Appendix 4

Air Quality and Greenhouse Gas Assessment

prepared by

Northstar Air Quality Pty Ltd

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This document has been prepared for **R. W. Corkery & Co. Pty Limited** on behalf of **Australian Strategic Material (Holdings) Ltd** by:

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Dubbo Project Modification 1

Air Quality Impact Assessment

Addressee(s):	R. W. Corkery & Co. Pty Limited
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Quality Control

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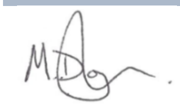
Final Authority

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 **7 March 2022**

Non-Technical Summary

Northstar Air Quality Pty Ltd was engaged by R. W. Corkery & Co. Pty Limited on behalf of Australian Strategic Materials Holdings Ltd, to perform an to perform an air quality assessment and greenhouse gas assessment for the proposed modification to approved operations at a small-scale open ore and rare metals mine located in the Central West of NSW, approximately 25 km south of Dubbo. .

This air quality impact assessment presents an assessment of the risks to local air quality associated with the construction and operation of the proposed modification, and also estimates the anticipated greenhouse gas emissions resulting from its operations

The prediction of potential impacts associated with operational activities was performed in general accordance with the requirements of the NSW Environment Protection Authority Approved Methods (NSW EPA 2016), using an approved and appropriate dispersion modelling technique.

The assessment of potential impacts indicates that minor exceedances of the annual average $PM_{2.5}$ criteria may be experienced at up to eight nearby sensitive receptors during both construction and operation of the Project, although this is dominated by the already high background $PM_{2.5}$ concentrations. A number of particulate matter controls would be employed during both construction and operational activities, which were not able to be robustly included in the modelling assessment. The addition of these measures, through an Air Quality Management Plan, would ensure that emissions are minimised, and the likelihood of those predicted exceedances occurring in reality, would be correspondingly lower. Maximum 24-hour average $PM_{2.5}$ concentrations are predicted to achieve the criteria at all surrounding receptor locations.

Predicted emissions of PM_{10}, NO_2, SO_2, odour, Rn, HCl and Cl_2 were also assessed taking into consideration the operation of the processing plant. Based upon the assumptions and methodology presented in the report, the predicted results indicate no exceedances of the relevant impact assessment criteria.

The GHG assessment was performed to estimate the GHG emissions resulting from operation of the Project. Estimates indicate that the operation of the Project at maximum capacity would contribute up to 0.06 % of Australian total GHG emissions and up to 0.24 % of NSW total GHG emissions in 2019.

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1. INTRODUCTION

Australian Strategic Materials (Holdings) Ltd (ASM) (the Applicant) owns the Dubbo Project, which is located in the Central West of New South Wales, near the Village of Toongi, approximately 25 kilometres (km) south of Dubbo, NSW.

The Dubbo Project operation was approved under State Significant Development (SSD) Consent SSD-5251 which was granted on 28 May 2015 by the NSW Planning Assessment Commission (PAC). The approved activities included a small-scale open cut mine supplying ore containing rare metals and rare earth elements to a processing plant. The Applicant has identified a number of adjustments to the approved site layout and operations which are required in order to maximise the efficiency of mining, processing and transportation operations on site. As a result, the Applicant is proposing a modification (MOD 1) to the Dubbo Project (the Project).

R. W. Corkery & Co. Pty Limited (RWC) has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of the Applicant to perform an air quality impact assessment (AQIA) for the Project. This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the modification application for the Project under Part 4 of the *Environmental Planning and Assessment Act* (1979).

The AQIA presents an assessment of the impacts of activities associated with the construction and operational phases of the Project. The AQIA has used a quantitative dispersion modelling approach, performed in accordance with the relevant NSW guidelines. The results of the assessment are presented as predicted incremental change, and as a cumulative impact accounting for the prevailing background air quality conditions.

The AQIA includes an assessment of greenhouse gas (GHG) emissions associated with the Project and presents a comparison of these emissions with National and State GHG emissions totals to provide context and scale of those emissions. Opportunities for GHG emissions reduction are also provided.

The relevant policies, guidelines and plans which have been referenced during the performance of the AQIA include:

- *Protection of the* Environment *Operations Act* (1997).
- Protection of the Environment Operations (Clean Air) Regulation (2021).
- 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 (NSW DEC, 2006)

The GHG Assessment has been performed with reference to

- National Greenhouse Accounts Factors (DISER, 2021).

The AQIA has been performed to be broadly consistent with the AQIA which supported the original approval (PEL, 2013).

2. THE PROJECT

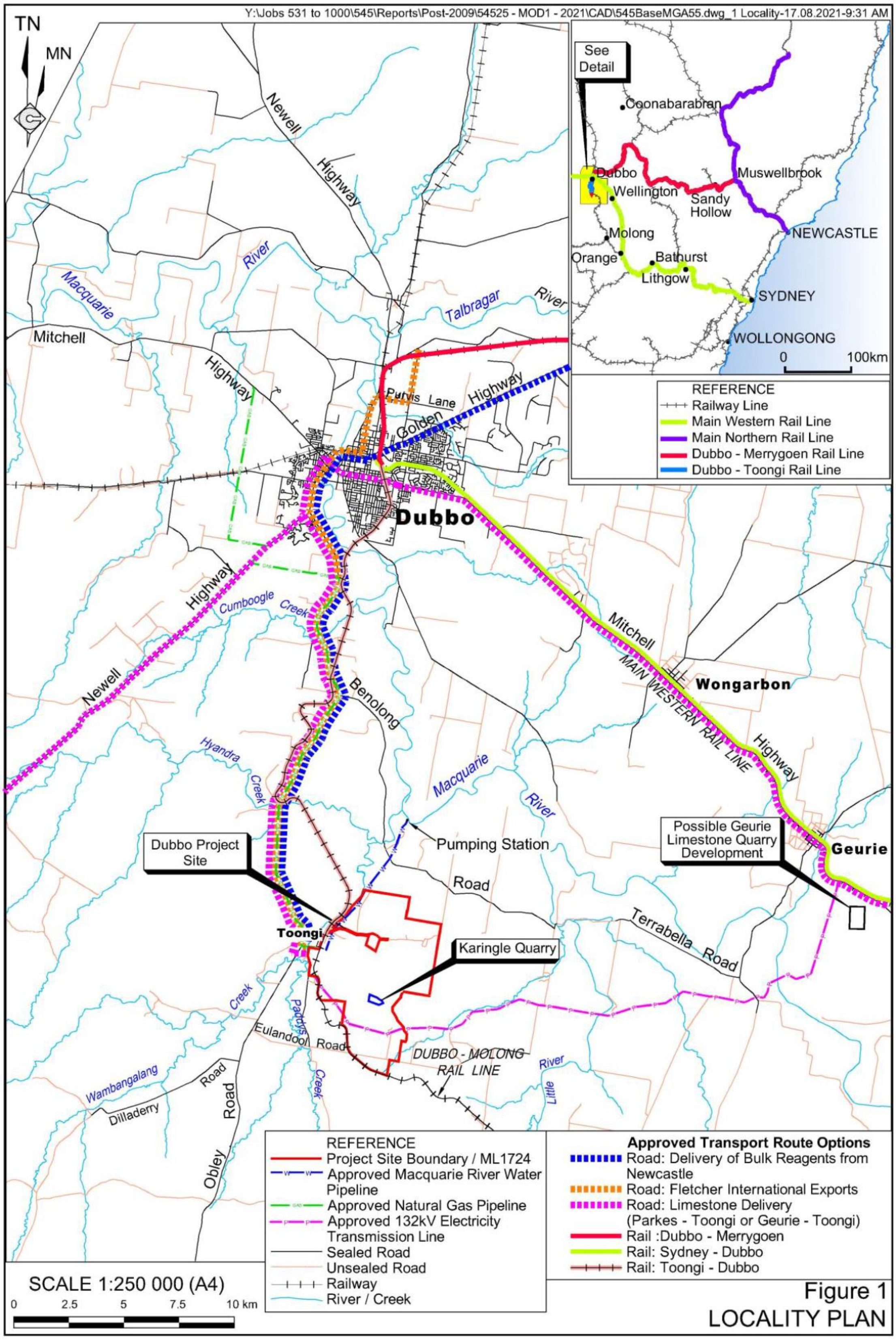
The following provides a description of the Project and describes the potential sources of air emissions associated with the construction and operational phases.

2.1 Overview

The Applicant owns the approved Dubbo Project (previously referred to as the Dubbo Zirconia Project), located within ML 1724 (coincident with the approved Dubbo Project Site Boundary) located in the Central West of New South Wales.

The location of the Project Site is presented in **Figure 1**.

Figure 1 Project location



Source: RWC

2.1.1 Current Approved Activities

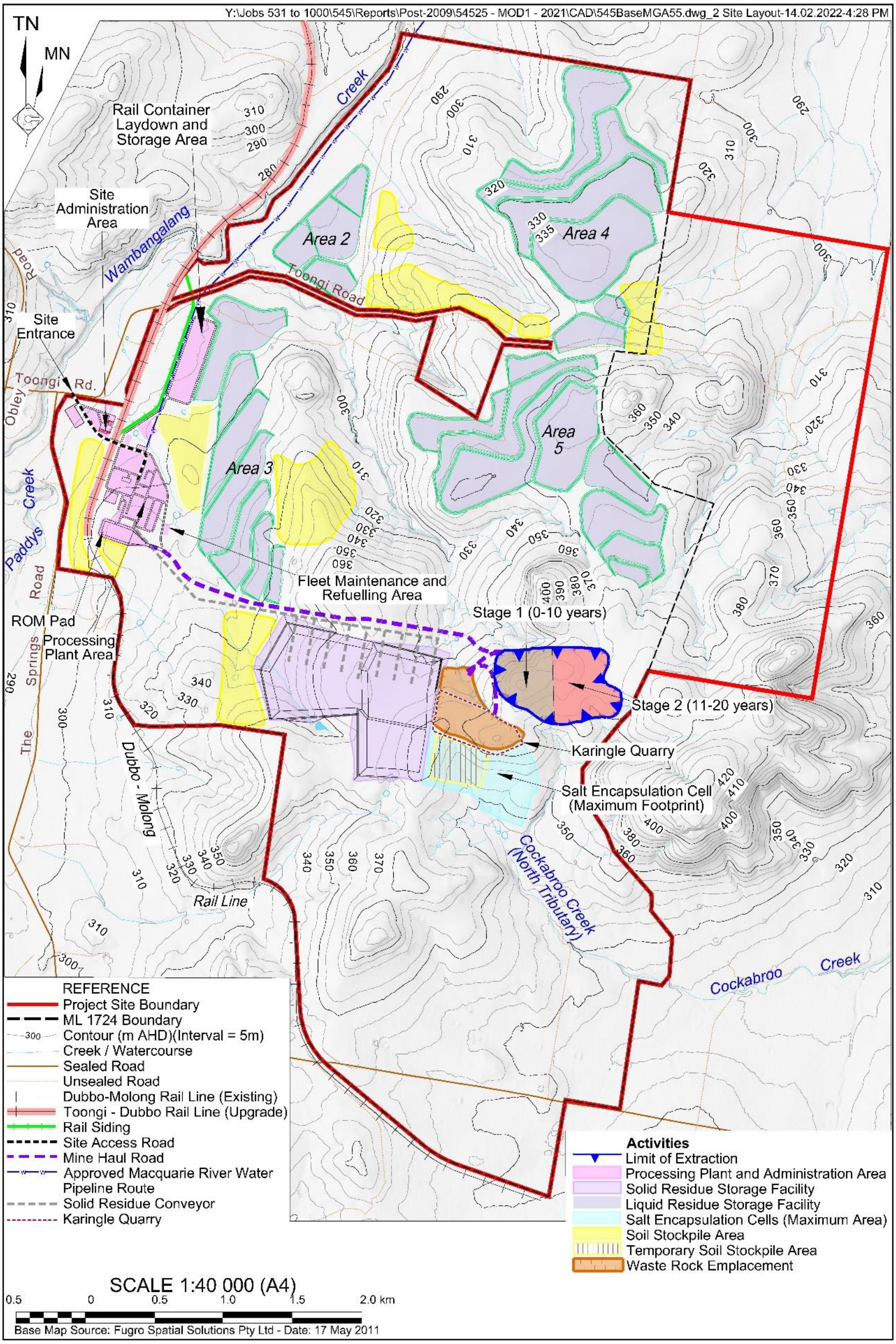
The activities approved at the Project Site under SSD-5251 include the following:

- Mining and extraction of approximately 19.5 Mt of ore at a maximum rate of 1 million tonnes per annum (Mtpa) from an Open Cut developed to a maximum depth of 32 metres (m) (355 m AHD) until 31 December 2037.
- Extraction and placement of approximately 3.5 Mt of waste rock within a small Waste Rock Emplacement to the southwest of the Open Cut.
- Haulage of ore to a Run-of-Mine (ROM) Pad and crushing and grinding of that material.
- Processing of the crushed and ground ore using the following methodology.
- Production of sulphuric acid, sulphation roast of ore and leaching to dissolve sulphated metals.
- Solvent extraction, precipitation, thickening, washing and drying of the various rare metals and rare earth element products.
- Construction and operation of a rail siding from the Toongi-Dubbo Rail Line and a Rail Container Laydown and Storage Area for the unloading and temporary storage of reagents and loading of products for despatch.
- Transportation by rail, including up to 3 trains from the site per week.
- Transportation by road via the public road network, with Obley Road and Toongi Road to be upgraded (approximately 22 km length) to accommodate heavy vehicle traffic. Receipt and despatch of up to 75 laden trucks to or from the Project Site per day and up to 16 laden trucks per hour.
- Mixing and neutralisation of solid residues produced by the processing of ore with crushed limestone and transportation via a conveyor to a Solid Residue Storage Facility.
- Pumping of water used in processing operations, which cannot be recycled, to a Liquid Residue Storage Facility, comprising a series of terraced and lined crystallisation cells.
- Recovery and disposal of an estimated 6.7 Mt of salt, which would accumulate within the Liquid Residue Storage Facility, within a series of Salt Encapsulation Cells adjoining the Waste Rock Emplacement and Solid Residue Storage Facility.
- Other ancillary activities including equipment maintenance, clearing, and stripping of the areas to be disturbed and rehabilitation activities.
- Construction of the Macquarie River Water Pipeline and associated infrastructure including a pumping station.
- Construction of a natural gas pipeline between the Central West Pipeline at Purvis Lane, Dubbo, and the Project Site.
- Construction of a 132 kV Electricity Transmission Line (approximately 30km length) between a substation located to the south of Geurie and the Project Site.
- Refurbishment of an approximately 27 km length of the Dubbo – Molong Railway to a Class 1 track and replacement, upgrade or reinstatement of associated infrastructure (e.g. bridges, culverts, level crossings).

The layout of the approved Dubbo Project is presented in **Figure 2** and **Figure 3**.

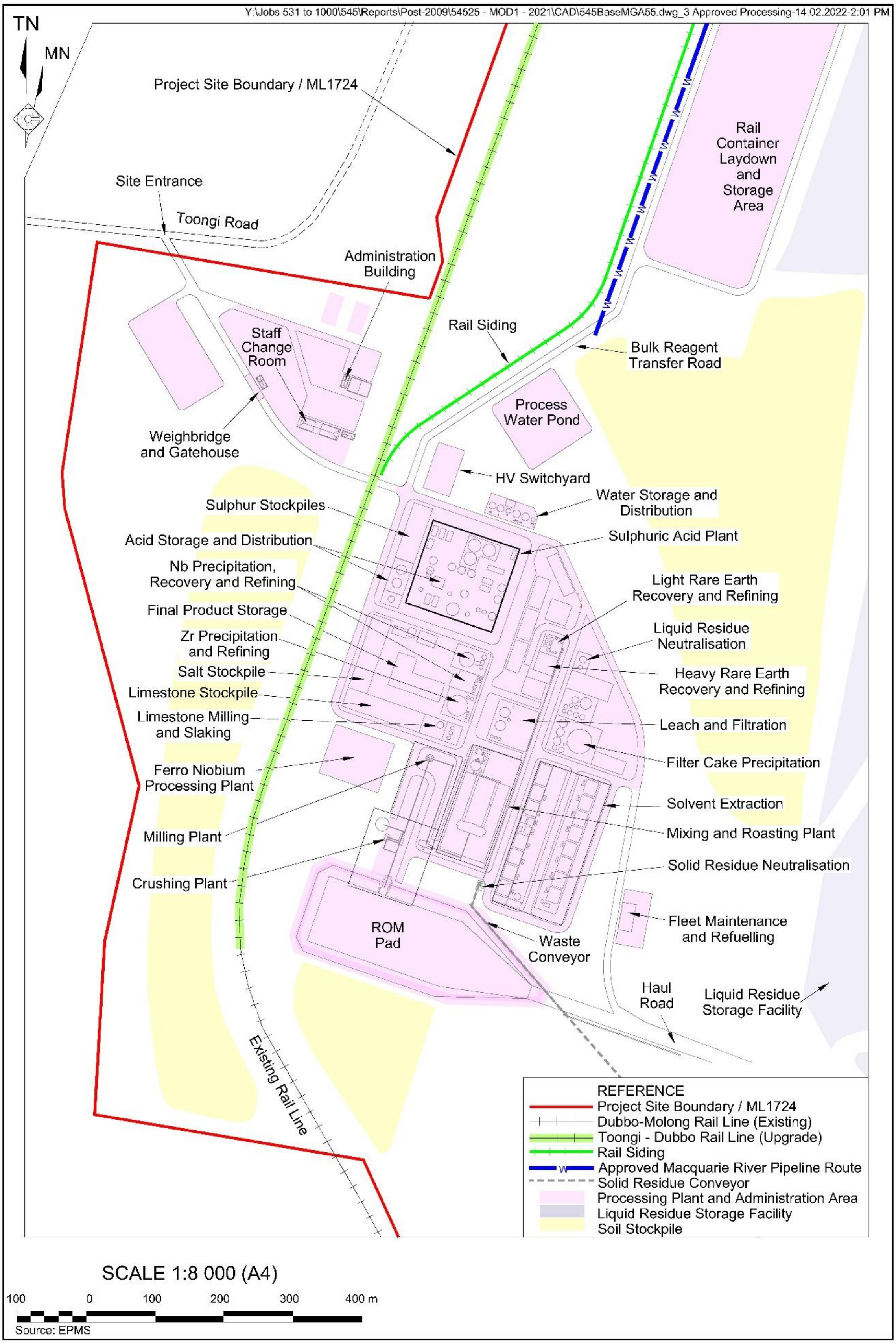
The Applicant also owns and operates the Karingle Basalt Quarry (DA D2016-70), located within the Project Site (see **Figure 2**). Basalt from the Karingle Basalt Quarry will be used for onsite construction, Obley Road upgrade works and as railway ballast for the Toongi-Dubbo Rail Line refurbishment.

Figure 2 Approved Project Site layout



Source: RWC

Figure 3 Approved processing plant and administration area layout



Source: RWC

2.1.2 Proposed Activities

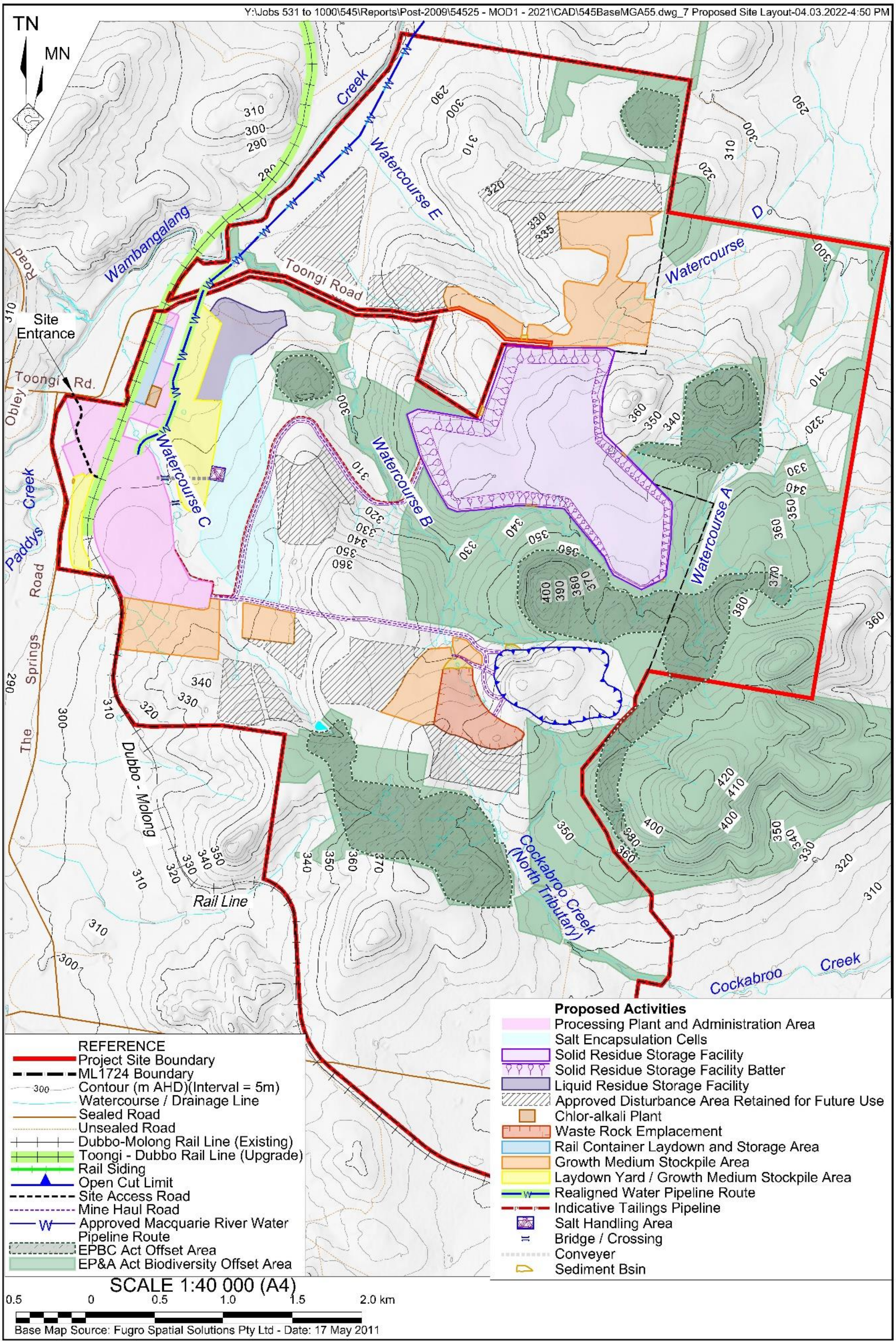
Following the granting of SSD-5251 on 28 May 2015, the Applicant has undertaken a range of studies and investigations targeting the optimisation of the design and operation of the Project. As a result of those studies and investigations, the Applicant has identified a number of adjustments to the approved site layout and operations which are required in order to maximise the efficiency of mining, processing and transportation operations on site. **Figure 4** presents the proposed Project Site layout and **Figure 5** presents the proposed processing plant and administration area layout.

Additionally, the Applicant is proposing to extend the approved construction hours in order to ensure that construction of the processing plant and site infrastructure can be completed expeditiously and in line with critical project deadlines.

In summary, the Applicant anticipates that the MOD 1 scope would include the following (see **Figure 4** and **Figure 5**).

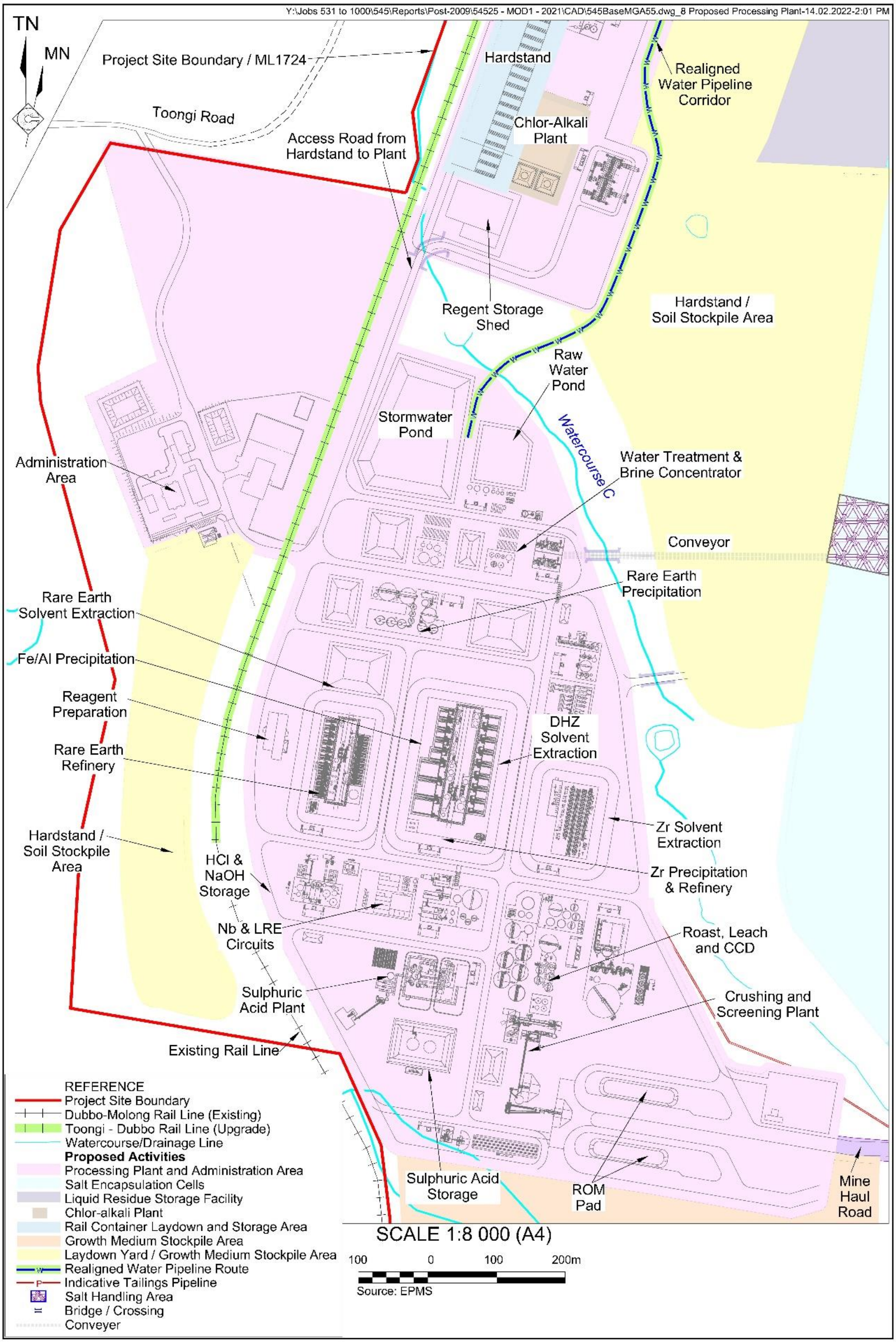
- Construction and operation of:
  - a Chlor-alkali Plant for the production of hydrochloric acid and sodium hydroxide for use in on-site processing operations;
  - a brine concentrator to maximise water recovery; and
  - a conveyor between the Processing Plant and Administration Area and the Salt Encapsulation Cells.
- Relocation of:
  - the Salt Encapsulation Cells from the approved location southwest of the Open Cut to the approved location of the Liquid Residue Storage Facility Area 3;
  - the Solid Residue Storage Facility from the approved location west of the Waste Rock Emplacement to the approved location of the Liquid Residue Storage Facility Area 5; and
  - the Rail Container Laydown and Storage Area from the approved location to an area immediately to the west of the approved location.
- Reclassification of various approved disturbance areas to permit alternate uses.
- Realignment of sections the approved Macquarie River Water Pipeline, located entirely within the Project Site.
- A range of adjustments to the approved Project Site layout.
- Extended construction hours for non-linear infrastructure to 24-hours per day, seven days per week.
- Extension of the Project life by eight years from 31 December 2037 to 31 December 2045.

