APPENDIX K

COMBINED BACKGROUND AIR QUALITY AND AIR QUALITY IMPACT ASSESSMENT

Central Eyre Iron Project

Iron Road Limited

Background Air Quality Monitoring

Revision | 1

13 October 2015

Central Eyre Iron Project

Project no:	Project Number
Document title:	Background Air Quality Monitoring
Revision:	1
Date:	13 October 2015
Client name:	Iron Road Limited
Project manager:	Nicholas Bull
Author:	Greg Simes

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 6, 30 Flinders Street
Adelaide SA 5000 Australia
T +61 8 8113 5400
F +61 8 8113 5440
www.jacobs.com

Document history and status

Revision	Date	Description	By	Review	Approved
0	2/10/15	Final Format	CG	NB	NB
1	13/10/2015	Practice Review	Matt Pickett	MP	MP

Contents

1. Introduction

A program was established in 2013 to monitor and characterise the existing (pre-mining) levels of airborne dust in the area surrounding the Central Eyre Iron Project (CEIP) mining lease.

Early monitoring was focussed on nuisance dust and utilises equipment with low power requirements allowing for quick deployment to sites without the added complication of sourcing mains power. The monitoring program commenced in November 2013.

An expanded air monitoring program is anticipated to commence 12 months prior to the construction phase, and would build on the information gained since 2013.

Monitoring has been undertaken for dust deposition (including chemical analysis of the deposited material), total suspended particulates (TSP), PM10 particulates and meteorological parameters.

2. Reference Methods

2.1 Australian Standards

The location of the monitoring sites was selected in accordance with the Australian Standard ‘AS 3580.1.1:2007 Methods for sampling and analysis of ambient air, Guide to siting air monitoring equipment’.

The Australian Standard method for TSP is by high volume sampler, and provides for a 24 hour (24hr) average; however it requires attendance at site for filter exchange and cannot measure TSP continuously. For this study more detailed information was desired and the MetOne E-BAM particulate analyser was installed and operated continuously to generate 24hr average TSP data on an ongoing basis.

The installed TSP system, although non-compliant with the Australian Standards, is an attractive option for continuous monitoring at remote sites where power is not readily available or for short term monitoring campaigns. The analyser operates by the Beta Attenuation Method, which is consistent with the Australian Standard method for PM_{10} and $PM_{2.5}$ monitoring in ambient air, but in a compact, low power consumption configuration, and is equipped with an attached solar power system. The E-BAM monitor is also equipped with meteorological sensors for temperature, wind speed and wind direction.

In 2015, one of the E-BAM instruments was re-configured to measure PM10 particulates.

Dust deposition (or ‘dust fallout’) was monitored at three locations in accordance with the Australian Standard ‘AS/NZS 3580.10.1:2003 Methods for sampling and analysis of ambient air, Determination of particulate matter – deposited matter – gravimetric method’.

3. Methodology

3.1 Monitoring Sites

Three sites were selected based on the Australian Standard guidance and logistical considerations such as site access, security and proximity to the proposed mine site. A short description of the three sites is included in Table 3-1. A vertical image showing the monitoring sites in relation to the proposed mine and sensitive receptors is included in Figure 3-1.

Table 3-1 Description of Monitoring Sites

Location	Harry's	Traeger's	Crow's Nest
Distance from proposed mine site	Approximately 8km south-west	Within mine site boundaries	Approximately 15km north
Nearest residence	Adjacent to working farm residence	Adjacent to disused farm residence	80m West of mining camp, 200m North-east of core-shed
Nearest road	140m from <10000 vehicle per day bituminised highway	60m from low use dirt access track	360m from < 10000 vehicle per day dirt road
Ground Cover	natural groundcover	natural groundcover	natural groundcover

3.2 Dust Deposition by Gauge

Dust deposition gauges are used for the assessment of nuisance dust impacts from various activities. In addition dust deposition can be useful for the assessment of the potential contamination of rainwater supplies, accumulation of deposits on farmland or the dust fallout onto crops and the associated effects on crop yields.

Dust deposition samples were analysed monthly and provide a measurement in grams deposited per square meter per month (g/m^2/month). Dust deposition monitoring was conducted at each of the three monitoring sites.

Analysis of the monthly samples was performed to characterise the deposited material as soluble, insoluble, combustible or ash and additional analysis for metals and soluble salts commenced later in the monitoring campaign.

The analysis of the deposited matter from the dust deposition gauges is summarised in Table 3-2.

Table 3-2 Summary of Dust Deposition Monitoring

Analysis Type.	Sampling Period (End date of sample)	Analytical Technique
Total dust deposition mass	8th Nov 2013 – 11th Jun 2015*	Gravimetric
Mass of soluble solids, insoluble solids, combustible solids and ash	8th Nov 2013 – 11th Jun 2015*	Gravimetric
Metals analysis of insoluble solids.	11th Mar 2014 – 11th Jun 2015*	ICP-AES/MS and / or CV/AAS
Soluble solids chemical analysis	10th Mar 2015 – 11th Jun 2015*	Various including ICP, FAAS, IC, and Classical Chemistry Techniques.

* Sampling is ongoing

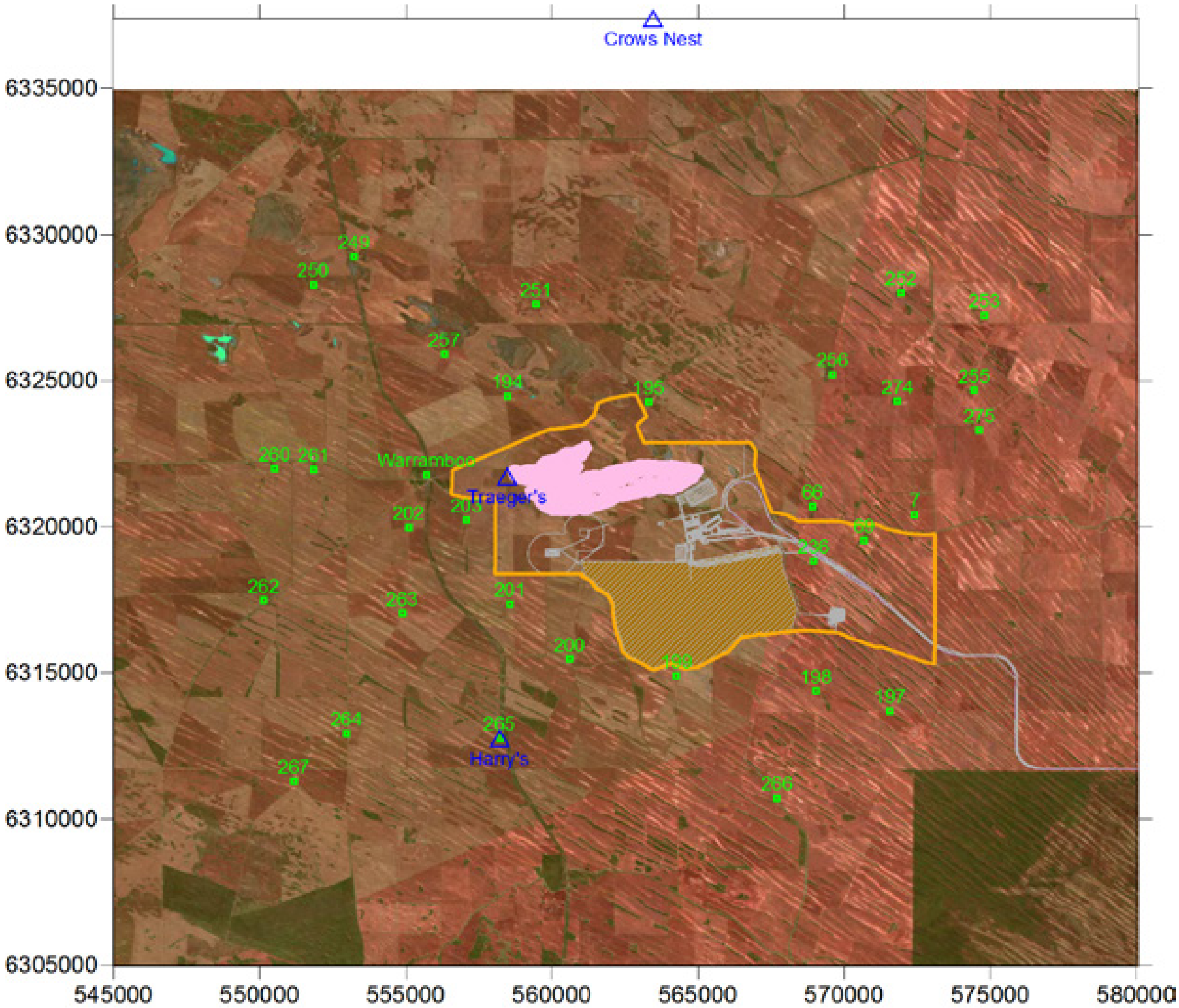


Figure 3-1 Monitoring Site Locations

3.3 Continuous TSP by Beta Attenuation Method (BAM)

The MetOne E-BAM continuous particulate analyser for total suspended particulates (TSP) was installed at Harry's and Traeger's in December 2013, and operated continuously to generate 24hr average TSP data. A summary of TSP measurements is included in Table 3-3.

Table 3-3 Summary of TSP measurements

Measurement method	Harry's	Traeger's
TSP by E-BAM	18th Dec 2013 – 18th Mar 2015	18th Dec 2013 – 6th Apr 2015

3.4 Continuous PM10 Monitoring

Monitoring for PM_{10} particulates has been conducted using two types of instruments and the monitoring period is summarised in Table 4. A period of overlap occurred prior to decommissioning of the DustTrak instruments which allowed for the instruments to be correlated.

Table 3-4 Summary of TSP measurements

Measurement method	Harry's	Traeger's
PM_{10} using DustTrak	16th Oct 2014 – 10th Mar 2015	16th Oct 2014 – 9th Apr 2015
PM10 by E-BAM	-	23rd Mar – 13th Jul 2015*

* Sampling is ongoing

4. Monitoring Results

This section discusses the results of the background air monitoring program.

4.1 Dust Deposition Results

Dust deposition results are summarised in Figure 4-1. The results are separated into soluble and insoluble solids, with the insoluble portion further classified into combustible matter and ash (material remaining after combustion).

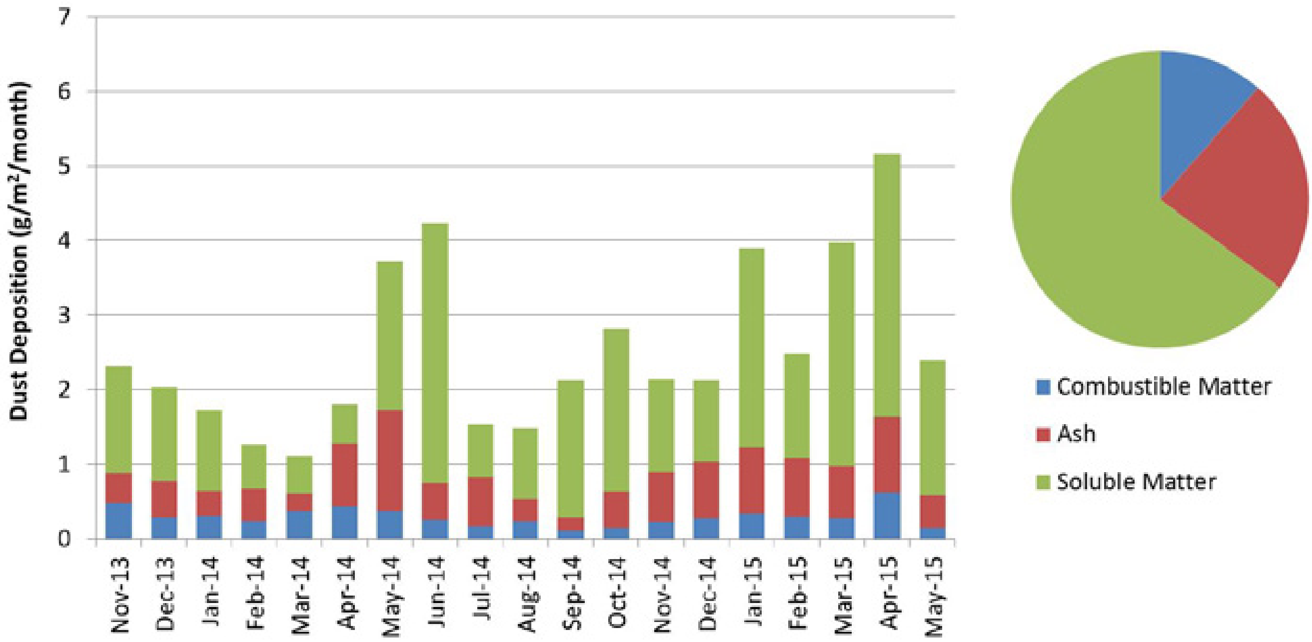


Figure 4-1 Summary of Monthly Dust Deposition

4.1.1 Insoluble Solid Results

Nuisance dust is assessed as the insoluble portion of deposited matter and guidelines are set at a maximum annual average of 4 g/m^2/month (DEC, 2005). The insoluble solids portions of deposited matter results are summarised in Figure 4-2 and the average insoluble dust concentration was 0.88 g/m^2/month. The average measured concentration is below the value of 2 g/m^2/month adopted for modelling study.

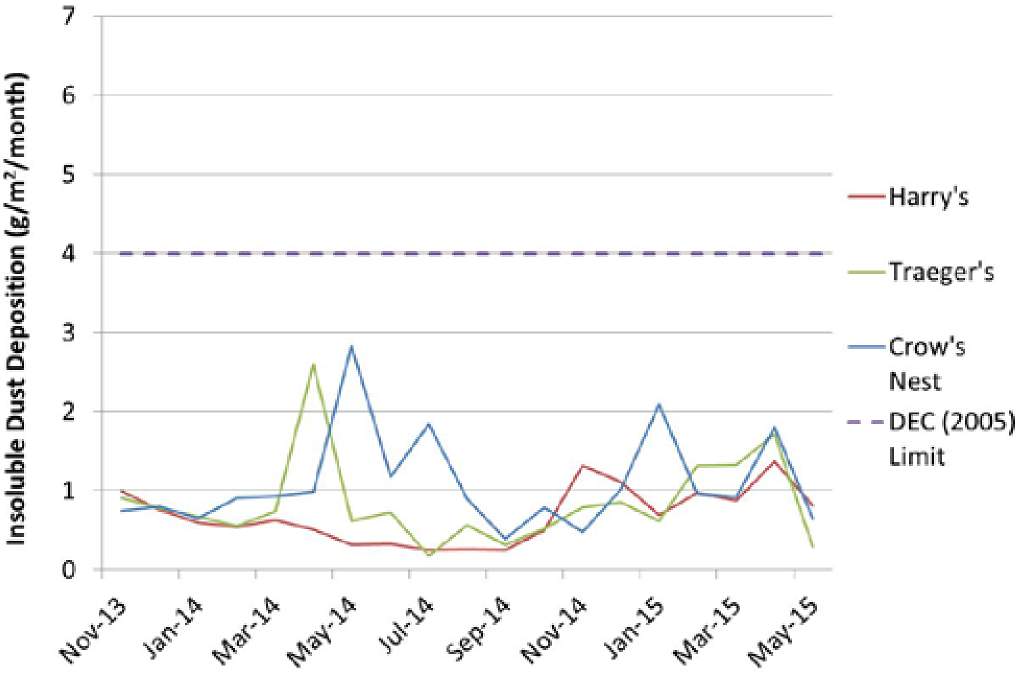


Figure 4-2 Summary of Deposited Insoluble Solids

The insoluble solids portion of the dust deposition was submitted for metals analysis. The results are summarised in Figure 4-3 and are similar to the elemental abundance in crustal matter.

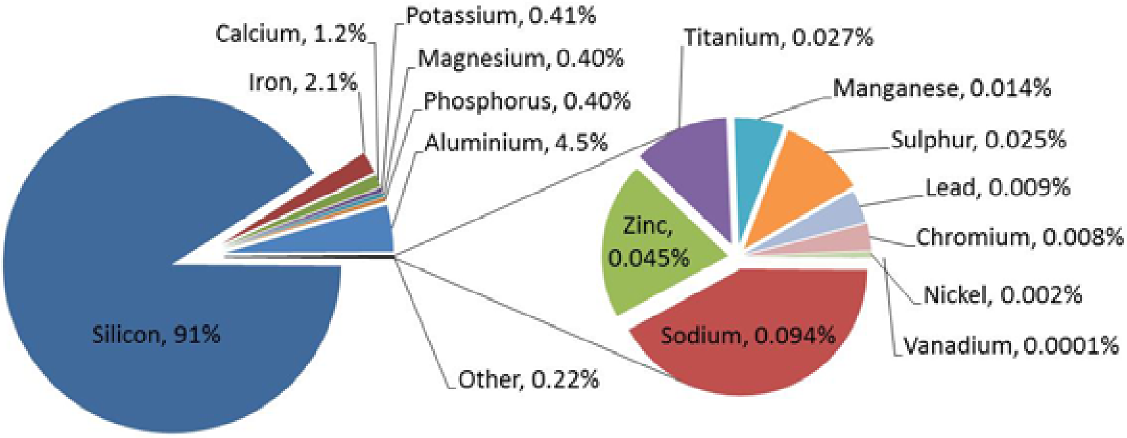


Figure 4-3 Metals Analysis of Insoluble Solids

4.1.2 Soluble Solid Results

There is no air quality standard for deposition of soluble solids; however analysis of this portion of dust deposition has been conducted in order to gain a better understanding of the nature of background salt deposition. Salt deposition has a potential impact on crop health. A summary of deposited soluble solids is shown in Figure 4-4, and the chemical composition of this material summarised in Figure 4-5.

A major component of deposited soluble material is NaCl, which is common table salt.

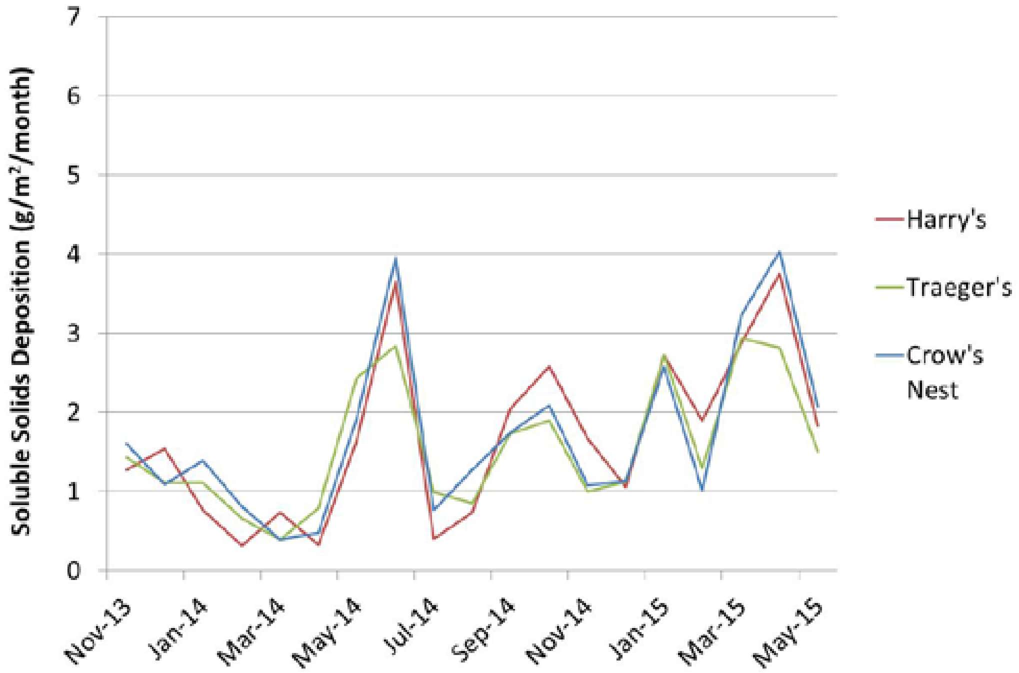


Figure 4-4 Summary of Deposited Soluble Solids

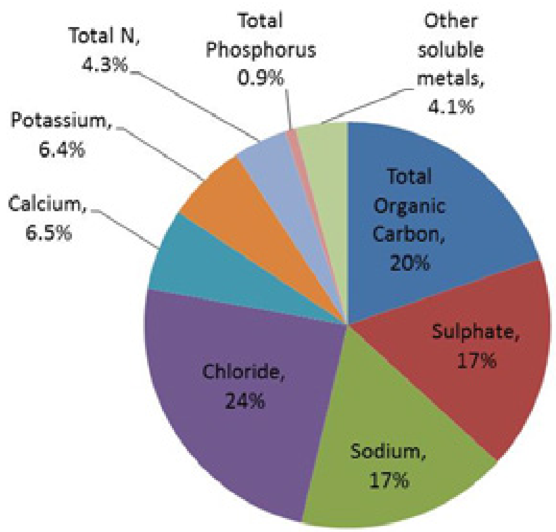


Figure 4-5 Chemical Composition of Deposited Soluble Solids

* Note: Insoluble solids analysis is for samples collected from Feb 2015 – June 2015.

4.2 TSP Monitoring Results

TSP monitoring was conducted continuously at two locations. The 24-hr average TSP results from Traeger's are shown in Figure 4-6.

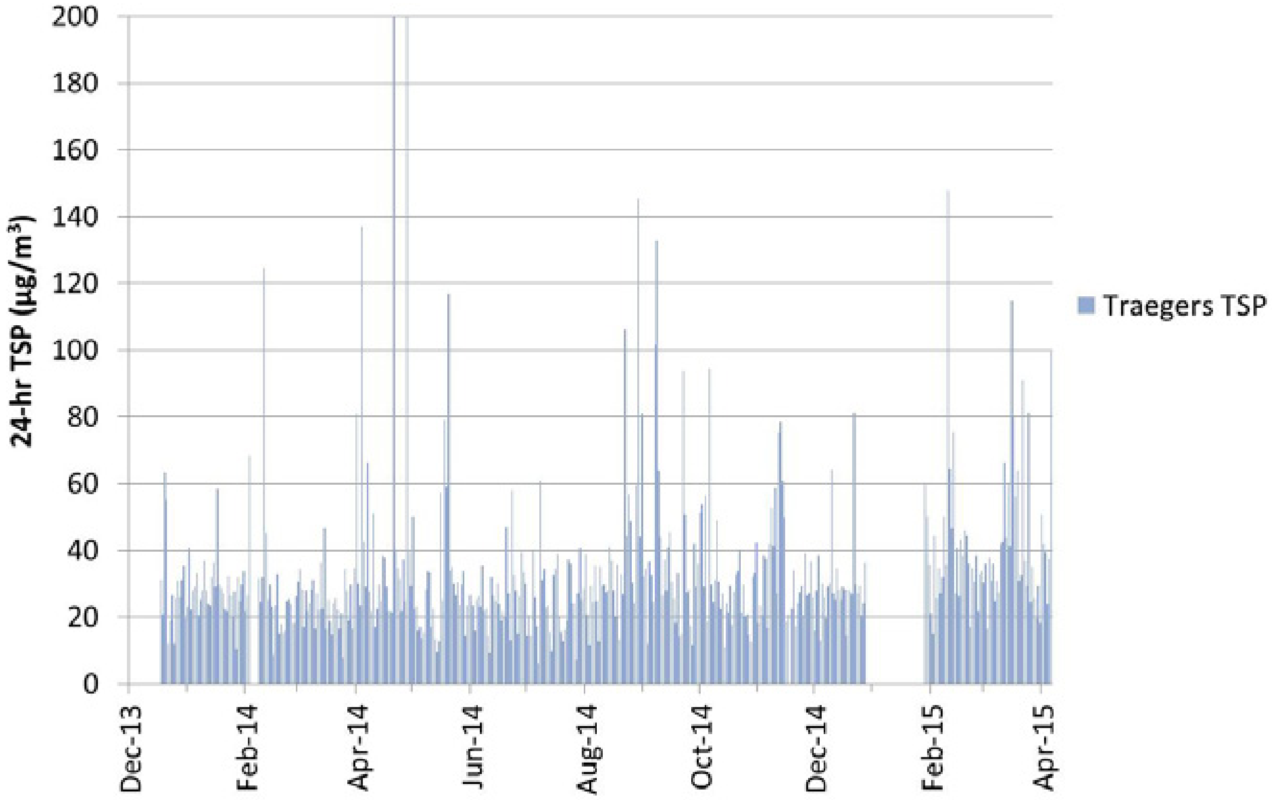


Figure 4-6 Summary of 24-hr TSP Results From Traeger's

During the monitoring program, there were two significant dust storm events, both occurring in April 2014. These two events contribute significantly to the annual average TSP. The average TSP concentration for all measurements between 18th Dec 2013 and 6th April 2015 was 37 µg/m^3, however when excluding the two dust storm days on 21st and 28th April 2014, the average concentration was 29.5 µg/m^3. This value (excluding two dust storm events) compares well with the value of 30 µg/m^3 adopted for the modelling study.

A nominal concentration of 120µg/m^3 was selected as a trigger level for further analysis and a summary of exceedances of this trigger level are included in Table 4-1.

When interpreting the observations in Table 4-1, it should be noted that on-site observations were only recorded once each month when dust deposition gauges were collected for analysis, and as such the information can only be used as a general indication of activity during the month leading up to the observation and cannot be inferred as representative of activities on any particular day.

Table 4-1 **Exceedances of Nominal 120µg/m^3** TSP 24-hr Trigger Level

Date	Harry's TSP (µg/m^3)	Harry's Wind Speed (m/sec)	Traeger's TSP (µg/m^3)	Traeger's Wind Speed (m/sec)	Observations at Time of Sample Collection
11 Feb 2014	No Data	No Data	124	2.4	Nil new activity – Harry's Nil new activity – Traeger's

Date	Harry's TSP (µg/m³)	Harry's Wind Speed (m/sec)	Traeger's TSP (µg/m³)	Traeger's Wind Speed (m/sec)	Observations at Time of Sample Collection
04 Apr 2014	No Data	No Data	137	2.0	Ripped far Nth and direct Sth – Harry's Ripped Nth and SE – Traeger's
21 Apr 2014	No Data	No Data	3061	5.0	High average wind speeds Seeding far Sth and far Nth – Harry's Ripping to Nth and NE – Traeger's
28 Apr 2014	493	4.1	2641	6.7	High average wind speeds Seeding far Sth and far Nth – Harry's Ripping to Nth and NE – Traeger's
29 Aug 2014	19	1.8	145	2.3	Nil new activity – Harry's Nil new activity – Traeger's
8 Sep 2014	114	4.4	131	5.5	High average wind speeds Nil new activity – Harry's Nil new activity – Traeger's
10 Feb 2015	25.7	2.1	149	2.2	Nil new activity – Harry's Nil new activity – Traeger's
11 Feb 2014	No Data	No Data	124	2.4	High average wind speeds Seeding far Sth and far Nth – Harry's Ripping to Nth and NE – Traeger's

4.3 PM 10 Monitoring Results

Monitoring results for PM10 particulates are summarised in Figure 4-7. Two instruments types have been used and data collection is currently ongoing with the E-BAM. There were two exceedance of the 50µg/m^3 24-hr NEPM standard (NEPC, 2003), one occurred on 2nd April 2015 (66 µg/m^3), and one on 8th June 2015 (55 µg/m^3). Both events experienced moderate wind speeds on that day, with 24-hr average speeds of 3.1 m/s and 2.2 m/s respectively.

The 70th percentile of PM_{10} measurements recorded between 15th Oct 2014 and 13th July 2015 is 23.9 µg/m^3. The 70th percentile statistic is used by SA EPA for calculating the background concentration for modelling purposes. The measured value compares well with the estimated background concentration of 22 µg/m^3 which was adopted for the modelling study.

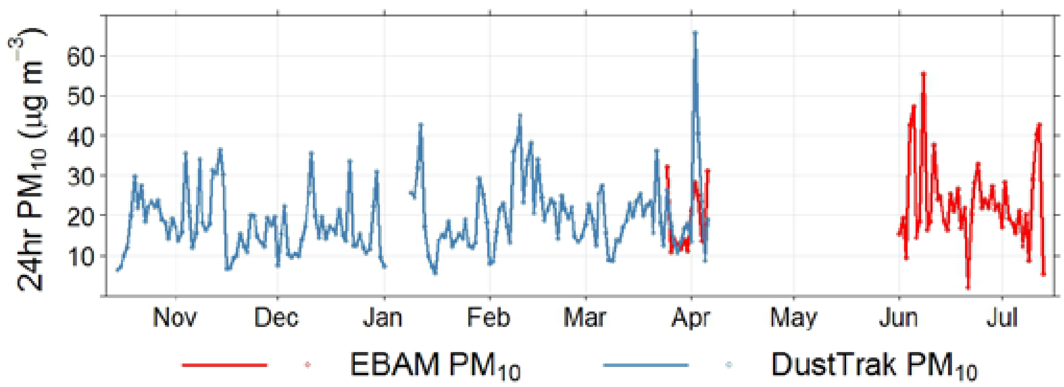


Figure 4-7 Summary of PM_{10} Monitoring Results at Traeger's

5. Calculation of Potential Salt Deposition

This section documents the calculation method used to estimate salt content of deposited dust and therefore the salt load distributed to surrounding properties as a result of mining activities.

The integrated waste landform (IWL) and wheel generated dust (WGD) have been identified as potential sources of salt due to saline water utilised for dust suppression on the IWL and haul roads. In addition unloading from trucks / conveyors onto the IWL is a significant source of TSP and this material will have a residual salt content from processing.

All referenced tables are extracted from Appendix F 'Air Quality Impact Assessment – Mine' report.

5.1 Proportion of Total TSP attributed to IWL and WGD.

Total TSP emission rates are summarised in Appendix F, Table 3-20, extracted below.

Table 3-20: Summary of dust particle emission scenarios

Scenario	Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)
Scenario No.1	Construction phase	115.9	36.1	8.0
Scenario No.2	Early mining phase	62.9	30.1	9.9
Scenario No.3	Peak mining phase	77.8	36.0	11.8

As the IWL is not present during construction, the figure of 77.8 g/s is therefore adopted from Scenario 3.

The proportion of TSP emissions attributed by each source is extracted from the model input calculations 'breakdown of emissions by activity type' and is included below for reference (Appendix F, Table C-1).

This figure assumes that there is only 12 months' worth of developed area which is 'active' at any time for the IWL, i.e. everything older than 12 months has been rehabilitated/capped/no longer active. So the same rate applies to all mining year scenarios. Also note that wind erosion emissions are activated in the model for wind speeds >= 5 m/s. For 2009 (modelled year), there were 7178 hours (of total 8760 hours) where wind speeds were >= 5 m/s.

Appendix C Dust emission estimates

Table C-1: Breakdown of TSP emissions estimates by activity type

Emissions Calculation Results - TSP Summary	Scenario 1 g/sec	Scenario 1 % of total	Scenario 2 g/sec	Scenario 2 % of total	Scenario 3 g/sec	Scenario 3 % of total
Topsoil removal and dumping	0.43	0.4%	2.30	3.7%	2.30	2.9%
Excavation by shovel and loading	1.10	1.0%	1.57	2.5%	1.60	2.1%
WGD - haul trucks + light vehicles	63.6	54.8%	6.06	9.6%	9.41	12%
WR conveyors and transfer points	13.0	11.2%	0.90	1.4%	0.99	1.3%
Ore and WR crushers	0.00	0.0%	8.67	14%	9.21	12%
Ore conveyors and transfer points	0.00	0.0%	0.74	1.2%	1.44	1.9%
IWL - unloading from trucks/conveyors	4.56	3.9%	12.6	20%	19.0	24%
Wind erosion of IWL, overburden, topsoil and crushed ore stockpiles	7.27	6.3%	7.27	12%	7.27	9.3%
Drilling and blasting	2.57	2.2%	1.28	2.0%	1.28	1.7%
Bulldozers	20.7	17.9%	4.09	6.5%	7.16	9.2%
Processing area	0.02	0.0%	14.8	24%	15.5	20%
Graders	2.61	2.3%	2.61	4.2%	2.61	3.4%
Total	**115.9**	**100%**	**62.9**	**100%**	**77.8**	**100%**

5.2 Salt Content of TSP and Deposited Dust

Salts are expected to accumulate as a result of the saline water used for dust suppression on the IWL and haul roads. The accumulation of salt may be concentrated on the upper surface as this is where evaporation occurs resulting in crystallised surface salt. We have therefore adopted a conservative estimate and assumed 100% of dust originating from WGD and wind-blown dust from the IWL is salt.

Saline water is also used in processing of the ore and therefore waste tailings will have a residual salt content. The moisture content of fine tailings in IWL is approximately 12% by mass. Salt content in the moisture is 5.2% (52 g/L) so the total salt concentration in the fine tailings is estimated to be 0.6%. We have assumed no salt accumulation occurs during handling of the waste tailings, since the material is being disturbed during handling, either by truck or conveyor.

The salt content of other dust generating sources is assumed to be negligible. A summary of salt sources is summarised in Table 5-1.

Table 5-1 Summary of Potential Salt Sources

Source Description	Emission Estimate (g/sec)	% of Total	Assumed Salt Content	Emission Estimate as Salt (g/sec)
Wind Generated Dust (WGD) – haul trucks + light vehicles	9.41	12%	100%	9.41
IWL unloading from trucks / conveyors	19.0	24%	0.6%	0.12
Wind Erosion of IWL	5.97	7.7%	100%	5.97
Total	**34.4**	**44%**		**15.5**

The proportion of TSP emissions conservatively estimated to be salt is therefore calculated to be

$$\frac{15.5}{77.8} = 20\%$$

5.3 Mass of Salt in Deposited Material (Dust Deposition)

Total dust deposition (TSP deposition) for modelled Scenario 3 are summarised in Appendix F, Table 3-30, extracted below.

Table 3-30: CALPUFF dust results for sensitive receptors, Scenario No.3

Sensitive Receptor ID	PM_{10} 24 hr avg. (ug/m^3)	$PM_{2.5}$ 24 hr avg. (ug/m^3)	$PM_{2.5}$ annual avg. (ug/m^3)	TSP annual avg. (ug/m^3)	TSP deposition (g/m^2/month)
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
Project air quality standard (max)	**50**	**25**	**8**	**90**	**4**

These values include the assumed background concentration of 2 g/m^2/month (Appendix F, Table 3-7) and therefore the maximum mass of deposited material attributed to mining operations was predicted to be 0.1 g/m^2/month. For further calculations we will assume a conservative value of 0.2 g/m^2/month to allow for rounding effects and margin of error.

Table 3-7: Estimates for background airborne particulate matter and deposited dust.

Parameter	Value	Derivation, source
Background maximum 24-hour average PM_{10} GLC for modelling study	22 µg/m³	70th percentile 1hr avg. PM_{10} GLCs, Whyalla (21.4 µg/m³)
Background maximum 24-hour average $PM_{2.5}$ GLC for modelling study	10 µg/m³	70th percentile 1hr avg. $PM_{2.5}$ GLCs, Netley (9.3 µg/m³)
Background annual average $PM_{2.5}$ GLC for modelling study	7 µg/m³	50th percentile 1hr avg. $PM_{2.5}$ GLCs, Netley (6.9 µg/m³)
Background annual average TSP GLC for modelling study (all seasons)	30 µg/m³	Double the 50th percentile 1hr avg. PM_{10} GLC, Whyalla(2 × 14.7 µg/m³)
Background monthly dust deposition for modelling study (all seasons)	2 g/m²/month	Conservative (high), based on 2014 measurements near Warramboo (Jacobs, 2015)

Using the predicted annual dust deposition attributed to mining activities (0.2 g/m²/month) and the calculated salt content of the TSP emissions (20%), then the annual average quantity of deposited salt would be

$$0.2 \; x \; 20\% \; = \; 0.04 \;\; \text{g/m}^2\text{/month}$$

5.4 Existing Background Salt Deposition

The calculated salt deposition attributed to mining operations can be compared to monitoring results and the chemical analysis of deposited matter obtained from background monitoring at several sites surrounding the mining lease.

The soluble portion of deposited matter from the three monitoring sites for the period Nov 2013 to May 2015 averages 1.65 g/m²/month. Chemical analysis of soluble solids between Feb 2015 and May 2015 attributed 75% of deposited soluble solids to be from compounds contributing to soil salinity i.e. Na, Ca, Mg, K, Cl and SO4 (Figure 4-5).

Average background salt deposition is then calculated to be

$$1.65 \; x \; 75\% \; = \; 1.24 \; \text{g/m}^2\text{/month}$$

5.5 Impact on Surrounding Soils

The contribution to soil salinity from windblown salt originating from the mining operations can be evaluated considering existing soil salinity levels and the existing contribution from background sources. The methodology and calculations presented in this section are attributed to Ground Water Science Pty Ltd (Jeuken 2015).

The CSIRO Australian Soil Resource Information System (ASRIS) (CSIRO, 2015) was used to estimate existing salt store of salt in top 1m of soil types found in the area surrounding the mine. The additional contribution to salt store over the 25year mine life was estimated using the methodology in Section 5.3 and Section 5.4 and multiplying by the 25year mine operational life.

