APPENDIX Y

AIR QUALITY IMPACT ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT

DALSWINTON QUARRY

HDB Town Planning and Design

19 November 2020

Job Number 18030826A

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Air Quality Impact Assessment
Dalswinton Quarry

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for HDB Town Planning and Design on behalf of Rosebrook Sand and Gravel Pty Ltd. The report presents an assessment of potential air quality impacts associated with the proposed expansion of the Dalswinton Quarry at Dalswinton, New South Wales (NSW) (hereafter referred to as the Project).

The existing quarrying operations include extracting sand and gravel resource from the site. The Project seeks to expand the existing quarrying operation across 89 hectares (ha) of the site with an estimated maximum production of 500,000 tonnes per annum (tpa).

This air quality impact assessment has been prepared in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**). The assessment forms part of the environmental impact assessment prepared to accompany the application for the Project.

To assess the potential air quality impacts associated with the proposed Project, this report incorporates the following aspects:

- A background to the Project and description of the proposed site and operations;
- A review of the existing meteorological and air quality environment surrounding the site;
- A description of the dispersion modelling approach and emission estimation used to assess potential air quality impacts; and,
- Presentation of the predicted results and discussion of the potential air quality impacts and associated mitigation and management measures.

2 PROJECT BACKGROUND

2.1 Project setting

The Project site is situated on Lot 72 DP1199484, located approximately 7 kilometres (km) southeast of Denman in the Hunter Valley Region. The local land use surrounding the site is a rural setting comprising various agricultural activities and scattered rural residences.

The nearest identified residential receptor is located approximately 500 metres (m) from the Project boundary. **Figure 2-1** presents the location of the residential receptors assessed as discrete receptors in this assessment.

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. The Project area can be characterised as relatively flat along the banks of the Hunter River. A ridge aligned north to south is located to the northeast and elevated topography is situated to the south of the site.

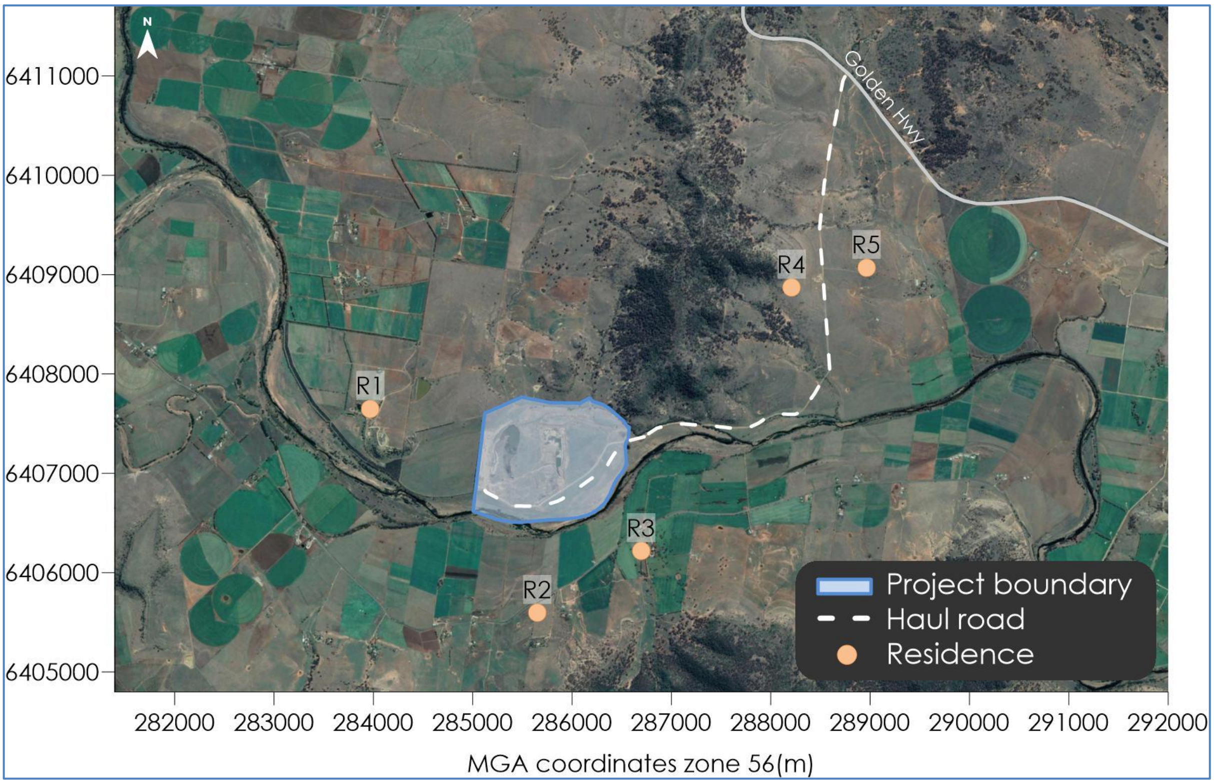


Figure 2-1: Project setting

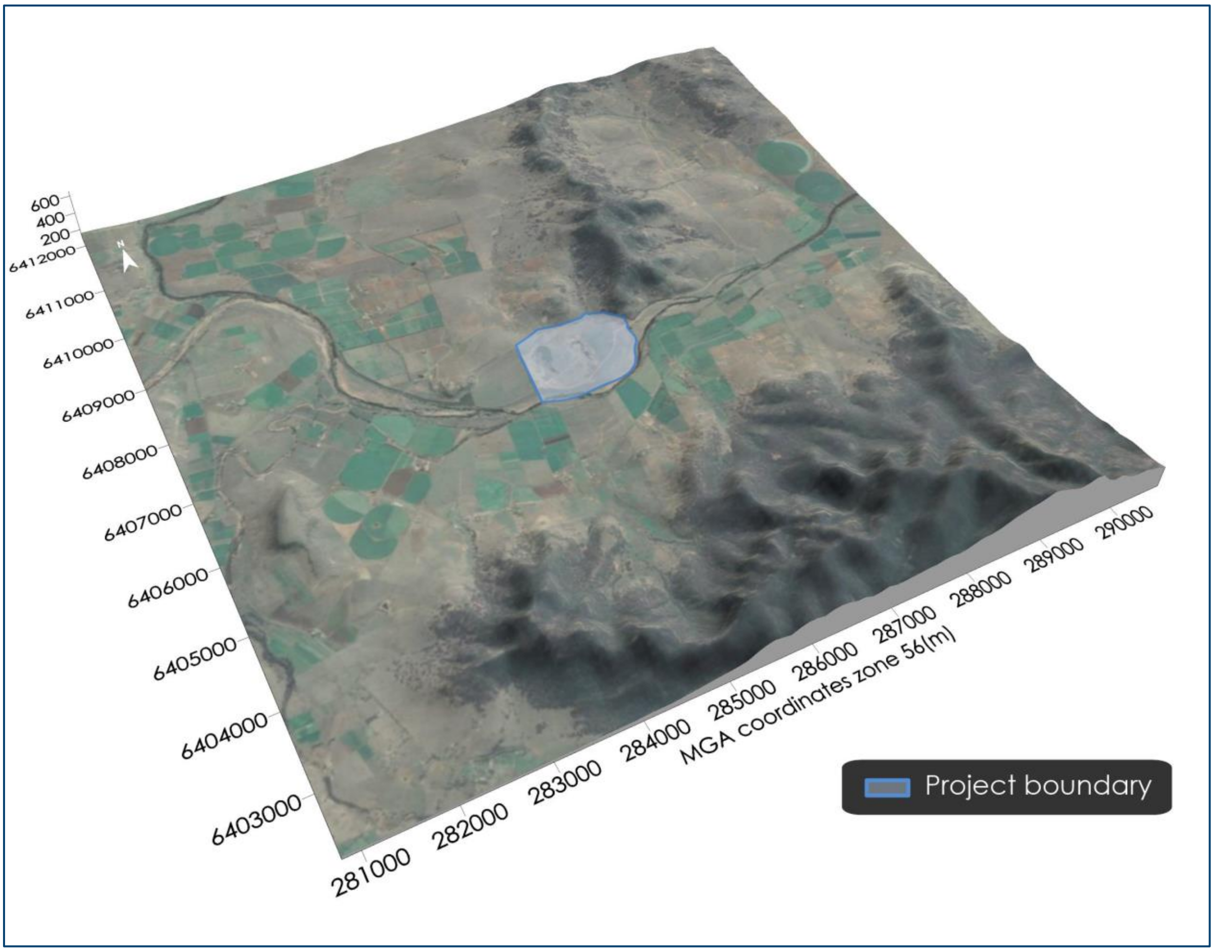


Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Project description

The existing quarrying activity occurs on the western section of the site with an average extraction rate of 80,000tpa. The Project seeks to increase the extraction rate to an average of 250,000tpa with a maximum of 500,000tpa. The extraction area will expand across approximately 89ha of the site in an easterly direction in addition to reworking the previously extracted areas to recover fines and larger aggregates which were previously discarded.

It is envisaged to have two working areas within the site, namely Work Area 1 and Work Area 2. Work Area 1 will consist of reworking approximately 50ha of land under the current Development Application (DA) and Work Area 2 will comprise 39ha of unmined land to the east of the site.

An indicative site layout is presented in **Figure 2-3**.

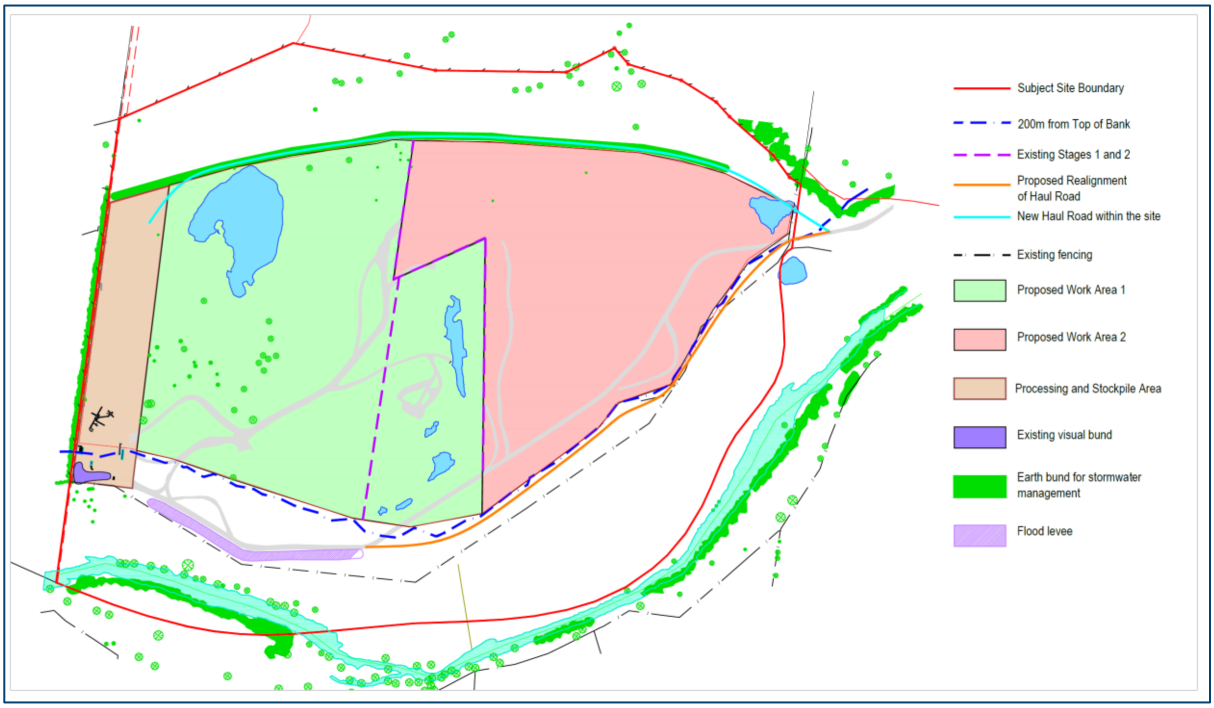


Figure 2-3: Indicative layout for the Project

A hydraulic excavator will be used to extract gravel, which will be then loaded onto trucks and transferred to the existing processing plant located in the south-eastern area of the site. Primary screening of the extracted materials will be followed by secondary screening and crushing to produce a large variety of decorative gravel, crushed aggregate and road base material. The produced materials will be stockpiled on-site and then transported to the markets in the Hunter Valley and Sydney regions.

The site will be progressively rehabilitated to reduce the amount of disturbed area. This will be performed by backfilling the extraction pits, reshaping and top soiling the pits and planting pasture species for grazing at the end of the operations.

There is no change to the approved operating hours of the quarry as follows, Monday to Friday 5:00am to 12:00am and Saturday 5:00am to 1:30pm with no quarrying on Sundays or public holidays.

3 AIR QUALITY CRITERIA

3.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

3.1.1 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the Project. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	$90\mu g/m^3$
PM_{10}	Annual	Total	$25\mu g/m^3$
	24 hour	Total	$50\mu g/m^3$
$PM_{2.5}$	Annual	Total	$8\mu g/m^3$
	24 hour	Total	$25\mu g/m^3$
Deposited dust	Annual	Incremental	$2g/m^2$/month
		Total	$4g/m^2$/month

Source: NSW EPA, 2017
$\mu g/m^3$ = micrograms per cubic metre
g/m^2/month = grams per square metre per month

4 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

4.1 Local climatic conditions

Long-term climatic data from the Bureau of Meteorology (BoM) weather station at Jerrys Plains Post Office (Site No. 061086) were analysed to characterise the local climate in the proximity of the Project. The weather station at Jerrys Plains Post Office is located approximately 15km east of the Project and has since closed on 17 April 2014.

Table 4-1 and **Figure 4-1** present a summary of data from the Jerrys Plains Post Office collected over an approximate 52 to 128-year period for the various meteorological parameters.

The data indicate that on average January is the hottest month with a mean maximum temperature of 31.8ºC and July is the coldest month with a mean minimum temperature of 3.8ºC.

Rainfall peaks during the summer months and declines during the winter months, with an annual average rainfall of 645.9 mm over 67.5 days. The data show January is the wettest month with an average rainfall of 77.1 mm over 6.4 days and August is the driest month with an average rainfall of 36.1 mm over 5.2 days.

Humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am humidity levels range from 59% in October to 80% in June. Mean 3pm humidity levels vary from 42% in October, November and December to 54% in June.

As expected, wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. The mean 9am wind speeds range from 8.6 km/h in April to 11.7 km/h in September. The mean 3pm wind speeds vary from 11.0 km/h in May to 14.7 km/h in September.

