2014 Data	Measurements		
				TSP	PM_{10}	$PM_{2.5}$
Junee	53.6	RAQMN	×	✓	×	×
Wagga Wagga	54.8	Decommissioned	×	×	✓	×
Wagga Wagga North	56.3	Regional	✓	×	✓	✓
Wagga	56.4	RAQMN	×	✓	✓	✓

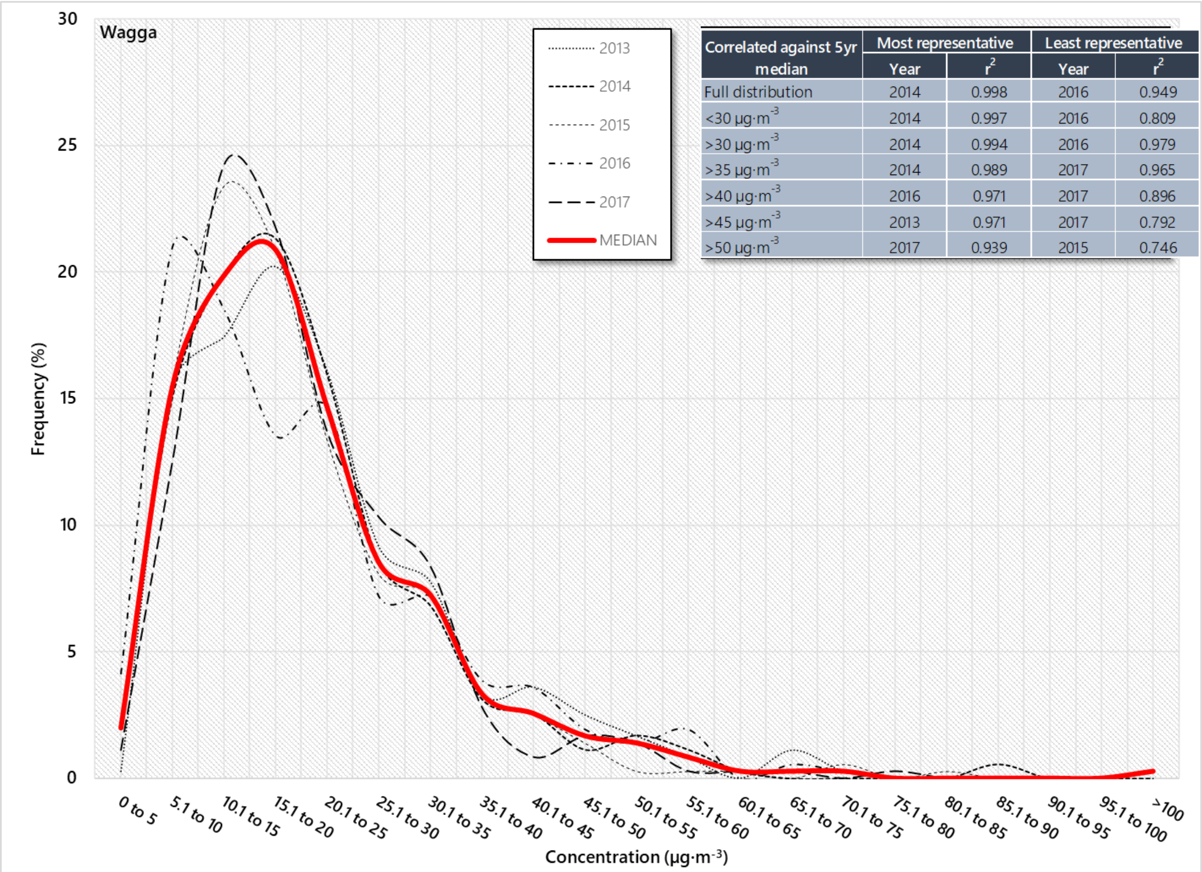
Figure C1 Meteorological and air quality monitoring surrounding the Proposal site



Based on the sources of AQMS data available and their proximity to the Proposal site, Wagga Wagga North was selected as the source of AQMS data for use in this assessment.