Figure 4 Proposed Project Site layout



Source: RWC

Figure 5 Proposed Modified Processing Plant and Administration Area Layout



Source: RWC

Two scenarios have been characterised to allow the potential air quality impacts of the proposed modification to be quantified at nearby sensitive receptor locations. The first scenario reflects construction related activities during the first two years (construction scenario), with a second scenario reflecting operations during (nominally) year 15 (operation scenario). These scenarios have been selected to ensure that the quantified impacts are reflective of maximum activity rates.

Table 1 provides a summary of the characteristics of the Project during the construction phase, with **Table 2** providing the same information for operational activities.

Table 1 Proposed characteristics of the Project – construction scenario

Parameter	Activity / Rate
Construction hours	**Construction**: 24 hours a day, 7 days a week. **Topsoil stripping and movements** - 7 am to 6 pm, Monday to Friday and 8 am to 5 pm, Saturday. No activities on Sundays or Public Holidays.
Working days per year	300
Site preparation	
Topsoil removed in Waste Rock Emplacement (WRE)	52 752 t
Topsoil removed at Liquid Residue Storage Facility (LRSF)	221 158 t
Topsoil removed at Solid Residue Storage Facility (SRSF)	1 023 240 t
Topsoil removed at Salt Encapsulation Cells (SEC)	689 973 t
Topsoil removed at Processing facility	236 189 t
Topsoil removed at Open Cut	98 120 t
Topsoil removed at Stockpile Area and Laydown Yard	219 534 t
Dozers moving overburden at WRE	739 hrs
Dozers moving overburden at SRSF	739 hrs
Equipment (type, or equivalent) (*hours operation per day*)	1 x Cat 980G Front End Loader or equivalent *(10-11)* 5 x Articulated Truck (Cat 740) 38t or equivalent *(10-11)* 1 x Cat D8R Dozer *(10-11)* 1 x Cat 14H Grader *(10-11)* 1 x Service Truck *(10-11)* 1 x Water cart Diesel Generators (Power supply as required)
Exposed areas	
LRSF	6.8 ha
WRE	86.0 ha
SRSF	64.8 ha
SEC	39.6 ha
Processing facility	18.1 ha
Open Cut	33.0 ha
Growth Medium Stockpile Areas (i.e. topsoil)	6.8 ha

Assumptions adopted in the construction of **Table 1** are presented below:

- One third of the total footprint of the WRE, Open Cut, and Processing Plant and Administration Area are assumed to be stripped during the construction phase.
- 50 % of the total footprint of the SRSF is assumed to be stripped during the construction phase.
- 100 % of the total footprint of the Salt Encapsulation Cells and are assumed to be stripped during the construction phase.
- Approximately one third of the total area of the Growth Medium Stockpile Areas are assumed to be exposed at any one time during the construction phase.
- No drilling or blasting would occur during the construction phase activities.
- Topsoil is assumed to be transported in 38 t loads, on unpaved roads with a 3 % silt content (consistent with the assumptions adopted in the AQIA supporting the original approval (PEL, 2013)).

Table 2 provides a summary of the characteristics of the Project during the operational phase.

Table 2 Proposed characteristics of the Project – operation phase

Parameter	Activity / Rate
Operating hours (extraction, processing, and haulage)	**Mining Operations** (excluding operation of the ore processing facility): 7 am to 6 pm, Monday to Friday and 8 am to 5 pm, Saturday. No activities on Sundays or Public Holidays. **Blasting**: 9 am to 5 pm **Operation of the ore processing facility and receipt of processing reagents**: 24 hours a day, 7 days a week. **Despatch of refined ore products and receipt of limestone products**6 am to 10pm, Monday to Friday and 8:00am to 5:00pm, Saturday. No activities on Sundays or Public Holidays.
Working days per year	300
Mining operations	
Annual ore extraction rate	998 558 t
Annual overburden generation rate	268 212 t
Number of blast holes drilled	213 per blast on average
Blasting frequency	21 per year (overburden) 179 per year (ore)
Volume of material removed per blast	7 000 to 14 000 bcm
Equipment (type, or equivalent) (*hours operation per day*)	1 x Cat 980G Front End Loader or equivalent *(10-11)* 5 x Articulated Truck (Cat 740) 38t or equivalent *(10-11)* 1 x Cat D8R Dozer *(10-11)* 1 x Cat 14H Grader *(10-11)* 1 x Service Truck *(10-11)*

Parameter	Activity / Rate
	1 x Water cart Diesel Generators (Power supply as required) 1 x Blast Hole Drill Rig *(10-11)* 1 x Explosives Delivery Vehicle *(10-11)*
Ore processing	
Annual ore processing rate	998 558 Mtpa
Equipment (*hours operation per day*)	Primary, secondary, tertiary and quaternary crushing circuit including ball mill *(11)*
Exposed areas	
WRE	20.9 ha
SRSF	20.5 ha
SEC	171.9 ha
Processing facility	64.8 ha
Open Cut	88.8 ha
Growth Medium Stockpile Areas (i.e. topsoil)	40.3 ha

Assumptions adopted in the construction of **Table 2** are presented below:

- 100 % of the total area for the exposed areas in **Table 2** are assumed to be available to be eroded by the wind during the operational phase. This is considered to be a conservative assumption.
- No wind erosion is assumed to occur from the LRSF, given that this material is moist.
- Topsoil is assumed to be transported in 38 t loads, on unpaved roads with a 3 % silt content (consistent with the assumptions adopted in the AQIA supporting the original approval (PEL, 2013)).

Odour is assumed to have the potential to be emitted from the LRSF and the SRSF during operation, which is consistent with the assumptions adopted in the AQIA supporting the original approval (PEL, 2013)).

Radon (Rn) is assumed to have the potential to be emitted from the Open Cut, ROM Stockpiles, WRE, SRSF, LRSF, and from the Ore Mill exhaust, again consistent with the assumptions adopted in the AQIA supporting the original approval (PEL, 2013)).

2.2 Identified Potential for Emissions to Air

The processes which may result in the emission of pollutants to air during Project construction would include:

- Topsoil removal;
- Materials handling;
- Loading of haul trucks, transport, unloading, and storage of topsoil;
- Wind erosion of stripped areas, and topsoil storage locations; and
- Emissions from vehicle and equipment exhaust.

The processes which may result in the emission of pollutants to air during Project operation would include:

- Drilling and blasting;
- Materials handling;
- Loading of haul trucks, transport, unloading, and storage of ore material and overburden;
- Processing of ore material and storage of refined ore;
- Loading product trucks with refined ore material, and haulage offsite;
- Wind erosion of the extraction, processing and materials storage areas; and
- Emissions from vehicle and equipment exhaust.

The specific pollutants of interest associated with the construction and operational phase activities are:

- Total suspended particulate (TSP);
- Particulate matter with an aerodynamic diameter of 10 microns (PM_{10});
- Particulate matter with an aerodynamic diameter of 2.5 microns ($PM_{2.5}$);
- Nitrogen dioxide (NO_2), sulphur dioxide (SO_2), hydrogen chloride (HCl) and chlorine (Cl_2) from the processing plant;
- Radon (Rn); and
- Odour associated with the solid and liquid waste residues.

3. LEGISLATION, REGULATION AND GUIDANCE

3.1 NSW EPA Approved Methods

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'* (NSW EPA, 2017) (the Approved Methods) which has been consulted during the preparation of this assessment report.

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

The criteria listed in the Approved Methods are derived from a range of sources (including National Health and Medical Research Council [NHMRC], National Environment Protection Council [NEPC], Department of Environment [DoE], and World Health Organisation [WHO]).

3.1.1 Criteria Air Pollutants

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

Table 3 NSW EPA air quality standards and goals

Pollutant	Averaging period	Criterion		Notes
		$\mu g \cdot m^{-3}$ (A)		
Sulphur dioxide (SO_2)	10 minutes	712		
	1 hour	570		
	24 hours	228		
	Annual	60		
Nitrogen dioxide (NO_2)	1 hour	246		Numerically equivalent to the AAQ NEPM(B) standards and goals
	Annual	62		
Particulates (as PM_{10})	24 hours	50		
	1 year	25		
Particulates (as $PM_{2.5}$)	24 hours	25		
	1 year	8		
Particulates (as TSP)	1 year	90		
Pollutant	**Averaging period**	**$g \cdot m^{-2} \cdot month^{-1}$**	**$g \cdot m^{-2} \cdot month^{-1}$**	**Notes**
Deposited dust	1 year	2(C)	4(D)	Defined by AS 3580.10.1

Notes: (a): micrograms per cubic metre of air

(b): National Environment Protection (Ambient Air Quality) Measure

(c): Maximum increase in deposited dust level

(d): Maximum total deposited dust level

3.1.2 Toxic Air Pollutants

The NSW EPA 'Approved Methods' document list the impact assessment criteria for individual toxic air pollutants. Criteria for other individual toxic air pollutant of relevance to this assessment are presented in **Table 4**.

Hydrochloric acid also known as muriatic acid, is not easily formed in the environment, with the most significant source of ambient contributions derived from anthropogenic emissions release during metal pickling, ore refining and/or other industrial processes. Hydrogen chloride is a colourless, non-flammable gas with an acrid odour. Exposure to concentrate HCl can strongly irritates the eyes and is highly toxic if inhaled or ingested among a number of health effects.

As per (NSW EPA, 2017), principal toxic air pollutants must be minimised to the maximum extent achievable through the application of best-practice process design and/or emission controls. Decisions with respect to achievability will have regard to technical, logistical and financial considerations. Technical and logistical considerations include a wide range of issues that will influence the feasibility of an option, for example whether a particular technology is compatible with an enterprise's production processes.

Table 4 Impact assessment criteria for individual toxic air pollutants

Individual toxic air pollutant	Averaging period	Impact assessment criteria	
		$mg{\cdot}m^{-3}$	ppm
Hydrogen chloride	1 hour	0.14	0.09
Chlorine	1-hour	0.05	0.018

Source: NSW EPA (NSW EPA, 2017), Victorian Government Gazette 2001

3.1.3 Odour

As identified in **Section 2.2**, a number of activities performed as part of the Project have the potential to give rise to odour emissions. Odour emissions may be released from the by-product solid and liquid waste residues after processing the ore material.

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.

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 5** 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 5 NSW EPA Technical Framework odour criteria

Population of Affected Community	Impact Assessment Criteria for Complex Mixture of Odours (99th 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

It is noted that the odour assessment criteria outlined in **Table 5** 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'.

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 above, numerous papers and articles identify the disconnect between those 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.

Consistent with the AQIA performed for the approved development, a conservative approach has been adopted in the determination of the odour impact assessment criteria by basing the criteria on the most densely populated area within the vicinity of the Project. There are five sensitive receptors located within a square kilometre area that are located to the immediate west of the Project Site. Therefore, in accordance with **Table 5** it is appropriate to adopt an impact assessment criterion of 6 OU, which is consistent with the criterion adopted in the AQIA supporting the original approval (PEL, 2013).

3.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations* (POEO) *Act* (1997) sets the statutory framework for managing air quality in NSW, including establishing the licensing scheme for major industrial premises and a range of air pollution offences and penalties.

The Project would be defined as a scheduled activity under the POEO Act and an Environment Protection License (EPL) would be required, which would contain a number of requirements to manage emissions associated with the Project, including those to air.

3.3 Protection of the Environment (Clean Air) Regulation 2021

The Protection of the Environment Operations (POEO) (Clean Air) Regulation (2021) sets standards of concentration for emissions to air (also termed 'in-stack concentrations') from both scheduled and non-scheduled activities. For the activities performed at the Project Site, the POEO (Clean Air) Regulation provides general standards of concentration for scheduled premises which are presented in **Table 6** for the pollutants of relevance to this assessment.

Table 6 POEO (Clean Air) Regulation – General standards of concentration

Air Impurity	Activity	Standard of Concentration (Group 6)[1]
Solid particles (total)	Any plant used for heating metals	50 $mg \cdot m^{-3}$

Air Impurity	Activity	Standard of Concentration (Group 6)[1]
	Any crushing, grinding, separating or materials handling activity	20 mg·m^{-3}
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Any boiler operating on gas	350 mg·m^{-3}
Sulfur dioxide (SO_2)	Sulfuric acid manufacture using elemental sulfur	1 000 mg·m^{-3}
Sulfur trioxide (SO_2)	Any activity or plant	100 mg·m^{-3}
Hydrogen chloride (HCl)	Any activity, other than the manufacture of glazed terracotta roofing tiles	100 mg·m^{-3}
Chlorine (Cl_2)	Any activity or plant	N/A

Note: (1) Group 6 – pursuant to application made on or after 1 September 2005

Further to the requirements in **Table 6** Part 4 Clause 15 of the POEO (Clean Air) Regulation requires that motor vehicles do not emit excessive air impurities which may be visible for a period of more than 10-seconds when determined in accordance with the relevant standard.

All vehicles, plant and equipment to be used either at the Project Site or to transport materials to and from the Project Site will be maintained regularly and in accordance with manufacturers' requirements, where these vehicles are under the operational control of the Applicant.

3.4 Radon

Ore contains low levels of naturally occurring uranium, which when mined can result in the release of radon gas.

Radon (Rn) is a colourless, odorless, tasteless noble gas, occurring naturally as the decay product of radium. It is important to note that Rn is a noble gas, whereas all its decay products are metals. The main mechanism for the entry of radon into the atmosphere is diffusion through the soil. As a gas, Rn diffuses through rocks and the soil. There is a direct relationship between the Rn concentration and the decay product concentration, therefore an understanding of the Rn concentration from the air quality modelling provides a basis for calculating the potential decay product concentrations, which will be used to assess the impact to people and the environment. It is noted that a Radiation Assessment was provided in 2013 by JHRC Enterprises.

The concentration of radon in the air is measured in units of becquerels per cubic meter (Bq·m^{-3}), where one Bq corresponds to one disintegration per second.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) recommends the following reference levels for radon:

- 200 Bq·m^{-3} for households.
- 1 000 Bq·m^{-3} for workplaces.

3.5 Greenhouse Gas Legislation and Guidance

The Australian Government Clean Energy Regulator administers schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions.

Schemes administered by the Clean Energy Regulator include:

- National Greenhouse and Energy Reporting Scheme, under the *National Greenhouse and Energy Reporting Act* (2007).
- Emissions Reduction Fund, under the *Carbon Credits (Carbon Farming Initiative) Act* (2011).
- Renewable Energy Target, under the *Renewable Energy (Electricity) Act* (2000).
- Australian National Registry of Emissions Units, under the *Australian National Registry of Emissions Units Act* (2011).

3.5.1 National Greenhouse and Energy Reporting Scheme

The National Greenhouse and Energy Reporting (NGER) scheme, established by the *National Greenhouse and Energy Reporting Act* (2007) (NGER Act), is a national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.

The objectives of the NGER scheme are to:

- inform government policy.
- inform the Australian public.
- help meet Australia's international reporting obligations.
- assist Commonwealth, state and territory government programmes and activities.
- avoid duplication of similar reporting requirements in the states and territories.

Further information on the NGER scheme, specifically the definitions of various scopes and types of GHG emissions which have also been adopted for the purposes of this assessment, is provided in Section 5.2.2.

3.5.2 Relevant NSW Legislation

There is no specific GHG legislation administered within NSW. The NGER scheme (and other identified Commonwealth schemes in **Section 3.5.1**) forms the applicable legislation within NSW.

3.5.3 Relevant NSW Policy Framework

The NSW Government Net Zero Plan Stage 1: 2020-2030 (NSW DPIE, 2020) is the foundation for NSW's action on climate change and goal to reach net zero emissions by 2050. It outlines the NSW Government's plan to grow the economy, create jobs and reduce emissions over the next decade.

The plan aims to enhance the prosperity and quality of life of the people of NSW, while helping the state to deliver a 35 % reduction in emissions by 2030 compared to 2005 levels. The plan supports a range of initiatives targeting electricity and energy efficiency, electric vehicles, hydrogen, primary industries, coal innovation, organic waste and carbon financing.

Under the plan, businesses will be supported to modernise their plant and increase productivity.

3.5.4 Guidance

The GHG accounting and reporting principles adopted within this GHG assessment are based on the following financial accounting and reporting standards:

- Australian Government Department of the Environment, Australian National Greenhouse Accounts, National Greenhouse Accounts Factors, August 2021 (DISER, 2021).
- The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) GHG Protocol: A Corporate Accounting and Report Standard (WRI, 2004).
- ISO 14064-1:2018 (Greenhouse Gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removal).
- ISO 14064-2:2018 (Greenhouse Gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements).
- ISO 14064-3:2018 (Greenhouse Gases – Part 3: Specification with guidance for the validation and verification of GHG assertions) guidelines (internationally accepted best practice).

4. EXISTING CONDITIONS

4.1 Surrounding Land Sensitivity

4.1.1 Discrete Receptor Locations

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed. 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 noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see **Section 4.1.2**) that are used to plot out the predicted impacts and as such, the accidental non-inclusion of a location sensitive to changes in air quality does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

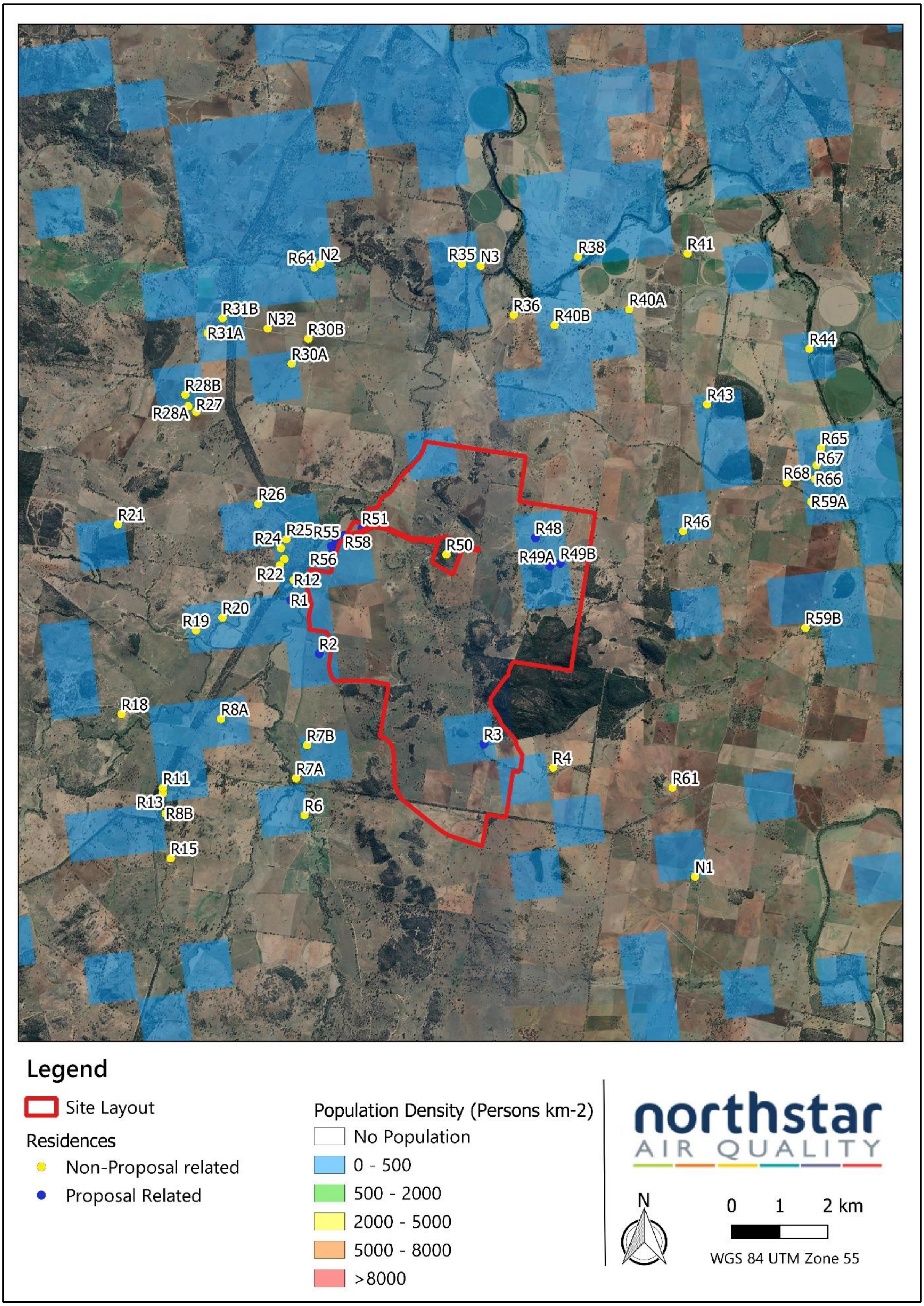
To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the Project Site reside, population density data has been examined. Population density data based on the 2016 census have been obtained from the Australian Bureau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

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

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

Using ABS data in a GIS, the population density of the area surrounding the Project site are presented in **Figure 6**. The Project Site is located in an area of low to very low population density (between 0 and < 500 persons·km^{-2}). A number of residential locations surrounding the Project Site have been identified and these receptors have been adopted for use within this AQIA as presented in **Table 7**. Note that the Project-related receptors are shown in gray text at the bottom of **Table 7**.

Figure 6 Population density and sensitive receptors surrounding the Project



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

Figure 6 identifies a number of 1 km^2 grids that are identified by the ABS as being populated. The desk-top mapping study performed for this AQIA examined those grid cells to ensure all relevant receptor locations had been identified. For a number of cells, sheds or unmaintained (assumed derelict) structures were identified that appear to have been erroneously assumed to be residential properties, and for other cells no structures were identified.

Table 7 Discrete sensitive receptor locations used in the study

ID	Land Use	Location (m, UTM 55)	
		Eastings	Northings
N1	Residential	657 179	6 402 467
N2	Residential	649 566	6 415 286
N3	Residential	652 907	6 415 195
R11	Residential	646 126	6 404 470
R32	Residential	648 449	6 413 964
R64	Residential	649 440	6 415 212
R65	Residential	659 947	6 411 308
R12	Residential	648 915	6 408 740
R13	Educational	646 127	6 404 363
R18	Residential	645 286	6 406 014
R19	Residential	646 860	6 407 725
R20	Residential	647 419	6 407 981
R21	Residential	645 271	6 409 949
R22	Residential	648 630	6 409 050
R23	Residential	648 722	6 409 175
R24	Residential	648 655	6 409 405
R25	Residential	648 773	6 409 586
R26	Residential	648 198	6 410 328
R27	Residential	646 932	6 412 256
R28A	Residential	646 770	6 412 371
R28B	Residential	646 710	6 412 614
R30A	Residential	648 938	6 413 225
R30B	Residential	649 291	6 413 737
R31A	Residential	647 194	6 413 883
R31B	Residential	647 513	6 414 190
R35	Residential	652 515	6 415 243
R36	Residential	653 577	6 414 166
R38	Residential	654 941	6 415 357
R4	Residential	654 258	6 404 772
R40A	Residential	655 990	6 414 243
R40B	Residential	654 430	6 413 942
R41	Residential	657 224	6 415 385
R43	Residential	657 582	6 412 251

ID	Land Use	Location (m, UTM 55)	
		Eastings	Northings
R44	Residential	659 731	6 413 370
R46	Residential	657 042	6 409 628
R50	Residential	652 101	6 409 221
R59A	Residential	659 720	6 410 193
R59B	Residential	659 560	6 407 588
R6	Residential	649 065	6 403 864
R61	Residential	656 736	6 404 315
R66	Residential	659 813	6 410 665
R67	Residential	659 847	6 410 950
R68	Residential	659 217	6 410 606
R7A	Residential	648 902	6 404 633
R7B	Residential	649 139	6 405 312
R8A	Residential	647 355	6 405 883
R8B	Residential	646 176	6 403 938
R51	Project Related	650 348	6 409 795
R1	Project Related	648 845	6 408 321
R2	Project Related	649 424	6 407 205
R3	Project Related	652 823	6 405 282
R48	Project Related	653 963	6 409 538
R49A	Project Related	654 259	6 408 943
R49B	Project Related	654 471	6 409 003
R54	Project Related	649 708	6 409 426
R55	Project Related	649 810	6 409 530
R56	Project Related	649 743	6 409 345
R58	Project Related	649 983	6 409 650

4.1.2 Uniform Receptor Locations

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

4.2 Meteorology

In accordance with the requirements of the NSW EPA Approved Methods, the AQIA is required to describe and account for the influence of the prevailing meteorological conditions.

The meteorology experienced within an area can govern the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorology of the area surrounding the Project Site has been examined using data collected by the Australian Government Bureau of Meteorology (BoM) at the Dubbo Airport Automatic Weather Station (AWS), which is approximately 30 km to the north. This AWS is considered the most representative station for the area surrounding the Project Site.

