CHAPTER 15

AIR QUALITY

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Subject to that declaration:

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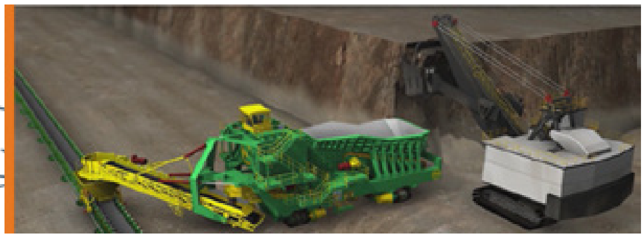
15 Air Quality 15-1

List of Figures

List of Plates

List of Tables



15 Air Quality

The proposed mine will introduce new air emission sources to the project area as a result of ground disturbance, excavation of overburden and waste rock, materials handling and processing activities.

This chapter describes how the introduction of these emissions sources may affect ambient air quality and public amenity values. It provides a comparison of the predicted particulate concentrations and dust deposition levels to regulatory limits (where available) or advisory standards at sensitive receiver locations. These predictions take into account design and management measures to reduce dust generation. Risks associated with mine-related emissions that could reasonably occur as a result of uncertainty in the impact assessment process are also considered. Appendix K presents further details on the assessment methodology and outcomes of modelling in the Mine Air Quality Impact Assessment technical report.

The potential effects of air emissions from the proposed mine on terrestrial flora and fauna are addressed in Chapters 12 and 11 respectively.

15.1 Applicable Legislation and Standards

The relevant legislation relating to air emissions from the proposed mine is as follows:

- *Mining Act 1971*
- *Environment Protection Act 1993*

The *Native Vegetation Act 1991* is also potentially applicable if dust from proposed mining operations impacts native vegetation. Further information regarding the requirements and relevance of the legislation is provided in Chapter 4 Statutory Framework.

The following standards provide a range of assessable criteria relevant to the protection and management of air quality:

- National Pollutant Inventory Emissions Estimation Technique Manual for Mining (2012)
- National Environment Protection (Ambient Air Quality) Measure (NEPC 2003)
- NSW Department of Environment and Conservation standards and guidelines for Total Suspended Particulates (2005)

Air quality indicators and ambient air quality criteria are specified in the EPA guidance document, *EPA 386/06, Air quality impact assessment using design ground level pollutant concentrations (DGLCs)*, updated January 2006 (EPA 2006). These criteria were used for the assessment of gaseous emissions such as non-particulate emissions from blasting and emissions from the combustion of diesel.

While EPA (2006) does not provide air quality criteria for particulate matter, there is a requirement to source appropriate alternatives. The National Environment Protection (Ambient Air Quality) Measure (NEPM) standards and guidelines for particulate matter 10 µm or less in diameter (PM_{10}) and for particulate matter 2.5 µm or less in diameter ($PM_{2.5}$) were adopted for the assessment of air emissions from the proposed mine (NEPC 2003). The NSW Department of Environment and Conservation (DEC) standards and guidelines for Total Suspended Particulates (TSP) and deposited dust were adopted as the assessment criteria for the protection of amenity from nuisance dust (DEC 2005). The adoption of these standards for the proposed mine was agreed in discussions held with the EPA throughout 2013-2014.

A 24-hour average TSP concentration was not adopted as a project criterion because:

- Deposited dust represents a direct measure of the environmental effect of nuisance dust (in units of g/m^2/month), whereas TSP is only an indirect indicator for nuisance dust impacts.
- The 24-hour average PM_{10} concentration was proposed as the key indicator for dust management, i.e. if the PM_{10} emissions can be controlled then the nuisance dust effects, measured by dust deposition, will be controlled also.

The ambient air quality standards adopted for the assessment of air emissions from the proposed mine are set out in Table 15-1.

Table 15-1 Adopted Project Criteria for Gaseous Emissions from Locomotives (EPA 2006)

Assessment Parameter	Averaging Period	Maximum, including Background	Notes
Nitrogen dioxide (NO_2)	1 hour	158 $\mu g/m^3$	Outside Adelaide metropolitan area, based on toxicity
Sulphur dioxide (SO_2)	1 hour	450 $\mu g/m^3$	Based on toxicity
Carbon Monoxide (CO)	1 hour	29 mg/m^3	Based on toxicity

Table 15-2 Adopted Project Criteria for the Protection of Human Health from Airborne Particles (NEPC 2003)

Assessment Parameter	Averaging Period	Maximum, including background	Goal (maximum allowable exceedances)
PM_{10}	24 hours	50 $\mu g/m^3$ (NEPM)	5 days a year (due to natural events)
$PM_{2.5}$	24 hours	25 $\mu g/m^3$ (NEPM)	Not specified*
$PM_{2.5}$	Annual	8 $\mu g/m^3$ (NEPM)	Not specified*

*There is currently no specified goal in NEPC 2003 for maximum allowable exceedances for $PM_{2.5}$, however there is a goal specified to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards as part of the review of this Measure. Should the NEPM adopt these as a standard, then Iron Road would comply. Monitoring will occur in compliance with the NEPM in the interim.

Table 15-3 Adopted Project Criteria for Nuisance Dust (DEC 2005)

Assessment Parameter	Averaging Period	Maximum, including Background Level	Notes
TSP	Annual	90 $\mu g/m^3$	-
Dust deposition	Annual	4 g/m^2/month	Maximum total deposited dust level

15.2 Assessment Method

An air quality impact assessment was completed to predict the effects from dust and non-dust particle (gaseous) emissions associated with proposed mining operations. The air quality impact assessment considered three modelling scenarios which are expected to represent the different stages of the mining operation:

- Construction phase (Year 0-1)
- Early mining (Year 2)
- Peak mining (Year 18 onwards)

The assessment incorporated the following tasks:

- Identification of potential air (dust particle and gaseous air pollutant) emissions sources from the proposed mine.
- Determination of relevant air quality standards and criteria.
- Identification of sensitive receivers.
- Establishment of existing air quality conditions in the project locality via literature review and air monitoring at various sites in the vicinity of the proposed mine site.
- Prediction of meteorological conditions using the TAPM and CALMET computer models (where applicable).
- Prediction of ground level concentrations of air emissions from the project using the CALPUFF computer dispersion model (where applicable).
- Comparison of the predicted emission levels with relevant air quality criteria.
- Modification of design or development of management measures to reduce the predicted levels to below the relevant criteria (if necessary).

Air emission sources associated with this project were identified and estimated based on techniques set out in the National Pollutant Inventory Emission Estimation Technique Manual for Mining (NPI EETM, January 2012).

For a detailed description of the impact assessment methodology, refer to the Air Quality Impact Assessment Technical Report presented in Appendix K.

15.3 Existing Environment

This section discusses the existing air quality conditions and location of sensitive receivers within the locality of the proposed mine site. Background air pollution estimates were included in the modelling to provide a thorough assessment of cumulative impacts to air quality.

15.3.1 Existing Background Air Quality

The existing air quality in the area surrounding the proposed mine site is expected to be very good or good (as defined by the EPA in the SA Air Quality Index) due to the rural location with low levels of road traffic and limited industrial activity. The existing air pollution is expected to be airborne particulate matter including wind-blown salt from oceans and regional salt lakes and dust, vehicle / machinery-generated dust from un-paved roads, ground disturbance in paddocks, other agricultural activities and fires, as depicted in Plate 15-1, Plate 15-4 and Plate 15-5.

Plate 15-1 Example of Machinery-Generated Dust on Eyre Peninsula

The EPA provided background particulate levels to be used in the air quality modelling based on monitoring data for two sites:

- Schultz Park, Whyalla for PM_{10} particulate concentrations
- Netley, Adelaide for $PM_{2.5}$ particulate concentrations

No EPA data is available for total suspended particulates (TSP) at the two monitoring sites. Typically, for rural areas, TSP is approximately twice the concentration of PM_{10} based on the PM_{10} and TSP emission factors outlined in the NPI EETM for Mining (DSEWPaC 2012).

Monitoring of nuisance dust measured as TSP and dust deposition was undertaken to establish the existing (pre-mining) levels of the airborne dust and confirm the background levels adopted for air modelling. Monitoring activities included:

- Continuous monitoring of TSP at two sites using continuous particle analysers (see Plate 15-2). The installed TSP system is regarded as the best solution for continuous monitoring at remote sites where power is not readily available or for short-term monitoring campaigns. Meteorological conditions were also measured at these sites.
- Deployment of dust deposition gauges at three sites (installed in quadruplicate) to record dust fallout (see Plate 15-3). Three of the gauges were used for measurement of dust deposition, with the fourth used for elemental analysis of the deposited dust to assist in characterising the nature of the deposited material.

The field monitoring near the proposed mine site during 2014 for dust deposition show that the levels adopted for the air quality assessment were conservative (high). Adopted background value for the dust deposition modelling was 2 g/m^2/month while the measured annual dust deposition was 0.88 g/m^2/month. TSP and PM_{10} measurements were obtained in 2014 - 2015 and are consistent with the adopted estimated concentrations.

The background concentration levels adopted for the air quality assessment are presented in Table 15-4. A comparison with field measured values is also presented and a summary of monitoring results is included in Appendix K.

Plate 15-2 E-BAM TSP Analyser Installed at Harry's

Plate 15-3 Dust Deposition Gauges at Crow's Nest

Table 15-4 Background Concentration Levels used in the Air Quality Assessment

Parameter	Adopted Background Value for Modelling Study	Estimated Background based on 2014-2015 Measurements(1)
Estimated background 24-hour average PM_{10} concentration	22 µg/m^3	23.9 µg/m^3 (2)
Estimated background 24-hour average $PM_{2.5}$ concentration	10 µg/m^3	12.0 µg/m^3 (3)
Estimated background annual average $PM_{2.5}$ concentration	7 µg/m^3	7.1 µg/m^3 (4)
Estimated background annual average TSP concentration (all seasons)	30 µg/m^3	29.8 µg/m^3 (5)
Estimated background monthly dust deposition (all seasons)	2 g/m^2/month	0.88 g/m^2/month (6)

1. All statistics are based on methodology adopted for baseline calculations and approved by SA EPA
2. 70th percentile of hourly average PM_{10} records between 15/10/14 to 13/7/15.
3. Assumed conservative high $PM_{2.5}/PM_{10}$ ratio of 50% (i.e. 50% of PM_{10} result).
4. Estimate using $PM_{2.5}/PM_{10}$ ratio of 50% and median of hourly average PM_{10} GLCs (14.1 µg/m^3).
5. Average of hourly TSP between 18/12/13 to 6/4/2015 excluding two dust storm event days (21/4/14 and 28/4/14).
6. Average of monthly dust deposition results for insoluble solids between Nov 2013 and May 2015.

The insoluble portion of one of the dust deposition gauges at each site was submitted for elemental (primarily metals) analysis, starting in December 2013. The most abundant metals detected in the deposited dust at each of three monitoring stations were typical of a relative abundance profile for crustal material; i.e. the three most abundant metals detected being iron, aluminium and calcium (Fleischer, 1953). –The results of this analysis are presented in Appendix K.

Plate 15-4 Vehicle-Generated Dust on Kimba Road

Plate 15-5 Truck-Generated Dust on Sealed Road

15.3.2 Air Quality Receptors

Air quality receptors include environmental, social, cultural and economic elements of the receiving environment that may be altered by increased air emissions. For the air quality impact assessment, potential receptors identified include:

- Sensitive receivers
- Commercial receptors (agricultural land)
- Native vegetation

Sensitive Receivers

Sensitive receivers include locations where people live or work that may be affected by air emissions due to the proposed mining operations. These include dwellings, schools, hospitals, business premises or public recreational areas. Environmental receivers such as terrestrial flora and fauna are addressed in Chapters 12 and 11 respectively.

The closest sensitive receivers to the proposed mine are illustrated in Figure 15-1. The sensitive receivers closest to the proposed mine are residential dwellings located intermittently around the proposed mine site, the Warramboo township and the Warramboo grain silos. Table 15-5 lists the sensitive receivers and their estimated distance to the proposed mine site boundary.

Table 15-5 Sensitive Receivers

Sensitive Receiver ID	Site Use	Distance to Proposed Mining Lease Boundary (m)
Warramboo	Township	750
7	Dwelling	650
48	Dwelling	510
92	Dwelling	1590
93	Dwelling	260
95	Dwelling	1980
96	Dwelling	2040
97	Dwelling	340
98	Dwelling	1820
99	Dwelling	1030
100	Dwelling	1870
101	Dwelling	780
140	Dwelling	8050
141	Dwelling	7920
142	Dwelling	3990
143	Dwelling	7270
144	Dwelling	7660
146	Dwelling	5090
147	Dwelling	3640
148	Dwelling	3760
151	Dwelling	6070
152	Dwelling	4730
153	Dwelling	7390
154	Dwelling	3450
155	Dwelling	7460
156	Dwelling	5140
157	Dwelling	5210
158	Dwelling	9890
165	Dwelling	4260
166	Dwelling	3850

* Note:

- The sensitive receiver IDs are not sequential due to progressive development of the database over time.
- The same sensitive receiver IDs are used for the same sites throughout the Mining Proposal.

Commercial Receptors (Agricultural Land)

The dominant land use in the study area is dryland agriculture, including mixed cereal crops and grazing. Proposed mining operations resulting in the deposition of airborne emissions to adjoining agricultural land may impact on agricultural values including land quality and crop yields.

Native Vegetation

There are small patches of degraded native vegetation within and adjacent to the proposed mine site and larger areas of native vegetation at greater distances from the primary dust generating activities. Hambidge WPA is greater than 10km from the open pit and thus impacts as a result of dust emissions form the mine and related activities to this area are not considered credible. Proposed mining operations resulting in the deposition of airborne emissions on nearby native vegetation may impact the quality of this vegetation.

15.3.3 Summary of Key Environmental Values

The proposed mine site is located in an area where the existing air quality is expected to be very good or good (as defined by the EPA in the SA Air Quality Index) due to the rural location, with low levels of road traffic and limited industrial activity. Subsequently the good air quality experienced by the sensitive receivers and local communities is considered a key environmental value. Good air quality is highly valued by community members as it relates directly to maintaining community health and safety (e.g. visibility).

Agriculture is identified as a relevant environmental value due to its proximity to the proposed mine and significance to the local and regional economy.

Native vegetation is also identified as a relevant environmental value, although remaining vegetation within and adjacent to the proposed mine site is degraded.