Table 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (ºC)	31.8	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.3	29.1	31.2	25.2
Mean min. temp. (ºC)	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	15.7	10.6
Rainfall													
Rainfall (mm)	77.1	73.1	59.7	44.0	40.7	48.1	43.4	36.1	41.7	51.9	61.9	67.5	645.9
No. of rain days (≥1mm)	6.4	6.0	5.8	4.9	4.9	5.5	5.2	5.2	5.2	5.8	6.3	6.3	67.5
9am conditions													
Mean temp. (ºC)	23.4	22.7	21.2	18.0	13.6	10.6	9.4	11.4	15.3	19.0	21.1	23.0	17.4
Mean R.H. (%)	67	72	72	72	77	80	78	71	65	59	60	61	70
Mean W.S. (km/h)	9.6	9.0	8.8	8.6	9.0	9.4	10.6	11.0	11.7	10.9	10.5	9.9	9.9
3pm conditions													
Mean temp. (ºC)	29.8	28.9	27.2	24.1	20.1	17.1	16.4	18.2	21.2	24.2	26.9	29.0	23.6
Mean R.H. (%)	47	50	49	49	52	54	51	45	43	42	42	42	47
Mean W.S. (km/h)	13.2	13.0	12.4	11.3	11.0	11.5	13.0	14.3	14.7	14.1	14.2	14.2	13.1

Source: **BoM, 2020 (accessed November 2020)**

°C = degrees Celsius mm = millimetres % = percent km/h = kilometres per hour

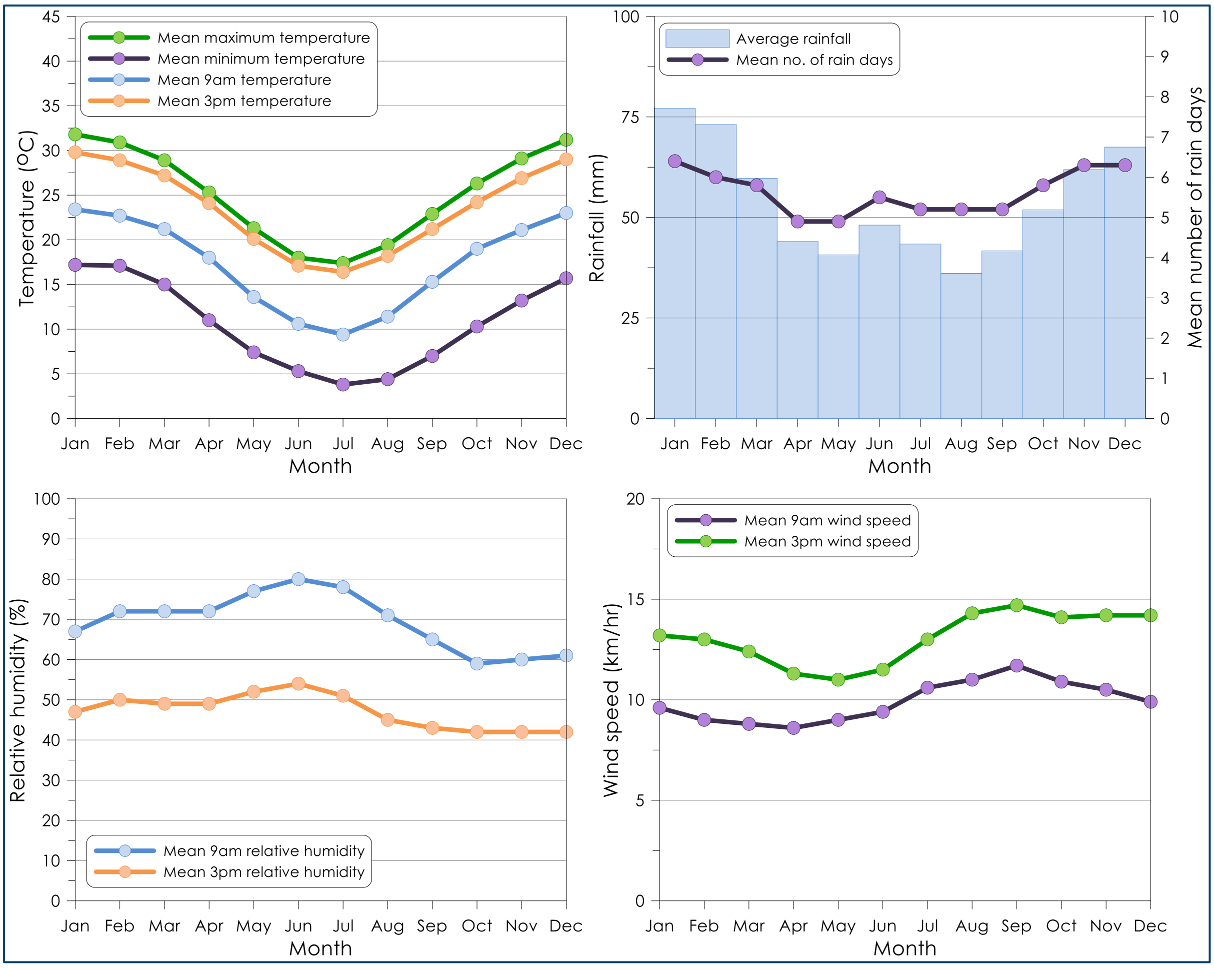


Figure 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

4.2 Local meteorological conditions

Annual and seasonal windroses for the NSW Department of Planning, Industry and Environment (DPIE) Jerrys Plains monitoring station during the 2015 calendar period are presented in **Figure 4-2**.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded for the area and air quality levels as outlined in **Appendix A**.

On an annual basis, predominant wind flows are along a west-northwest to southeast axis which is typical of the Hunter Valley Conditions. Very few winds originate from the northeast and southwest quadrants. The seasonal windroses indicate similar distribution to the annual windrose with the predominant winds from the west-northwest and southeast.

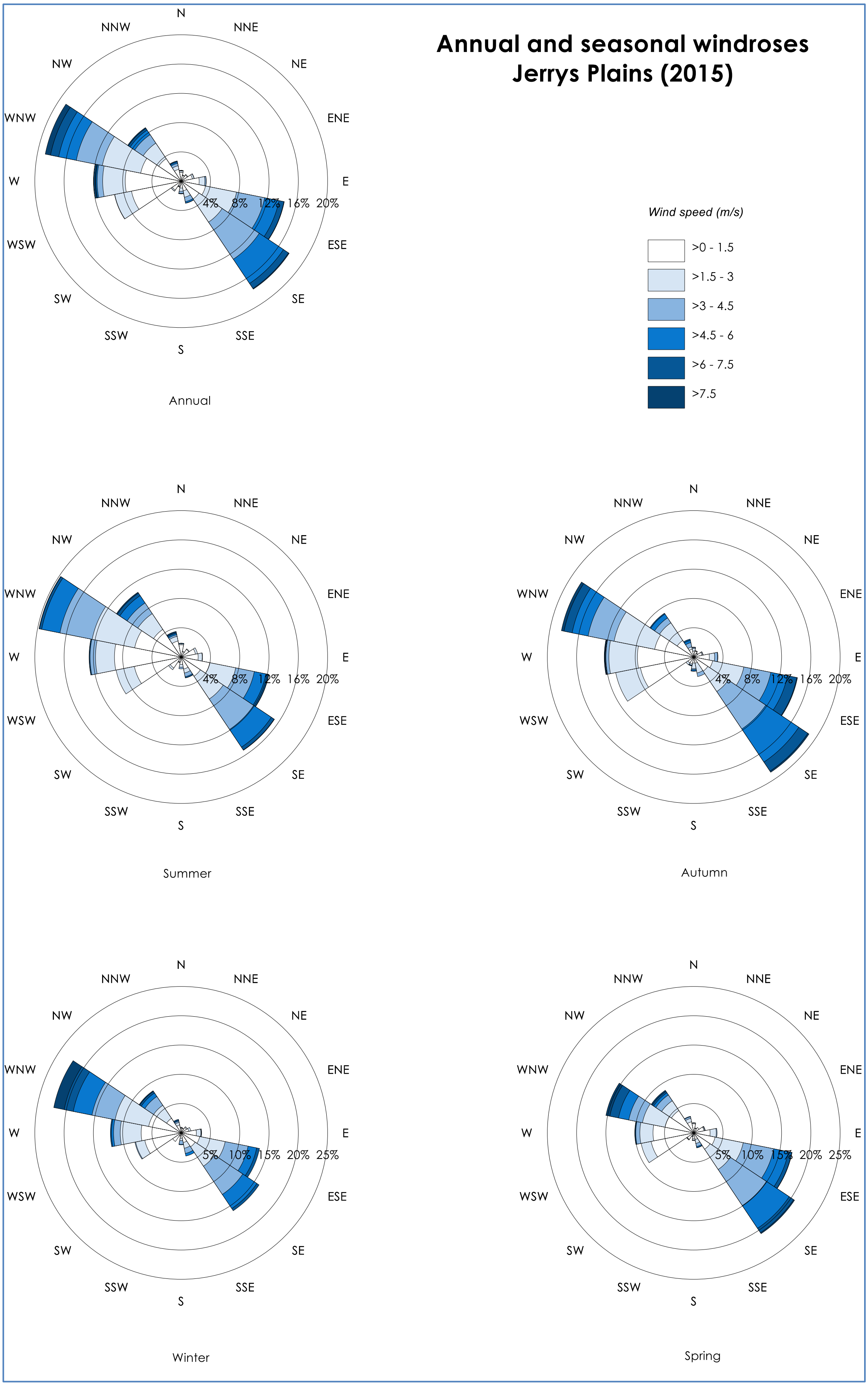


Figure 4-2 : Annual and seasonal windroses – Jerrys Plains (2015)

4.3 Local air quality monitoring

The main sources of air pollutants in the wider area surrounding the Project include mining, agriculture, commercial and industrial (including power generation) activities, urban activity and emissions from local anthropogenic activities such as motor vehicle exhaust and domestic wood heaters.

Ambient air quality monitoring data sourced from the NSW DPIE operated Upper Hunter Air Quality Monitoring Network (UHAQMN) have been reviewed. The air quality monitoring stations at Jerrys Plains and Muswellbrook are located approximately 15km and approximately 25km respectively from the site. The air quality monitoring data from these monitors have been used to quantify the existing ambient background levels for this study.

4.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data is presented in **Table 4-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-3**.

A review of **Table 4-2** indicates that the annual average PM_{10} concentrations for each monitoring station were below the relevant criterion of 25µg/m³ with the exception of Muswellbrook in 2018 and 2019 and Jerrys Plains in 2019. The maximum 24-hour average PM_{10} concentrations recorded at these stations were found to exceed the relevant criterion of 50µg/m³ on occasion during the review period

Examination of the potential cause of the elevated PM_{10} levels indicate that they typically coincide with regional dust events and bushfires which affect a wide area, for example as indicated by other air quality monitoring stations in the surrounding region also recording elevated levels on such days. At other times, potential sources including local agriculture, open cut mining activity and localised fires may have contributed to the periods of elevated PM_{10} levels. The high PM_{10} concentrations recorded in 2018, 2019 and 2020 are attributed to the drought period and widespread bushfires affecting NSW.

Table 4-2: Summary of PM_{10} levels from UHAQMN monitoring stations (µg/m³)

Year	Muswellbrook	Jerrys Plains	Criterion
Annual average			
2012	21.8	10.8	**25**
2013	22.6	18.6	**25**
2014	21.4	18.2	**25**
2015	19.1	15.5	**25**
2016	19.2	16.8	**25**
2017	21.7	18.0	**25**
2018	**27.2**	24.3	**25**
2019	**34.4**	**32.1**	**25**
2020	22.5	19.8	**25**
Maximum 24-hour average			
2012	**51**	43.7	**50**
2013	**55.6**	**63.3**	**50**
2014	**53**	**64.4**	**50**
2015	**72.6**	**70**	**50**
2016	43.9	42.9	**50**
2017	**56.5**	**50.5**	**50**
2018	**185.9**	**201.4**	**50**
2019	**231.3**	**226.7**	**50**
2020	**181**	**134.5**	**50**

It can be seen from **Figure 4-3** that PM_{10} concentrations are nominally highest in spring and summer with the warmer weather raising the potential for drier ground, elevating the occurrence of windblown dust, bushfires and increased pollen levels.

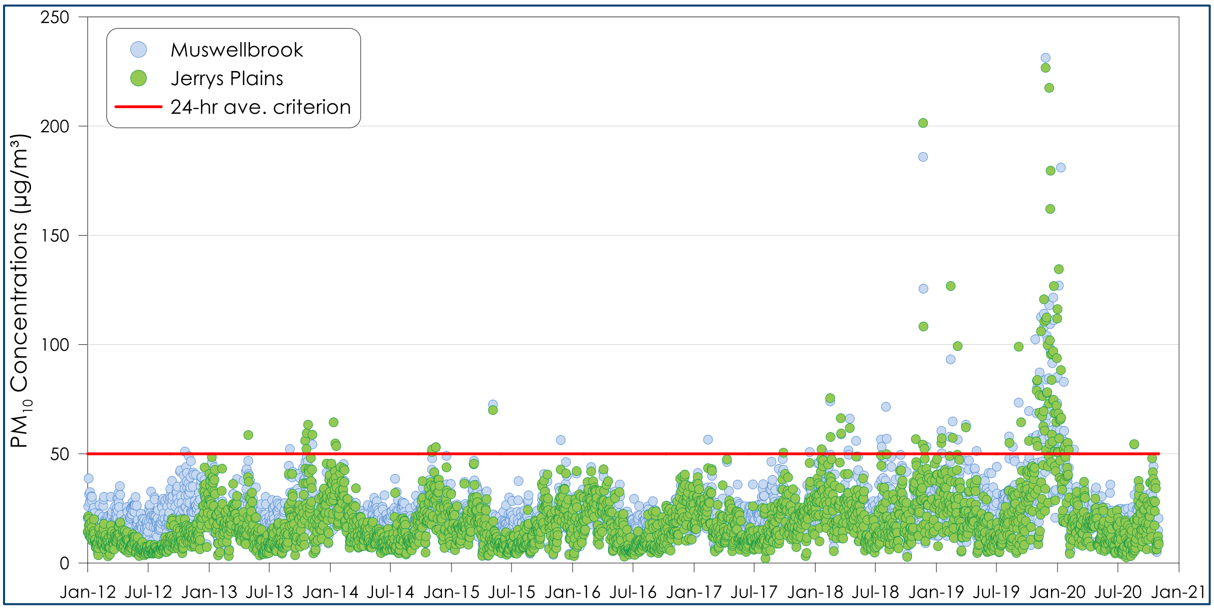


Figure 4-3: 24-hour average PM_{10} concentrations at UHAQMN monitoring stations

4.3.2 $PM_{2.5}$ monitoring

A summary of the available $PM_{2.5}$ monitoring data is presented in **Table 4-3**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-4**.