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

Data from the year 2015 have been selected for use in the AQIA to provide an approximation of 'representative' conditions surrounding the Project Site. This year has been selected through examination of meteorology and background air quality conditions for the six-year period 2015 to 2020. The year 2015 was selected as being most representative as wind speed and direction measured at Dubbo Airport AWS in 2015 were considered to be most representative of the six-year period examined.

A summary of the inputs and outputs of the meteorological modelling assessment, including model validation, is presented in **Appendix B**. This analysis includes a discussion of data availability and variability.

It is noted that a meteorological station maintained by the Applicant at the "Wychitella" property (see **Figure 6**) has been operating since 2001. However, wind speed data represented in the wind roses of the Annual Review and Annual Rehabilitation Report (ASM, 2019-2020), indicate that wind speed data is missing from the record since October 2018. Furthermore, recorded data is not available for the other measured years (2001 – 2020) and for these reasons, data from Dubbo Airport AWS has been used in this assessment.

4.3 Air Quality

4.3.1 DPIE Air Quality Monitoring Stations

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

When assessing the 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 DPIE operates AQMS in regional centres and as part of the Rural Air Quality Monitoring Network (RAQMN). Due to the rural setting and the nature / scale of air quality emissions in the area, the Bathurst AQMS does not measure all of the air pollutants subject to assessment within this AQIA. Subsequently, data from the closest AQMS that do measure the individual pollutants of concern have been adopted in this study, where possible. These AQMS are briefly summarized in **Table 8**.

The year 2015 is indicated in **Table 8** as this is the year selected for assessment (refer below and **Section 4.2**).

Table 8 Closest DPIE AQMS to the Project Site

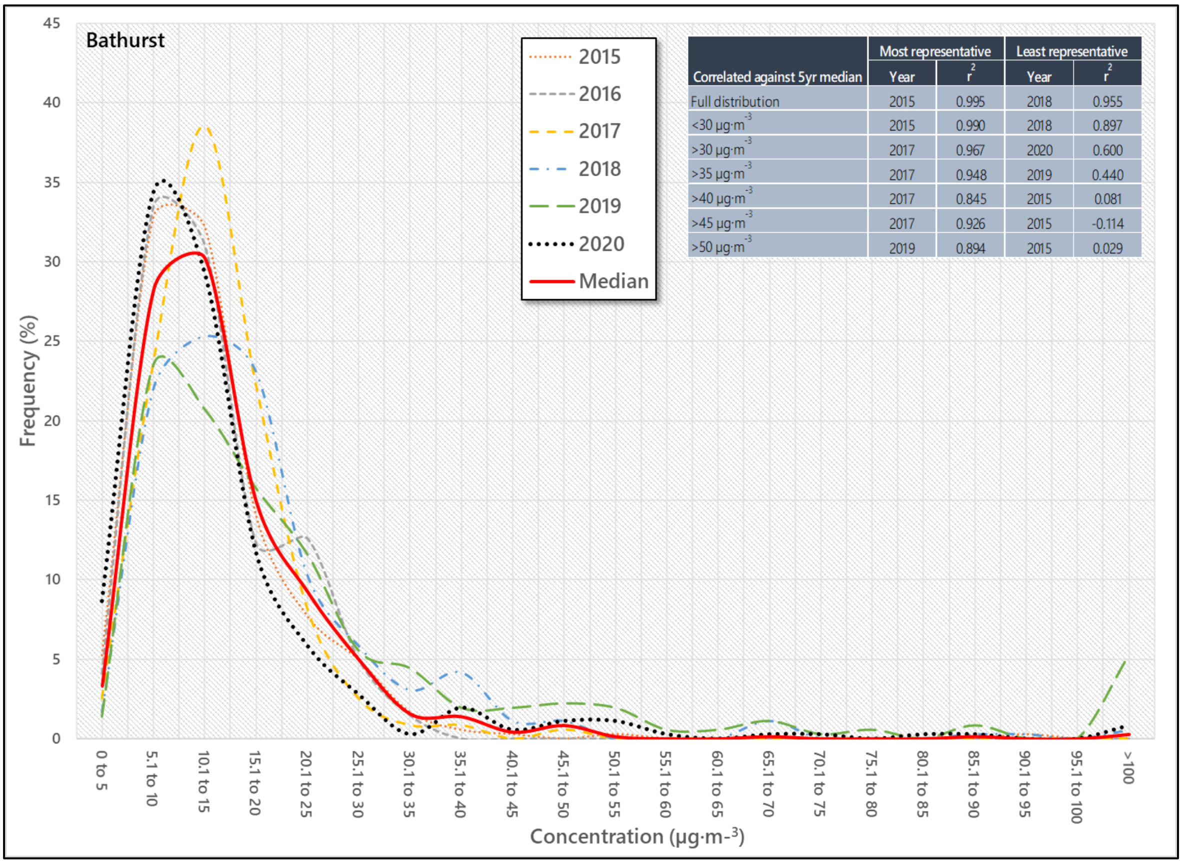
AQMS Location	Approximate distance to Project (km)	2015 Data	Measurements						
			PM_{10}	$PM_{2.5}$	TSP	NO_2	SO_2	HCl	Cl_2
Bathurst	140	✓	✓	×	×	×	×	×	×
Oakdale	230	✓	✓	✓	×	✓	×	×	×
Bargo	280	✓	✓	✓	×	✓	✓	×	×
Wagga Wagga North	312	✓	✓	✓	×	×	×	×	×

The adoption of air quality monitoring data, often collected at significant distances from proposed projects, to represent conditions at those locations is a routinely adopted approach in NSW. NSW DPIE operates an extensive air quality monitoring network, generally reflective of the most populated areas of the State. Site specific air quality monitoring funded by proponents can sometimes be used, although for the purposes of use within an AQIA, at least a full year of continuous measurement is required. In the absence of specific monitoring data available in the vicinity of the Project, the closest and more representative of the Project Site DPIE monitoring data were selected for use in this AQIA as follows:

- Bathurst AQMS is the closest and most reflective of the environment at the Project Site with PM_{10} data available.
- The closest representative (although not closest) AQMS with $PM_{2.5}$ data available is noted to be located at Wagga Wagga North and is considered to be the monitoring location most reflective of the conditions at the Project Site.
- NO_2 and SO_2 concentrations measured at Bargo AQMS were adopted for use in this assessment. It is noted that Oakdale AQMS is the closest station with NO_2 data available, however the adoption of the annual average NO_2 concentration measured at Bargo AQMS is more conservative for the purposes of this assessment.
- It is noted that none of the AQMS identified in **Table 8** measure concentrations of TSP. This pollutant is of relevance to the expected emissions from the Project. Other sources of data have been adopted to allow representation of the TSP environment in the area surrounding the Project, and a full discussion is provided in **Appendix C**.
- None of the proximate AQMS measure HCl or Cl_2. It is noted that these air pollutants are not routinely measured at any AQMS in NSW, and the background concentrations of HCl and Cl_2 are considered to be negligible.

Data from the year 2015 have been selected for use in the AQIA to provide an approximation of 'representative' conditions surrounding the Project Site (see **Section 4.2**). This year has been selected through examination of meteorology and air quality for the six-year period 2015 to 2020. In terms of background air quality, the year 2015 was selected as being most representative, as PM_{10} data measured at the Bathurst AQMS in 2015 were statistically shown to be most representative of the six-year median particulate distribution at that location, when considering the full particulate distribution (see **Figure 7**).

Figure 7 Statistical analysis of PM_{10} concentrations at Bathurst, 2015 to 2020



Correlated against 5yr median	Most representative		Least representative	
	Year	r^2	Year	r^2
Full distribution	2015	0.995	2018	0.955
<30 µg·m⁻³	2015	0.990	2018	0.897
>30 µg·m⁻³	2017	0.967	2020	0.600
>35 µg·m⁻³	2017	0.948	2019	0.440
>40 µg·m⁻³	2017	0.845	2015	0.081
>45 µg·m⁻³	2017	0.926	2015	-0.114
>50 µg·m⁻³	2019	0.894	2015	0.029

Table 9 presents a summary of the annual average of the air pollutants measured by the DPIE for each calendar year over the 2015 to 2020 period at each AQMS used in this assessment.

Table 9 Air quality background concentrations

Pollutant		Annual average concentration (µg·m^{-3})					
		2015	2016	2017	2018	2019	2020
PM_{10}	(Bathurst)	13.4	13.3	14.1	18.8	27.4	17.0
$PM_{2.5}$	(Wagga Wagga North)	7.6	7.4	8.1	8.4	11.3	10.7
NO_2	(Bargo)	10.9	10.3	11.4	11.8	12.2	9.5
SO_2	(Bargo)	0.7	0.9	0.8	0.9	1.2	0.6

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 10**.

Table 10 Summary of background air quality used in the AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP) (derived from PM_{10})	Annual µg·m^{-3}	30.1	Estimated on a TSP:PM_{10} ratio of 2.2434:1
Particles (as PM_{10}) (Bathurst)	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum for PM_{10} in 2015 was 94.6 µg·m^{-3} (exceeding the criterion)
	Annual µg·m^{-3}	13.4	
Particles (as $PM_{2.5}$) (Wagga Wagga North)	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum for $PM_{2.5}$ in 2015 was 24.2 µg·m^{-3}
	Annual µg·m^{-3}	7.6	
Nitrogen dioxide (NO_2) (Bargo)	1-hour µg·m^{-3}	98.4	Hourly max 1-hr average in 2015
	Annual µg·m^{-3}	10.9	Annual average in 2015
Sulphur Dioxide (SO_2) (Bargo)	10-minute	36.9	Calculated from hourly data
	1-hour µg·m^{-3}	25.8	Hourly max 1-hr average in 2015
	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum for SO_2 in 2015 was 5.72 µg·m^{-3}
	Annual µg·m^{-3}	0.7	Annual average in 2015

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

In the absence of measured data, the sub hourly (10-minute) SO_2 concentrations were calculated using the following Power Law adjustment[1]:

$$C_{p,t} = C_{p,60}\left[\frac{60}{t}\right]^{0.2}$$

Where:

$C_{p,t}$ = concentration of pollutant (p) at averaging time (mins) (t)

$C_{p,60}$ = concentration of pollutant (p) at averaging time (60 mins)

t = time (mins)

Two exceedances of the NSW EPA 24-hour average PM_{10} criterion were measured at the Bathurst AQMS in 2015 due to exceptional events discussed further in **Section 4.3.2**.

No exceedances of the NSW EPA 24-hour average $PM_{2.5}$ criterion were measured at the Wagga Wagga North AQMS during 2015. The maximum 24-hour average $PM_{2.5}$ concentration measured at that AQMS in 2015 was 24.2 µg·m^{-3}.

The maximum 1-hour NO_2 average concentration at Bargo AQMS in 2015 was 98.4 µg·m^{-3} (see **Table 10**), below the NSW EPA criterion of 246 µg·m^{-3}. The annual average concentrations of NO_2 measured between 2015-2020 range between 9.5 µg·m^{-3} and 12.2 µg·m^{-3} presented in **Table 9.**

1 http://www.epa.vic.gov.au/~/media/Publications/1551.pdf

Annual average concentrations of SO_2 measured at Bargo AQMS from 2015 -2020, range between 0.6 µg·m^{-3} and 1.2 µg·m^{-3}. In 2015 the maximum 1-hour average concentration was 25.8 µg·m^{-3}, below the EPA criterion of 570 µg·m^{-3}. The maximum 10-min average concentration was calculated as 36.9 µg·m^{-3} below the EPA criterion of 712 µg·m^{-3}.

Background air quality monitoring of other pollutants assessed in this AQIA, including HCl and Cl_2, are not routinely performed in NSW or Australia although specific pollutant monitoring campaigns may be performed to identify and quantify risks surrounding specific emission sources. As such data is not available for the study area, background concentrations of other pollutants, including HCl, Cl_2 and odour are assumed to be negligible (i.e. at trace concentrations). This is a commonly adopted assumption, and consistent with the AQIA adopted for the approved Project (PEL, 2013). Furthermore, the NSW EPA Approved Methods require that only the incremental impact of HCl and Cl_2 is evaluated.

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

4.3.2 Exceptional Events

Daily PM_{10} concentrations above the NSW EPA standard of 50 µg·m^{-3} were recorded for at least one day at most sites throughout the NSW network in 2015. This was mainly a result of a statewide dust storm that originated from the Victorian Mallee and southern NSW regions and travelled throughout NSW during 5 and 6 May (DPIE NSW, 2015b). On 25 November moderate size grass fires occurred to the west of the Bathurst AQMS (DPIE NSW, 2015a). The above is consistent with the exceedances recorded at Bathurst AQMS on 6 May 2015 and 25 November 2015. A plot of the PM_{10} at Bathurst AQMS is available in **Appendix C**. These exceedances have not been removed from the background monitoring data adopted within this assessment.

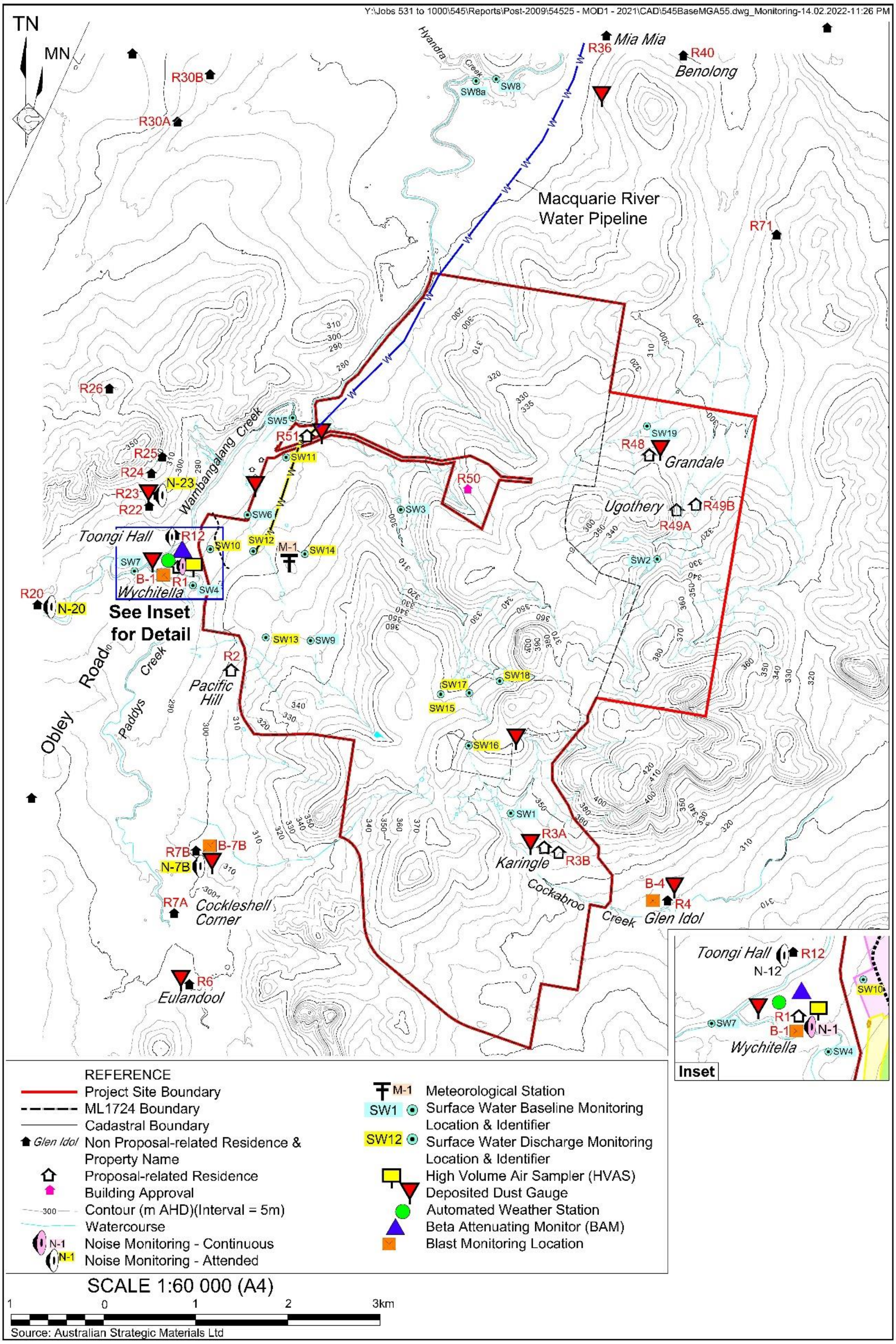
4.3.3 On-Site Monitoring

Deposited dust has been monitored at 12 locations within and neighbouring the Project Site since November 2012 and up to January 2020. **Table 11** presents a summary of the annual average deposited dust rates (2015-2020) at each dust gauge. The location of the deposited dust gauges is presented in **Figure 8**.

To date there is no data on total suspended particulates (TSP) as the permanent environmental monitoring has not yet been established (ASM, 2019-2020).

Six and a half years of deposited dust monitoring indicates that the Project Site yields low levels of nuisance dust and is typical of mixed agricultural land with an average 550 mm annual rainfall (ASM, 2019-2020).

Figure 8 Environmental monitoring locations surrounding the Project Site



Source: RWC

Table 11 Annual dust deposition rates

Site ID	Site Name	Annual Dust Deposition Rates (g·m^{-2}·month^{-1})					
		FY 2014-2015	FY 2015-2016	FY 2016-2017	FY 2017-2018	FY 2018-2019	FY 2019-2020
		30/5/2014 –23/6/2015	23/6/2015 -2/6/2016	2/6/16-2/6/2017	4/7/2017-2/7/2018	2/7/2018 2/7/2019	2/7/2019-3/1/2020
EML-LB	Lifestyle Blocks	0.3	0.8	0.6	0.8	2.0	3.1
EML-MB	Malcolms Bye's	0.4	1.8	1.6	0.7	2.3	2.7
EML-TV	Toongi Valley	0.3	1.1	0.9	1.1	2.7	3.3
EML-WY1	Wychitella Homestead	-	-	1.6	1.0	2.5	4.6
EML-W	Wychitella	0.6	0.8	0.6	1.0	2.5	2.5
EML-CC	Cockleshell Corner	2.3	-	-	-	-	-
EML-CC1	Cockleshell Corner Cottage	-	-	1.6	1.3	3.4	3.1
EML-E	Eulandool		2.0	1.5	1.1	3.0	2.5
EML-K	Karingle	0.3	0.7	1.5	0.9	2.0	2.3
EML-OB	Ore Body	0.3	0.6	0.8	0.7	1.9	2.7
EML-GI	Glen Idol	0.8	1.1	1.3	1.7	2.9	5.0
EML-G	Grandale	0.7	4.7	2.7	1.2	2.2	2.3
EML-MM	Mia Mia	1.1	3.5	0.9	0.7	1.8	1.9
Average		0.7	1.7	1.3	1.0	2.4	3.0

The Cockleshell Corner (EML-CC) dust gauge was relocated to Eulandool on 3 August 2015 to enable baseline data to be presented to the property owner (AZL, 2015-2016).

All monitoring locations have recorded dust deposition levels below the 4 g·m^{-2}·month^{-1} dust criteria, with the exception of:

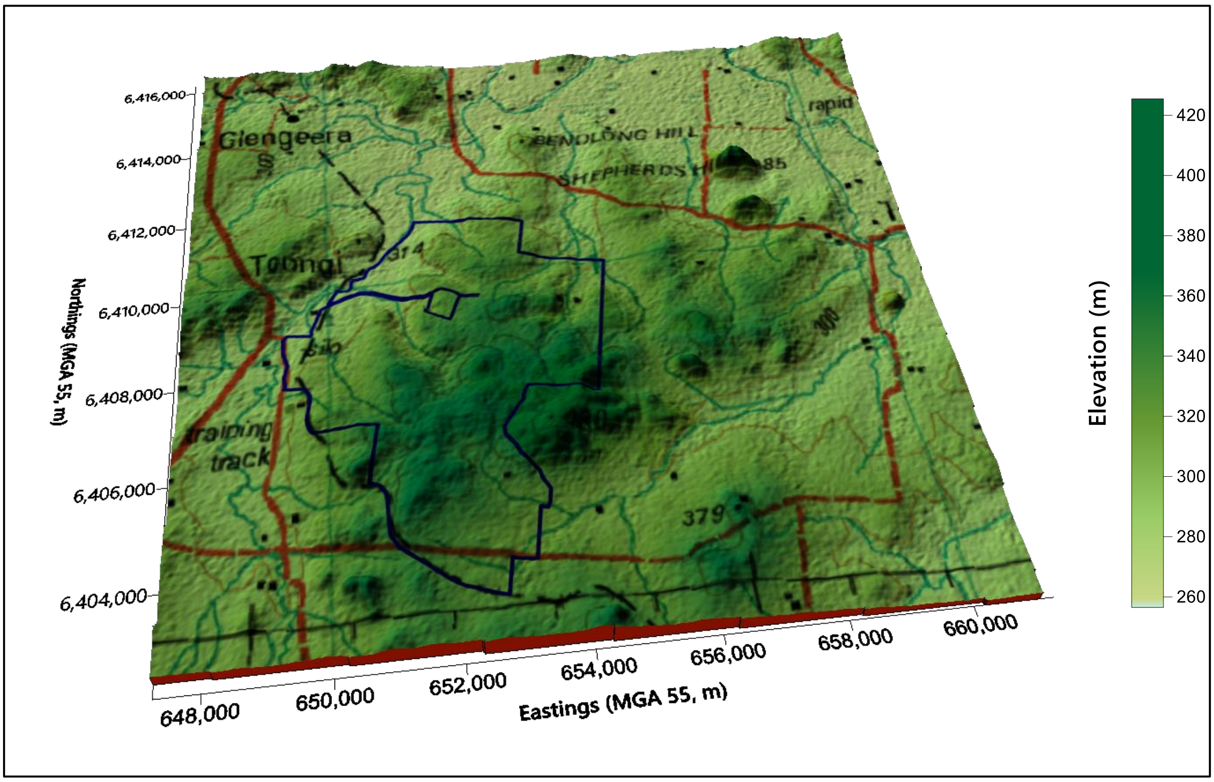
- 2018-2019: "*Has seen numerous raised dust events due to state-wide drought conditions*" (ASM, 2018-2019); and
- 2019-2020: "*There were several weeks of poor air quality between November 2019 and January 2020 due to bushfires across eastern Australia*" (ASM, 2019-2020).

Given that the average dust deposition (at all the dust gauges) in the most recent year (FY2019-2020) of data show dust deposition levels of 3 g·m^{-2}·month^{-1} a background dust deposition level of 3 g·m^{-2}·month^{-1} has been adopted for this AQIA.

4.4 Topography

Topography across the Project Site and the surrounding area is gently undulating. The elevation of the Project Site is between approximately 260 m and 420 m AHD. Gently undulating cleared grasslands dominate the central and western portions of the Project Site. A 3-dimensional representation of the topography surrounding the Project Site is presented in **Figure 9**. The topography of the area, and the locations of surrounding receptors in relation to the Project and surrounding topography has informed the approach to meteorological modelling (refer **Section 5.1**).

Figure 9 3-dimensional representation of topography surrounding the Project



Source: Northstar Air Quality

4.5 Potential for Cumulative Impacts

The area surrounding the Project Site is generally agricultural in nature, with no significant sources of particulate matter that may impact cumulatively with the Project on nearby sensitive receptors. The inclusion of the background air quality data as described in **Section 4.3** would appropriately account for any potential cumulative impacts associated with surrounding land uses.

4.6 Greenhouse Gas

Emissions of GHG are tracked by the Commonwealth of Australia through the Australian National Greenhouse Accounts program. This program, and the reports and data submitted as part of the program, fulfils Australia's international and domestic reporting requirements. Carbon emission totals by State and Territory by year and by sector are reported in the 'State and Territory Greenhouse Gas Inventories' report for each reporting year and provided online[2].

These data are used to:

- Meet Australia's reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC);
- Track progress against Australia's emission reduction commitments; and
- Inform policy makers and the public.

Data for 2019 have been obtained for the purposes of this GHG assessment. These data are the most recent available at the time of reporting.

Emissions of GHG from Australia in 2019 across all economic sectors were 529.9×10^6 tonnes (Mt) carbon dioxide equivalent (CO_2-e) and in NSW were 136.5 Mt CO_2-e.

[2] https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-2019/state-and-territory-greenhouse-gas-inventories-2019-emissions

5. APPROACH TO ASSESSMENT

5.1 Air Quality Impact Assessment

5.1.1 Dispersion Modelling

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 3-dimensional (3-D) mode, adopting a 'No-Obs' meteorological modelling simulation, in accordance with NSW DPIE guidance (Barclay & Scire, 2011) (please refer to **Appendix B** for further information). This approach allows the inclusion of topographical features which are present in the area surrounding the Project, as discussed in **Section 4.4**.

An assessment of the impacts of the operation of activities at the Project has been performed which characterises the likely day-to-day operation of the Project, approximating average operational characteristics which are appropriate to assess against longer term air quality criteria. Given the nature of the Project, the peak activity rates are likely to be similar to average activity rates, and the comparison of potential impacts against shorter term air quality criteria is also valid.

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

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

5.1.2 Emissions Estimation

Particulate matter

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. This assessment has adopted emission factors for drilling, blasting, materials handling processes, movement of trucks on unpaved site roads, crushing, and wind erosion contained within the US EPA AP-42 emission factor compendium (US EPA, 1995 and updates) to represent the emission of particulate matter resulting from the construction activities and operations occurring at the Project Site as described in **Section 2.2**. These factors are appropriate for adoption in Australia and are routinely adopted in the assessment of operations of this nature.

Full emissions inventories describing the emission factors adopted, and calculated emissions totals, are presented in **Appendix D**.

Odour

Consistent with the AQIA submitted to support the original approval (PEL, 2013), odour emissions are anticipated to be released from the wastes produced as part of the ore processing operations. It is anticipated that odour emissions may be released from the liquid/solid waste streams that are to be deposited as part of the Project.

The liquid waste stream would be pumped to Liquid Residue Storage Facility (LRSF) at a rate of approximately 2.5 gigalitres (GL) per year. The liquid waste stream may contain residues containing ammonia (NH_3).

The solid (compound) waste stream would comprise a complex mixture of odorous compounds that may include hydrogen sulphide (H_2S) and would be conveyed to the Solid Residue Storage Facility (SRSF).