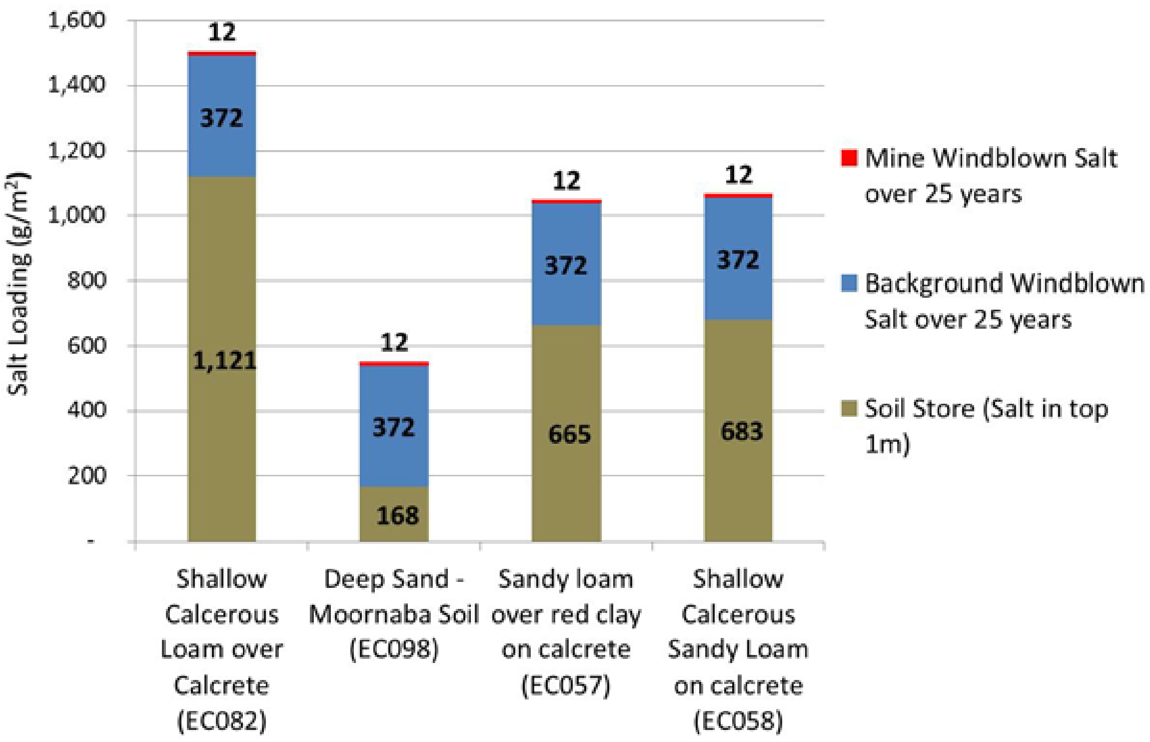
Soil Type	Soil Store (Existing Salt in top 1m)[1, 2, 3, 4] (g/m³)	Background Salt Deposition (g/25years)	Mine Windblown Salt Deposition (g/25years)
Shallow Calcerous Loam over Calcrete (EC082)	1,121	372	12
Deep Sand - Moornaba Soil (EC098)	168	372	12
Sandy loam over red clay on calcrete (EC057)	665	372	12

Soil Type	Soil Store (Existing Salt in top 1m)[1, 2, 3, 4] (g/m^3)	Background Salt Deposition (g/25years)	Mine Windblown Salt Deposition (g/25years)
Shallow Calcerous Sandy Loam on calcrete (EC058)	683	372	12

1. Soil Salinity data measured as EC in a 1:5 soil : water suspension and converts to mg/L salt per unit volume of soil.
2. Soil salinity data taken from ASRIS database (CSIRO, 2015)
3. EC to mg/L conversion is 'EC x 650 = mg/L'
4. Conversion from soil particle volume to soil bulk volume is 'particle volume x 0.7'

Results of the calculation are shown in Figure 5-1.

Figure 5-1 Summary of Estimated Salt Store Contribution Over 25 year Mine Life.



5.6 Summary of Salt Deposition Estimates

A conservative estimate for salt deposition from mining sources was calculated to be 0.04 g/m^2/month based on predicted dust deposition rates and emissions from sources with potentially elevated salt contents.

This compares to measured background salt deposition of 1.2 g/m^2/month for sites surrounding the mining lease.

The contribution of salt deposition from mining sources is calculated to add 3% 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.

In summary the deposited salt due to airborne dust particle emissions from activities associated with mining, is expected to be low.

6. Future Monitoring Activities

A comprehensive baseline air monitoring program is planned to commence 12 months prior to the start of construction, and will consist of upgraded instrumentation and an expanded geographical study area. It is intended that a key long term monitoring site will be established near the Warramboo community which will serve as a point of reference for the project duration. This will consist of Australian Standard (AS) compliant monitors for PM_{10} and $PM_{2.5}$, an AS compliant meteorological station and instrumentation for dust deposition and TSP. Smaller monitoring sites equipped with either PM_{10} and / or dust deposition gauges will be located at key locations around the mining lease.

During the construction and mining phases, data generated from the monitoring network will be used to assist in managing mining activities to prevent exceedances of human health and nuisance dust objectives. In addition to real-time monitoring data, forecasting will be utilised in forward planning of mining activities and managing dust mitigation measures.

A staged Trigger Action Response Plan (TARP) will be implemented and will be designed to prevent exceedances at sensitive receptor sites. The TARP will have several trigger levels based on real-time monitoring data, with a staged shut down of activities depending on the level of risk (trigger level activated).

The trigger levels and response will be developed around various parameters and averaging periods and may include 1-hr, 3-hr and 24-hr or other rolling averages, wind speeds, wind direction and rain events.

The TARP will be developed based on analysis of site specific monitoring data collected during baseline monitoring, and may be fine-tuned during the construction and operation phase to account for changes in mine activities and as a better understanding is gained of how specific mine activities impact on dust generation.

Iron Road will maintain a website with public access for viewing air monitoring and meteorological data collected from the monitoring network.

7. References

AS/NZS 3580.1.1:2007; Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment

AS/NZS 3580.9.11:2008; Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – PM10 beta attenuation monitors.

AS/NZS 3580.9.12:2013; Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – PM2.5 beta attenuation monitors.

AS/NZS 3580.10.1:2003; Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter – Gravimetric method.

DEC (2005) (now NSW EPA) DEC 2005/361, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment and Conservation NSW, August 2005.

CSIRO (2015); Australian Soil Resource Information System (ASRIS) www.asris.csiro.au, accessed October 2015.

Jeuken (2015); Email communication, Ground Water Science Pty Ltd, 12th October 2015.

NEPC (2003). National Environment Protection Council (NEPC), National Environment Protection (Ambient Air Quality) Measure ("NEPM"), as amended made under section 20 of the National Environment Protection Council Act 1994 (Cth), National Environment Protection Council (Victoria) Act 1995 (Vic), (and other states), Prepared by the Office of Legislative Drafting, Attorney-General's Department, Canberra, 7 July 2003.

CENTRAL EYRE IRON PROJECT
IRON ROAD LIMITED

AIR QUALITY IMPACT ASSESSMENT - MINE
REVISION 0

CLIENT DOCUMENT NUMBER: E-F-34-RPT-0044_0

27 MAY 2015

DOCUMENT HISTORY AND STATUS

Revision	Date	Description	By	Review	Approved
A	23/02/2015	Draft for client review	M Hall & M Pickett	S Lakmaker	L Daddow
0	27/05/2015	Final for client approval	M Hall	M Pickett	

Central Eyre Iron Project

Project no:	IW064300
Document title:	Central Eyre Iron Project: Air Quality Impact Assessment - Mine
Document no:	E-F-34-RPT-0040
Revision:	0
Date:	27 May 2015
Client name:	Iron Road Limited
Project manager:	Nick Bull
Author:	Michelle Hall and Matthew Pickett

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 6, 30 Flinders Street
PO Box 152 Rundle Mall
Adelaide SA 5000 Australia
T +61 8 8424 3800
F +61 8 8424 3810
www.jacobs.com

Contents

List of Figures

List of Tables

Abbreviations and Glossary of Terms

Abbreviation	Expansion
AG	Australian Government
AS/NZS	Australian Standard/New Zealand Standard
ANFO	Ammonium Nitrate and Fuel Oil (explosive type)
BoM	Bureau of Meteorology
CDP	Conveyor Distribution Point
CEIP	Central Eyre Iron Project
CEIP Infrastructure	Port, railway line, pipeline, transmission line, borefield and long term employee village associated with the proposed CEIP
CO	Carbon monoxide (molecular formula)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DEC	Department of Environment and Conservation (NSW)
DEM	Dust Extinction Moisture; see AS 4156.6—2000
Design Criterion	Ambient air quality standard (EPA)
Deposited dust	Total particulate matter deposited to the ground surface, usually reported in units of g/m2/month. The relevant measurement is insoluble solids as defined by Australian Standard, AS/NZS 3580.10.1–2003.
DGLC	Design Ground Level Concentration
DMITRE	Department for Manufacturing, Innovation, Trade, Resources and Energy (South Australia (now Department of State Development)
DSD	Department of State Development
Dust	In this report the generic term 'dust' is used for airborne or deposited dust particles of any size.
EETM	Emission Estimation Technique Manual
EPA	Environment Protection Authority (South Australia)
g/m^2/month	Grams per square metre per month
g/sec	Grams per second
GLC	Ground Level Concentration
IWL	Integrated Waste Landform
Indicator	Air pollutant substance for assessment e.g. PM_{10}, NO_2
IPCC	In Pit Crushing and Conveying
Iron Road	Iron Road Limited
kg	Kilograms
km	Kilometres
km/h	Kilometres per hour

Abbreviation	Expansion
L	litres
LAPS	Limited Area Prediction System
$\mu g/m^3$	Micrograms per cubic metre
µm	Microns
m	Metres
mm	Millimetres
MGA94	Map Grid of Australia 1994
Mining Lease	Proposed mining lease e.g. with boundaries as illustrated in Figure 2-2 of this report.
ML	Million litres
Mtpa	Million tonnes per annum
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NIOSH	National Institute for Occupational Safety and Health (US)
NO	Nitric oxide (molecular formula)
NO_2	Nitrogen dioxide (molecular formula)
NO_x	Oxides of nitrogen (molecular formula)
NPI	National Pollutant Inventory
O_3	Ozone (molecular formula)
OLM	Ozone Limiting Method
$PM_{2.5}$	Particulate Matter 2.5 – mass concentration of airborne particulate matter comprising a collection of particles with aerodynamic diameters less than 2.5 microns.
PM_{10}	Particulate Matter 10 – mass concentration of airborne particulate matter comprising a collection of particles with aerodynamic diameters less than 10 microns.
ppm	Parts per million
Proposed borefield	The CEIP borefield near Kielpa
Proposed infrastructure corridor	Incorporates the proposed railway line, rail access road, road crossings and realignments, water pipeline and transmission line between the mine site and the port site
Proposed long term employee village	The long term accommodation for Iron Road's mining workforce at Wudinna
PSD	Particle Size Distribution
SA	South Australia
SAG	Semi-autogenous grinding
SKM	Sinclair Knight Merz

Abbreviation	Expansion
SO_2	Sulphur dioxide (molecular formula)
t/h	Tonnes per hour
TAPM	The Air Pollution Model
TEOM	Tapered Element Oscillating Microbalance
TSP	Total Suspended Particulates – total mass concentration of airborne particulate matter comprising a collection of particles with aerodynamic diameters up to approximately 30-50 microns.
US	United States
WGD	Wheel Generated Dust (NPI term)
WR	Waste rock
VKT	Vehicle Kilometres Travelled (NPI term)
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Executive Summary

This report presents the results of an air quality impact assessment carried out for Iron Road Limited's proposed open cut iron ore mine as part of the Central Eyre Iron Project (CEIP) ('the Project').

The air quality impact assessment for the proposed mine site was based on a dust dispersion modelling study undertaken in accordance with the South Australian Environmental Protection Authority (EPA) Guidelines: *Air quality impact assessment using design ground level pollutant concentrations (DGLCs)*, EPA 386/06; and *Presentation of air pollution modelling outputs*, EPA 578/05.

The assessment's main tasks included:

- identification of key air emission sources from activities expected to be associated with the CEIP mining operations;
- calculation of dust particle source terms for modelling;
- meteorological modelling using the 'TAPM' and 'CALMET' models; and
- dust particle dispersion modelling using 'CALPUFF'.

Three distinct air emissions scenarios were set out for assessment at the mine site based on the key proposed mining phases and their associated activities. Of these scenarios, the emissions from the construction phase and the peak mining phase were found to represent the worst case in terms of potential dust impact, and these were therefore selected for modelling.

The key air quality indicators identified for the Project were associated with dust emissions including PM_{10}, $PM_{2.5}$, TSP and dust deposition (these terms are defined in the Glossary). In the assessment, model predicted ground-level concentrations for these indicators were compared with ambient air quality standards. The key ambient air quality standards adopted for the Project were the National Environment Protection Measures (NEPMs) for PM_{10} and $PM_{2.5}$.

Air dispersion modelling of worst-case dust emissions from the proposed mine site showed that airborne particle concentrations (PM_{10} and $PM_{2.5}$) would comply with air quality standards at all sensitive receptors outside the proposed Mining Lease boundaries for the construction phase and the peak mining phase. This outcome assumes that the construction activities will be modified in response to actual and forecast dust and meteorological conditions. This means the potential cessation or relocation of selected activities for approximately 15% of the year with respect to meeting the key particulate matter target i.e. maximum 24 hour average PM_{10}, 50 ug/m^3.

The air dispersion modelling showed that no nuisance dust impacts are expected from dust deposition at any of the sensitive receptors.

In addition to the assessment of the potential dust impact from the mine site, an assessment of non-particulate emissions was also undertaken. This included identification of key emission sources from blasting operations and the consumption of diesel at the mine site, and dispersion modelling to predict the potential impacts at the sensitive receptors. The ambient air quality standards for the Project were adopted from the South Australian Environmental Protection Authority (EPA) Guidelines: *Air quality impact assessment using design ground level pollutant concentrations (DGLCs)*, EPA 386/06. This assessment found that the gas concentrations of the key pollutant, nitrogen dioxide, would comply with air quality standards at all sensitive receptors outside the proposed Mining Lease boundaries.

1 Introduction

1.1 Background

The proposed Central Eyre Iron Project (CEIP) Mine is South Australia's largest iron ore project and second only to Olympic Dam as South Australia's largest resources project.

The CEIP Mine is expected to produce 21.5 million tonnes per annum (Mtpa) of magnetite concentrate at full capacity, over an expected mine life of 25 years. CEIP Mine includes development of an iron ore mine and process facility in the central Eyre Peninsula, a bulk export port facility at Cape Hardy on the east coast of the Eyre Peninsula, and an infrastructure corridor connecting the mine and port site (maps are provided in Section 2). The infrastructure corridor would include a heavy haul railway line, maintenance track and a water supply pipeline. Augmentation of the existing electrical transmission network would also be required to provide power to the proposed mine.

The CEIP consists of five main components:

1. **Mine** – the mine site will include an open pit excavation, with on-site processing plant and waste rock handling. The processing plant includes metallurgical facilities, crushing, grinding and milling facilities, tailings handling and retention. Additional onsite infrastructure includes a small desalination plant for potable water supply, temporary and permanent camps for accommodation, workshops, warehouses, security, emergency services and rail infrastructure including a rail loop and train loading facility. Production of 21.5 Mtpa of iron concentrate is proposed with sufficient resource for a mine life of at least 25 years.

2. **Long term employee village** – long term accommodation for the mine site workforce is proposed to be located adjacent to the town of Wudinna, approximately 26 kilometres (km) north-east of the mine site.

3. **Infrastructure corridor** – the infrastructure corridor will connect the mine site with a port facility at Cape Hardy and will be approximately 130 km in length[1]. Spanning the length of the infrastructure corridor is a heavy railway line to transport iron concentrate from the mine to the port. Running parallel to the railway line, in the northern section of the infrastructure corridor, will be a water supply pipeline. An electricity transmission line will also be included along part of the corridor. The corridor will incorporate ancillary infrastructure such as a service road, laydown areas and pump stations to support the railway line, transmission line and water pipeline.

4. **Proposed borefield** – borefield located approximately 60 km from the proposed mine and 7.5 km west of Kielpa to supply saline groundwater for use in processing at the mine site.

5. **Port** – the port is proposed at a greenfield site at Cape Hardy, approximately 7 km south of Port Neill[2]. The site provides a natural deep water location; i.e., no dredging would be required during any construction of a port. A port has been designed to have capacity to export 70 Mtpa, of which 21.5 Mtpa would be used by Iron Road. The port design would support Panamax and Cape size vessels, with a 1.2 km jetty structure that incorporates a tug harbor, module off loading facility and wharf. Onshore, the port facility would incorporate material handling facilities, car parking and internal access roads,

[1] Measured from the boundary of the proposed Mining Lease to the boundary of the port site
[2] Measured from the approximate centre of Port Neill to the centre of the proposed port facility

stormwater management and ancillary facilities including an administration building, emergency services building, control room(s), warehouse, maintenance workshop, ablutions facility and crib room, laboratory and fuel storage. Temporary construction workforce accommodation would also be located at the port site during construction of the port and infrastructure corridor. The proposed development is for infrastructure to support Iron Road's operations of 21.5 Mtpa. Any additional infrastructure or activities proposed by third party users of the port facility would be subject to a separate approvals process.

The components of the CEIP Mine will be within a Mining Lease to be assessed and approved under the Mining Act, 1971.

1.2 Scope of Works

1.2.1 Overview

This assessment report considers air quality impacts associated with the construction and operation of the CEIP Mine. A separate air quality assessment report addresses air quality impacts from the proposed CEIP Infrastructure, i.e. the port site and infrastructure corridor (Jacobs, 2014).

The scope of works of the air quality impact assessment for the proposed CEIP Mine is detailed in the following list of tasks:

- Detailed air quality dust impact assessment of the proposed mining activities based on air dispersion modelling in accordance with procedures set out by the South Australian Environment Protection Authority (EPA). The assessment used standard emissions estimation techniques for key dust sources, e.g., crushing operations, bulldozers, loading and reclaiming of stockpiles, and wheel generated dust.
- Air quality impact assessment of non-dust particle emissions expected from other sources associated with the proposed mine operation; e.g., emissions from diesel engine powered equipment.

1.2.2 Air quality dust impact assessment – mine operations

This section describes the dust modelling study component of the air quality impact assessment for the mine site. The main tasks of the assessment were:

1) Identification of key air (dust particle) emissions sources;
2) Identification of key environmental (ambient air quality) indicators i.e. the substances for assessment;
3) Description of the existing environment;
4) Calculation of dust emissions estimates;
5) Meteorological modelling;
6) Dust dispersion modelling; and
7) Assessment of ambient air quality impacts by comparisons of model results with standards.

Key dust emissions sources associated with this Project were identified and air emissions estimates were based primarily on techniques set out in the National Pollutant Inventory (NPI) *Emission Estimation Technique Manual (EETM) for Mining* Version 3.1, January 2012 (NPI EETM for Mining, 2012). These are discussed in detail in Section 3.3.

An inventory of dust emission sources and the dust emission estimates were calculated for three mining phases: (1) construction; (2) early mining; and (3) peak mining.

The potential environmental effects associated with the emissions and ambient air quality standards relevant for the mine site are identified and set out in Section 3.

Summaries of local climatology and estimates for existing air quality are described. Local climatology was based on a review of observations from a Bureau of Meteorology (BoM) weather station located at Wudinna Aerodrome, approximately 26 km north-northwest of Warramboo town. Existing air quality was estimated based on a review of air quality parameters measured primarily at Whyalla, on the eastern coast of Eyre Peninsula. The estimates for existing air quality parameters were reviewed in consultation with the EPA. The dust dispersion modelling study was carried out for two scenarios, representing the construction phase and the peak operational phase for the life of the mine. These scenarios were expected to capture the 'worst-case' predicted air pollutant Ground Level Concentrations (GLCs) at the sensitive receptors.

The study included meteorological modelling for the mine site using the CSIRO Marine and Atmospheric Research model, TAPM; e.g., see Hurley (2008a). From discussions with EPA, the climatology of 2009 was considered to be representative of a wide range of weather conditions for South Australia. Therefore the TAPM 2009 data generated specifically for the region around the proposed mine site, i.e. for all (8,760) hours in 2009, was considered to be satisfactory for capturing all meteorological conditions expected for the mine site in a typical year.

Air quality modelling, primarily dust particle dispersion modelling, was undertaken for the mine site study area using outputs of the TAPM meteorological model and air pollutant emissions estimates. The air dispersion modelling was undertaken with 'CALPUFF' (Earth Tech 2000a; Earth Tech 2000b), which provided results for the following environmental indicators:

- 24-hour average GLCs for PM_{10} and $PM_{2.5}$ for the assessment of human health impacts[3];
- Annual average PM_{10} and $PM_{2.5}$ GLCs, similarly for the assessment of human health impacts;
- Annual average TSP concentrations as an indicator for nuisance dust;
- Annual dust depositions as an indicator for nuisance dust; dust deposition was determined by modelled TSP fluxes to the ground surface.

1.2.3 Assessment of other (non-dust) emissions from mine operations

A second quantitative air quality impact assessment using the same modelling methodology was undertaken to investigate the potential air quality effects from other (non-dust) emissions sources associated with the proposed mining activities. The assessment of gaseous air pollutants included the following tasks:

1) Identification of key (highest risk) sources of gaseous air pollutants;
2) Identification of key ambient air quality indicators i.e. the substances for assessment;
3) Calculation of gaseous pollutant emissions estimates;
4) Dispersion modelling; and
5) Assessment of ambient air quality impacts by comparisons of model results with standards.

The key sources for gaseous air pollutants were found to be those associated with the combustion of diesel, in particular, from the mobile vehicle fleet (heavy industrial and light vehicles), and emissions from blasting operations. Emissions estimates for the gaseous pollutants were determined using the National Pollutant Inventory (NPI) *Emission Estimation Technique Manual (EETM) for Mining* Version 3.1, January 2012 and a study of emissions from blasting activities (NIOSH, 2000). These are discussed in detail in Section 3.3.

[3] Definitions for 'PM_{10}', $PM_{2.5}$' and other abbreviations are provided in 'Abbreviations and Glossary of Terms'.

The existing background concentrations of the key gaseous pollutant for assessment, which was found to be NO_2, were used in the assessment. Hourly NO_2 data for the modelling period 2009 were obtained from the SA EPA.

The same meteorological data used as input for the dust modelling was used for the NO_2 modelling. The NO_2 assessment was based on comparisons of model predicted NO_2 GLCs with a South Australian Design Criterion for that pollutant.

2 Project Description

2.1 Proposed CEIP Mine Site

The proposed CEIP Mine site is centrally located on Eyre Peninsula, adjacent and directly east of the town of Warramboo and approximately 30km south-southeast of Wudinna. The proposed Mining Lease area will occupy approximately 8,500 hectares.

The location of the proposed CEIP Mine site is shown in Figure 2-1.

A simplified layout of the proposed layout of the mine site, at full development, is shown in Figure 2-2.

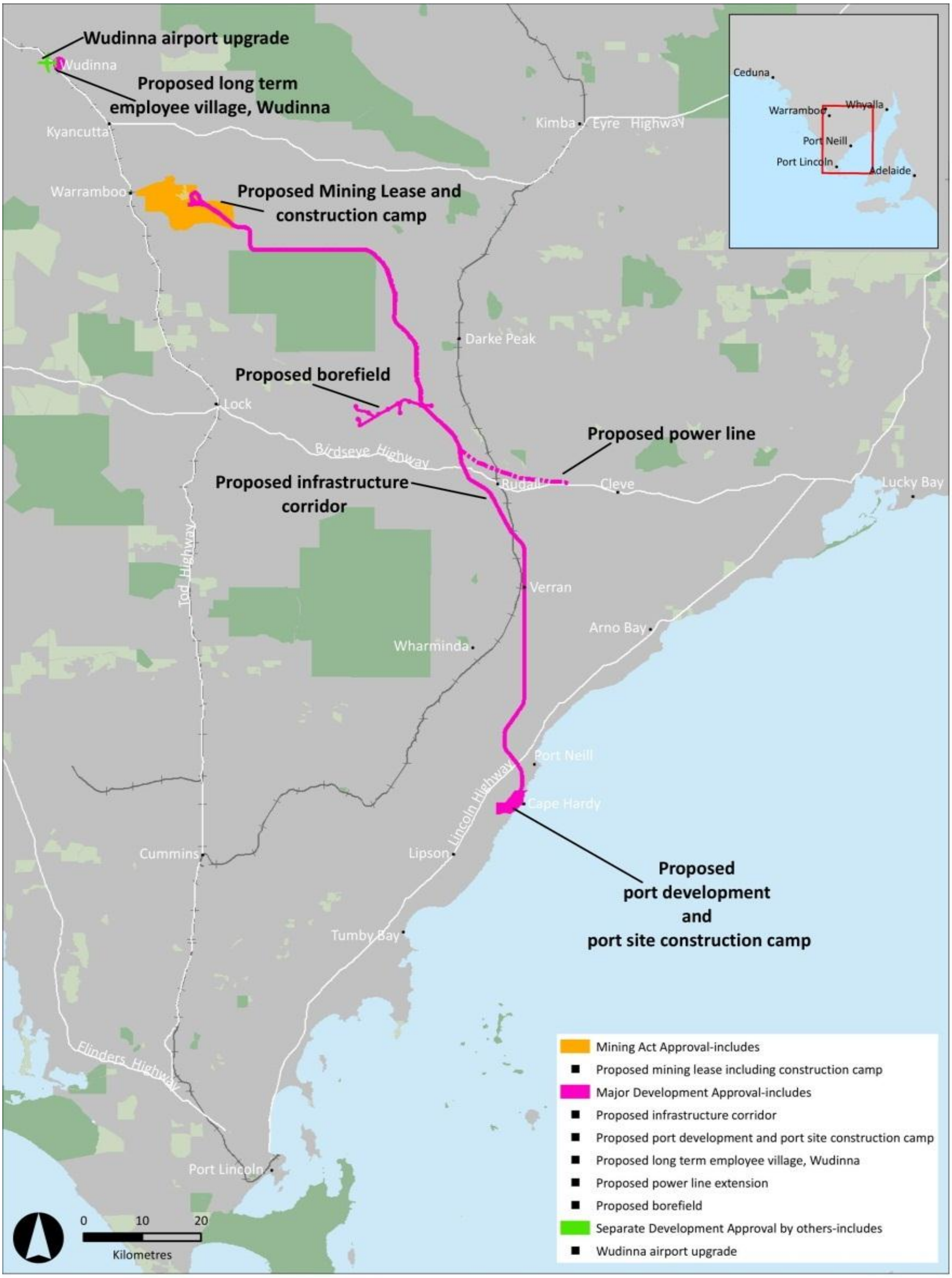


Figure 2-1: Eyre Peninsula showing location of proposed Mining Lease area

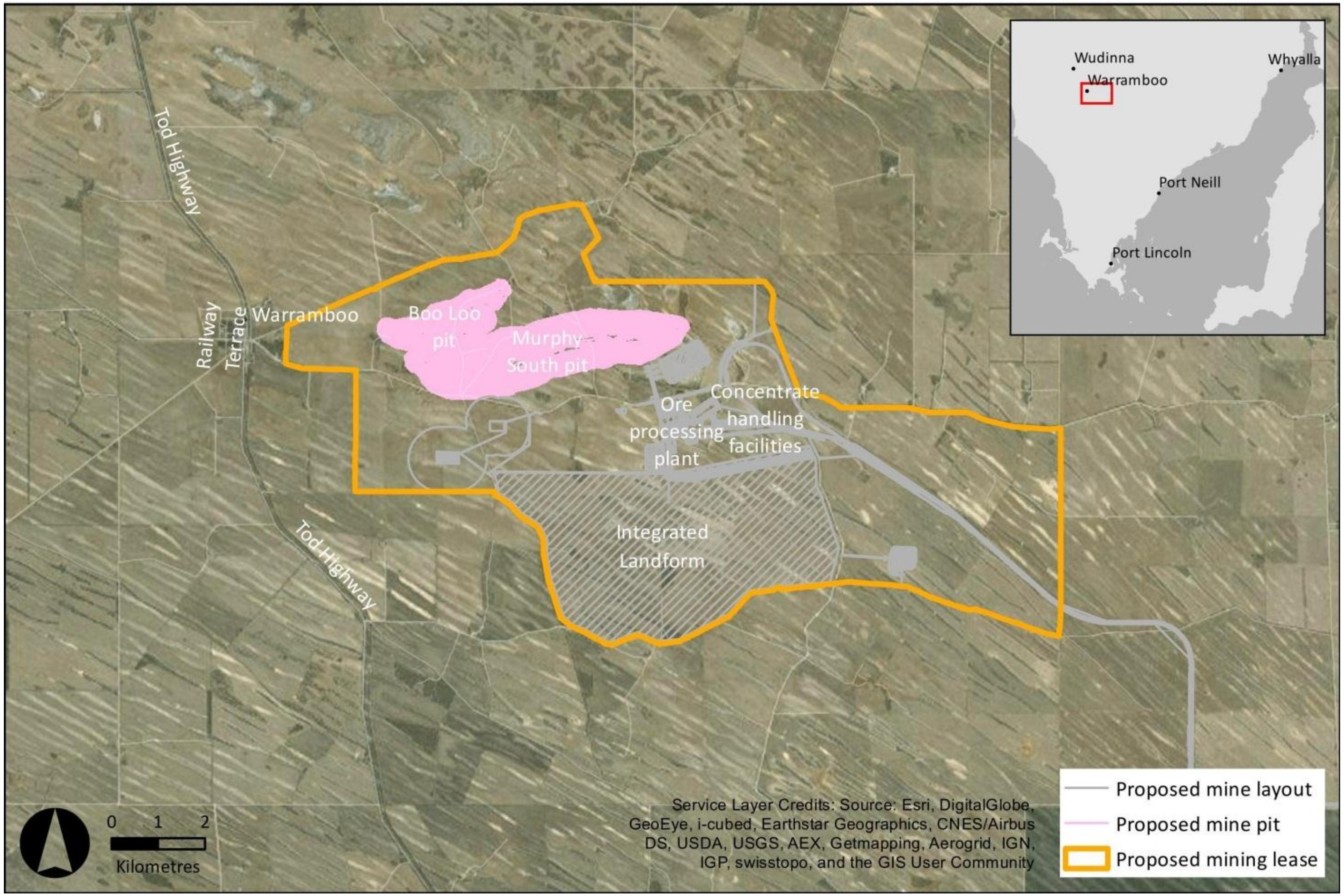


Figure 2-2: Proposed mine site: simplified layout

2.2 Summary of Mining Process

The mining schedule incorporates 3 years of pre-stripping and surface facilities construction (construction phase) followed by 25 years of mining (production phase). It is proposed that the mine will produce 21.5 Mt of iron concentrate per annum following a staged ramp up over 2.5 years.

An open pit mine is proposed with two distinct stages of production, first focusing on the Murphy South pit area, then extending into the Boo Loo pit area. The pre-strip to expose the orebody would start in the eastern half of the Murphy South pit area. Mining will remain exclusively in the Murphy South pit until year 11 of production, when pre-stripping of Boo Loo pit commences. Ore from the Boo Loo pit is expected from year 14 with both pits in operation up to year 25 of production.

An In-Pit Crushing and Conveying (IPCC) mining operation is proposed. IPCC has many benefits, including significant safety advantages and cost savings by reducing the trucking fleet, diesel use and personnel requirements. Crucially for this assessment, the adoption of IPCC for this mine had the effect of significantly reducing the dust emissions estimates by eliminating the earlier proposed large haul truck fleet.

The IPCC mining method comprises traditional open pit operation consisting of drilling and blasting followed by direct feed of six mobile primary crushers by large diesel powered excavators or loaders. Each crusher will feed a conveyor exiting the mine pit where the material will be batch handled for delivery by conveyor either to the coarse ore stockpiles or the integrated landform.

All conveyors on the mine site will be covered to contain the material and reduce dust emissions. Transfer stations are included in the conveyor system design to enclose the transfer points where the conveyors change direction and will be fitted with dust extraction and filtration units to capture dust.

Ore treatment by conventional crushing, milling and magnetic/gravity separation is planned to deliver low impurity iron concentrate. The ore processing facility will treat up to 150 Mtpa of feed material at a head grade of 15.5% iron. It has been designed to produce up to 21.5 Mtpa iron concentrate at approximately 67% iron.

The modularised ore processing facility will be constructed on the south-east edge of the pit. The facility has three discrete crushing, grinding and recovery trains to provide a high level of plant availability and to minimise operational downtime. Each processing train will incorporate:

- Semi-Autogenous Grinding Mill
- Rougher Magnetic Separator
- Gravity Beneficiation Circuit
- Ball Mills
- Cleaner Magnetic Separator

Tailings from each processing train will pass through the tailings thickener and filter building to reduce moisture to approximately 10%. The moist tailings will then be transferred to the integrated landform via the waste rock conveyor from the mine. The cost-efficient tailings and waste rock handling method minimises water use and reduces the tailings footprint.

A simplified schematic of the mining process is shown in Appendix A.

2.3 Construction Phase

Pre-stripping (removal of overburden) will be completed by conventional truck and shovel, load and haul method on a 'just in time' basis as mining commences. Pre-stripping to expose the orebody would start in the eastern half of the Murphy South pit area during the construction phase and approximately 50% of the pit would be pre-stripped during a one year period prior to the operational phase commencing.

Pre-stripping during the construction phase will be completed by six excavators (Liebherr R 9800) and twelve 360T Ultra Class trucks (i.e. 360 tonne). Blasting will occur once per day in the Murphy South pit. Water trucks will be operating during the construction phase to minimise dust emissions. Other mobile fleet will complete surface earthworks and assist with construction of surface infrastructure, including 240T Class trucks (i.e. 240 tonne), a loader, dozers and graders. A complete list of mobile fleet that will be in operation during the construction stage is provided in Table 2-1 below.

Table 2-1: Construction phase mobile equipment fleet

Mobile Equipment Item	Quantity
Cranes	3
Excavator - Liebherr 9800	6
Haul truck - 360T Ultra Class	12
Haul Truck - 240T class	2
Cat 944H Loader	1
Dozer - D11	6
Dozer - D10	4
Dozer - Wheel	3
Grader - 24M	6
Grader 16M	1
Water Truck - 135Kl	5
Water Truck - 85Kl	2
Drill rigs	20

The 360T haul trucks will deliver the excavated material to a conveyor at the edge of the area to be mined. One conveyor stream from the edge of the mine area to the integrated landform will be in operation to deliver the excavated waste rock to the integrated landform. Transfer stations will be used to transfer waste rock from one conveyor to the next. These will be enclosed and have dust extraction and filtration units fitted to minimise dust emissions.

Waste rock will be used to construct the ramp required for the integrated landform spreaders. The waste rock delivered to the integrated landform by the conveyor will be worked by dozers to construct the ramp.

Iron Road intends to use modular construction methods for large scale infrastructure and buildings including the crushers, conveyors, transfer stations, ore processing facility components and concentrate handling facility components. This method involves the majority of the construction work being undertaken at an off-shore pre-assembly yard and shipping the substantially completed assemblies to the proposed module offloading facility at the port site using lift on / lift off and roll on / roll off ships.

2.4 Operational Phase

2.4.1 Drilling and blasting

The CEIP Mine would use both packaged and bulk type explosives. The bulk explosives used in the operation will be Ammonium Nitrate and Fuel Oil (ANFO) or emulsion based and will usually be manufactured on site with a mobile manufacturing unit. ANFO will be the preferred explosive used with the use of emulsions generally restricted to those cases where the blast holes contain water.

The drilling operation will include work on two benches daily with a bench height of 15 m, drilling 310 mm diameter holes to a typical depth of 13.1 m, at 9 m spacing resulting in 335 holes daily. The total blast area will be 10,000 m^2.

The drill rig fleet will comprise twenty drill rigs with 90% utilisation. Dust generation from the drilling operations will be mitigated with the use of fabric filters or equivalent.

The daily blast charge requirement is approximately 0.9 tonnes per hole. Blasting will take place once per day during daylight hours at a regular time advised to the local community.

2.4.2 Excavation and loading crushers

Seven excavators (Liebherr R 9800) will be located within the mine pit to excavate iron ore and waste rock at a peak material movement rate of 347 Mtpa. Each excavator has an operating weight of 810,000 kg with a bucket capacity of 42 m^3.

During the construction phase, all excavators will be in the Murphy South pit. During the peak mining phase, there will be two excavators in the Boo Loo pit feeding crushers, four excavators in the Murphy South pit, with an additional excavator located as needed or in maintenance. The excavated material will be excavated from the face and loaded directly into the mobile crushers. Water sprays will be used to mitigate dust generation during the excavation activities and loading of the crushers. No load and haul by trucks of iron ore or waste rock will be required in the mine pit.

The mobile primary crushers and conveyors will gradually move around the mine pit, followed by the excavators, as the pit deepens and extends to allow the excavators to load directly following blasting.

2.4.3 Mobile in-pit crushers

Six mobile primary crushers will be located in the mine pits. The crushers will be gyratory crushers selected as the most suitable equipment for the CEIP Mine magnetite gneiss at the required crushing capacities. Each crusher will feed a conveyor which transports crushed material from the mine pit to a Conveyor Distribution Point (CDP) at the pit edge. The CDP will direct the batch handled materials to, either: (1) The three waste rock conveyors and three integrated landform spreaders; or, (2) The two iron ore conveyors feeding the three coarse stockpiles close to the ore processing facility.