Table 4-3 indicates that the annual average $PM_{2.5}$ concentrations were above the criterion of 8µg/m^3 for the review period. The maximum 24-hour average $PM_{2.5}$ concentrations also exceeded the relevant criterion of 25µg/m^3 on occasion during the review period.

A seasonal trend in 24-hour average $PM_{2.5}$ concentrations for the Muswellbrook monitoring station can be seen in **Figure 4-4** with elevated levels occurring in the cooler months. This is the opposite of the seasonal trend for PM_{10} concentrations which has elevated levels during the warmer months.

Ambient $PM_{2.5}$ levels at the Muswellbrook monitoring station are likely to be governed by local background sources such as wood heaters and motor vehicles. Studies have shown that other $PM_{2.5}$ monitors located near mining operations (and away from towns) have no significant seasonal trends in comparison to the Muswellbrook monitoring station (**Todoroski Air Sciences, 2019**). This suggests the influence of anthropogenic sources on $PM_{2.5}$ levels are localised to the towns and do not significantly affect the areas which are sparsely populated near the open cut mining operations.

Table 4-3: Summary of $PM_{2.5}$ levels from UHAQMN monitoring station (µg/m³)

Year	Muswellbrook	Criterion
Annual average		
2012	**10.1**	**8**
2013	**9.4**	**8**
2014	**9.7**	**8**
2015	**8.7**	**8**
2016	**8.4**	**8**
2017	**9.4**	**8**
2018	**9.4**	**8**
2019	**12.2**	**8**
2020	**9.8**	**8**
Maximum 24-hour average		
2012	**26.4**	**25**
2013	**36.6**	**25**
2014	**27.4**	**25**
2015	**31.2**	**25**
2016	**29.4**	**25**
2017	**31.1**	**25**
2018	**26.5**	**25**
2019	**77.4**	**25**
2020	**49.1**	**25**

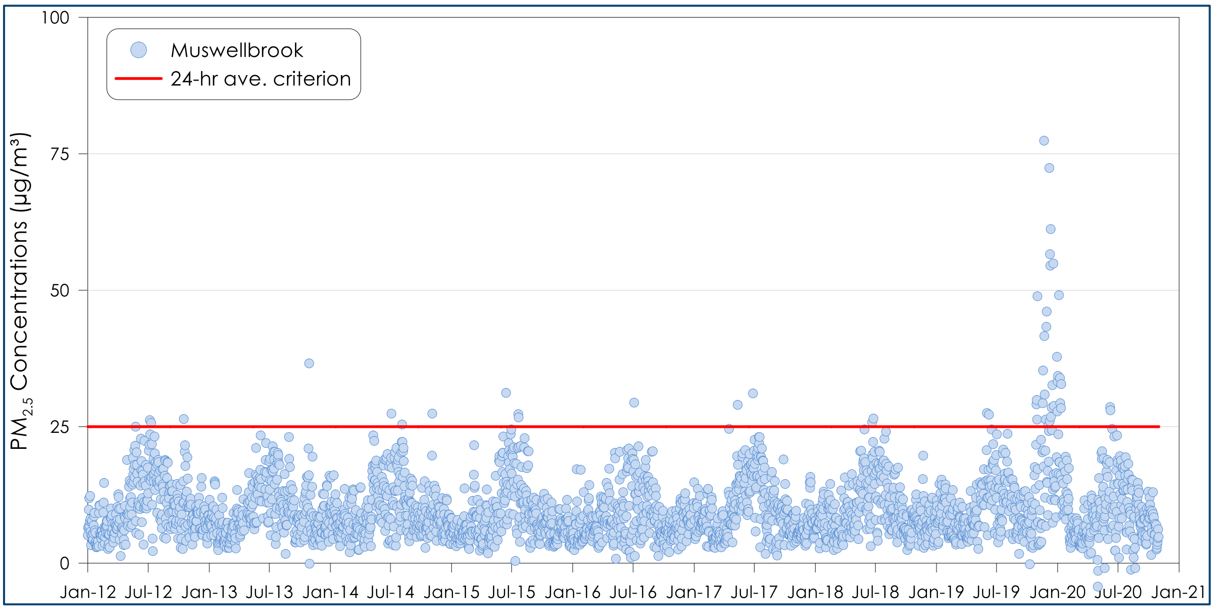


Figure 4-4: 24-hour average $PM_{2.5}$ concentrations at UHAQMN monitoring station

4.3.3 Estimated background dust levels

As outlined above, there are no readily available site-specific monitoring data, and therefore the background dust levels around the Project site were estimated to be similar to those recorded at the nearby NSW DPIE monitoring sites for the 2015 calendar period which corresponds to the period of meteorological modelling used in this assessment.

The annual average PM_{10} level from the Jerrys Plains monitoring station (15.5µg/m^3) was used to represent the background levels for the Project. As $PM_{2.5}$ is not readily available for the Jerrys Plains monitoring station, the average ratio of the measured $PM_{2.5}$ to PM_{10} levels at the Muswellbrook monitor of 0.48 has been used to estimate the $PM_{2.5}$ levels at Jerrys Plains. We note that as the Muswellbrook monitor is in a more urban setting compared to Jerrys Plains and would generally experience higher $PM_{2.5}$ levels due to local anthropogenic sources (wood smoke and vehicle exhaust) this is likely to provide a conservative estimate. Applying this ratio, an annual average $PM_{2.5}$ concentration of 7.5µg/m^3 is estimated for the Project site.

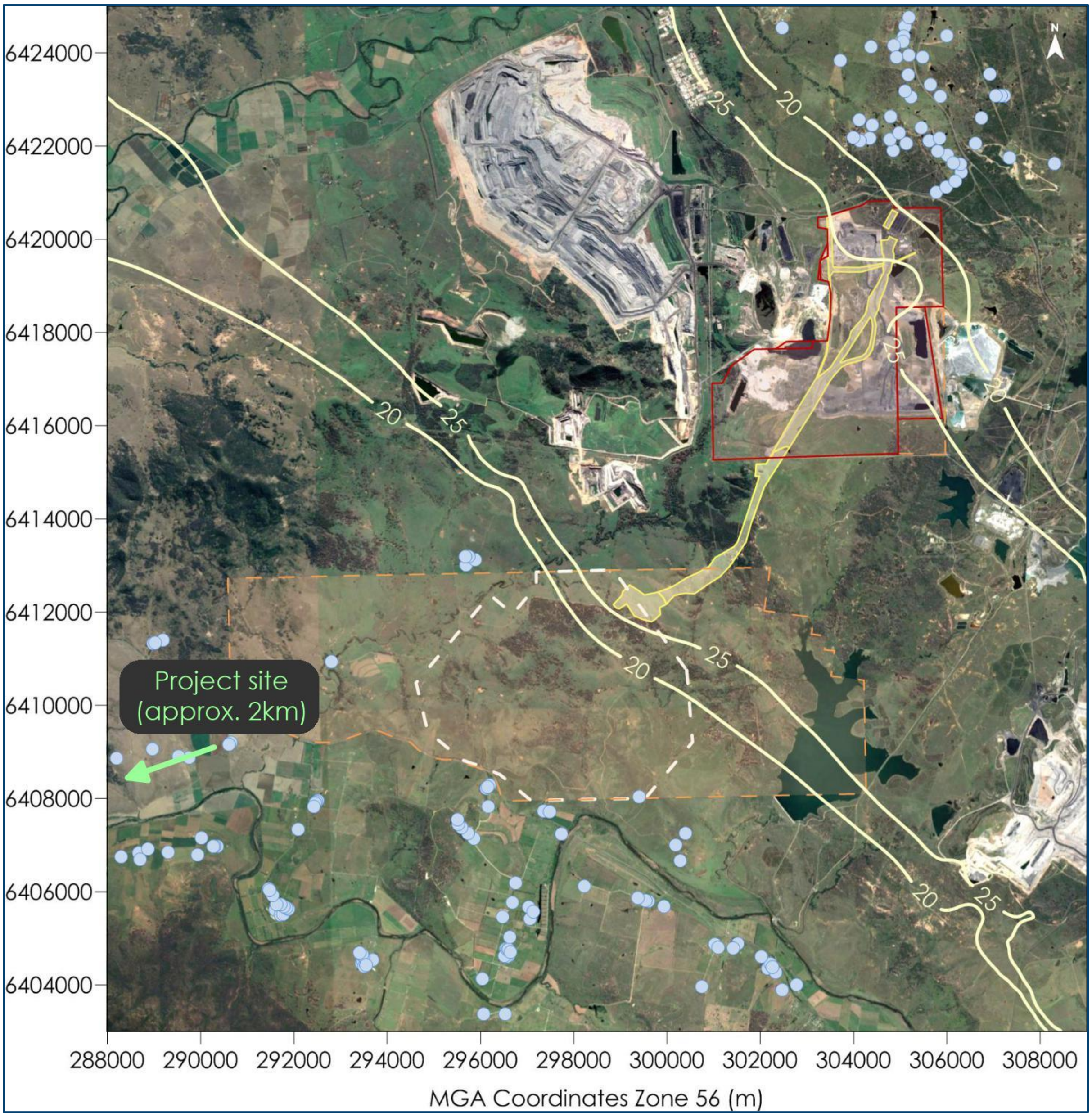
In the absence of data, estimates of the annual average background TSP and deposited dust concentrations have been determined from a relationship between $PM_{10,}$ TSP and deposited dust concentrations and the measured PM_{10} levels. This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month. This assumption is based on the NSW EPA air quality impact criteria. Applying this relationship with the measured annual average PM_{10} concentration of 15.5µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 55.8µg/m^3 and 2.5g/m^2/month, respectively.

4.3.4 Background dust from coal mining operations

The predicted dust levels in the *Maxwell Project Air Quality and Greenhouse Gas Assessment* (**Todoroski Air Sciences, 2019**) are used to infer the potential background dust contribution from coal mining operations in the Hunter Valley. The Project is located approximately 12km to the southwest of the Maxwell Project and approximately 15km southwest of the Mt Arthur Coal Mine.

Figure 4-5 presents the predicted annual average PM_{10} concentrations due to the Maxwell Project and other sources for Scenario 1. The modelling predictions include the contribution from the Maxwell Project and surrounding coal mining operations including Mt Arthur Coal Mine, Bengalla Mine and Hunter Valley Operations along with a contribution from non-mining sources. **Figure 4-5** indicates by the shape of the contour, that the dust contribution from the coal mining operations follow a northwest to southeast band with levels reaching approximately 20µg/m^3 to the southwest which would continue to decrease over distance towards the Project area.

The applied background level annual average PM_{10} concentration of 15.5µg/m^3 is therefore considered an appropriate background level for the Project and would already include a potential contribution from the coal mining operations, hence these have not been explicitly included in the modelling assessment for the Project.



Source: **Todoroski Air Sciences (2019)**

Figure 4-5: Predicted annual average PM_{10} concentration due to emissions from the Maxwell Project and other sources for Scenario 1 (µg/m³)

4.3.5 Summary of background dust levels

The annual average background air quality levels applied in this assessment are as follows:

- $PM_{2.5}$ concentrations – 7.5µg/m^3;
- PM_{10} concentrations – 15.5µg/m^3;
- TSP concentrations – 55.8µg/m^3; and,
- Deposited dust levels – 2.5g/m^2/month.

5 DISPERSION MODELLING APPROACH

5.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment. The CALPUFF is an advanced air dispersion model which can deal with the effects of complex local terrain on the dispersion meteorology over the modelling domain in a three-dimensional, hourly varying time step.

The model was setup in general accord with the methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC**, **2011**).

5.2 Modelling methodology

Modelling was undertaken using a combination of the CALPUFF Modelling System and The Air Pollution Model (TAPM). The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

5.2.1 Meteorological modelling

TAPM was applied to the available data to generate a three dimensional (3D) upper air data file for use in CALMET. The centre of analysis for TAPM was 32deg23min south and 150deg53.5min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the 3D wind field from the coarser grid outer domain is used as the initial guess (or starting) field for the finer grid inner domain. The CALMET initial domain was run on a 85 x 85 km area with a 1.7km grid resolution and refined for a second domain on a 50 x 50 km area with a 1km grid resolution and a final domain on a 10 x 10 km area with 0.1km grid resolution.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on analysis of long-term data trends in meteorological data and ambient air quality data recorded for the area as outlined in **Appendix A**. The available meteorological data from eight nearby meteorological stations were included in the simulation. **Table 5-1** outlines the parameters used from each station.

Table 5-1: Surface observation stations used in modelling

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Muswellbrook NW (NSW DPIE)	✓	✓			✓	✓	
Muswellbrook (NSW DPIE)	✓	✓			✓	✓	
Jerrys Plains (NSW DPIE)	✓	✓			✓	✓	
Scone Airport AWS (BoM) (Station No. 061363)	✓	✓			✓	✓	✓
Murrurundi Gap AWS (BoM) (Station No. 061392)	✓	✓	✓	✓	✓	✓	✓
Merriwa (Roscommon) Weather Station (BoM) (Station No, 061287)	✓	✓	✓	✓	✓	✓	✓
Cessnock Airport AWS (BoM) (Station No. 061260)	✓	✓			✓	✓	✓
Nullo Mountain AWS (BoM) (Station No. 062100)	✓	✓			✓	✓	

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity and SLP = station level pressure.

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extracted data.