As outlined in PEL (2013), odour samples from each waste stream were collected from a pilot processing plant operated by ANSTO at Lucas Heights, in 2012 and 2013. The specific odour emission rate (SOER) for the liquid waste stream was determined to be 0.15 $OU \cdot m^{-3} \cdot m^{-2} \cdot s^{-1}$, with the SOER for the compound waste stream 0.08 $OU \cdot m^{-3} \cdot m^{-2} \cdot s^{-1}$. As discussed in PEL (2013), odour emissions from these sources decrease rapidly with time, and in the AQIA for the original approval, a range of assumptions were adopted to allow a more realistic representation of odour emissions from the Project Site. This included the adoption of a 'diluted' SOER (0.01 $OU \cdot m^{-3} \cdot m^{-2} \cdot s^{-1}$) from the LRSF, which has been adopted within this AQIA.

Odour emissions have been applied to the maximum area of the LRSF and SRSF, which results in a greater total odour emission rate from the Project Site when compared to the original approval.

Full emissions inventories describing the emission factors adopted, and calculated emissions totals, are presented in **Appendix D**.

Radon

Consistent with the AQIA submitted to support the original approval (PEL, 2013), emissions of Rn have been assessed during Year 15 of operations. The Rn emission rates were determined as part of the previous radiation assessment (JRHC Enterprises, 2013), with all emissions modelled as area sources, with the exception of those which may potentially be released from the Ore Mill Exhaust Vent at the Processing Plant.

Full emissions inventories describing the emission factors adopted, and calculated emissions totals, are presented in **Appendix D**.

Other Emissions

Other pollutants anticipated to be released during the Project operations include SO_2, NO_2, HCl, Cl_2, PM_{10} and $PM_{2.5}$, which would be released from various stack sources at the Processing Plant. Modifications to the layout and operation of the Processing Plant have been made since the original approval, and this AQIA provides the emission source parameters, emission rates, and locations as provided by the Applicant which represent these modifications. This includes the addition of the chlor-alkali plant, as described in **Section 2.1.2**.

Full emissions inventories are presented in **Appendix D**.

5.1.3 Emissions Controls

A range of emissions controls will be implemented during the construction and operation of the Project. These are discussed in detail in **Section 7**.

5.1.4 NO_X to NO_2 Conversion

The emission rates of oxides of nitrogen (NO_X) have been modelled as nitrogen dioxide (NO_2). Approximately 90 % - 95 % of NO_X from a combustion process will be emitted as nitric oxide (NO), with the remaining 5 % - 10 % emitted directly as NO_2. Over time and after the point of discharge, NO in ambient air will be transformed by secondary atmospheric reactions to form NO_2, and this reaction often occurs at a considerable distance downwind from the point of emission, and by which time the plume will have dispersed and diluted significantly from the concentration at point of discharge.

Air quality impact assessments need to account for the conversion of NO to NO_2 to enable a comparison against the air quality criterion for NO_2. To perform this, various techniques are common, which are briefly outlined below:

- **100% conversion**: the most conservative assumption is to assume that 100% of the total NO_X emitted is discharged as NO_2, and that further reactions do not occur.
- **Jansen method**: where the location is represented by good monitoring data for NO and NO_X, the empirical relationship between NO and NO_2 may be used to derive 'steady state' relationships.
- **Ozone limiting method**: this method uses contemporaneous ozone (O_3) data to estimate that rate at which NO is oxidised to NO_2 hour-on-hour using an established relationship.

The conservative assumption that 100% of the total NO_X emitted is discharged as NO_2, (100% conversion above) has been adopted.

5.2 Greenhouse Gas Assessment

The purpose of the GHG assessment is to examine the potential impacts of the operation of the Project relating to emissions of GHG. A quantitative assessment of emissions is performed with direct emissions compared with total national and NSW GHG emissions for context (refer **Section 4.6**).

Emission factors as outlined in the Australian Government Department of the Environment (DoE) document, "National Greenhouse Accounts Factors" Workbook (NGA Factors) (DISER, 2021) have been adopted within this GHG assessment, although it is acknowledged that the processing of ore results in emissions of CO_2, which are not appropriately covered in the NGA Factors. An external consultant (Carbon X) has been engaged by the Applicant to assess the quantum of processing emissions, and those values have been adopted and referenced within this assessment.

The scope of the GHG assessment is to provide a quantitative assessment of GHG emissions arising from the operation of the Project, including the proposed modification. This report does not provide a definitive quantification of GHG emissions arising from the Project operation but provides the general context of the likely quantum of emissions.

Opportunities for reduction of GHG emissions are discussed.

5.2.1 Emission Types

The Australian Government Department of the Environment (DoE) document, "National Greenhouse Accounts Factors" Workbook (NGA Factors) (DISER, 2021) defines two types of GHG emissions (see **Table 12**), namely 'direct' and 'indirect'. This assessment considers both direct emissions and indirect emissions resulting from the Project operation.

Table 12 Greenhouse gas emission types

Emission Type	Definition
Direct	Produced from sources within the boundary of an organisation and as a result of that organisation's activities (e.g. consumption of fuel in on-site vehicles)
Indirect	Generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation (e.g. consumption of purchased electricity).

Note: Adapted from NGA Factors Workbook (DISER, 2021)

5.2.2 Emission Scopes

The NGA Factors (DISER, 2021) identifies three 'scopes' of emissions for GHG accounting and reporting purposes as shown in **Table 13**.

Table 13 Greenhouse gas emission scopes

Emission Scope	Definition
Scope 1	Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate Scope 1 emissions.
Scope 2	Indirect emission factors are used to calculate Scope 2 emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.
Scope 3	Indirect emissions which are not included in scope 2, occurring within an organisation's value chain. The majority of a company's value chain greenhouse gas emissions may lie outside their own operations. Emissions from a company's value chain occurring externally to their operations within Australia may be estimated using the available scope 3 emission factors

Note: Adapted from NGA Factors Workbook (DISER, 2021)

5.2.3 Source Identification and Boundary Definition

The geographical boundary set for the GHG assessment covers the Project Site (i.e. encompassing the approved Project and those proposed as part of the modification) but also includes the transport of raw materials to the Project Site, product from the Project Site, and personnel to/from the Project Site.

All Scope 1, 2 and Scope 3 emissions within the defined boundary have been identified and reported as far as possible.

5.2.4 Emission Source Identification

The activities/operations being performed as part of the Project which have the potential to result in emissions of GHG (as included in (DISER, 2021)) are presented in **Table 14**.

Table 14 Greenhouse gas emission sources

Project Component	Scope	Emission Source Description
Emissions of CO_2 from ore processing operations	1	Emissions from materials processing
Consumption of natural gas in processing operations	1,3	Emissions from combustion of fuel (scope 1) Emissions associated with extraction and processing of fuel (scope 3)
Consumption of diesel fuel in mobile plant and equipment	1,3	
Consumption of electricity	2	Emissions associated with electricity generation
Consumption of diesel fuel / unleaded fuel for employee transport purposes	3	Emissions associated with the extraction and processing of fuels
Consumption of diesel fuel in the transport of materials to the Project Site	3	Emissions associated with the extraction and processing of fuels

5.2.5 Emissions Estimations

Emissions of GHG from each of the sources identified in **Table 14** have been calculated using activity data for each source per annum (e.g. kL diesel fuel) and the relevant emission factor for each source. In relation to process emissions of CO_2, these values have been provided by Carbon-X (pers. comm.).

The assumptions used in the calculation of activity data for each emissions source are presented below. Emission factors are presented in the following section.

5.2.6 Activity Data

Information relating to the quantities of gas, electricity, and diesel fuel used as a result of the Project, have been provided by the Applicant. In the calculation of certain values, assumptions have been made based on the levels of activity at the Site.

Emissions associated with the processing of ore, the transport of raw materials to the Project Site (sulphur [from Canada], limestone [from Geurie], caustic soda, hydrochloric acid, and diesel [from Newcastle], soda ash [from Sydney], and salt [from Salt Lake]), and the transport of product from the Project Site have been calculated by Carbon-X. These data and assumptions are outlined in **Table 15.**

Table 15 Calculated activity data

Project Component	Assumptions	Activity	Units
Process emissions of CO_2	Information provided by Carbon X indicates that processing emissions of CO_2 may be of the order of 226 082 t per annum	226 082	$t{\cdot}annum^{-1}$
Consumption of natural gas in processing operations	Information provided by the Applicant indicates the natural gas use to be 1 863 067 GJ per annum	1 863 067	$GJ{\cdot}annum^{-1}$
Consumption of diesel fuel in mobile plant and equipment at the Project Site	Information provided by the Applicant indicates the diesel fuel use to be 786.7 kL per annum	786.7	$kL{\cdot}annum^{-1}$
Consumption of electricity	Information provided by the Applicant indicates the electricity use to be 317 925 MWh per annum	317 925	$MWh{\cdot}annum^{-1}$
Consumption of diesel fuel / unleaded fuel for employee transport purposes	Up to 270 personnel to be employed at the Project Site on a full-time equivalent basis Assume employees reside in Dubbo (56 km as a two-way journey) 11.1 L per 100 km fuel efficiency (ABS, 2020)	1.7	$kL{\cdot}annum^{-1}$
Consumption of diesel fuel in the transport of materials to the Project Site	Information provided by Carbon X indicates that emissions of CO_2 associated with the transport of raw materials to the Project Site may be of the order of 16 332 t per annum	16 332	$t{\cdot}annum^{-1}$

Project Component	Assumptions	Activity	Units
Consumption of diesel fuel in the transport of product from the Project Site	Information provided by Carbon X indicates that emissions of CO_2 associated with the transport of product from the Project Site may be of the order of 456 t per annum	456	t·annum^{-1}

5.2.7 Emission Factors

Emissions factors used for the assessment of GHG emissions associated with the operation of the Project have been sourced from the NGA Factors (DISER, 2021) (refer to **Table 16**).

Table 16 Greenhouse gas emission factors

Emission Scope	Emission Source	Emission Factor (per unit energy)	Energy Content Factor	Emission Factor (per unit activity)
Scope 1	Diesel fuel for mobile plant and equipment	70.2 kg CO_2-e GJ^{-1}	38.6 GJ·kL^{-1}	2 709.7 kg·kL^{-1}
	Natural gas^{A}	51.53 kg CO_2-e GJ^{-1}	39.3 × 10^{-3} GJ·m^{-3}	51.53 kg CO_2-e GJ^{-1}
Scope 2	Electricity consumption (NSW)	0.78 kg CO_2-e kWh^{-1}	-	0.78 kg CO_2-e kWh^{-1}
Scope 3	Natural gas	14.0 kg CO_2-e GJ^{-1}	39.3 × 10^{-3} GJ·m^{-3}	14.0 kg CO_2-e GJ^{-1}
	Electricity consumption (NSW)	0.07 kg CO_2-e kWh^{-1}	-	0.07 kg CO_2-e kWh^{-1}
	Unleaded fuel for employee transport	3.6 kg CO_2-e GJ^{-1}	34.2 GJ·kL^{-1}	123.1 kg·kL^{-1}

Note: A Activity data provided in GJ. For information the energy content of natural gas distributed in a pipeline is 39.3 × 10^{-3} GJ·m^{-3} (from table 2 of (DISER, 2021))

Emission factors associated with raw material and product transport, and those associated with process emissions are not presented in **Table 16**, as the total CO_2-e emission has been provided by Carbon-X, and these values have been adopted *prima facie*.

6. AIR QUALITY IMPACT ASSESSMENT

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

- **Incremental impact** – relates to the concentrations predicted as a result of the operation of the Project in isolation.
- **Cumulative impact** – relates to the concentrations predicted as a result of the operation of the Project PLUS the background air quality concentrations, where relevant, as discussed in **Section 4.3**.

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

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

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

6.1 Construction Scenario

6.1.1 Particulate Matter

Results are presented in this section for the predictions of particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) during the construction phase. The averaging periods associated with the criteria for these pollutants is 24-hour and annual average, as specified in **Table 3**. The emissions adopted for this scenario reflect the operational profile of the Project over those averaging periods (refer **Section 5.1.2**).

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 construction of the Project, are presented in **Table 17**, noting all Project related receptors have been excluded from the incremental concentration calculations, and are presented in gray text at the end of the table.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at residential receptor locations during construction works are relatively low (less than (<) 8.1 % of the annual average TSP criterion, ≤ 19.8 % of the annual average PM_{10} criterion and ≤ 9.9 % of the $PM_{2.5}$ criterion).

Background concentrations of annual average $PM_{2.5}$ are noted to be high, and close to the relevant criterion (95% of the criterion) without the addition of the Project related incremental impact. The addition of existing background concentrations (refer **Section 4.3**) results in predicted concentrations representing, as a maximum:

- 41.5 % of the annual average TSP criterion;
- 73.4 % of the annual average PM_{10} criterion; and
- 104.9 % of the annual average $PM_{2.5}$ criterion.

Table 17 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – construction scenario

Receptor	Annual Average Concentration (µg·m⁻³)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
Criterion	90			25			8		
Max % of criterion	8.1%	33.4%	41.5%	19.8%	53.6%	73.4%	9.9%	95.0%	104.9%
N1	<0.1	30.1	30.2	<0.1	13.4	13.5	<0.1	7.6	7.7
N2	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
N3	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R11	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
R32	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R64	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
R65	0.2	30.1	30.3	0.1	13.4	13.5	<0.1	7.6	7.7
R12	7.3	30.1	37.4	4.9	13.4	18.3	0.8	7.6	8.4
R13	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
R18	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R19	1.4	30.1	31.5	1.0	13.4	14.4	0.2	7.6	7.8
R20	1.9	30.1	32.0	1.4	13.4	14.8	0.2	7.6	7.8
R21	0.8	30.1	30.9	0.7	13.4	14.1	0.1	7.6	7.7
R22	4.8	30.1	34.9	3.5	13.4	16.9	0.6	7.6	8.2
R23	4.8	30.1	34.9	3.4	13.4	16.8	0.6	7.6	8.2
R24	4.0	30.1	34.1	2.9	13.4	16.3	0.5	7.6	8.1
R25	3.9	30.1	34.0	2.9	13.4	16.3	0.5	7.6	8.1
R26	1.7	30.1	31.8	1.3	13.4	14.7	0.2	7.6	7.8
R27	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R28A	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R28B	0.4	30.1	30.5	0.4	13.4	13.8	<0.1	7.6	7.7
R30A	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R30B	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7

Receptor	Annual Average Concentration (µg·m⁻³)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
Criterion	90			25			8		
Max % of criterion	8.1%	33.4%	41.5%	19.8%	53.6%	73.4%	9.9%	95.0%	104.9%
R31A	0.3	30.1	30.4	0.2	13.4	13.6	<0.1	7.6	7.7
R31B	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
R35	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R36	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R38	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
R4	0.3	30.1	30.4	0.2	13.4	13.6	<0.1	7.6	7.7
R40A	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R40B	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R41	0.3	30.1	30.4	0.2	13.4	13.6	<0.1	7.6	7.7
R43	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R44	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R46	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R50	7.1	30.1	37.2	4.5	13.4	17.9	0.7	7.6	8.3
R59A	0.2	30.1	30.3	0.1	13.4	13.5	<0.1	7.6	7.7
R59B	0.1	30.1	30.2	0.1	13.4	13.5	<0.1	7.6	7.7
R6	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R61	0.1	30.1	30.2	0.1	13.4	13.5	<0.1	7.6	7.7
R66	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R67	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R68	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R7A	0.6	30.1	30.7	0.5	13.4	13.9	<0.1	7.6	7.7
R7B	0.9	30.1	31.0	0.7	13.4	14.1	0.1	7.6	7.7
R8A	0.7	30.1	30.8	0.5	13.4	13.9	<0.1	7.6	7.7
R8B	0.3	30.1	30.4	0.2	13.4	13.6	<0.1	7.6	7.7
R51	9.7	30.1	39.8	6.2	13.4	19.6	1.0	7.6	8.6
R1	6.5	30.1	36.6	4.4	13.4	17.8	0.7	7.6	8.3
R2	5.3	30.1	35.4	3.8	13.4	17.2	0.6	7.6	8.2
R3	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R48	2.7	30.1	32.8	1.8	13.4	15.2	0.3	7.6	7.9
R49A	2.1	30.1	32.2	1.5	13.4	14.9	0.2	7.6	7.8
R49B	1.6	30.1	31.7	1.1	13.4	14.5	0.2	7.6	7.8
R54	12.0	30.1	42.1	6.8	13.4	20.2	1.1	7.6	8.7

Receptor	Annual Average Concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
Criterion	90			25			8		
Max % of criterion	8.1%	33.4%	41.5%	19.8%	53.6%	73.4%	9.9%	95.0%	104.9%
R55	10.2	30.1	40.3	6.3	13.4	19.7	1.0	7.6	8.6
R56	18.8	30.1	48.9	8.8	13.4	22.2	1.4	7.6	9.0
R58	11.1	30.1	41.2	7.0	13.4	20.4	1.1	7.6	8.7

The analysis identifies that the annual average $PM_{2.5}$ criterion is predicted to be exceeded at six receptor locations but these are driven by high existing background concentrations (95% of the criterion). Predicted changes to existing background concentrations as a result of the Project are predicted to be minor.

Annual average dust deposition

Table 18 below presents the annual average dust deposition predicted as a result of the construction activities at the Project Site. An assumed background dust deposition of 3 g·m^{-2}·month^{-1} is presented in **Table 18**. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the Project Site where the predicted impacts are less than 10.8 % of the incremental criterion, and less than 80.4 % of the cumulative criterion at non-Project related receptor locations. No contour plot of annual average dust deposition is presented, given the minor contribution from the Project at the nearest sensitive receptors.

Table 18 Predicted annual average dust deposition – construction scenario

Receptor	Annual Average Dust Deposition (g·m^{-2}·month^{-1})		
	Incremental Impact	Background	Cumulative Impact
Criterion	2	-	4
Max % of Criterion	10.8%		80.4%
N1	<0.1	3.0	3.1
N2	<0.1	3.0	3.1
N3	<0.1	3.0	3.1
R11	<0.1	3.0	3.1
R32	<0.1	3.0	3.1
R64	<0.1	3.0	3.1
R65	<0.1	3.0	3.1
R12	0.2	3.0	3.2
R13	<0.1	3.0	3.1
R18	<0.1	3.0	3.1

Receptor	Annual Average Dust Deposition (g·m^{-2}·month^{-1})		
	Incremental Impact	Background	Cumulative Impact
Criterion	2	-	4
Max % of Criterion	10.8%		80.4%
R19	<0.1	3.0	3.1
R20	<0.1	3.0	3.1
R21	<0.1	3.0	3.1
R22	0.1	3.0	3.1
R23	0.1	3.0	3.1
R24	<0.1	3.0	3.1
R25	<0.1	3.0	3.1
R26	<0.1	3.0	3.1
R27	<0.1	3.0	3.1
R28A	<0.1	3.0	3.1
R28B	<0.1	3.0	3.1
R30A	<0.1	3.0	3.1
R30B	<0.1	3.0	3.1
R31A	<0.1	3.0	3.1
R31B	<0.1	3.0	3.1
R35	<0.1	3.0	3.1
R36	<0.1	3.0	3.1
R38	<0.1	3.0	3.1
R4	<0.1	3.0	3.1
R40A	<0.1	3.0	3.1
R40B	<0.1	3.0	3.1
R41	<0.1	3.0	3.1
R43	<0.1	3.0	3.1
R44	<0.1	3.0	3.1
R46	<0.1	3.0	3.1
R50	0.2	3.0	3.2
R59A	<0.1	3.0	3.1
R59B	<0.1	3.0	3.1
R6	<0.1	3.0	3.1
R61	<0.1	3.0	3.1
R66	<0.1	3.0	3.1
R67	<0.1	3.0	3.1
R68	<0.1	3.0	3.1
R7A	<0.1	3.0	3.1
R7B	<0.1	3.0	3.1
R8A	<0.1	3.0	3.1
R8B	<0.1	3.0	3.1

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
Criterion	2	-	4
Max % of Criterion	10.8%		80.4%
R51	0.2	3.0	3.2
R1	0.2	3.0	3.2
R2	0.2	3.0	3.2
R3	<0.1	3.0	3.1
R48	<0.1	3.0	3.1
R49A	<0.1	3.0	3.1
R49B	<0.1	3.0	3.1
R54	0.4	3.0	3.4
R55	0.3	3.0	3.3
R56	1.0	3.0	4.0
R58	0.3	3.0	3.3

Maximum 24-hour average PM_{10} and $PM_{2.5}$

Table 19 below presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the construction of the Project. No background concentrations are included within this table.

Table 19 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – construction scenario

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
Criteron	50	25
Max % of criterion	47.9%	15.8%
N1	1.3	0.2
N2	3.1	0.6
N3	3.1	0.5
R11	2.5	0.5
R32	2.9	0.5
R64	3.3	0.6
R65	1.8	0.3
R12	23.9	3.9
R13	2.4	0.5
R18	3.6	0.6
R19	6.0	0.9
R20	7.4	1.2

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM$_{10}$	PM$_{2.5}$
Criteron	50	25
Max % of criterion	47.9%	15.8%
R21	7.1	1.2
R22	16.8	2.6
R23	16.3	2.7
R24	15.5	2.5
R25	14.0	2.3
R26	8.2	1.4
R27	3.9	0.7
R28A	3.7	0.6
R28B	3.4	0.6
R30A	3.5	0.6
R30B	3.7	0.7
R31A	2.8	0.5
R31B	2.2	0.4
R35	2.6	0.5
R36	3.7	0.6
R38	3.4	0.6
R4	2.5	0.4
R40A	2.6	0.4
R40B	3.7	0.6
R41	1.7	0.3
R43	3.0	0.5
R44	1.8	0.3
R46	4.0	0.7
R50	15.0	2.3
R59A	2.5	0.4
R59B	3.1	0.6
R6	3.3	0.6
R61	2.6	0.4
R66	2.5	0.4
R67	2.1	0.4
R68	2.7	0.5
R7A	5.5	0.9
R7B	6.8	1.2
R8A	4.9	0.9
R8B	2.3	0.4

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
Criteron	**50**	**25**
Max % of criterion	**47.9%**	**15.8%**
R51	44.7	6.9
R1	18.4	2.8
R2	32.3	6.3
R3	3.7	0.6
R48	16.4	2.7
R49A	14.7	2.4
R49B	12.6	2.1
R54	31.9	5.1
R55	39.1	6.0
R56	52.8	8.0
R58	43.8	6.7

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the construction of the Project, with background included are presented in **Table 20** and **Table 21** respectively.

The left side of the tables show the predicted concentration on days with the highest predicted cumulative impact (generally driven by elevated regional background conditions), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations respectively.

For PM_{10}, the maximum cumulative impact (the left hand side of **Table 20**) is predicted at receptor R50, and the maximum incremental impact (the right hand side of **Table 20**) is predicted at Receptor R12.

For $PM_{2.5}$, the maximum cumulative impact (the left hand side of **Table 21**), and the maximum incremental impact (the right hand side of **Table 21**) are both predicted at Receptor R12. Two exceedances for $PM_{2.5}$ are predicted to occur at receptor R12 during construction activities. However, this is driven by the existing high background concentration, which without any Project contribution, is 95 % of the criteria. Predicted changes to existing background concentrations as a result of the incremental impact are relatively minor.

The analysis identifies two days that are predicted to exceed the 24-hour PM_{10} criterion at receptor R50, but these are driven by background concentrations already exceeding the criterion. Predicted changes to existing background concentrations as a result of the proposal are relatively minor.

Examination of the remaining results indicates that no additional exceedances of the PM_{10} or $PM_{2.5}$ criteria are likely to occur as a result of the operation of the Project at any of the receptor locations.

Table 20 Summary of contemporaneous impact and background – PM_{10} – construction scenario

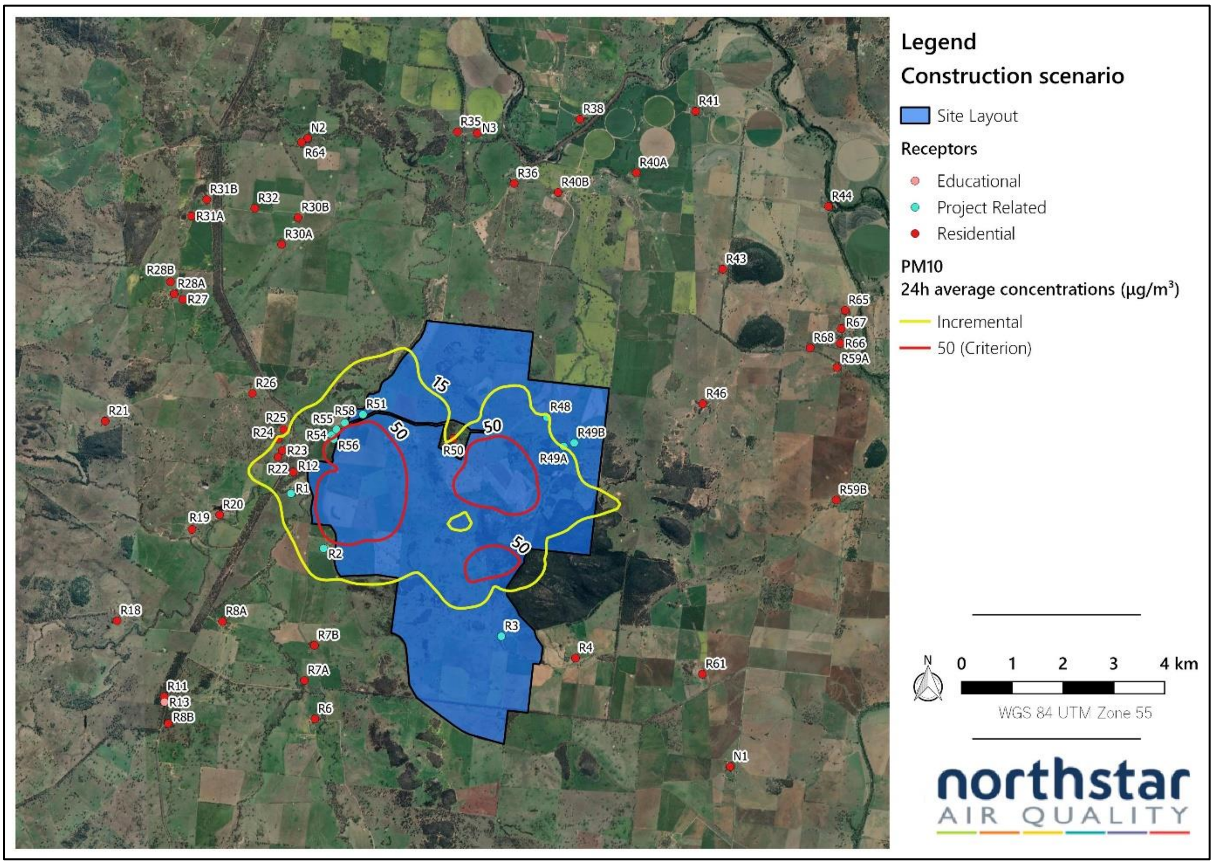
Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R50			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R12		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
6/05/2015	3.7	94.6	98.3	24/05/2015	23.9	10.2	34.1
25/11/2015	2.1	51.7	53.8	21/06/2015	23.4	12.8	36.2
5/05/2015	2.9	40.9	43.8	29/06/2015	21.3	16.3	37.6
6/10/2015	3.1	39.4	42.5	14/06/2015	20.8	13.9	34.7
20/03/2015	5.1	32.7	37.8	13/06/2015	19.4	15.7	35.1
18/03/2015	2.3	34.5	36.8	12/06/2015	18.4	13.6	32.0
26/11/2015	1.2	35.2	36.4	8/07/2015	16.9	9.7	26.6
15/12/2015	6.9	28.9	35.8	25/05/2015	16.7	15.6	32.3
10/03/2015	4.1	30.1	34.2	17/05/2015	16.3	9.6	25.9
7/10/2015	4.3	29.6	33.9	16/05/2015	16.1	11.8	27.9
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the construction of the Project.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the construction of the Project.			