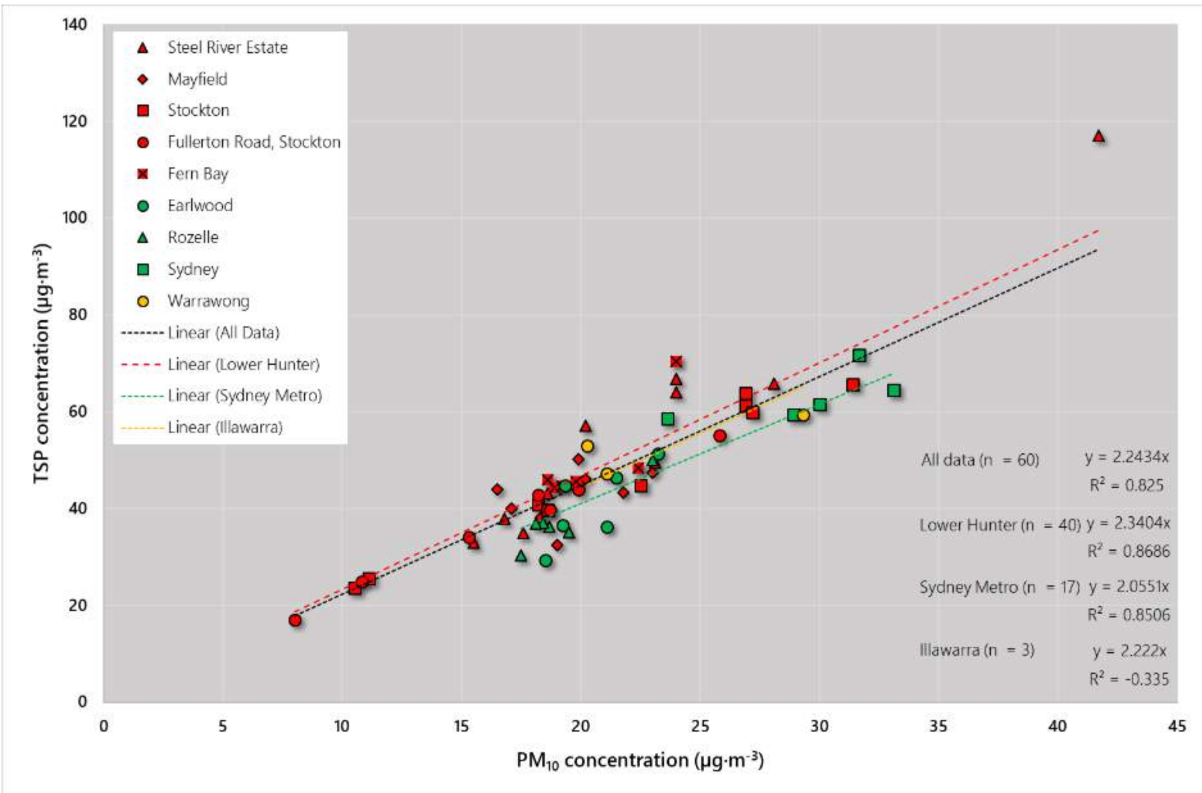
The annual frequency distribution of PM_{10} has been analysed to determine a representative year to be adopted as background air quality in this assessment. **Figure C2** illustrates the frequency distribution over the recent 5-year period (2013-2017). The distribution shows that 2014 is most representative of the overall 5-year median. Subsequently, 2014 has been adopted in this assessment as it best represents the long-term trend for PM_{10}.

Figure C2 Annual PM_{10} distribution at Wagga Wagga North



It is noted that as part of the DPI&E Rural Air Quality Monitoring Network program there are AQMS that measure TSP, however access to that data is not available at the time of reporting. Based upon long-term historic monitoring data, 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 C3**. 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 2.222 : 1 (i.e. PM_{10} represents ~45% of TSP) from the Illawarra region is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA, resulting in a background annual average TSP concentration of 46.0 µg·m^{-3} being adopted.

Figure C3 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 Proposal 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 $g \cdot m^{-2} \cdot month^{-1}$).

Summary statistics are for TSP, PM_{10} and $PM_{2.5}$ are presented in **Table C2**.