Figure 5-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period. The wind fields are seen to follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas

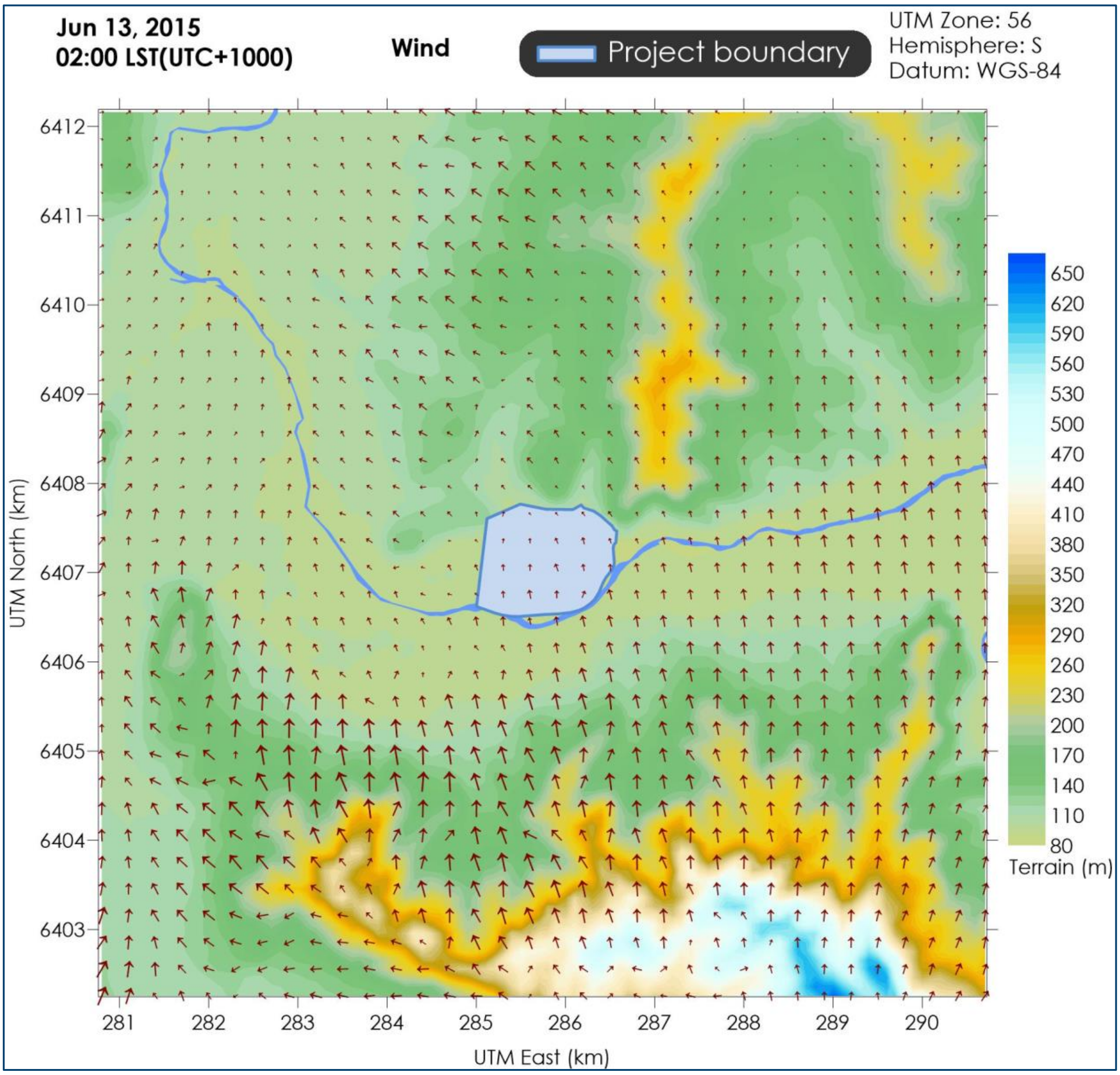


Figure 5-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 5-2** and **Figure 5-3**.

Figure 5-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 5-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and show sensible trends considered to be representative of the area.

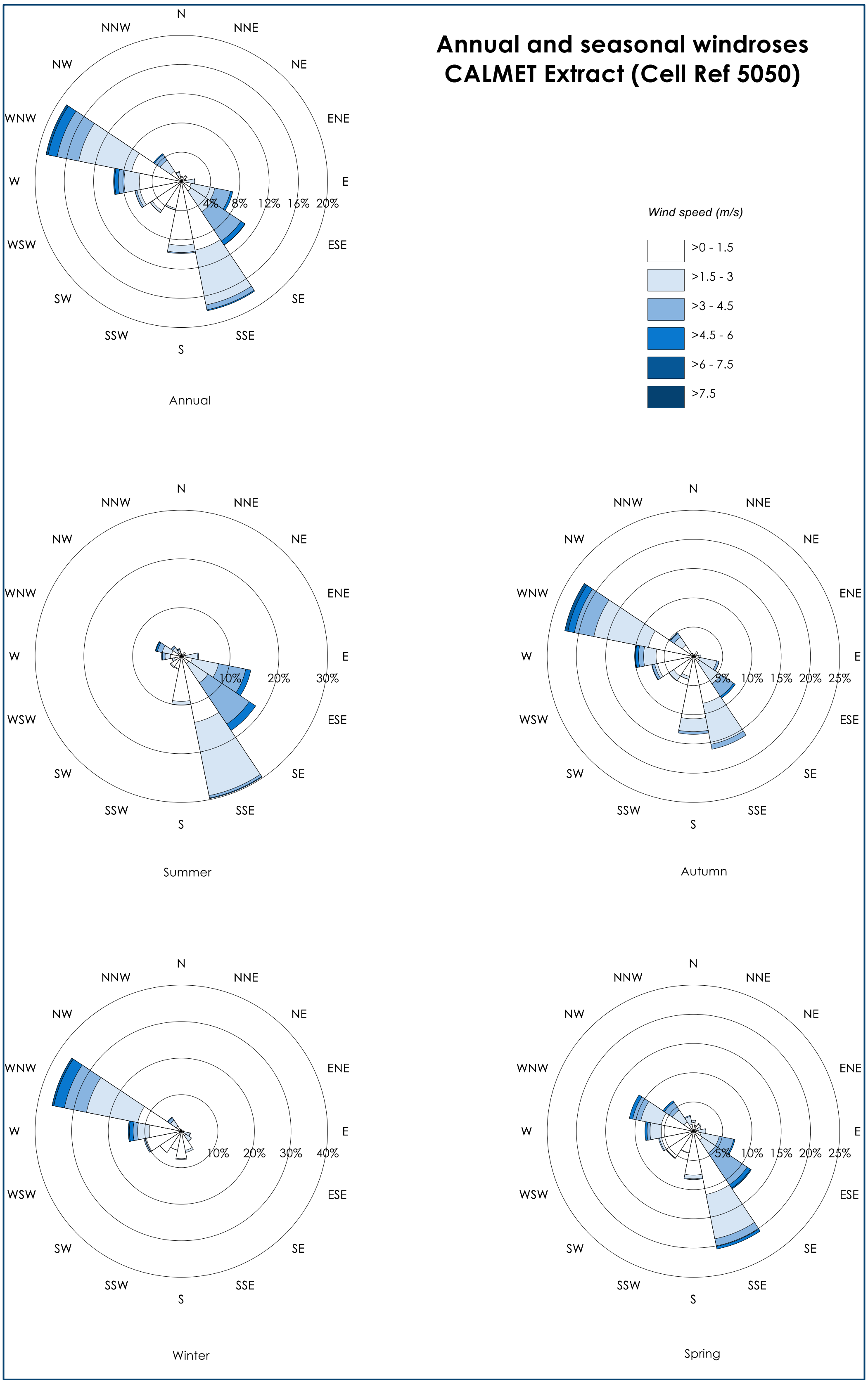


Figure 5-2: Annual and seasonal windroses from CALMET (Cell reference 5050)

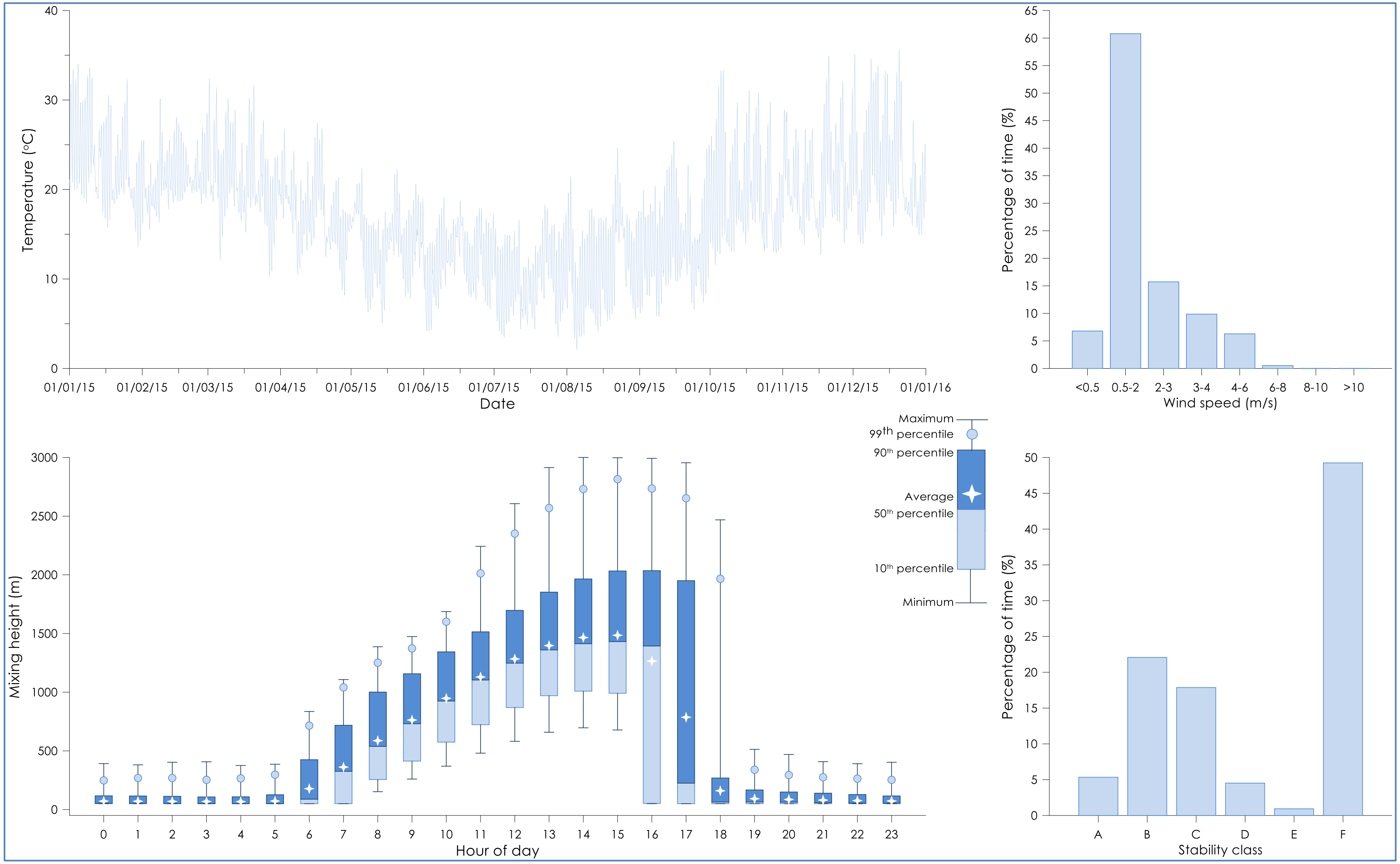


Figure 5-3: Meteorological analysis of CALMET (Cell Ref 5050)

5.2.2 Dispersion modelling

Emissions from each operational activity of the Project were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

5.3 Emission estimation

The significant dust generating activities associated with operation of the Project are identified as the removal of topsoil/ overburden, loading/unloading of material, vehicles travelling on-site and off-site, crushing and screening processes, and windblown dust from exposed areas and stockpiles. The on-site and off-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation.

Average and peak conditions have been assessed for the operation of the Project. The average scenario is based on the proposed maximum annual tonnage of 500,000tpa of sand and gravel processed at the site. The peak conditions assess the maximum potential 24-hour average impacts from the Project, based on the peak daily movements of 60 trucks per day (60 load/day x 35 t/load = 2100 t/day) occurring very day of the year (365 days). This results in an equivalent annual tonnage of 766,500tpa for the peak scenario and is assessed only for 24-hour average impacts.

A summary of the estimated average and peak TSP, PM_{10} and $PM_{2.5}$ emissions is presented in **Table 5-2**. Detailed calculations of the dust emission estimates are provided in **Appendix B**. The calculations apply conservative variables based on the use of practical dust controls applied to the proposed activities outlined in **Section 7**.

The estimated peak scenario in **Table 5-2** is approximately one and a half times the average scenario and is used to assess the worst-case potential daily impacts from the operation.

Table 5-2: Summary of estimated dust emissions for the Project (kg/year)

Activity	TSP Emissions	PM_{10} emissions	$PM_{2.5}$ emissions
Total emissions - Average	90,635	27,946	4,150
Total emissions - Peak	132,740	39,557	5,570

6 DISPERSION MODELLING RESULTS

This section presents the predicted impacts on air quality which may arise from air emissions generated by the Project.

6.1 Dust concentrations

The dispersion model predictions presented in this section include those for the operation of the Project in isolation (incremental impact) and the operation of the Project with consideration of other sources (total cumulative impact). The results show the predicted:

- Maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$, PM_{10} and TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) in the one year long modelling period.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**.

Table 6-1 presents the predicted incremental particulate dispersion modelling results at each of the assessed receptor locations. The results show that minimal incremental effects would arise at the receptor locations due to the Project.

Table 6-1: Particulate dispersion modelling results for assessed receptors – Incremental impact

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Air quality impact criteria					
	-	-	-	-	-	2
R1	0.5	0.1	3.1	0.6	1.3	<0.1
R2	0.2	<0.1	1.6	0.1	0.1	<0.1
R3	0.4	0.1	2.3	0.3	0.7	<0.1
R4	0.6	0.2	5.0	1.3	3.2	0.1
R5	0.7	0.1	5.4	0.8	1.9	<0.1

*Deposited dust

The cumulative (total) impact is defined as the modelling impact associated with the operation of the Project combined with the estimated ambient background levels in **Section 4.3.5**.

The predicted cumulative annual average $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project with the estimated background levels are presented in **Table 6-2**. The results in **Table 6-2** indicate that all of the assessed receptors are predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

Table 6-2: Particulate dispersion modelling results for assessed receptors – Cumulative impact

Receptor ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Annual average			
	Air quality impact criteria			
	8	25	90	4
R1	7.6	16.1	57.1	2.5
R2	7.5	15.6	55.9	2.5
R3	7.6	15.8	56.5	2.5
R4	7.7	16.8	59.0	2.5
R5	7.6	16.3	57.7	2.5

6.2 Assessment of Total (Cumulative) 24-hour average $PM_{2.5}$ and PM_{10} Concentrations

As shown in **Section 4.3**, the maximum measured 24-hour concentrations of $PM_{2.5}$ and PM_{10} have in the past exceeded or come close to the relevant criterion level on occasion.

As a result, the NSW EPA Level 1 contemporaneous assessment approach of adding maximum background levels to maximum predicted levels from the Project would show levels above the criterion whether or not the Project was operating.

In such situations, the NSW EPA applies a Level 2 contemporaneous assessment approach where the measured background levels are added to the day's corresponding predicted dust level from the Project.

Ambient (background) $PM_{2.5}$ and PM_{10} concentration data corresponding with the year of modelling (2015) from the NSW DPIE monitoring site at Jerrys Plains have been applied in this case to represent the prevailing background levels in the vicinity of the Project and at the receptor locations surrounding the Project.

Table 6-3 provides a summary of the findings from the Level 2 assessment at representative receptor locations for both $PM_{2.5}$ and PM_{10}. Detailed tables of the contemporaneous assessment results are provided in **Appendix D**.