Table 21 Summary of contemporaneous impact and background – $PM_{2.5}$ – construction scenario

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R12			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R12		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
21/06/2015	3.9	23.7	27.6	21/06/2015	3.9	23.7	27.6
19/07/2015	2.3	23.7	26.0	24/05/2015	3.8	17.6	21.4
29/06/2015	3.6	21.3	24.9	29/06/2015	3.6	21.3	24.9
8/06/2015	<0.1	24.2	24.3	14/06/2015	3.2	19.2	22.4
13/06/2015	3.0	21.0	24.0	13/06/2015	3.0	21.0	24.0
14/06/2015	3.2	19.2	22.4	12/06/2015	2.8	16.2	19.0
8/07/2015	2.6	19.5	22.1	25/05/2015	2.8	13.7	16.5
17/04/2015	0.9	20.6	21.5	8/07/2015	2.6	19.5	22.1
7/06/2015	1.9	19.6	21.5	27/05/2015	2.5	10.9	13.4
24/05/2015	3.8	17.6	21.4	17/05/2015	2.5	13.0	15.5
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the construction of the Project.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the construction of the Project.			

A contour plot of the predicted incremental 24-hour PM_{10} concentrations associated with the Project construction are presented in **Figure 10** to allow examination of the distribution of particulate matter in the area surrounding the Project.

Figure 10 Incremental maximum 24-hour average PM_{10} concentrations – construction scenario



6.2 Operation Scenario

Results are presented in this section for the predictions of particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition), odour, Rn and other pollutants emitted from the processing of materials during the operational phase of the Project . The averaging periods associated with the criteria for these pollutants are as specified in **Table 3**. The emissions adopted for this scenario reflect the operational profile of the Project over those averaging periods (refer **Section 5.1.2**).

6.2.1 Particulate Matter

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 operation of the Project, are presented in **Table 22**, noting all Project related receptors have been excluded from the incremental concentration calculations, and are presented in gray text at the end of the table.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at residential receptor locations represent, as a maximum:

- 9.9 % of the annual average TSP criterion;
- 27.8 % of the annual average PM_{10} criterion; and
- 15.8 % of the $PM_{2.5}$ criterion.

Again, background concentrations of $PM_{2.5}$ are noted to be relatively high, and close to the relevant criterion (95 % of the criterion) without the addition of the Project related incremental impact. The addition of existing background concentrations (refer **Section 4.3**) results in predicted concentrations representing, as a maximum:

- 43.3 % of the annual average TSP criterion;
- 81.4 % of the annual average PM_{10} criterion; and
- 110.8 % of the annual average $PM_{2.5}$ criterion.

Table 22 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – operation scenario

Receptor	Annual Average Concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
Criterion	90			25			8		
Max % of criterion	9.9%	33.4%	43.3%	27.8%	53.6%	81.4%	15.8%	95.0%	110.8%
N1	<0.1	30.1	30.2	<0.1	13.4	13.5	<0.1	7.6	7.7
N2	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
N3	0.4	30.1	30.5	0.4	13.4	13.8	<0.1	7.6	7.7
R11	0.4	30.1	30.5	0.4	13.4	13.8	0.1	7.6	7.7
R32	0.5	30.1	30.6	0.4	13.4	13.8	0.1	7.6	7.7
R64	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R65	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R12	4.3	30.1	34.4	3.5	13.4	16.9	0.7	7.6	8.3
R13	0.4	30.1	30.5	0.4	13.4	13.8	0.1	7.6	7.7
R18	0.6	30.1	30.7	0.5	13.4	13.9	0.1	7.6	7.7
R19	1.4	30.1	31.5	1.2	13.4	14.6	0.4	7.6	8.0
R20	1.8	30.1	31.9	1.5	13.4	14.9	0.5	7.6	8.1
R21	0.9	30.1	31.0	0.8	13.4	14.2	0.2	7.6	7.8
R22	3.7	30.1	33.8	3.0	13.4	16.4	0.6	7.6	8.2
R23	3.8	30.1	33.9	3.1	13.4	16.5	0.6	7.6	8.2
R24	3.3	30.1	33.4	2.7	13.4	16.1	0.6	7.6	8.2
R25	3.3	30.1	33.4	2.7	13.4	16.1	0.6	7.6	8.2
R26	1.7	30.1	31.8	1.5	13.4	14.9	0.3	7.6	7.9

Receptor	Annual Average Concentration (µg·m-3)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
Criterion	90			25			8		
Max % of criterion	9.9%	33.4%	43.3%	27.8%	53.6%	81.4%	15.8%	95.0%	110.8%
R27	0.6	30.1	30.7	0.5	13.4	13.9	0.2	7.6	7.8
R28A	0.6	30.1	30.7	0.5	13.4	13.9	0.2	7.6	7.8
R28B	0.5	30.1	30.6	0.5	13.4	13.9	0.1	7.6	7.7
R30A	0.6	30.1	30.7	0.5	13.4	13.9	0.1	7.6	7.7
R30B	0.6	30.1	30.7	0.5	13.4	13.9	0.1	7.6	7.7
R31A	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R31B	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R35	0.4	30.1	30.5	0.4	13.4	13.8	<0.1	7.6	7.7
R36	0.5	30.1	30.6	0.5	13.4	13.9	0.1	7.6	7.7
R38	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R4	0.4	30.1	30.5	0.3	13.4	13.7	<0.1	7.6	7.7
R40A	0.4	30.1	30.5	0.4	13.4	13.8	<0.1	7.6	7.7
R40B	0.5	30.1	30.6	0.5	13.4	13.9	0.1	7.6	7.7
R41	0.3	30.1	30.4	0.3	13.4	13.7	<0.1	7.6	7.7
R43	0.4	30.1	30.5	0.4	13.4	13.8	<0.1	7.6	7.7
R44	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R46	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R50	8.9	30.1	39.0	7.0	13.4	20.4	1.3	7.6	8.9
R59A	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R59B	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R6	0.5	30.1	30.6	0.4	13.4	13.8	<0.1	7.6	7.7
R61	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R66	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R67	0.2	30.1	30.3	0.2	13.4	13.6	<0.1	7.6	7.7
R68	0.3	30.1	30.4	0.2	13.4	13.6	<0.1	7.6	7.7
R7A	0.6	30.1	30.7	0.6	13.4	14.0	0.1	7.6	7.7
R7B	0.9	30.1	31.0	0.8	13.4	14.2	0.2	7.6	7.8
R8A	0.8	30.1	30.9	0.7	13.4	14.1	0.2	7.6	7.8
R8B	0.4	30.1	30.5	0.3	13.4	13.7	0.1	7.6	7.7
R51	5.4	30.1	35.5	4.4	13.4	17.8	0.8	7.6	8.4
R1	3.8	30.1	33.9	3.1	13.4	16.5	0.7	7.6	8.3
R2	4.1	30.1	34.2	3.2	13.4	16.6	0.8	7.6	8.4

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
Criterion	90			25			8		
Max % of criterion	9.9%	33.4%	43.3%	27.8%	53.6%	81.4%	15.8%	95.0%	110.8%
R3	0.9	30.1	31.0	0.7	13.4	14.1	0.1	7.6	7.7
R48	2.9	30.1	33.0	2.4	13.4	15.8	0.5	7.6	8.1
R49A	2.5	30.1	32.6	2.1	13.4	15.5	0.4	7.6	8.0
R49B	1.9	30.1	32.0	1.6	13.4	15.0	0.3	7.6	7.9
R54	6.7	30.1	36.8	5.0	13.4	18.4	0.9	7.6	8.5
R55	6.9	30.1	37.0	5.2	13.4	18.6	0.9	7.6	8.5
R56	7.2	30.1	37.3	5.3	13.4	18.7	0.9	7.6	8.5
R58	7.2	30.1	37.3	5.4	13.4	18.8	0.9	7.6	8.5

The analysis identifies that the annual average $PM_{2.5}$ criterion is predicted to be exceeded at eight receptor locations but these are driven by high existing background concentrations (95 % of the criterion). Predicted changes to existing background concentrations as a result of the Project are predicted to be minor.

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

Annual average dust deposition

Table 23 below presents the annual average dust deposition predicted as a result of the operation of the Project. An assumed background dust deposition of 3 g·m^{-2}·month^{-1} is presented in **Table 23**. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the Project site where the predicted impacts are less than 7.2 % of the incremental criterion at receptor locations. No contour plot of annual average dust deposition is presented, given the minor contribution from the Project at the nearest sensitive receptors.

Table 23 Predicted annual average dust deposition – operation scenario

Receptor	Annual Average Dust Deposition (g·m^{-2}·month^{-1})		
	Incremental Impact	Background	Cumulative Impact
Criterion	2	-	4
Max % of Criterion	7.2%		78.6%
N1	<0.1	3.0	3.1
N2	<0.1	3.0	3.1
N3	<0.1	3.0	3.1
R11	<0.1	3.0	3.1
R32	<0.1	3.0	3.1
R64	<0.1	3.0	3.1
R65	<0.1	3.0	3.1
R12	<0.1	3.0	3.1
R13	<0.1	3.0	3.1
R18	<0.1	3.0	3.1
R19	<0.1	3.0	3.1
R20	<0.1	3.0	3.1
R21	<0.1	3.0	3.1
R22	<0.1	3.0	3.1
R23	<0.1	3.0	3.1
R24	<0.1	3.0	3.1
R25	<0.1	3.0	3.1
R26	<0.1	3.0	3.1
R27	<0.1	3.0	3.1
R28A	<0.1	3.0	3.1
R28B	<0.1	3.0	3.1
R30A	<0.1	3.0	3.1
R30B	<0.1	3.0	3.1
R31A	<0.1	3.0	3.1
R31B	<0.1	3.0	3.1
R35	<0.1	3.0	3.1
R36	<0.1	3.0	3.1

Receptor	Annual Average Dust Deposition (g·m^{-2}·month^{-1})		
	Incremental Impact	Background	Cumulative Impact
Criterion	2	-	4
Max % of Criterion	7.2%		78.6%
R38	<0.1	3.0	3.1
R4	<0.1	3.0	3.1
R40A	<0.1	3.0	3.1
R40B	<0.1	3.0	3.1
R41	<0.1	3.0	3.1
R43	<0.1	3.0	3.1
R44	<0.1	3.0	3.1
R46	<0.1	3.0	3.1
R50	0.1	3.0	3.1
R59A	<0.1	3.0	3.1
R59B	<0.1	3.0	3.1
R6	<0.1	3.0	3.1
R61	<0.1	3.0	3.1
R66	<0.1	3.0	3.1
R67	<0.1	3.0	3.1
R68	<0.1	3.0	3.1
R7A	<0.1	3.0	3.1
R7B	<0.1	3.0	3.1
R8A	<0.1	3.0	3.1
R8B	<0.1	3.0	3.1
R51	<0.1	3.0	3.1
R1	<0.1	3.0	3.1
R2	0.1	3.0	3.1
R3	<0.1	3.0	3.1
R48	<0.1	3.0	3.1
R49A	<0.1	3.0	3.1
R49B	<0.1	3.0	3.1
R54	0.1	3.0	3.1
R55	0.1	3.0	3.1
R56	0.1	3.0	3.1
R58	<0.1	3.0	3.1

Maximum 24-hour average PM_{10} and $PM_{2.5}$

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

Table 24 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – operation scenario

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
Criteron	50	25
Max % of criterion	34.6%	16.1%
N1	1.9	0.4
N2	3.5	0.8
N3	4.8	1.4
R11	3.5	1.2
R32	3.4	1.0
R64	3.4	0.8
R65	2.3	0.7
R12	13.3	2.4
R13	3.4	1.1
R18	3.6	1.7
R19	5.7	1.6
R20	7.8	2.3
R21	6.7	1.6
R22	15.1	2.5
R23	14.7	2.6
R24	12.6	2.7
R25	14.6	3.1
R26	9.2	2.3
R27	3.9	1.4
R28A	3.8	1.6
R28B	3.5	1.4
R30A	3.7	1.0
R30B	4.1	1.1
R31A	3.1	1.0
R31B	3.0	0.9
R35	3.1	0.9
R36	4.5	1.1
R38	3.2	1.1
R4	3.5	0.7

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
Criteron	50	25
Max % of criterion	34.6%	16.1%
R40A	3.1	0.9
R40B	3.9	1.1
R41	2.4	0.8
R43	4.4	0.9
R44	2.4	0.6
R46	4.6	1.1
R50	17.3	4.0
R59A	2.9	0.7
R59B	3.4	0.7
R6	3.7	1.0
R61	3.7	1.3
R66	3.0	0.8
R67	2.7	0.8
R68	3.2	0.8
R7A	5.0	1.2
R7B	5.9	1.3
R8A	5.1	2.5
R8B	3.9	1.4
R51	29.7	5.4
R1	12.7	2.9
R2	18.3	4.1
R3	8.5	1.4
R48	21.8	3.9
R49A	18.2	3.7
R49B	15.0	3.1
R54	23.8	4.0
R55	27.0	5.0
R56	24.2	4.0
R58	33.2	5.9

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Project, with background included are presented in **Table 25** and **Table 26** respectively. These results as presented, demonstrate that even with the addition of background concentrations, the cumulative impacts are not in exceedance of the relevant criterion.

Results are presented in Table 25 and **Table 26** for those receptors at which the greatest impacts have been predicted.

The left side of the tables show the predicted concentration on days with the highest predicted cumulative impact (generally driven by elevated regional background), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations respectively.

For PM_{10}, the maximum cumulative impact (the left hand side of **Table 25**), and the maximum incremental impact (the right hand side of **Table 25**) are both predicted at Receptor R50.

For $PM_{2.5}$, the maximum cumulative impact (the left hand side of **Table 26**) is predicted at Receptor R23, and the maximum incremental impact (the right hand side of **Table 26**) predicted at Receptor R50.

Again, where there are predicted exceedances of the criteria, these are driven by high existing background concentrations, with predicted changes to existing background concentrations as a result of the Project relatively minor. The analysis indicates that no exceedances of the 24-hour average impact assessment criteria for PM_{10} or $PM_{2.5}$ are likely to occur, as a result of the operation of the Project in itself.

Table 25 Summary of contemporaneous impact and background – PM_{10} – operation scenario

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R50			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R50		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
6/05/2015	9.2	94.6	103.8	12/05/2015	17.3	8.2	25.5
25/11/2015	2.9	51.7	54.6	5/04/2015	17.0	5.7	22.7
6/10/2015	5.7	39.4	45.1	8/08/2015	16.1	10.4	26.5
5/05/2015	3.6	40.9	44.5	28/04/2015	15.3	10.3	25.6
20/03/2015	6.8	32.7	39.5	4/06/2015	15.1	12.2	27.3
18/03/2015	3.9	34.5	38.4	23/04/2015	14.9	8.4	23.3
9/10/2015	9.1	28.7	37.8	5/07/2015	14.8	13.7	28.5
26/11/2015	2.1	35.2	37.3	16/07/2015	14.7	4.1	18.8
6/03/2015	7.1	29.8	36.9	6/06/2015	14.5	11.8	26.3
10/03/2015	6.7	30.1	36.8	9/05/2015	14.5	9.4	23.9
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Project.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Project.			

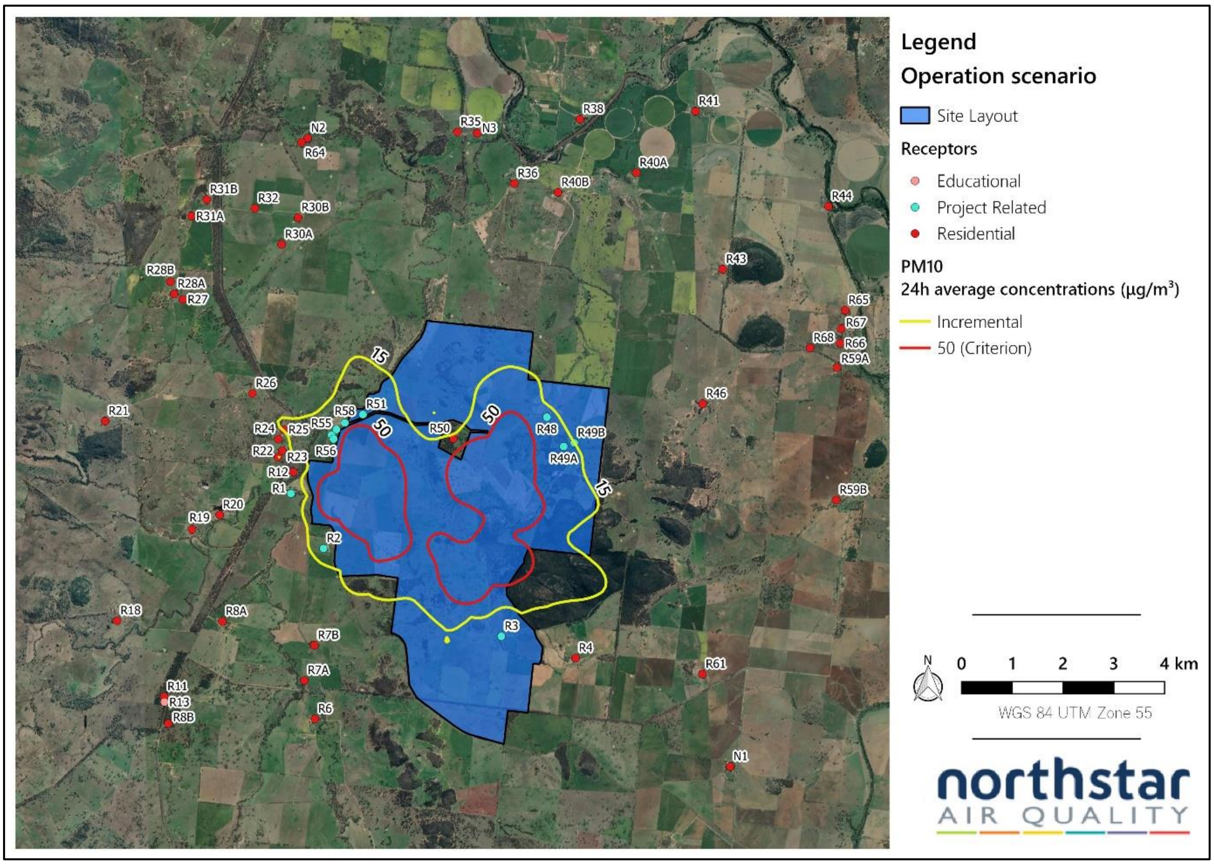
Table 26 Summary of contemporaneous impact and background – $PM_{2.5}$ – operation scenario

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R23			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R50		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
19/07/2015	2.4	23.7	26.1	9/05/2015	4.0	1.1	5.1
21/06/2015	2.0	23.7	25.7	5/04/2015	3.8	3.9	7.7
8/06/2015	<0.1	24.2	24.3	6/07/2015	3.4	13.8	17.2
29/06/2015	2.6	21.3	23.9	23/04/2015	3.4	4.5	7.9

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R23			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R50		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
13/06/2015	2.0	21.0	23.0	8/05/2015	3.4	4.8	8.2
17/04/2015	1.1	20.6	21.7	26/08/2015	3.2	2.3	5.5
14/06/2015	2.4	19.2	21.6	12/05/2015	3.2	3.3	6.5
8/07/2015	1.7	19.5	21.2	10/12/2015	3.1	5.0	8.1
7/06/2015	1.5	19.6	21.1	5/07/2015	2.8	15.2	18.0
24/05/2015	2.1	17.6	19.7	16/07/2015	2.8	4.9	7.7
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Project.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Project.			

Contour plots of the predicted incremental 24-hour PM_{10} concentrations associated with the Project operation are presented in **Figure 11** to allow examination of the distribution of particulate matter in the area surrounding the Project.

Figure 11 Incremental maximum 24-hour average PM_{10} concentrations – operation scenario



6.2.2 Nitrogen Dioxide

Table 27 below presents both the 1-hourly and annual average NO_2 concentrations, resulting from the operation of the Processing Plant. Results indicate predicted cumulative impacts do not exceed the relevant cumulative impact assessment criterion at any receptor location, with results representing, as a maximum:

- 81.5% of the 1-hour criterion; and
- 19.5% of the annual average criterion.

The method adopted in the assessment of NO_2 concentrations assumes that the maximum background NO_2 concentrations are added to the maximum predicted NO_X increment at each receptor, presenting a highly conservative approximation of impacts.

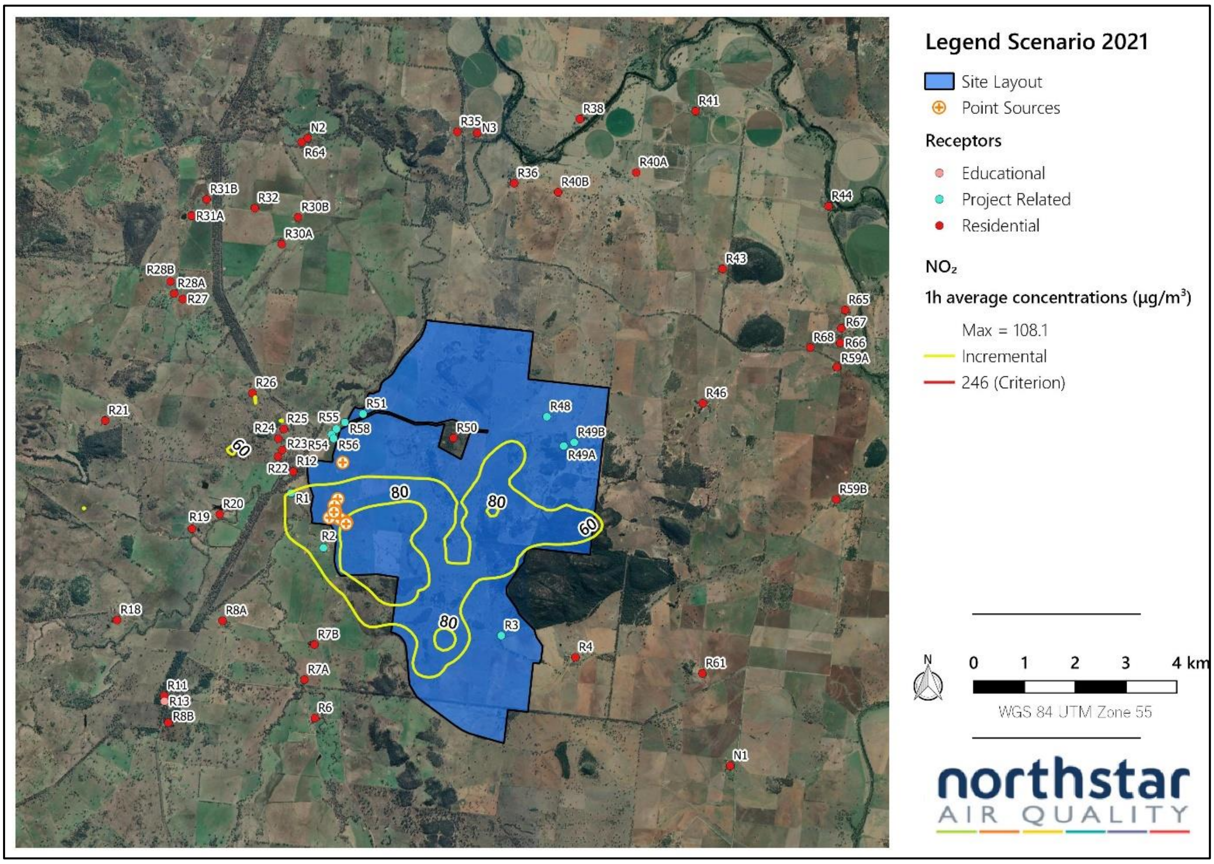
A contour plot of the maximum 1-hour NO_X (as NO_2) impacts surrounding the Project site is presented in **Figure 12**.