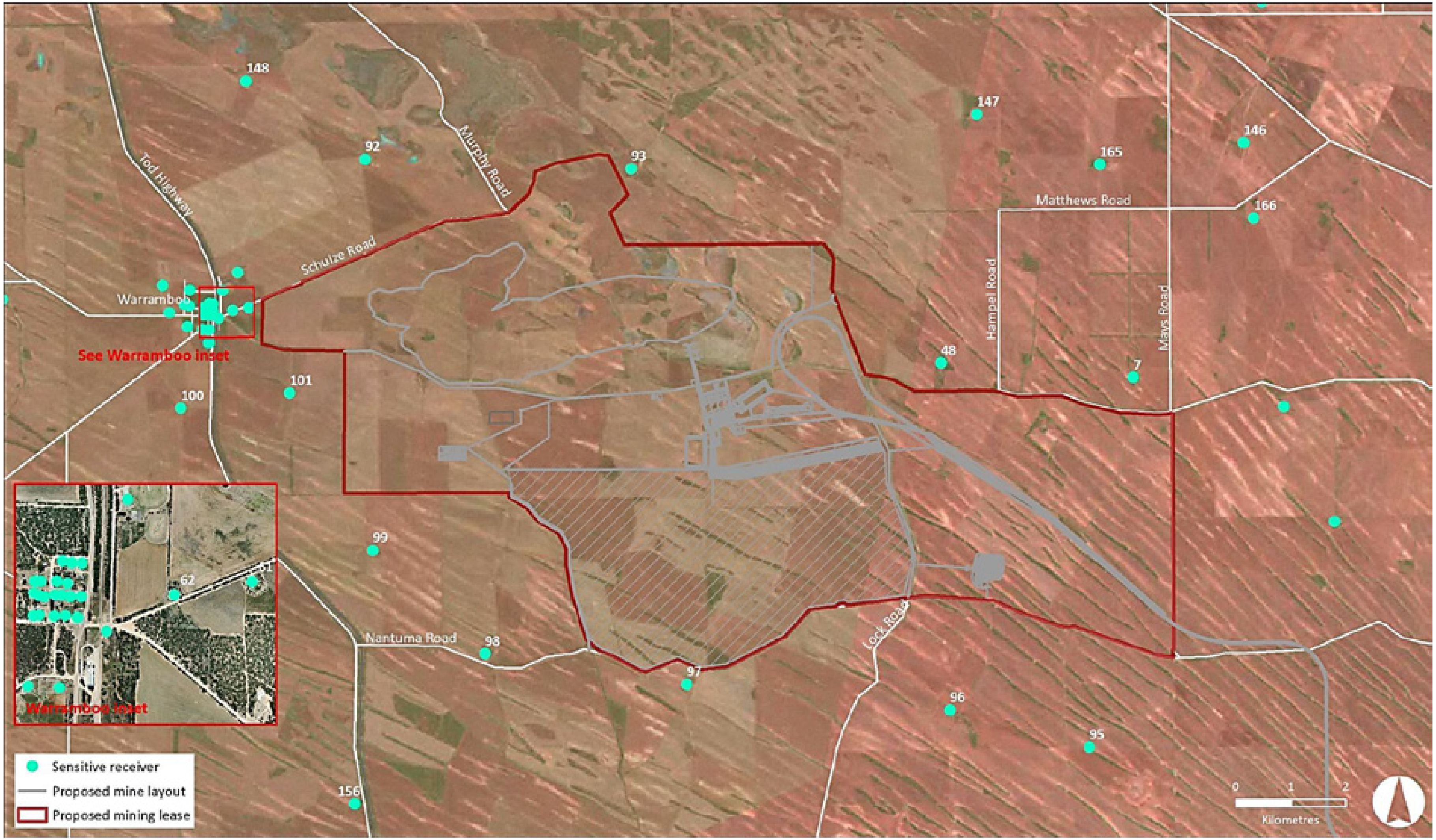


Figure 15-1 Sensitive Receivers in the Vicinity of the Proposed Mine Site

15.4 Context and Views of Affected Parties

The stakeholders relevant to air quality include the local landowners and community, Wudinna District Council, the EPA and DSD. Some members of the local community who have raised concerns about the potential effects of air emissions on community health and stakeholders generally are seeking the following outcomes in relation to air quality:

- Minimise dust during construction, when earthworks are on or near ground surface (IM_15_01).
- Have no health impacts to sensitive receivers due to construction and operation (IM_15_11, IM_15_12).
- Have no reduced productivity of surrounding agricultural land due to dust deposition (IM_15_05, IM_15_06, IM_15_07, IM_15_08).
- Have no reduction in land quality and productivity of surrounding agricultural land due to airborne transfer of salts, including post-mining (IM_15_05, IM_15_06, IM_15_07, IM_15_08).
- Have no impacts to the local native vegetation (IM_15_09, IM_15_10)
- Have no loss of amenity due to dust emissions (IM_15_02, IM_15_15).

All issues raised by stakeholders across the entire project are presented in Chapter 5, Stakeholder Consultation and summarised in Table 5-8. Impacts and risks relevant to the existing environmental value of good air quality identified by stakeholders are discussed below and summarised in Table 15-14. All impact events across the entire project are presented in the Impact and Risk Register in Appendix C.

15.5 Potentially Impacting Events

Considering the views and contexts of affected parties and the issues raised during technical studies, an assessment of Source Pathway Receptor (SPR) has been undertaken, as per the methodology outlined in Chapter 6, Assessment Methodology, to determine which potential impact events are considered applicable to this project. Potential impact events associated with the construction, operation and closure of the proposed mine site that have a confirmed SPR linkage associated with air emissions include:

- Dust generation from mine construction or operation results in poor visual amenity for local residents and local community (IM_15_01, 02)
- Dust generation from mining operations or IWL post closure results in poor visual amenity for local residents and local community (IM_15_03, 04)
- Dust deposition from IWL (including salts, metals) on agricultural land resulting in reduced productivity (IM_15_05, 06)
- Dust deposition from mining operations (other than IWL) on agricultural land resulting in reduced productivity (IM_15_07, 08)
- Dust from construction and mining operations or post-closure impacting native vegetation growth in areas surrounding the proposed mining lease (IM_15_09, 10)
- Fine particles in dust from construction and mining operations or post closure adversely affect human health (IM_15_11 – 13)
- Dust deposition from mining operations or post closure results in nuisance impacts on public amenity (IM_15_14, 15)
- Nitrogen oxide emissions from blasting adversely affect human health (IM_15_16)

The impact and risk register presented in Appendix C provides confirmation of a SPR for each of the potential impact events (PIMs) considered above and therefore follows each through as actual impact events (IMs) with a complete impact and risk assessment, discussed below and summarised in Table 15-14.

For air quality, a number of potential impact events (listed below) are not considered further as there is no confirmed linkage between source, pathway and receptor, as demonstrated in Appendix C.

These include:

- Air emissions (non-dust) from the processing plant, vehicles or other equipment result in nuisance impacts on public amenity or human health impacts (PIM15_18).
- Bio-uptake of disturbed airborne metals/toxins by vegetation, native fauna and stock (PIM15_14).

15.6 Control Measures to Protect Environmental Components

This section identifies design and control measures to be implemented to mitigate the level of impact and risk associated with air emissions such that it is considered as low as reasonably practicable (ALARP).

15.6.1 Design Measures

The following design control measures have been incorporated to minimise the impacts and risks from air emissions as a result of the construction, operation and closure of the proposed mine:

- Unpaved roads will be located as far away from residences and any other sensitive receptors as practicable.
- Dust-control measures will be used on drilling operations.
- Water sprays will be used to mitigate dust generation during the excavation activities and loading of the crushers within the mine pit.
- Each of the ore and waste rock crushers will be enclosed and fitted with water sprays to minimise dust generation from the crushing activities.
- Water trucks will be used to minimise dust from the stockpiles during stacking activities associated with the coarse ore stockpiles.
- Ore will be maintained in the form of a slurry throughout the Semi-Autogenous Grinding (SAG) process, no dust generation is expected to occur from this facility.
- The dewatered tailings stream from the ore processing facility will have a moisture content of approximately 10%.
- Covered conveyor systems will be used to transport the majority of ore and waste rock from the mine as a replacement for a large fleet of trucks.
- Transfer stations will be included in the conveyor system design to enclose the transfer points where the conveyor changes direction. The change of direction requires transfer of material from one conveyor to another via a transfer chute. Dust extraction units fitted to the transfer stations will capture dust generated inside the transfer chute.
- Full enclosure and dust extraction units will be fitted to the train load-out facility.
- Water trucks will be used to minimise dust from the two stockpiles during stacking and reclaiming activities at the concentrate handling facility.
- The integrated waste landform will be capped and rehabilitated progressively during the life of the mine, reducing the area exposed to wind erosion.

- The integrated waste landform design includes a ‘capillary’ break of waste rock material beneath the upper surface to avoid upward capillary migration of moisture containing salts (to avoid them becoming airborne as dust and impacting surrounding areas).
- The integrated waste landform design includes a surface ‘capping’ of topsoils and sub-soils which will retain (and release) rainfall. Dust suppression during the collection of these soils will involve the use of fresh water to facilitate rehabilitation or revegetation of surface areas, thereby reducing the potential for dust generation.

15.6.2 Management Strategies and Commitments

Management measures that will be adopted to assist in the avoidance or mitigation of air quality impacts and risks during the construction, operation and closure of the proposed mine are outlined in Table 15-6.

Table 15-6 Control and Management Strategies: Air Quality

Control and Management Strategies	Project Phase
All dust-generating material covered when being transported to and from the construction site.	Construction
Regular use of water sprays or suitable chemical wetting agent on susceptible earthen material loads, active stockpiles, particularly during dry or windy conditions (otherwise use covers where appropriate).	Construction, Operation
Stockpiles located as far from sensitive receivers as practically possible.	Construction, Operation
Vegetation retained on site where possible and rehabilitation of vegetation to occur as soon as practicable. Progressive rehabilitation of the integrated waste landform undertaken during the life of the mine.	Construction, Operation, Closure
Temporary haul roads constructed of compacted gravel or similar and kept in good condition.	Construction
Use of water trucks or chemical wettings agents where appropriate on unpaved roads or other exposed areas.	Construction, Operation
Engine emissions controls installed on vehicles and diesel engine-powered equipment where practicable (this is also partly for protection of Work, Health and Safety) and vehicles and machinery maintained and operated to minimise emissions of gaseous and particulate pollutants.	Construction, Operation
Vehicle speed limits managed in accordance with site traffic management procedures and site conditions to mitigate wheel-generated dust.	Construction, Operation
Should visible air quality impacts be clearly observed (e.g. visible dust plumes being emitted off-site), relevant work activities would be reduced or ceased to stop the impacts and alternative work methods implemented.	Construction, Operation
Conveyor speeds synchronised to minimise disruption to flows at transfer points.	Operation
Maintenance, inspection and verification requirements for dust control equipment and technology.	Construction, Operation

Control and Management Strategies	Project Phase
Monitoring programme to confirm compliance with the air quality criteria for the project. The dust monitoring programme will focus on the sensitive receivers with the greatest potential for air quality impacts. Monitoring would also enable planned modification or suspension of activities in response to the following triggers: · Predicted increased dust emission risk from weather forecast information (e.g. very high wind speeds) · Warnings or exceedance alarms from real-time dust monitoring at selected sites around the proposed mine site · Observations of significant dust generation during visual monitoring	Construction, Operation
Active operation control informed by the air quality monitoring programme to manage dust emissions within the air quality criteria.	Operation
Continuous meteorological monitoring at the Warramboo site with telemetry capable equipment linked to a real-time reporting system that will be available on a public internet site.	Operation

15.7 Impact and Risk Assessment

This section identifies and assesses impact and risk associated with existing air quality values as a result of the construction, operation and closure of the proposed mine. Impact events (confirmed by the presence of a source, pathway and receptor) are those which are predicted to occur as a result of the development, whilst risk events would not be expected as part of the normal operation of the project, but could occur as a result of uncertainty in the impact assessment process. Although the risks may or may not eventuate, the purpose of the risk assessment process is to identify management and mitigation measures required to reduce the identified risks to a level that is ALARP. This assessment has been undertaken in accordance with the methodology outlined in Chapter 6, Assessment Methodology.

Impact and risk events were identified through both technical studies and stakeholder consultation. Impact events can include multiple sources, pathways or receptors and where practical, have been grouped and discussed together here to minimise duplication of information. Risks are events that would not be expected as part of the normal operation of the project, but could occur as a result of either uncertainties with the impact assessment, or as a result of faults, failures and unplanned events. A summary of impact and risk events relating to air quality is presented in Table 15-14 at the end of this section (with Impact IDs). A complete register of impact and risk events by source, pathway and receptor is provided in Appendix C.

Impacts and risks are assessed following the application of the design measures outlined in Section 15.6. Where required, management measures are proposed to reduce the impact to a level that is considered ALARP. Through the adoption of design modification or specific mitigation measures, all identified impacts were categorised as low and identified risks were categorised as medium (or low) and are considered ALARP. The key environmental risks would be monitored through the environmental management framework.

15.7.1 Air Quality Modelling

Model simulations were used to predict and assess air quality impacts on surrounding receivers that are expected from the construction and operation of the proposed mine. The following sections present the modelling results for the following air quality indicators:

- Maximum 24-hour average PM_{10} concentration
- Maximum 24-hour average $PM_{2.5}$ concentration
- Maximum annual average $PM_{2.5}$ concentration

- Maximum annual average TSP concentration
- Maximum annual average dust deposition
- Maximum 1-hour NO_2 concentration

Throughout the construction, operation and closure of the proposed mine, air emissions will vary based on the extent and location of works undertaken on the site. This means there will be changes in the dust emission rates for the three particle size groups ($PM_{2.5}$, PM_{10} and TSP), as well as changes to the locations at which the emissions occur. The potential level of impact to sensitive receivers could also change over the life of the mine.

The air quality impact assessment calculated emissions estimates for three modelling scenarios which are considered representative of different stages of the proposed mine:

- **Construction phase**, No iron ore concentrate production, activity in Murphy pit only.
- **Early mining phase**, Year 2 of operations. Maximum mining rate of 81.4 Mtpa. Activity in Murphy pit only.
- **Peak mining phase**, Year 18 of operations and onwards. Maximum mining rate of 347.1 Mtpa. Activity in both Murphy South pit and Boo Loo pit.

The emissions estimates are presented in Table 15-7.

Table 15-7 Summary of Dust Particle Emission Scenarios

Scenario	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)
Construction phase	115.9	36.1	8.0
Early mining phase	62.9	30.1	9.9
Peak mining phase	77.8	36.0	11.8

Based on the emissions estimates, the two scenarios that reflected worst case were used as the basis of air dispersion modelling. These were the:

- **Construction phase** scenario with the equal highest PM_{10} emissions and the highest TSP emissions
- **Peak mining phase** scenario with the equal highest PM_{10} emissions and the highest $PM_{2.5}$ emissions

A summary of the inputs into the scenario models is provided in Table 15-8.