The results indicate that the Project does not increase the number of days above the 24-hour average criterion at the assessed receptors.

Table 6-3: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0
R2	0	0
R3	0	0
R4	0	0
R5	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for the most impacted receptor, Receptor R5, are presented in **Figure 6-1**. The orange bars in the figure represent the contribution from the Project and the blue bars represent the background levels. It is clear from the figures that the Project has a relatively small influence at the assessed receptor locations.

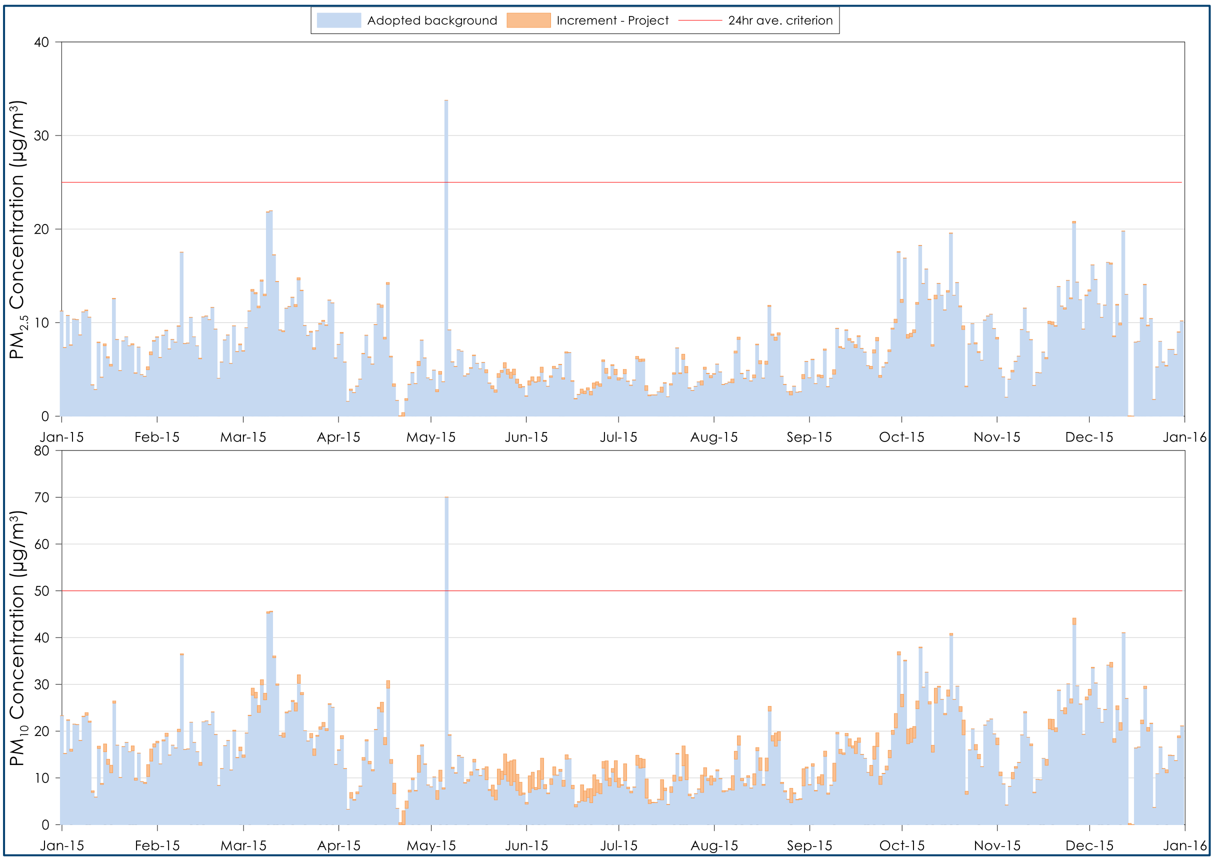


Figure 6-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for R5

7 DUST MITIGATION AND MANAGEMENT

The proposed operations at the Project have the potential to generate dust emissions.

To ensure that activities associated with the Project have a minimal effect on the surrounding environment and at receptor locations, it is recommended that appropriate operational and physical mitigation measures should be implemented where feasible and reasonable as outlined in **Table 7-1**.

Table 7-1: Potential operational dust mitigation options

Source	Mitigation Measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means).
	Weather forecast to be checked prior to undertaking material handling or processing.
	Engines of on-site vehicles and plant to be switched off when not in use.
	Vehicles and plant are to be fitted with pollution reduction devices where practicable.
	Vehicles are to be maintained and serviced according to manufacturer's specifications.
	Visual monitoring of activities is to be undertaken to identify dust generation.
Exposed areas/stockpiles	The extent of exposed surfaces and stockpiles is to be kept to a minimum.
	Exposed areas and stockpiles are either to be covered or are to be dampened with water as far as is practicable if dust emissions are visible, or there is potential for dust emissions outside operating hours.
	Minimise dust generation by undertaking rehabilitation earthworks when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.
Material handling	Reduce drop heights from loading and handling equipment where practical.
	Dampen material when excessively dusty during handling.
	Use dust suppression for crushing and screening activity.
Hauling activities	Haul roads should be watered using water carts such that the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out to occur.
	Driveways and hardstand areas to be swept/cleaned regularly as required etc.
	Vehicle traffic is to be restricted to designated routes.
	Speed limits are to be enforced.
	Vehicle loads are to be covered when travelling off-site.

It is anticipated that the Project would develop a suitable Air Quality Management Plan (AQMP) for the site to assist with the management of air emissions. The AQMP would outline the measures to manage dust emissions at the site and include aspects such as key performance indicators, monitoring methods, response mechanisms, compliance reporting and complaints management.

The air emission controls applied at the site would be regularly assessed to ensure they are working effectively and required modification or adjustments to the air emission control measures would be revised on a regular basis and documented in the AQMP.

8 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the proposed expansion of the sand and gravel extraction and processing facility at Dalswinton Quarry.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the Project. The estimated emissions of dust applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that all the assessed air pollutants generated by the operation of the Project would comply with the applicable assessment criteria at the receptors and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area.

Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the Project can operate without causing any significant air quality impact at receptors in the surrounding environment.

9 REFERENCES

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Climate statistics for Australian locations, Bureau of Meteorology website, accessed January 2018. http://www.bom.gov.au/climate/averages

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"NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining", Katestone Environmental Pty Ltd prepared for DECCW, 2010.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

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, Australia", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

Todoroski Air Sciences (2019)

"Maxwell Project Air Quality and Greenhouse Gas Assessment", prepared for Malabar Coal Limited by Todoroski Air Sciences, July 2019.

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"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

Appendix A

Selection of Meteorological Year

Selection of meteorological year

The selection of the period for modelling considered the representativeness of the chosen year against available long-term datasets.

A statistical analysis of seven contiguous years of meteorological data from the Scone Airport Automatic Weather Station (AWS) is presented in **Table A-1**. The standard deviations of the seven years were analysed against the long-term measured wind speed, temperature and relative humidity spanning a 14 to 19 year period.

The analysis indicates that 2012 is closest to the long-term average for wind speed followed closely by 2014, 2016 and 2015. 2012 and 2013 are the closest to the long-term average for temperature and suggests the inter-annual temperature variation is small. For relative humidity, 2015 is the closest and shows greater variation between the selected years.

Overall this analysis would suggest 2012 or 2015 could be considered for the assessment as they are generally representative of the long-term wind speed, temperature, and relative humidity.

Table A-1: Statistical analysis results of standard deviation from long-term meteorological data at Scone Airport AWS

Year	Wind speed	Temperature	Relative humidity
2011	0.37	1.08	4.33
2012	0.29	0.91	5.23
2013	0.38	0.90	5.42
2014	0.30	1.03	5.82
2015	0.32	0.97	3.76
2016	0.30	1.16	6.35
2017	0.36	1.45	8.32

The analysis shows that of the last seven years, 2015 is not an outlier year in terms of deviation from the long term mean wind speed and relative humidity. On this basis, a further more detailed analysis of 2015 against the last seven years of data was performed to confirm if there may be any potential for significant bias to arise.

Figure A-1 shows the frequency distributions for wind speed, wind direction, temperature and relative humidity of 2015 compared with the mean of the 2011 to 2017 data set. The 2015 data aligned satisfactorily with mean data.

The 2015 data trends satisfactorily with the average of the dataset values for temperature and humidity and overall show little inter-annual variation. The wind speeds are above the monthly average in the first half of the year and typically below in the second half. Wind direction indicates little variation throughout the year.

Therefore, based on a review of all years the 2015 data were selected for modelling.

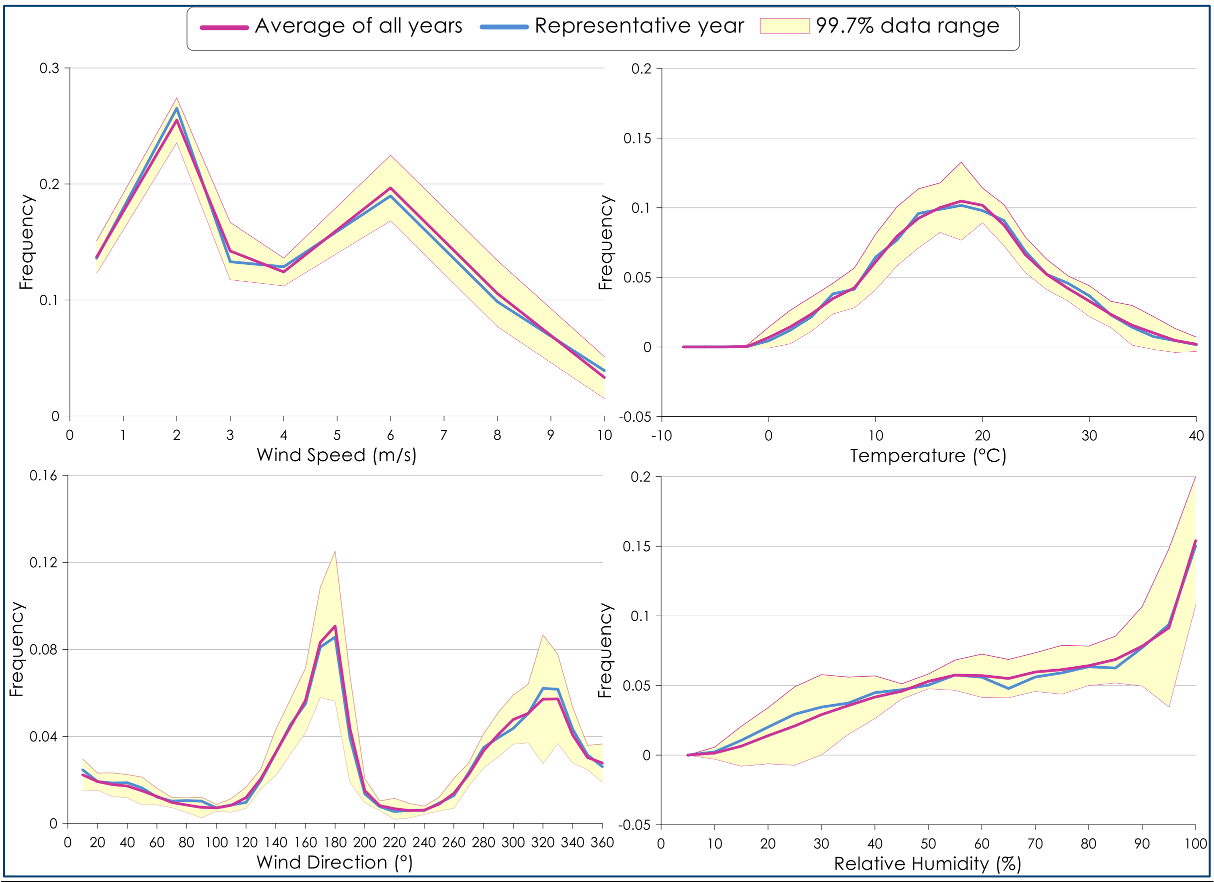

Figure A-1: Graphical analysis of meteorological conditions at Scone Airport AWS

Appendix B

Emission Calculations

Emission Calculation

The dust emissions from the Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: International Best Practise Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining", prepared by Katestone Environmental (**Katestone Environmental, 2010**).

The emission factor equations used for each dust generating activity are outlined in **Table B-1** below. A detailed emission inventory for the modelled year is presented in **Table B-2.**

Control factors include the following:

- Hauling on unpaved surfaces – 80% control for watering of trafficked areas.
- Wind erosion on exposed areas and stockpiles – 50% control for watering

Table B-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$
Crushing	$EF = 0.0027\ kg/tonne$	$EF = 0.0012\ kg/tonne$	$0.075 \times TSP$
Screening	$EF = 0.0125\ kg/tonne$	$EF = 0.0043\ kg/tonne$	$0.075 \times TSP$
Wind erosion on exposed areas, stockpiles	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), VKT = vehicle kilometres travelled (km).