Table 27 Predicted hourly annual average nitrogen dioxide concentrations

Rec.	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})					
	1 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative
Criterion	246			62		
Max % of criterion	41.5%	40.0%	81.5%	2.0%	17.6%	19.5%
N1	16.5	98.4	114.9	<0.1	10.9	11.0
N2	27.3	98.4	125.7	0.1	10.9	11.0
N3	25.6	98.4	124.0	0.2	10.9	11.1
R11	30.7	98.4	129.1	0.3	10.9	11.2
R32	20.7	98.4	119.1	0.2	10.9	11.1
R64	29.9	98.4	128.3	0.2	10.9	11.1
R65	26.6	98.4	125.0	0.1	10.9	11.0
R12	94.6	98.4	193.0	0.4	10.9	11.3
R13	30.6	98.4	129.0	0.3	10.9	11.2
R18	59.1	98.4	157.5	0.4	10.9	11.3
R19	53.2	98.4	151.6	1.2	10.9	12.1
R20	53.0	98.4	151.4	1.1	10.9	12.0
R21	65.9	98.4	164.3	0.5	10.9	11.4
R22	102.0	98.4	200.4	0.4	10.9	11.3
R23	76.5	98.4	174.9	0.5	10.9	11.4
R24	58.2	98.4	156.6	0.5	10.9	11.4
R25	75.2	98.4	173.6	0.6	10.9	11.5
R26	78.4	98.4	176.8	0.5	10.9	11.4
R27	37.0	98.4	135.4	0.3	10.9	11.2
R28A	32.5	98.4	130.9	0.3	10.9	11.2
R28B	35.0	98.4	133.4	0.3	10.9	11.2
R30A	22.1	98.4	120.5	0.2	10.9	11.1
R30B	27.3	98.4	125.7	0.2	10.9	11.1
R31A	29.4	98.4	127.8	0.2	10.9	11.1
R31B	21.4	98.4	119.8	0.2	10.9	11.1
R35	26.3	98.4	124.7	0.2	10.9	11.1
R36	32.3	98.4	130.7	0.2	10.9	11.1
R38	31.0	98.4	129.4	0.2	10.9	11.1
R4	22.4	98.4	120.8	<0.1	10.9	11.0
R40A	20.7	98.4	119.1	0.2	10.9	11.1
R40B	25.1	98.4	123.5	0.2	10.9	11.1
R41	27.3	98.4	125.7	0.2	10.9	11.1
R43	23.7	98.4	122.1	0.2	10.9	11.1
R44	19.5	98.4	117.9	0.1	10.9	11.0
R46	25.3	98.4	123.7	0.2	10.9	11.1
R50	66.5	98.4	164.9	0.8	10.9	11.7

Rec.	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)					
	1 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative
Criterion	246			62		
Max % of criterion	41.5%	40.0%	81.5%	2.0%	17.6%	19.5%
R59A	26.4	98.4	124.8	0.1	10.9	11.0
R59B	13.7	98.4	112.1	0.1	10.9	11.0
R6	25.0	98.4	123.4	0.2	10.9	11.1
R61	35.4	98.4	133.8	0.1	10.9	11.0
R66	29.2	98.4	127.6	0.1	10.9	11.0
R67	28.2	98.4	126.6	0.1	10.9	11.0
R68	26.0	98.4	124.4	0.1	10.9	11.0
R7A	31.0	98.4	129.4	0.2	10.9	11.1
R7B	39.0	98.4	137.4	0.3	10.9	11.2
R8A	48.4	98.4	146.8	0.4	10.9	11.3
R8B	33.0	98.4	131.4	0.3	10.9	11.2
R51	60.3	98.4	158.7	0.4	10.9	11.3
R1	212.0	98.4	310.4	0.8	10.9	11.7
R2	74.2	98.4	172.6	1.7	10.9	12.6
R3	33.3	98.4	131.7	0.2	10.9	11.1
R48	39.6	98.4	138.0	0.3	10.9	11.2
R49A	31.2	98.4	129.6	0.3	10.9	11.2
R49B	26.4	98.4	124.8	0.3	10.9	11.2
R54	46.9	98.4	145.3	0.3	10.9	11.2
R55	53.6	98.4	152.0	0.3	10.9	11.2
R56	46.9	98.4	145.3	0.3	10.9	11.2
R58	54.1	98.4	152.5	0.3	10.9	11.2

Figure 12 Incremental maximum 1-hour average NO_2 concentrations – operation scenario



6.2.3 Sulphur Dioxide

Table 28 below presents the predicted 10-minute, 1-hourly, 24-hourly and annual average SO_2 concentrations, resulting from the operation of the Processing Plant. Results indicate predicted cumulative impacts do not exceed the relevant cumulative impact assessment criterion at any receptor location, with results representing, as a maximum:

- 35.4% of the 10-minute criterion;
- 31.3% of the 1-hour criterion;
- 7.9% of the 24-hour criterion; and
- 2.9% of the annual average criterion.

Table 28 Predicted sulphur dioxide concentrations – operation scenario

Rec.	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)											
	10 min			1 hour			24 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative	Increment	Background	Cumulative	Increment	Background	Cumulative
Criteria	712			570			228			60		
Max % of criterion	30.2%	5.2%	35.4%	26.3%	5.0%	31.3%	5.4%	2.5%	7.9%	1.7%	1.3%	2.9%
N1	18.1	36.9	55.0	12.6	28.5	41.1	0.8	5.7	6.6	<0.1	0.8	0.8
N2	23.4	36.9	60.3	16.3	28.5	44.8	2.3	5.7	8.1	<0.1	0.8	0.8
N3	36.5	36.9	73.4	25.5	28.5	54.0	2.8	5.7	8.5	0.2	0.8	0.9
R11	60.5	36.9	97.4	42.3	28.5	70.8	4.3	5.7	10.0	0.2	0.8	1.0
R32	24.0	36.9	60.9	16.8	28.5	45.3	2.3	5.7	8.1	<0.1	0.8	0.8
R64	25.7	36.9	62.6	17.9	28.5	46.4	2.6	5.7	8.3	<0.1	0.8	0.8
R65	18.8	36.9	55.7	13.1	28.5	41.6	1.6	5.7	7.3	0.1	0.8	0.9
R12	214.9	36.9	251.8	150.2	28.5	178.7	10.0	5.7	15.7	0.4	0.8	1.2
R13	54.4	36.9	91.3	38.1	28.5	66.6	5.2	5.7	10.9	0.2	0.8	1.0
R18	43.1	36.9	80.0	30.1	28.5	58.6	4.0	5.7	9.7	0.4	0.8	1.1
R19	89.7	36.9	126.6	62.7	28.5	91.2	10.8	5.7	16.5	1.0	0.8	1.8
R20	125.5	36.9	162.4	87.7	28.5	116.2	11.7	5.7	17.4	1.0	0.8	1.7
R21	74.6	36.9	111.5	52.1	28.5	80.6	3.6	5.7	9.3	0.2	0.8	1.0
R22	187.4	36.9	224.3	130.9	28.5	159.4	7.9	5.7	13.7	0.4	0.8	1.1
R23	150.1	36.9	187.0	104.9	28.5	133.4	11.7	5.7	17.5	0.4	0.8	1.1
R24	105.8	36.9	142.7	74.0	28.5	102.5	11.5	5.7	17.2	0.4	0.8	1.1
R25	93.1	36.9	130.0	65.1	28.5	93.6	12.3	5.7	18.0	0.3	0.8	1.1
R26	72.0	36.9	108.9	50.3	28.5	78.8	6.6	5.7	12.3	0.2	0.8	1.0
R27	41.9	36.9	78.8	29.3	28.5	57.8	2.9	5.7	8.6	0.1	0.8	0.9

Rec.	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)											
	10 min			1 hour			24 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative	Increment	Background	Cumulative	Increment	Background	Cumulative
Criteria	712			570			228			60		
Max % of criterion	30.2%	5.2%	35.4%	26.3%	5.0%	31.3%	5.4%	2.5%	7.9%	1.7%	1.3%	2.9%
R28A	40.1	36.9	77.0	28.0	28.5	56.5	2.6	5.7	8.3	0.1	0.8	0.9
R28B	39.4	36.9	76.3	27.6	28.5	56.1	2.7	5.7	8.4	0.1	0.8	0.9
R30A	32.7	36.9	69.6	22.9	28.5	51.4	4.0	5.7	9.7	0.1	0.8	0.9
R30B	32.3	36.9	69.2	22.6	28.5	51.1	4.4	5.7	10.1	<0.1	0.8	0.8
R31A	24.5	36.9	61.4	17.1	28.5	45.6	1.7	5.7	7.4	<0.1	0.8	0.8
R31B	35.0	36.9	71.9	24.5	28.5	53.0	2.2	5.7	7.9	<0.1	0.8	0.8
R35	27.8	36.9	64.7	19.4	28.5	47.9	3.5	5.7	9.2	0.2	0.8	0.9
R36	19.6	36.9	56.5	13.7	28.5	42.2	3.4	5.7	9.1	0.2	0.8	0.9
R38	20.8	36.9	57.7	14.6	28.5	43.1	3.2	5.7	8.9	0.1	0.8	0.9
R4	30.4	36.9	67.3	21.2	28.5	49.7	1.7	5.7	7.4	0.1	0.8	0.9
R40A	18.7	36.9	55.6	13.1	28.5	41.6	2.4	5.7	8.1	0.1	0.8	0.9
R40B	26.2	36.9	63.1	18.3	28.5	46.8	2.5	5.7	8.2	0.2	0.8	0.9
R41	17.9	36.9	54.8	12.5	28.5	41.0	2.7	5.7	8.4	0.1	0.8	0.9
R43	23.8	36.9	60.7	16.6	28.5	45.1	3.0	5.7	8.7	0.1	0.8	0.9
R44	17.6	36.9	54.5	12.3	28.5	40.8	1.8	5.7	7.5	<0.1	0.8	0.8
R46	27.8	36.9	64.7	19.4	28.5	47.9	3.3	5.7	9.0	0.2	0.8	0.9
R50	80.0	36.9	116.9	55.9	28.5	84.4	10.1	5.7	15.8	0.6	0.8	1.4
R59A	25.3	36.9	62.2	17.7	28.5	46.2	2.0	5.7	7.7	0.1	0.8	0.9
R59B	18.0	36.9	54.9	12.5	28.5	41.0	2.9	5.7	8.6	0.1	0.8	0.9
R6	54.2	36.9	91.1	37.9	28.5	66.4	3.7	5.7	9.5	0.2	0.8	1.0
R61	28.4	36.9	65.3	19.9	28.5	48.4	2.9	5.7	8.6	<0.1	0.8	0.8

Rec.	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)											
	10 min			1 hour			24 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative	Increment	Background	Cumulative	Increment	Background	Cumulative
Criteria	712			570			228			60		
Max % of criterion	30.2%	5.2%	35.4%	26.3%	5.0%	31.3%	5.4%	2.5%	7.9%	1.7%	1.3%	2.9%
R66	32.1	36.9	69.0	22.4	28.5	50.9	2.4	5.7	8.1	0.1	0.8	0.9
R67	25.3	36.9	62.2	17.7	28.5	46.2	1.8	5.7	7.5	0.1	0.8	0.9
R68	28.5	36.9	65.4	19.9	28.5	48.4	2.1	5.7	7.8	0.1	0.8	0.9
R7A	55.7	36.9	92.6	38.9	28.5	67.4	5.3	5.7	11.0	0.3	0.8	1.1
R7B	69.1	36.9	106.0	48.3	28.5	76.8	8.1	5.7	13.8	0.5	0.8	1.2
R8A	83.1	36.9	120.0	58.1	28.5	86.6	3.8	5.7	9.5	0.4	0.8	1.2
R8B	43.0	36.9	79.9	30.0	28.5	58.5	5.9	5.7	11.6	0.2	0.8	1.0
R51	132.8	36.9	169.7	92.8	28.5	121.3	12.6	5.7	18.3	0.4	0.8	1.2
R1	159.9	36.9	196.8	111.8	28.5	140.3	12.4	5.7	18.1	0.6	0.8	1.3
R2	209.4	36.9	246.3	146.4	28.5	174.9	10.3	5.7	16.0	0.9	0.8	1.7
R3	34.3	36.9	71.2	23.9	28.5	52.4	3.1	5.7	8.8	0.2	0.8	0.9
R48	40.4	36.9	77.3	28.2	28.5	56.7	4.7	5.7	10.4	0.3	0.8	1.0
R49A	46.6	36.9	83.5	32.5	28.5	61.0	6.6	5.7	12.3	0.3	0.8	1.0
R49B	40.7	36.9	77.6	28.4	28.5	56.9	6.1	5.7	11.8	0.2	0.8	1.0
R54	146.8	36.9	183.7	102.6	28.5	131.1	7.9	5.7	13.6	0.3	0.8	1.0
R55	159.5	36.9	196.4	111.5	28.5	140.0	7.7	5.7	13.4	0.3	0.8	1.1
R56	155.9	36.9	192.8	108.9	28.5	137.4	8.1	5.7	13.8	0.3	0.8	1.1
R58	94.2	36.9	131.1	65.9	28.5	94.4	12.1	5.7	17.8	0.4	0.8	1.1

6.2.4 Hydrogen Chloride and Chlorine

Table 29 below presents predicted average incremental 1-hour average concentrations for HCl and Cl_2 resulting from the operation of the Processing Plant. Results indicate predicted impacts do not exceed the relevant impact assessment criterion at any receiver location, with results representing, as a maximum:

- 9.2 % of the HCl criterion; and
- <0.1 % of the Cl_2 criterion.

Table 29 Predicted maximum 1-hour average concentrations – other pollutants – operation scenario

Receptor	Maximum 1-hour average concentration (µg·m^{-3})	
	HCl	Cl_2
Criterion µg·m^{-3}	**140**	**50**
Max % of criterion	**9.2%**	**<0.1%**
N1	1.6	<0.1
N2	1.9	<0.1
N3	2.9	<0.1
R11	2.8	<0.1
R32	2.8	<0.1
R64	1.7	<0.1
R65	0.8	<0.1
R12	11.7	<0.1
R13	2.9	<0.1
R18	3.3	<0.1
R19	3.2	<0.1
R20	5.8	<0.1
R21	6.0	<0.1
R22	7.3	<0.1
R23	7.5	<0.1
R24	12.9	<0.1
R25	11.0	<0.1
R26	9.3	<0.1
R27	4.4	<0.1
R28A	5.7	<0.1
R28B	4.1	<0.1
R30A	2.2	<0.1
R30B	1.8	<0.1
R31A	2.1	<0.1

Receptor	Maximum 1-hour average concentration ($\mu g \cdot m^{-3}$)	
	HCl	Cl_2
Criterion $\mu g \cdot m^{-3}$	140	50
Max % of criterion	9.2%	<0.1%
R31B	2.3	<0.1
R35	1.5	<0.1
R36	1.7	<0.1
R38	1.5	<0.1
R4	1.2	<0.1
R40A	2.1	<0.1
R40B	1.5	<0.1
R41	1.2	<0.1
R43	1.5	<0.1
R44	1.5	<0.1
R46	1.4	<0.1
R50	7.5	<0.1
R59A	0.6	<0.1
R59B	1.2	<0.1
R6	2.4	<0.1
R61	2.3	<0.1
R66	0.8	<0.1
R67	0.8	<0.1
R68	0.9	<0.1
R7A	2.5	<0.1
R7B	3.6	<0.1
R8A	11.7	<0.1
R8B	4.0	<0.1
R51	2.6	<0.1
R1	10.4	<0.1
R2	14.0	<0.1
R3	4.0	<0.1
R48	2.6	<0.1
R49A	3.7	<0.1
R49B	3.0	<0.1
R54	3.7	<0.1
R55	4.2	<0.1
R56	4.5	<0.1
R58	3.5	<0.1

No contour plots of HCl or Cl_2 impacts are presented given the minor concentrations predicted.

6.2.5 Odour

Presented in **Table 30** are the 99th percentile 1-second average odour concentrations predicted at the surrounding receptor locations, as a result of the operation of the Project. The predicted 99th percentile 1-second nose response time odour concentrations are compared against the relevant odour assessment criterion, as discussed in **Section 3.1.3**. The predicted concentrations are anticipated to be < 32 % of the relevant criterion at all surrounding receptors.

No contour plot of odour impacts are presented given the minor concentrations predicted.

Table 30 Predicted 99th percentile odour concentrations

Receptor	99th percentile 1-hour average odour (OU)
Criterion	6
Max. % of criterion	32.0 %
N1	<0.1
N2	0.3
N3	0.3
R11	0.2
R32	0.3
R64	0.3
R65	0.2
R12	0.5
R13	0.2
R18	0.2
R19	0.3
R20	0.4
R21	0.4
R22	0.6
R23	0.7
R24	0.8
R25	0.8
R26	0.7
R27	0.4
R28A	0.4
R28B	0.4
R30A	0.4
R30B	0.4

Receptor	99th percentile 1-hour average odour (OU)
Criterion	6
Max. % of criterion	32.0 %
R31A	0.3
R31B	0.3
R35	0.3
R36	0.3
R38	0.2
R4	0.2
R40A	0.2
R40B	0.3
R41	0.2
R43	0.3
R44	0.2
R46	0.3
R50	1.9
R59A	0.2
R59B	0.1
R6	0.2
R61	<0.1
R66	0.2
R67	0.2
R68	0.2
R7A	0.2
R7B	0.2
R8A	0.3
R8B	0.2
R51	0.6
R1	0.5
R2	0.4
R3	0.4
R48	1.1
R49A	1.2
R49B	1.0
R54	0.7
R55	0.7
R56	0.6
R58	0.8

6.2.6 Radon

Predicted maximum hourly, 24-hour and annual Rn concentrations are presented in **Table 31**. The predicted maximum radon concentrations are shown to be well below the recommended reference levels as outlined in Section 3.4 for both households and workplaces at all receptor locations.

Table 31 Predicted maximum radon concentrations

Receptor	Maximum concentration ($bq \cdot m^{-3}$)		
	1 hour	24 hour	Annual
N1	4.6	0.7	<0.1
N2	14.7	2.1	0.1
N3	13.5	2.4	0.1
R11	8.9	1.1	0.1
R32	14.9	1.6	0.2
R64	14.1	2.0	0.1
R65	6.1	1.1	<0.1
R12	15.6	2.6	0.5
R13	8.8	1.0	<0.1
R18	8.0	1.3	0.1
R19	10.5	1.8	0.3
R20	12.2	1.9	0.3
R21	10.1	3.1	0.3
R22	20.4	3.2	0.6
R23	22.5	3.7	0.6
R24	23.9	4.1	0.6
R25	26.4	5.2	0.7
R26	14.8	4.3	0.5
R27	11.2	2.5	0.2
R28A	11.0	2.5	0.2
R28B	9.9	2.4	0.2
R30A	18.0	1.9	0.2
R30B	17.8	1.7	0.2
R31A	11.0	2.4	0.1
R31B	14.1	2.1	0.1
R35	11.7	2.1	0.1
R36	15.0	2.1	0.2
R38	9.6	1.8	0.1
R4	10.0	1.7	0.1
R40A	6.5	1.7	0.2
R40B	9.7	2.3	0.2

Receptor	Maximum concentration (bq·m^{-3})		
	1 hour	24 hour	Annual
R41	7.3	1.3	0.1
R43	8.7	2.6	0.2
R44	5.5	1.3	<0.1
R46	11.8	2.5	0.2
R50	60.6	13.7	5.6
R59A	6.0	1.4	<0.1
R59B	7.1	1.6	<0.1
R6	6.8	1.1	<0.1
R61	11.2	1.8	<0.1
R66	6.7	1.5	<0.1
R67	6.2	1.2	<0.1
R68	8.7	1.6	0.1
R7A	8.3	1.3	0.1
R7B	10.0	1.7	0.2
R8A	10.2	1.7	0.2
R8B	8.1	1.3	<0.1
R51	25.0	4.1	0.7
R1	17.0	2.5	0.5
R2	13.3	2.7	0.4
R3	14.2	3.9	0.3
R48	35.5	8.2	1.4
R49A	45.4	14.8	1.4
R49B	36.4	11.5	1.0
R54	28.3	3.8	0.6
R55	29.2	4.1	0.6
R56	24.9	3.6	0.6
R58	28.7	4.5	0.7

7. GREENHOUSE GAS ASSESSMENT

This section presents the results of the GHG assessment and compares estimated direct emissions totals with NSW and Australian totals. Opportunities for GHG management and mitigation are presented in **Section 8.2**.

Based on the activity data for the operation of the Project and the emission factors outlined in **Section 5.2**, annual GHG emissions have been calculated and are presented in **Table 32**. The Project is calculated to result in direct (scope 1) GHG emissions of 324 217.6 t CO_2-e per annum.

Table 32 Calculated Project GHG emissions

Scope		Activity Rate	Units	Emission Factor		CO_2-e ($t \cdot yr^{-1}$)
1	Process emissions of CO_2 (A)	-	-	-	-	226 082
	Natural gas	1 863 067	$GJ \cdot year^{-1}$	51.53	kg CO_2-e$\cdot GJ^{-1}$	96 003.8
	Diesel fuel in plant	786.7	$kL \cdot year^{-1}$	2 709.7	kg CO_2-e$\cdot kL^{-1}$	2 131.7
					Scope 1 (subtotal)	**324 217.6**
2	Electricity consumption	317 925	$MWh \cdot year^{-1}$	0.78	kg CO_2-e$\cdot kWh^{-1}$	247 981.5
					Scope 2 (subtotal)	**247 981.5**
3	Natural gas	1 863 067	$GJ \cdot year^{-1}$	14.0	kg CO_2-e$\cdot GJ^{-1}$	26 082.9
	Diesel fuel in plant	786.7	$kL \cdot year^{-1}$	3.6	kg CO_2-e$\cdot kL^{-1}$	2.8
	Electricity consumption	317 925	$MWh \cdot year^{-1}$	0.07	kg CO_2-e$\cdot kWh^{-1}$	22 254.8
	Employee travel	1.7	$kL \cdot year^{-1}$	123.1	kg CO_2-e$\cdot kL^{-1}$	0.2
	Raw material transport to Site (A)	-	-	-	-	16 332
	Product transport from Site (A)	-	-	-	-	456
					Scope 3 (subtotal)	**65 128.7**
					TOTAL	**637 327.8**

Note: (A) provided by Carbon-X

A comparison of the calculated direct (scope 1) GHG emissions associated with the Project against Australian and NSW total emissions in 2019 is presented in **Table 33**. Scope 2 and scope 3 emissions are not compared with Australian and NSW total emissions as this results in double counting of emissions (e.g. the electricity supplier would report emissions associated with energy production as a Scope 1 emission).

Table 33 Project GHG emissions in context

Project Phase	Emissions (t CO_2-e per annum)		
	Project	NSW (2019)	Australia (2019)
		Total 136 579 000	Total 529 298 000
Operation	324 217.6	0.24%	0.06 %

These data indicate that the operation of the Project would contribute 0.06 % of Australian total GHG emissions 0.24 % of NSW total GHG emissions in 2019. These emissions are dominated (approximately 70 %) by the emission of CO_2 during ore processing at the Processing Plant.

Scope 1 emissions reported in the AQIA for the original approval (PEL, 2013) were calculated be lower than those presented above. However, those estimates did not include the emissions of CO_2 resulting from ore processing.

8. MITIGATION AND MONITORING

8.1 Air Quality

Emission controls will be employed at the Project Site during both construction and operation. The following sections describe those controls, with some of them (where quantifiable reductions are available in the literature) being applied in this modelling assessment, with others being applied, but not able to be adopted in the assessment.

Development consent conditions were provided for the Project following the original approval. Where relevant, these are re-committed to in following sections.

8.1.1 Construction

A summary of the emissions reductions measures that would be adopted as part of the Project construction is presented in **Table 34**. These emission reductions are outlined in the NPI EETM for Mining (NPI, 2012) and relevant AP-42 documentation (US EPA, 1995). They are also consistent with the control factors adopted in the AQIA supporting the original approval (PEL, 2013).

Table 34 Summary of emission reduction methods adopted as part of Project construction

Emission control method	Control efficiency (%)
Application of water on haulage routes	75

While dust emissions from construction activities can have impacts on local air quality, impacts are typically of a short duration and relatively easy to manage through commonly applied dust control measures.

During unfavourable meteorological conditions, such as when it is dry and windy, dust emissions may be higher requiring specific corrective measures. A Construction Air Quality Management Plan (CAQMP) would be prepared prior to construction and would identify triggers and procedures for dealing with these conditions.

In addition to the measures adopted in this AQIA, as presented in **Table 34**, additional procedures for controlling dust impacts during construction will include, but not necessarily be limited to the following.

- Application of gravel to disturbed areas where possible.
- Rehabilitation / cover crops where possible and on exposed areas.
- Modifying working practices by limiting excavation during periods of high winds.
- Limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing.
- Confining all vehicles on-site to designated routes with speed limits enforced.

- Controlling and reducing trips and trip distances where possible, for example by coordinating delivery and removal of materials to avoid unnecessary trips.

Based on the above, the quantification of particulate matter emissions during the construction phase can be viewed as a conservative approximation of the emissions which might be anticipated in reality, and the impacts presented in **Section 6** should be viewed with that in mind.

8.1.2 Operation

A summary of the emissions reductions measures that would be adopted as part of the Project operation is presented in **Table 35**. These emission reductions are outlined in the NPI EETM for Mining (NPI, 2012) and relevant AP-42 documentation (US EPA, 1995). Once again, they are also consistent with the control factors adopted in the AQIA supporting the original approval (PEL, 2013).

Table 35 Summary of emission reduction methods adopted as part of Project operation

Emission control method	Control efficiency (%)
Water sprays on drill rig	70
Application of water on haulage routes	75
Application of water sprays on materials screening operations	83
High moisture content of SRSF	30

Air quality will need to be managed to ensure that emissions from mining do not contribute to exceedances of the NSW EPA air quality criteria. This may involve the implementation of emission controls to minimise emissions and the implementation of modifications to mining under dry conditions when winds have the potential to transport dust from mining activities to occupied receptors, for example.

As per the Development Consent conditions for the approved development, a detailed operational Air Quality Management Plan (AQMP) will be developed in consultation with the relevant regulatory authorities. This plan will:

- be prepared in consultation with the EPA, and be submitted for approval prior to the commencement of construction activities under any consent, unless the Secretary agrees otherwise;
- describe the measures that would be implemented to ensure compliance with air quality criteria and operating conditions of any consent
- describe the proposed air quality management system
- include an air quality monitoring program that:
    - Adequately supports the proactive and reactive air quality management system;
    - Evaluates and reports on:
        - The effectiveness of the air quality management system; and
        - Compliance with the air quality operating conditions

- Defines what constitutes an air quality incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any air quality incidents; and
- Include procedures and a schedule for the preparation of emissions validation reports for the processing plant during the operation of the development.

Furthermore, prior to undertaking any development on the site, the Applicant will ensure that there is a suitable meteorological station operating in the vicinity of the site that:

- complies with the requirements in the Approved Method for Sampling of Air Pollutants in NSW guidelines; and
- is capable of measuring temperature inversion conditions (Stability category) determined by the sigma-theta method in accordance with the NSW Industrial Noise Policy, unless a suitable alternative is approved by the Secretary following consultation with the EPA.

In relation to odour, and as per the Development Consent conditions associated with original approval, the Applicant will ensure that no offensive odours, as defined under the POEO Act, are emitted from the site.