Table 15-8 Scenario Inputs

Input Data	Construction Scenario		Peak Operation Scenario	
	Murphy Pit	Boo Loo Pit	Murphy Pit	Boo Loo Pit
Total annual excavation (Mtpa)	108.2		347.1	
Rate of waste material transfer to IWL (t/h)	13,692		55,836	
IWL area (m^2)	0		13,824,000	
IWL height (m)	0		135	
Topsoil/subsoil stockpile area (m^2)	150,000		150,000	
Excavation rate (%)	100%	0%	66%	34%
Excavation rate (Mtpa)	108.2	0	229.1	118
Primary ore crusher processing rate (t/h)	87	0	13,506	6,958
Rate of waste material transfer to IWL (t/h)	13,692	0	15,658	8,067
Rate of topsoil / material removed (t/h)	86	0	0	457

Input Data	Construction Scenario		Peak Operation Scenario	
	Murphy Pit	Boo Loo Pit	Murphy Pit	Boo Loo Pit
Number of crushers in pit	0	0	4	2
Number of shovels in pit	7	0	5	2
Number of 360T haul trucks allocated to pit	12	0	0	0
360T haul truck average distance to crusher	1.9	0	0	0
360T haul truck distance per day (VKT/day/truck)	287	0	0	0
Number of 240T haul trucks operating	2	0	0	2
240T haul truck distance from pit to IWL	4.2	0	0	8
240T haul truck distance per day (VKT/day/truck)	40	0	0	403
Number of bulldozers in pit	6	0	7	3

Note: The peak material movement rates for tailings, waste rock, ore and combined tailings and waste rock represent the maximum hourly rates. These take into account the ‘up time’ for the different processing streams which are dependent on equipment utilisation and availability.

Sources of Air Emissions

Air emissions associated with the proposed mine will result from excavation, materials handling and stockpiling activities. The sources of emissions and emission estimates for significant sources are summarised below.

The locations of emission sources for construction are shown in Figure 15-2 and for mining at Year 18 are illustrated in Figure 15-3.

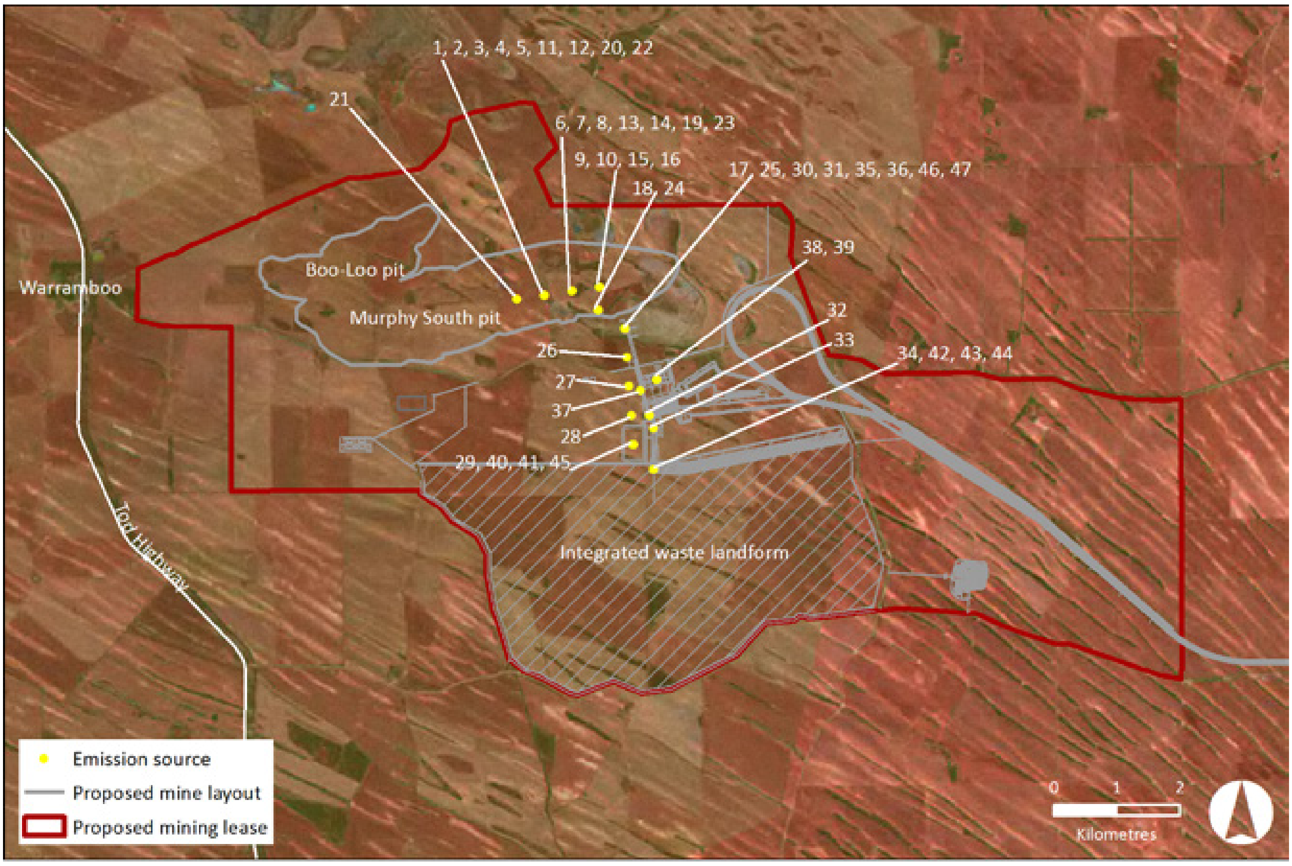


Figure 15-2 Emission Source Locations: Construction Scenario (refer to Table 15-9 for emission source descriptions)

Table 15-9 Emission Source Locations: Construction Scenario

Emission Source ID	Emission Source Description
1	Topsoil and subsoil removal
2	Drilling (Murphy Pit)
3	Blasting (Murphy Pit)
4-10	Excavation, loading mobile crushers
11-16	Dozers (Murphy Pit)
17-20	Truck haulage (waste rock to crusher station)
21-29	Truck haulage (topsoil from pit to IWL)
30	Truck dump at crushing station
31-34	Waste material transfer points (mine pit edge to IWL)
35	Truck dump at ore crushing station
36-37	Ore transfer points (mine pit edge to stockpiles)
38	Loading of crushed ore stockpile
39	Wind erosion of crushed ore stockpile
40	Truck dump at topsoil stockpiles
41	Dozers at topsoil stockpiles
42	Loading of overburden at ramp area
43	Dozers, overburden
44	Wind erosion of overburden
45	Wind erosion of topsoil stockpiles
46	Road maintenance (graders)
47	Truck and light vehicle wheel generated dust

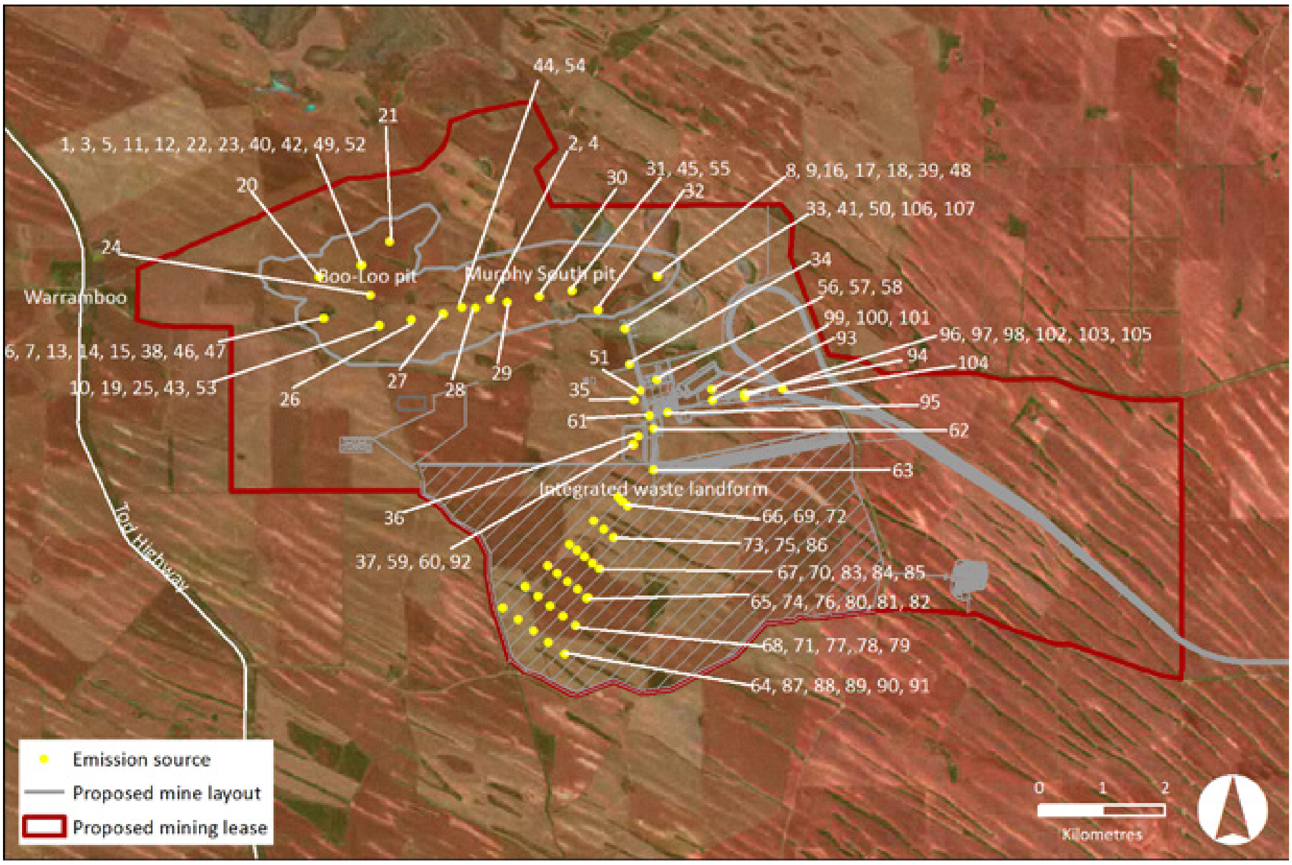


Figure 15-3 Emission Source Locations: Peak Operation Scenario (refer to Table 15-10 for emission source descriptions)

Table 15-10 Emission Source Locations: Peak Operation Scenario

Emission Source ID	Emission Source Description
1	Topsoil and subsoil removal (Boo Loo pit)
2	Drilling (Murphy Pit)
3	Drilling (Boo Loo Pit)
4	Blasting (Murphy Pit)
5	Blasting (Boo Loo Pit)
6-12	Excavation, loading mobile crushers
13-19	Dozers (Murphy Pit)
20-22	Dozers (Boo Loo Pit)
23-37	Truck haul route
38-40	Waste rock crushing
41-45	Waste rock transfer points
46	Feed bin to crushers (transfer points)
47-49	Primary ore crushing
50-55	Ore transfer point
56	Loading of crushed ore stockpile
57	Bulldozer at crushed ore stockpile
58	Wind erosion of crushed ore stockpile
59	Truck dump at topsoil stockpiles

Emission Source ID	Emission Source Description
60	Bulldozers at topsoil stockpiles
61-64	IWL transfer points
65	Loading of waste materials to IWL
66-91	Wind erosion of IWL
92	Wind erosion of topsoil stockpiles
93	Concentrate handling at transfer station
94	Concentrate transfer point (mine stacker feed conveyor to stockpile stacker
95	Concentrate transfer points (from processing plant on to process plant discharge conveyor)
96	Loading of mine concentrate stockpile with stacker
97	Loading of mine concentrate stockpile with front end loader (from bypass stockpile)
98	Wind erosion of mine concentrate stockpile
99	Loading of concentrate bypass stockpile
100	Wind erosion of concentrate bypass stockpile
101	Front end loader reclaim at concentrate bypass stockpile
102	Reclaim (wheel and bucket conveyor) at mine concentrate stockpile
103	Concentrate transfer points (2 of reclaimer to outfeed conveyor and conveyor to train load-out package)
104	Loading concentrate to rail wagons
105	Bulldozers at concentrate stockpiles
106	Road maintenance (graders)
107	Truck and light vehicle wheel generated dust

Air Emissions from Closure

Progressive rehabilitation will be undertaken where practical throughout the life of the mine to minimise exposed surfaces and the potential for wind-generated dust. Following closure, further rehabilitation will occur to stabilise potential emissions sources such as the integrated waste landform.

15.7.2 Dust Emissions during Construction

The air quality assessment results for the construction of the proposed mine are presented in this section. The predicted air emissions are a conservative assessment due to following assumptions:

- Use of lower wind speeds (from the TAPM generated meteorological file) than measured at Wudinna. Higher dust concentrations near the proposed mine are predicted to occur when the wind speeds are low to medium due to decreased dust dispersion.
- Modelling emissions sources concurrently (i.e. all sources generating dust at the same time).
- Modelling based on design material movement rates. Actual material movement and hence dust emissions, could be less, but not more, than these rates.
- Exclusion of rainfall effects from the model which uses a worst case meteorological scenario.

During construction, activities would be adjusted based on forecasting of unfavourable climatic conditions and real-time dust monitoring to manage air emissions within air quality criteria levels. The predicted air emissions for adjusted operations during the Construction phase are presented for the 24 hour average PM_{10} and $PM_{2.5}$ concentrations. The modelling included adjusted operations for approximately 1340 hours, which is equivalent to 15.3% of the year, to achieve compliance with the PM_{10} and $PM_{2.5}$ air quality criteria.

In practice, the need for adjusted operations will be assessed as part of a real-time air quality monitoring programme and will involve active management of dust emissions through implementation of a hierarchy of controls e.g. eliminate, avoid, mitigate and manage.

This form of management is standard practice and well established across the mining industry, in particular where mines are operated in close proximity to residents or other industries, such as agriculture. Standard mitigation activities that are available to operators utilising real-time monitoring and predictive weather systems are aligned with the dust generating activities listed in Table 15-10. For example, where large volumes of earth are required to be moved, the first step is to eliminate the need wherever possible in having to move the earth. This is achieved by efficient mine planning and infrastructure layout to minimise volumes and distances for the earth to be transported. The next step is to use the least dust generating equipment to move the earth. The extensive use of in-pit crushing and conveying has achieved this for the operation phases but it is not feasible during the construction phase, thus truck and bulldozer use cannot be avoided. To reduce the generation of dust, the activity is first mitigated by the training of operators e.g. low drop heights, staying on watered roads and requesting additional water.