Table B-2: Emissions Inventory

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	EF. TSP	EF. PM10	EF. PM2.5	Units	Var. 1	Units	Var. 2	Units	EF. TSP/ PM10/ PM2.5	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Work Area 1																					
Excavator loading overburden to haul truck	10	5	1	10,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to overburden emplacement	60	15	2	10,000	t/yr	0.030	0.0077	0.0008	kg/t	35.0	tonnes/load	0.4	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Emplacing overburden as backfill	10	5	1	10,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Loading sand/gravel material to truck	241	114	17	250,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to sand/gravel to processing area	4,914	1,252	125	250,000	t/yr	0.098	0.0250	0.0025	kg/t	35.0	tonnes/load	1.3	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Unloading sand/gravel to stockpile at processing area	241	114	17	250,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Work Area 2																					
Excavator loading overburden to haul truck	10	5	1	10,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to overburden emplacement	60	15	2	10,000	t/yr	0.030	0.0077	0.0008	kg/t	35.0	tonnes/load	0.4	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Emplacing overburden as backfill	10	5	1	10,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Loading sand/gravel material to truck	241	114	17	250,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to sand/gravel to processing area	9,071	2,312	231	250,000	t/yr	0.181	0.0462	0.0046	kg/t	35.0	tonnes/load	2.4	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Unloading sand/gravel to stockpile at processing area	241	114	17	250,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Processing																					
Loading sand/gravel to crusher	483	228	35	500,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Crushing sand/gravel material	1,350	600	101	500,000	t/yr	0.003	0.0012	0.0002	kg/t												
Loading sand/gravel to crusher	483	228	35	500,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Primary screening sand/gravel material	6,250	2,150	469	500,000	t/yr	0.013	0.0043	0.0009	kg/t												
Unloading processed sand/gravel material to stockpil	483	228	35	500,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Rehandle processed sand/gravel material at stockpile	483	228	35	500,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Loading processed sand/gravel material to haul truck	483	228	35	500,000	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling product sand/gravel material offsite	53,748	13,698	1,370	500,000	t/yr	0.537	0.1370	0.0137	kg/t	35.0	tonnes/load	7.1	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Other sources																					
Wind erosion - exposed area 1	2,125	1,063	159	2.50	ha	850	425	64	kg/ha/yr												
Wind erosion - exposed area 2	2,125	1,063	159	2.50	ha	850	425	64	kg/ha/yr												
Wind erosion - processing area	6,702	3,351	503	7.88	ha	850	425	64	kg/ha/yr												
Exhaust emissions	809	809	785																		
Total TSP emissions (kg/yr.)	**90,635**	**27,946**	**4,150**																		

Peak - Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	EF. TSP/ PM10/ PM2.5	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Work Area 1																					
Excavator loading overburden to haul truck	15	7	1	15,330	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to overburden emplacement	93	24	2	15,330	t/yr	0.030	0.0077	0.0008	kg/t	35.0	tonnes/load	0.4	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Emplacing overburden as backfill	15	7	1	15,330	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Loading sand/gravel material to truck	370	175	27	383,250	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to sand/gravel to processing area	7,533	1,920	192	383,250	t/yr	0.098	0.0250	0.0025	kg/t	35.0	tonnes/load	1.3	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Unloading sand/gravel to stockpile at processing area	370	175	27	383,250	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Work Area 2																					
Excavator loading overburden to haul truck	15	7	1	15,330	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to overburden emplacement	93	24	2	15,330	t/yr	0.030	0.0077	0.0008	kg/t	35.0	tonnes/load	0.4	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Emplacing overburden as backfill	15	7	1	15,330	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Loading sand/gravel material to truck	370	175	27	383,250	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling to sand/gravel to processing area	13,907	3,544	354	383,250	t/yr	0.181	0.0462	0.0046	kg/t	35.0	tonnes/load	2.4	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Unloading sand/gravel to stockpile at processing area	370	175	27	383,250	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Processing																					
Loading sand/gravel to crusher	740	350	53	766,500	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Crushing sand/gravel material	2,070	920	155	766,500	t/yr	0.003	0.0012	0.0002	kg/t												
Loading sand/gravel to crusher	740	350	53	766,500	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Primary screening sand/gravel material	9,581	3,296	719	766,500	t/yr	0.013	0.0043	0.0009	kg/t												
Unloading processed sand/gravel material to stockpil	740	350	53	766,500	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Rehandle processed sand/gravel material at stockpile	740	350	53	766,500	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Loading processed sand/gravel material to haul truck	740	350	53	766,500	t/yr	0.001	0.0005	0.0001	kg/t	0.8	$(WS/2.2)^{1.3}$ (m/s)	2.0	% M.C.								
Hauling product sand/gravel material offsite	82,396	21,000	2,100	766,500	t/yr	0.537	0.1370	0.0137	kg/t	35.0	tonnes/load	7.1	km/rt	2.6/ 0.7/ 0.1	kg/VKT	4.8	% S.C.	48.0	t	80	% C.
Other sources																					
Wind erosion - exposed area 1	2,125	1,063	159	2.50	ha	850	425	64	kg/ha/yr												
Wind erosion - exposed area 2	2,125	1,063	159	2.50	ha	850	425	64	kg/ha/yr												
Wind erosion - processing area	6,702	3,351	503	7.88	ha	850	425	64	kg/ha/yr												
Exhaust emissions	875	875	848																		
Total TSP emissions (kg/yr.)	**132,740**	**39,557**	**5,570**																		