At the commencement of operational phase, the mobile primary crushers and associated excavators will be located in the eastern half of the Murphy South pit. As mining progresses the crushers will move towards the western end of the pit. When mining commences in the Boo Loo pit, (in approximately year 14 of mining), two crushers and associated excavators will operate in this pit while four crushers and associated excavators will remain in the Murphy South 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.

2.4.4 Ore and waste rock conveyors and transfer stations

Conventional belt conveyors on ground frames are proposed. The conveyor belts will be 2 m wide and speed will vary depending on material moved from 4.0 m/s to 5.85 m/s. All conveyors on the mine site will be covered to contain the material being moved and reduce dust emissions.

Transfer stations are 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.

The conveyor flights connecting the crushers in the mine pit with the CDP will be re-locatable. The conveyor flights from the CDP to the coarse ore stockpile and integrated landform, associated with the ore processing facility and concentrate handling facilities, will be fixed.

There will be 4 transfer stations located within the pit, for each of the ore and waste rock streams. Downstream of the CDP, there will be two ore transfer stations and one waste rock transfer station.

2.4.5 Coarse ore stockpiles

The conveyors from the CDP will deliver iron ore to the three coarse ore stockpiles, located on a pad. Each stockpile will have a maximum height of 60 m, maximum diameter of 170 m and contain approximately 500,000 t of iron ore. The stockpiles will comprise sufficient iron ore for approximately 80 days of processing.

The ore will drop from the delivery conveyor onto the coarse ore stockpile. Ore will be reclaimed from the stockpile by feeders located under the stockpile, and be conveyed through the reclaim tunnel to the SAG mill.

Water trucks will be used to minimise dust from the stockpiles during stacking activities.

2.4.6 Ore processing facility

The modularised ore processing facility will be constructed on the south east edge of the mine pit. The facility will comprise three identical processing streams including crushing, grinding and recovery to provide a high level of plant availability and to minimise operational downtime.

The ore processing facility will treat up to 150 Mtpa of iron ore at a head grade of 15.5% iron. It has been designed to operate 24 hours a day, seven days a week and produce up to 21.5 Mtpa iron concentrate with the following specifications:

- Iron grade (Fe) 67%
- Silica (SiO_2) < 4%
- Alumina (Al_2O_3) < 2%
- Phosphorous (P) 0.005%
- Sulphur (S) 0.002%

The processing of iron ore into iron concentrate will not require any chemicals. Only saline bore water is used in the processing of the ore. The final treatment of the concentrate will be by a wash with treated water to remove salts from the concentrate.

The crushed ore from the coarse ore stockpiles first enters the Semi-Autogenous Grinding (SAG) mill for secondary crushing which reduces the feed from approximately 160 mm to less than 6 mm. Process water is added during crushing in the SAG mill and the discharge feed is then pumped as slurry to the Rougher Magnetic Separator (RMS) building. As the ore will be maintained in the form of a slurry throughout the 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%; i.e. a maximum without impacting feed flow properties. The Dust Extinction Moisture (DEM) for a bulk material represents the moisture content needed to minimise dust emissions to insignificant levels. A typical DEM for iron ore is 7%; e.g., SKM (2002). As such no dust emissions are expected to be generated from the processing and handling of the tailings stream.

2.4.7 Concentrate handling and storage and train load out facility

The concentrate handling facilities incorporates the following equipment:

- concentrate conveyor from the ore processing facility to the concentrate stockpile
- concentrate stockpile and stacker
- reclaimer, concentrate conveyor from the stockpile, and the train load-out facility.

The concentrate handling facilities are located east of the ore processing facility and on the south eastern side of the mine pit. The concentrate discharge points feed concentrate onto a conveyor that delivers the concentrate for stacking on the stockpile. The conveyor is approximately 850 m long, from the furthermost processing stream to the concentrate stockpile.

All conveyors on the mine site will be covered to assist in maintaining moisture content and reducing dust generation. Transfer stations are 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.

The ore concentrate stockpile will be approximately 390 m long and 42 m wide, with maximum angle of repose of 42 degrees (Iron Road Drawings E-F-55-A-2001 and E-F-55-A-2002). The concentrate stacker will be a conventional tripper style. Reclaim of the concentrate stockpile will be via drum style reclaim system that will load a conveyor which will discharge into a concentrate load out bin. The concentrate load out bin will be positioned above the rail loop. Rail cars will pass under the load out bin and will be filled with concentrate. Full enclosure and dust extraction units will be fitted to the train load out facility.

There will also be a bypass ore concentrate stockpile. This will have a diameter of approximately 40 m and height of approximately 18 m (diameter from Iron Road Drawing E-F-55-A-2001). Loading of this facility will be done using a conveyor stacker and reclaiming will be carried out using a front end loader.

Water trucks will be used to minimise dust from the two stockpiles during stacking and reclaiming activities.

2.4.8 Waste rock and tailings integrated landform

The combined waste rock and dewatered tailings will be delivered by covered conveyors to the integrated landform spreaders at a total maximum rate of 325.6 Mtpa. The waste rock lumps will be up to 160 mm in diameter. The dewatered tailings will comprise 80% coarse particles (130 µm - 6 mm) and 20% fines (<130 µm). The moisture content of the tailings will be approximately 10%.

The integrated landform spreaders will have a capacity of 20,000 t/h each. The spreaders will progressively stack the waste at three levels of 45 m, 90 m and 135 m with a radius of approximately 3.0 to 3.5 km.

The integrated landform will be capped progressively during the life of the mine, reducing the area exposed to wind erosion.

2.4.9 Topsoil

Topsoil will be removed during the construction phase and deposited at a temporary storage area located on the northern edge of the integrated landform. The storage area is expected to have a maximum area of approximately 15 hectares (estimated from Iron Road Drawing E-F-50-Z-2000_P). Once the depositing of the waste rock and tailings at the integrated landform has commenced, the topsoil will be progressively reclaimed and re-deposited on top of the landform and revegetated.

2.4.10 Mobile fleet

In addition to the seven excavators and up to 20 drill rigs operating in the mine pit, additional mobile fleet will support operations in the mine pit and on the surface.

In the mine pit, modified pipe layers will be used to relocate conveyors and primary crusher stations will be self-propelled. Dozers will operate in the mine pit supporting the excavators. Water trucks with water cannons will operate as required alongside each excavator to minimise dust during excavation.

Graders will undertake road construction and maintenance on pit roads and also on surface roads across the proposed Mining Lease area. Other mobile equipment including trucks, loaders, water trucks and dozers will operate at the stockpiles, cart topsoil, complete rehabilitation and maintenance work as required across the Mining Lease. A complete list of mobile fleet is provided in Table 2-2.

Table 2-2: Operational phase mobile equipment fleet

Mobile Equipment Item	Quantity
Excavators - Liebherr R 9800	7
Pipe layer - 300 kW	4
Haul Truck - 240T class	2
Cat 944H Loader	1
Dozer - D11	6
Dozer - D10	4
Dozer - Wheel	3
Grader - 24M	6
Grader 16M	1
Water Truck - 135Kl	5
Water Truck - 85Kl	2
Drill rigs	20

3 Mine Air Quality Assessment

3.1 Project Ambient Air Quality Standards

Key ambient air quality indicators selected for the assessment were: (1) For the protection of human health, Particulate Matter 10 (PM_{10}) and $PM_{2.5}$ (see Glossary for technical definitions); and (2) For the protection of amenity, Total Suspended Particulates (TSP) and dust deposition. The adoption of ambient standards for the Project was undertaken in accordance with discussions held between EPA, DMITRE (now DSD), Iron Road and SKM throughout 2013.

In South Australia, air quality indicators and their ambient air quality standards or 'design criteria' are specified in the Environment Protection Authority (EPA) guidance document, *EPA 386/06, Air quality impact assessment using design ground level pollutant concentrations (DGLCs), Updated January 2006* (EPA, 2006). While EPA (2006) does not list design 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 PM_{10} and $PM_{2.5}$ were adopted for the Project (National Environment Protection Council, 2003).

The NSW Environment Protection Authority (formerly the Department of Environment and Conservation or DEC) criteria for TSP and deposited dust were adopted for the Project for the protection of amenity from nuisance dust (DEC, 2005).

The ambient air quality standards adopted for the Project are set out in Table 3-1 (NEPC, 2003), Table 3-2 (DEC, 2005) and Table 3-3 (EPA, 2006) for gaseous pollutants.

Table 3-1: Project criteria for airborne dust particles

Assessment Parameter	Averaging Period	Max GLC, including background	Goal (maximum allowable exceedances)
PM_{10}	24 hours	50 $\mu g/m^3$ (NEPM)	5 days a year
$PM_{2.5}$	24 hours	25 $\mu g/m^3$ (NEPM advisory reporting goal)	Not specified
$PM_{2.5}$	Annual	8 $\mu g/m^3$ (NEPM advisory reporting goal)	Not specified

Table 3-2: Project criteria for nuisance dust

Assessment Parameter	Averaging Period	Maximum including background level	Notes:
TSP	Annual	90 $\mu g/m^3$	Nil
Dust deposition	Annual	4 g/m^2/month	Maximum total deposited dust level
	Annual	2 g/m^2/month	Maximum increase in deposited dust level

Table 3-3: Project criteria for gaseous emissions

Assessment Parameter	Averaging Period	Max GLC, including background	Notes:
NO_2	1 hour	158 $\mu g/m^3$	For assessments outside of the Adelaide metro area
CO	1 hour	29,000 $\mu g/m^3$	
SO_2	1 hour	450 $\mu g/m^3$	

3.2 Existing Environment

This section describes the geographical setting of the proposed mine site and provides climatological summaries representative of the Warramboo location.

3.2.1 Geographical setting

The proposed Mining Lease area is located in a rural district of the central Eyre Peninsula, adjacent and directly east of the small township of Warramboo (33.24° S, 135.595° E). The next closest town is Kyancutta, approximately 12.6 km NNW from Warramboo, on the Tod Highway.

The proposed Mining Lease area is approximately 8,500 hectares. The terrain is relatively flat, with land elevations ranging from 53 to 192 metres above sea level.

A terrain map of the area surrounding the proposed mine site is provided in Figure 3-1. The terrain elevations are shown exaggerated in the vertical and represent the final extent of the mine.

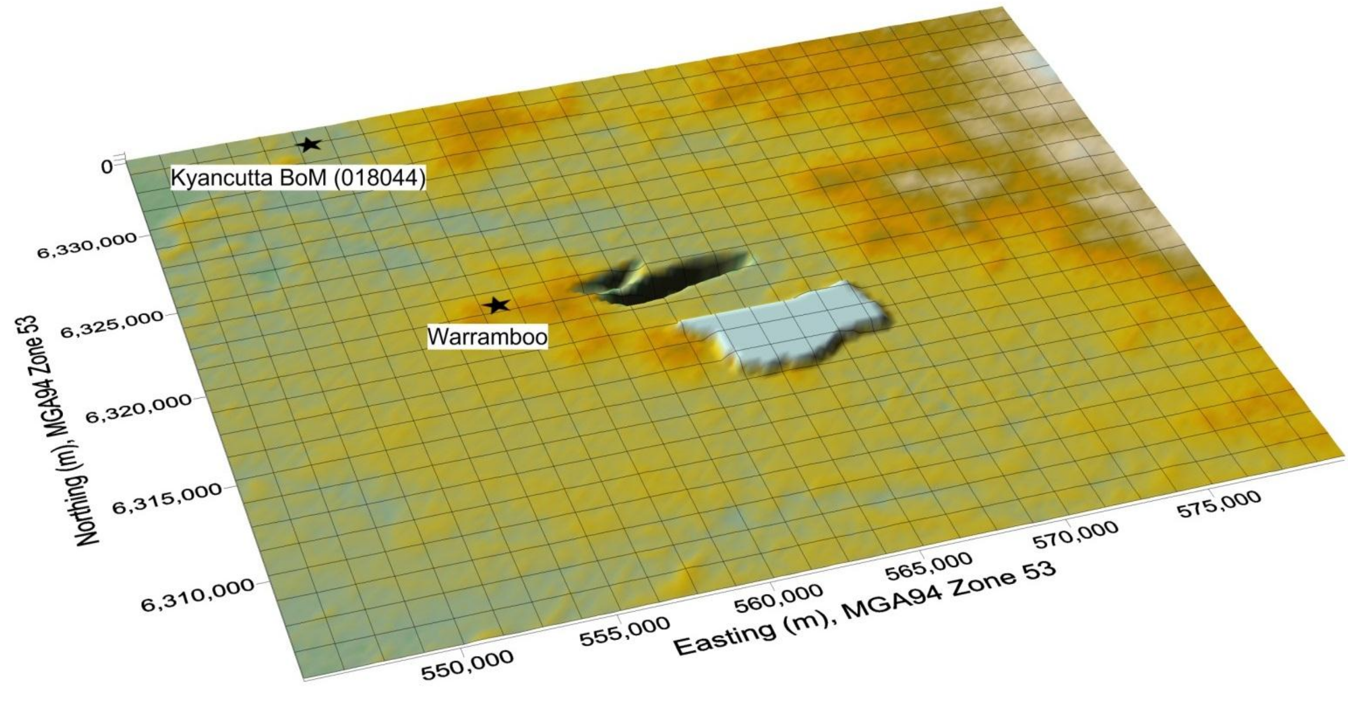


Figure 3-1: Terrain in vicinity of proposed Mining Lease area

3.2.2 Sensitive receptors and base map

A base map was created for overlaying the dispersion model spatial results in accordance with the guidance set out in EPA (2005) and EPA (2006). The base map is shown in Figure 3-2. The co-ordinate system used was Map Grid of Australia 1994 (MGA94). In the figure, the blue markers represent the locations of the sensitive receptors identified in the vicinity of the proposed Mining Lease area. The orange line shows the boundaries of the proposed Mining Lease area.

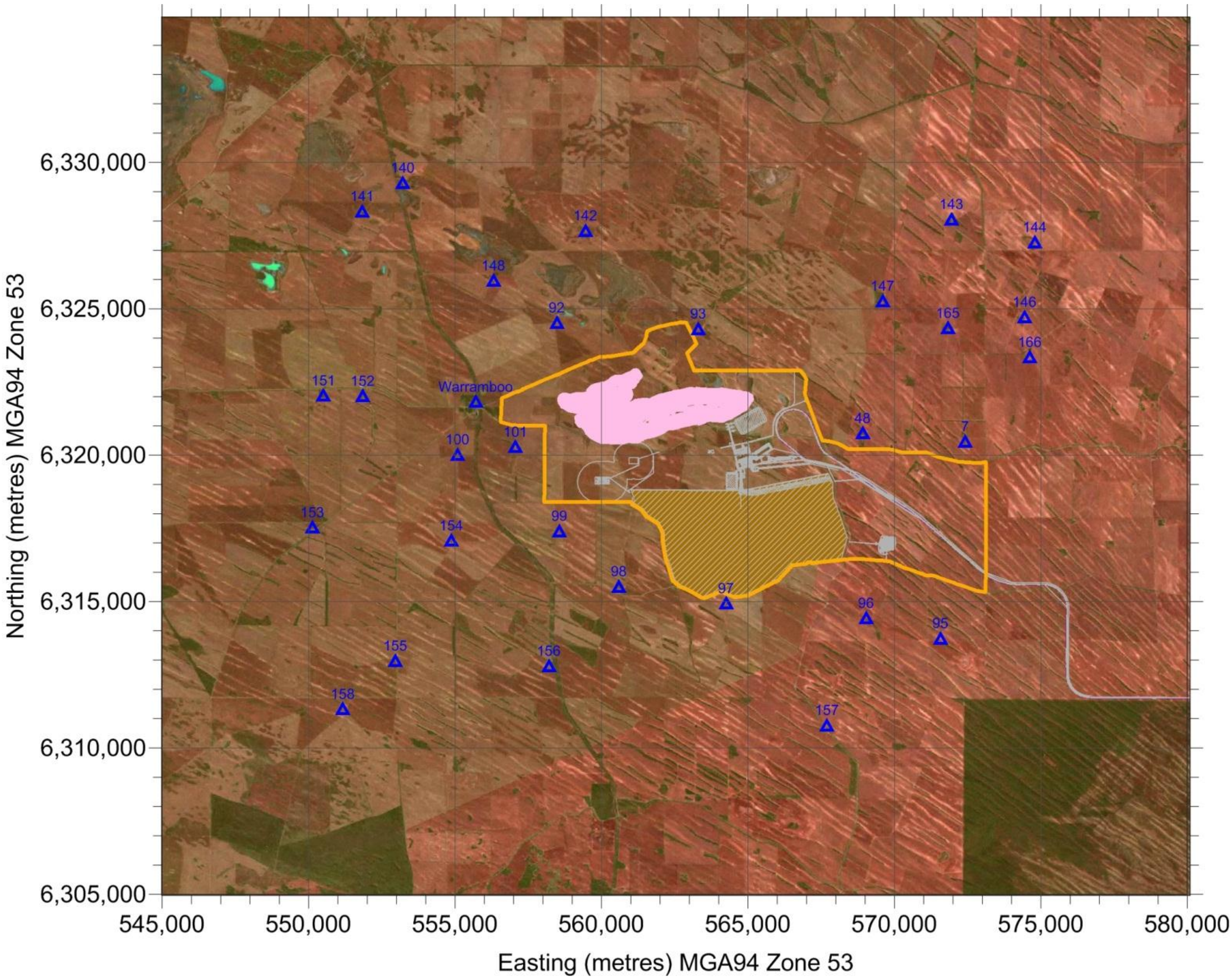


Figure 3-2: Proposed Mining Lease area: base map and sensitive receptor locations

The approximate distances of each of the sensitive receptors to the Mining Lease boundaries are provided in Table 3-4.

Table 3-4: Sensitive receptor distances from mine site boundaries

Sensitive Receptor Identifier	Approx. distance from mine site boundary (m)
Warramboo	860
7	650
48	510
92	1590
93	260
95	1980
96	2040
97	340
98	1820
99	1030
100	1870
101	780
140	8050
141	7920
142	3990
143	7270
144	7660
146	5090
147	3640
148	3760
151	6070
152	4730
153	7390
154	3450
155	7460
156	5140
157	5210
158	9890
165	4260
166	3850

3.2.3 Climatological summaries

Local meteorology is important for determining the direction and rate at which emissions from a source are likely to disperse. This section provides climatological summaries of local conditions representative of longer term conditions for the Mining Lease area.

Meteorological data for 2009, (the case study year used for the modelling), are compared with the outputs from the meteorological modelling in Section 3.5.1.

Observations of local meteorology or climatology for the Warramboo locality are limited. The BoM's closest weather station is Kyancutta, approximately 12km north-northwest of Warramboo (BoM station number 018044, 33.13° S, 135.55° E), however provides only four observations daily.

The closest weather station to the mine site that provides hourly data is the Wudinna Aerodrome station (BoM station number 018083, 33.04° S, 135.45° E), located approximately 26 km NNW from Warramboo (also on the

Tod Highway; see Figure 3-3). A summary of some key geographical parameters important for climatology of the mine site locality and the two locations of the BoM weather stations is provided in Table 3-5.

Table 3-5: Geographical parameters for Warramboo, Kyancutta and Wudinna

Parameter	Warramboo	Kyancutta	Wudinna
Approximate latitude	S. 33.24°	S. 33.13°	S. 33.04°
Approximate distance from major waters of Spencer Gulf	115 km	130 km	145 km
Approximate distance from Great Australian Bight	75 km	75 km	70 km

Summaries of longer term BoM observations for Wudinna (Wudinna Aero) are provided in the following figures:

- Wudinna Aero 1999-2013 observations of monthly mean maximum and minimum temperatures; Figure 3-4.
- Wudinna Aero 1999-2010 observations for monthly mean 9AM and 3PM relative humidity; Figure 3-5 .
- Wudinna Aero 1999-2013 observations for mean monthly and highest monthly rainfalls; Figure 3-6.
- Wudinna Aero 1999-2010 observations for monthly mean 9AM and 3PM wind speeds; Figure 3-7.

A summary of selected climatological statistics for the Wudinna Aero observations is provided in Table 3-6.

Table 3-6: BoM Wudinna Aero climatological summary

Month	Mean Temp. (°C) 1999–2013	Mean Rainfall (mm) 1999–2013	Mean 9AM wind speed (m/s): 1999–2010	Mean 3PM Wind Speed (m/s) 1999–2010
January	33.5	9.8	5.3	5.8
February	32.8	12.8	4.8	5.4
March	29.3	21.1	3.9	5.1
April	25.2	15.1	4.4	5.2
May	207	21.9	4.1	5.3
June	17.4	32	4.3	5.9
July	16.9	34.8	4.7	6.0
August	18.7	34.3	5.2	6.3
September	22.3	26.5	5.7	6.7
October	25.4	22.4	5.8	6.5
November	29.5	14.1	5.4	5.9
December	30.9	18.9	5.6	6.1
Annual	25.2	263.1	4.9	5.8

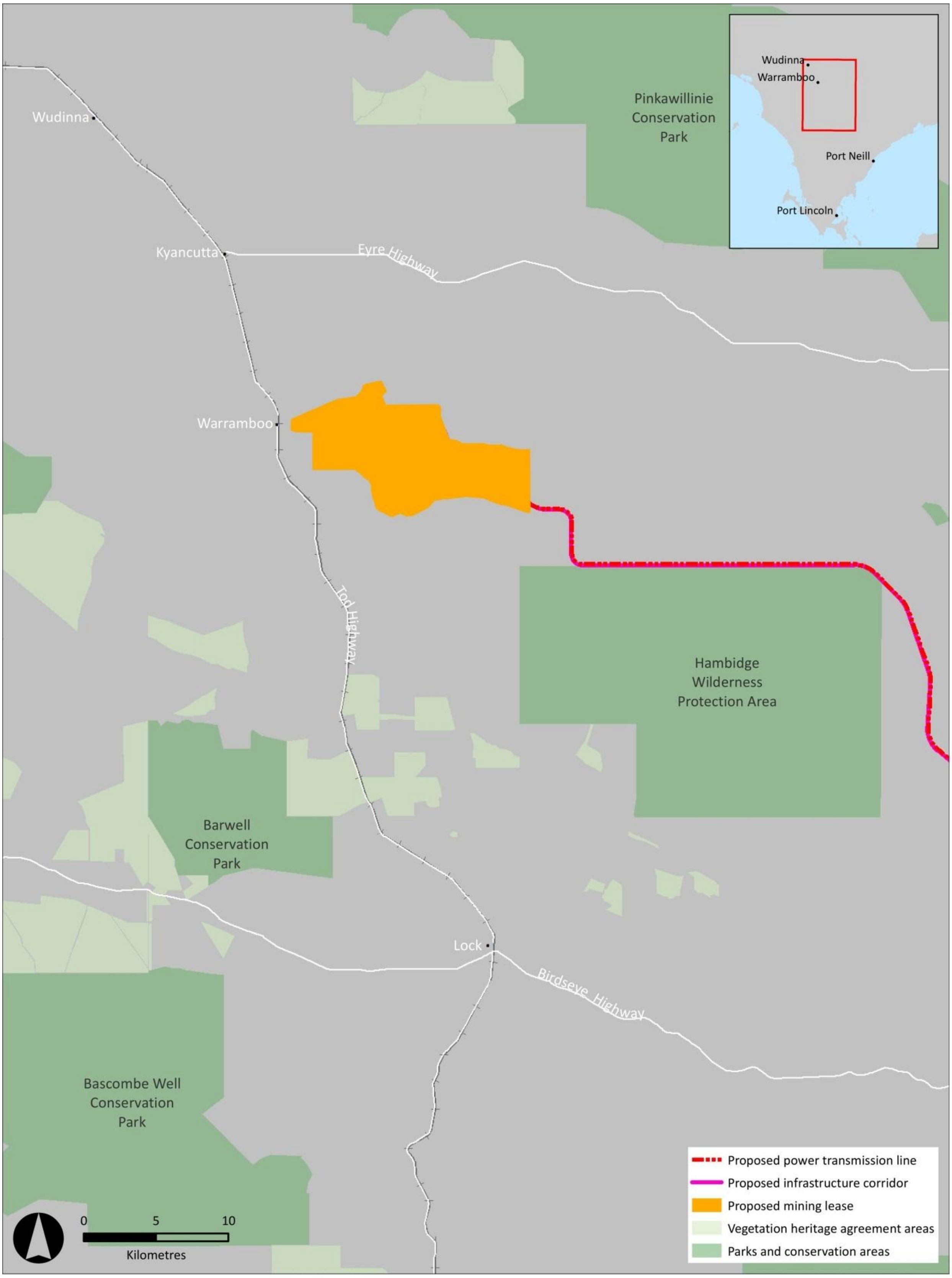


Figure 3-3: Local setting for proposed Mining Lease area

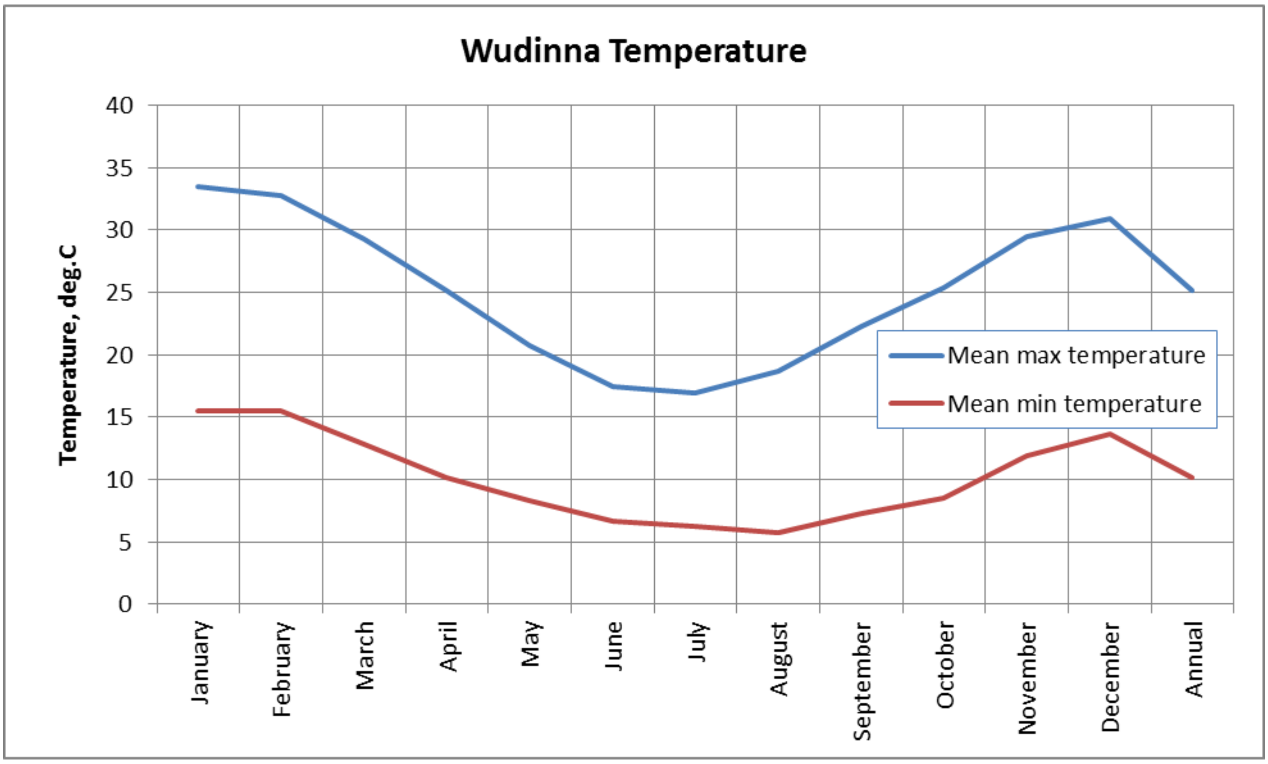


Figure 3-4: BoM Wudinna Aero temperature observations 1999 – 2013

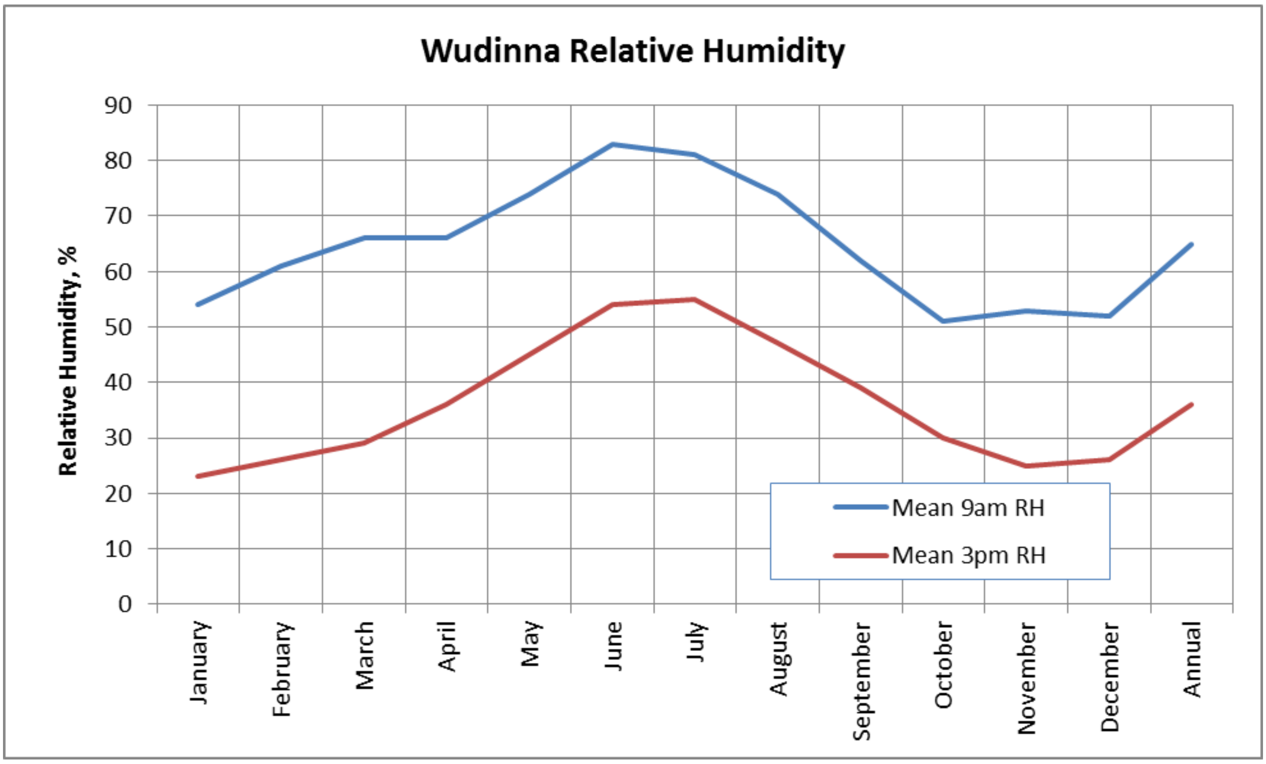


Figure 3-5: BoM Wudinna Aero relative humidity observations 1999 – 2010

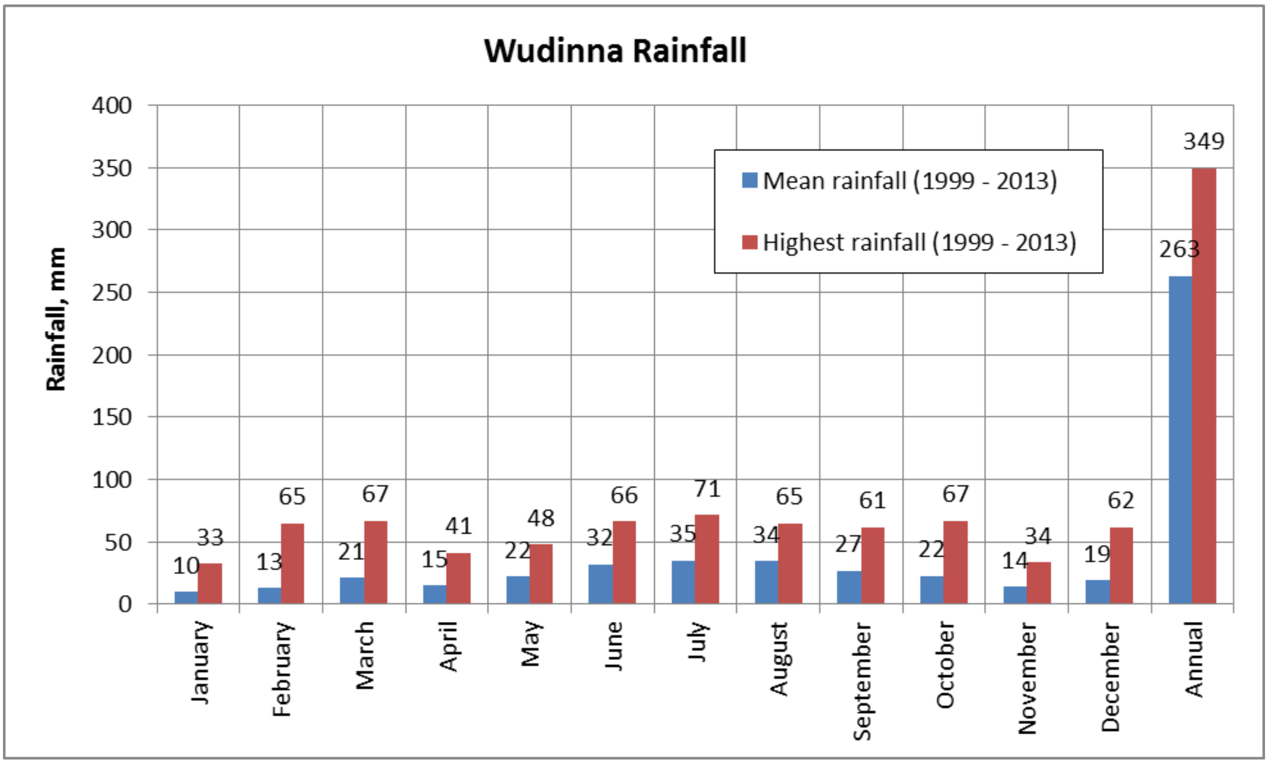


Figure 3-6: BoM Woomera Aero rainfall observations 1999 – 2013

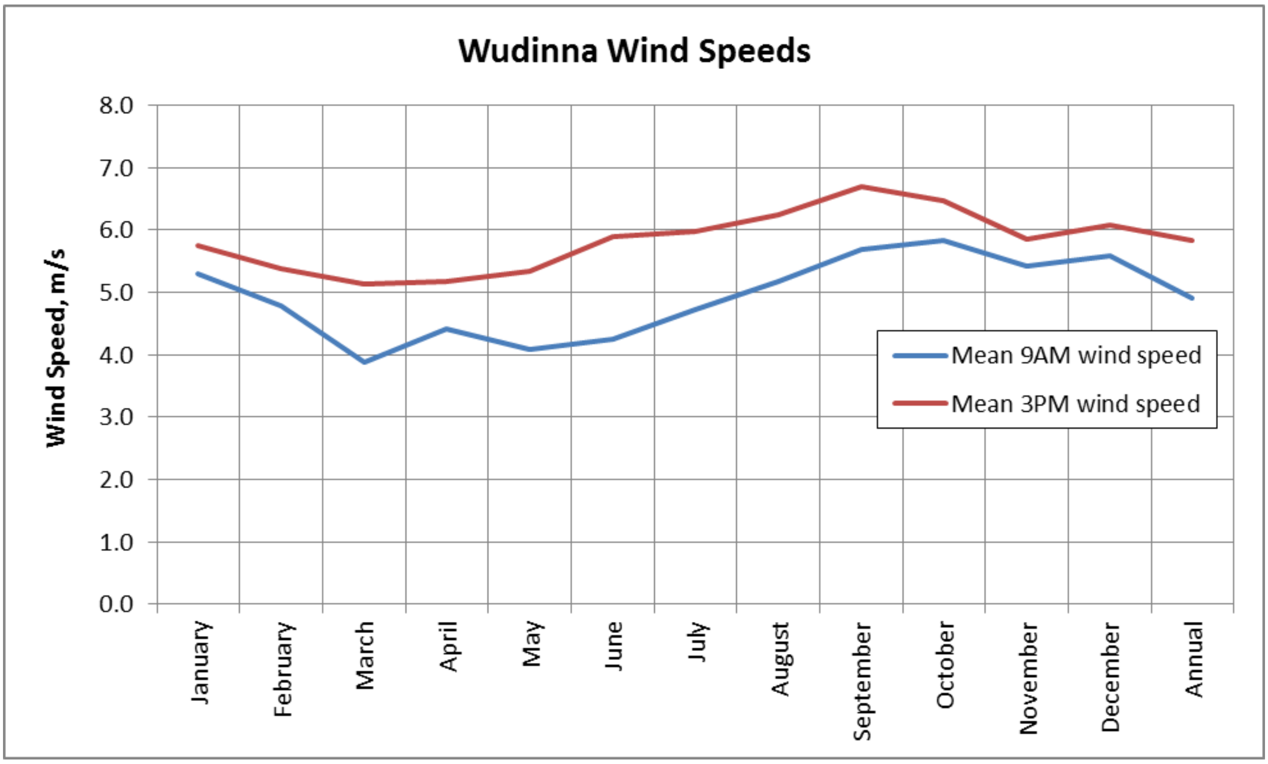
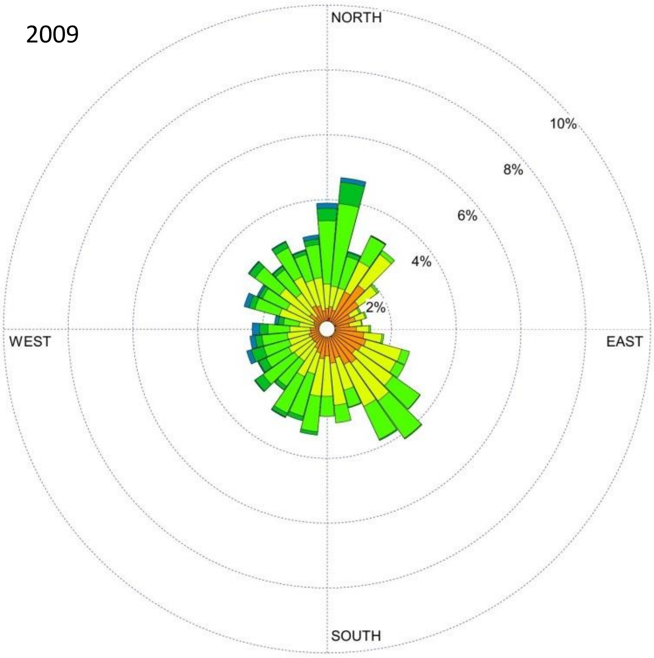


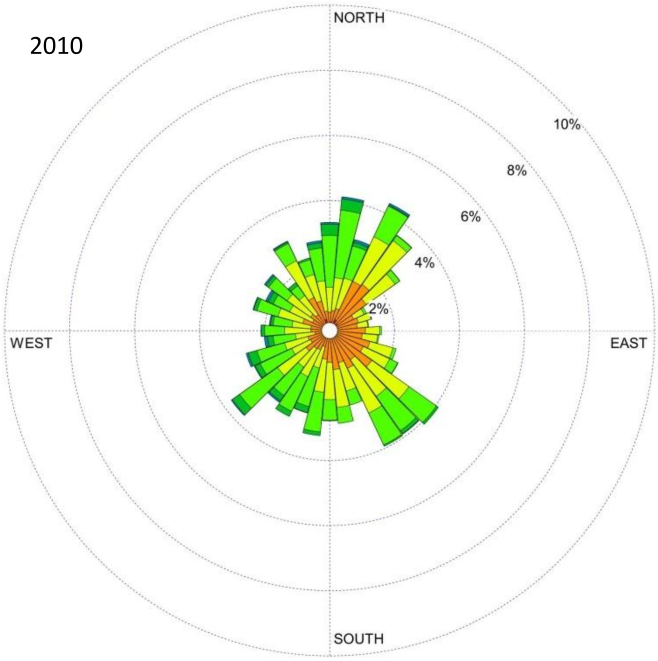
Figure 3-7: BoM Wudinna wind speed observations 1999 – 2010

The year 2009 was selected as the study year for the assessment (see Section 1.2.2; also further explanation is provided in Section 3.4.1). For comparison, Figure 3-8 shows the wind rose for 2009 alongside those from 2010, 2011, 2012 and 2013.