Other forms of daily management can be employed as appropriate and include reducing dust generating activities during periods of unfavourable wind conditions or in areas near the mine lease boundary or delaying the activities to a period following the unfavourable conditions. Conversely, scheduling potentially dust generating activities during and post rain events, or in locations central to the proposed mining lease at large distances from sensitive receivers is an effective way to minimise potential impacts.

This approach, combining forecasts and real-time monitoring and dynamic management, is recognised as a best practice environmental management system. For example, NSW government environmental compliance and performance audits undertaken for the NSW coal industry focussed on dust management at coal mines to assist environmental performance (Department of Environment, Climate Change and Water (DECCW), 2010).

A summary of the predicted ground-level concentrations and dust deposition for the proposed mine at the nearest sensitive receivers is provided in Table 15-11. The ground-level concentrations are illustrated in Figure 15-4 to Figure 15-8. Refer to Figure 15-1 for the locations of the sensitive receivers.

Table 15-11 Dust Results for Sensitive Receptors: Construction Scenario

Sensitive Receptor ID	PM_{10} 24 hr avg. (ug/m^3)*	$PM_{2.5}$ 24 hr avg. (ug/m^3)*	$PM_{2.5}$ 24 Annual avg. (ug/m^3)*	TSP Annual avg. (ug/m^3)	Dust Deposition (g/m^2/month)
Project air quality standard (max)	**50**	**25**	**8**	**90**	**4**
Warramboo	42.9	14.5	7.2	31.5	2.0
7	33.0	12.9	7.2	31.2	2.0
48	43.1	14.1	7.4	33.4	2.1
92	38.8	14.0	7.4	33.5	2.1
93	43.1	13.3	7.4	35.2	2.2
95	35.4	13.8	7.2	30.9	2.0
96	49.4	17.8	7.3	31.3	2.0
97	41.2	15.6	7.4	32.5	2.1
98	43.5	14.8	7.3	32.5	2.1
99	41.2	15.6	7.3	32.0	2.1
100	38.4	14.4	7.2	31.2	2.0
101	47.7	16.5	7.3	32.3	2.1
140	32.2	12.4	7.2	31.2	2.0
141	28.8	11.6	7.1	30.9	2.0
142	41.1	14.2	7.3	32.9	2.0
143	34.7	13.1	7.2	30.9	2.0
144	29.9	11.8	7.1	30.6	2.0
146	29.1	11.8	7.1	30.6	2.0
147	43.6	15.2	7.3	32.1	2.0
148	35.3	13.2	7.3	32.1	2.0
151	29.6	11.8	7.1	30.5	2.0
152	31.3	12.1	7.1	30.6	2.0
153	28.1	11.7	7.1	30.4	2.0
154	33.8	13.5	7.2	30.8	2.0
155	27.9	11.7	7.1	30.4	2.0
156	33.4	12.9	7.2	30.9	2.0
157	42.5	16.5	7.2	30.8	2.0
158	26.5	11.4	7.1	30.3	2.0
165	33.9	12.8	7.2	31.2	2.0
166	30.1	11.8	7.1	30.7	2.0

Note:

- The sensitive receiver IDs are not sequential due to development and correction of the database over time.
- The same sensitive receiver IDs are used for the same sites throughout the Mining Proposal.
- * The results represent adjusted operations, in which mining operations are suspended during unfavourable climatic conditions.

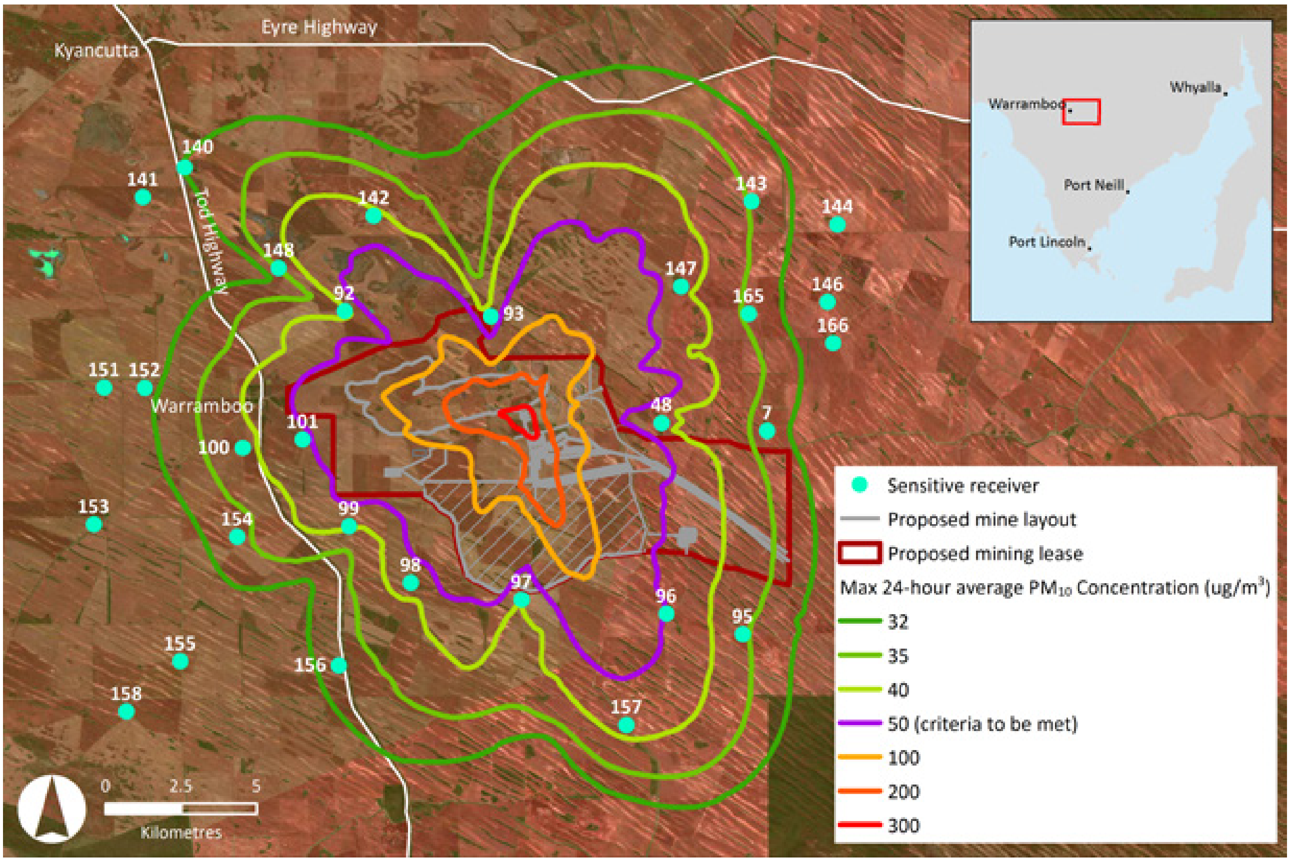


Figure 15-4 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Construction Scenario

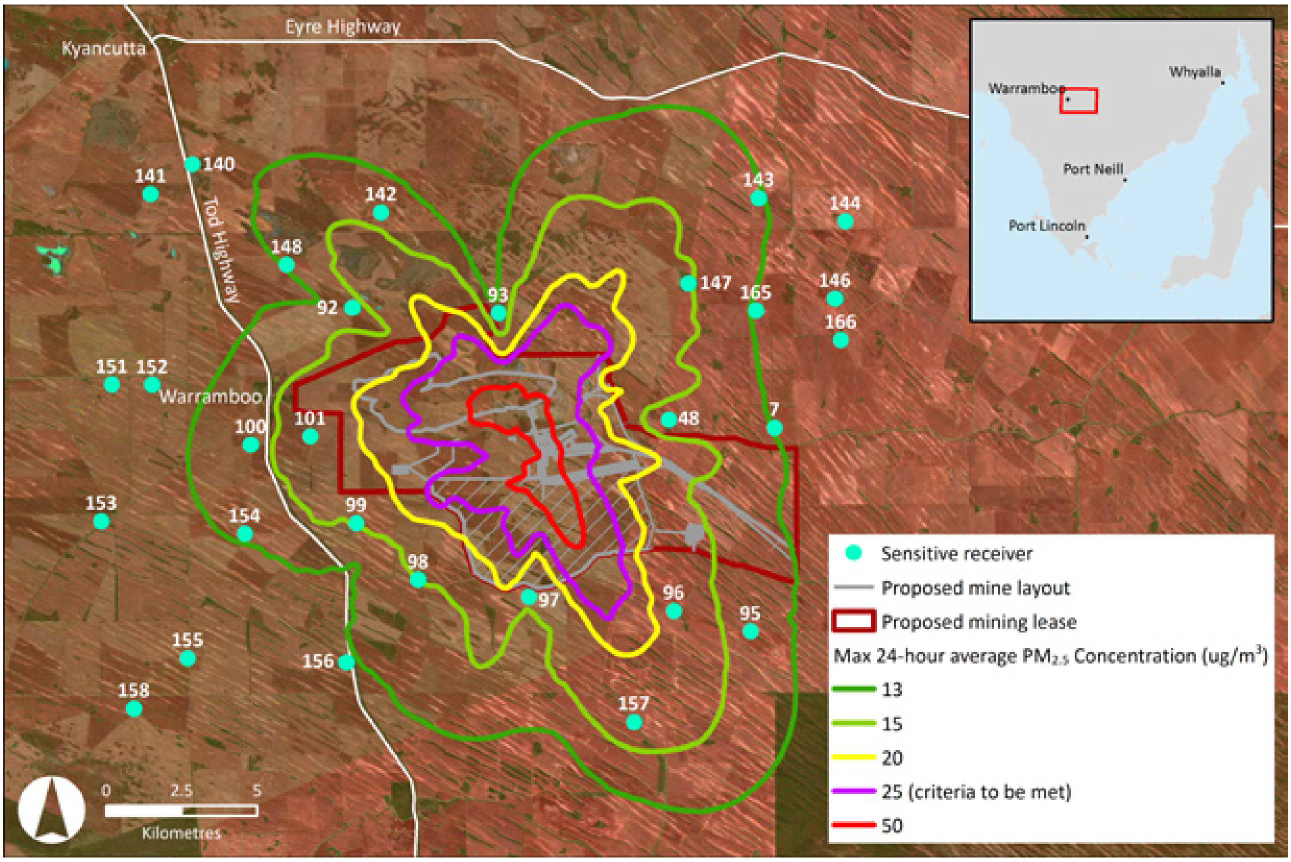


Figure 15-5 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations – Construction Scenario

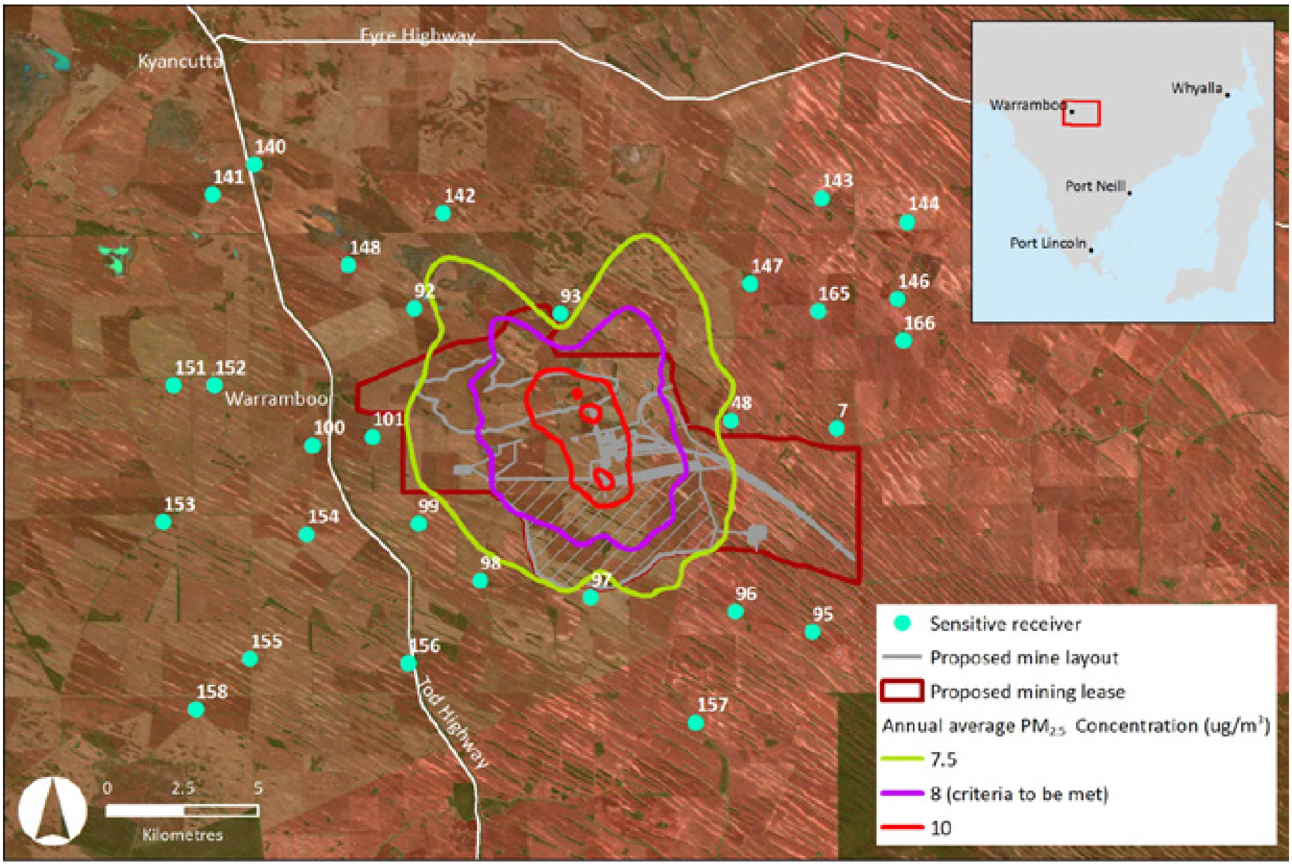


Figure 15-6 Predicted Annual Average $PM_{2.5}$ Concentrations – Construction Scenario