With reference to the Development Consent conditions associated with the original approval, the Applicant commits to:

- Implementing all reasonable and feasible measures to minimise the:
  - Odour, fume, dust and radon emissions of the development;
  - Gaseous emissions from the ore processing facility; and
  - Greenhouse gas emissions from the site
- minimise the surface disturbance of the site
- Operate a comprehensive air quality management system that uses a combination of predictive meteorological forecasting and real-time air quality monitoring data to guide the day to day planning of mining operations and implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of any consent.
- minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events to the satisfaction of the Secretary.

8.1.3 Processing Plant

The following mitigation measures would be put in place to minimise emissions to atmosphere from the processing plant:

- The use of spray curtains would be adopted at all crushers and miscellaneous transfers (not already located within enclosures).
- A bag house would be used to capture particulate matter from the grinding mill.

- Emissions from the stacks and vents would be regulated by operating within the prescribed in-stack concentrations limits. This would be initially determined through the detailed design phase and verified by in-stack monitoring.
- Periodic extractive monitoring would be undertaken to demonstrate compliance with in-stack limits. This may be required to be completed every 3 months for the first year of operation and then annually if compliance is easily achieved.
- A regular and documented maintenance and inspection program would be implemented for all plant items where emissions to air is deemed likely.

With reference to the Development Consent conditions associated with the original approval, prior to commissioning the ore processing facility, the Applicant commits to:

- finalise the detailed design of the emission control measures at the ore processing facility to ensure:
  - It has TM-1 compliant sample ports so sampling of emissions will comply with the EPA's Approved Methods for the Sampling and Analysis of Air Pollutants in NSW 2006 (or its latest version); and
  - Compliance with the minimum stack height detailed in this AQIA, unless otherwise agreed with the EPA; and
  - Prepare a revised air quality impact assessment to predict the emission for the development at surrounding sensitive receivers based on the final design of the ore processing facility, in consultation with the EPA and the satisfaction of the Secretary.

- Within 1 month of commissioning the ore processing facility, unless the Secretary agrees otherwise, the Applicant shall prepare an emissions validation report, which includes monitoring to compare the actual emissions with:
  - the predicted emissions in this AQIA; and
  - the criteria in **Section 3**, in consultation with the EPA to the satisfaction of the Secretary.

8.2 Greenhouse Gas

The AQMP will include a section on the sources and management of GHG at the Project Site.

The Applicant will track energy consumption and greenhouse gas emissions, establish targets for reduction and facilitate assessment and reporting against targets for reduction.

Light vehicles, dump trucks, loaders, drills, graders and any other mobile equipment will all undergo regular maintenance on site. They will be serviced by a mobile maintenance department in the on-site workshop to ensure they are operating within required specifications.

The Applicant is committed to continue to investigate ways to minimise the emission of GHG, which may include:

- maximise energy efficiency as a key consideration in the development of the Project. For example, significant savings of GHG emissions (through increased energy efficiency) can be achieved by mine planning decisions which minimise haul distances for ore and waste rock transport, and therefore fuel use;
- improving energy use and efficiency;
- considering the use of alternative fuels where economically and practically feasible;
- the review of mining practices to minimise double handling of materials and ensuring that ore and overburden haulage is undertaken using the most efficient routes;
- ongoing scheduled and preventative maintenance to ensure that diesel and electrically powered plants operate efficiently;
- developing targets for greenhouse gas emissions and energy use, and monitor and report against these;
- implementing a detailed energy monitoring programme. This would include monitoring the electricity and diesel usage on-site to identify the main sources of greenhouse gas emissions and apply appropriate reduction mechanisms where possible;
- regular maintenance of diesel powered equipment to ensure operation at peak efficiency;
- dedicating a number of trucks for each digging unit to minimise truck wait times;
- ensuring that dump trucks are fully loaded to maximise productivity and efficiency;
- conducting a baseline study of energy use; and
- assessing lighting plant efficiency;

The Applicant is also committed to reviewing any schemes which may provide opportunity to reduce GHG emissions and increase productivity, under the NSW Government Net Zero Plan Stage 1: 2020-2030.

9. CONCLUSION

RWC Ltd has engaged Northstar on behalf ASM to perform an AQIA for the proposed modification to approved operations at a small-scale open ore and rare metals mine located in the Central West of NSW, approximately 25 km south of Dubbo.

This AQIA forms part of the documentation to accompany the development modification for the Project under Part 4 of the *Environmental Planning and Assessment Act* (1979).

The AQIA has been performed in accordance with the NSW EPA Approved Methods document and includes a detailed description of the construction and operational phase activities to be performed as part of the Project and includes a description of the management measures that will be employed to minimise air pollutant generation. The locations of surrounding sensitive receptor locations, a description of existing air quality and meteorology, and a description of the method used to assess potential impacts are also provided.

The potential air quality impacts at all the identified receptor locations are presented in **Section 6** which documents these predictions as:

- **Incremental impact** – relates to the concentrations predicted as a result of the construction and operation of the Project in isolation.
- **Cumulative impact** – relates to the concentrations predicted as a result of the construction and operation of the Project PLUS the background air quality concentrations discussed in **Section 4.3**.

The AQIA indicates that minor exceedances of the annual average $PM_{2.5}$ criteria may be experienced at up to eight nearby sensitive receptors during both construction and operation of the Project, although this is dominated by the already high $PM_{2.5}$ concentration (95 % of the criterion, without the impact of the Project added). A number of particulate matter controls would be employed during both construction and operational activities, which were not able to be robustly included in the modelling assessment. The addition of these measures, through an Air Quality Management Plan, should ensure that emissions are minimised, and the likelihood of those predicted exceedances occurring in reality, would be correspondingly lower. Maximum 24-hour average $PM_{2.5}$ concentrations are predicted to achieve the criteria at all surrounding receptor locations.

Predicted emissions of PM_{10}, NO_2, SO_2, odour, Rn, HCl and Cl_2 were also assessed taking into consideration the operation of the processing plant. Based upon the assumptions and methodology presented in the report, the predicted results indicate no exceedances of the relevant impact assessment criteria.

In relation to greenhouse gas, the assessment indicates that direct emissions associated with the Project are likely to be of the order of approximately 324.2 kt CO_2-e per annum. Scope 1 emissions are dominated by process emissions of CO_2. Indirect electricity emissions represent emissions of approximately 247.9 kt CO_2-e per annum. The Applicant is committed to continue to investigate ways to minimise the emission of GHG, and to reviewing any schemes which may provide opportunity to reduce GHG emissions and increase productivity, under the NSW Government Net Zero Plan Stage 1: 2020-2030.

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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
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AWS	automatic weather station
BoM	Bureau of Meteorology
°C	degrees Celsius
Cl_2	chlorine
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIE	NSW Department of Planning, Industry and Environment
EETM	emission estimation technique manual
EPA	Environment Protection Authority
FEL	front end loader
GDA	Geocentric Datum of Australia
GIS	geographical information system
HCl	hydrogen chloride
K	kelvin (-273°C = 0 K, ±1°C = ±1 K)
kW	kilowatt
L	litre
MGA	Map Grid of Australia
$mg \cdot m^{-3}$	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
OEH	NSW Office of Environment and Heritage (now defunct)
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
Rn	radon
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy

Abbreviation	Term
SEE	Statement of Environmental Effects
SO_2	sulphur dioxide
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

APPENDIX B

Meteorology

As discussed in **Section 4.2** a meteorological modelling exercise has been performed to characterise the meteorology of the Project Site in the absence of site-specific measurements. The meteorological modelling has been based on measurements taken at a number of surrounding automatic weather stations (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

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

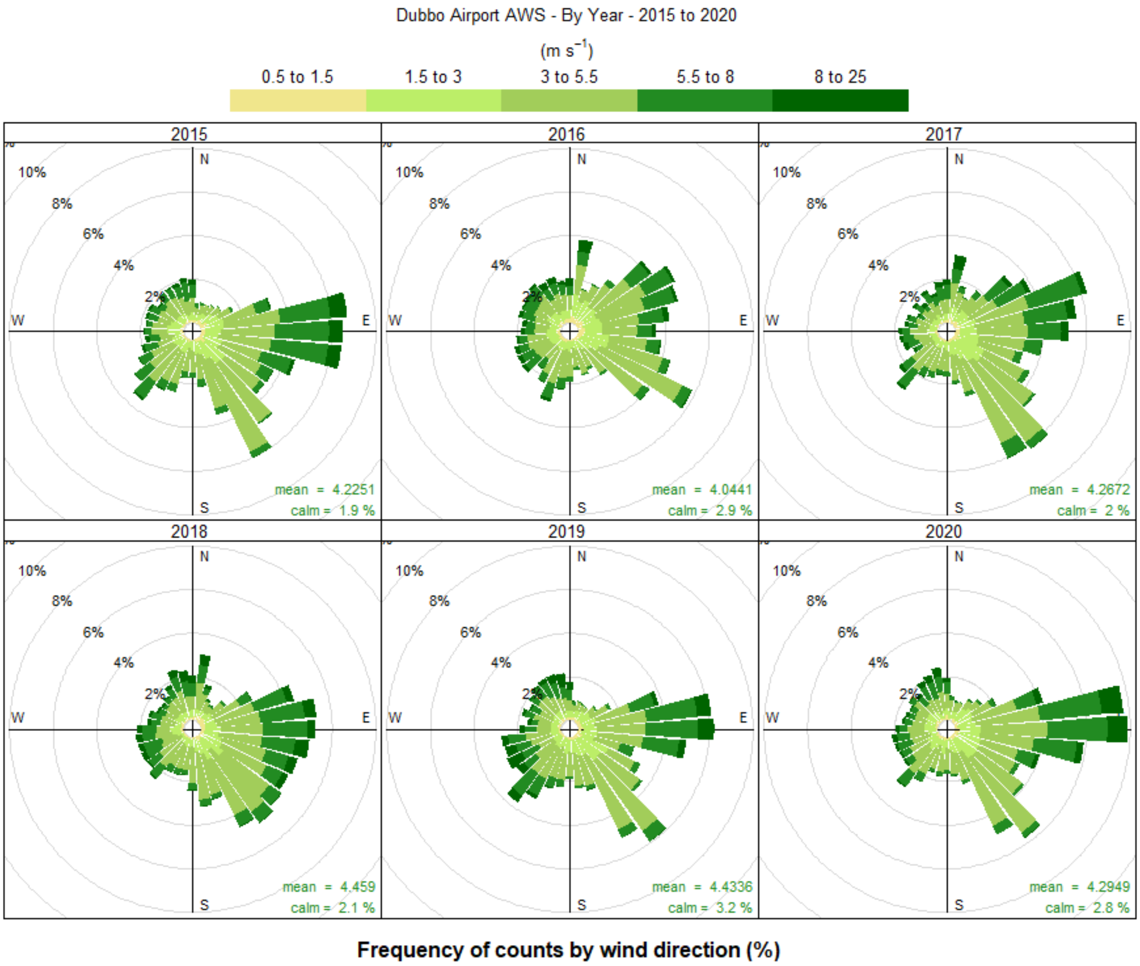
Table B1 Details of the meteorological monitoring surrounding the Project Site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Dubbo Airport AWS #065070	BoM	648 446	6 434 023	25.4
Parkes Airport AWS #065068	BoM	615 932	6 333 824	83.1

Figure B1 Meteorological monitoring stations surrounding the Project Site

Meteorological conditions at Dubbo Airport AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2015 to 2020) are presented in **Figure B2**.

Figure B2 Annual wind roses 2015 to 2020, Dubbo Airport AWS



The wind roses indicate that from 2015 to 2020, winds at Dubbo Airport AWS shows a predominant east, east south-easterly and east north-easterly component to the wind direction.

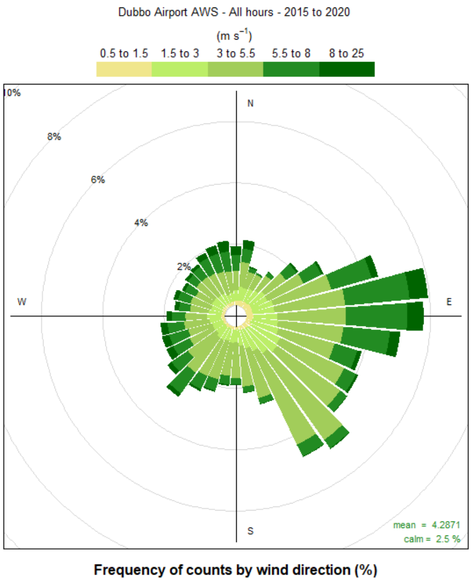
The majority of wind speeds experienced at Dubbo Airport AWS over the 6-year period, 2015 to 2020 are generally in the range <3 metres per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from an easterly or east north-easterly direction, although winds of this speed are also observed from the southwest and north north-westerly. Winds of this speed are not frequent, occurring during approximately 6% of the observed hours over the 6-year period at Dubbo Airport AWS. Calm winds (<0.5 $m \cdot s^{-1}$) occur during 2.6% of hours on average across the 6-year period.

Given the wind distributions across the years examined, data for the year 2015 has been selected as being appropriate for further assessment, as it best represents the general trend across the 6-year period studied.

Presented in **Figure B3** are the annual wind rose for the 2015 to 2020 period and the year 2015 and in **Figure B4** the annual wind speed distribution for Dubbo Airport AWS. These figures indicate that the distribution of wind speed and direction in 2015 is very similar to that experienced across the longer-term period.

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

Figure B3 Annual wind roses 2015 to 2020, and 2015 Dubbo Airport AWS



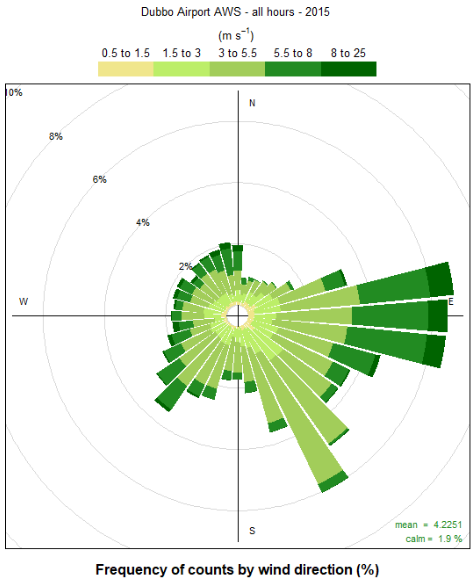
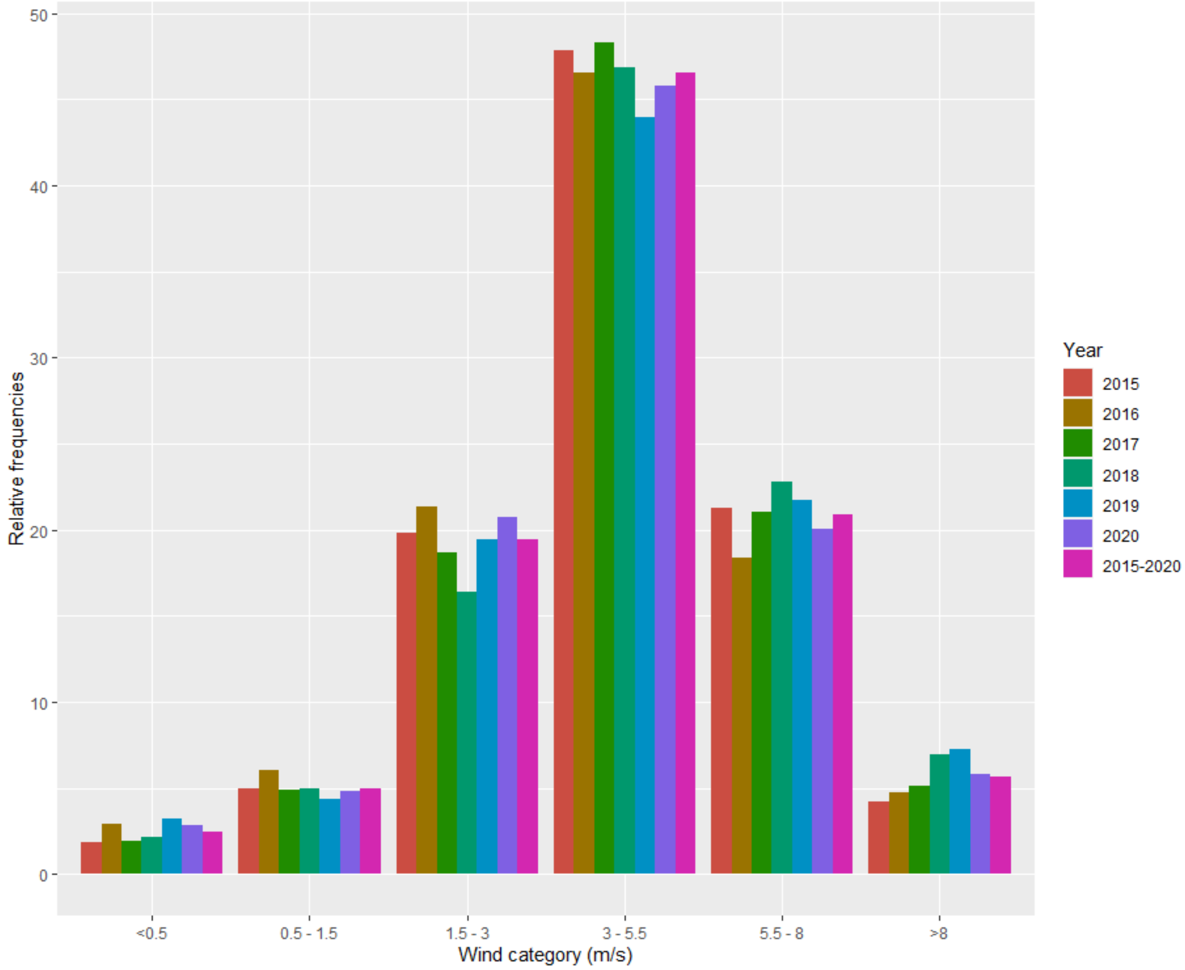


Figure B4 Annual wind speed distribution – Dubbo Airport AWS



Meteorological Modelling

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

In absence of any measured onsite meteorological data, site representative meteorological data for this Project was generated using the CALMET meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 4.2**).

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, rainwater 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.

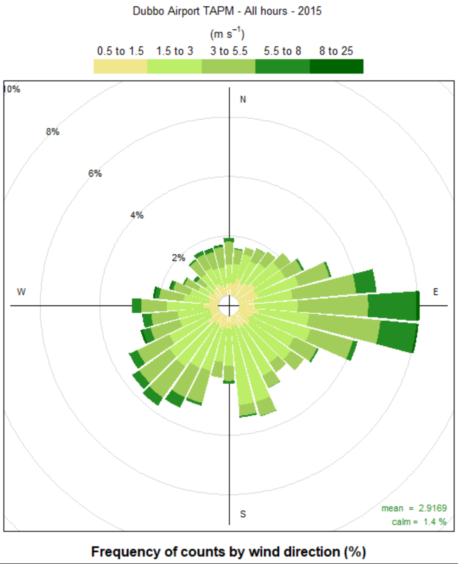
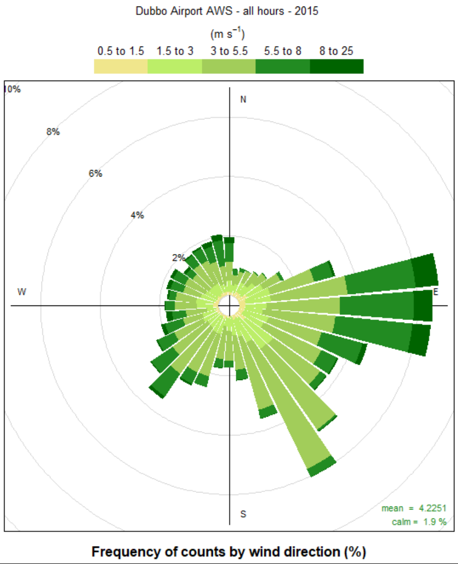
The parameters used in TAPM and CALMET modelling are presented in **Table B2**.

Table B2 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2015 to 31 December 2015
Centre of analysis	649 817 mE, 6 422 426 mN (UTM Coordinates)
Number of grid points	41 x 41 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	No data assimilation
CALMET	
Modelling period	1 January 2015 to 31 December 2015
South-West corner of analysis	631 000 mS, 6 402 000 mN (UTM Coordinates)
Meteorological grid domain (resolution)	76 km x 76 km (0.5 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 Dubbo Airport AWS are presented in **Figure B5**.

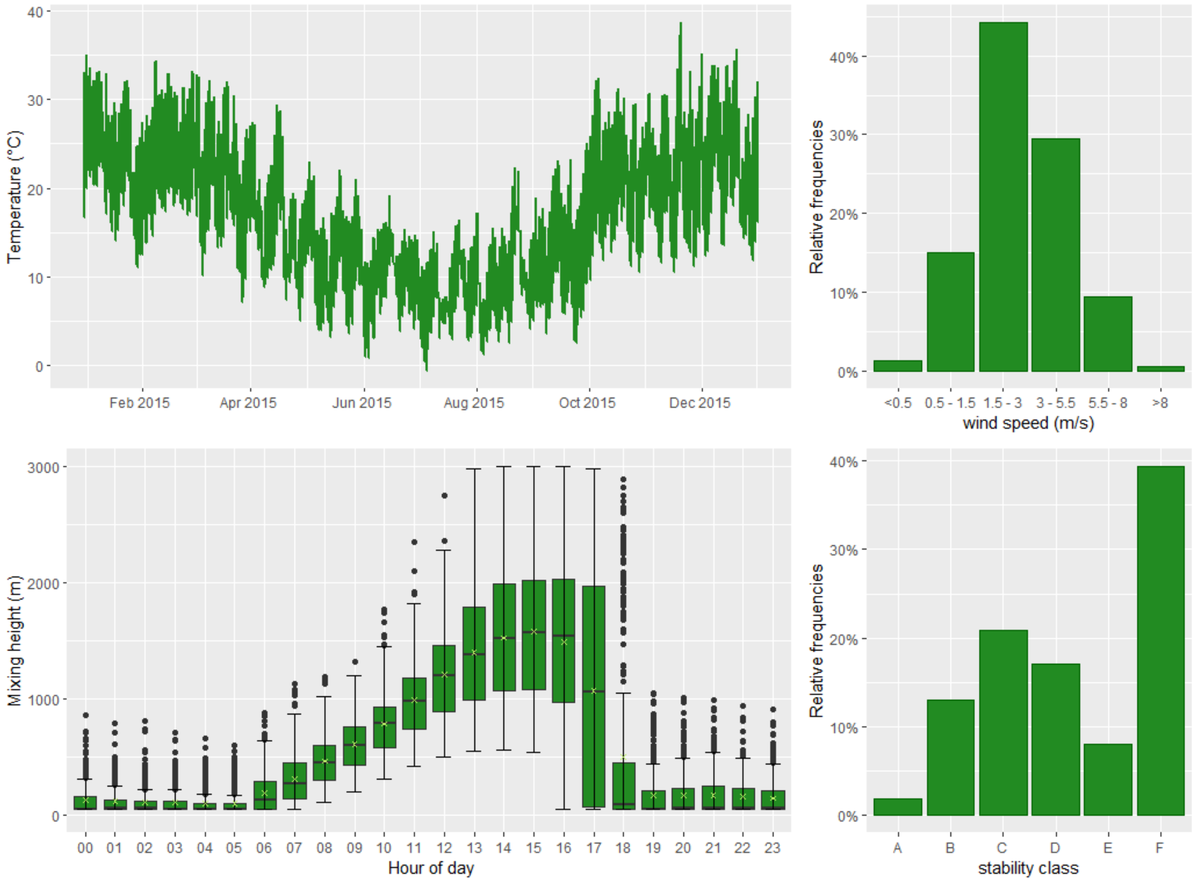
Figure B5 Modelled and observed meteorological data – Dubbo Airport AWS, 2015

Dubbo Airport TAPM generated windrose	Observations at Dubbo Airport 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 Project Site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirulation potential of the Project Site has not been provided. Details of the CALMET predictions of wind speed and direction, mixing height, temperature and stability class at the Project Site are provided in **Figure B6**.

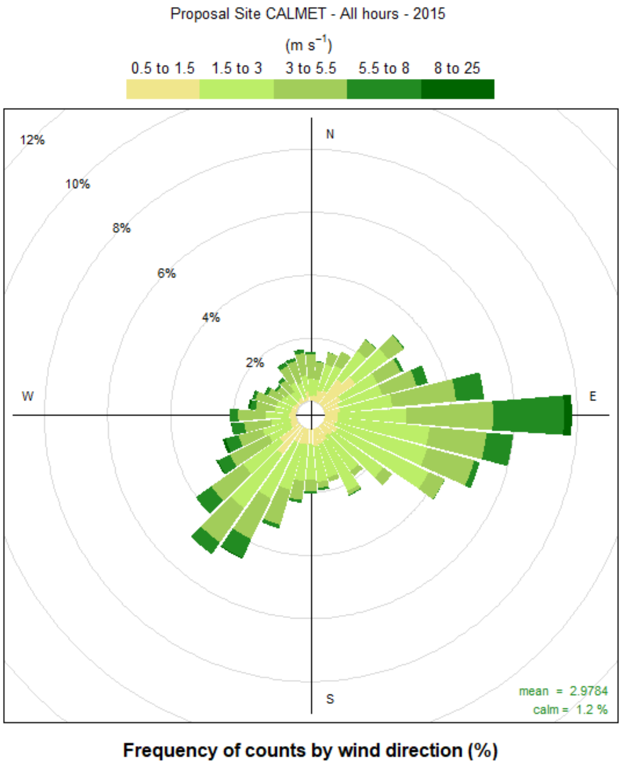
Diurnal variations in maximum and average mixing heights during the 2015 period shows that, as expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure B6 Predicted temperature, mixing height and wind speed frequency – Project Site 2015



The modelled wind speed and direction at the Project Site during 2014 are presented in **Figure B7**.

Figure B7 Predicted wind speed and direction – Project Site 2015



APPENDIX C

Background Air Quality Data

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

- the sources of air pollutant emissions around the Project Site and representative air quality monitoring station(s); 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 (DPIE) at four air quality monitoring station (AQMS) within a 320 km radius of the Project Site. Details of the monitoring performed at these AQMS is presented in **Table C1** and **Figure C1**. As discussed in **Section 4.2** and **Section 4.3**, the year 2015 was selected for assessment based upon an analysis of meteorological and background air quality data.