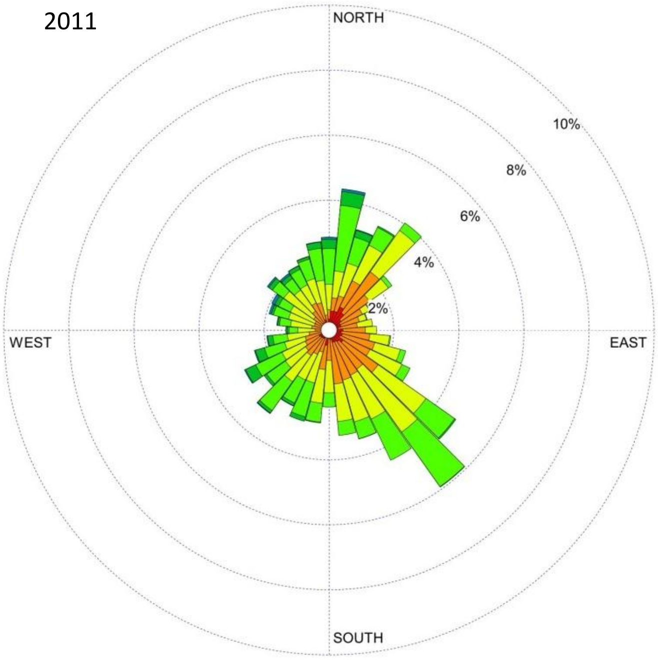
2009



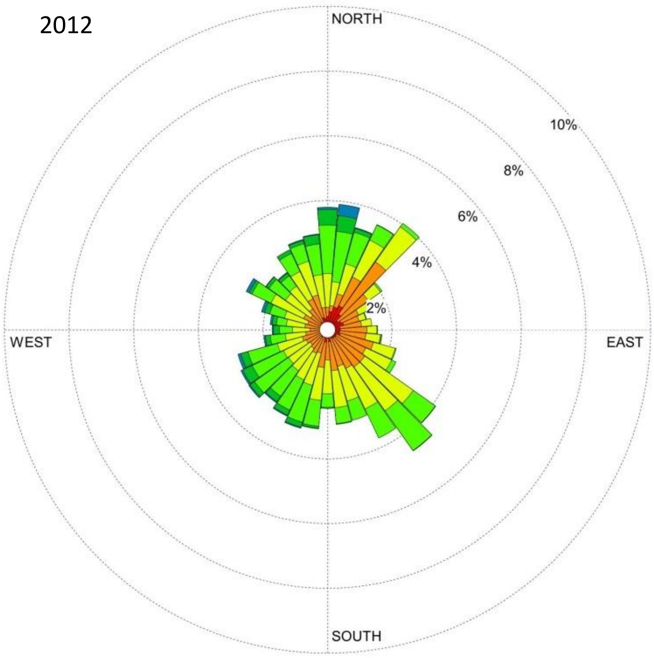
2010



2011



2012



2013

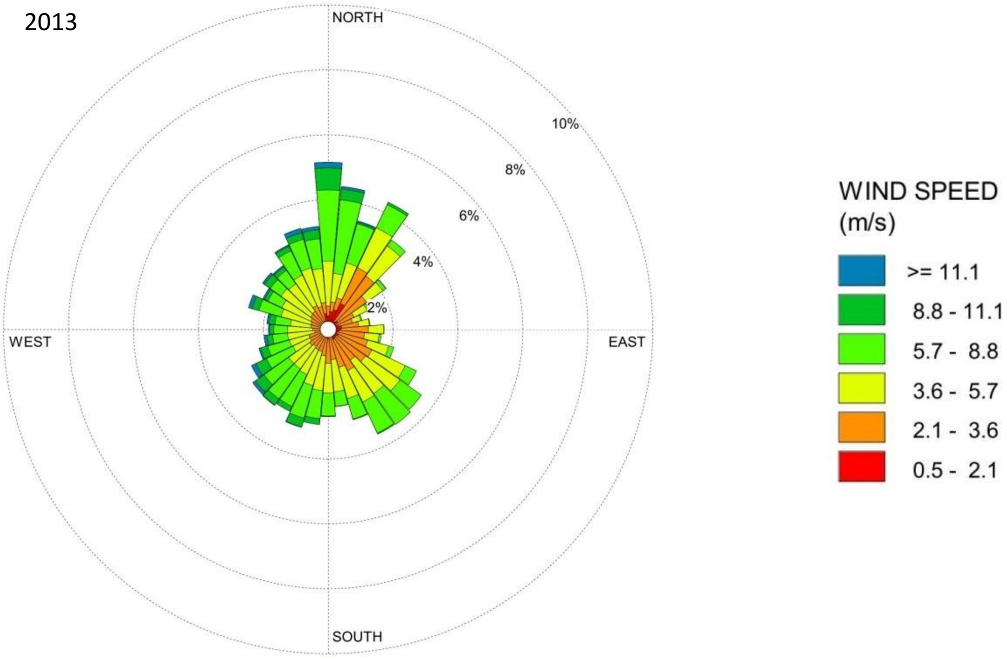
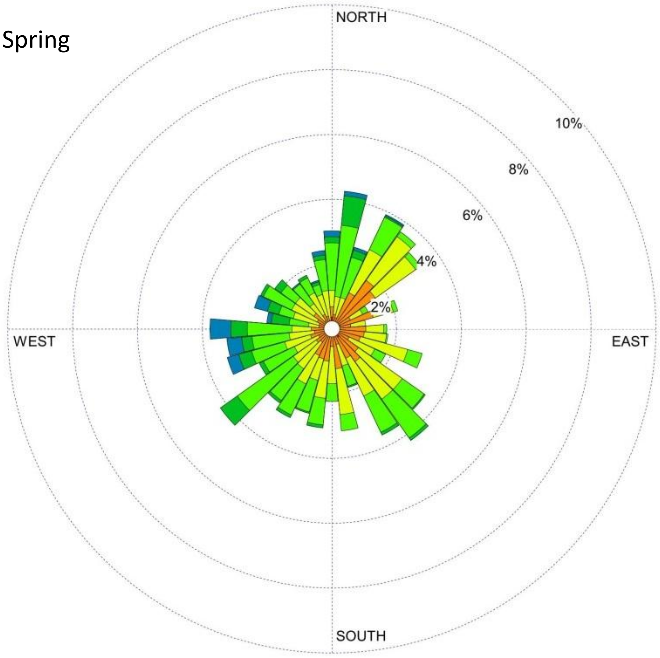


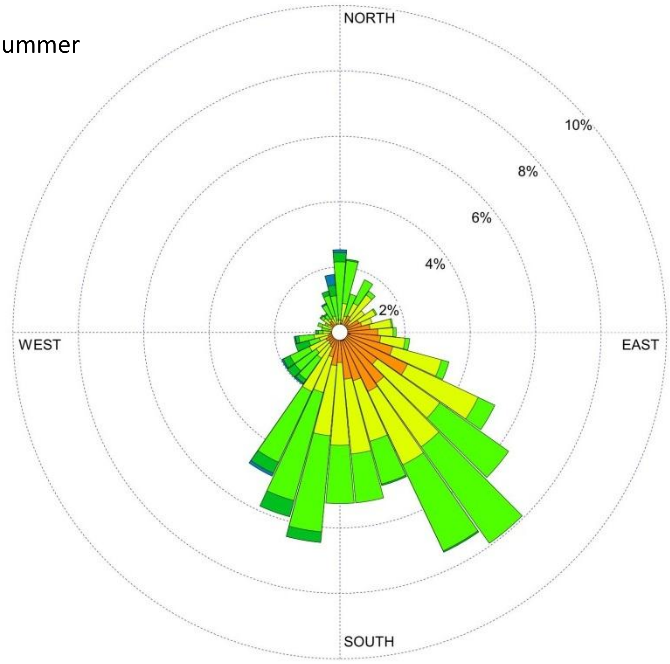
Figure 3-8: Wudinna BoM wind roses, all hours – 2009, 2010, 2011, 2012 and 2013

The Wudinna Aero annual wind roses for 2009 through to 2013 show dominant south-easterly and north-northeasterly winds for each year. The wind roses show that 2009 is typical of conditions seen in other years. Seasonal wind roses for 2009 are provided in Figure 3-9.

Spring



Summer



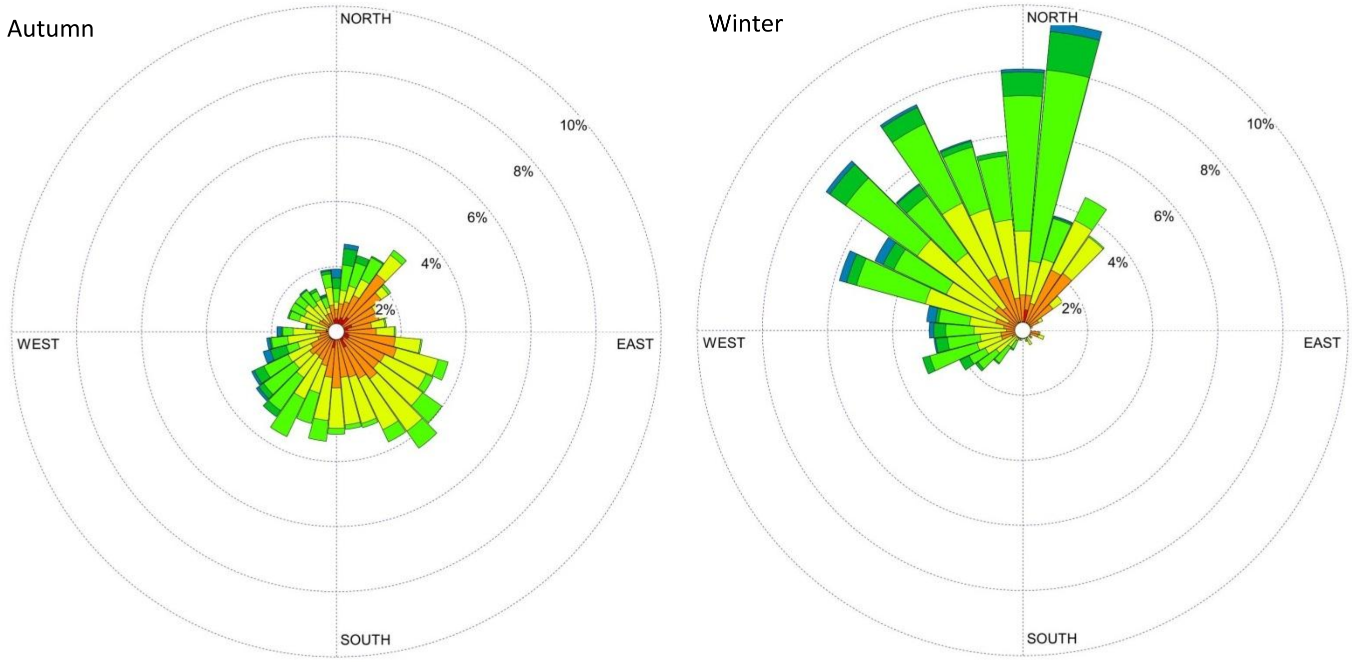


Figure 3-9: Wudinna BoM seasonal wind roses, 2009

The seasonal wind roses show the large seasonal variations in winds for the region. The dominant south-easterly wind direction seen in the annual wind rose occurs mainly during the summer months, and the north-north-easterly winds occur mainly in winter. Calm wind conditions are observed most often in autumn and the highest average wind speed occurs in winter.

Inspection of the seasonal wind roses is useful for determining which areas around the mine site may be subject to potential dust impacts at different times of the year. For example, sensitive receptors to the northwest of the site may have a higher risk of dust impact during the summer and autumn months when wind speeds are low to moderate (thereby limiting dust dispersion), and the predominant wind direction is south-easterly.

3.2.4 Existing air quality

The proposed Mining Lease area is centrally located on Eyre Peninsula, in a rural environment expected to be characterised by clean air; i.e., the Warramboo locality as well as most other localities on Eyre Peninsula are expected to have “good air quality” or “very good air quality” as defined by the EPA (2015). The only existing air pollutant of significance is expected to be airborne particulate matter. Sources of particles would include wind-blown dust on regional and local scales, vehicle movements and wind-blown dust from unpaved roads and exposed areas, agricultural activities, and fires.

At the time of this modelling study there was very little quality information about existing air quality on central Eyre Peninsula. As such estimates for background particulate matter levels for the study area were determined using Tapered Element Oscillating Microbalance (TEOM) measurements at Whyalla and Adelaide; this monitoring was undertaken in consultation with the EPA.

Estimates for representative 24-hour average data for the proposed Mining Lease area were determined using: (1) PM_{10} data from Schultz Park, Whyalla; and (2) $PM_{2.5}$ data from Netley, Adelaide.

The TEOM data were used to calculate the 50th percentile (median) and 70th percentile particulate matter concentrations for the selected modelling year, 2009. The calculated 50th percentile concentration for $PM_{2.5}$ was used for comparison with the NEPM $PM_{2.5}$ annual average concentration criterion, and the 70th percentile particulate matter concentrations were used for comparison with the NEPM $PM_{2.5}$ and the PM_{10} 24-hour average criteria. The precedent for using the 70th percentile of the 24 hour average concentrations is guidance set out in the Victorian Government (VG) *State Environment Protection Policy (Air Quality Management)* (VG, 2001).

The TSP background concentration was estimated by doubling the concentration of the 50th percentile PM_{10} dust concentration. Initially background dust deposition (2 g/m^2/month) was an estimate based on previous experience with measured dust deposition in remote areas. Subsequently this estimate was supported by 2014 dust deposition measurements obtained from near Warramboo (Jacobs, 2015). The estimates for background GLCs used in the dust modelling assessment are provided in Table 3-7.

Table 3-7: Estimates for background airborne particulate matter and deposited dust.

Parameter	Value	Derivation, source
Background maximum 24-hour average PM_{10} GLC for modelling study	22 µg/m^3	70th percentile 1hr avg. PM_{10} GLCs, Whyalla (21.4 µg/m^3)
Background maximum 24-hour average $PM_{2.5}$ GLC for modelling study	10 µg/m^3	70th percentile 1hr avg. $PM_{2.5}$ GLCs, Netley (9.3 µg/m^3)
Background annual average $PM_{2.5}$ GLC for modelling study	7 µg/m^3	50th percentile 1hr avg. $PM_{2.5}$ GLCs, Netley (6.9 µg/m^3)
Background annual average TSP GLC for modelling study (all seasons)	30 µg/m^3	Double the 50th percentile 1hr avg. PM_{10} GLC, Whyalla(2 × 14.7 µg/m^3)
Background monthly dust deposition for modelling study (all seasons)	2 g/m^2/month	Conservative (high), based on 2014 measurements near Warramboo (Jacobs, 2015)

Estimates for background NO_2 and ozone (O_3) concentrations used in the assessment were taken from a Netley 2009 dataset provided by the EPA (EPA, 2014). This dataset consisted of hourly average records of NO_2 and O_3 concentrations for several localities across the metropolitan area of Adelaide. The hourly concentrations for each of NO_2 and O_3 for Netley were adopted as the representative concentrations for the modelling work.

A summary of the NO_2 and O_3 concentration statistics for Netley is provided in Table 3-8.

Table 3-8: SA EPA ozone and NO_2 concentration data, Netley 2009

Calculated statistic	O_3, ppm	O_3, ug/m^3	NO_2, ppm	NO_2, ug/m^3
70th percentile	0.024	51.4	0.010	20.5
90th percentile	0.030	64.3	0.020	41.1
Average	0.018	38.7	0.008	16.1
Maximum	0.070	150	0.050	103

3.3 Air Emissions Sources and Estimates

This section sets out the dust particle (TSP, PM_{10}, and $PM_{2.5}$) emissions estimates for modelling. The emissions calculations were based on techniques set out in the following sources:

- NPI *Emission Estimation Technique Manual (EETM) for Mining* (NPI EETM for Mining, 2012)
- AP-42 (US EPA, 1995 and updates)
- Control of Open Fugitive Dust Sources; for WGD control factor equation (US EPA, 1998)
- User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Model Algorithms; for pit retention formula (US EPA, 1995)

Emissions of non-particulate air pollutants, i.e. gases, are also discussed in this section. The following sources were used for estimating emissions for the gaseous pollutants for the mine site:

- NPI *Emission Estimation Technique Manual (EETM) for Combustion Engines*; for diesel equipment emissions (NPI EETM for Combustion Engines, 2008)
- NPI *Emission Estimation Technique Manual (EETM) for Explosives detonation and firing ranges,* (NPI EETM for Explosives, 2012)
- NIOSH, *Factors Affecting ANFO Fumes Production* (NIOSH, 2000)

3.3.1 Key air particulate emission sources

The air quality assessment for the mine site is based on estimates of particle emission rates for each of the various mining and processing activities to be carried out.

The key activities used for the air emissions estimates are detailed in the following points:

- Drilling and blasting
- Excavating ore and waste rock at the Murphy and Boo Loo pits and loading the material into the mobile crushers
- Crushing of ore and waste rock at the primary crushers
- Handling, transferring and conveying crushed ore from the crushers to the processing area
- Loading the crushed ore to the coarse ore stockpiles adjacent the processing area
- Handling, transferring and conveying crushed waste rock from the crushers
- Handling, transferring and conveying the combined tailings and crushed waste rock to the integrated land form
- Loading the combined tailings and waste rock to the integrated land form
- Handling, transferring and conveying the ore concentrate product
- Loading and reclaiming ore concentrate to and from the mine concentrate stockpile and bypass stockpile
- Loading ore concentrate to trains
- Wind erosion of the mine concentrate stockpile and bypass stockpile
- Wind erosion of the integrated land form
- Wind erosion of the topsoil stockpile
- Removing and transferring topsoil to stockpiles
- Wheel generated dust from haul trucks
- Bulldozers operation
- Road maintenance activities

Each of the activities listed above is considered to be a potential dust source and included in the modelling input. Various dust control measures such as water sprays, enclosure and filtration, etc., will be adopted to minimise dust emissions from each of the potential sources where practical. These are described in detail in Section 3.3.4.

3.3.2 Modelling scenarios

Throughout the life of the mine, the extent of mining activity will vary and there will be various stages during which different activities will occur. This means that as the mine site progresses, 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 three key operating scenarios which are expected to represent the different stages of the mining operation are:

1) **Scenario No.1** – Construction phase, Year 0 – Year 1. No iron ore concentrate production, activity in Murphy pit only.
2) **Scenario No.2** – Early mining phase, Year 2. Maximum mining rate of 81.4 Mtpa. Activity in Murphy pit only.
3) **Scenario No.3** – Peak mining phase, Year 18 and onwards. Maximum mining rate of 347.1 Mtpa. Activity in both Murphy South pit and Boo Loo pit.

It is acknowledged that there will be other intermediate mining stages that are combinations of the above scenarios. However these three scenarios are expected to best represent distinct stages of the mining operation in terms of changes in dust emissions. For each phase, the maximum materials movement rate during that phase is included in the dust emissions estimate work such that the 'worst-case' dust emission estimates are captured.

The dust emission estimates for mining operations after Year 18 have not been provided here as the mining production rate is not expected to exceed that captured under Scenario No.3. As the dust emission estimates for the operational phase are heavily dependent on the material movement rate, Scenario No.3 was considered to represent the worst case scenario for air quality assessment. The maximum area extents for the Murphy and Boo Loo pit and the maximum area and height extents have been assumed for Scenario No.3.

During the construction phase, represented by Scenario No.1, there will be a large heavy mobile vehicle fleet operating at the pit areas as well as the processing area. Key activities will include clearing areas of vegetation and topsoil, stockpiling of topsoil, establishing excavation works, constructing foundations for infrastructure, commencing the building of the ramp for the integrated land form, etc. Emissions from these activities have been estimated and are provided in Section 3.3.6.

After the construction phase is complete and when the processing of ore begins, the type of activities will change and affect the particulate emissions expected. The key change will be a decrease in the number of heavy mobile vehicles operating at the pit area. Mobile crushers (ore and waste rock) and conveyors will be established within and near the pit area. The excavated material will be loaded directly into the mobile crushers. Following crushing, the ore will be transferred to the processing area and the waste rock will be transferred to the integrated land form.

The use of mobile crushers and conveyor systems is expected to lead to a significant reduction in emissions in comparison with traditional excavation and haul truck transfer of material due to the reduction in wheel generated dust. In this way, a potentially large haul truck fleet, very likely in excess of 50 large haul trucks with its associated dust emissions, was eliminated from the mining proposal.

3.3.3 Key input data and assumptions

Estimates for material movement rates and other parameters detailing the final extent of the open cut pit and Integrated Land Form (IWL), for all three air emissions scenarios, are provided in Table 3-9, through to Table 3-12.

Table 3-9: Material movement rates and pit/IWL extent input data

Material Movement Rates and Pit/IWL Extents			
Boo Loo Pit Area - total maximum extent	2,415,747	m^2	Max extent at end of mine life
Murphy Pit Area - total maximum extent	5,309,160	m^2	Max extent at end of mine life
IWL Area - total maximum extent	19,200,000	m^2	Maximum extent at end of mine life. [Note 1]
IWL - ultimate height	135	m	Max height at end of mine life
Total mass rate of material excavated	347.1	Mtpa	Max annual rate within mine life
Strip ratio (waste rock : ore)	1.2		
Rate of ore processed at crushers	160.7	Mtpa	Max annual rate within mine life
Mass rate of waste rock processed at crushers	186.4	Mtpa	Max annual rate within mine life
Ore and waste rock processing 'up time'	89.7	%	Represents the expected equipment availability and utilisation
Concentrate production rate	21.5	Mtpa	Max annual rate within mine life
Combined WR and tailings production rate	325.6	Mtpa	Max annual rate within mine life
Mass rate of tailings to IWL	139.3	Mtpa	Max annual rate within mine life
Ore concentrate and WR/tailings processing 'up time'	95.0	%	Represents the expected equipment availability and utilisation
Mine product to stockpile rate – peak	2,582	tphr	
Mine product stockpile reclaim and train loading rate	6,500	tphr	
Mine product bypass stockpile reclaim rate	540	tphr	
Topsoil movement rate	0.75	Mtpa	1.5 mt over 2 years

Table 3-10: Mine process operations input data

Mine Processing Operations			
Crushed rock stockpile area ex Primary crusher	83,350	m^2	Area of total of 3 cone stockpiles
Number of ore transfer points	6		
Number of WR transfer points	5		
Number of WR/Tailings transfer points	5		From processing area to IWL
Mine product stockpile area	22,789	m^2	Single stockpile
Mine product bypass stockpile area	1,691	m^2	Single cone stockpile

Table 3-11: General equipment fleet input data

Equipment Fleet Details			
Haul truck payload, 360 US (short) ton	327	tonnes	
Haul truck payload, 240 US (short) ton	218	tonnes	
Average speed of haul truck	30	km/hr	
Max number of bulldozers operating at any one time	13		
Max number drill rigs operating at any one time	20		90% utilisation
Max number of graders operating at any one time	7		
Grader VKT per year	306,600	VKT/year	Estimate includes each grader operating 50% of the year, 10 km/hr average speed.
Average speed of light duty vehicle	50	km/hr	40 km/hr near mine site, 60 km/hr on open roads. 50% split assumed.
Light vehicle VKT per day - total	450	VKT/day	Estimate includes 15 vehicles, 5 km per trip average, 6 trips per day.

Table 3-12: Mine site miscellaneous input data

Miscellaneous Input Data			
Assume emission rates for $PM_{2.5}$ as % of PM_{10}	35%	%	Default, if not specified otherwise by NPI Emission Estimation Technique Manuals
Excavated material silt content	10	%	NPI EETM default
Haul road material silt content	8.3	%	US EPA AP-42 Note 2
Excavated material moisture content	4.8	wt%	Estimate by Iron Road Note 3
Haul road moisture content	2	wt%	
Number of blasts per day	1	Per day	
Number of holes drilled per day	335	Per day	
Topsoil stockpile area	150,000	m^2	

Notes:

1. The input to the modelling assumes that at any one time, the ‘active’ area of the IWL stockpile which is subject to wind erosion is the area which has been developed within the previous 12 months. At a development rate of 76.8 hectares per year (over the 25 year life of the mine) for the IWL, this means that 76.8 hectares will be subject to wind erosion at any one time. It is expected that for the IWL area created prior to this time, the surface will be capped. In addition, any dust particles which may be subject to wind erosion would have been depleted from the landform and this area would be ‘inactive’.
2. The silt content of the material to be used on haul roads at the site was adopted from Section 13.2.2 (Miscellaneous Sources, Unpaved Roads) of US EPA AP-42 (1995 and updates) for “stone quarrying and processing” on a haul road.
3. The moisture content for the excavated material was estimated to be 6% by weight (6wt%) by IRD. From Section 13.2.4 (Aggregate Handling and Storage Piles) of US EPA AP-42 (November 2006), the

range of source conditions for the use of the Equation 1 to estimate the emission rate generated for the batch drop operation is 0.25 to 4.8 %. As the estimated moisture content for the excavated material is above this, the maximum or the range, i.e. 4.8% was adopted.

The input data specific to each of the three scenarios is provided in Table 3-13.

Table 3-13: Scenario input data summary

Scenario Input Data	Scenario No.1 Construction - Year 0 - 1		Scenario No.2 Early mining - Year 2		Scenario No. 3 Peak mining - Year 18	
Total annual excavation rate, Mtpa	108.2		323.0		347.1	
Rate of transfer of tailings to IWL (peak), t/h Note 1	0		11,722		16,726	
Rate of transfer of waste rock and tailings to IWL (peak), t/h Note 1	13,692		36,217		39,110	
IWL area, m^2	0		1,536,000		13,824,000	
IWL height, m	0		135		135	
Topsoil stockpile area, m^2	150,000		150,000		150,000	
	Murphy Pit	**Boo Loo Pit**	**Murphy Pit**	**Boo Loo Pit**	**Murphy Pit**	**Boo Loo Pit**
Excavation rate, % in each pit	100%	0%	100%	0%	66%	34%
Excavation rate, Mtpa	108.2	0	323.0	0	229.1	118.0
Primary ore crusher processing rate (peak), t/h Note 1	**87**	**0**	**15,161**	**0**	**13,506**	**6,958**
Rate of transfer of waste rock to IWL (peak), t/h Note 1	**13,692**	**0**	**26,961**	**0**	**15,658**	**8,067**
Rate of topsoil/miscellaneous material removed, t/h	86	0	457	0	0	457
Number of crushers in pit	0	0	6	0	4	2
Number of shovels in pit at any one time	7	0	7	0	5	2
Number of 360 T haul trucks allocated to pit	12	0	0	0	0	0
Number of 240 T haul trucks operating	2	0	2	0	0	2
Number of bulldozers in pit at any one time	6	0	10	0	7	3
Haul truck 360 T average travel distance to Crusher Station No.1, km	1.9	0	0	0	0	0
Haul truck 240 T average distance from pit to IWL, km	4.2	0	5.0	0	0	8.0
360T Haul truck travel distance per day - VKT/day/truck (Scenario No.1 only)	287	0	0	0	0	0
Haul truck 240 T travel distance per day - VKT/day/truck	40	0.0	252	0	0	403

Notes:

1. 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.

The conceptual layout design for the mine site was used to map the air emissions source locations for modelling. The air emissions estimates associated with each of the activities were assigned to 'volume sources'. The markers shown in Figure 3-10 below indicate the location of the key emission sources for Scenario No.1. The emission source locations for Scenario No.3 are shown in Figure 3-11.

The mining operation will change year to year and day to day, both in terms of material movement and processing rates, e.g. excavation rate, crushing rate, etc., and the location of various activities, e.g. location of excavators, mobile crushers and conveyors, siting of key haul routes, etc. This means that the dust emission rates and dust source locations will be highly variable. When allocating dust source locations, sites are selected to best represent the different possible phases of the Project as far as practicable. For some very small emission sources, a single emission location was selected which was representative of the various locations from which dust might be generated for a specific activity. For larger sources, emissions were spread out over the area for which emissions were expected. As an example, for wheel generated dust, a key haul route was identified and the emissions were spread out along the entire length of this key route. It is acknowledged that there will be other routes which may be used at different times, however the objective is to capture the typical worst case operating scenario in the modelling input.

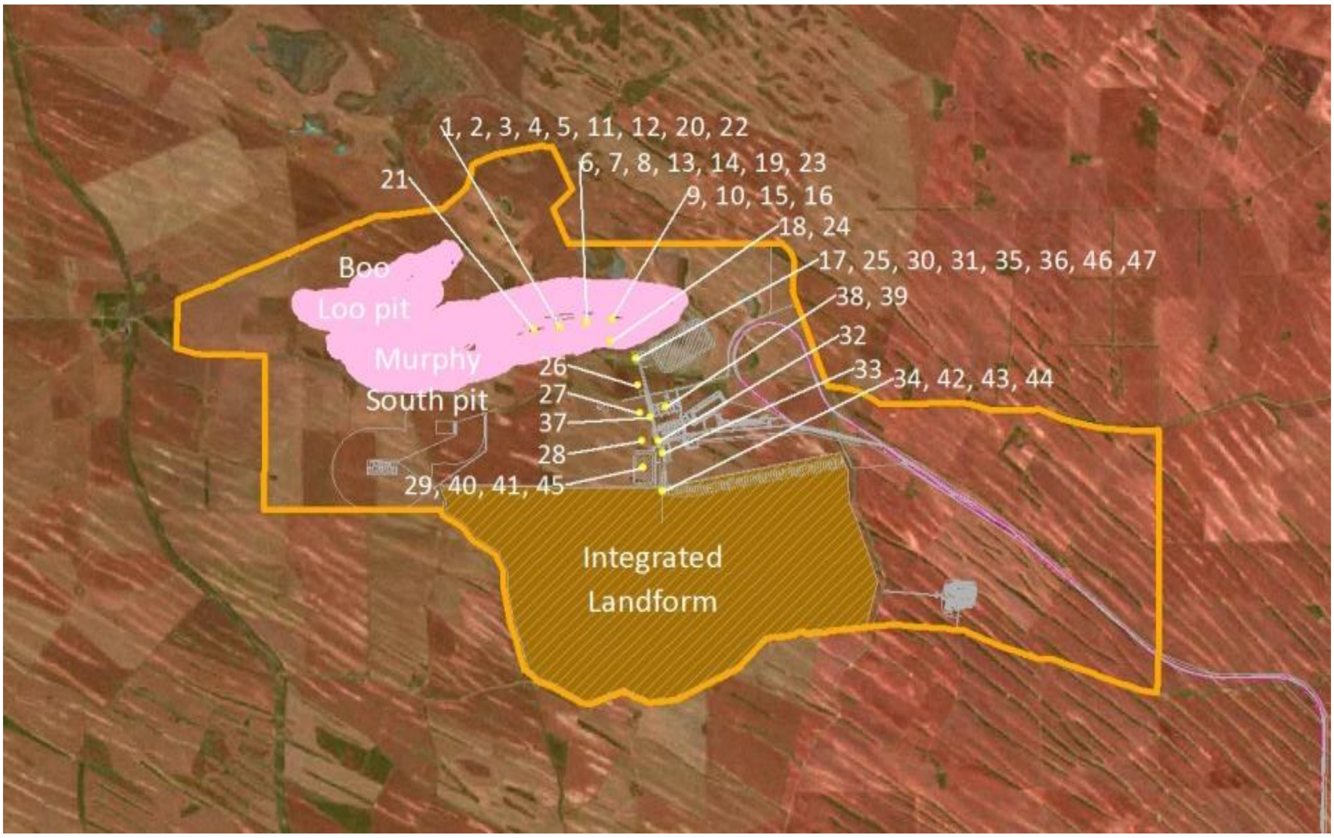


Figure 3-10: Key emission source locations (Scenario No.1)

Table 3-14: Scenario No.1 emission source location legend

Source ID	Emission source activity description
1	Topsoil 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 Murphy pit to IWL)
30	Truck dump at crushing station
31 - 34	Waste rock transfer points (mine edge to IWL)
35	Truck dump of ore at crushing station
36 - 37	Ore transfer points (mine 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 wheel generated dust (WGD), light duty vehicles

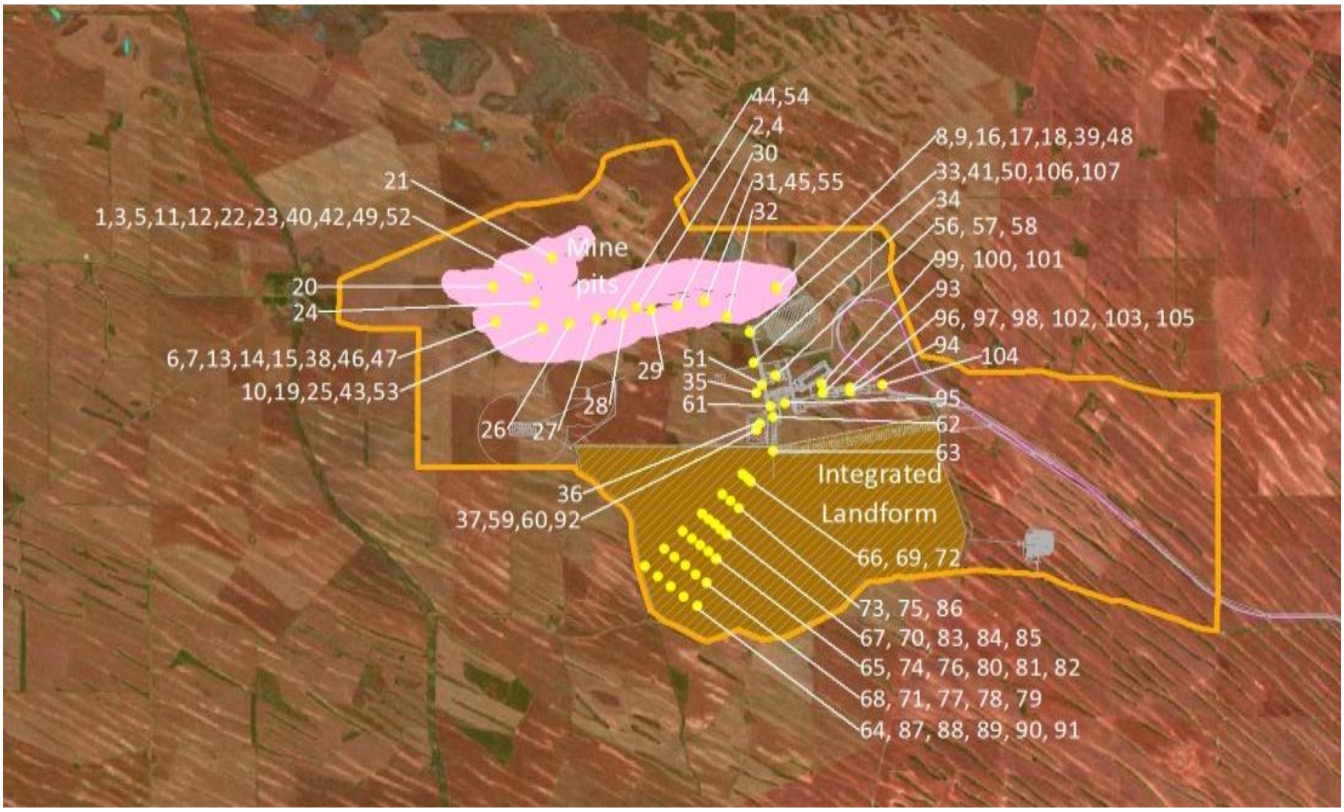


Figure 3-11: Key emission source locations (Scenario No.3)

Table 3-15: Scenario No.3 emission source location legend

Source ID	Emission source activity description
1	Topsoil 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
60	Bulldozers at topsoil stockpiles
61 - 64	IWL transfer points
65	Loading of waste rock and tailings 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 (3 off, 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 off, reclaimer to outfeed conveyor and conveyor to train loadout package)
104	Loading concentrate to rail wagons
105	Bulldozers at concentrate stockpiles
106	Road maintenance (graders)
107	Truck wheel generated dust (WGD), light duty vehicles

3.3.4 Dust emission and control factors

Dust emissions

The emission factors used for the calculation of particulate emissions from each of the mining activities are provided in Table 3-16. For the most part, these have been sourced from the NPI manual for mining (NPI EETM for Mining 2012). Exceptions to this have been noted beneath the table.