Appendix C

Isopleth Diagrams

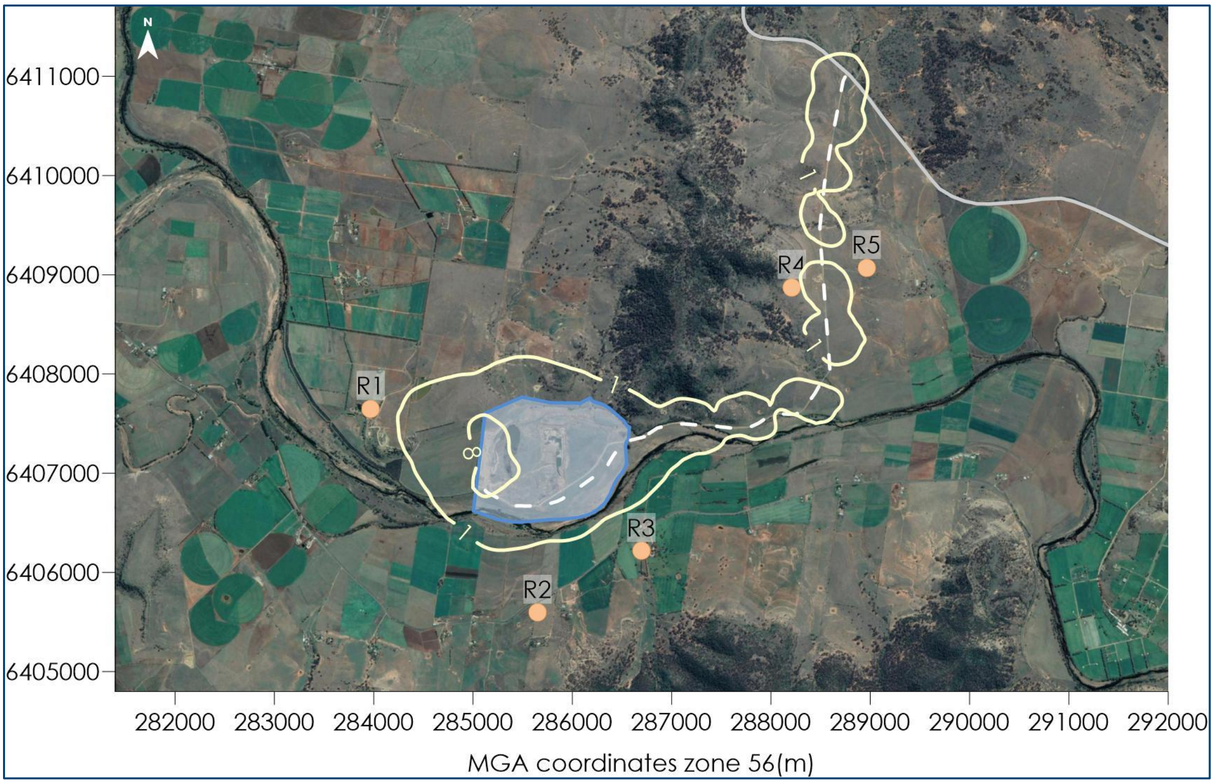

Figure C-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

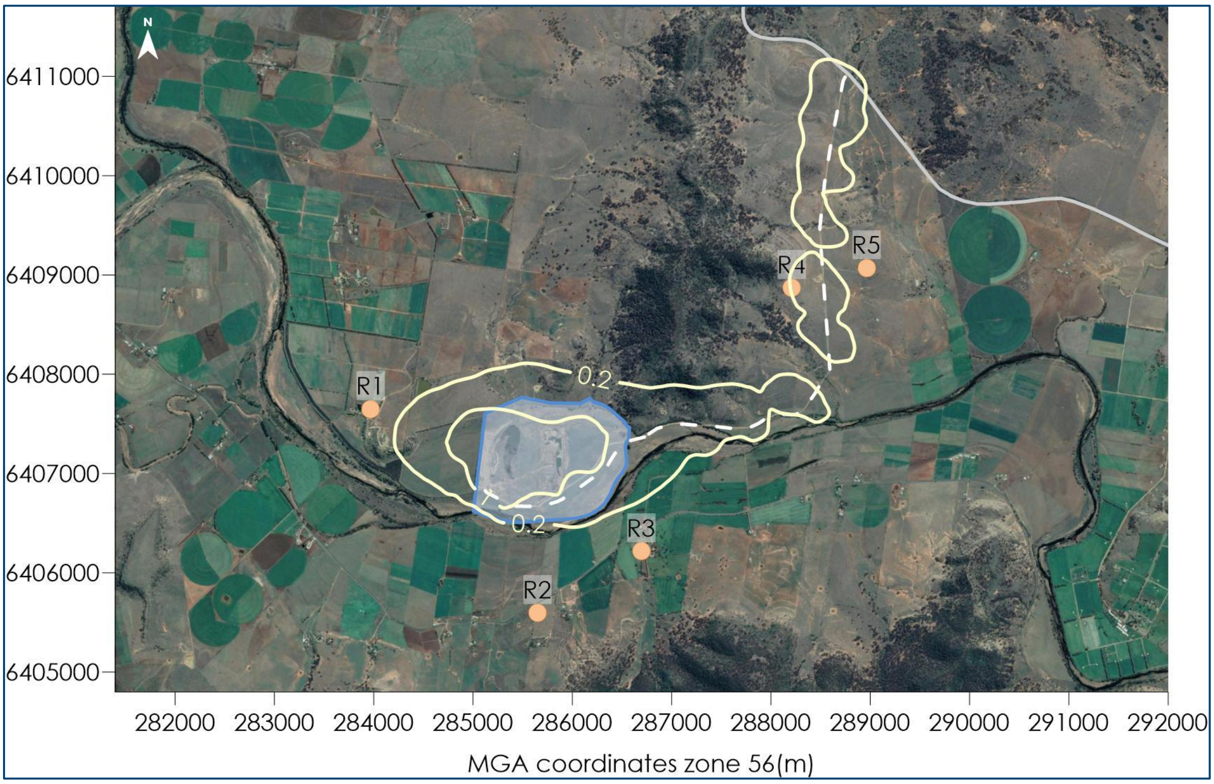

Figure C-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

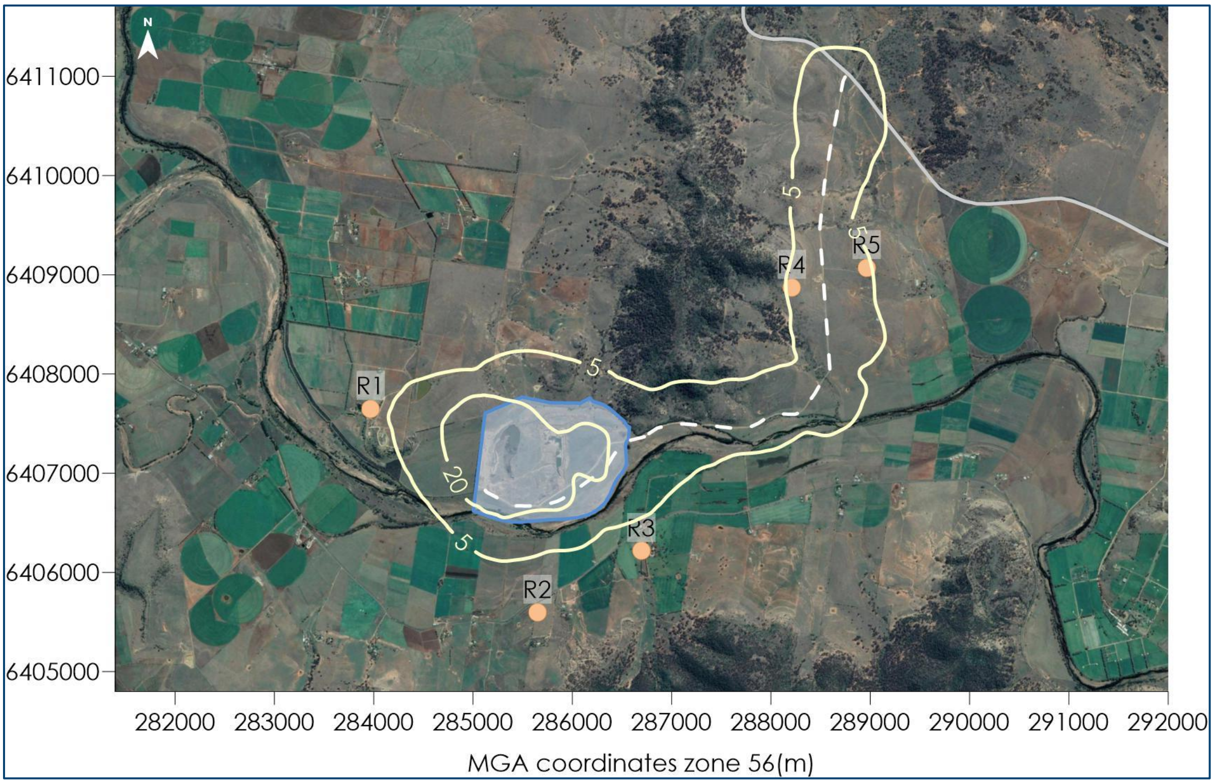

Figure C-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

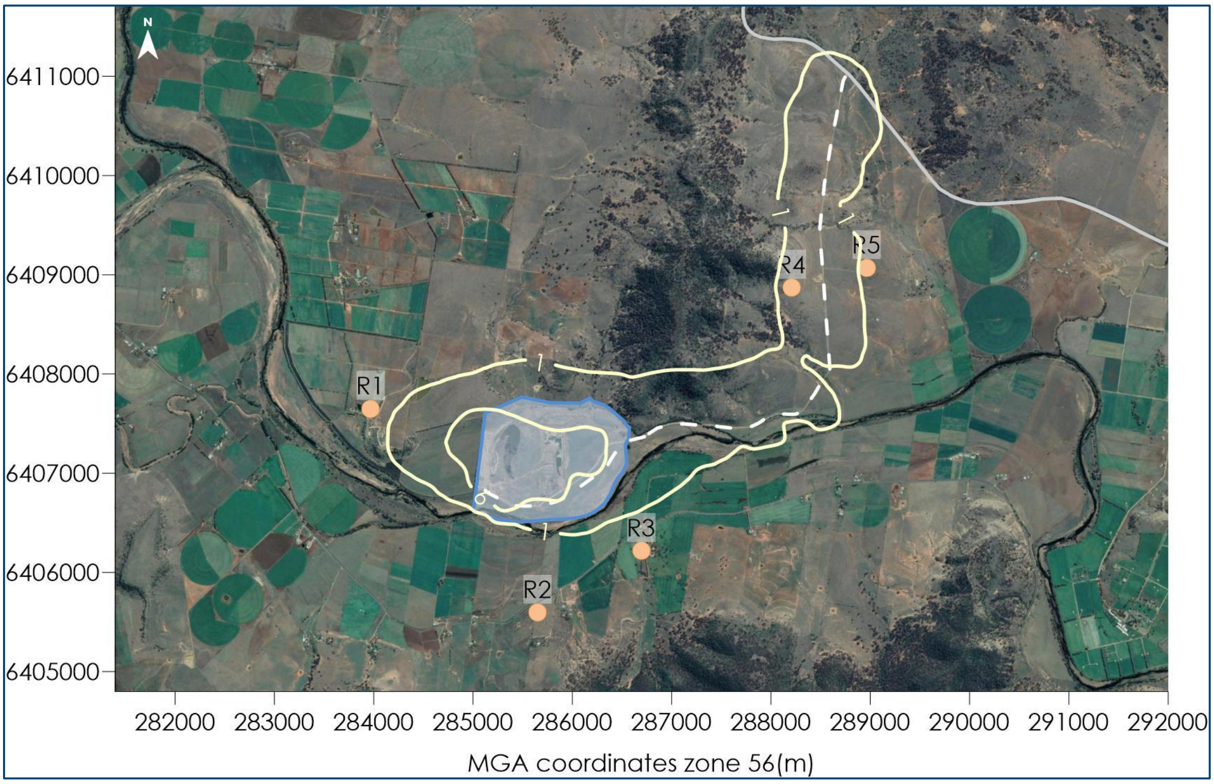

Figure C-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

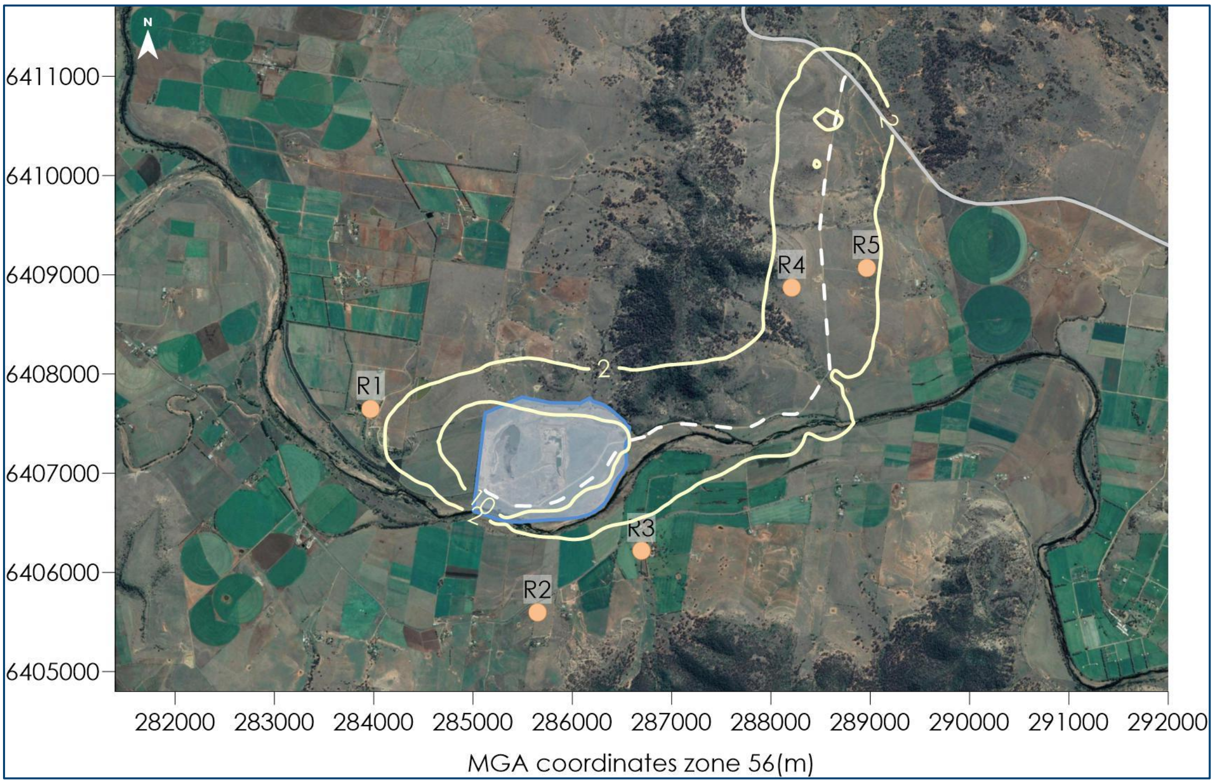

Figure C-5: Predicted incremental annual average TSP concentrations (µg/m³)

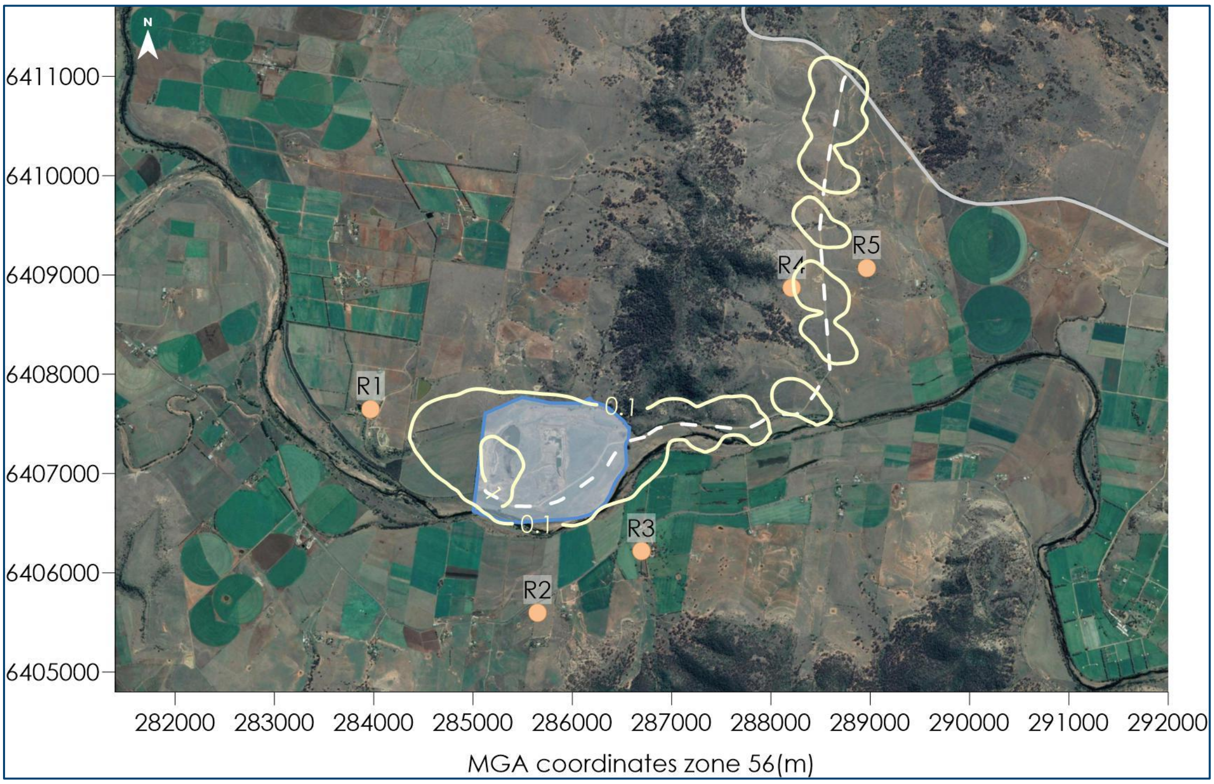

Figure C-6: Predicted incremental annual average dust deposition levels (g/m²/month)

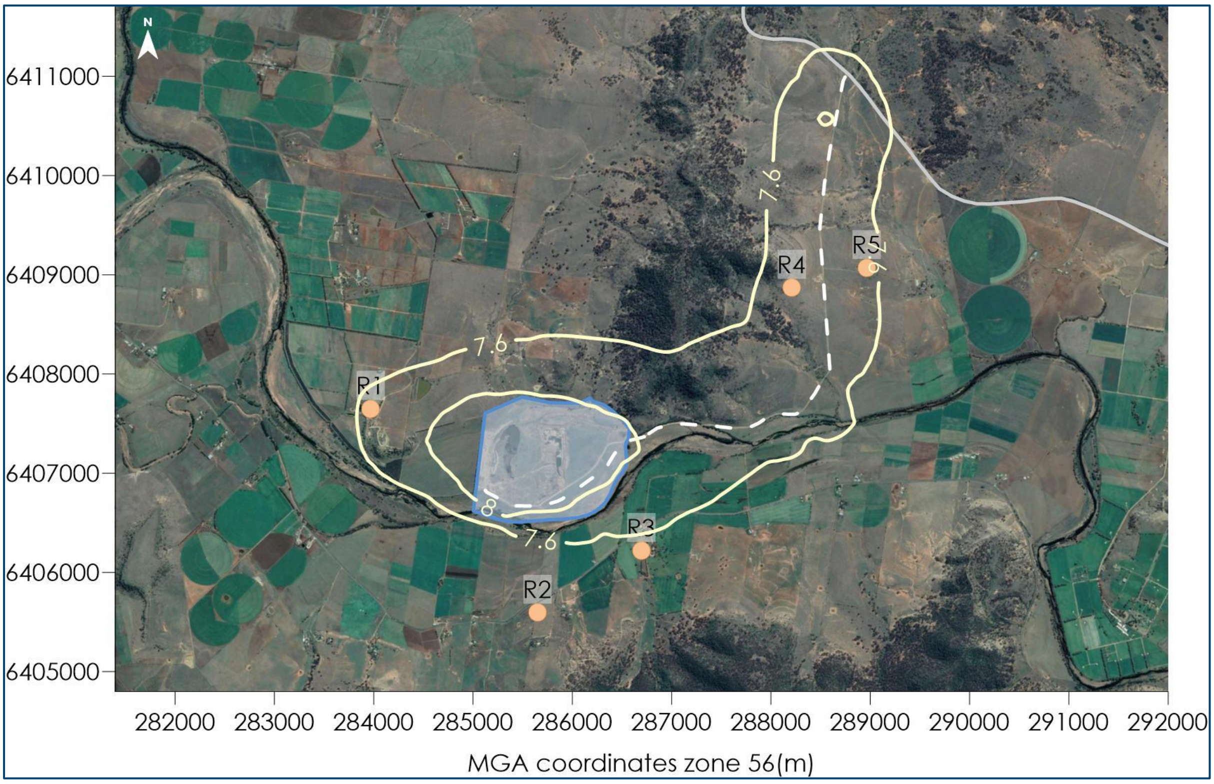

Figure C-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

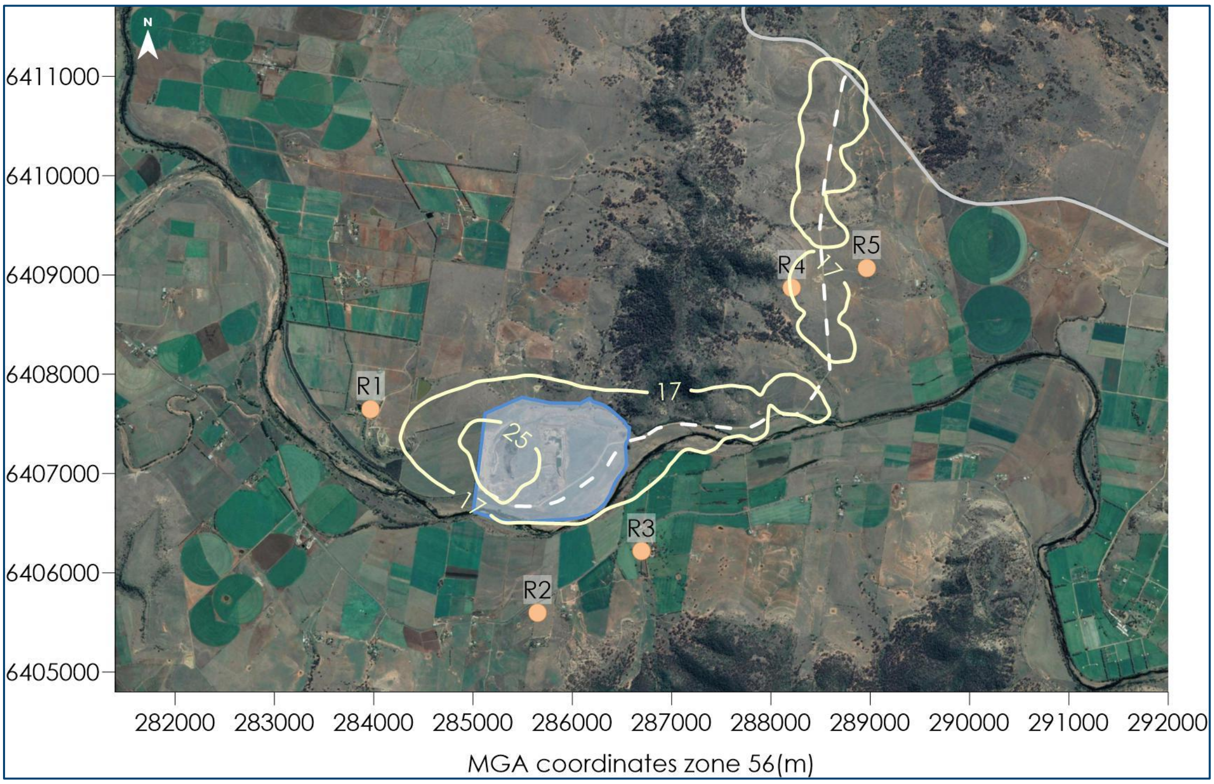

Figure C-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

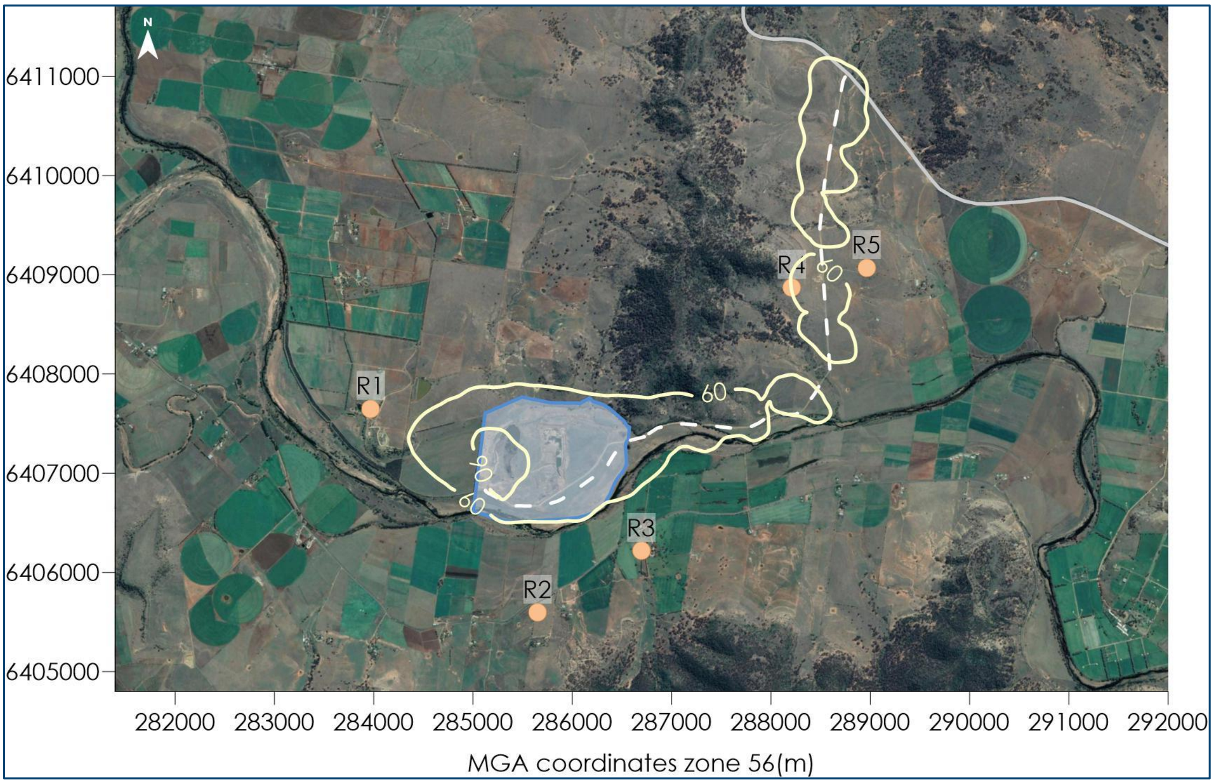

Figure C-9: Predicted cumulative annual average TSP concentrations (µg/m³)