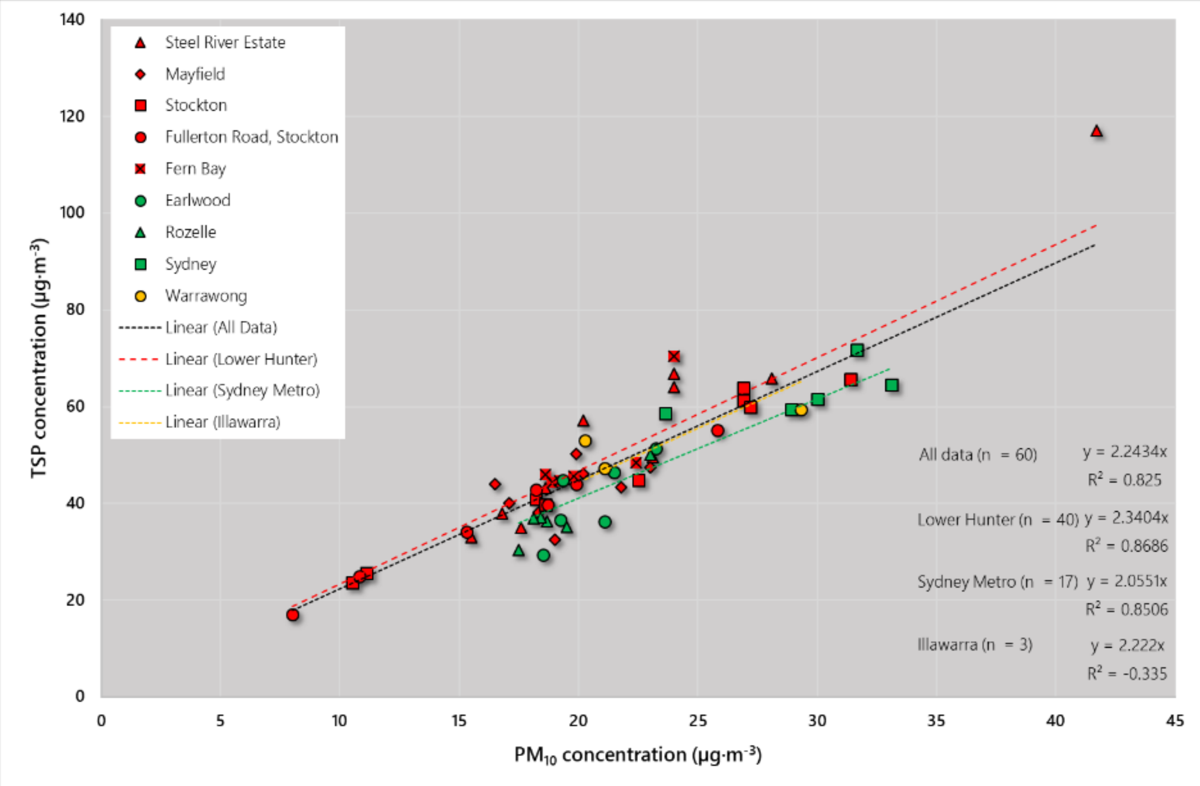
Table C1 Details of closest AQMS surrounding the Project

AQMS Location	Approximate distance to Project (km)	Screening Parameters						
		2015 Data	Measurements					
			PM_{10}	$PM_{2.5}$	TSP	NO_2	SO_2	HCl
Bathurst	140	✓	✓	×	×	×	×	×
Oakdale	230	✓	✓	✓	×	✓	×	×
Bargo	280	✓	✓	✓	×	✓	✓	×
Wagga Wagga North	312	✓	✓	✓	×	×	×	×

Figure C1 AQMS surrounding the Project

Concentrations of TSP are not measured at any AQMS surrounding the Project Site. An analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure C1**. 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 2.2434 : 1 (i.e. PM_{10} represents ~45% of TSP) from the average of all regions is appropriate, and the most conservative of all the relationships assessed. 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 30.1 µg·m^{-3} being adopted.

Figure C1 Co-located TSP and PM_{10} Measurements, Lower Hunter, Sydney Metro and Illawarra



Graphs presenting the daily varying PM_{10} and $PM_{2.5}$, NO_2 and SO_2 data recorded at each AQMS used in this assessment in 2015 are presented in **Figure C2**, **Figure C3**, **Figure C4** and **Figure C5**, respectively.

Figure C2 PM$_{10}$ Measurements, Bathurst 2015

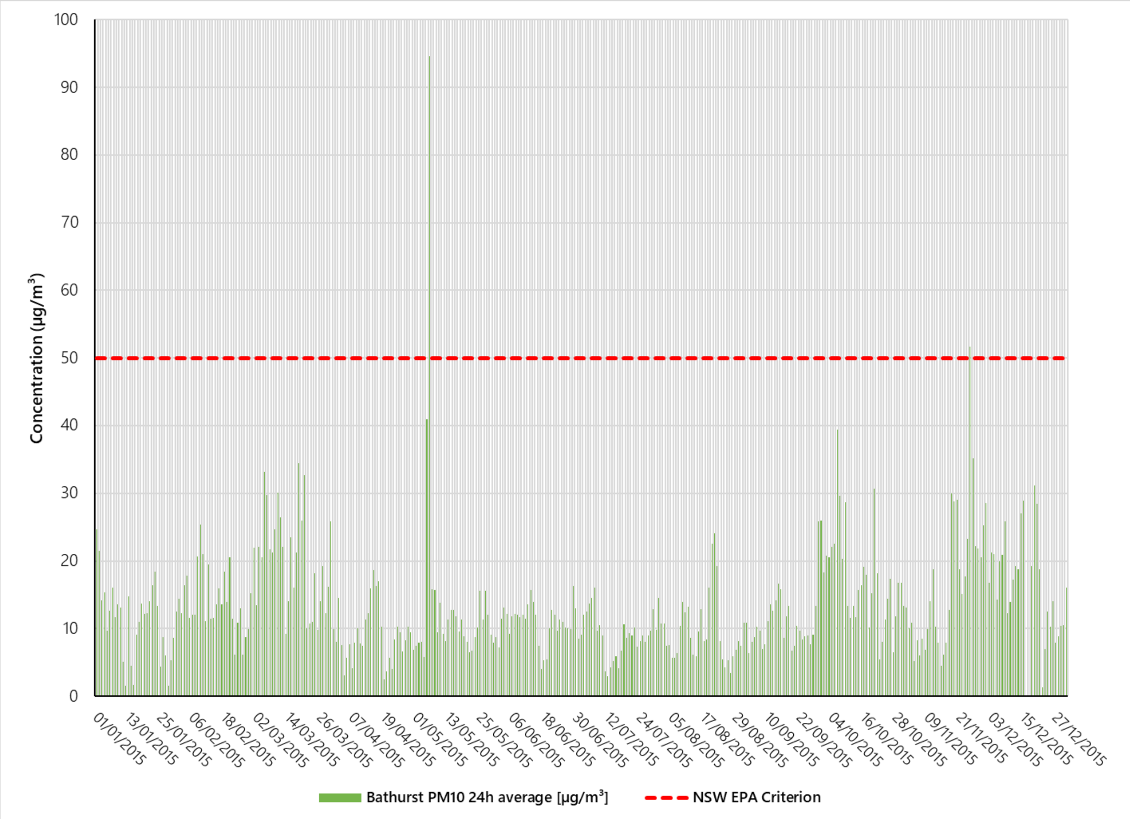


Figure C3 PM$_{2.5}$ Measurements, Wagga Wagga North 2015

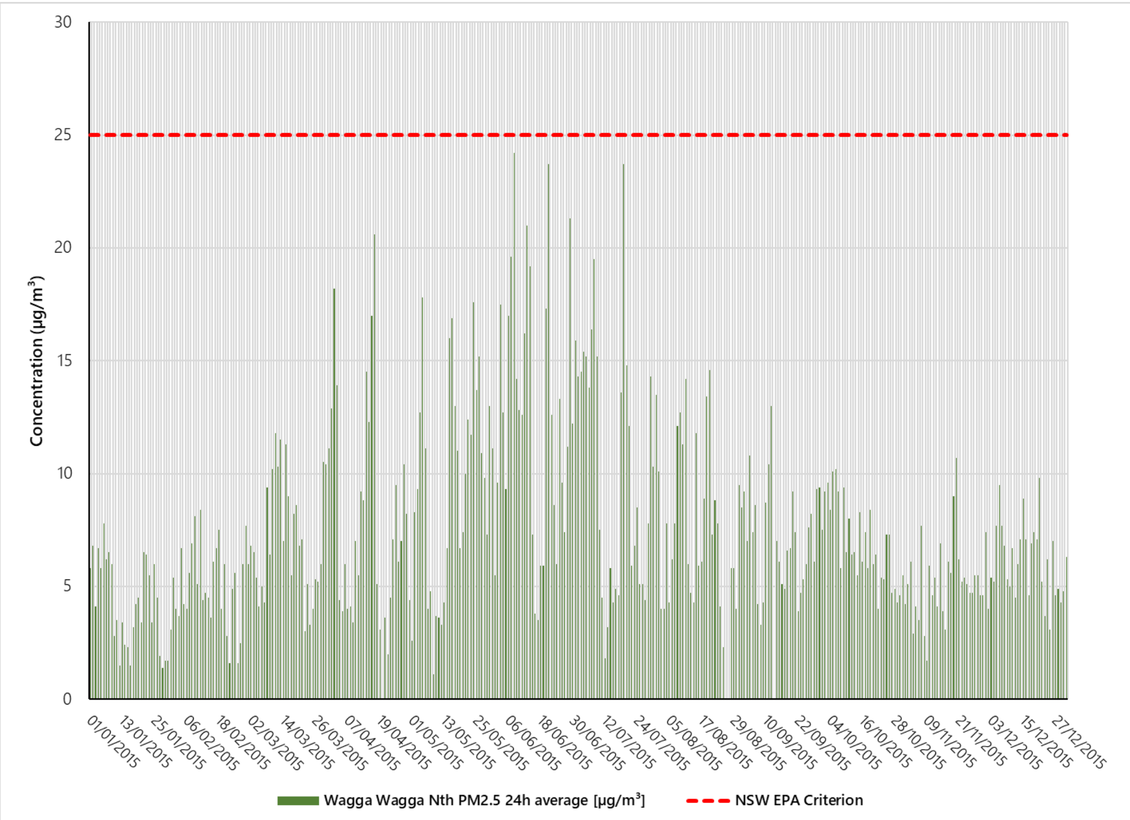


Figure C4 NO_2 Measurements, Bargo 2015

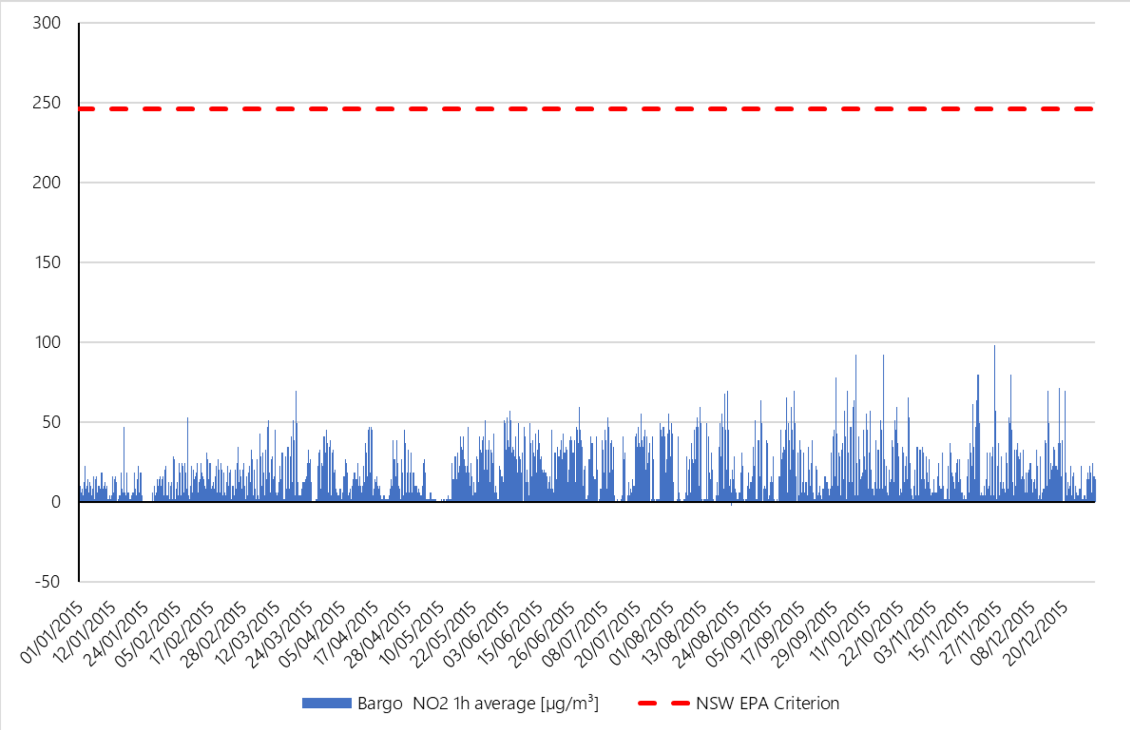
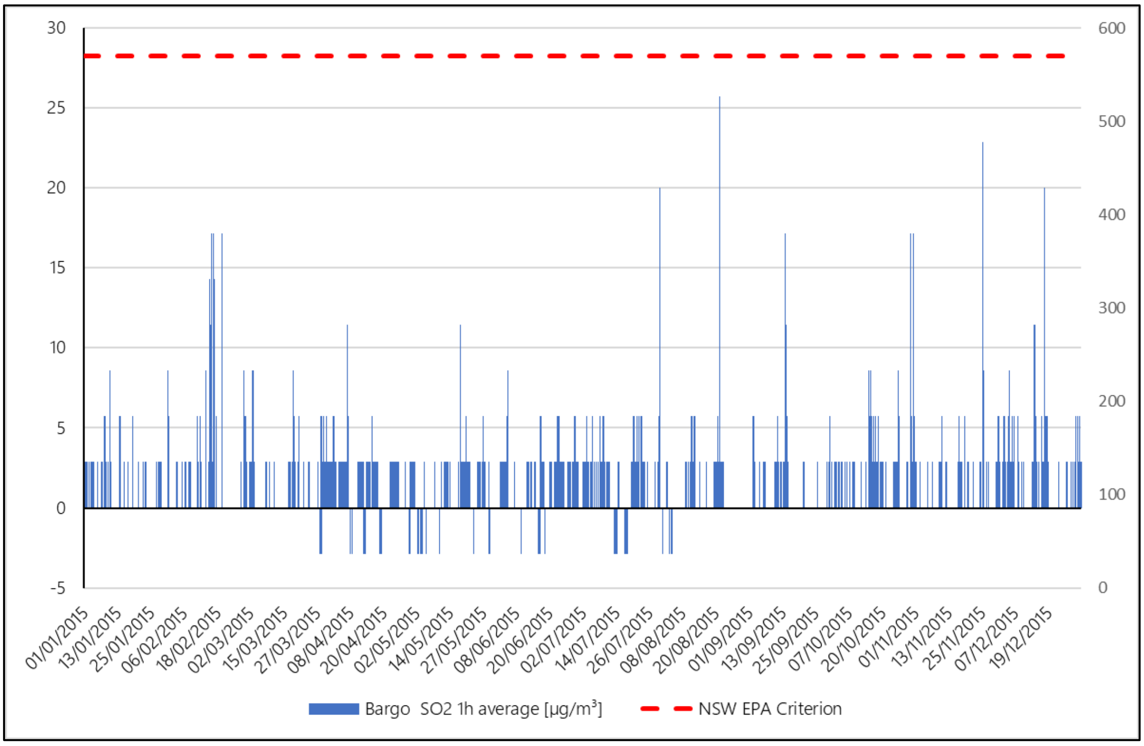


Figure C5 SO_2 Measurements, Bargo 2015



HCl is not routinely performed in NSW, or Australia. Although specific pollutant monitoring campaigns may be performed to identify and quantify risks surrounding specific emission sources. As such data is not available for the study area, background concentrations of other pollutants, including HCl and odour are assumed to be very low, if not at trace concentrations.

APPENDIX D

Emissions Inventory

CONSTRUCTION

Description	Emission Factor	Emission rate						Emission Controls	Controlled emission (kg/yr)		
		TSP	PM10	PM2.5	Units	Activity Rate	Units		TSP	PM10	PM2.5
Topsoil removal - Stripping topsoil - in waste rock	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	52,752	t		1,529.8	382.5	57.4
Topsoil removal - Stripping toposil at new LRSF in	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	221,158	t		6,413.6	1,603.4	240.5
Topsoil removal - Stripping topsoil - SRSF	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	1,023,240	t		29,674.0	7,418.5	1,112.8
Topsoil removal - Stripping topsoil - Salt Encapsul	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	689,973	t		20,009.2	5,002.3	750.3
Topsoil removal - Stripping topsoil - Processing Pl	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	236,189	t		6,849.5	1,712.4	256.9
Topsoil removal - Stripping topsoil - Open Cut	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	98,120	t		2,845.5	711.4	106.7
Topsoil removal - Stripping topsoil - Stockpile Are	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	219,534	t		6,366.5	1,591.6	238.7
Loading soil to haul trucks in WRE area	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	52,752	t		35.0	16.5	2.5
Loading soil to haul trucks at LRSF	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	221,158	t		146.6	69.3	10.5
Loading soils to haul trucks at SRSF	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	1,023,240	t		678.1	320.7	48.6
Loading soil to haul truckss at Salt Encapsulation (	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	689,973	t		457.3	216.3	32.8
Loading soil to haul trucks at Processing Plant	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	236,189	t		156.5	74.0	11.2
Loading soil to haul trucks at Open Cut	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	98,120	t		65.0	30.8	4.7
Loading soil to haul trucks at Stockpile Area and L	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	219,534	t		145.5	68.8	10.4
Unloading soil from WRE	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	52,752	t		35.0	16.5	2.5
Unloading soil from LRSF	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	221,158	t		146.6	69.3	10.5
Unloading soil from SRSF	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	1,023,240	t		678.1	320.7	48.6
Unloading soil from Salt Encapsulation Cells	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	689,973	t		457.3	216.3	32.8
Unloading soil from Processing Plant	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	236,189	t		156.5	74.0	11.2

Description	Emission Factor	Emission rate						Emission Controls	Controlled emission (kg/yr)		
		TSP	PM10	PM2.5	Units	Activity Rate	Units		TSP	PM10	PM2.5
Unloading soil from Open Cut	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	98,120	t		65.0	30.8	4.7
Unloading soil from Stockpile Area and Laydown \	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	219,534	t		145.5	68.8	10.4
OB - Dozers on D1 north dump	AP-42 - Bulldozing (Overburden) - Table 11.9-2	9.9E-01	1.4E-01	1.0E-01	kg/hr	739	hr		728.1	101.3	76.4
OB - Dozers on SRSF	AP-42 - Bulldozing (Overburden) - Table 11.9-2	9.9E-01	1.4E-01	1.0E-01	kg/hr	739	hr		728.1	101.3	76.4
Haul truck moving soil from WRE to GMSA 1	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	1,671	VKT	Level 2 watering (75%)	820.6	190.4	19.0
Haul truck moving soil from LRSF to GMSA 3	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	33,383	VKT	Level 2 watering (75%)	16,390.2	3,802.5	380.2
Haul truck moving soil from SRSF to GMSA 4	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	57,625	VKT	Level 2 watering (75%)	28,291.9	6,563.7	656.4
Haul truck moving soil from Salt Encapsulation Ce	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	98,884	VKT	Level 2 watering (75%)	48,549.0	11,263.3	1,126.3
Haul truck moving soil from Processing Plant to G	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	19,504	VKT	Level 2 watering (75%)	9,576.0	2,221.6	222.2
Haul truck moving soil from Open Cut to GMSA 2	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	5,293	VKT	Level 2 watering (75%)	2,598.9	602.9	60.3
Haul truck moving soil from Stockpile Area and La	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	28,643	VKT	Level 2 watering (75%)	14,063.1	3,262.6	326.3
WE - WRE	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	6.8	ha		5,780.0	2,890.0	433.5
WE - LRSF	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	21.3	ha		18,079.5	9,039.8	1,356.0
WE - SRSF	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	86.0	ha		73,100.0	36,550.0	5,482.5
WE - Salt Encapsulation Cells	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	66.3	ha		56,363.5	28,181.8	4,227.3
WE - Processing Plant	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	29.6	ha		25,160.0	12,580.0	1,887.0
WE - Open Cut	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	18.1	ha		15,385.0	7,692.5	1,153.9
WE - Stockpile Areas	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	33.0	ha		28,050.0	14,025.0	2,103.8
								TOTAL	**420,719.8**	**159,083.5**	**22,592.0**

OPERATION

Description	Emission Factor	Emission rate				Activity Rate	Units	Emission Controls	Controlled emission (kg/yr)		
		TSP	PM10	PM2.5	Units				TSP	PM10	PM2.5
Topsoil removal - Stripping toposil at waste rock e	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	52,752	t		1,529.8	382.5	57.4
OB - Drilling	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	4,473	holes	Water injection (70%)	791.7	411.7	23.8
OB -Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	1.2E+01	6.0E+00	3.5E-01	kg/blast	21	blasts		242.0	125.8	7.3
OB - Sh/Ex/FELs loading OB to trucks at Pit	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	268,212	t		177.8	84.1	12.7
OB- Trucks emplacing OB at emplacement area	AP-42 - Batch drop - Section 13.2.4.3	6.6E-04	3.1E-04	4.7E-05	kg/t	268,212	t		177.8	84.1	12.7
OB - Dozers on D1 north dump	AP-42 - Bulldozing (Overburden) - Table 11.9-2	9.9E-01	1.4E-01	1.0E-01	kg/hr	739	hr		728.1	101.3	76.4
OB - Dozers on SRSF	AP-42 - Bulldozing (Overburden) - Table 11.9-2	9.9E-01	1.4E-01	1.0E-01	kg/hr	739	hr		728.1	101.3	76.4
ORE - Dozers ripping/pushing/clean-up inpit	AP-42 - Overburden replacement - Table 11.9-4	6.0E-03	2.8E-03	4.2E-04	kg/t	739	t		4.4	2.1	0.3
ORE - Drilling	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	38,604	holes	Water injection (70%)	6,832.9	3,553.1	205.0
ORE - Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	1.2E+01	6.0E+00	3.5E-01	kg/blast	179	blasts		2,062.9	1,072.7	61.9
Ore - Loading ore from Pit to trucks	AP-42 - Batch drop - Section 13.2.4.3	3.0E-04	1.4E-04	2.2E-05	kg/t	998,558	t		302.3	143.0	21.7
ORE - Unloading ore from truck to ROM pad	AP-42 - Batch drop - Section 13.2.4.3	3.0E-04	1.4E-04	2.2E-05	kg/t	998,558	t		302.3	143.0	21.7
ORE- primary crushing	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	998,558	tonnes		2,696.1	1,198.3	215.7
ORE- secondary crushing	AP-42 - Secondary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	998,558	tonnes		2,696.1	1,198.3	215.7
ORE - tertiary crushing	AP-42 - Tertiary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	998,558	tonnes		2,696.1	1,198.3	215.7
ORE - Quarternary crushing	AP-42 - Tertiary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	998,558	tonnes		2,696.1	1,198.3	215.7
ORE- Dry Grinding	AP-42 - Tertiary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	998,558	tonnes	83%	458.3	203.7	36.7
ORE - Misc transfers	AP-42 - Batch drop - Section 13.2.4.3	3.0E-04	1.4E-04	2.2E-05	kg/t	3,994,232	t		1,209.3	572.0	86.6
OB - Hauling OB from Pit to emplacement area	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	14,201	VKT	Level 2 watering (75%)	6,972.3	1,617.6	161.8
ORE - Hauling ore from Pit to ROM Pad	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	166,444	VKT	Level 2 watering (75%)	81,718.9	18,958.6	1,895.9
Topsoil from WRE to GMSA 1	AP-42 Unpaved roads - Section 13.2.2	2.0E+00	4.6E-01	4.6E-02	kg/VKT	1,560	VKT	Level 2 watering (75%)	766.1	177.7	17.8
WE - Stripped topsoil area at salt encapulation cell	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	66.3	ha		56,363.5	28,181.8	4,227.3
WE - waste emplacement	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	20.4	ha		17,306.0	8,653.0	1,298.0
WE - Pit	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	40.9	ha		34,748.0	17,374.0	2,606.1
WE - Stockpiles other - SRSF	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	172.1	ha		102,369.8	51,184.9	7,677.7
WE- ROM stockpiles	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	18.0	ha		15,300.0	7,650.0	1,147.5
WE - Stockpiles other - soil stockpiles	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	111.5	ha		94,775.0	47,387.5	7,108.1
								TOTAL	**436,651.6**	**192,958.3**	**27,703.3**

PROCESSING PLANT

Source	Easting	Northing	Stack height (m)	Stack diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	Emission Rate (g/s)					
							SO_2	NO_2	PM_{10}	$PM_{2.5}$	HCL	Cl2
Sulphuric Acid Plant Stack	649,754	6,407,763	80	2.1	6.4	353	17.78	0.67	-	-	-	-
Roaster heater exhaust vent - Roaster 1	649,878	6,407,703	30	1	3.5	548	-	0.97	-	-	-	-
Gas Boiler stack	649,785	6,407,760	30	1.2	12.3	423	-	4.86	-	-	-	-
Ore Mill exhaust vent	649,905	6,407,676	20	1.2	12.3	383	-	0.42	0.28	0.28	-	-
Ore Preheater exhaust vents - Roaster 1	649,895	6,407,652	20	1	8.8	473	-	2.43	0.14	0.14	-	-
Zr Dryer vent	649,684	6,408,030	20	1	7.1	383	-	-	0.28	0.28	-	-
Nb Dryer vent	649,695	6,407,919	20	1	7.1	383	-	-	0.14	0.14	-	-
Ferro-niobium Process stack	649,572	6,407,790	80	2.1	6.4	323	0.14	0.14	0.14	0.14	0.28	-
Chlor-alkali plant stack	649,896	6,408,863	23.325	0.6	9.8	323	-	-	-	-	0.000111	0.000111

RADON

Area	Area (m^2)	EF ($Bq/m^2/s$)	Total emission
Open Cut	409,000.0	0.6	245,400.0
ROM stockpiles	180,000.0	3.0	540,000.0
Waste rock	204,000.0	0.3	53,040.0
SRSF	1,721,000.0	1.1	1,944,730.0
LRSF	209,000.0	0.0	41.8
Processing plant	n/a		50.0
Total			**2,783,261.8**

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