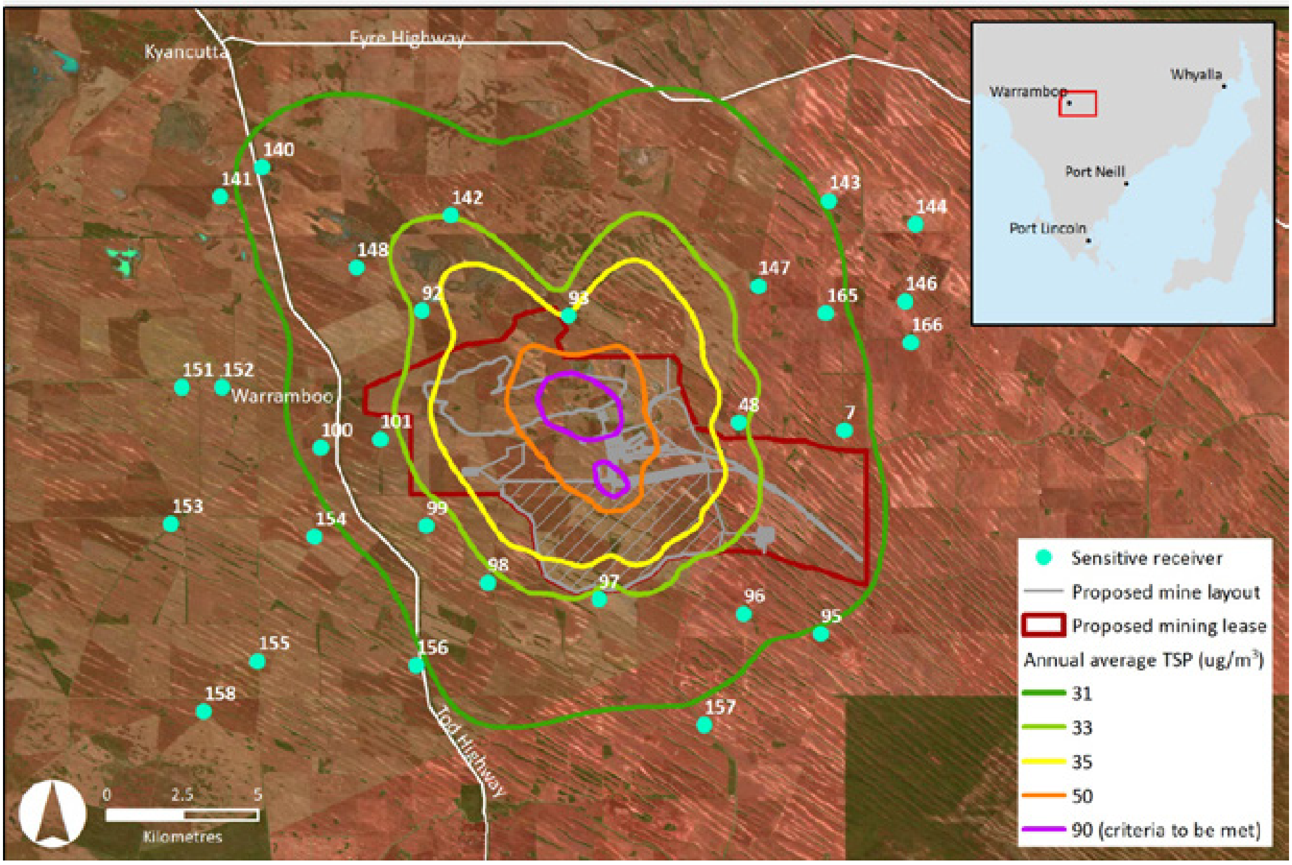


Figure 15-7 Predicted Annual Average TSP Concentration – Construction Scenario

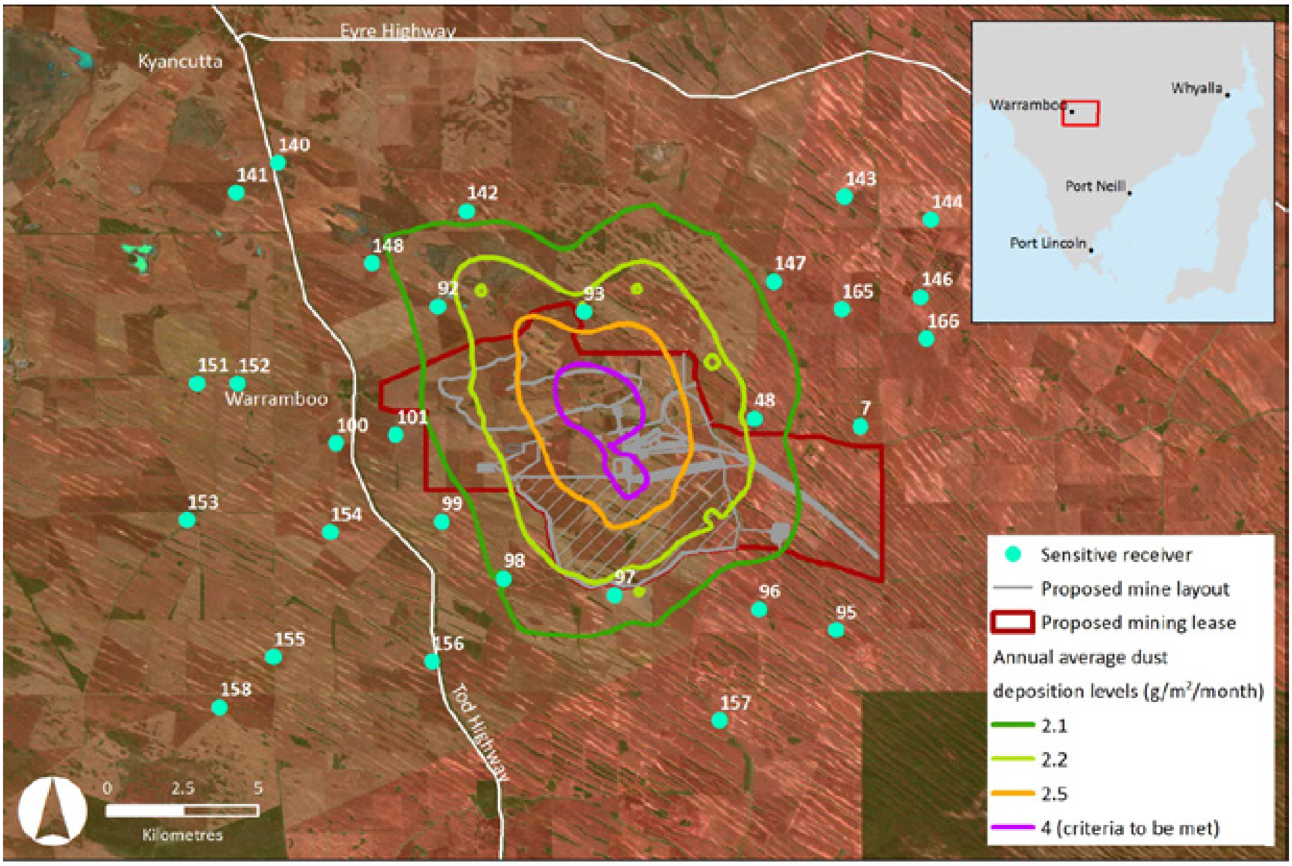


Figure 15-8 Predicted Annual Average Dust Deposition Levels ($g/m^2/month$) – Construction Scenario

Health Impacts to Sensitive Receivers from Dust Generated during Construction Phase

The modelling of dust emissions during construction predicts compliance with all relevant air quality criteria for particulate matter ($PM_{2.5}$ and PM_{10}) at sensitive receiver locations surrounding the proposed mine site. Operational modification using real-time dust monitoring is required to achieve compliance. Based on these model predictions, the impact of these emissions at sensitive receivers is considered to be **low**.

There is a risk that higher than predicted dust (particulate matter) emissions could occur if unfavourable (exceptionally dry or windy) weather conditions are experienced, if background levels are higher than anticipated or if the predicted effectiveness of dust control is not achieved. Real-time dust monitoring in conjunction with monitoring of weather forecast information, will enable planned modification or suspension of activities to limit impacts associated with excessive dust generation.

The health effects of greater than predicted dust generation during construction are expected to be **minor** as a result of a localised and short-term exceedance of air quality standards. As modelling has already identified the need for operational modification using real-time dust monitoring to achieve compliance with PM_{10} and $PM_{2.5}$ criteria, it is considered **possible** that higher than predicted dust emissions could occur leading to exceedances of air quality standards related to health.

The risk of health impacts due to greater than predicted emissions during construction is therefore considered to be **low**.

Amenity Impacts to Sensitive Receivers due to Dust Generated during Construction Phase

The modelling of dust emissions during construction predicts compliance with all relevant air quality criteria for deposited dust (TSP and dust deposition) at sensitive receiver locations surrounding the proposed mine site. The model results incorporate dust control measures, including the application of water for dust suppression. During construction, this water will be sourced from advanced mine pit dewatering. A water balance has been undertaken to confirm sufficient water will be available for dust control.

Therefore, the amenity impact of these emissions at sensitive receivers is considered to be **low**. No simulated shut-downs of activities were needed to achieve this result.

There is a risk that higher than predicted dust deposition could occur if unfavourable (exceptionally dry or windy) weather conditions are experienced, if background levels are higher than anticipated or if the predicted effectiveness of dust control is not achieved. Real-time dust monitoring in conjunction with monitoring of weather forecast information, will enable planned modification or suspension of activities to limit impacts associated with unplanned dust generation. It is also acknowledged that while no exceedances of the TSP and air quality criteria are predicted, these standards represent annual averages and there is a risk that short-term (24 hour) nuisance dust impacts could occur. On this basis, a **minor** consequence rating has been assigned reflecting a localised and short-term exceedance of air quality standards. A likelihood of **likely** has been assigned reflecting the potential for short-term nuisance dust events to occur and the need to demonstrate the effectiveness of operational responses in practice.

The risk of amenity impacts during construction is therefore considered to be **medium**.

15.7.3 Dust Emissions during Operation

This section presents the air quality assessment results for the operation of the proposed mine site. The predicted air emissions are conservative as a result of the following assumptions:

- Use of lower wind speeds (from TAPM generated meteorological file) than measured at Wudinna. Higher dust concentrations near the proposed mine are predicted to occur when the wind speeds are low to medium due to decreased dust dispersion.
- Modelling of all emissions sources concurrently (i.e. all sources generating dust at the same time which is unlikely in practice).
- Modelling based on design material movement rates. Actual material movement and hence dust emissions, could be less, but not more, than these rates.
- Exclusion of rainfall effects from the model which uses a worst case air emissions scenario.

A summary of the predicted ground level concentrations and dust deposition for the proposed mine during peak operation at the nearest sensitive receivers is provided in Table 15-12. The ground level concentrations are illustrated in Figure 15-9 to Figure 15-13. Refer to the Figure 15-1 for the locations of the sensitive receivers.

Table 15-12 Dust Results for Sensitive Receptors: Peak Operation Scenario

Sensitive Receptor ID	PM_{10} 24 hr avg. (ug/m^3)	$PM_{2.5}$ 24 hr avg. (ug/m^3)	$PM_{2.5}$ 24 Annual avg. (ug/m^3)	TSP Annual avg. (ug/m^3)	Dust Deposition ($g/m^2/month$)
Project air quality standard (max)	**50**	**25**	**8**	**90**	**4**
Warramboo	32.8	14.2	7.4	31.1	2.0
7	31.0	14.0	7.3	30.9	2.0
48	46.1	21.2	7.7	32.7	2.1
92	42.7	19.5	7.8	32.7	2.1
93	35.2	15.7	7.8	33.1	2.1
95	28.2	12.8	7.2	30.5	2.0
96	33.1	14.6	7.3	30.8	2.0
97	41.4	17.4	7.5	32.1	2.1
98	28.8	12.6	7.2	30.8	2.0
99	35.6	15.0	7.4	31.3	2.1
100	29.1	12.7	7.2	30.7	2.0
101	38.5	16.3	7.5	31.4	2.0
140	29.8	13.2	7.3	30.8	2.0
141	28.5	12.7	7.3	30.8	2.0
142	30.4	14.0	7.5	31.6	2.0
143	29.8	12.9	7.2	30.5	2.0
144	27.5	12.1	7.1	30.4	2.0
146	26.7	12.4	7.2	30.4	2.0
147	34.3	14.5	7.3	31.1	2.0
148	37.5	16.3	7.5	31.6	2.0
151	26.2	11.6	7.1	30.4	2.0
152	26.8	12.0	7.2	30.5	2.0
153	25.7	11.4	7.1	30.3	2.0
154	27.6	12.3	7.2	30.4	2.0
155	25.8	11.6	7.1	30.2	2.0
156	26.5	11.7	7.2	30.5	2.0
157	26.5	11.9	7.1	30.4	2.0
158	25.1	11.3	7.1	30.2	2.0
165	29.8	13.5	7.2	30.8	2.0
166	27.4	12.5	7.2	30.5	2.0

Note:

- The sensitive receiver IDs are not sequential due to development and correction of the database over time.
- The same sensitive receiver IDs are used for the same sites throughout the MLP.