Table 3-16: Mine site air emission factors

Activity	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor Note 2	Emission factor reference Note 1
Removing vegetation and topsoil, kg/t	0.029	0.0073	N/A	A, Appendix A, Section 1.1.13, scraper removing topsoil
Drilling, kg/hole	0.59	0.31	N/A	A, Table 2
Blasting, kg/blast	$0.00022 * A^{1.5}$	52% of TSP	3% of TSP	A, Table 2 for TSP and PM_{10} B, Table 11.9-2 for $PM_{2.5}$
Excavation and loading crusher bins, kg/t	See Note 3	See Note 3	N/A	A, Appendix A, Section 1.1.2, batch equation
Bulldozers, kg/hr/vehicle	$2.6\ s^{1.2} / M^{1.3}$	$0.34\ s^{1.5}/M^{1.4}$	0.105 * TSP	A, Table 2 (Material other than coal)
Wheel generated dust (industrial sites), kg/VKT	$1.38 * (s/12)^{0.7} *(0.37*W)^{0.45}$	$0.42 * (s/12)^{0.9} *(0.37*W)^{0.45}$	$0.04 * (s/12)^{0.9} *(0.37*W)^{0.45}$	A, Table 2 for TSP and PM_{10} B for $PM_{2.5}$
Primary crushing, kg/t	0.01	0.004	N/A	A, Table 3 (high moisture content ores Note 4)
Conveyor transfer points, kg/t	0.005	0.002	N/A	A, Table 3 (high moisture content ores), applied to each transfer point
Loading stockpiles, kg/t	0.004	0.0017	N/A	A, Appendix A1.1.15
Wind erosion of stockpiles, kg/ha/hr	0.4	0.2	N/A	A, Appendix A1.1.17
Truck dump at stockpiles	0.012	0.00426	N/A	A, Appendix A1.1.6
Front-end loaders at stockpiles, kg/t	0.025	0.012	N/A	A, Table 3
Reclaiming from stockpiles, kg/t	0.03	0.013	N/A	A, Appendix A1.1.15
Loading to trains, kg/t	0.0004	0.00017	N/A	A, Appendix A1.1.15
Graders	$0.0034\ S^{2.5}$	$0.0034\ S^{2.0}$	0.031 * TSP	A, Table 2 for TSP and PM_{10} B, Table 11.9-2 for $PM_{2.5}$

Notes:

1. Emission factor references are as follows:
   A – NPI EETM for Mining, v3.1, January 2012
   B – AP-42, Compilation of Air Pollution Emission Factors, Volume 1, 5th edition, US EPA (1995) and updates

2. Where no $PM_{2.5}$ emission factor is provided, the default factor of 35% of the PM_{10} emission factor has been used. This was based on information received from the EPA[4].

3. The US EPA AP-42 Compilation of Air Pollution Emission Factors, Volume 1, 5th edition, Section 13.2.4.3 (November 2006), provides emission factor equations for TSP and PM_{10} for activities associated with aggregate storage piles and these equations have been used for the excavation and loading of the primary crusher bins for ore and waste rock. The emission factor (EF) equations for the batch activities are:

$$EF\ (TSP) = 0.74\ \times 0.0016\ \times \frac{(U/_{2.2})^{1.3}}{(M/_{2})^{1.4}}$$

$$EF\ (PM_{10}) = 0.35\ \times 0.0016\ \times \frac{(U/_{2.2})^{1.3}}{(M/_{2})^{1.4}}$$

   Where EF are in units of kg/t.

   These equations were adopted instead of the default emission factors because they included consideration of moisture content, as well as wind speed, for the specific application. It is proposed to use the water collected within the mine pits to increase the in-situ moisture content of the ore material at the excavation and loading stage of the mining process to control dust as necessary. This will be done by applying water to the material before it is excavated and loaded. As such, the moisture content of the ore material will increase. The use of the batch equation enables the additional moisture content to be captured.

4. Water sprays are to be used during the excavation and loading process within the pits for both the ore and waste rock. The ore and waste rock at the primary crushers is expected to be greater than 4 wt% and hence the 'high moisture content' emission factors which relate to material having a moisture content of more than 4% by weight (NPI EETM for Mining, 2012).

5. Abbreviations:
   s = silt content in % (by weight)
   M = moisture content in % (by weight)
   A = area blasted in m^2
   W = vehicle gross mass in tonnes
   VKT = vehicle kilometres travelled
   S = mean vehicle speed in km/h
   U = mean wind speed in m/s

Dust Controls

Dust control measures have been included in the design of equipment items and operational activities at the mine site to minimise dust emissions wherever practicable. Some of the dust mitigation measures could not be included in the modelling; e.g., baffles to reduce air velocity at conveyor transfer chutes, etc., due to a lack of supporting information in the literature. The design features and operational activities adopted to control dust which specifically affect the modelling inputs are described below in Table 3-17. The control factors adopted are all from the NPI EETM for Mining (2012), except where noted.

[4] EPA communication by email to DMITRE, Iron Road and SKM, 9 October 2013.

Table 3-17: Dust control factors adopted at the mine site

Emission activity	Control factor adopted	Notes
Excavation by shovel and loading crusher bins (ore and waste rock)	50%	Water sprays. Pit retention also applied.
Wheel generated dust (WGD) – 240 ton haul trucks + light vehicles	84.2% (Scenario No.1) 88.5% (Scenario No.2 and No.3)	Reference: Control of Open Fugitive Dust Sources, Sept 1988 (US EPA, 1988). Pit retention applied to routes within pits.
Ore and WR conveyor transfer points	99%	Enclosure and fabric filters. Pit retention also applied for points in pit.
Ore and WR crushers	85%	50% for water sprays, 70% for enclosure. Pit retention also applied for crushers in pit.
Combined waste rock and tailings - transfer points	99%	Transfer points - enclosure and fabric filter
IWL loading to stockpile	62.5%	25% for variable height stacker, 50% for water sprays
Wind erosion of IWL	30%	Primary earthworks
Wind erosion of SAG mill feed stockpile, topsoil stockpile, ore concentrate stockpiles	50%	Water sprays at stockpiles
Drilling	99%	Fabric filters or other technology with equivalent control efficiency. Pit retention factors applied.
Blasting	0%	No control for blasting. Pit retention factors applied.
Bulldozers	50%	Water sprays. Pit retention also applied for bulldozers in pit.
Processing area	50% 75% 99%	Water sprays for reclaiming stockpiles Loading stockpiles (telescopic chute and water sprays) Conveyor transfer points (enclosure and fabric filters)
Topsoil removal and dumping	50% 70%	Removing topsoil (water sprays) Truck dumping at stockpiles (water sprays)
Graders	75%	Level 2 watering (> 2 litres/m^2/hr)

The control factors adopted for wheel generated dust (WGD) emissions from the haul routes have been calculated based on the procedure outlined in the US EPA guideline “Control of Open Fugitive Dust Sources”, September 1988 (US EPA, 1988). The control efficiency of water application for an unpaved road is based on the daily evaporation rate, the traffic on the haul route, and the amount and frequency of water application. The control factor equation used is:

$$C = 100 - \frac{0.8 \times p \times d \times t}{i}$$

Where:
C = average control efficiency, %
p = potential average hourly daytime evaporation rate, mm/hr
d = average hourly daytime traffic rate (per hour)

i = application intensity (L/m^2)
t = time between applications (hours)

Values of each of the input parameters for the WGD control factor equation are provided in Table 3-18 below.

Table 3-18: Control factor equation input parameters for wheel generated dust

Equation input parameter	Value	Notes
Potential average hourly daytime evaporation rate, p (mm/hr)	0.45	Based on maximum of monthly means from available data within the region. See Note 1 below.
Average hourly daytime traffic rate, d (per hour) – Scenario No.1	87	Conservative estimate which assumes majority of mine site traffic travelling on a single key route
Average hourly daytime traffic rate, d (per hour) – Scenario No.2 and 3	63	Conservative estimate, as per Scenario No.1 above
Water application rate, i/t ($L/m^2/hr$)	2	Corresponds to Level 2 watering within NPI EETM for Mining (2012)

Notes:

1. The evaporation rate data was obtained from the Minnipa BoM weather station which is approximately 62 km north west of the mine site. The maximum mean monthly evaporation rate recorded for this site between 1965 and 2001 was 10.9 mm/day (0.45 mm/hr). The maximum evaporation rate from the available data for the Kyancutta BoM between 1930 and 1952 was 7.2 mm/day (0.30 mm/hr). Although Kyancutta BoM is closer than the Minnipa BoM station, the Minnipa data was selected as this resulted in the more conservative control factor estimate.

For Scenario No.2 and No.3, there is a significantly reduced amount of traffic on the haul routes due to the use of mobile crushers and conveyors in the pit, i.e. the conveyors instead of haul trucks are used to transport the material. The excavators will be transferring the excavated material direct to the crusher feed bins. The traffic for these two scenarios will consist primarily of light vehicles, smaller (240T) haul trucks, water trucks and the movement of miscellaneous mobile equipment (bull-dozers, graders, etc.). For Scenario No.1, i.e. the construction phase, there will be twelve 360T haul trucks, as well as the two smaller haul trucks and other vehicles, using the main haul routes. As a result, the average control efficiency calculated for dust control of wheel generated dust on the unpaved haul routes is 88.5% for Scenario No.2 and No.3, and 84.2% for Scenario No.1. It should be noted that the water proposed to be used for dust control of wheel generated dust from the haul routes (and other activities/locations) will have a very high salt content. This is expected to assist in the formation of a crust on the top of the road surface, thereby limiting dust emissions. The control factor for hauling provided by the NPI EETM for Mining (2012) is 100% for salt-encrusted roads.

Pit Retention

For each of the Scenario No.2 and No.3 activities which are located within the pits, pit retention factors have been included in the model simulations. The pit retention calculation determines the fraction of dust emitted in the pit that may escape the pit. The “escaped fraction” is a function of the gravitational settling velocity of the particles and the wind speed and is shown by the following relationship (US EPA, 1995).

$$\varepsilon = \frac{1}{1 + \frac{v_g}{\alpha U_r}}$$

where:

ε = escaped fraction for the particle size category

v_g = gravitational settling velocity (m/s)

α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit (0.029)

U_r = approach wind speed at 10 m (m/s)

3.3.5 Particle size distribution

The selection of particle size for air dispersion modelling of smaller particles such as those that fit within the PM_{10} and $PM_{2.5}$ size classes is not critical, as these small particles exhibit behaviour not dissimilar to that of a gas. The fall velocities of small particles are very slight, therefore the particles can be transported over very large distances. Sensitivity tests undertaken using CALPUFF for a two-day test at the Iron Road port site confirmed that results for PM_{10} ground level concentrations were not affected significantly by the selection of particle size. Therefore for this assessment the nominal particle size of 6.0 microns (µm) was selected to represent PM_{10} and 1.4 µm to represent $PM_{2.5}$.

The selection of the Particle Size Distribution (PSD) for particles approximately 10 µm and larger is important, as larger particles from dust emissions near ground level re-deposit to the surface over relatively short distances. These larger particles have a significant effect on the predicted dust deposition and therefore on the (depleted) TSP GLCs.

CALPUFF has the capability to model a log-normal particle size distribution of particles using the PSD geometric mean and geometric standard deviation as input (Earth Tech, 2000b). A review of literature was conducted to determine reasonable estimates for the PSD geometric mean and geometric standard deviation for TSP dispersion modelling. Ayers et al. (1999) provided a result for an Australian aerosol mass distribution comprising soil-derived elements (silicon, iron and aluminium), which indicated that 10 µm would be a reasonable estimate for the geometric mass mean diameter of a dust aerosol PSD. A review of measured log-normal dust size distributions including dust aerosols provided by Zender (2010), indicated that 2.0 µm would be a reasonable estimate for the geometric standard deviation of a dust aerosol. In summary the two parameters selected for the TSP modelling were: geometric mean of lognormal PSD, 10.0 µm; and geometric standard deviation for the lognormal PSD, 2.0 µm. The particle size parameters used in the modelling are shown in Table 3-19.

Table 3-19: Particle size input data

Particle group	Geometric mass mean diameter (microns)	Geometric standard deviation (microns)
PM_{10}	6.0	0 (i.e. monodispersion)
$PM_{2.5}$	1.4	0 (i.e. monodispersion)
TSP	10.0	2.0

3.3.6 Summaries of particle emissions estimates

For each potential dust generating activity at the mine site, dust particle emission rates were estimated and used as input to the modelling. Emissions estimates were calculated for each of the three operating scenarios. A summary of total emissions corresponding to each of these scenarios is provided in Table 3-20.

Table 3-20: Summary of dust particle emission scenarios

Scenario	Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)
Scenario No.1	Construction phase	115.9	36.1	8.0
Scenario No.2	Early mining phase	62.9	30.1	9.9
Scenario No.3	Peak mining phase	77.8	36.0	11.8

Scenario No.1 which represents the construction phase has the highest total estimated TSP emissions and the equal highest PM_{10} emissions (with Scenario No.3). Scenario No.3, representing the peak mining operational scenario has the equal highest PM_{10} emissions (with Scenario No.1) and the highest $PM_{2.5}$ emissions. These two scenarios were selected for the CALPUFF dispersion modelling work. In addition, these two scenarios represent the two opposite extremes in terms of capturing the potential impact of the terrain and associated local meteorology. Under Scenario No.1, the terrain is essentially the same as the existing terrain at the mine site, whereas for Scenario No.3, the pit and IWL development is close to its full extent.

The calculated TSP emissions for Scenario No.1 are significantly higher than those of Scenario No.3 (and No.2) as a result of the wheel generated dust from the haul truck fleet and the operation of bulldozers. Due to the implementation of IPCC for the operational phase, (represented by Scenario No.3), the number of 360T haul trucks reduces from 12 in the construction phase to zero in the operational phase. This dramatically affects the amount of wheel generated dust. Although the bulldozer fleet numbers are the same for each of Scenario No.1 and No.3, the calculated TSP emissions relating to the bulldozers are lower for Scenario No.3 due to the application of the pit retention factor (and higher moisture content) for the bulldozers operating within the pits.

A breakdown of the calculated emission rates for the key indicator PM_{10}, determined for each of the scenarios at the mine site by activity type, is shown in Table 3-21. Results for TSP and $PM_{2.5}$ were similarly determined and are provided in Appendix C.

Table 3-21: Breakdown of PM_{10} emissions estimates by activity type

Emissions Calculation Results - PM_{10} Summary	Scenario 1 g/sec	Scenario 1 % of total	Scenario 2 g/sec	Scenario 2 % of total	Scenario 3 g/sec	Scenario 3 % of total
Topsoil removal and dumping	0.12	0.3%	0.63	2.1%	0.63	1.7%
Excavation by shovel and loading	0.51	1.4%	1.41	4.7%	1.44	4.0%
WGD - haul trucks + light vehicles	18.1	50%	1.75	5.8%	2.71	7.5%
WR conveyors and transfer points	4.66	12.9%	0.56	1.8%	0.63	1.8%
Ore and WR crushers	0.00	0.0%	6.59	22%	7.00	19%
Ore conveyors and transfer points	0.00	0.0%	0.41	1.4%	0.89	2.5%
IWL - unloading from trucks/conveyors	1.94	5.4%	5.28	18%	8.01	22%
Wind erosion of IWL, overburden, topsoil and crushed ore stockpiles	3.63	10.1%	3.63	12%	3.63	10%
Drilling and blasting	1.34	3.7%	1.27	4.2%	1.27	4%
Bulldozers	4.96	13.7%	1.44	4.8%	2.39	6.6%
Processing area	0.01	0.03%	6.30	21%	6.62	18%
Graders	0.83	2.3%	0.83	2.7%	0.83	2.3%
Total	**36.1**	**100%**	**30.1**	**100%**	**36.0**	**100%**

Notes:

1. The emission rates shown in the table for blasting have been averaged out over a 24 hour period. In the modelling input, the blasting rate has been adjusted such that the emissions occur once for each 24 hour period.
2. The calculated emission rates in the table include a nominal 50% pit retention factor for TSP and 5% factor for PM_{10}. In the model input, these pit retention factors are refined and adjusted using the gravitational settling velocity of the particles and the hourly wind speed (US EPA, 1995) as discussed in Section 3.3.4.

3.3.7 Other (non-particulate) air emissions

In addition to particulate matter there are expected to be other air emissions associated with the mine site operations, primarily these are the result of the blasting of explosives and the combustion of diesel in engines at the mine site. The non-particulate emissions from the blasting of explosives are mainly NO_x, CO and SO_2. Note that the particulate emissions from the blasting operations are addressed in Section 3.3.4.

The combustion of diesel will result in a mixture of gaseous and particulate emissions including: carbon monoxide (CO), nitrogen dioxide (NO_2), Volatile Organic Compounds (VOCs), sulphur dioxide (SO_2), and PM_{10} and $PM_{2.5}$.

Blasting Operations

A total of 335 holes will be drilled and blasted at the mine site each day, with the blasting operation occurring once daily during daylight hours. The explosive type used will typically be ANFO (ammonium nitrate and fuel oil), mixed on site. Emulsion based explosives may also be used at times, however ANFO will be the preferred explosive used with the use of emulsions generally restricted to those cases where the blast holes contain water.

In addition to the particulate emissions caused by the breaking up of rock at the time of detonation, there will also be gaseous emissions resulting from combustion of the explosive material. The emissions from the detonation of the explosives will be different for different explosive fuel types, however, key combustion emissions from the ANFO explosive (on site mix) are expected to be NO_x, CO and SO_2 (as set out in the NPI *Emission Estimation Technique Manual (EETM) for Explosives detonation and firing ranges,* Version 3.0, January 2012). When assessing the emission factors with respect to the respective GLC criteria, the highest risk in terms of air quality impact is for NO_x, as shown in Table 3-22 below. As such, the gas pollutant NO_x was used as the key assessment indicator for the study.

Table 3-22: Blasting (non-particulate) emission factors and GLC criteria

Pollutant	Emission Factor (kg/tonne)	GLC criteria (mg/m^3)	Emission factor/GLC criteria
CO	34	29	1.2
NO_x	8	0.158	51
SO_2	0.06	0.45	0.1

Notes:

1. Emission factors based on Table 7 of NPI *Emission Estimation Technique Manual (EETM) for Explosives detonation and firing ranges,* (NPI EETM for Explosives, 2012), ANFO on site mix.
2. GLC criteria are as set out by the EPA Guidelines (EPA, 2006) and represent 1 hour averages.

The US Bureau of Mines is the original source of the emission factors for NO_x for the use of ANFO, on-site mix (US Bureau of Mines, 1975; US Bureau of Mines, 1976). Subsequently tests were undertaken by the National Institute for Occupational Safety and Health (NIOSH) Pittsburgh Research Laboratory's Experimental Mine facility. NIOSH (2000) presents data collected on toxic fumes produced by the detonation of various ANFO mixtures since 1997. The NO_x and NO_2 emission rates from the NIOSH (2000) test data for a 6% fuel oil and 94% ammonium nitrate mixture ('normal mix'; NPI EETM for Explosives, 2012), were used to calculate a NO_x mass emission rate of 5.6 kg/tonne.

These input data and resulting emission rates for NO_x are provided in Table 3-23 below.

Table 3-23: Air emissions data and estimates for blasting

Input Parameter	Units	Value	Notes
Number holes blasted per day	holes/day	335	
ANFO charge weight per hole	t/hole	0.9	Approximate
Number of blasts per day	blasts/day	1	See Note 1
Blast area	m^2	10,000	
ANFO consumption per blast	t/blast	302	
NO_x emission factor	kg/tonne	5.6	Calculated from NIOSH (2000)
NO_x emission rate per blast	kg/blast	1,699	
NO_x 1-hour average emission rate	g/sec	472	

Notes:

1. The model input assumes that blasting occurs in the Boo Loo pit for Scenario No.3.

Diesel Combustion Emissions

The largest consumer of diesel at the mine site during normal operation is expected to be the mobile fleet including heavy moving equipment (haul trucks, bulldozers, graders, etc.) and light mobile equipment (utility vehicles, small trucks, forklifts, etc.). There will be no stationary engines at the mine site which consume diesel during normal operations. Back-up emergency generators using diesel fuel will only be used under abnormal conditions and hence are not included in the gaseous pollutant inventory.

The diesel consumption for the construction phase is expected to be less than that for normal operation.

A summary of construction and operational diesel consumption is provided below in Table 3-24.

Table 3-24: Diesel consumption summary

Input Information	Unit	Value
Construction phase diesel consumption - total	ML/year	22.75
Operational phase diesel consumption – total	ML/year	26.20
Heavy mobile equipment	ML/year	26.07
Light vehicles	ML/year	0.128

The diesel consumption for the operational phase represents the expected maximum consumption rates for any one year throughout the life of the mine site. The combustion emissions from the operational phase were the focus of the assessment as they are expected to be considerably higher than those from diesel consumption during the construction phase of the Project.

To provide an initial estimate of the emission rates of the combustion gases from heavy mobile equipment and light vehicles, the *National Pollutant Inventory Emission Estimation Technique Manual for Combustion Engines* (NPI EETM for Combustion Engines, 2008) was used. The emission factors representing miscellaneous diesel industrial vehicles were used for the heavy mobile equipment and the emission factors for diesel light goods vehicles (less than 3.5 tonnes) were adopted. From the calculated gas emission rates, NO_x was found to present the highest risk of the gas pollutants with respect to meeting the GLC criteria. A summary of the NO_x emission factors and calculated gas emission rates are provided in Table 3-25 below.

Table 3-25: NO_x emission factors and calculated emission rates

Diesel Use Category	Emission Factors kg/m^3	Calculated NO_x emission rate g/sec
Miscellaneous industrial vehicles	44.4	36.7
Light vehicles	8.90	0.036
Total emission rate	N/A	36.74

The calculated NO_x emission rates were combined with those from the blasting emissions and used as input data for the NO_2 modelling work. As part of this process, it is necessary to estimate the extent of the conversion of NO to NO_2 following release of the gas to the atmosphere. In reality, a 100% conversion of NO to NO_2 does not occur as the conversion is dependent on, among other factors, the concentration of ozone in the atmosphere. The US EPA Ozone Limiting Method (OLM), as described in Section 3.4.4, was adopted for estimation of the conversion of NO to NO_2 in the atmosphere.

3.4 Modelling Methodology

This section describes the meteorological and air dispersion modelling methodology.

3.4.1 Selection of meteorological study year

The modelling assessment used hourly average meteorological data for a selected study year to assess the Project dust emissions under a very wide range of conditions; i.e., a total of 8760 hours. To select the year for modelling, a review was undertaken of annual weather conditions for Australia. The year 2009 was identified as a typical meteorological year for South Australia, primarily as it was free of strong El Niño and La Niña events (BoM, 2014).

A weak and very short La Niña event occurred across the north of Australia during the period August 2008 to April 2009. January to February 2009 was very dry across much of southern Australia, including Victoria and South Australia. Two extreme heat waves occurred during the same period, contributing to the Black Saturday bushfires. While most of Australia was dry from May to October 2009, eastern Victoria and most of NSW had below average rainfall (weak effects from an El Niño event). Western Victoria and southern South Australia had average to above average rainfall. By November, a wet period occurred over the eastern half of the country. For the 5 months from November 2009 to March 2010, South Australia had areas of rainfall in the top 10% (BoM, 2014).

The selection of 2009 as the case study year for the Project assessment was confirmed with the EPA[5].

3.4.2 Meteorological modelling

Meteorology will vary across the mine site horizontally and vertically, particularly wind patterns. On a relatively small scale, the mine site winds will be affected by local topography. At larger scales, winds are affected by synoptic scale winds, which are modified by atmospheric phenomena such as convective processes in the daytime and drainage flows that can develop overnight. It is important that the complex mechanisms that affect air movements are incorporated into dispersion modelling studies for accurate predictions of air pollutant concentrations.

A limitation of Gaussian plume dispersion models is that they assume that the meteorological conditions are the same, spatially, over the entire modelling domain for any given hour. Meteorological and dispersion conditions are expected to be more accurately represented using wind-field and so called "puff" models, which have been applied for this Project. This assessment used CALPUFF dispersion modelling software. The CALPUFF model, through the CALMET meteorological processor, simulates the complex meteorological patterns just described.

In the absence of long-term, quality meteorological data for the locality, surface and upper-air meteorological data for 2009 were generated for this study by the CSIRO's prognostic model, The Air Pollution Model (TAPM). TAPM is a prognostic model with capability to generate meteorological data for any location in Australia, commonly from 1997 onwards, historically based on synoptic information obtained from the six-hourly Limited Area Prediction System (LAPS) but more recently (from 2010 onwards) based on models developed by the National Centers for Environmental Prediction. TAPM is discussed in the model's user manual and various model verification studies; *e.g.*, see Hurley (2008b) and Hurley *et al.* (2008).

TAPM was used to generate 3-dimensional surface and upper-air temperatures, wind vectors, air pressures and other meteorological parameters. Hourly average meteorological data were generated for 2009 (a total of 8760 hours), for a number of meteorological parameters covering a large study volume for the Project area.

5 EPA/DMITRE/Iron Road/SKM meeting, 10th May, 2013.

The TAPM default vegetation for the mine site geography was found to include an area of forest, located at the proposed location for the Murphy South pit, which had the effect of lowering local wind speeds. This would have misrepresented actual wind conditions after construction of the mine. As such, the TAPM land use type was modified to better represent the proposed use of the land and the corresponding local wind conditions.

While there is some influence of real observations to TAPM inputs through the synoptic data, it is recognised that this approach is a simulation of actual conditions. In recognition of using a prognostic model to generate upper air data, the 3-dimensional meteorological data from TAPM were used as CALMET's initial guess wind-field. This approach places less emphasis on the prognostic data for the development of the final wind field as the prognostic data are not treated as observations.

As part of the quality review of the meteorological output data from TAPM, comparisons of modelled data with BoM observations were carried out. Hourly BoM data were not available for 2009 from the closest station to the mine site, Kyancutta, which had limited data in any case. The next nearest BoM weather station was Wudinna Aerodrome ('Wudinna Aero'); 2009 observations from this station were compared with the TAPM results (see Section 3.5.1).

The TAPM generated initial wind field was input to the meteorological component of the CALPUFF software, 'CALMET'. Subsequently CALMET was used to generate a simulation of three-dimensional hourly meteorological conditions specific to the mine site area, but at finer resolution (250 metres). The geophysical terrain and land use data for CALMET was also generated using the same finer resolution.

The final Project terrain design, including the integrated land form to a height of approximately 135 metres, was included in the terrain data file for the modelling of the operational phase. For the construction phase, the existing terrain information was used i.e. with no pit and no IWL.

A summary of the data and parameters used as part of the meteorological component of this study is shown below in Table 3-26.

Table 3-26 Summary of meteorological modelling parameters

Met. Modelling Parameter	Setting
TAPM met. modelling parameters:	
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 (west-east) x 30 (north-south) x 25 (vertical)
Year of analysis	2009
Centre of analysis	Approximate centre of proposed Mining Lease area: S. 33 ^{o}15.5'; E. 135 ^{o}40.5'
Met. data assimilation	None, considered to be a better prescriptive modelling approach
CALMET modelling parameters:	
Meteorological grid domain	Horizontal: 133 x 109 grid points at 250 m resolution (33 km x 27 km); total of 14,497 horizontal grid points. Vertical: 10 x levels from the surface to 1,200 m height
Surface meteorological stations	3-dimensional meteorological output from TAPM used as initial guess wind-field for CALMET
Upper air meteorological	3-dimensional meteorological output from TAPM used as initial guess wind-field

Met. Modelling Parameter	Setting
data	for CALMET
Simulation length	Start Jan 2009 to end Dec 2009
Land use	Scenario No.1: unirrigated agricultural land (land use code 20) inside and outside the proposed Mining Lease boundary Scenario No.3: unirrigated agricultural land (land use code 20) outside the proposed Mining Lease boundary and barren land (land use code 70) inside

3.4.3 Dust dispersion modelling methodology

The CALPUFF model, (Version 6.42), was used to predict Ground Level Concentrations (GLCs) using the air emissions estimates as inputs. CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs, emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and the serial release is representative of a continuous release.

The CALPUFF model differs from simpler Gaussian plume models in that it models spatially varying wind and turbulence fields that are important in complex terrain, for long-range transport, and near-calm conditions. It is the approved model of the US EPA for the long-range transport of pollutants and for complex terrain (Exponent, 2015).

The meteorological results provided by CALMET and the source emission estimates were used as input to CALPUFF. CALPUFF was used to predict the air pollutant concentrations at a set of ground-level receptors covering a region of 33 km by 27 km. Gridded receptors with a spacing of 250 metres were used for an inner grid covering the mine site and closest surrounding areas with an extent of 15 km by 13 km. Beyond this inner grid, discrete receptors were applied to cover the remaining model domain. A total of 3233 gridded and 104 discrete receptors were used in the horizontal plane.

CALPUFF dispersion coefficients used turbulence computed from micrometeorology and the partial plume path method was used for terrain adjustment.

Scenario No.3, representing the peak mining phase, and Scenario No.1, representing the construction phase, were modelled using CALPUFF based on the activities detailed in Section 3.3. The emissions scenarios incorporated time-varying emissions, specifically:

Excavation and loading – The emissions calculation for excavation and loading the excavated material to the crushers is dependent on wind speed (see Section 3.3.4). Hourly wind speed data extracted from the CALMET model was used for the dust emissions calculations.

Wind erosion – The model input assumed that there was no contribution resulting from wind erosion for wind speeds of less than 5 m/s. This is conservatively based on Equation 22 of Section 1.1.17 of NPI EETM for Mining, (NPI EETM for Mining, 2012), which infers that there are no dust emissions from wind erosion for wind speeds less than 5.4 m/s. Hourly wind speed data from the CALMET output was used to switch hourly wind erosion emissions (on/off), depending on the CALMET results for wind speed. This approach was supported by an analysis of TSP measurements near Warramboo on two days in April 2014, which showed that a 5-minute average wind speed of 5–6 m/s, (measured at a height of approximately 1.5 metres above ground level), was strongly associated with a substantial increase in airborne dust particle concentrations.

Blasting – Particulate emissions from blasting activities are expected to occur once daily. This was incorporated into the model input using a variable emissions file.

Pit retention – As detailed in Section 3.3.4, the pit retention factors for TSP and PM_{10} are dependent on wind speed. As such, the hourly predicted wind speed data for the mine site was used to calculate expected pit retention factors for each hour of the year for Scenario No.1 and No.3.

Summaries of the variable emissions data for Scenario No.1 and No.3 used as input to the models are provided in Appendix D and Appendix E.

The predicted dust concentration results shown in Section 3.6 include the effects of ceasing all mining operations at selected times throughout 2009 to prevent model-predicted exceedances of ambient air quality standards occurring at any of the sensitive receptors. To achieve this result, the simulated mining activities, with the exception of the wind erosion emission sources, were deactivated in the model for selected hours. The following methodology was adopted:

- Review the hourly average PM_{10} ground level concentrations predicted by the CALPUFF model for each of the sensitive receptors where exceedances of the PM_{10} criteria were predicted.
- Identify the hours in the year which correspond to the exceedances at each sensitive receptor.
- Modify the emissions from the operational activities for the specific hours identified, to reflect the likely operational changes which would be made in the case that forecasting predicted a high dust risk. The 'cut-off' PM_{10} dust hourly average concentration level over which emissions were switched off varied depending on the sensitive receptor site. Generally, for the sensitive receptor sites predicted to experience the highest PM_{10} hourly average concentrations, the 'cut-off' point was 80 ug/m^3. For others, the 'cut-off' point was 94 ug/m^3.
- Re-run the CALPUFF model using the revised emissions inputs.

This approach is expected to simulate actual operations during which mining operation will be adjusted based on forecasting and/or real-time dust monitoring to prevent potential adverse dust impacts at sensitive receptors around the mine site.

Results are provided for $PM_{2.5}$, PM_{10} and TSP concentrations, and dust depositions in Section 3.6.

3.4.4 NO_2 dispersion modelling methodology

This section describes the modelling methodology for NO_2 (gas) emissions from blasting and diesel engine operations at the mine site. The NO_2 emissions are expected to be highest for the normal operational scenario (Scenario No.3; see Section 3.3.7), as such Scenario No. 3 was selected for assessment.

It is expected that the extent of conversion of NO to NO_2 would be limited by, among other factors, the presence of atmospheric O_3. As such, the Ozone Limiting Method (OLM) was used to predict the ground level concentrations of NO_2 at the sensitive receptors. This method assumes that all the available ozone in the atmosphere will react with NO until either all of the O_3, or all NO, is used.

Air quality monitoring data for the Eyre Peninsula are limited, as such ambient O_3 and NO_2 concentrations were obtained from the EPA Netley hourly dataset for 2009 (Section 3.2.4), for use in the assessment. The hourly O_3 and NO_2 ambient concentration data were used to estimate the extent of NO to NO_2 conversion for the maximum predicted NO_x concentration estimated from the model output at each gridded and sensitive receptor site.

The results of the final predicted NO_2 concentrations at the mine site are provided in Section 3.6.4. CALPUFF results were provided as contour plots showing the spatial distribution of dispersed indicators, in accordance with EPA (2005). The CALPUFF results for NO_2 were compared with the EPA (2006) air quality criterion).

3.5 Meteorological Modelling Results

This section presents the TAPM meteorological modelling results and air dispersion modelling results, for the mine site.

3.5.1 TAPM modelled meteorology

The TAPM 2009 meteorological modelling results for near-ground level wind data at the mine site, (data generated at Murphy South pit), are illustrated as a wind rose in Figure 3-12; with a corresponding wind rose for the BoM's Wudinna Aero station shown alongside. The frequency distributions of wind speed are shown in Figure 3-13.