Table C2 TSP, PM_{10} and $PM_{2.5}$ statistics 2014 – Wagga Wagga North

Pollutant	TSP ($\mu g.m^{-3}$)[3]	PM_{10} ($\mu g.m^{-3}$)	$PM_{2.5}$ ($\mu g.m^{-3}$)
Averaging Period	Annual	24-Hour	24-Hour
Data Points (number)	352	352	351
Mean	46.0	20.7	7.5
Standard Deviation	-	12.3	3.9
Skew[1]	-	1.8	1.4
Kurtosis[2]	-	5.1	3.8
Minimum	46.0	3.7	1.3
Percentiles ($\mu g \cdot m^{-3}$)			
1	-	4.7	1.8
5	-	6.6	2.9
10	-	8.4	3.3
25	-	12.6	4.7

Pollutant	TSP (µg.m^{-3})[3]	PM_{10} (µg.m^{-3})	$PM_{2.5}$ (µg.m^{-3})
Averaging Period	Annual	24-Hour	24-Hour
50	-	18.3	6.6
75	-	25.4	9.8
90	-	36.6	12.7
95	-	43.8	14.0
97	-	52.3	14.4
98	-	54.8	16.5
99	-	58.4	19.6
Maximum	46.0	88.2	27.6
Data Capture (%)	96.4	96.4	96.2

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.

Graphs presenting the daily varying PM_{10} and $PM_{2.5}$ data recorded at Wagga Wagga North in 2014 are presented in **Figure C4** and **Figure C5**, respectively.

It is also noted that during 2014 in the months of January, February and November, there were numerous exceedances of PM_{10} and $PM_{2.5}$ measured at Wagga Wagga North, which according to NSW DPI&E through the NEPM compliance review process, were a result of local grass fires. The Victorian bushfires also caused an exceedance at Wagga Wagga North during February. These events are evident in the **Figure C4** and **Figure C5**.