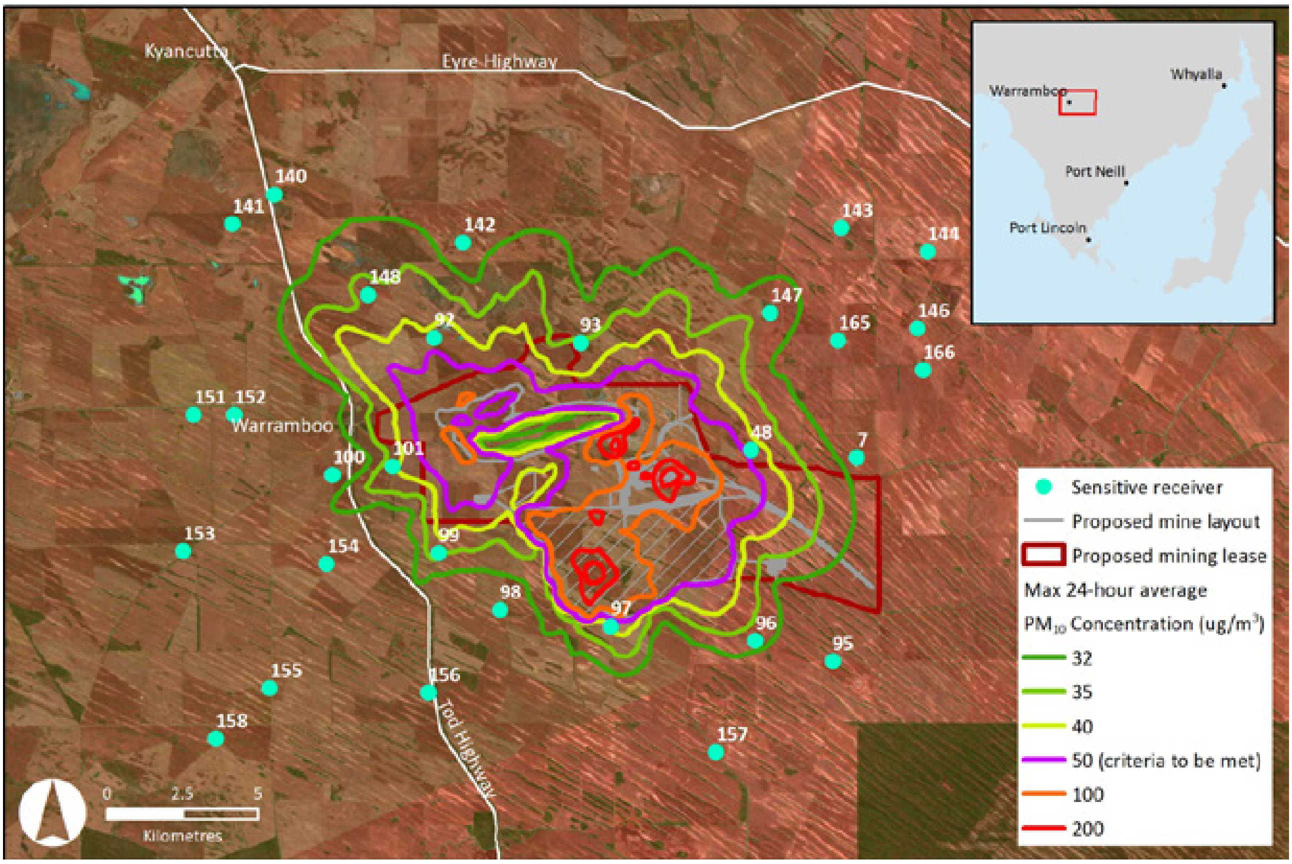


Figure 15-9 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Peak Operation Scenario

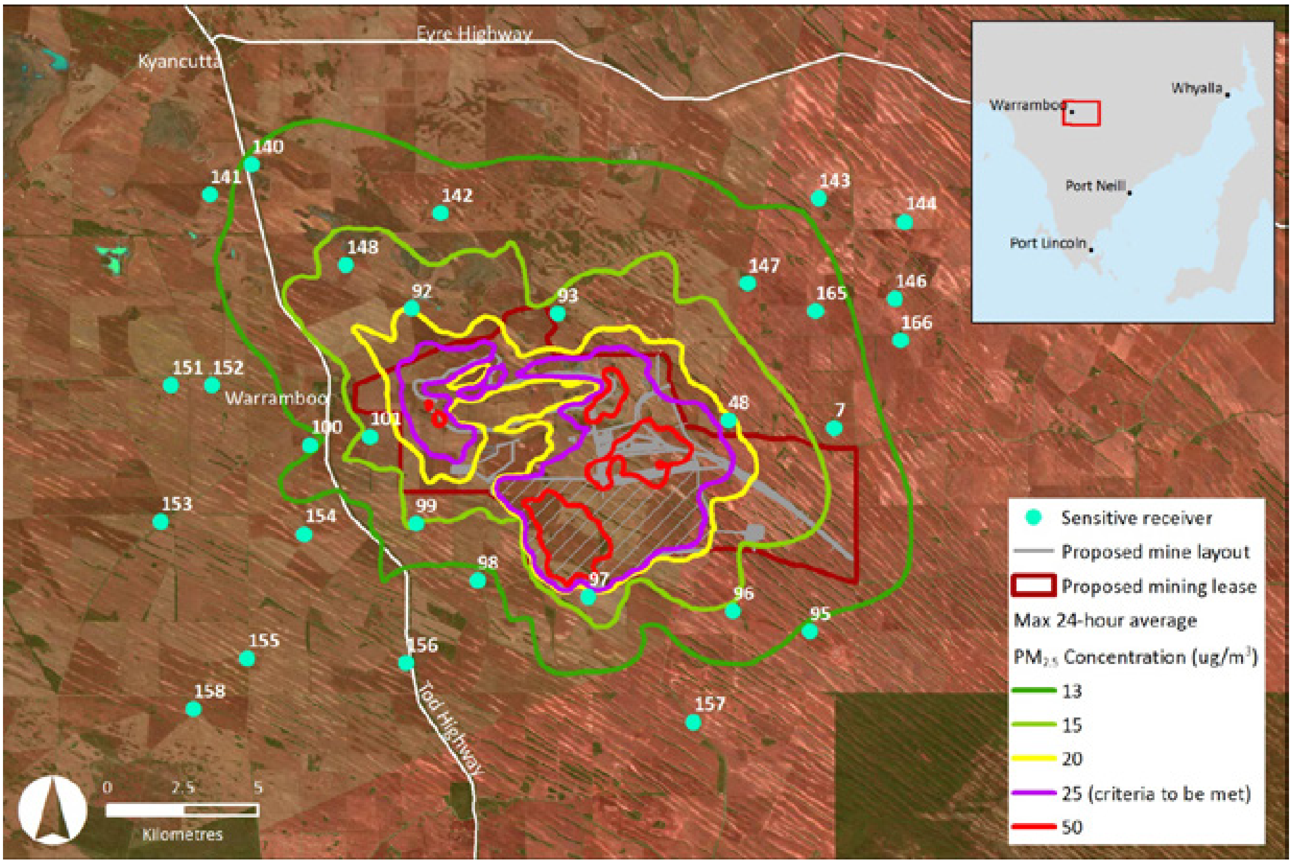


Figure 15-10 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations – Peak Operation Scenario

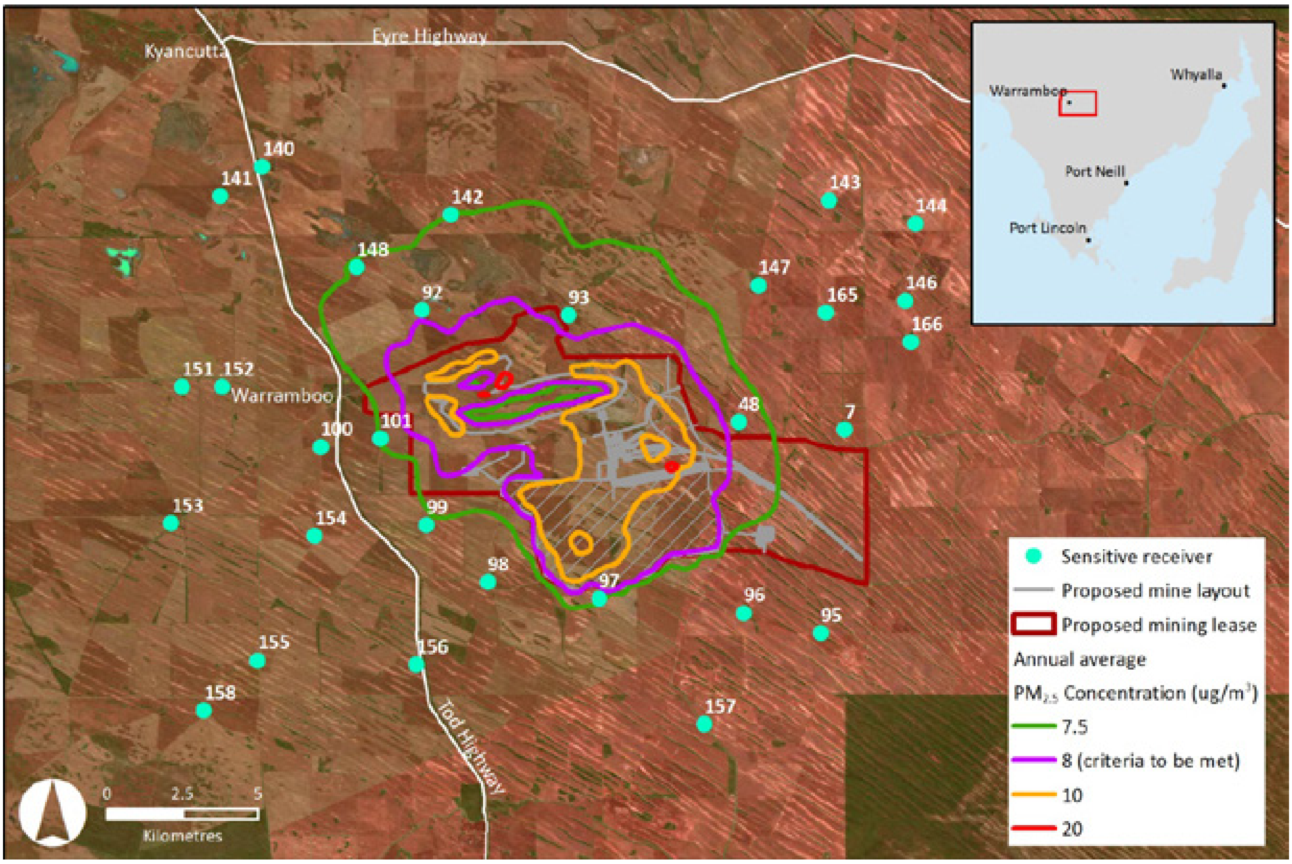


Figure 15-11 Predicted Annual Average $PM_{2.5}$ Concentrations – Peak Operation Scenario

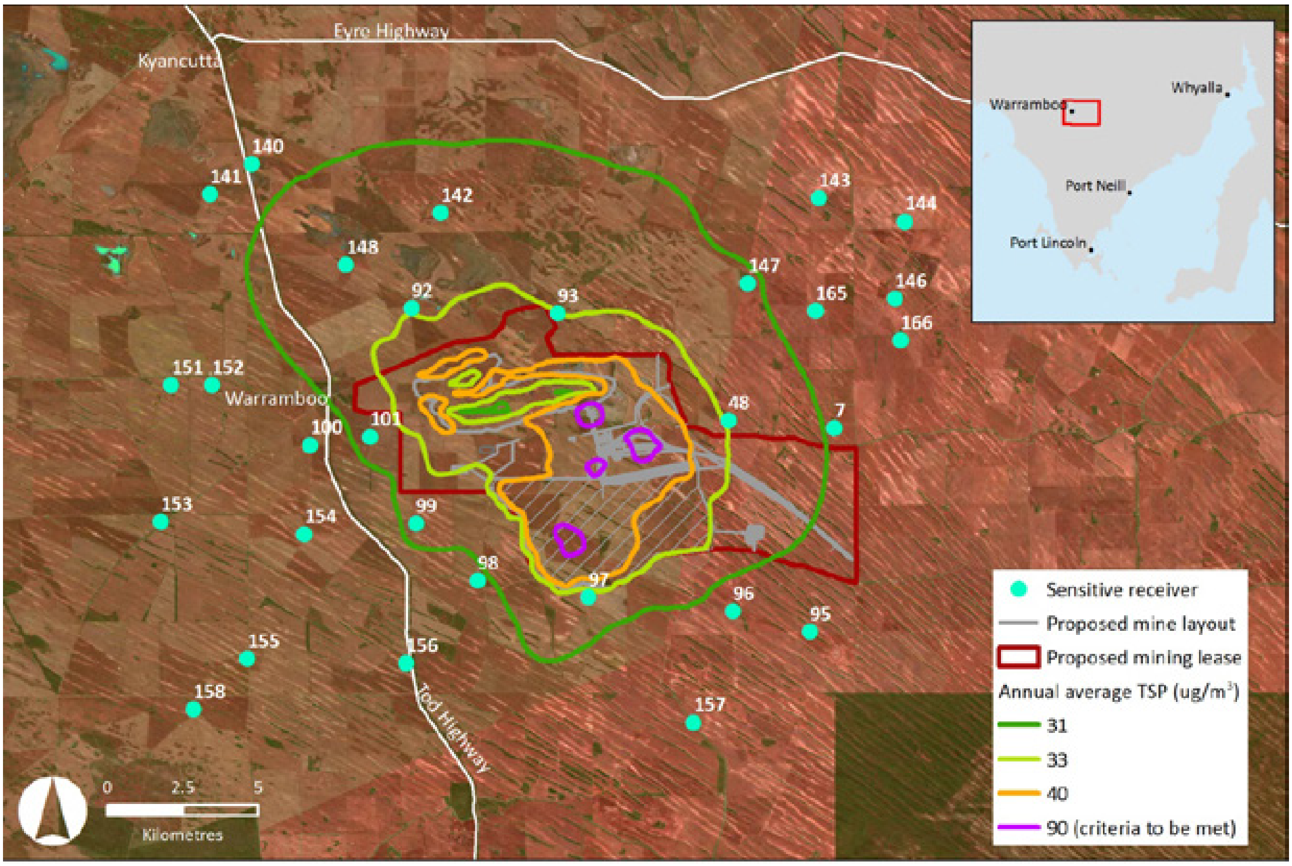


Figure 15-12 Predicted Annual Average TSP Concentration – Peak Operation Scenario