Wudinna BoM, annual **Murphy Pit TAPM, annual**

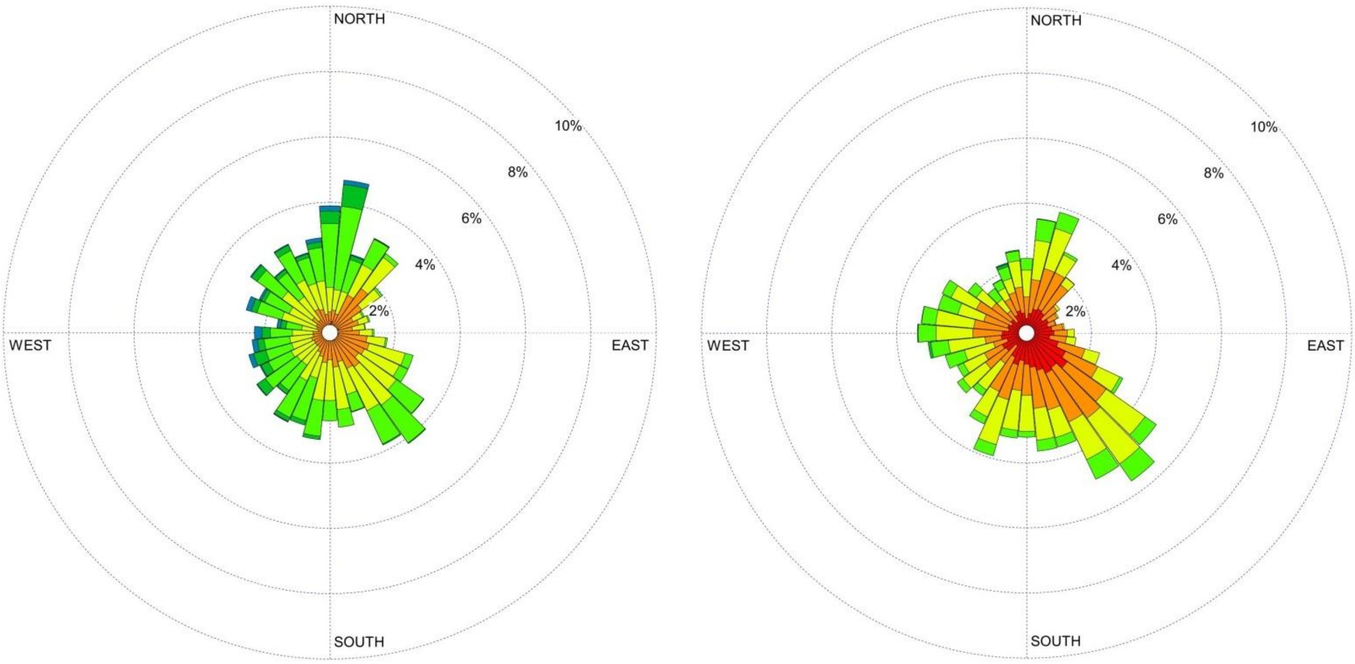


Figure 3-12: Wudinna BoM and Murphy Pit TAPM 2009 wind roses

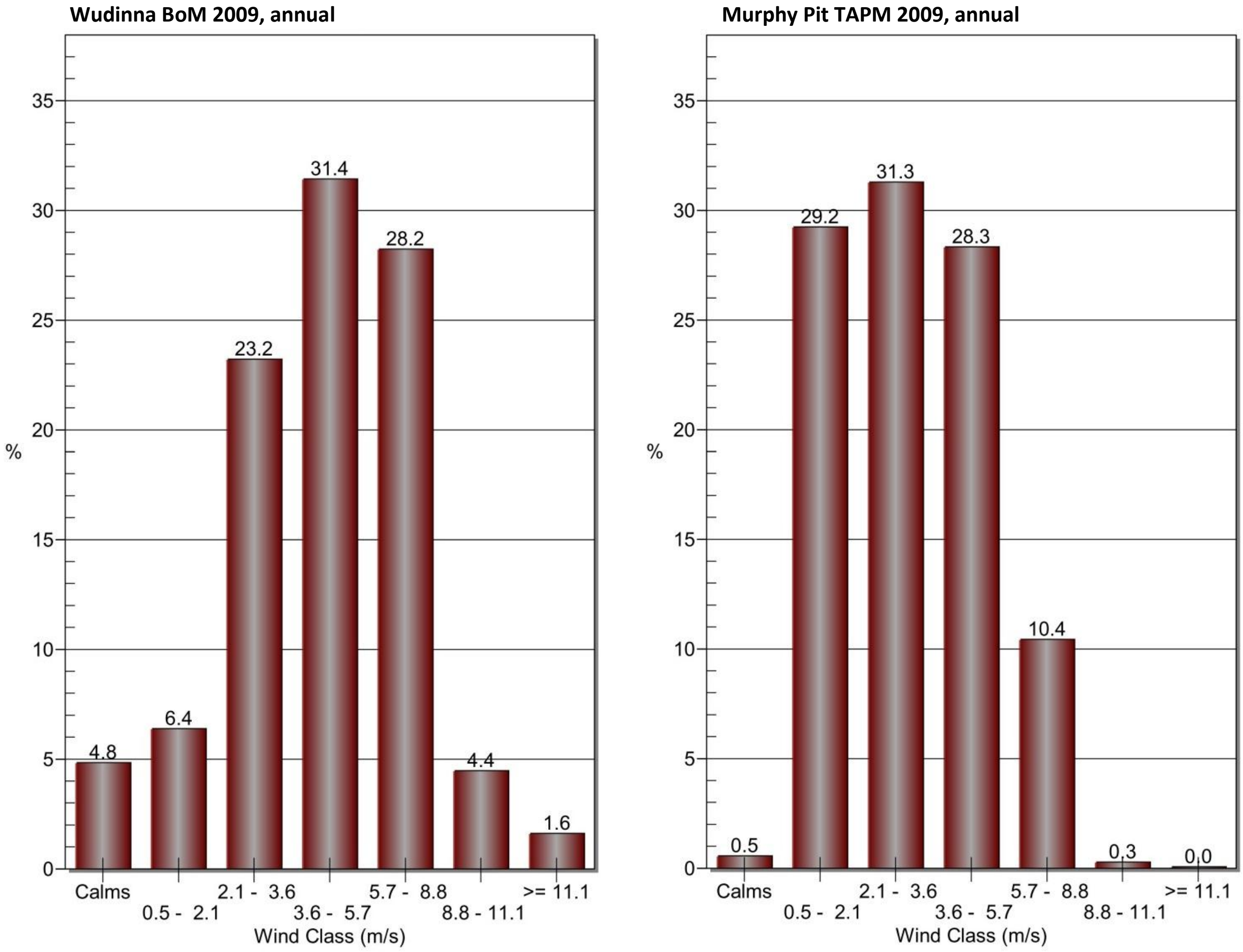


Figure 3-13: Wind frequency distributions (2009) for Wudinna BoM and Murphy Pit TAPM

The wind speeds measured at Wudinna Aero in 2009 were found to be higher than those predicted by TAPM at the proposed Murphy pit location. Early indications from analysis of wind speed measurements support this model result. Analysis of wind speed measurements undertaken in 2014 found that, in general, wind speeds at Warramboo were lower than at Wudinna Aero.

However current uncertainty tolerances for wind speed measurements at Wudinna Aero are +/- 10% of the wind speed for wind speeds greater than 10 m/s and +/- 1 m/s for wind speeds at or below 10 m/s. Further comparisons of results are needed to confirm any differences between wind speeds at the two locations.

Comparisons between the TAPM model wind speed results and Wudinna Aero observations from 2009 are shown in Figure 3-13. The average wind speed measured at the Wudinna BoM station for 2009 is 4.6 m/s, which is higher than the 3.3 m/s wind speed predicted by TAPM for a location near Murphy pit. As higher dust concentrations nearer the mine site are predicted to occur when the wind speeds are low to medium (due to decreased dust dispersion), use of the lower TAPM-predicted wind speeds by CALPUFF was considered to be a conservative approach in the modelling.

The wind roses shown in Figure 3-12 demonstrate that the dominant wind directions observed at Wudinna Aero (2009), i.e. from the south east and from the north-northeast, are reasonably well represented by the TAPM model predictions for 2009.

The TAPM-generated seasonal wind patterns for the Murphy pit location are provided in Appendix B.

Comparisons between the TAPM outputs and the Wudinna Aero observations for 2009 are shown in Figure 3-14 (temperatures) and Figure 3-15 (wind speeds). 'Warramboo Centre' means the approximate centre of the township and 'Murphy Pit' relates to a point within Murphy pit.

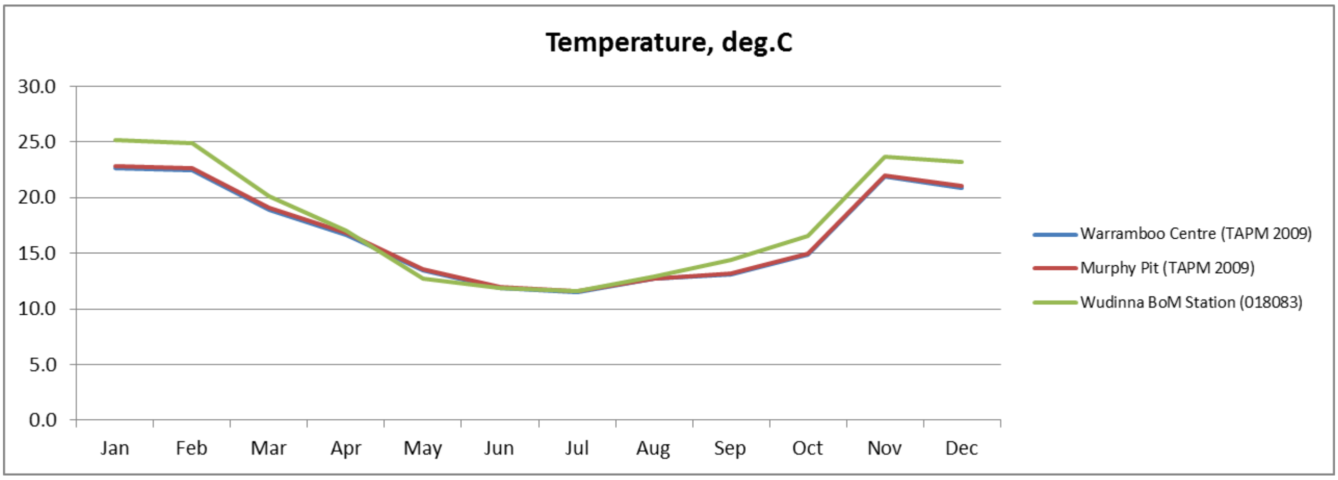


Figure 3-14: Comparisons of temperatures: Warramboo/Murphy Pit and Wudinna Aero

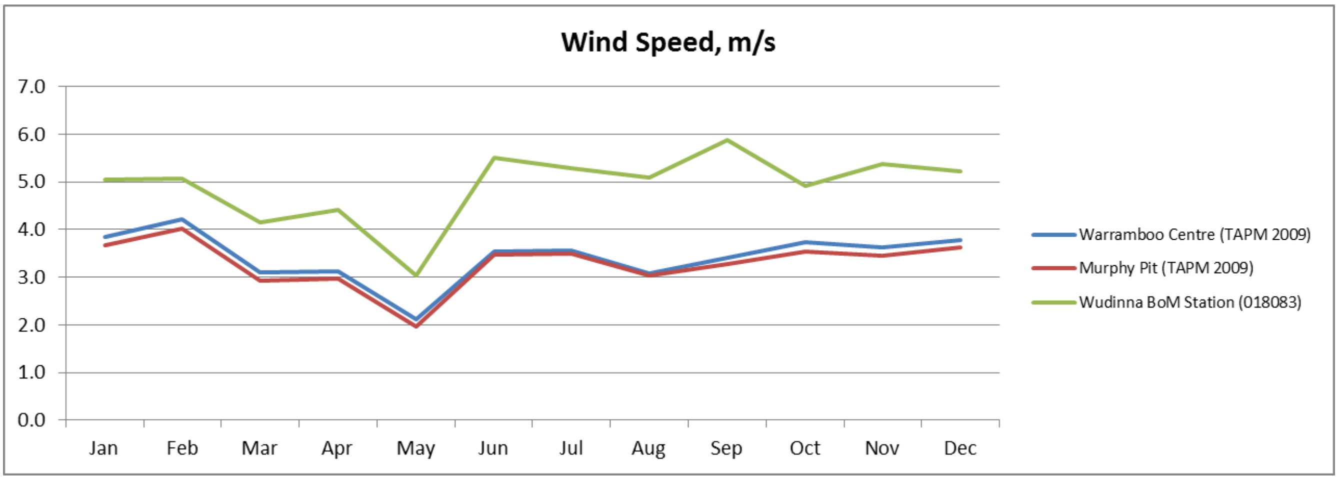


Figure 3-15: Comparisons of wind speeds: Warramboo/Murphy Pit and Wudinna Aero

Inspection of Figure 3-14 shows very good agreement between the TAPM model data and Wudinna Aero observations for 2009. At first glance, inspection of Figure 3-15 indicates that TAPM may be underestimating true wind speeds for the Warramboo locality. However some further analysis could not confirm that TAPM was in error – longer term results for wind speeds observed at Wudinna Aero were compared with corresponding data from other stations on Eyre Peninsula; a summary is provided in Table 3-27. The last two rows of Table 3-27 show 9 am and 3 pm wind speed data extracted from TAPM for 2009. The results show that there is a significant amount of variability in the wind speeds across the Eyre Peninsula, including large variations between locations in the same locality; e.g., Wudinna and Kyancutta. The conclusion was the TAPM-predicted wind speeds were well within the range that expected from the observations.

Table 3-27: Long term average 9 am and 3 pm wind speed (BoM observations and TAPM model)

BoM site/TAPM output	Monitoring period	9 am WS (average for period), m/s	3 pm WS (average for period), m/s
Cleve	1992 – 2010	3.6	4.3
Kyancutta	1934 – 2010	2.8	3.8
Wudinna	1999 – 2010	4.9	5.8
Pt Lincoln	1992 – 2010	5.2	6.8
Pt Lincoln	1892 – 2002	3.5	4.3
Minnipa	1965 – 2001	4.4	4.6
Kimba	1967 – 2010	2.3	3.2
TAPM 2009 Murphy pit	2009	3.4	4.4
TAPM 2009 Warramboo	2009	3.5	4.4

3.5.2 CALMET modelling Results

As discussed earlier, the CALMET meteorological processor was used to simulate the meteorological patterns for the proposed Mining Lease area and beyond. The model enables effects of local topography and changes in land surface characteristics to be incorporated. The output is a three-dimensional output of meteorological data which is then used within the CALPUFF air dispersion model. Examples of the output of the CALMET model for each of Scenario No.1 and Scenario No.3, for 1 January 2009 23:00, are provided in Figure 3-16 and Figure 3-17. Comparison of the wind vectors in the two figures illustrates the impact of the terrain on the local wind field.

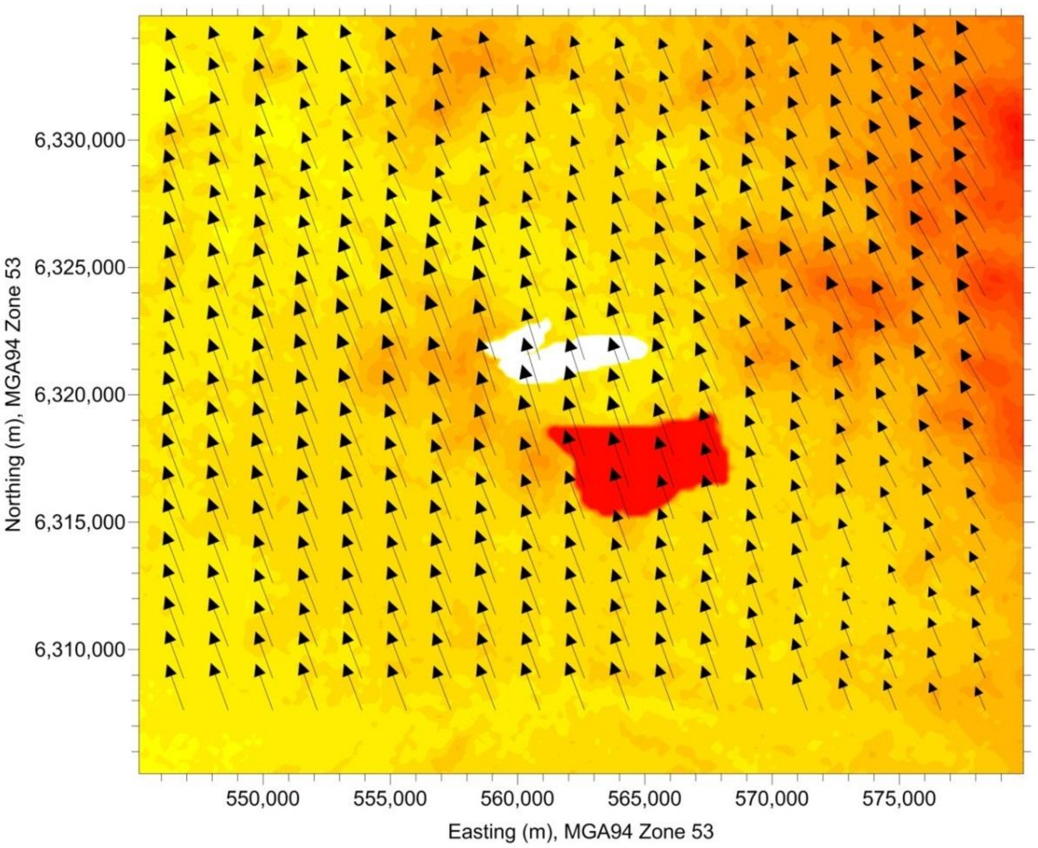


Figure 3-16: Example of CALMET output simulated wind flow vectors, Scenario No.1

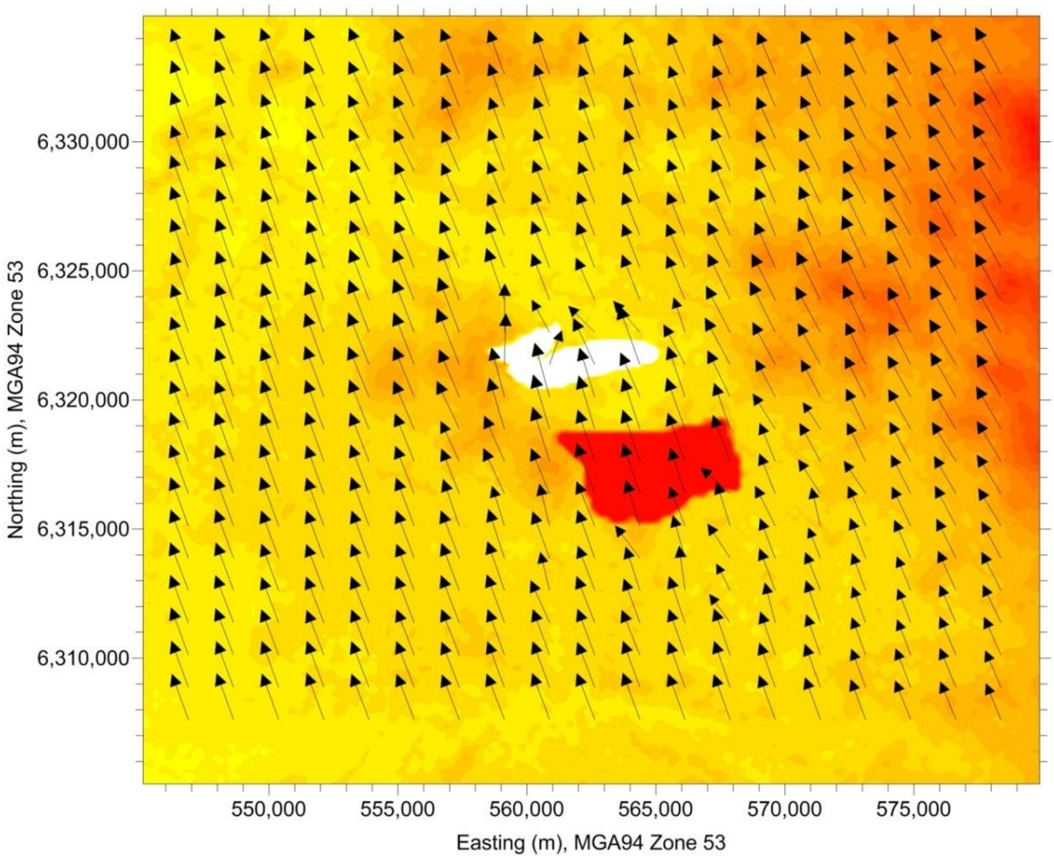


Figure 3-17: Example of CALMET output simulated wind flow vectors, Scenario No.3

3.6 CALPUFF Modelling Results

This section sets out CALPUFF modelling results for the following indicators and standards:

- Maximum 24-hour average PM_{10} concentration (NEPM, 50 µg/m^3);
- Maximum 24-hour average $PM_{2.5}$ concentration (NEPM, 25 µg/m^3);
- Maximum annual average $PM_{2.5}$ concentration (NEPM, 8 µg/m^3);
- Maximum annual average TSP concentration (DEC, 2005; 90 µg/m^3);
- Maximum annual average dust deposition (DEC, 2005; 4 g/m^2/month; and maximum addition to background, 2 g/m^2/month); and
- Maximum 1-hour NO_2 concentration (EPA, 2006, 158 µg/m^3).

The dispersion model simulations for the construction phase incorporated the representation of suspension of mining activities caused by unfavourable meteorological conditions. The hours during the year for which unfavourable meteorological conditions occurred were identified by predicted high hourly average PM_{10} GLCs at specific sensitive receptors. This simulation of the suspension of mining activities reflects the planned ceasing of activities at the mine triggered by an operational air monitoring system signalling a risk of exceedance of a Project standard. Further information regarding this approach to operational dust emissions management is provided in Section 3.4.3.

The number of annual hours for which the simulation of mine construction activities was suspended due to unfavourable meteorological conditions, is provided in Table 3-28.

Table 3-28: Suspension of mine construction activities within Scenario No.1 model simulation

Number of hours for which simulated mine construction activities were suspended	1341 hours
Percentage of the year	15.3 %

3.6.1 Scenario No.1 – Construction Phase dust model results

This section provides the CALPUFF results as contour plots for the following indicators in accordance with EPA (2005):

- Maximum 24-hour Average PM_{10} GLCs
- Maximum 24-hour average $PM_{2.5}$ GLCs
- Annual average $PM_{2.5}$ GLCs
- Annual average TSP GLCs
- Annual average dust (TSP) deposition

Maximum 24-hour Average PM_{10} GLCs

The CALPUFF results for maximum 24-hour average PM_{10} GLCs (µg/m^3) for Scenario No.1 (mine construction), are provided in Figure 3-18. The relevant Project standard is 50 µg/m^3, shown by the purple contour. The results include the background PM_{10} concentration of 22 µg/m^3.

These results indicate that for Scenario No.1, PM_{10} concentrations would be below the 50 µg/m^3 level at all sensitive receptors outside the proposed Mining Lease boundaries, but only if including operational modification using real-time dust monitoring.

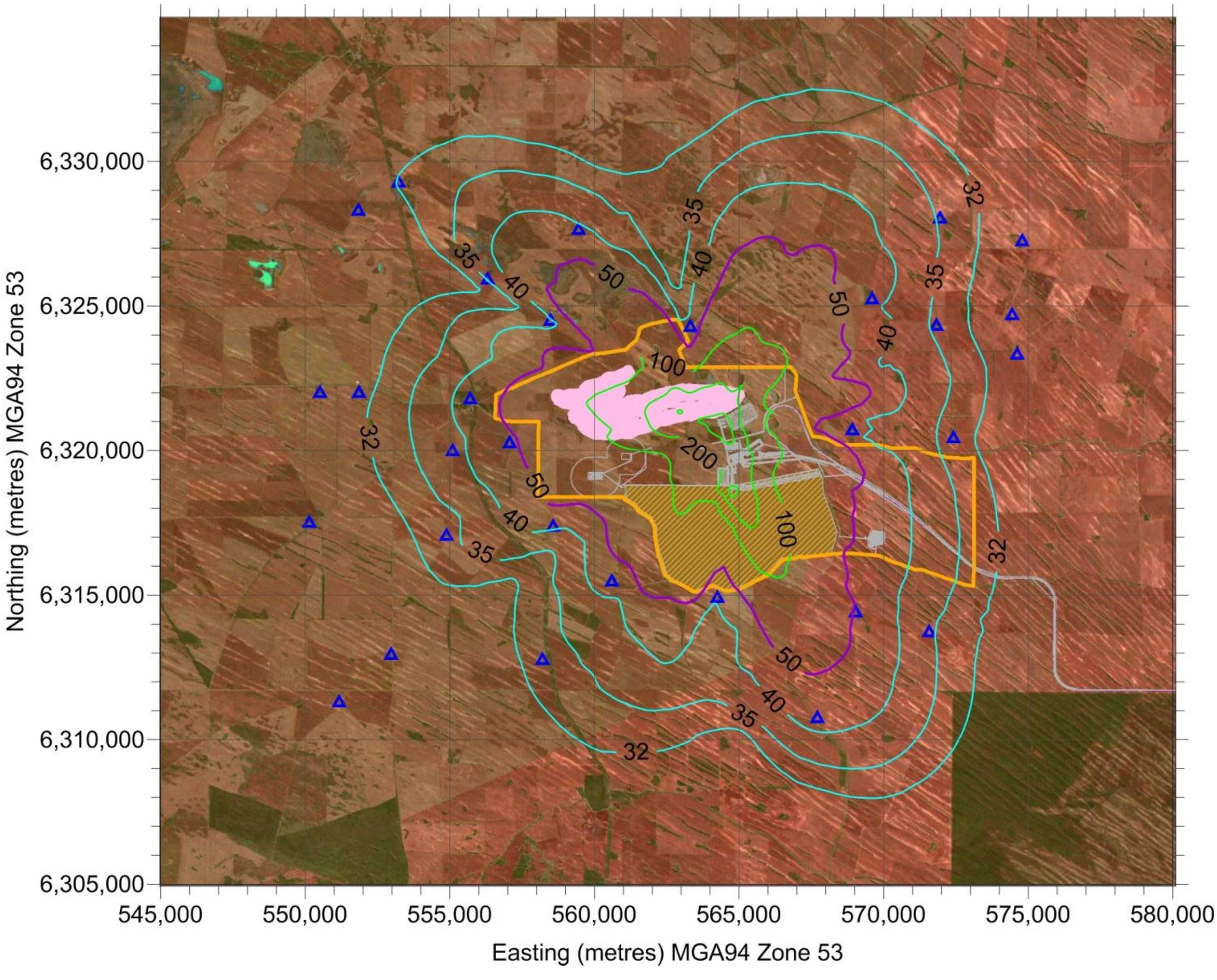


Figure 3-18: CALPUFF results for maximum 24-hour average PM_{10} GLCs (µg/m^3), Scenario No.1

Maximum 24-hour average $PM_{2.5}$ GLCs

The CALPUFF results for maximum 24-hour average $PM_{2.5}$ GLCs (µg/m^3) for Scenario No.1 (mine construction), are provided in Figure 3-19. The relevant Project standard is 25 µg/m^3, shown by the purple contour. The results include the background $PM_{2.5}$ concentration of 10 µg/m^3.

These results show that the $PM_{2.5}$ GLCs would be less than the 25 µg/m^3 criteria at all sensitive receptors outside the proposed Mining Lease boundaries, but only if including operational modification using real-time dust monitoring.

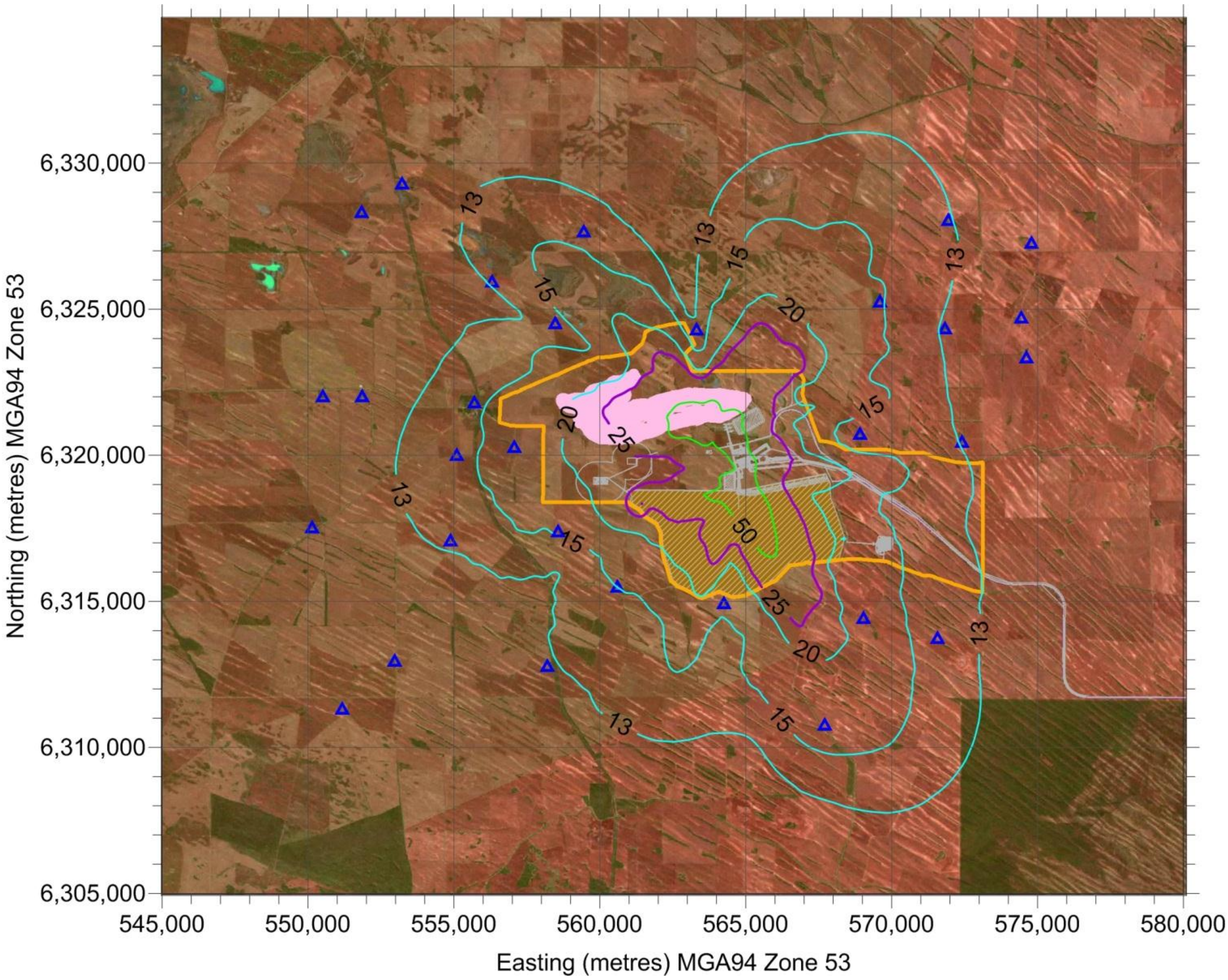


Figure 3-19: CALPUFF results for maximum 24-hour average $PM_{2.5}$ GLCs (µg/m^3), Scenario No.1

Annual average $PM_{2.5}$ GLCs

The CALPUFF results for annual average $PM_{2.5}$ GLCs are shown in Figure 3-20, for Scenario No.1 (mine construction). The relevant Project standard is 8 µg/m^3, shown by the purple contour. The model results include a $PM_{2.5}$ background concentration of 7 µg/m^3.

These results show that the annual average $PM_{2.5}$ GLCs would comply with the relevant standard at all sensitive receptors outside the proposed Mining Lease boundaries, but only if including operational modification using real-time dust monitoring.

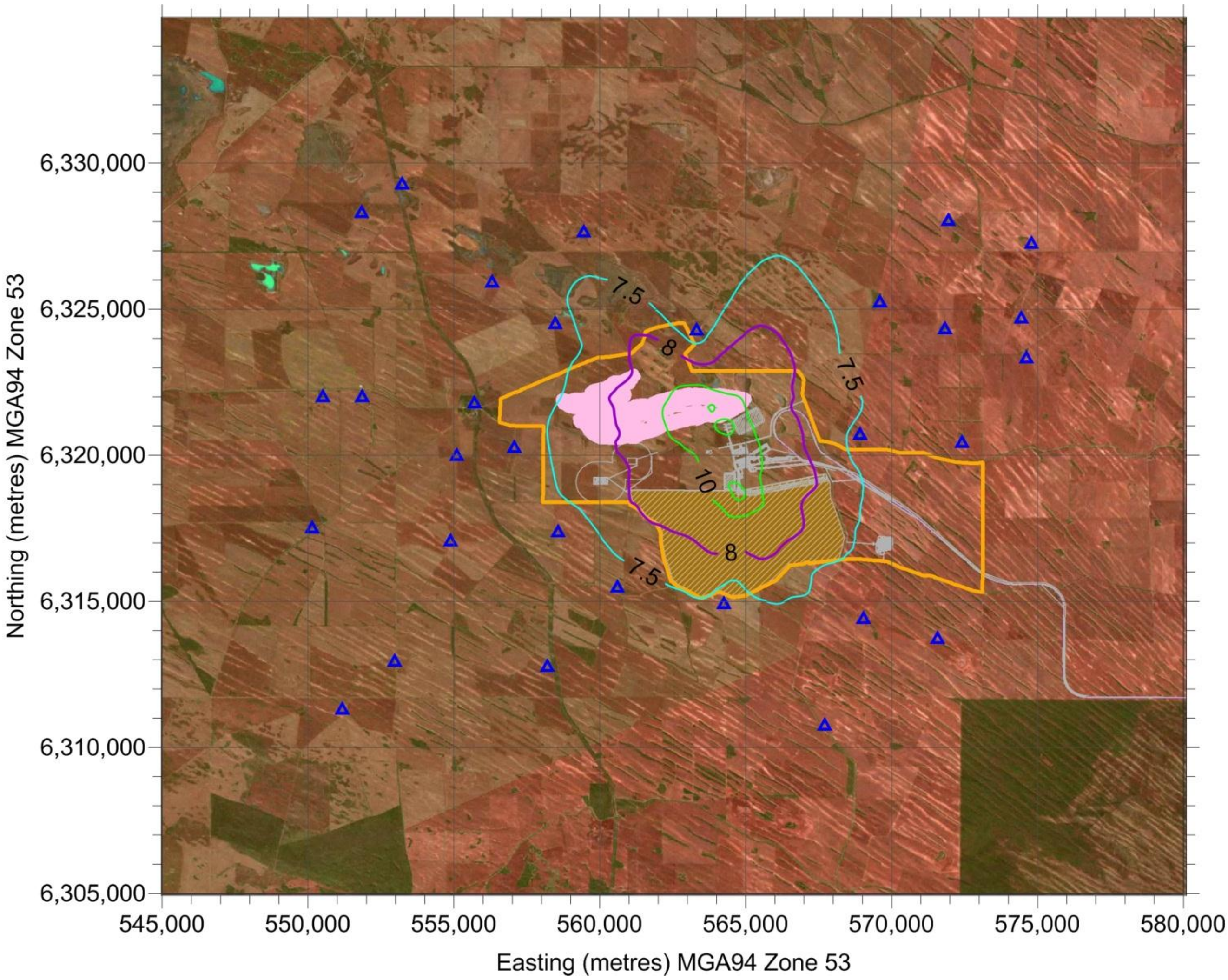


Figure 3-20: Predicted annual average $PM_{2.5}$ GLCs (µg/m^3) for Scenario No.1

Annual average TSP GLCs

Results for TSP GLCs represent an intermediary step to producing the dust deposition results. The CALPUFF results for annual average TSP GLCs ($\mu g/m^3$) for Scenario No.1 (mine construction), are provided in Figure 3-21. The relevant Project standard (90 $\mu g/m^3$), is shown by the purple contour. These results include a background TSP level of 30 $\mu g/m^3$.

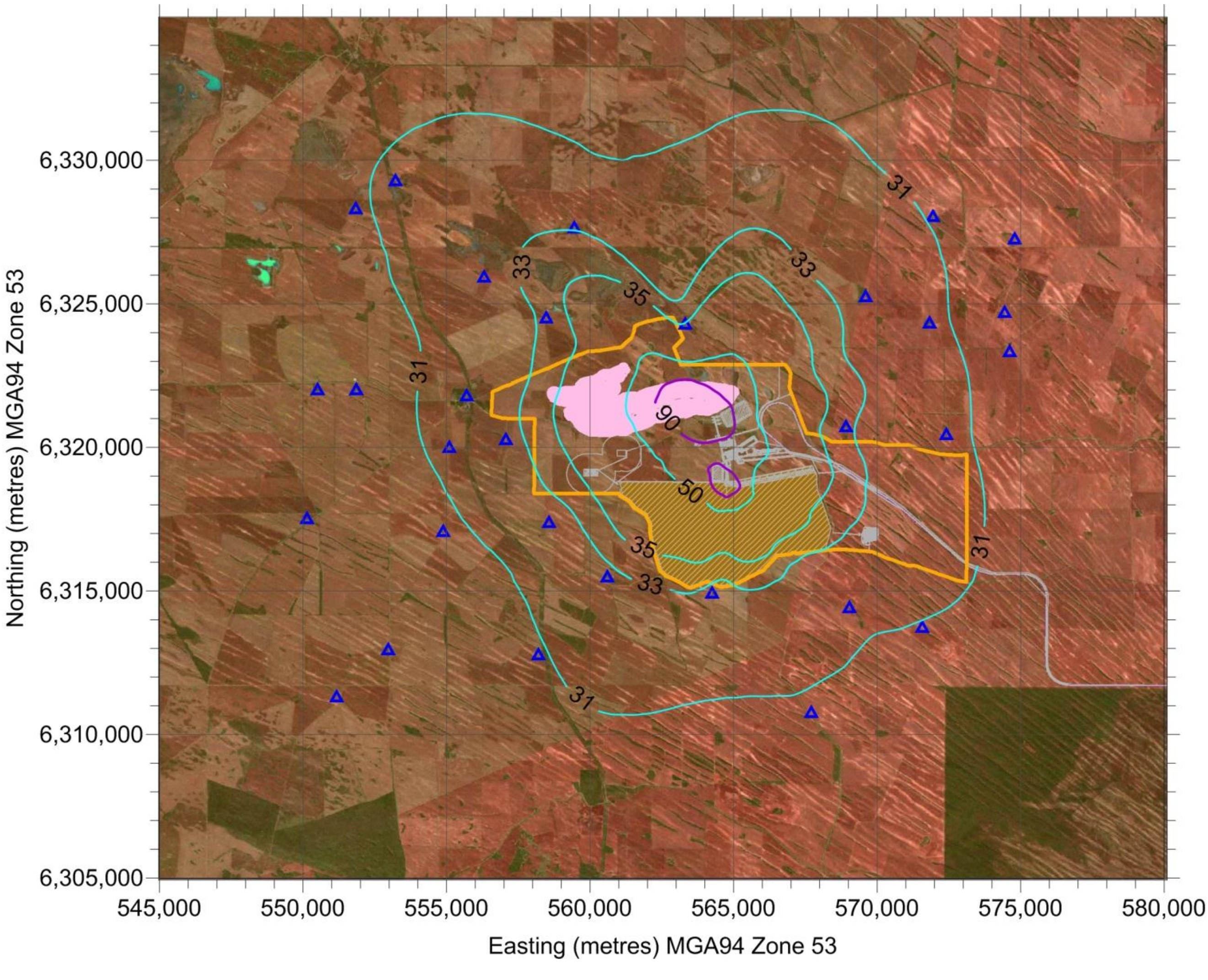


Figure 3-21: CALPUFF results for annual average TSP GLCs ($\mu g/m^3$) for Scenario No.1

Annual dust deposition

The CALPUFF results for annual average dust depositions for Scenario No.1 (mine construction), are provided in Figure 3-22; expressed in units of $g/m^2/month$ in accordance with DEC (2005). The relevant Project standard of 4.0 $g/m^2/month$ for the total dust deposition, is shown by the purple contour. The results include a background dust deposition level of 2.0 $g/m^2/month$.