Figure C4 PM_{10} Measurements, Wagga Wagga North 2014

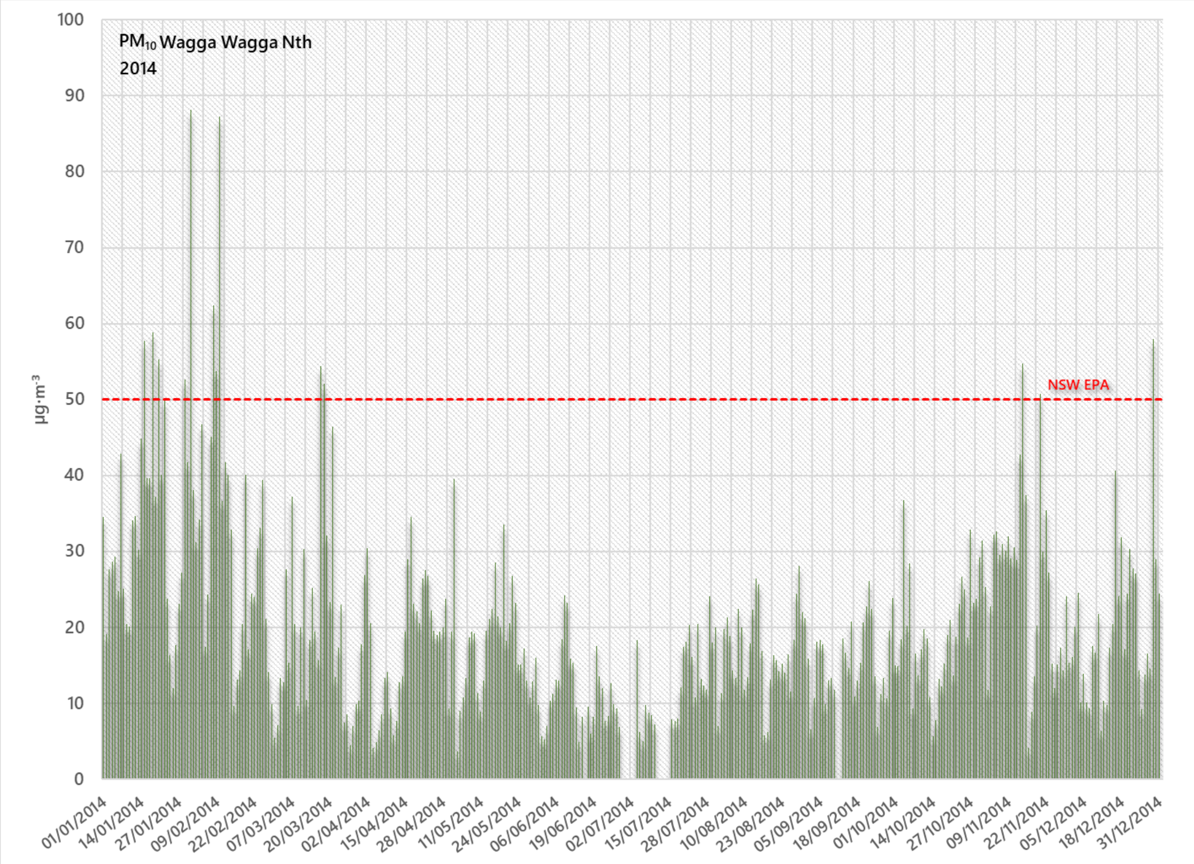
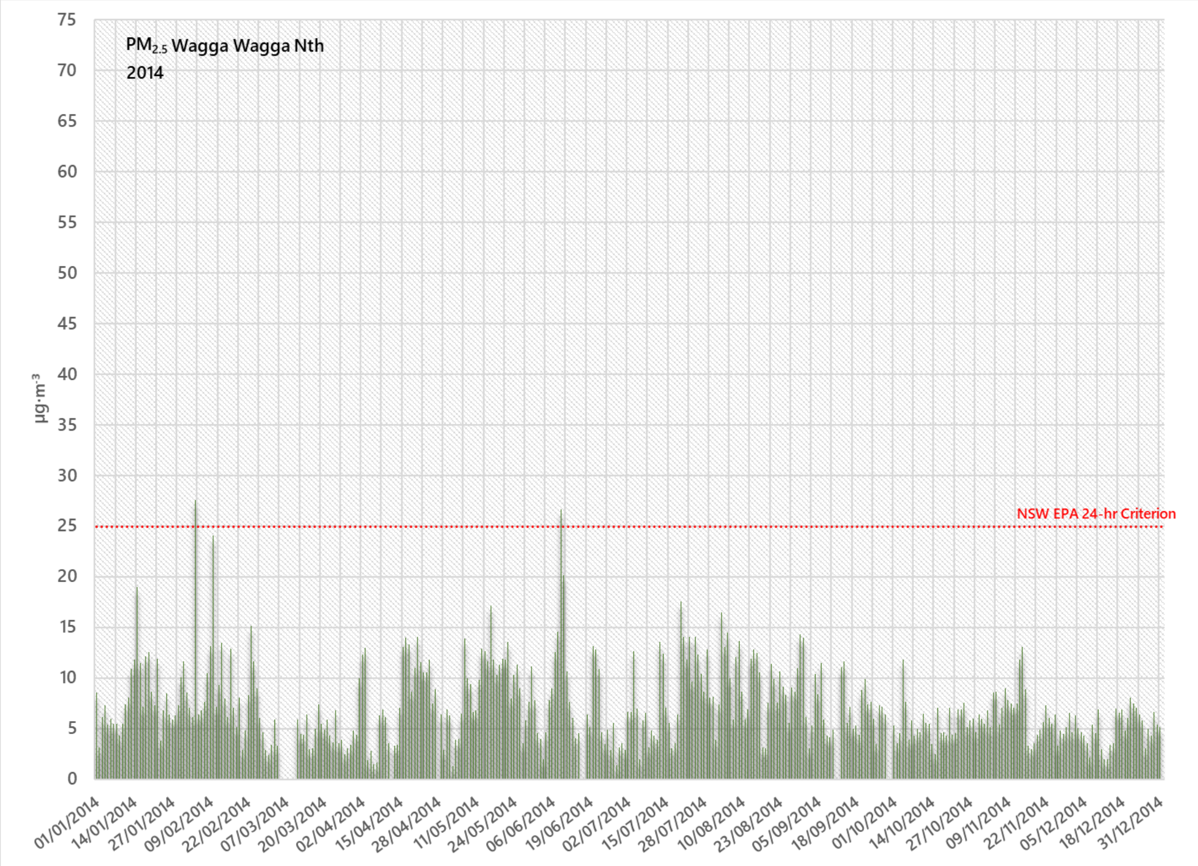


Figure C5 $PM_{2.5}$ Measurements, Wagga Wagga North 2014



APPENDIX D

Emissions Estimation

Emission factors – particulate matter

As outlined in **Section 2.4**, a number of operations to be performed as part of the Proposal have the potential to result in emissions of particulate matter. A detailed outline of the emission estimation techniques adopted to derive total emissions from the sources identified in **Section 2.4** are presented below.