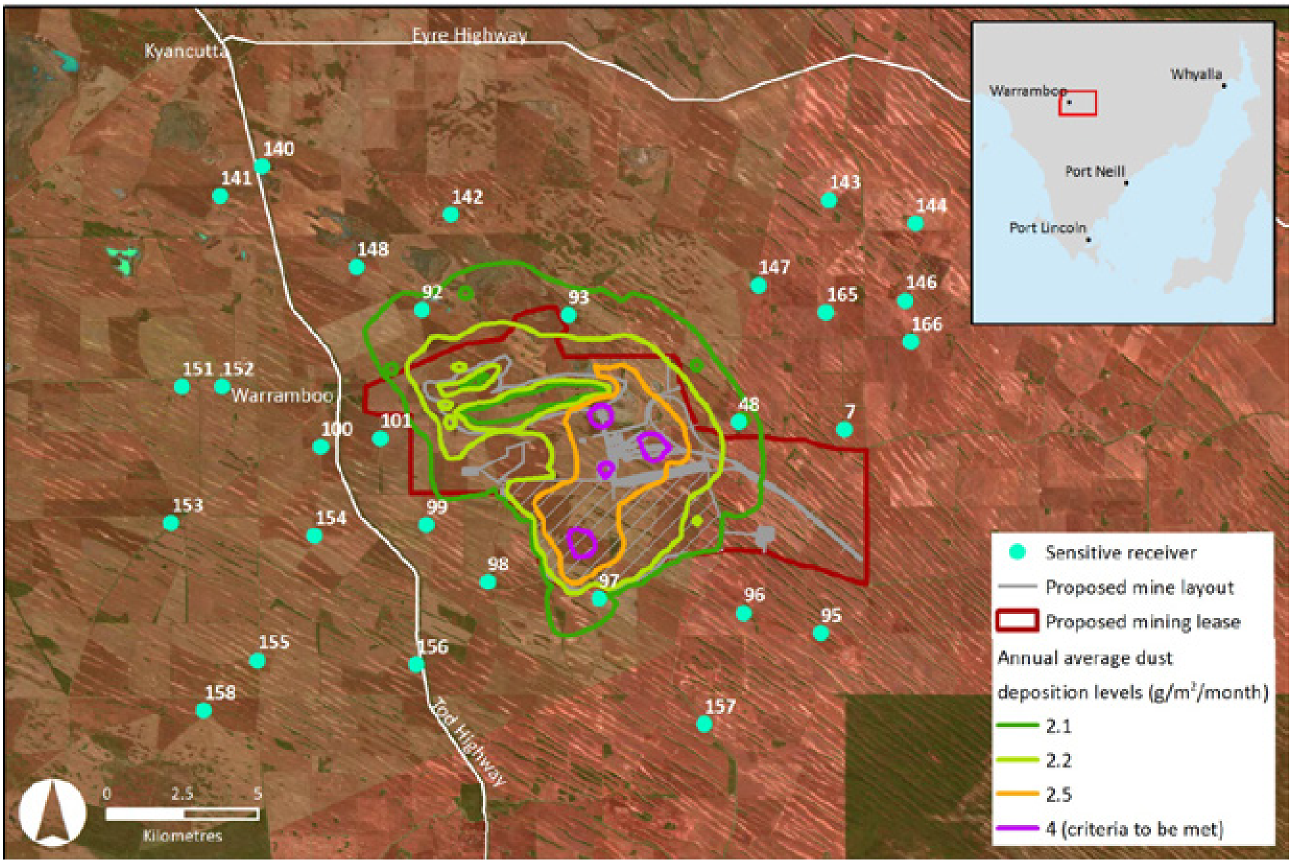


Figure 15-13 Predicted Annual Average Dust Deposition Levels (g/m^2/month) – Peak Operation Scenario

Health Impacts to Sensitive Receivers due to Dust Generated during Operations

The modelling of dust emissions during peak operations predicts compliance with all relevant air quality criteria for particulate matter ($PM_{2.5}$ and PM_{10}) at sensitive receiver locations surrounding the proposed mine site. Based on these model predictions, the impact of these emissions at sensitive receivers is considered to be **low**. No simulated shut-downs of activities were needed to achieve this result.

There is a risk that higher than predicted dust (particulate matter) emissions could occur if unfavourable (exceptionally dry or windy) weather conditions are experienced, if background levels are higher than anticipated or if the predicted effectiveness of dust control is not achieved. Real-time dust monitoring in conjunction with monitoring of weather forecast information, will enable planned modification or suspension of activities to limit impacts associated with excessive dust generation.

The health effects of greater than predicted dust generation during operations are expected to be **minor** reflecting a localised and short-term exceedance of air quality standards. Modelling has demonstrated that PM_{10} and $PM_{2.5}$ criteria are expected to be achieved for normal operating conditions; however, predictions show that a relatively small increase in predicted emissions is required to cause exceedances at sensitive receivers to the south and east of the proposed mine site. Therefore, it is considered **possible** that higher than predicted dust emissions could occur leading to exceedances of air quality standards related to health. The risk of health impacts due to greater than predicted emissions during operations is therefore considered to be **low**.

Amenity Impacts to Sensitive Receivers due to Dust Generated During Operations

The modelling of dust emissions during peak operations predicts compliance with all relevant air quality criteria for deposited dust (TSP and dust deposition) at sensitive receiver locations surrounding the proposed mining lease. The impact of these emissions at sensitive receivers is considered to be **low**. No simulated shut-downs of activities were needed to achieve this result.

There is a risk that higher than predicted dust deposition could occur if unfavourable (exceptionally dry or windy) weather conditions are experienced, if background levels are higher than anticipated or if the predicted effectiveness of dust control is not achieved. Real-time dust monitoring in conjunction with monitoring of weather forecast information, will enable planned modification or suspension of activities to limit impacts associated with unplanned dust generation. It is also acknowledged that while no exceedances of the TSP and air quality criteria are predicted, these standards represent annual averages and there is a risk that short-term nuisance dust impacts could occur. On this basis, a **minor** consequence rating has been assigned reflecting a localised and short-term exceedance of air quality standards. A likelihood of **likely** has been assigned reflecting the potential for short-term nuisance dust events to occur and the need to demonstrate the effectiveness of operational responses in practice.

The risk of amenity impacts during operation is therefore considered to be **medium**.

15.7.4 Dust Emissions following Closure

As noted in Section 15.7.1, progressive rehabilitation will be undertaken where practical throughout the life of the mine, particularly the integrated waste landform to minimise exposed surfaces and the potential or wind-generated dust. Following closure, final rehabilitation will occur to stabilise potential emissions sources such as the areas used for ore processing and other removed infrastructure. The health, amenity and nuisance impact of dust emissions at sensitive receivers following closure is considered to be **low**. There is a risk that dust generation from exposed surfaces could occur post mining if rehabilitation is not adequate, resulting in health, amenity and/or nuisance impacts to sensitive receivers. Impacts of greater than anticipated dust generation following closure are expected to be **minor** as a result of localised and short-term exceedance of air quality standards. Revegetation trials will be undertaken on the integrated waste landform once established, to inform detailed closure and rehabilitation planning. Alternative dust suppression methods will also be trialled if required. Therefore, it is considered **possible** that the air quality criteria will be exceeded due to inadequate rehabilitation, due to reliance on the success of rehabilitation trials, even though there will be more than 20 years of operating experience prior to this time.

The risk of impacts to sensitive receivers from dust emissions following closure is therefore considered to be **low**.

15.7.5 Nitrogen Oxide Emissions from Blasting

This section presents the air quality assessment results relating to NO_2 emissions from the proposed mine. The assessment was completed for the peak mining operational scenario, as NO_2 emissions are expected to be highest during this phase.

A summary of the maximum predicted ground level concentrations of NO_2 for the proposed mine at the nearest sensitive receivers is provided in Table 15-13. The ground level concentrations are illustrated in Figure 15-14.

Table 15-13 Results for Maximum NO_2 at Sensitive Receptors (peak)

Sensitive Receptor ID	NO_2 1-hr Average (ug/m^3)
Project air quality standard (max)	158
Warramboo	79.0
7	82.6
48	87.4
92	67.7
93	58.6
95	60.5
96	62.8
97	76.5
98	57.9
99	75.0
100	62.5
101	86.2
140	72.4
141	72.6
142	64.6
143	38.1
144	42.9
146	70.0
147	60.9
148	86.6
151	54.8
152	58.0
153	69.3
154	71.4
155	68.8
156	67.8
157	57.8
158	42.3
165	68.9
166	69.8

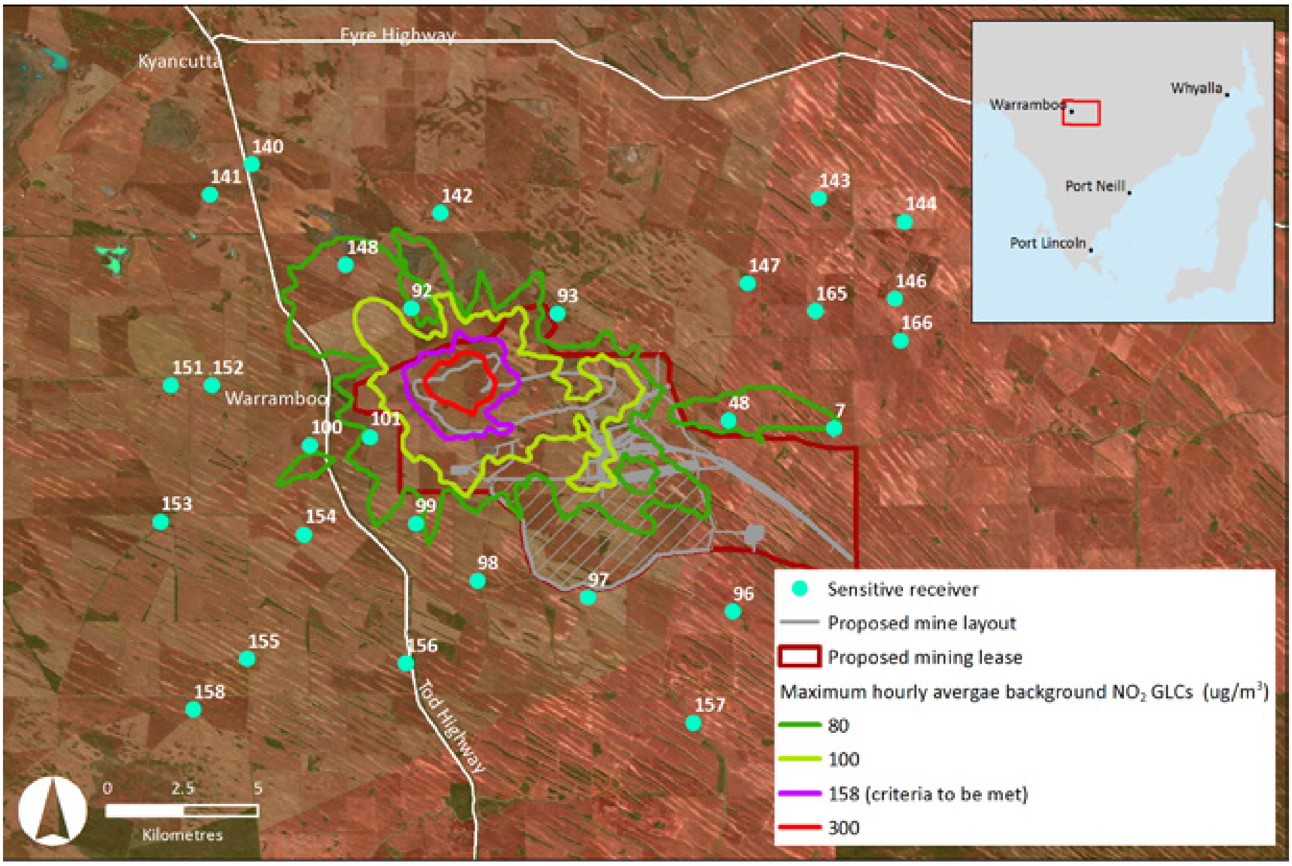


Figure 15-14 Predicted Maximum Hourly Average Background NO_2 Ground-Level Concentrations

Nitrogen Oxide Emissions from Blasting Adversely Affect Human Health

The modelling of maximum hourly average background NO_2 ground-level concentrations during peak operations predicts compliance with the relevant air quality criterion at sensitive receiver locations surrounding the proposed mine site. Therefore, the impact of these emissions at sensitive receivers is considered to be **low**. No simulated shut-downs of activities were needed to achieve this result.

There is a risk that although the air dispersion model predicts compliance with the NO_2 criterion at all sensitive receivers, there is potential for actual emissions to exceed predicted levels associated with model assumptions, unexpected weather conditions or actual operational requirements. It is predicted that NO_2 levels will be less than 100 ug/m^3 at all sensitive receiver locations, well below the adopted standard of 158 ug/m^3. Given that a relatively substantial increase in gaseous emissions is needed for exceedance of the standard, the credible worst-case consequence of greater than predicted gaseous emissions is expected to be **minor**, reflecting a localised and short-term exceedance of air quality standards.

The impact assessment for gaseous emissions is based on a single modelling scenario, which represents a worst-case scenario and is based on conservative modelling assumptions. On this basis, it is considered **unlikely** that the consequence of exceeding the predicted impact will occur.

The risk of health impacts due to greater than predicted gaseous emissions is therefore considered to be **low**.

15.7.6 Impacts on Agricultural Values

Impacts to Agricultural Values (Reduced Yields) due to Dust Generated from Proposed Mine

The use of land for cropping will be maintained on undisturbed areas of the proposed mine site for as long as reasonably possible and land adjoining the proposed mine site will also continue to be subject to cropping and other agricultural activities.

The proposed mine will operate differently from existing operations in the region with key differences including:

- The use of in-pit crushing and conveying will result in substantially reduced emissions compared to a truck and shovel fleet.
- A high level of dust suppression is expected to be achieved through water application. Project planning has included identification of a suitable water source for this purpose.
- A dust management plan will be implemented, incorporating real-time monitoring of dust emissions and weather forecast information to enable early identification of potential dust issues and adaptive management strategies.

A review of available literature assessing the potential impacts of dust emissions on the surrounding agricultural industry (Jacobs 2014) identified that the rate of dust deposition expected from the proposed mine is significantly less (approximately 3 times less than or 2.5 g/m^2/month at the proposed mine lease boundary) than presented in many existing studies, most of which focussed on impacts immediately adjacent to unsealed roads or in the immediate vicinity of dust-generating activities. As an example, Doley (2006) and Doley and Rossato (2010) indicate that plant species (that are considered likely to be more susceptible to the impacts of dust due to their broad leaf habit) show impacts at levels of greater than approximately 7 g/m^2/month.

Chemical analysis of the orebody (Table 13-3) shows low levels of heavy metals and that the ore is chemically unreactive, therefore any dust effects on crops due to the proposed mining operations will most likely be limited to minor leaf shading, increased leaf temperature and blocking of stomata (pores in the leaf surface) by particles (Jacobs 2014). It is also noted that the crop growing season coincides with the highest likelihood of regional rain which is considered likely to wash dust of growing crop leaves. With model predictions showing only a small increment in dust deposition above the existing background level outside the mine site boundary (Appendix K), the cumulative effect of leaf shading, increased leaf temperature and blocking of stomata is expected to be insignificant. As such, the impact of dust deposition on crop yields has been assessed as **low**.

However, there is a risk that greater impact than predicted may eventuate if:

- Crops are more sensitive to dust deposition that anticipated
- Dust deposition outside the mine site boundary is higher than predicted

From the literature review, the variety of dust types, plant physiologies and other environmental effects creates some uncertainty of the level at which dust deposition impacts yields for specific crop types. It should also be noted that land is successfully cropped in close proximity to existing dirt roads, salt scalds/lakes and the coast, indicating a relatively high tolerance of cereal crops to dust and salt, though this has not been quantified.

However, the rate of dust deposition expected from the proposed mine is considerably less than many of the studies reviewed and the physiology of wheat is considered comparable or less susceptible to dust impacts than many of those studied and so reference to these studies is considered conservative.