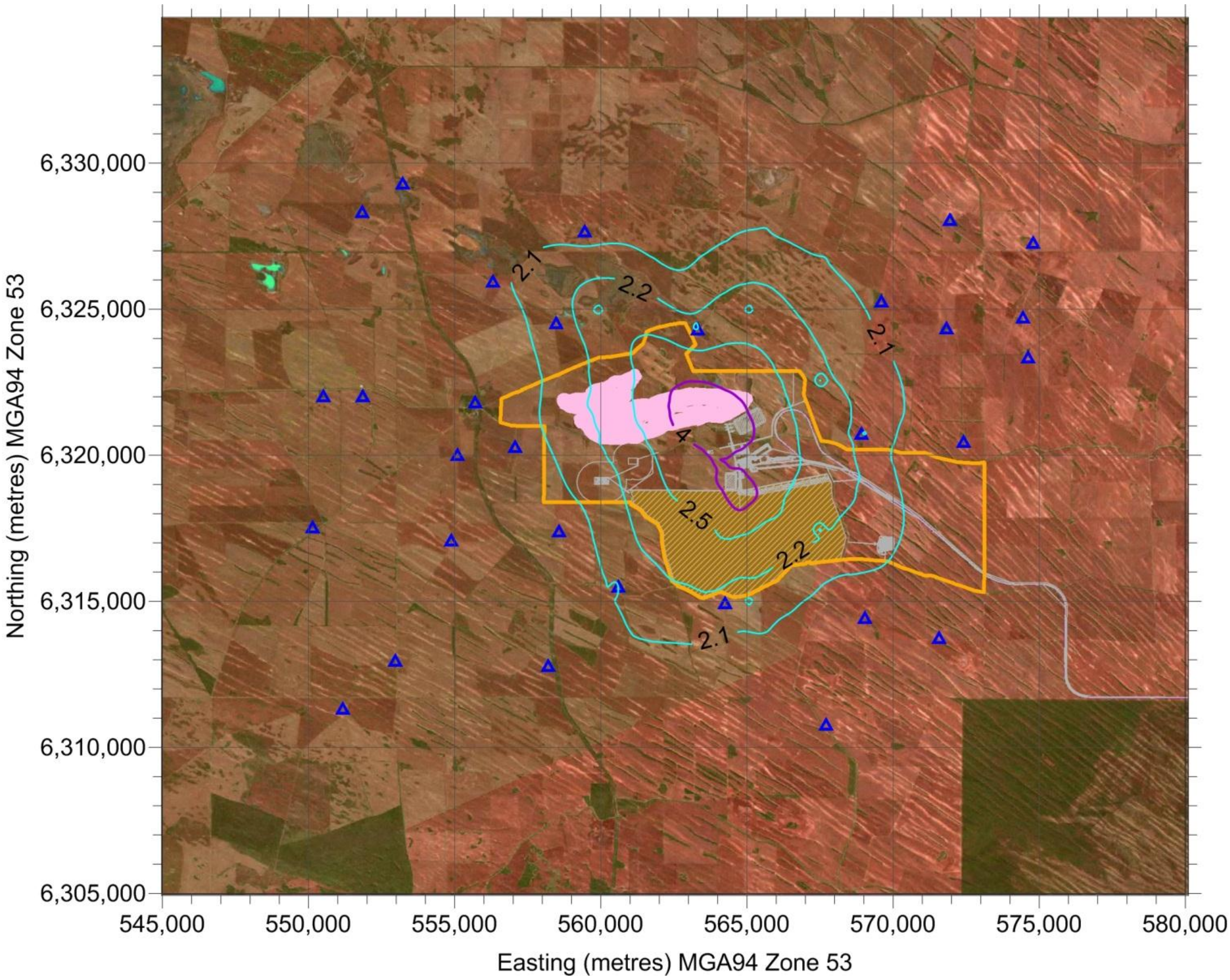


Figure 3-22: CALPUFF results for annual average dust deposition ($g/m^2/month$) for Scenario No.1

3.6.2 Scenario No.3 – Operational Phase dust model results

This section provides the CALPUFF results as contour plots for the following indicators in accordance with EPA (2005):

- Maximum 24-hour Average PM_{10} GLCs
- Maximum 24-hour average $PM_{2.5}$ GLCs
- Annual average $PM_{2.5}$ GLCs
- Annual average TSP GLCs
- Annual average dust deposition

Maximum 24-hour Average PM_{10} GLCs

The CALPUFF results for maximum 24-hour average PM_{10} GLCs (µg/m^3) for Scenario No.3 (operating mine), are provided in Figure 3-23. A background PM_{10} GLC of 22 µg/m^3 is included in the results.

The relevant Project standard (50 µg/m^3), is shown by the purple contour. These results indicate that for Scenario No.3, PM_{10} concentrations would be below the 50 µg/m^3 level at all sensitive receptors outside the mine site boundary. No simulated shut-downs of activities were needed to achieve this result.

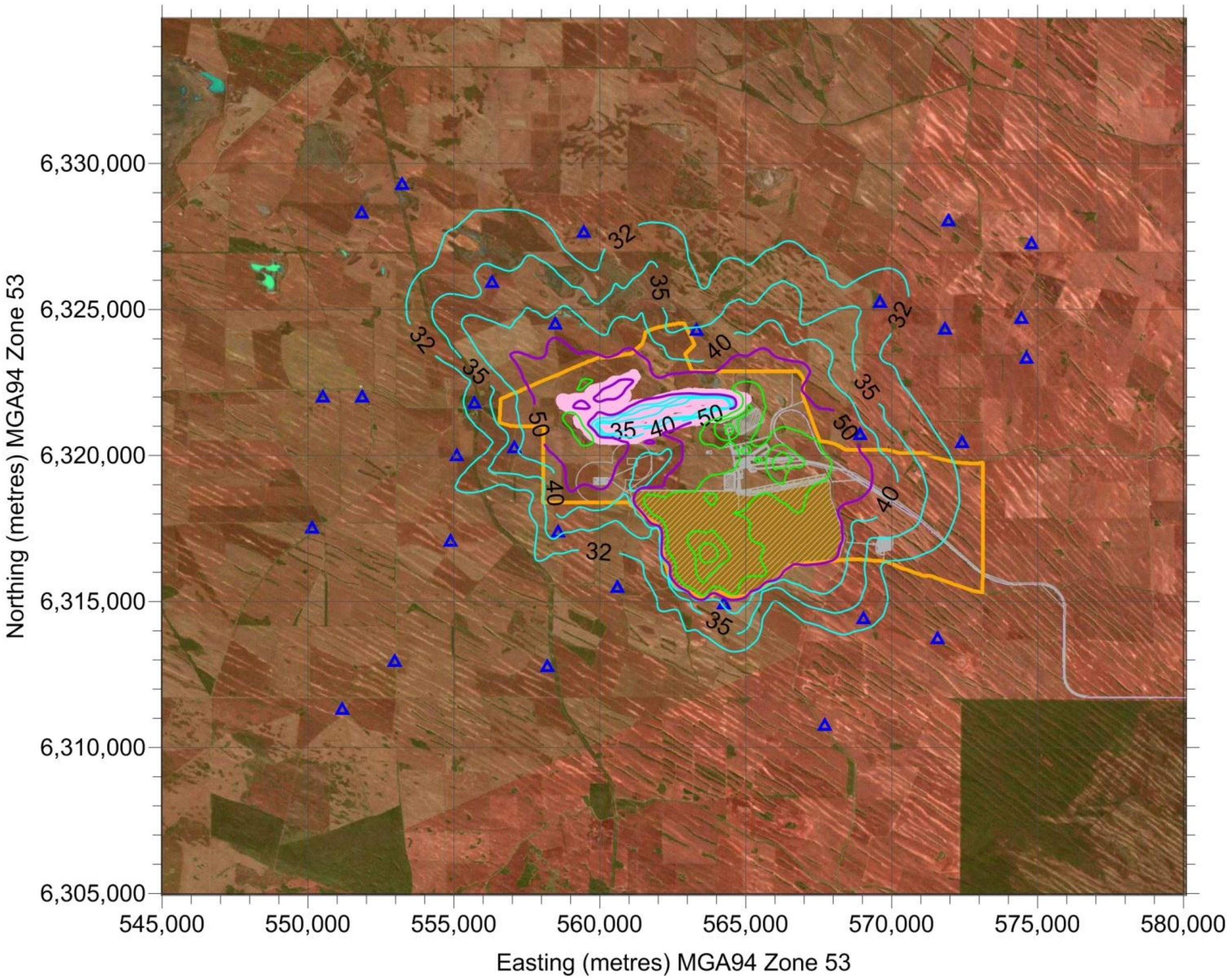


Figure 3-23: CALPUFF results for maximum 24-hour Average PM_{10} GLCs (µg/m^3), Scenario No.3

Maximum 24-hour average $PM_{2.5}$ GLCs

The CALPUFF results for maximum 24-hour average $PM_{2.5}$ GLCs (µg/m^3) for Scenario No.3 (operating mine), are provided in Figure 3-24. The results include the background $PM_{2.5}$ GLC of 10 µg/m^3.

The relevant Project standard (25 µg/m^3), is shown by the purple contour. These results show that the $PM_{2.5}$ GLCs would be less than the 25 µg/m^3 criteria at all sensitive receptors. No simulated shut-downs of activities were needed to achieve this result.

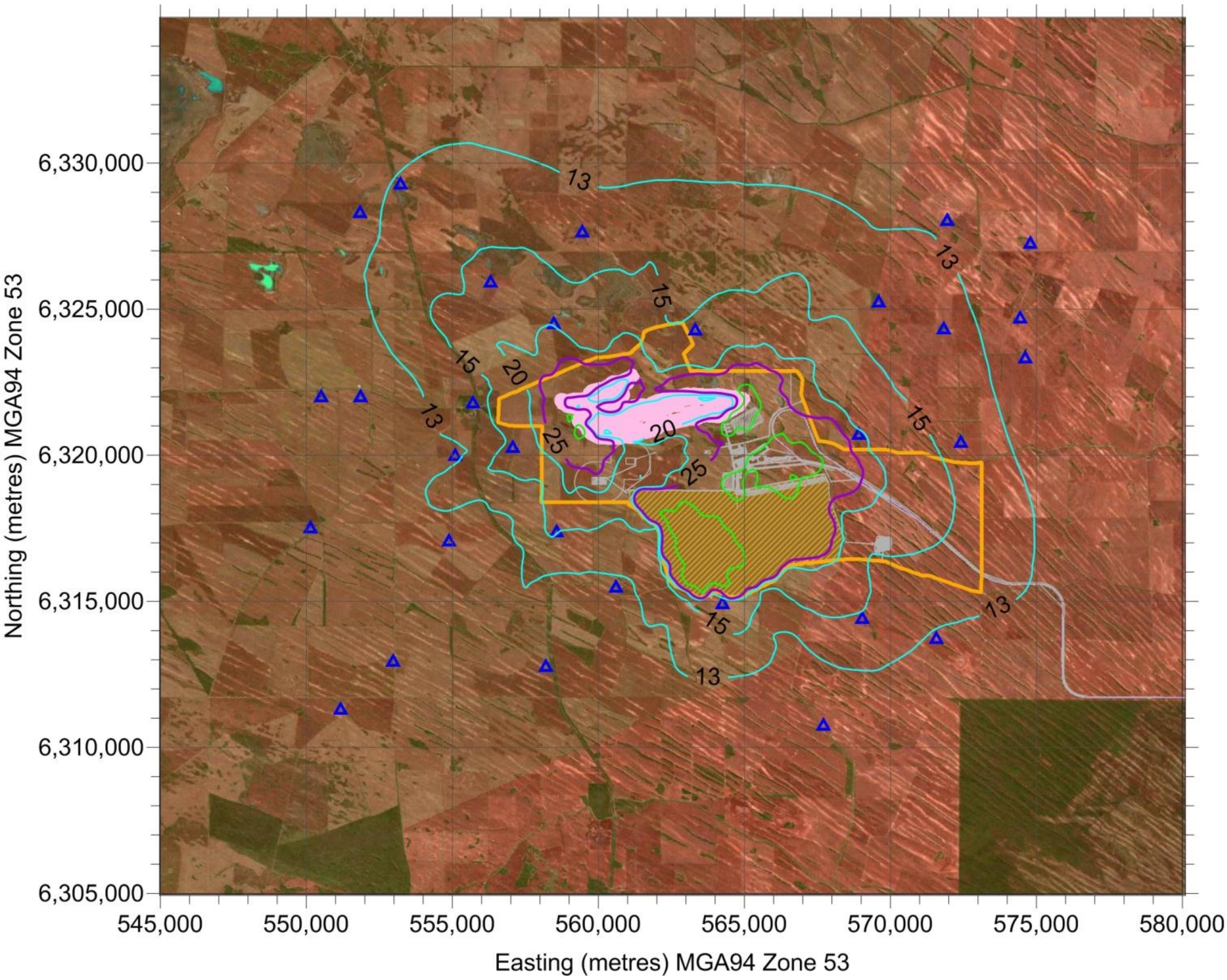


Figure 3-24: CALPUFF results for maximum 24-hour average $PM_{2.5}$ GLCs (µg/m^3), Scenario No.3

Annual average $PM_{2.5}$ GLCs

The annual average $PM_{2.5}$ GLCs are shown in Figure 3-25 for Scenario No.3 (operating mine). The results include a background $PM_{2.5}$ GLC of 7 µg/m^3.

The relevant Project standard is 8 µg/m^3, shown by the purple contour. These results show that the $PM_{2.5}$ GLCs would comply with the standard at all sensitive receptors.

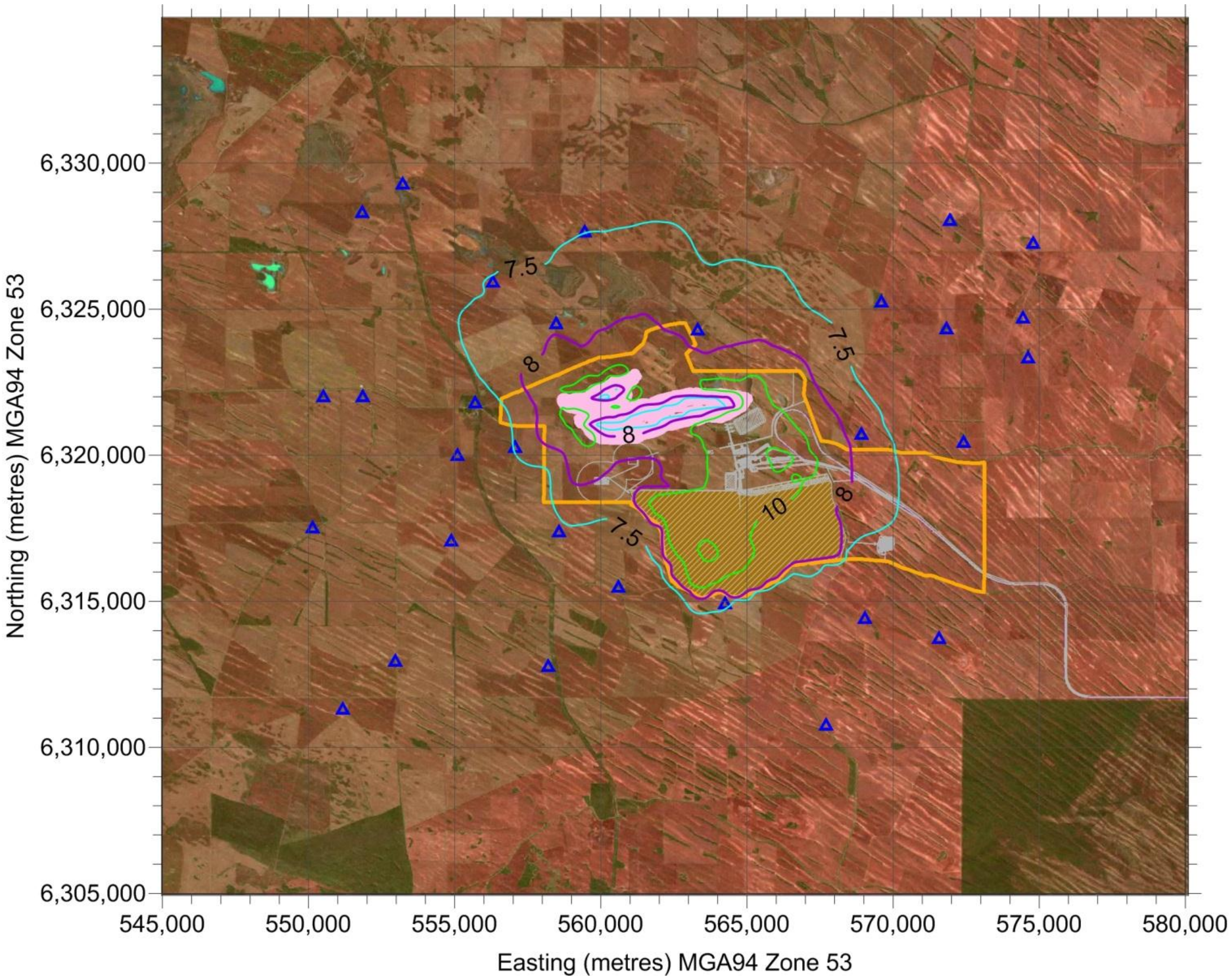


Figure 3-25: CALPUFF results for annual average $PM_{2.5}$ GLCs (µg/m^3) for Scenario No.3

Annual TSP GLCs

The results for TSP were an intermediary step to producing the dust deposition results. The CALPUFF results for annual average TSP GLCs (µg/m^3) for Scenario No.3 (operating mine), are provided in Figure 3-26. The results include a background TSP GLC of 30 µg/m^3.

The relevant Project standard is 90 µg/m^3, shown by the purple contour. These results show that the TSP GLCs would comply with the standard at all sensitive receptors.

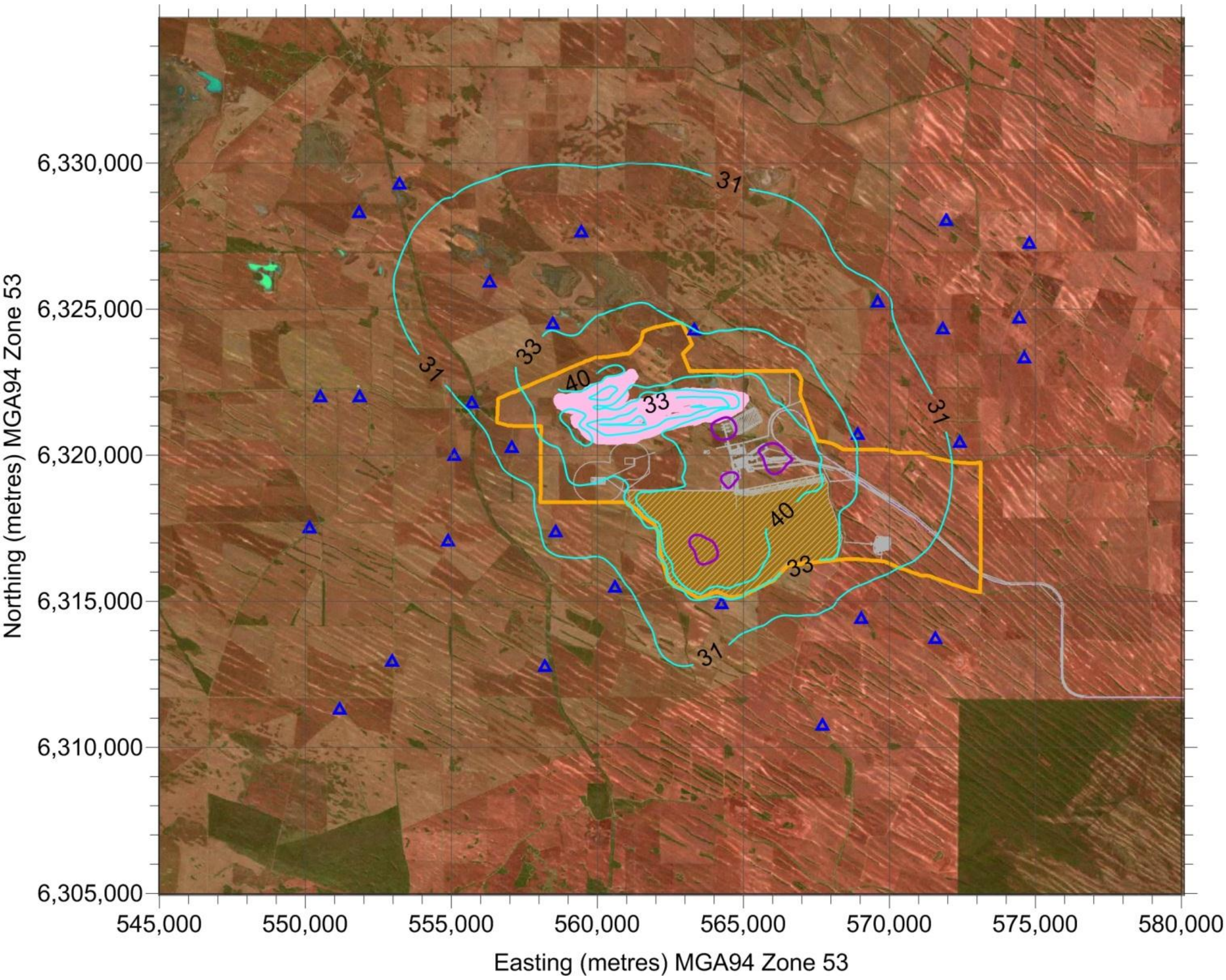


Figure 3-26: CALPUFF results for annual average TSP GLCs (µg/m^3), Scenario No.3

Annual dust deposition

The CALPUFF results for annual average dust deposition (g/m^2/month) for Scenario No.3 (operating mine), are provided in Figure 3-27. The results include a background dust deposition of 2.0 g/m^2/month.

The relevant Project criterion of 4.0 g/m^2/month (total dust deposition), is shown by the purple contour. The results show that the dust deposition would comply with the standard at all sensitive receptors.

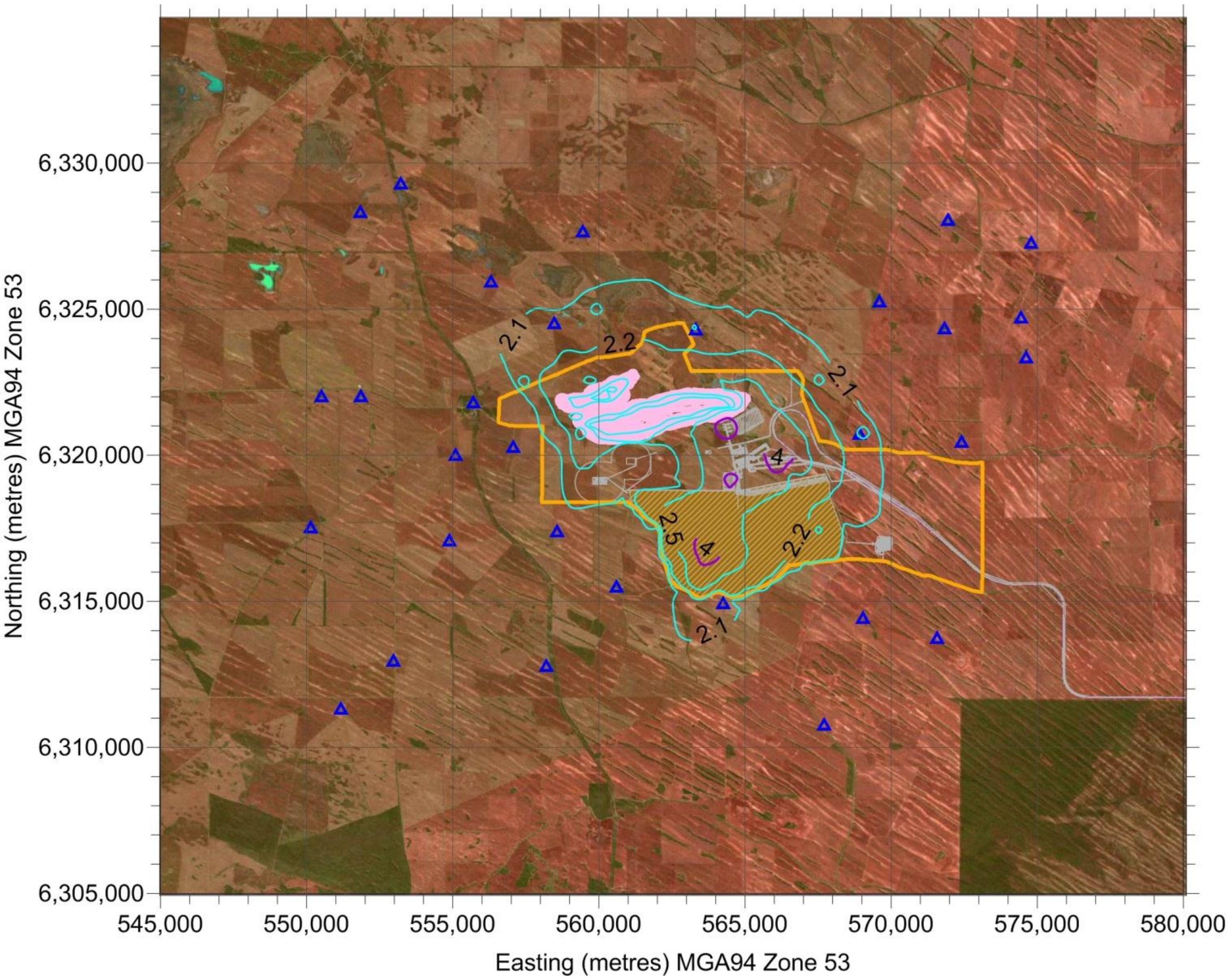


Figure 3-27: CALPUFF results for annual average dust deposition (g/m^2/month), Scenario No.3

3.6.3 Discussion of CALPUFF results for dust

Inspection of the PM_{10} results for Scenarios No.1 and No.3 (see Figure 3-18 and Figure 3-23), and giving consideration to the fractions of time that emissions were deactivated in the model to achieve compliance, indicates that the predicted GLCs are higher for Scenario No.1 in comparison with Scenario No.3. This is despite the total PM_{10} emissions estimates being approximately the same for the two scenarios (approximately 36 g/sec. each). The explanation is to be found in the differences between the heights of emission for the volume sources between the two models. Approximately 30% of the total PM_{10} emissions for Scenario No.3 (mine operations) are located at elevations of 220 metres (above sea level); i.e., on top of the IWL. For the construction phase (Scenario No.1), the dust sources are located at elevations ranging from 62–85 metres. The higher elevations for the sources resulted in enhanced dust dispersion.

In addition, results from further model sensitivity tests showed that for volume sources at the same location and elevation, the mine site terrain including the pit and IWL increased dust dispersion in comparison with the existing, unmodified terrain. The results of the CALPUFF simulation indicated that the mine pit and IWL will have the effect of mitigating air quality impacts.

3.6.4 NO_2 model results

The predicted hourly average NO_2 GLCs for the operational phase of the mine (Scenario No.3), are provided in Figure 3-28. The purple contour represents the relevant Project standard (158 ug/m^3). Using the OLM (see Section 3.4.4), the results for NO_2 GLCs were approximately 24% of the NO_x GLCs. The CALPUFF results complied with the Project standard at all sensitive receptors.

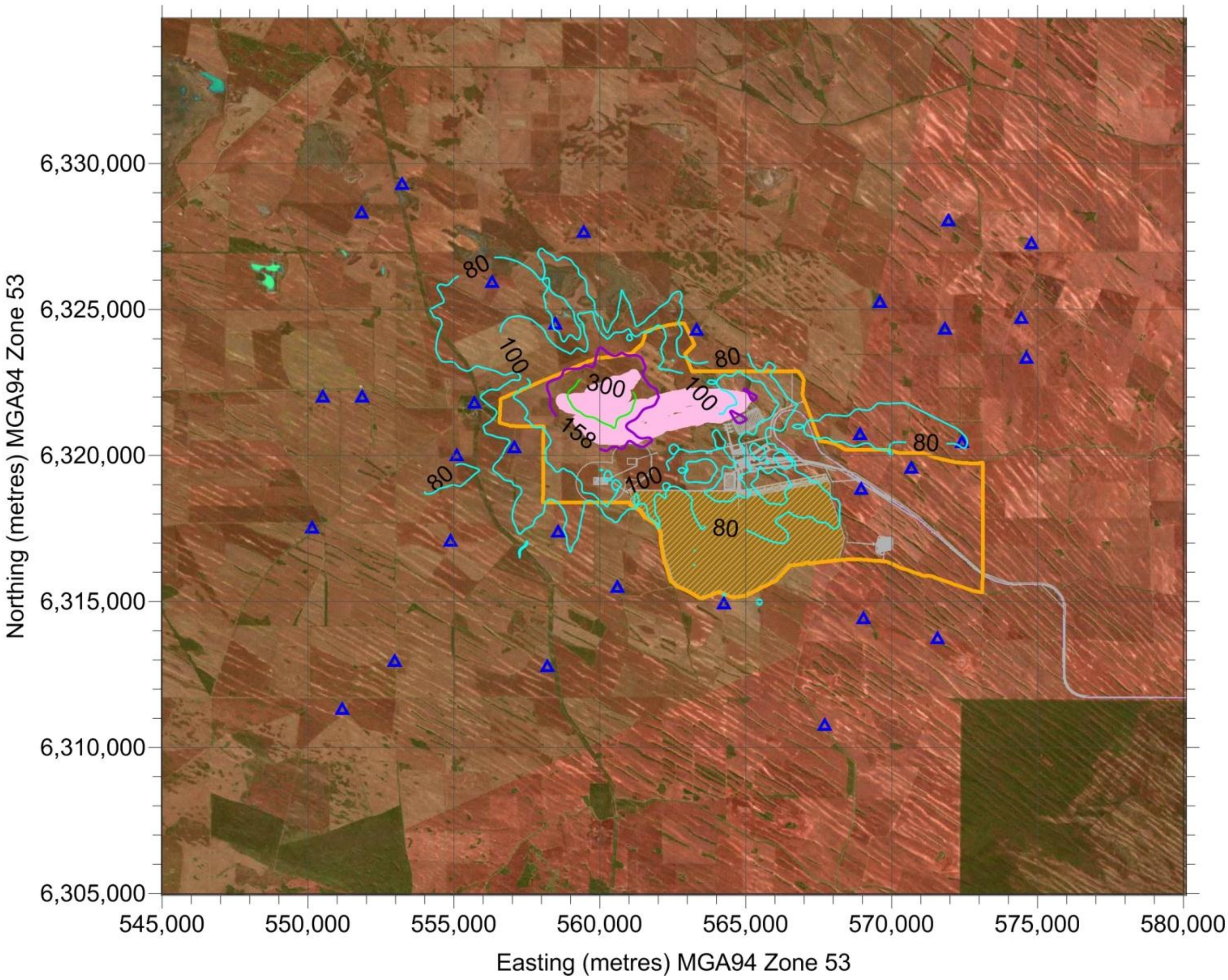


Figure 3-28: CALPUFF results for NO_2 GLCs (ug/m^3), Scenario No.3

3.6.5 Assessment at sensitive receptors – particulate emissions

A summary of the CALPUFF results for predicted airborne dust particle GLCs and dust deposition for Scenario No.1 and No.3 at each of the sensitive receptors identified for the mine site is provided in Table 3-29 and Table 3-30, respectively. The results correspond to the CALPUFF results for maximum GLCs and include estimates for background concentrations and dust deposition.

The results for Scenario No.1 (mine construction), are those representing airborne dust particle GLCs and dust deposition, with mining construction activities ceased for 15.3% of the year as a dust emissions control measure.

It is noted that by ceasing all mining activities for 15.3% of the year, the predicted 24 hour PM_{10} concentration at some sensitive receptors reduces to well below the maximum 24 hour average criteria of 50 ug/m^3. As such, this modelling approach of 'switching off' all dust emissions (except dust from wind erosion for wind speeds greater than 5 m/s) for specific hours is conservative. In practice, it is expected that cessation of all mining activities may not to be required and instead, specific activities can continue but be relocated to areas of the mine which result in a lower dust impact for specific sensitive receptors.

Table 3-29: CALPUFF dust results for sensitive receptors, Scenario No.1

Sensitive Receptor ID	PM_{10} 24 hr avg. (ug/m^3)	$PM_{2.5}$ 24 hr avg. (ug/m^3)	$PM_{2.5}$ annual avg. (ug/m^3)	TSP annual avg. (ug/m^3)	TSP deposition (g/m^2/month)
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
Project air quality standard (max)	**50**	**25**	**8**	**90**	**4**

Table 3-30: CALPUFF dust results for sensitive receptors, Scenario No.3

Sensitive Receptor ID	PM_{10} 24 hr avg. (ug/m^3)	$PM_{2.5}$ 24 hr avg. (ug/m^3)	$PM_{2.5}$ annual avg. (ug/m^3)	TSP annual avg. (ug/m^3)	TSP deposition (g/m^2/month)
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
Project air quality standard (max)	**50**	**25**	**8**	**90**	**4**

3.6.6 Assessment at sensitive receptors – NO_2 emissions

A summary of the CALPUFF results for NO_2 GLCs for the operational phase (Scenario No.3), at each of the sensitive receptors identified for the mine site is provided in Table 3-31. The results correspond to the maximum predicted GLCs due to blasting and diesel consumption. The results include an estimate for hourly average background NO_2 GLCs.

Table 3-31: CALPUFF results for maximum NO_2 GLCs at sensitive receptors, Scenario No.3

Sensitive Receptor ID	NO_2 1-hr avg. (ug/m^3)
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
Project air quality standard (max)	**158**

4 Mine site monitoring and dust mitigation

4.1 Dust Management Plan for Construction and Operational Phases

A dust management plan will be implemented at the mine site, for both the construction and operational phases, to assist with air quality management in the vicinity of the proposed Mining Lease area. The plan will include the provision of weather forecasts and real-time, continuous dust monitoring at selected locations. This dust management approach will enable modification or suspension of operational activities at the mine site in response to the following triggers:

- Predicted increased dust risk from meteorological forecast information e.g. specific wind speeds in specific directions
- Warnings or exceedance notifications from real time dust monitoring at selected sites around the mining facility
- Visual observations of significant dust generation from workforce
- Community feedback

The approach of adjusting mining activities based on meteorological forecasting and/or real-time dust monitoring has been included in the modelling work for the dust emissions to demonstrate the impact of operational changes on predicted dust ground level concentrations at sensitive receptors.

The dust management plan will also set out specific dust mitigation activities and best practice for dust emissions management.

During the two year construction phase, the degree of dust nuisance will depend on the proximity of the dust sources to sensitive receptors, intensity of earth works in specific areas, the nature of the soil/excavated material including moisture content, and weather conditions. The predicted cessation of construction activities for 15.3% of the year to meet the 24 hour PM_{10} concentration criterion at sensitive receptors was carried out using 1-hour average PM_{10} thresholds, as discussed in Section 3.4.3. This resulted in the 24 hour average PM_{10} concentrations being well below the project criterion of 50 ug/m^3 at some sensitive receptors, and the criterion just being met at other sensitive receptor locations. In practice it is expected that construction activities directly upwind of sensitive receptors that are forecast to cause potential nuisance dust issues i.e. via meteorological forecasting and/or ambient dust monitoring, may be ceased or relocated to other areas of the mine. Cessation of all mining activities at one time may not to be required. Instead specific activities may be able to be continued but relocated to areas of the mine where dust effects are predicted to be insignificant.

The implementation of dust mitigation measures will be a primary focus during construction. The dust control measures to be detailed in the dust management plan will give consideration to the following items:

- All materials transported to and from the construction site will be covered
- Temporary stockpiles of soil or other material are to be covered or sprayed with water or suitable chemical wetting agents on a regular basis, particularly during dry or windy conditions
- Vegetation will be retained on site wherever possible to minimise exposed areas as dust sources and increase surface roughness thereby improving air pollutant dispersion.
- All stockpiles and other exposed areas e.g. unpaved roads will be located as far from residences and any other sensitive receptors as practicable
- Temporary haul roads will be constructed of compacted gravel, or similar, and well maintained

- Water/chemical wetting agents will be used to suppress dust on temporary roadways and other exposed areas
- Dust-generating activities will be minimised during windy conditions, with consideration given to reducing the frequency and intensity of visible dust plumes, and a high-wind speed threshold used to halt operations during very high winds.
- Best practice engine emissions controls will be installed on vehicles and diesel engine powered equipment where practicable (this is also for the protection of workforce health); and vehicles and machinery will be maintained and operated to minimise emissions of gaseous and particulate pollutants.