Emission factors published by the US EPA in the Compilation of Air Pollutant Emission Factors (AP-42) have been adopted to allow estimation of particulate matter emissions (TSP, PM_{10} and $PM_{2.5}$) from the activities being performed at the Proposal site. Several AP-42 sections have been consulted in the preparation of this assessment including:

11.9	Western Surface Coal Mining
11.19.2	Crushed Stone Processing and Pulverised Mineral Processing
13.2.2	Unpaved Roads
13.2.1	Paved Roads
13.2.4	Aggregate Handling and Storage Piles

Material excavation, loading and unloading, managing stockpiles

Emissions of particulate matter resulting from the excavation of material, loading of materials to trucks, and the unloading of materials at stockpiles, or daily cover have been estimated using the emission factor presented in Section 13.2.4 of AP-42 (Aggregate Handling and Storage Piles) (US EPA, 2006b).

The emission factor on page 13.2.4-4 has been adopted for the operations outlined above:

$$E\ (kg \cdot tonne^{-1}) = k(0.0016)\ \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:

E = emission factor

k = particle size multiplier (dimensionless)

U = mean wind speed ($m \cdot s^{-1}$)

M = material moisture content (%)

The particle size multiplier (k) for TSP, PM_{10} and $PM_{2.5}$ are provided in (US EPA, 2006b) as 0.74, 0.35 and 0.2, respectively.

The value adopted for U (mean wind speed) has been calculated from the output of the modelled meteorological file which has been calculated to be 2.1 $m \cdot s^{-1}$.

The value adopted for M (material moisture content) has been assumed to be 2 % for all materials handled at the Proposal site. A review of several AQIA was performed which indicates that a range of values between 2 % and 5 % moisture content for materials handled at hard rock or aggregate quarries have been previously adopted. For the purposes of this assessment, a value of 2 % has been adopted for all materials to be handled as part of Proposal operations. This is the lowest value of those reviewed and is conservative. The moisture content of all materials has also been assumed to be 2 %.

Transportation

Emissions of particulate matter resulting from the movement of materials on unpaved and paved roads have been estimated using the emission factors presented in Section 13.2.2 (Unpaved Roads) and 13.2.1 (Paved Roads) of AP-42, respectively (US EPA, 2006a), (US EPA, 2011).

The emission factor on page 13.2.2-4 of (US EPA, 2006a) has been adopted for the operations of vehicles on unpaved roads:

$$E\ (kg \cdot VKT^{-1}) = 0.2819\ \times k(s/12)^{a}(W\ \times\ 0.907185/3)^{b}$$

where:

E = emission factor (kg per vehicle kilometre travelled) multiplied by 0.2819 to convert from lb per vehicle mile travelled

k = particle size multiplier (dimensionless)

s = surface material silt content (%)

W = mean vehicle weight (tons) multiplied by 0.907185 to convert to metric tonnes

The particle size multipliers (k) for TSP, PM_{10} and $PM_{2.5}$ are provided in (US EPA, 2006a) as 4.9, 1.5 and 0.15, respectively. The silt content (s) of unpaved haul roads at the Proposal site has been taken to be 7.1 % which equates to a haul road at a landfill facility (Table 13.2.2-1 of (US EPA, 2006a)). This is considered to most appropriately reflect the proposed operations.

The mean weight (W) of vehicles has been calculated based on the use of 25 t Moxy (MT26) dump trucks (or similar) which has a payload of 23.5 t, tare weight of 22.0 t and a loaded weight of 45.5 t (ritchiespecs.com). The average vehicle weight has therefore been calculated to be 33.75 t (metric).

The emission factor on page 13.2.1-4 of (US EPA, 2011) has been adopted for the operations of vehicles on paved roads:

$$E\ (kg \cdot VKT^{-1}) = k(sL)^{0.91}(W\ \times\ 0.907185)^{1.02}$$

where:

E = emission factor (kg per vehicle kilometre travelled)

k = particle size multiplier (dimensionless)

sL = road surface silt loading (g·m^{-2})

W = average weight (tons) of vehicles travelling the road multiplied by 0.907185 to convert to metric tonnes

The particle size multipliers (k) for TSP, PM_{10} and $PM_{2.5}$ are provided in (US EPA, 2011) as 3.23, 0.62 and 0.15, respectively.