Model predictions show only a small increment in dust deposition above the existing background level outside the mine site boundary. Higher than predicted dust deposition could occur if unfavourable (exceptionally dry or windy) weather conditions are experienced, if background levels are higher than anticipated or if the predicted effectiveness of dust control is not achieved. Real-time dust monitoring in conjunction with weather forecast information, will enable planned modification or suspension of activities to limit impacts associated with dust generation.

Therefore, the credible worst-case consequence of greater than predicted dust deposition is expected to be **minor**, reflecting a localised and short-term reduction in crop yields. In the absence of a quantitative assessment of dust impacts on crops, a likelihood of **possible** has been assigned.

A higher than anticipated level of impact to crop yields due to mine-related dust is therefore considered a **low** risk.

Due to the importance of this issue to the community and Iron Road, significant research is being investigated in partnership with others. A nation-wide and industry-accepted crop yield monitoring program (YieldProphet™) is currently being considered in partnership with SARDI and would be included in the PEPR should this program be found to be supported by the surrounding landowners and offer advantages over incident-based methods. In addition to this program, Iron Road is considering a partnership with the Minnipa Agricultural Centre for a research project that determines the locally grown wheat species tolerance to dust and saline aerosols, despite air quality concentration predictions being below potential problem levels.

Both programs will be detailed in the PEPR should the CEIP be granted government and Iron Road Board approvals.

Impacts to Agricultural Values (Reduced Yields or Contamination) due to Deposition of Saline Aerosols and Salts from Proposed Mine, including Post-Mining

In addition to dust impacts directly on crops, some members of the local community have highlighted increasing salt loads as a potential impact on soil quality and consequently crop production. As saline water will be used within the mine site for dust suppression and ore processing purposes, there is potential for salt accumulation on areas where dust-suppression water is being applied. A few members of the local community have expressed particular concern about the potential accumulation of salt in the integrated waste landform and the potential for the integrated waste landform to become a significant source of airborne salts.

If the accumulation of salts does occur on the integrated waste landform or on areas where dust suppression is active, the mobilisation of salts would be limited through the routine dust management procedures and continued suppression of TSP, PM_{10} and $PM_{2.5}$. Furthermore, fresh water will be used for the suppression of dust during the collection of topsoil and sub-soils for the construction of the 'cap' of the integrated waste landform to facilitate rapid revegetation and eliminate this as a salt/dust source.

A program was established in 2013 to monitor and characterise the existing (pre-mining) levels of airborne dust in the area surrounding the proposed mining lease (Appendix K). Background salt deposition was found to be 1.2 g/m^2/month. A conservative estimate for salt deposition from mining sources was calculated to be 0.04 g/m2/month based on predicted dust deposition rates and emissions from sources with potentially elevated salt contents. Figure 15-15 shows the contribution of salt in mine dust to salt storage in the soil as calculated in Appendix K. The contribution of salt deposition from mining sources is calculated to add 3 per cent to existing background salt deposition rates. Over the 25 year operational life of the mine, salt deposition derived from mining operations is small when compared to the existing salt store in surrounding soils and the background deposition rates.

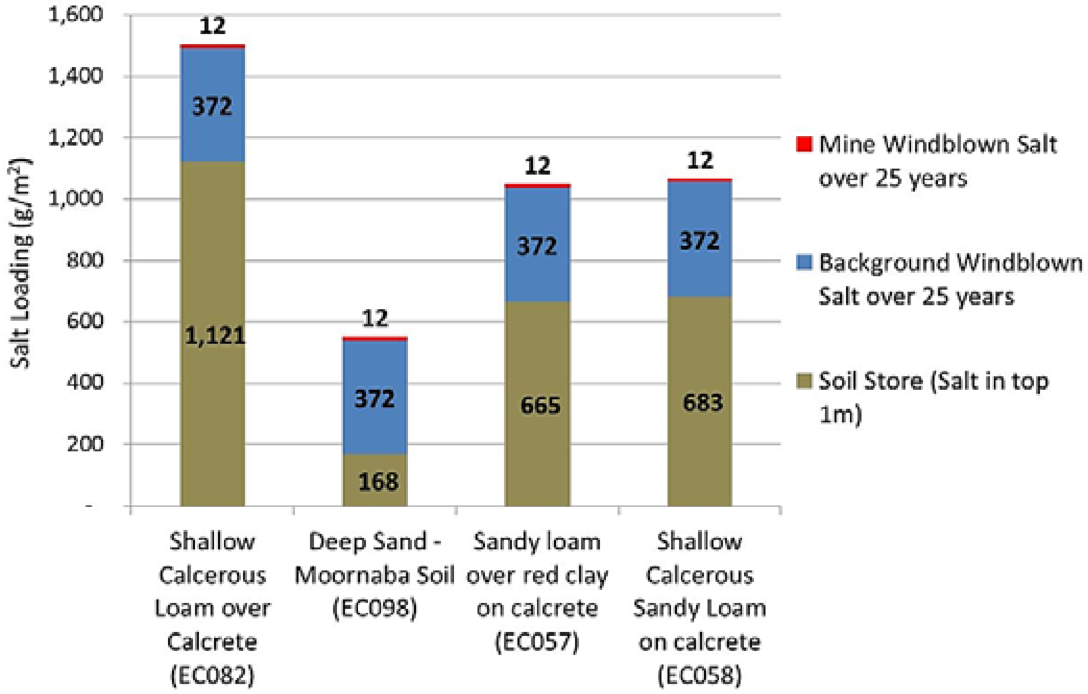


Figure 15-15 Summary of Estimated Salt Store Contribution Over 25 Year Mine Life

The impact to surrounding crops and land from the use of saline water within the proposed mine site boundary during construction and operations is considered **low**.

Post-mining, any salt-affected areas of the mine site, including the integrated waste landform, will be rehabilitated and stabilised. As such, the impact to surrounding crops and land from accumulated salts within the proposed mine site becoming airborne and depositing off site post-mining is considered **low**.

Although impacts to agricultural values from salt deposition are expected to be avoided through effective dust control during construction and operations and successful stabilisation and rehabilitation post-mining, there is a risk that impacts could occur if these control measures fail.

As previously identified, real-time dust monitoring in conjunction with weather forecast information, will enable planned modification or suspension of activities to limit impacts associated with excessive dust generation. It is anticipated that monitoring will continue on site post-mining until control of emissions from the rehabilitated landform is demonstrated.

The credible worst-case consequence of greater than predicted salt deposition off site is expected to be **minor**, reflecting a localised and short-term reduction in crop yields. In the absence of a quantitative assessment of salt impacts on crops, a likelihood of **possible** has been assigned. A higher than anticipated level of impact to crop yields due to transfer of accumulated salt is considered a **low** risk.

As identified above, lead indicators will be established prior to construction to provide confidence to adjoining landowners that predicted dust deposition levels will not affect crops. A nation-wide and industry accepted crop yield monitoring program (YieldProphet™) is currently being considered in partnership with SARDI and would be included in the PEPR should this program be found to be supported by the surrounding landowners and offer advantages over incident-based methods.

15.7.7 Impacts on Native Vegetation

Potential impacts and risks to the ecological values (native vegetation and habitat) surrounding the proposed mine due to dust deposition have been addressed in Chapter 11 Fauna and Pest Species and Chapter 12 Vegetation and Weeds.

15.7.8 Summary of Impacts and Risks

With the implementation of design and management measures, all residual negative impacts have been categorised as low. Similarly, all risks have been reduced to a level of medium or lower. The impacts and risks were considered to be ALARP and not warrant further specific control measures other than the environmental management controls and measures outlined here. A summary of each of the identified impacts and risks associated with air emissions from the proposed mine site are presented in Table 15-14.

Table 15-14 Impact and Risk Summary: Air Quality

Impact ID	Impact Event	Level of Impact[1]	Level of Risk[2]
IM_15_11	Health impacts to sensitive receivers from dust generated during the Construction phase.	Low	Low
IM_15_01	Amenity impacts to sensitive receivers due to dust generated during the Construction phase.	Low	Medium
IM_15_12	Health impacts to sensitive receivers due to dust generated during operations.	Low	Low
IM_15_02 IM_15_14	Amenity impacts to sensitive receivers due to dust generated during operations.	Low	Medium
IM_15_13	Health impacts to sensitive receivers from dust generated post closure.	Low	Low
IM_15_03 IM_15_15	Amenity impacts to sensitive receivers due to dust generated post closure.	Low	Low
IM_15_16	Nitrogen oxide emissions from blasting adversely affect human health.	Low	Low
IM_15_04 IM_15_05 IM_15_06 IM_15_07 IM_15_08	Impacts to agricultural values (reduced yields) due to dust generated from the proposed mine.	Low	Low
IM_15_09 IM_15_10	Dust from minesite impacting native vegetation	Low	Low

[1] Impact events are expected to occur as part of the project. Level of impact is assessed post control strategies, as per the impact assessment methodology provided in Chapter 6.

[2] Level of risk reflects the risk that the assessment of impact is incorrect due to uncertainties in the assessment method, the control strategies, or in assumptions used. Risk is assessed post control strategies, as per the risk assessment methodology provided in Chapter 6.

15.7.9 Justification and Acceptance of Residual Impact and Risk

With the implementation of design and operational management measures, all impacts associated with air quality are considered to be **low**. Similarly, all risks have been reduced to a level of **low**, with the exception of risk to amenity from short-term dust events, which was assigned a **medium** risk rating.

The **medium** risk rating is due to the assigned consequence rating of **minor** and likelihood rating of **likely**. The **minor** consequence rating reflects a localised and short-term nuisance impact. The **likely** likelihood rating reflects the potential for short-term (24 hour) nuisance impacts due to exceptional dust events and the strong reliance on operational controls.

The impacts and risks are considered to be ALARP.

15.8 Proposed Outcome(s)

In accordance with the methodology presented in Chapter 6, outcomes have been developed for all impact events with a confirmed linkage between source, pathway and receptor. Each outcome is supported by measureable assessment criteria that will be used to assess compliance against the proposed outcomes during the relevant phases (Construction, Operation, Closure and Post Closure) of the mine. Whilst outcomes may be the same for multiple impact events, separate measurement criteria and leading indicators are proposed to demonstrate compliance. Proposed outcomes and measurement criteria have been developed for each of the impact events identified with a confirmed linkage and these are presented in Table 15-15. Outcomes for the entire project are presented along with all impact events in Appendix C.

The detailed monitoring program will be provided in the PEPR to support the below Outcome Measurement Criteria and Leading Indicator Criteria. There is a commitment to undertake continuous meteorological monitoring at the Warramboo site with telemetry capable equipment linked to a real-time reporting system that will be available on a public internet site.

Table 15-15 Outcomes and Assessment Criteria: Air Quality

Proposed Outcome	Impact ID	Impact Event	Draft Outcome Measurement Criteria (all concentrations include background)	Draft Leading Indicator Criteria (all concentrations include background)
No public health impacts from dust generated by construction, mining, closure or post closure activities.	IM_15_11 IM_15_12 IM_15_13 IM_15_16	Health impacts to sensitive receivers from small (inhalable) airborne dust particles and nitrogen dioxide gas generated during construction, operations and closure.	Compliance with the Ambient Air Quality NEPM 24 hour average PM_{10} concentration of 50 g/m^3. Compliance with the EPA Design Ground-Level Concentration (DGLC) for nitrogen dioxide (NO_2) i.e. maximum hourly average NO_2 DGLC 158 ug/m^3.	A Trigger Action Response Plan (TARP) to be implemented which will include continuous PM_{10} (multiple sites) monitoring. Compliance with the Ambient Air Quality NEPM $PM_{2.5}$ advisory reporting standards of 25 ug/m^3 (24 hour average) and 8 ug/m^3 (annual average). Should the revised NEPM include $PM_{2.5}$ standards then these would be adopted as new Outcome Measurement Criteria.
No public nuisance impacts from dust generated by construction, mining or closure or post closure activities.	IM_15_01 IM_15_02 IM_15_03 IM_15_14 IM_15_15	Amenity impacts to sensitive receivers due to dust generated during the construction, operations and closure.	Long term - compliance with the EPA adopted criteria for annual average dust deposition to exceed 4 g/m^2/month and no more than 2 g/m^2/month above background. Short term – all dust complaints acknowledged and recorded immediately and closed out within 14 days to the satisfaction of the complainant or as agreed with the Director of Mines.	A Trigger Action Response Plan (TARP) to be implemented which will include continuous PM_{10} (multiple sites) and TSP (Warramboo) monitoring to mitigate any short term amenity/nuisance potential impacts.
No loss of productivity on properties surrounding the mine site from dust generated by construction, mining, closure or post closure activities, without independent verification and timely compensation.	IM_15_04 IM_15_05 IM_15_06 IM_15_07 IM_15_08	Impacts to agricultural values (reduced yields or livestock impacts) due to dust deposition of dust and/or saline aerosols during the construction, operations and closure.	Average annual dust deposition not to exceed 4 g/m^2/month and no more than 2 g/m^2/month above background. As per the Mining Act, compensation is duly paid to any loss (confirmed by an independent expert) of productivity of agricultural yields as a result of dust and/or saline aerosols from construction, operations and closure activities.	A TARP to be implemented which will include monthly dust deposition from mining activities. Should a crop productivity monitoring program, such as YieldProphet^{TM} or the like, be supported by surrounding landowners, then crop yields on properties within the proposed mine site are comparable with control sites during construction, operation and closure of the mine, measured annually.

Proposed Outcome	Impact ID	Impact Event	Draft Outcome Measurement Criteria (all concentrations include background)	Draft Leading Indicator Criteria (all concentrations include background)
No loss of abundance or diversity of native vegetation on or off the lease during construction, operation and post mine completion through; • clearance, • dust/contaminant deposition, • fire, • reduction in water supply • salinisation, or • other damage, unless prior approval under the relevant legislation is obtained.	IM_15_09 IM_15_10	Impacts to degraded native vegetation adjacent to the proposed mining lease due to deposition of dust generated by construction, operations and closure.	Average annual dust deposition not to exceed 4 g/m^2/month and no more than 2 g/m^2/month above background.	A TARP to be implemented which will include monthly dust deposition from mining activities. Regular visual inspection by an experienced ecologist.

15.9 Findings and Conclusion

The proposed mine will introduce new air emission sources as a result of excavation, materials handling and processing activities. A low level of impact to the health and amenity of sensitive receivers is expected based on predicted air emissions for construction and operational scenarios. However, during construction it is anticipated that operational modification using real-time dust monitoring will be required to achieve compliance with air quality standards.

Risks to air quality receptors will be alleviated wherever possible through the implementation of control and management strategies. The risk of identified impact events being higher than predicted in the impact assessment is considered **medium** (to **low**) for all identified actual impact events.

Outcomes proposed ensure that Iron Road will manage air quality effects to a level which is as low as reasonably practicable.