4.2 Mine Closure

At the completion of the operational mining activities, the mine site will enter a closure phase before relinquishment of the mining lease. The key activities during the closure phase will include final capping and rehabilitation of the IWL and decommissioning of site infrastructure.

One of the key objectives of the IWL capping and rehabilitation process is to provide effective surface protection and armouring to enhance surface stability and protect against erosion and dust generation. As discussed in Section 2.4, capping and rehabilitation of the IWL is to occur progressively throughout the operational phase of the mine to provide stability to the IWL and minimise areas prone to dust generation. The progressive nature of the landform rehabilitation throughout the life of the mine allows an important opportunity to trial rehabilitation techniques and capping material compositions, so it is expected that by the end of mining, effective rehabilitation strategies will be well understood.

Landform capping will be carried out by the mobile stackers and the preferred concept landform design includes a capillary break layer of waste rock, covered in a layer of waste rock mixed with topsoils and subsoils applied to the landform plateau for both the slopes and benches. The rehabilitation trials during the life of the mine will focus on providing a soil profile that will support indigenous vegetation.

Similarly any unused stockpiles at the mine site will be covered with topsoil and revegetated to minimise wind erosion and dust emissions.

During the process of completing the capping of the IWL, the dust emissions from the conveying and transferring of the topsoil/subsoil/WR mix and loading of the material to the IWL using the mobile stackers are expected to be similar to dust emissions quantified in Section 3.3.6 for the construction of the IWL.

Decommissioning activities will include the dismantling and removal of equipment items from the mine site. It is expected that the duration of potential dust emissions associated with these activities will be relatively short. These emissions are to be effectively managed by the use of best practice dust management as provided in the dust management plan.

At the completion of excavation at the Murphy and Booloo pits, the ground water pumps will be turned off and ground water will gradually seep into the pit via the pit walls and will collect at the bottom of the pits. A safety bund will be constructed around the top edge of the pits. Dust emissions generated during the construction of this wall are to be effectively managed with the implementation of water sprays and ceasing or relocating activities based on meteorological forecasting.

During the mine closure phase, there will be a significant reduction in the activities which generate dust compared to those during the operation phase, i.e. no crushing operations, no handling or transfer of ore and concentrate, no operational activities in the pits, etc. As a result, the overall dust emissions from the site are expected to be significantly less than those expected during the operational phase of the mine as represented by the Scenario No.3 assessment.

5 Conclusion

This report provides the results of an air quality impact assessment undertaken for the Iron Road proposed CEIP Mine site. The study was undertaken by the identification of key air pollutant sources from activities expected to be associated with the proposed CEIP Mine; calculation of dust particle and gaseous pollutant source terms for modelling; TAPM and CALMET meteorological modelling; and dispersion modelling using CALPUFF.

The main part of this assessment was a dust dispersion modelling study of the proposed mining operation, with a focus on key dust indicators: PM_{10}, $PM_{2.5}$, TSP and dust deposition. Three air emissions scenarios were set out based on key mining phases and associated material movement rates. The two scenarios considered to present the highest potential risk to sensitive receptors were the construction phase (Scenario No.1) and the peak mining phase (Scenario No.3). Dispersion modelling was carried out for these two scenarios. The modelling assessment focussed on the following air quality indicators:

- Maximum 24 hour average PM_{10} and $PM_{2.5}$ particle GLCs
- Annual average airborne particle (TSP) and $PM_{2.5}$ GLCs
- Annual average dust depositions

In addition to the dust modelling, a CALPUFF modelling assessment of the potential impact of gaseous pollutants from blasting operations and diesel consumption was carried out. Of the gaseous pollutants, NO_2 was found to present the highest potential risk to sensitive receptors. Emission estimates and dispersion modelling was carried out for NO_2.

A summary of the results of the dust dispersion modelling for the mine site is provided in the following points:

- **Scenario No.1 – Mine construction phase**
    - **PM_{10} and $PM_{2.5}$ 24-hour**: CALPUFF modelling was undertaken using estimates for 24-hour average background GLC of 22 µg/m^3 for PM_{10}, and 10 µg/m^3 for $PM_{2.5}$. Compliance with the Project assessment criteria for both PM_{10} i.e. maximum 24-hour average GLC 50 µg/m^3; and $PM_{2.5}$ i.e. maximum 24-hour average GLC 25 µg/m^3; was predicted to be achieved with the implementation of an operational management plan using dust monitoring. Dust plume forecasting is also expected to assist the future operators of the mine. The CALPUFF results indicated that mining activities and dust mitigation practices would need to be modified based on inputs from the monitoring and forecasting tools for approximately 15% of each year during the construction period.
    - **$PM_{2.5}$ annual:** Similarly, for annual average $PM_{2.5}$, using a background GLC of 7 µg/m^3, the assessment demonstrated that exceedances of the of the project assessment criteria, 8 µg/m^3, were expected to be preventable by modifying mining activities for approximately 15% of each year during the construction period.
    - **Dust deposition.** Annual dust deposition at sensitive receptors was predicted to be 2.0–2.2 g/m^2/month (maximum project assessment criteria of 4 g/m^2/month), including the modification of dust generating activities. Results of 4 g/m^2/month and higher were predicted directly over the construction area, i.e. the eastern half of the Murphy pit, and along the haul route to the north edge of the IWL, but not outside of the proposed Mining Lease boundary.

- **Scenario No.3 – Operational phase**
  - **PM_{10} and $PM_{2.5}$ 24-hour:** Model predictions were undertaken using estimates for 24-hour average background GLC of 22 µg/m^3 for PM_{10}, and 10 µg/m^3 for $PM_{2.5}$. There were no predicted exceedances of the project assessment criteria for PM_{10} i.e. maximum 24-hour average GLC 50 µg/m^3; and $PM_{2.5}$ i.e. maximum 24-hour average GLC 25 µg/m^3).
  - **$PM_{2.5}$ annual:** Similarly, the project assessment criteria for $PM_{2.5}$ annual average GLC of 8 µg/m^3 was predicted to be satisfied at all sensitive receptors. The results included a background GLC of 7 µg/m^3.
  - **Dust deposition.** Typical model results for dust deposition within the proposed Mining Lease boundary for Scenario No.3 were 2.3 – 10.7 g/m^2/month; results of 4 g/m^2/month and higher were predicted directly over the most intensive dust generation sites, including the IWL and processing area. The model results for dust deposition indicated that there would be no nuisance dust impacts outside the proposed Mining Lease boundary.

The NO_2 dispersion modelling assessment predicted that there would be no exceedance of the NO_2 GLC criterion of 158 ug/m^3 at the sensitive receptors.

6 References

AS 4156.6—2000: Australian Standard, *Coal preparation Part 6: Determination of dust/moisture relationship for coal*.

AS/NZS 3580.10.1:2003: Australian/New Zealand Standard, *Methods for sampling and analysis of ambient air, Method 10.1: Determination of particulate matter–deposited matter–gravimetric method*.

Ayers, G. P., M.D. Keywood and J.L. Gras, D. Cohen, D. Garton and G.M. Bailey, *Chemical and Physical Properties of Australian Fine Particles: A Pilot Study*, Prepared for the Environment Protection Group, Environment Australia, Final Report. Division of Atmospheric Research, CSIRO, and the Australian Nuclear Science and Technology Organisation, June 1999.

BoM (2014): Bureau of Meteorology, El Niño - Detailed Australian Analysis, El Niño: 2009-10, http://reg.bom.gov.au/climate/enso/enlist/, accessed 16/1/14.

EPA South Australia, Data: South Australian EPA air quality monitoring data tables from web site; http://www.epa.sa.gov.au/environmental_info/air_quality/reports_and_summaries; accessed July 2014

EPA South Australia, AQI: South Australian EPA air quality index information from web site: http://www.epa.sa.gov.au/environmental_info/air_quality/recent_air_quality/what_is_an_air_quality_index; accessed February 2015.

EPA (2006): *Air quality impact assessment using design ground level pollutant concentrations (DGLCs)*, EPA 386/06, EPA South Australia, updated January 2006.

EPA (2005): *Presentation of air pollution modelling outputs*, EPA 578/05, EPA South Australia, issued February 2005.

EPA (2014): Ambient air quality monitoring data from the Netley monitoring station, provided to Jacobs on 13 November 2014 by EPA South Australia.

EPA (2015): *Recent Air Quality, What is an Air Quality Index*, http://www.epa.sa.gov.au/environmental_info/air_quality/recent_air_quality/what_is_an_air_quality_index, accessed 15/2/15.

Exponent (2015): CALPUFF model web-site (http://src.com/calpuff/calpuff1.htm), accessed February 2015

DEC (2005): Department of Environment and Conservation NSW (DEC), DEC 2005/361, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, August 2005.

Earth Tech (2000a): *A User's Guide for the CALMET Meteorological Model (Version 5)*, Prepared by: J.S. Scire, F. R. Robe, M. E. Fernau, and R. J. Yamartino, January, 2000.

Earth Tech (2000b): *A User's Guide for the CALPUFF Dispersion Model (Version 5)*, Prepared by: J.S. Scire, D. G. Strimaitis, and R. J. Yamartino, January, 2000.

Hurley (2008a): *TAPM v.4. User Manual*, CSIRO Marine and Atmospheric Research Internal Report No. 5, October 2008.

Hurley (2008b): Peter Hurley, TAPM V4. Part 1: Technical Description, CSIRO Marine and Atmospheric Research Paper No. 25, October 2008.

Hurley et al. (2008): Peter Hurley, Mary Edwards and Ashok Luhar, TAPM V4. Part 2: Summary of Some Verification Studies. CSIRO Marine and Atmospheric Research Paper No. 26, October 2008.

Jacobs (2014): Jacobs, *Central Eyre Iron Project, Iron Road Limited, Air Quality Impact Assessment – Infrastructure*, Revision 0, Client Document Number: E-F-34-RPT-0040_0, 13 Nov 2014.

Jacobs (2015): Jacobs, *Central Eyre Iron Project, Iron Road Limited, Campaign Harvest Air Monitoring Program*, Revision A3, 20 Feb 2015.

NEPC (2011): National Environment Protection Council (NEPC), *Ambient Air Quality NEPM Review, National Environment Protection (Ambient Air Quality) Measure*, Review Report, Prepared for the National Environment Protection Council, May 2011.

NEPC (2003): National Environment Protection Council (NEPC), *National Environment Protection (Ambient Air Quality) Measure ("NEPM")*, as amended made under section 20 of the National Environment Protection Council Act 1994 (Cwlth), National Environment Protection Council (Victoria) Act 1995 (Vic), (and other states), Prepared by the Office of Legislative Drafting, Attorney-General's Department, Canberra, 7 July 2003.

NIOSH (2000): Factors Affecting ANFO Fumes Production, James H Rowland III and Richard Mainiero, presented at the 26th Annual Conference on Explosives and Blasting Techniques, Anaheim, California, February 2000

NPI EETM for Combustion Engines (2008): Australian Government, *National Pollutant Inventory Emission Estimation Technique Manual for Combustion Engines Version 3.0*, June 2008.

NPI EETM for Mining (2012): Australian Government, *National Pollutant Inventory Emission Estimation Technique Manual for Mining*, Version 3.1, January 2012.

NPI EETM for Explosives (2012): Australian Government, *National Pollutant Inventory Emission Estimation Technique Manual for Explosives detonation and firing ranges,* Version 3.0, January 2012.

SKM (2002): Sinclair Knight Merz, *BHPBilliton Iron Ore, Product and Capacity Expansion, On Site Emission Sampling*, 2002.

TRC (2011) "*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW'* ".Prepared for the Office of Environment and Heritage by TRC, March 2011.

US EPA (1988): United States Environmental Protection Agency, *Control of Open Fugitive Dust Sources*, US EPA Office of Air Quality, Planning and Standards Emissions, EPA-450/3-88-908, September 1988

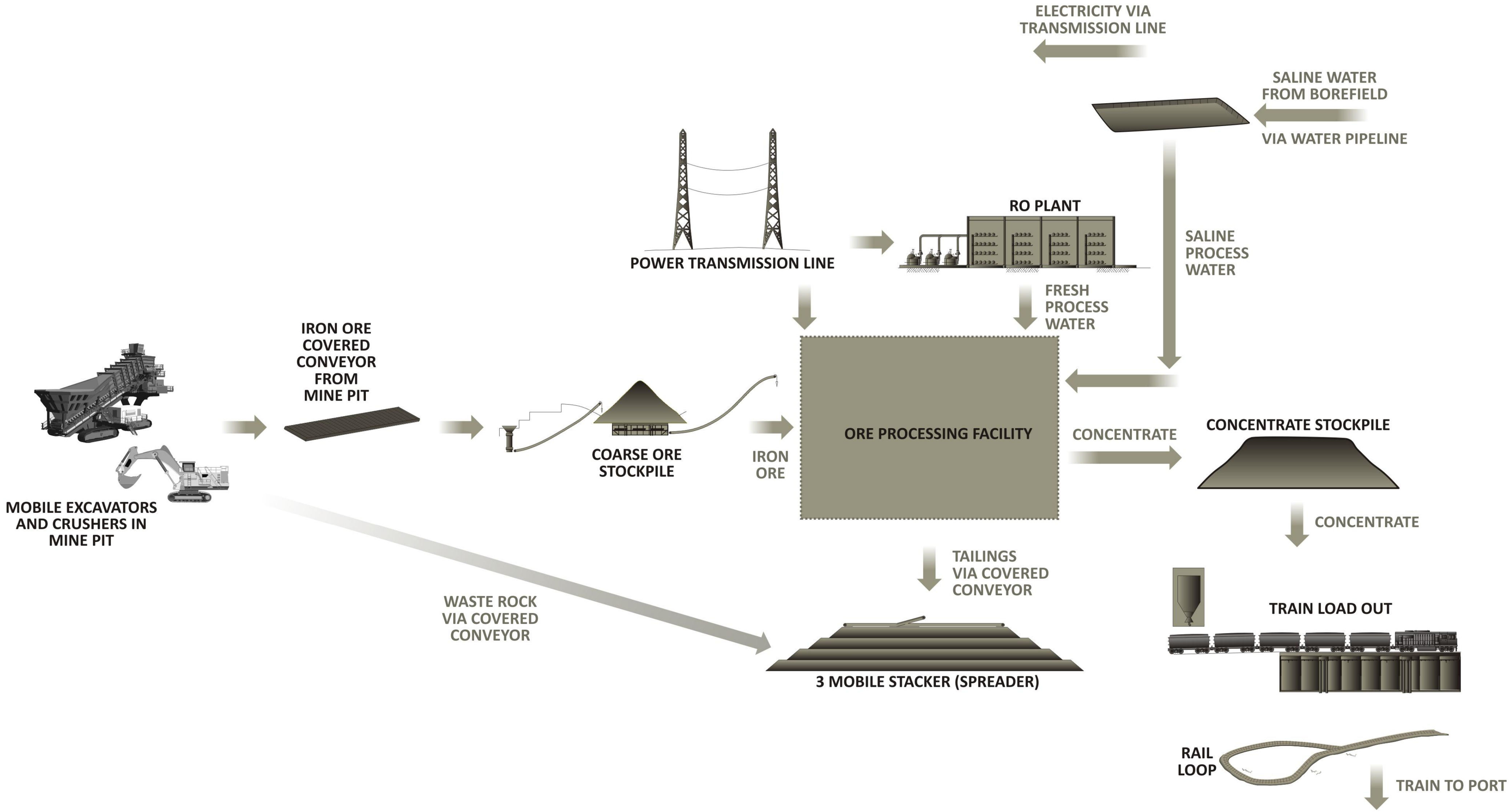
US EPA (1995): "User's Guide for the Industrial Source Complex (ISC3) Dispersion Models – Volume 1 User's Instructions" and "Volume 2 Description of Model Algorithms" US EPA, Office of Air Quality Planning and Standards Emissions, 1995.

US EPA AP-42 (1995 and updates) "Compilation of Air Pollutant Emission Factors", AP-42, Volume I, 5th edition, United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

VG (2001): Victoria Government, *State Environment Protection Policy (Air Quality Management)*, Victoria Government Gazette, No. S 240 Friday, 21 December 2001.

Zender, C., *Particle Size Distributions: Theory and Application to Aerosols, Clouds, and Soils*. University of California, Irvine. On-line, http://dust.ess.uci.edu/facts, updated 30th Aug, 2010.

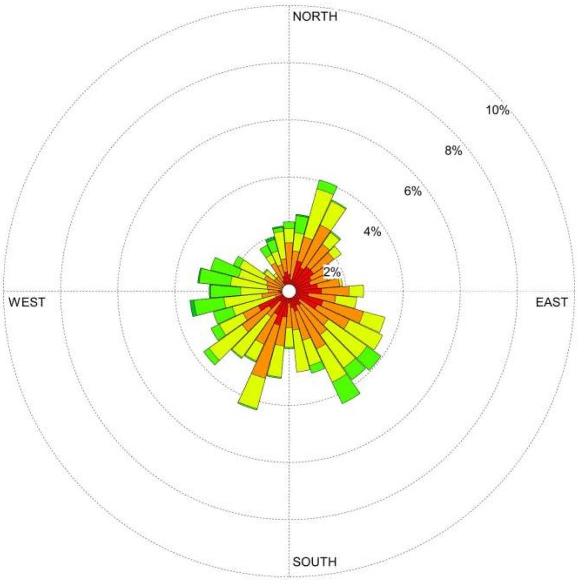
Appendix A CEIP simplified process flow diagram



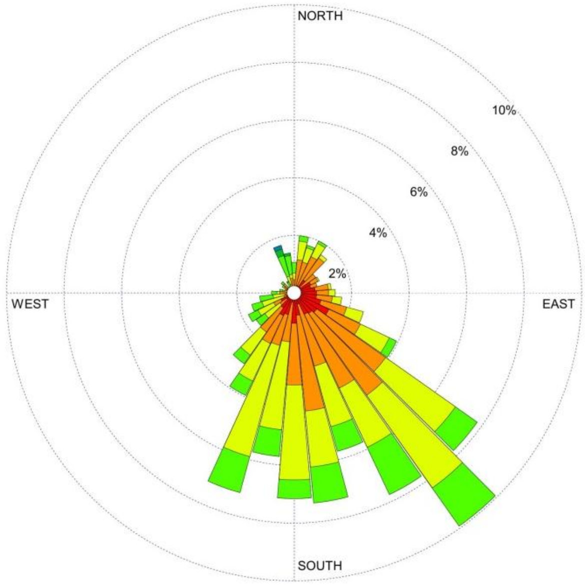
ELECTRICITY VIA
TRANSMISSION LINE
SALINE WATER
FROM BOREFIELD
VIA WATER PIPELINE
RO PLANT
SALINE
PROCESS
WATER
POWER TRANSMISSION LINE
FRESH
PROCESS
WATER
IRON ORE
COVERED
CONVEYOR
FROM
MINE PIT
ORE PROCESSING FACILITY
CONCENTRATE
CONCENTRATE STOCKPILE
COARSE ORE
STOCKPILE
IRON
ORE
MOBILE EXCAVATORS
AND CRUSHERS IN
MINE PIT
CONCENTRATE
TAILINGS
VIA COVERED
CONVEYOR
TRAIN LOAD OUT
WASTE ROCK
VIA COVERED
CONVEYOR
3 MOBILE STACKER (SPREADER)
RAIL
LOOP
TRAIN TO PORT

Appendix B Mine site seasonal wind roses 2009, TAPM model

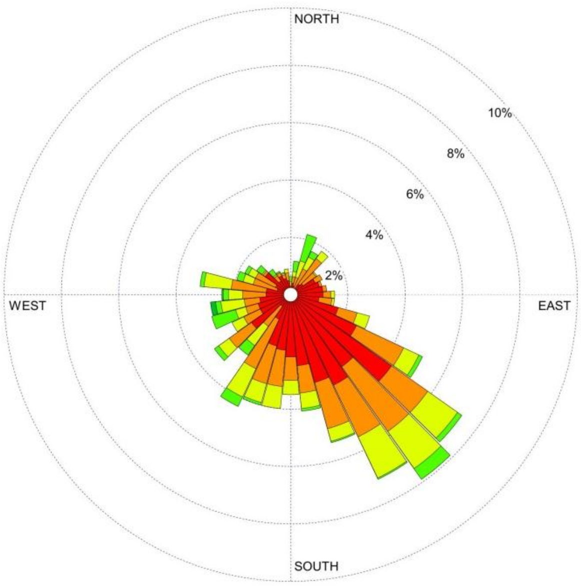
Spring



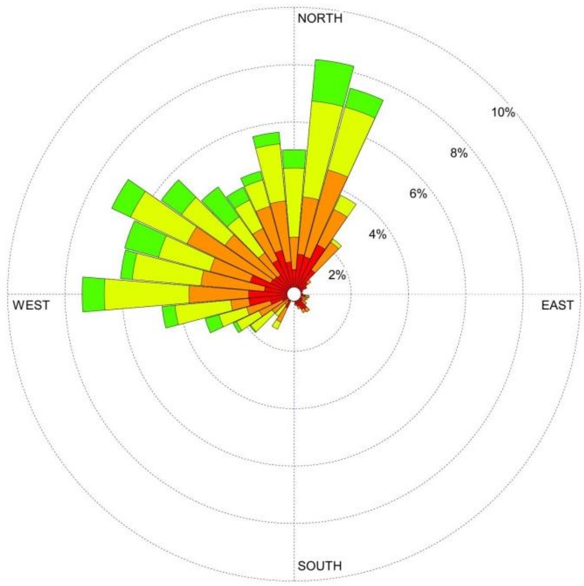
Summer

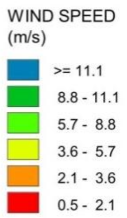


Autumn



Winter





Appendix C Dust emission estimates

Table C-1: Breakdown of TSP emissions estimates by activity type

Emissions Calculation Results - TSP Summary	Scenario 1 g/sec	Scenario 1 % of total	Scenario 2 g/sec	Scenario 2 % of total	Scenario 3 g/sec	Scenario 3 % of total
Topsoil removal and dumping	0.43	0.4%	2.30	3.7%	2.30	2.9%
Excavation by shovel and loading	1.10	1.0%	1.57	2.5%	1.60	2.1%
WGD - haul trucks + light vehicles	63.6	54.8%	6.06	9.6%	9.41	12%
WR conveyors and transfer points	13.0	11.2%	0.90	1.4%	0.99	1.3%
Ore and WR crushers	0.00	0.0%	8.67	14%	9.21	12%
Ore conveyors and transfer points	0.00	0.0%	0.74	1.2%	1.44	1.9%
IWL - unloading from trucks/conveyors	4.56	3.9%	12.6	20%	19.0	24%
Wind erosion of IWL, overburden, topsoil and crushed ore stockpiles	7.27	6.3%	7.27	12%	7.27	9.3%
Drilling and blasting	2.57	2.2%	1.28	2.0%	1.28	1.7%
Bulldozers	20.7	17.9%	4.09	6.5%	7.16	9.2%
Processing area	0.02	0.0%	14.8	24%	15.5	20%
Graders	2.61	2.3%	2.61	4.2%	2.61	3.4%
Total	**115.9**	**100%**	**62.9**	**100%**	**77.8**	**100%**

Table C-2: Breakdown of PM_{10} emissions estimates by activity type

Emissions Calculation Results – PM_{10} Summary	Scenario 1 g/sec	Scenario 1 % of total	Scenario 2 g/sec	Scenario 2 % of total	Scenario 3 g/sec	Scenario 3 % of total
Topsoil removal and dumping	0.12	0.3%	0.63	2.1%	0.63	1.7%
Excavation by shovel and loading	0.51	1.4%	1.41	4.7%	1.44	4.0%
WGD - haul trucks + light vehicles	18.1	50%	1.75	5.8%	2.71	7.5%
WR conveyors and transfer points	4.66	12.9%	0.56	1.8%	0.63	1.8%
Ore and WR crushers	0.00	0.0%	6.59	22%	7.00	19%
Ore conveyors and transfer points	0.00	0.0%	0.41	1.4%	0.89	2.5%
IWL - unloading from trucks/conveyors	1.94	5.4%	5.28	18%	8.01	22%
Wind erosion of IWL, overburden, topsoil and crushed ore stockpiles	3.63	10.1%	3.63	12%	3.63	10%
Drilling and blasting	1.34	3.7%	1.27	4.2%	1.27	4%
Bulldozers	4.96	13.7%	1.44	4.8%	2.39	6.6%
Processing area	0.01	0.03%	6.30	21%	6.62	18%
Graders	0.83	2.3%	0.83	2.7%	0.83	2.3%
Total	**36.1**	**100%**	**30.1**	**100%**	**36.0**	**100%**

Table C-3: Breakdown of $PM_{2.5}$ emissions estimates by activity type

Emissions Calculation Results - $PM_{2.5}$	**Scenario 1**		**Scenario 2**		**Scenario 3**	
Summary	g/sec	% of total	g/sec	% of total	g/sec	% of total
Topsoil removal and dumping	0.04	0.5%	0.22	2.2%	0.22	1.8%
Excavation by shovel and loading	0.18	2.3%	0.52	5.2%	0.53	4.5%
WGD - haul trucks + light vehicles	1.81	23%	0.17	1.8%	0.27	2.3%
WR conveyors and transfer points	1.63	21%	0.20	2.0%	0.23	1.9%
Ore and WR crushers	0.00	0.0%	2.43	24%	2.58	22%
Ore conveyors and transfer points	0.00	0.0%	0.15	1.5%	0.32	2.7%
IWL - unloading from trucks/conveyors	0.68	8.5%	1.85	19%	2.80	24%
Wind erosion of IWL, overburden, topsoil and crushed ore stockpiles	1.27	16%	1.27	13%	1.27	11%
Drilling and blasting	0.08	1.0%	0.08	0.8%	0.08	0.7%
Bulldozers	2.18	27%	0.74	7.5%	1.14	9.6%
Processing area	0.00	0.0%	2.20	22%	2.32	20%
Graders	0.08	1.0%	0.08	0.8%	0.08	0.7%
Total	**8.0**	**100%**	**9.9**	**100%**	**11.8**	**100%**

JACOBS

Appendix D CALPUFF model input summary data for Scenario No.1

25-Jan-2015 20:27

DUST EMISSION CALCULATIONS XL1

Output emissions file : C:\Users\MAHall\Desktop\emiss10r.vol
Meteorological file : NA
Number of dust sources : 47
Number of activities : 21

-----ACTIVITY SUMMARY-----
ACTIVITY NAME : Removing topsoil
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 10875 kg/y TSP 2738 kg/y PM10 958 kg/y PM2.5
FROM SOURCES : 1
1
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Drilling (Murphy pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 721 kg/y TSP 379 kg/y PM10 133 kg/y PM2.5
FROM SOURCES : 1
2
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Blasting (Murphy pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 80300 kg/y TSP 41756 kg/y PM10 2409 kg/y PM2.5
FROM SOURCES : 1
3
HOURS OF DAY :
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

ACTIVITY NAME : Excavation, loading mobile crushers
ACTIVITY TYPE : Wind sensitive
DUST EMISSION : 33930 kg/y TSP 16048 kg/y PM10 5617 kg/y PM2.5
FROM SOURCES : 7
4 5 6 7 8 9 10
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Dozers (Murphy pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 140924 kg/y TSP 31432 kg/y PM10 14797 kg/y PM2.5
FROM SOURCES : 6
11 12 13 14 15 16
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck haulage (Waste rock to Crusher Station No.1)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 1945645 kg/y TSP 553271 kg/y PM10 55327 kg/y PM2.5
FROM SOURCES : 4
17 18 19 20
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck haulage (Topsoil from Murphy pit to WR/Tailings)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 38156 kg/y TSP 10850 kg/y PM10 1085 kg/y PM2.5
FROM SOURCES : 9
21 22 23 24 25 26 27 28 29
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck dump at crushing station
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 387193 kg/y TSP 137454 kg/y PM10 48109 kg/y PM2.5
FROM SOURCES : 1
30
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Additional WR transfer points (mine edge to ILF)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 23989 kg/y TSP 9596 kg/y PM10 3358 kg/y PM2.5
FROM SOURCES : 4
31 32 33 34
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck dump of ore at crushing station
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 2452 kg/y TSP 870 kg/y PM10 305 kg/y PM2.5
FROM SOURCES : 1
35
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Ore transfer points - mine edge to stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 76 kg/y TSP 30 kg/y PM10 11 kg/y PM2.5
FROM SOURCES : 2
36 37
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Crushed Ore Stockpile - loading
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 759 kg/y TSP 323 kg/y PM10 113 kg/y PM2.5
FROM SOURCES : 1
38
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of crushed ore stockpile
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 14603 kg/y TSP 7301 kg/y PM10 2556 kg/y PM2.5
FROM SOURCES : 1
39
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck dump at topsoil stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 2700 kg/y TSP 959 kg/y PM10 335 kg/y PM2.5
FROM SOURCES : 1

40
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Dozers, topsoil stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 146602 kg/y TSP 35690 kg/y PM10 15393 kg/y PM2.5
FROM SOURCES : 1
41
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Loading of overburden at ramp area
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 143933 kg/y TSP 61171 kg/y PM10 21410 kg/y PM2.5
FROM SOURCES : 1
42
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Dozers, overburden
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 366504 kg/y TSP 89224 kg/y PM10 38483 kg/y PM2.5
FROM SOURCES : 1
43
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of overburden
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 188375 kg/y TSP 94188 kg/y PM10 32966 kg/y PM2.5
FROM SOURCES : 1
44
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of topsoil stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 26280 kg/y TSP 13140 kg/y PM10 4599 kg/y PM2.5
FROM SOURCES : 1
45
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Road Maintenance (graders).
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 82412 kg/y TSP 26061 kg/y PM10 2555 kg/y PM2.5
FROM SOURCES : 1
46
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck Wheel Generated Dust (WGD), light duty vehicles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 20227 kg/y TSP 7047 kg/y PM10 674 kg/y PM2.5
FROM SOURCES : 1
47
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Pit retention sources:

Appendix E CALPUFF model input summary data for Scenario No.3

22-Jan-2015 14:43

DUST EMISSION CALCULATIONS XL1

Output emissions file : C:\Users\MAHall\Desktop\emiss30l.vol
Meteorological file : NA
Number of dust sources : 107
Number of activities : 41

-----ACTIVITY SUMMARY-----
ACTIVITY NAME : Removing topsoil/misc. material
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 58000 kg/y TSP 14600 kg/y PM10 5110 kg/y PM2.5
FROM SOURCES : 1
1
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Drilling (Murphy pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 0 kg/y TSP 0 kg/y PM10 0 kg/y PM2.5
FROM SOURCES : 1
2
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Drilling (Booloo pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 721 kg/y TSP 379 kg/y PM10 133 kg/y PM2.5
FROM SOURCES : 1
3
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Blasting (Murphy pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 0 kg/y TSP 0 kg/y PM10 0 kg/y PM2.5
FROM SOURCES : 1
4
HOURS OF DAY :
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

ACTIVITY NAME : Blasting (Booloo pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 80300 kg/y TSP 41756 kg/y PM10 2409 kg/y PM2.5
FROM SOURCES : 1
5
HOURS OF DAY :
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

ACTIVITY NAME : Excavation, loading mobile crushers
ACTIVITY TYPE : Wind sensitive
DUST EMISSION : 106958 kg/y TSP 50588 kg/y PM10 17706 kg/y PM2.5
FROM SOURCES : 7
6 7 8 9 10 11 12
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Dozers (Murphy pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 164411 kg/y TSP 36670 kg/y PM10 17263 kg/y PM2.5
FROM SOURCES : 7
13 14 15 16 17 18 19
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Dozers (Booloo pit)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 70462 kg/y TSP 15716 kg/y PM10 7399 kg/y PM2.5
FROM SOURCES : 3
20 21 22
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck haulage (Booloo pit to WR/Tailings)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 282125 kg/y TSP 80226 kg/y PM10 8023 kg/y PM2.5
FROM SOURCES : 15
23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Waste rock crushing
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 311741 kg/y TSP 124697 kg/y PM10 43644 kg/y PM2.5
FROM SOURCES : 3
38 39 40
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : WR transfer points
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 10391 kg/y TSP 4157 kg/y PM10 1455 kg/y PM2.5
FROM SOURCES : 1
41
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Additional transfer points
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 41566 kg/y TSP 16626 kg/y PM10 5819 kg/y PM2.5
FROM SOURCES : 4
42 43 44 45
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer point - feed bin to WR crusher
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 10391 kg/y TSP 4157 kg/y PM10 1455 kg/y PM2.5
FROM SOURCES : 1
46
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer point - feed bin to prim. crusher
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 8963 kg/y TSP 3585 kg/y PM10 1255 kg/y PM2.5
FROM SOURCES : 1

46
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Primary Crusher
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 268903 kg/y TSP 107561 kg/y PM10 37646 kg/y PM2.5
FROM SOURCES : 3
47 48 49
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer points - mine edge to stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 17927 kg/y TSP 7171 kg/y PM10 2510 kg/y PM2.5
FROM SOURCES : 2
50 51
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Additional transfer pts - crushers to mine edge
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 35854 kg/y TSP 14341 kg/y PM10 5020 kg/y PM2.5
FROM SOURCES : 4
52 53 54 55
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Crushed Ore Stockpile - loading
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 179268 kg/y TSP 76189 kg/y PM10 26666 kg/y PM2.5
FROM SOURCES : 1
56
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Crushed Ore Stockpile - bulldozer
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 0 kg/y TSP 0 kg/y PM10 0 kg/y PM2.5
FROM SOURCES : 1
57
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of crushed ore stockpile
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 14603 kg/y TSP 7301 kg/y PM10 2556 kg/y PM2.5
FROM SOURCES : 1
58
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck dump at topsoil stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 14400 kg/y TSP 5112 kg/y PM10 1789 kg/y PM2.5
FROM SOURCES : 1
59
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Dozers, topsoil stockpiles

ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 73301 kg/y TSP 17845 kg/y PM10 7697 kg/y PM2.5
FROM SOURCES : 1
60
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer points - WR/tailings to WR/Tailings storage area
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 85651 kg/y TSP 34260 kg/y PM10 11991 kg/y PM2.5
FROM SOURCES : 4
61 62 63 64
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Loading of WR and tailings to stockpile
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 513903 kg/y TSP 218409 kg/y PM10 76443 kg/y PM2.5
FROM SOURCES : 1
65
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of WR/Tailings
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 188375 kg/y TSP 94188 kg/y PM10 32966 kg/y PM2.5
FROM SOURCES : 26
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of topsoil stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 26280 kg/y TSP 13140 kg/y PM10 4599 kg/y PM2.5
FROM SOURCES : 1
92
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Concentrate handling at transfer station, TS2001
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 1131 kg/y TSP 452 kg/y PM10 158 kg/y PM2.5
FROM SOURCES : 1
93
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer point - mine stacker feed conveyor to stockpile stacker
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 1131 kg/y TSP 452 kg/y PM10 158 kg/y PM2.5
FROM SOURCES : 1
94
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer points x 3 - from processing plant on to process plant discharge conveyor.
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 3393 kg/y TSP 1357 kg/y PM10 475 kg/y PM2.5
FROM SOURCES : 1
95
HOURS OF DAY :

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Loading of MCS with Mine Stacker (PK2001)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 22618 kg/y TSP 9613 kg/y PM10 3364 kg/y PM2.5
FROM SOURCES : 1
96
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Loading of MCS with front end loader (from Bypass stockpile)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 59130 kg/y TSP 28382 kg/y PM10 9934 kg/y PM2.5
FROM SOURCES : 1
97
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of MCS
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 3993 kg/y TSP 1996 kg/y PM10 699 kg/y PM2.5
FROM SOURCES : 1
98
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Loading of Bypass Stockpile
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 0 kg/y TSP 0 kg/y PM10 0 kg/y PM2.5
FROM SOURCES : 1
99
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion of Bypass Stockpile - passive
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 296 kg/y TSP 148 kg/y PM10 52 kg/y PM2.5
FROM SOURCES : 1
100
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Reclaim Bypass stockpile - front end loader
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 70956 kg/y TSP 30748 kg/y PM10 10762 kg/y PM2.5
FROM SOURCES : 1
101
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Reclaim mine stockpile (wheel and bucket conveyor)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 142350 kg/y TSP 56940 kg/y PM10 19929 kg/y PM2.5
FROM SOURCES : 1
102
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Transfer points x 2 (reclaimer to outfeed conveyor and conveyor to train loadout package)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 5694 kg/y TSP 2278 kg/y PM10 797 kg/y PM2.5

FROM SOURCES : 1
103
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Load to rail wagons
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 228 kg/y TSP 97 kg/y PM10 34 kg/y PM2.5
FROM SOURCES : 1
104
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Bulldozers, ore concentrate stockpiles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 35146 kg/y TSP 7666 kg/y PM10 3690 kg/y PM2.5
FROM SOURCES : 1
105
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Road Maintenance (graders).
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 82412 kg/y TSP 26061 kg/y PM10 2555 kg/y PM2.5
FROM SOURCES : 1
106
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Truck Wheel Generated Dust (WGD), light duty vehicles
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 14722 kg/y TSP 5129 kg/y PM10 491 kg/y PM2.5
FROM SOURCES : 1
107
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Pit retention sources:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 38 39 40 42 43 44 45 46 47 48 49 52 53 54 55

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to carry out the air quality assessment for the proposed CEIP Mine in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.