The road surface silt loading (sL) of the paved haul road from the Old Hume Highway to the Proposal site has been taken to be 7.4 g·m^{-2} which is associated with municipal solid waste landfills (US EPA, 2011).

The mean weight of vehicles (W) has been calculated based on the use of 30 t capacity truck and dog vehicles, which would have a payload of 30 t, tare weight of 15.0 t and a loaded weight of 45.0 t. The average vehicle weight has therefore been calculated to be 30.0 t (metric).

Redistribution of material for sub-base layer

The use of a bulldozer has been assumed to be required for the redistribution of material for the construction of the sub-base layer of the waste cells. The emissions of particulate matter from the bulldozing (overburden) process have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mining) (US EPA, 1998). The emission factor is:

$$EF_{TSP}\ (kg.hr^{-1}) = \frac{2.6 \times (s)^{1.2}}{(M)^{1.3}}$$

$$EF_{PM_{15}}\ (kg.hr^{-1}) = \frac{0.45 \times (s)^{1.5}}{(M)^{1.4}}$$

$$EF_{PM_{10}}(kg.hr^{-1}) = 0.75\ \times EF_{PM_{15}}$$

$$EF_{PM_{2.5}}\ (kg.hr^{-1}) = 0.105 \times EF_{TSP}$$

where:

$EF_{(kg \cdot hr^{-1})}$ = emission factor for particulate matter

$s_{(\%)}$ = silt content in %, by weight

$M_{(\%)}$ = moisture content of overburden in %, by weight

Vibrational roller

The use of a vibrational roller is anticipated as part of the construction of the waste cells. To represent emissions from this source, the emission factor for grading has been adopted.

The emissions of particulate matter from grading operations have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mine) (US EPA, 1998). The emission factor is:

$$EF_{TSP}\ (kg.VKT^{-1}) = 0.0034 \times (S)^{2.5}$$

$$EF_{PM_{15}}\ (kg.VKT^{-1}) = 0.0056 \times (S)^{2.0}$$

$$EF_{PM_{10}}\ (kg.VKT^{-1}) = 0.60 \times (EF_{PM_{15}})$$

$$EF_{PM_{2.5}}\ (kg.VKT^{-1}) = 0.031 \times (EF_{TSP})$$

where:

$EF_{\ (kg\cdot VKT^{-1})}$ = emission factor for particulate matter

S = mean vehicle speed (km.hr^{-1}), assumed to be 5 km.hr^{-1}.

Wind erosion

Emissions of particulate matter resulting from the wind erosion of materials from the extraction area, overburden emplacement, processing area (including material stockpiles) have been estimated using the emission factor presented in Section 11.9 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The emission factor in Table 11.9-4 of (US EPA, 1998) has been adopted for the action of wind erosion:

TSP $(tonne \cdot ha^{-1} \cdot yr^{-1}) = 0.85$

PM_{10} $(tonne \cdot ha^{-1} \cdot yr^{-1}) = 0.425$

$PM_{2.5}$ $(tonne \cdot ha^{-1} \cdot yr^{-1}) = 0.06375$

To determine PM_{10} and $PM_{2.5}$ emissions, the particle size multipliers in Section 13.2.5 (Industrial Wind Erosion) of AP-42 have been applied to TSP emissions, specifically 0.5 for PM_{10} and 0.075 for $PM_{2.5}$ (US EPA, 2006c).

Activity data – particulate matter

Activity data adopted in the assessment of activities associated with the emission of particulate matter are presented in Table D1. Notes on the assumptions adopted in the calculation of those data are outlined below. These quantities represent the potential maximum activity rates over the time periods assessed.

Note A: Quantity associated with the excavation of Cell 2. This is the larger quantity of extraction required in Cell 1 and Cell 2

Note B: Annual quantity (see A) assumed to be excavated over a period of nine weeks

Note C: Quantity includes an additional 19 914 t which was placed in Cell 2 during Cell 1 excavations

Note D: Assumed to be excavated over a period of nine weeks

Note E: Assumed length of transport route to adjacent Lot – 0.4 km

Note F: Assumed length of transport route to western flank – 0.12 km

Note G: Assumed length of transport route from Old Hume Highway to Proposal site – 1.3 km

Note H: Maximum quantity of waste received at site in any one day – 300 t

Table D1 Adopted activity data

Parameter	Units	Activity data	
Period	**-**	**1 year**	**24-hour**
Excavation of material	tonnes	228 600(A)	4 618(B)
Loading of dump trucks	tonnes	264 445(C)	5 342(D)
Movement of material to adjacent Lot for stockpiling(E)	kilometres	8 720	176
Movement of material to western flank for partial capping(F)	kilometres	85	2
Unloading of material on adjacent Lot	tonnes	256 147	5 175
Unloading of material at western flank	tonnes	8 298	168
Operation of dozer in the redistribution of material for sub-base layer	hours	215	3
Transfer of waste material to site(G)	kilometres	5 200	26
Unloading of waste material in active cell	tonnes	60 000	300(H)
Daily cover pickup and placement	tonnes	64 800	324
Excavated cell	hectares	2.3	2.3
Material stockpiled on adjacent Lot	hectares	0.12	0.12
Daily cover / active cell	hectares	0.06	0.06

Based on the activity data presented above, the emission factors adopted and the emission controls to be adopted during the Proposal construction and operation, the emissions anticipated to result are presented in **Table D2** and **Table D3**.

Table D2 Annual emissions totals

Description	Emission Factor				Units	Activity rate	Units	Controls	Controlled emission (kg·yr^{-1})		
	Source	TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Excavation of material	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	228 600	t	Pit retention (50 % TSP, 5% PM_{10}, $PM_{2.5}$)	127.4	114.5	17.2
Loading of dump trucks	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	264 445	t	Pit retention (50 % TSP, 5 % PM_{10}, $PM_{2.5}$) Minimise drop height (30 %)	103.2	92.7	14.0
Movement of material to adjacent Lot for stockpiling(E)	AP-42 Unpaved roads - Section 13.2.2	2.97030	0.81867	0.08187	kg·VKT^{-1}	8 720	km	Water application (50 %) Limit speed (50 %)	6 475.2	1 784.7	178.5
Movement of material to western flank for partial capping(F)	AP-42 Unpaved roads - Section 13.2.2	2.97030	0.81867	0.08187	kg·VKT^{-1}	85	km	Water application (50 %) Limit speed (5 %)	62.9	17.3	1.7
Unloading of material on adjacent Lot	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	256 147	t	Minimise drop height (30 %)	199.8	94.5	14.3
Unloading of material at western flank	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	8 298	t	Minimise drop height (30 %)	6.5	3.1	0.5
Operation of dozer in the redistribution of material for sub-base layer	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42589	0.36172	0.25472	kg·hr^{-1}	215	hrs	Pit retention (50 % TSP, 5% PM_{10}, $PM_{2.5}$)	260.2	73.7	51.9

Description	Emission Factor				Units	Activity rate	Units	Controls	Controlled emission (kg·yr^{-1})		
	Source	TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Transfer of waste material to site(G)	AP-42 Paved roads - Section 13.2.1	0.72284	0.13875	0.03357	kg·VKT^{-1}	5 200	km		3 758.8	721.5	174.6
Unloading of waste material in active cell	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	60 000	t	Minimise drop height (30 %)	66.9	31.6	4.8
Daily cover pickup and placement	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	64 800	t		61.4	29.0	4.4
Excavated cell	AP-42 - Batch drop - Section 13.2.4.3	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	2.3	ha		1 957.6	978.8	146.8
Material stockpiled on adjacent Lot	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	0.12	ha		102.0	51.0	7.7
Daily cover / active cell	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	0.06	ha		51.0	25.5	3.8
								Total	**13 233.2**	**4 018.3**	**620.2**

Table D3 Daily emissions totals

Description	Emission Factor				Units	Activity rate	Units	Controls	Controlled emission (kg·day^{-1})		
	Source	TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Excavation of material	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	4 618	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	2.6	2.3	0.3
Loading of dump trucks	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	5 342	t	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$) Minimise drop height (30%)	2.1	1.9	0.3
Movement of material to adjacent Lot for stockpiling[E]	AP-42 Unpaved roads - Section 13.2.2	2.97030	0.81867	0.08187	kg· VKT^{-1}	176	km	Water application (50%) Limit speed (50%)	130.8	36.1	3.6
Movement of material to western flank for partial capping[F]	AP-42 Unpaved roads - Section 13.2.2	2.97030	0.81867	0.08187	kg· VKT^{-1}	2	km	Water application (50%) Limit speed (50%)	1.3	0.4	0.0
Unloading of material on adjacent Lot	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	5 175	t	Minimise drop height (30%)	4.0	1.9	0.3
Unloading of material at western flank	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	168	t	Minimise drop height (30%)	0.1	0.1	0.0
Operation of dozer in the redistribution of material for sub-base layer	AP-42 - Bulldozing (Overburden) - Table 11.9-2	2.42589	0.36172	0.25472	kg·hr^{-1}	3	hrs	Pit retention (50% TSP, 5% PM_{10}, $PM_{2.5}$)	3.6	1.0	0.7

Description	Emission Factor				Units	Activity rate	Units	Controls	Controlled emission (kg·day^{-1})		
	Source	TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Transfer of waste material to site[(G)]	AP-42 Paved roads - Section 13.2.1	0.72284	0.13875	0.03357	kg·VKT^{-1}	26	km		16.7	3.2	0.8
Unloading of waste material in active cell	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	300	t	Minimise drop height (30%)	0.3	0.2	0.02
Daily cover pickup and placement	AP-42 - Batch drop - Section 13.2.4.3	0.00111	0.00053	0.00008	kg·t^{-1}	324	t		0.4	0.2	0.02
Excavated cell	AP-42 - Batch drop - Section 13.2.4.3	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	2.3	ha		5.4	2.7	0.4
Material stockpiled on adjacent Lot	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	0.12	ha		0.3	0.1	0.0
Daily cover / active cell	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	850.0	425.0	63.75	kg·ha^{-1}·yr^{-1}	0.06	ha		0.1	0.1	0.0
								Total	**576.0**	**161.3**	**17.8**

Emission factors – odour

Emission factors adopted within this AQIA have been adopted from site specific source sampling performed to support the Melbourne Regional Landfill (MRL) Air Quality Assessment (PEL, 2016). As previously discussed, the odour emission rates adopted are associated with putrescible waste operations and therefore represent a highly conservative approximation of likely odour emissions resulting from Proposal operation.

Measured odour emission rates at the MRL active tip face were 3.3 $OU \cdot m^{-2} \cdot s^{-1}$ with odour on interim covered waste at the MRL measured to be 0.16 $OU \cdot m^{-2} \cdot s^{-1}$.

Odour resulting from storage of leachate has been calculated using odour emission rates measured at the leachate dam within the Woodlawn Bioreactor facility at Tarago, NSW. The odour emission rate associated with leachate storage at that facility was 0.459 $OU \cdot m^{-2} \cdot s^{-1}$ (TOU, 2012). Once again, the leachate generated at the Woodlawn site is associated with putrescible waste, and the leachate collected as part of the Proposal is likely to be significantly less odorous.

Calculation of Peak Concentrations

The Approved Methods (NSW EPA, 2017) states that peak-to-mean ratios should be incorporated when conducting atmospheric dispersion modelling of odour. The peak to mean ratio (P/M60) is defined as the ratio of peak 1-second average concentrations to mean 1-hour average concentrations. To estimate peak concentrations, this assessment has adopted factors presented in Table 6.1 of the Approved Methods.

Specifically, to establish a conservatively high estimate of peak odour concentrations from an area source, the peak to mean ratio (P/M60) of 2.5 has been adopted in stability classes A to F (i.e. all stability classes).

Activity data - odour

The area of the landfill assumed to be present as active tip face would be a maximum area of 600 m^2. The remainder of both Cell 1 and Cell 2 would be under interim cover (35 300 m^2 – 600 m^2 = 34 700 m^2). The area of a full leachate storage area would be 1 050 m^2. These areas represent the landfill operating at maximum capacity.

Based on the odour emission rates adopted and the areas of each odour source, Table D4 presents the odour emissions adopted to represent the placement and storage of waste at the Proposal site.

Table D4 Odour emissions

Source name	Area (m^2)	Specific odour emission rate ($OU \cdot m^{-2} \cdot s^{-1}$)	Peak to mean factor	Modelled odour emission rate ($OU \cdot s^{-1}$)
Active tip face	600	3.3	2.5	4 950
Interim cover	34 700	0.16		13 880
Leachate storage	1 050	0.459		1 205