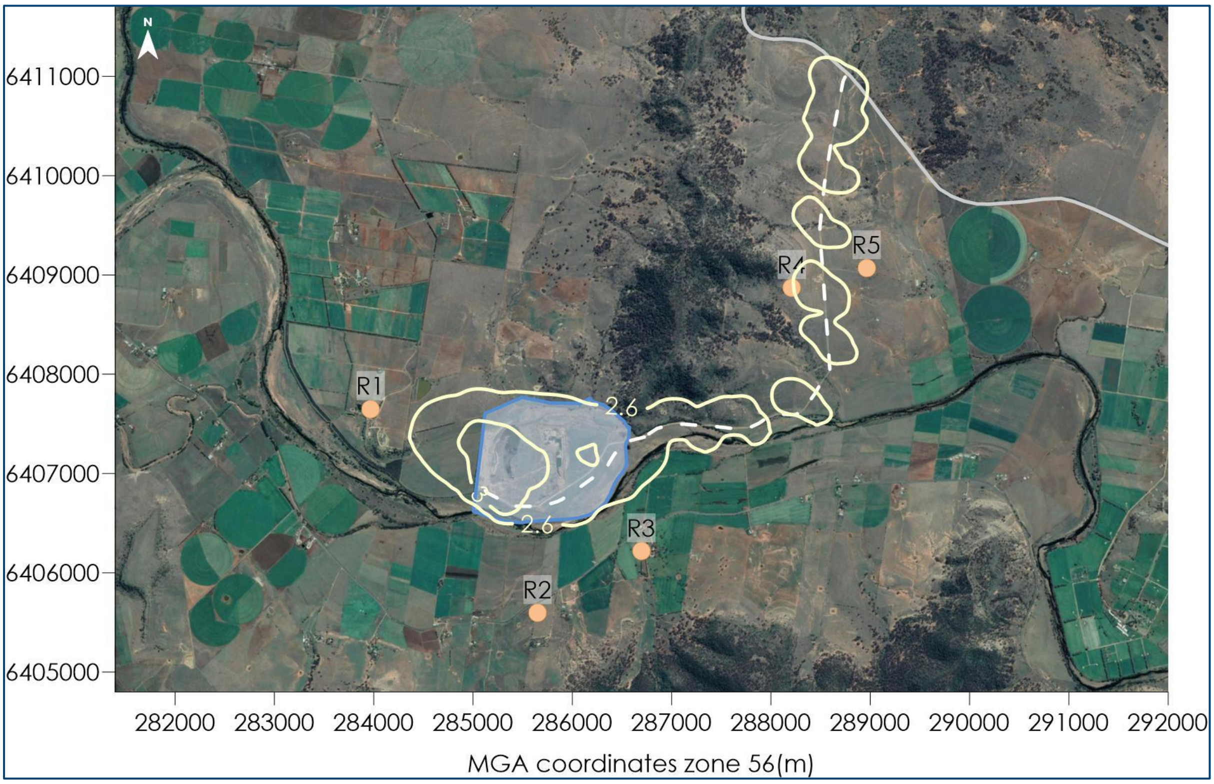

Figure C-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

Appendix D

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

Further detail regarding 24-hour average $PM_{2.5}$ and PM_{10} analysis

The analysis below provides a cumulative 24-hour $PM_{2.5}$ and a 24-hour PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 46 to 47 of the Approved Methods.

The background level is the ambient level at Richmond monitoring station for $PM_{2.5}$ and PM_{10}.

The predicted increment is the predicted level to occur at the receptor due to the project.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Each table assesses one receptor. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the project.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The orange shading represents days where the measured background level is already over the criteria.

Any value above the $PM_{2.5}$ criterion of 25µg/m^3 or above the PM_{10} criterion of 50µg/m^3 is in **bold red.**

Tables D-1 to **D-10** show the predicted maximum cumulative levels at each receptor surrounding the Quarry.

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Table D-1: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	33.8	0.0	33.8				
10/03/2015	21.9	0.2	22.2	11/06/2015	5.1	0.5	5.6
9/03/2015	21.8	0.2	22.0	20/07/2015	7.3	0.4	7.7
26/11/2015	20.6	0.0	20.7	19/07/2015	4.5	0.4	4.9
12/12/2015	19.8	0.1	19.9	29/06/2015	5.4	0.4	5.8
17/10/2015	19.5	0.1	19.7	12/06/2015	5.5	0.4	5.9
7/10/2015	18.2	0.2	18.4	8/07/2015	5.8	0.4	6.2
9/02/2015	17.5	0.2	17.7	13/06/2015	4.0	0.3	4.3
30/09/2015	17.5	0.2	17.7	17/05/2015	5.1	0.3	5.4
11/03/2015	17.2	0.3	17.5	18/05/2015	5.7	0.3	6.1
2/10/2015	16.9	0.3	17.1	28/04/2015	8.1	0.3	8.4

Table D-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	33.8	0.0	33.8				
10/03/2015	21.9	0.0	21.9	9/12/2015	8.5	0.2	8.7
9/03/2015	21.8	0.0	21.8	20/12/2015	9.6	0.2	9.9
26/11/2015	20.6	0.0	20.6	1/11/2015	8.2	0.2	8.5
12/12/2015	19.8	0.0	19.8	3/10/2015	8.3	0.2	8.5
17/10/2015	19.5	0.0	19.6	11/10/2015	7.5	0.2	7.6
7/10/2015	18.2	0.0	18.2	6/10/2015	12.0	0.2	12.1
9/02/2015	17.5	0.0	17.5	18/11/2015	9.9	0.1	10.0
30/09/2015	17.5	0.0	17.5	27/05/2015	4.1	0.1	4.2
11/03/2015	17.2	0.0	17.2	23/06/2015	3.0	0.1	3.1
2/10/2015	16.9	0.0	16.9	8/12/2015	16.3	0.1	16.4

Table D-3: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	33.8	0.1	33.9				
10/03/2015	21.9	0.0	21.9	11/07/2015	2.2	0.4	2.5
9/03/2015	21.8	0.1	21.9	5/05/2015	3.7	0.3	4.0
26/11/2015	20.6	0.1	20.7	18/04/2015	6.3	0.3	6.6
12/12/2015	19.8	0.0	19.8	20/12/2015	9.6	0.3	9.9
17/10/2015	19.5	0.1	19.6	23/06/2015	3.0	0.3	3.3
7/10/2015	18.2	0.0	18.3	21/09/2015	5.1	0.3	5.3
9/02/2015	17.5	0.0	17.5	8/05/2015	5.8	0.3	6.0
30/09/2015	17.5	0.0	17.5	7/06/2015	3.7	0.2	4.0
11/03/2015	17.2	0.0	17.2	19/05/2015	4.6	0.2	4.9
2/10/2015	16.9	0.0	16.9	23/04/2015	1.7	0.2	1.9

Table D-4: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	33.8	0.0	33.8				
10/03/2015	21.9	0.2	22.2	16/06/2015	3.7	0.6	4.3
9/03/2015	21.8	0.2	22.0	14/06/2015	6.8	0.5	7.3
26/11/2015	20.6	0.1	20.8	22/07/2015	6.1	0.5	6.6
12/12/2015	19.8	0.2	20.0	9/07/2015	5.9	0.5	6.4
17/10/2015	19.5	0.3	19.8	21/07/2015	4.5	0.5	5.0
7/10/2015	18.2	0.0	18.3	2/10/2015	16.9	0.5	17.4
9/02/2015	17.5	0.1	17.6	14/09/2015	8.1	0.5	8.6
30/09/2015	17.5	0.3	17.8	19/10/2015	14.3	0.5	14.7
11/03/2015	17.2	0.4	17.6	13/06/2015	4.0	0.4	4.4
2/10/2015	16.9	0.5	17.4	13/04/2015	9.8	0.4	10.2

Table D-5: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R5

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	33.8	0.0	33.8				
10/03/2015	21.9	0.0	22.0	23/07/2015	4.6	0.7	5.3
9/03/2015	21.8	0.0	21.8	27/05/2015	4.1	0.7	4.7
26/11/2015	20.6	0.2	20.8	28/05/2015	4.4	0.6	5.0
12/12/2015	19.8	0.0	19.8	30/06/2015	4.4	0.6	5.0
17/10/2015	19.5	0.1	19.6	6/06/2015	4.7	0.6	5.2
7/10/2015	18.2	0.0	18.3	25/05/2015	5.2	0.6	5.7
9/02/2015	17.5	0.0	17.5	23/06/2015	3.0	0.6	3.6
30/09/2015	17.5	0.1	17.6	15/07/2015	2.6	0.6	3.1
11/03/2015	17.2	0.0	17.3	22/07/2015	6.1	0.5	6.6
2/10/2015	16.9	0.0	16.9	26/05/2015	4.5	0.5	5.0

Table D-6: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	70.0	0.0	70.0				
10/03/2015	45.5	1.5	47.0	11/06/2015	10.6	3.1	13.7
9/03/2015	45.2	1.4	46.6	20/07/2015	15.1	2.6	17.7
26/11/2015	42.8	0.2	43.0	19/07/2015	9.3	2.4	11.7
12/12/2015	41.0	0.7	41.7	29/06/2015	11.2	2.3	13.5
17/10/2015	40.5	0.9	41.4	12/06/2015	11.4	2.3	13.7
7/10/2015	37.8	1.0	38.8	8/07/2015	12.1	2.1	14.2
9/02/2015	36.3	1.5	37.8	13/06/2015	8.2	2.1	10.3
30/09/2015	36.3	1.0	37.3	17/05/2015	10.5	2.1	12.6
11/03/2015	35.7	1.6	37.3	18/05/2015	11.9	2.0	13.9
2/10/2015	35.0	1.6	36.6	9/07/2015	12.2	2.0	14.2

Table D-7: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	70.0	0.0	70.0				
10/03/2015	45.5	0.0	45.5	9/12/2015	17.6	1.6	19.2
9/03/2015	45.2	0.0	45.2	20/12/2015	20.0	1.5	21.5
26/11/2015	42.8	0.0	42.8	1/11/2015	17.1	1.4	18.5
12/12/2015	41.0	0.0	41.0	3/10/2015	17.3	1.1	18.4
17/10/2015	40.5	0.1	40.6	6/10/2015	24.8	1.0	25.8
7/10/2015	37.8	0.0	37.8	11/10/2015	15.5	1.0	16.5
9/02/2015	36.3	0.0	36.3	18/11/2015	20.5	0.9	21.4
30/09/2015	36.3	0.0	36.3	27/05/2015	8.4	0.8	9.2
11/03/2015	35.7	0.1	35.8	23/06/2015	6.2	0.8	7.0
2/10/2015	35.0	0.0	35.0	8/12/2015	33.7	0.8	34.5

Table D-8: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	70.0	0.6	70.6				
10/03/2015	45.5	0.0	45.5	11/07/2015	4.5	2.3	6.8
9/03/2015	45.2	0.4	45.6	5/05/2015	7.6	1.9	9.5
26/11/2015	42.8	0.4	43.2	18/04/2015	13.1	1.8	14.9
12/12/2015	41.0	0.0	41.0	20/12/2015	20.0	1.8	21.8
17/10/2015	40.5	0.4	40.9	8/05/2015	12.0	1.7	13.7
7/10/2015	37.8	0.1	37.9	23/06/2015	6.2	1.7	7.9
9/02/2015	36.3	0.0	36.3	21/09/2015	10.5	1.6	12.1
30/09/2015	36.3	0.1	36.4	1/11/2015	17.1	1.6	18.7
11/03/2015	35.7	0.1	35.8	7/06/2015	7.7	1.5	9.2
2/10/2015	35.0	0.0	35.0	23/04/2015	3.5	1.5	5.0

Table D-9: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	70.0	0.0	70.0				
10/03/2015	45.5	1.8	47.3	16/06/2015	7.7	5.0	12.7
9/03/2015	45.2	1.9	47.1	14/06/2015	14.0	4.2	18.2
26/11/2015	42.8	0.8	43.6	21/07/2015	9.4	3.9	13.3
12/12/2015	41.0	1.6	42.6	22/07/2015	12.6	3.9	16.5
17/10/2015	40.5	2.3	42.8	2/10/2015	35.0	3.8	38.8
7/10/2015	37.8	0.2	38.0	9/07/2015	12.2	3.8	16.0
9/02/2015	36.3	0.5	36.8	19/10/2015	29.6	3.8	33.4
30/09/2015	36.3	2.1	38.4	14/09/2015	16.8	3.7	20.5
11/03/2015	35.7	3.3	39.0	13/04/2015	20.3	3.6	23.9
2/10/2015	35.0	3.8	38.8	14/02/2015	15.6	3.6	19.2

Table D-10: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R5

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
6/05/2015	70.0	0.0	70.0				
10/03/2015	45.5	0.2	45.7	23/07/2015	9.6	5.4	15.0
9/03/2015	45.2	0.3	45.5	27/05/2015	8.4	5.3	13.7
26/11/2015	42.8	1.4	44.2	28/05/2015	9.2	4.7	13.9
12/12/2015	41.0	0.1	41.1	6/06/2015	9.7	4.5	14.2
17/10/2015	40.5	0.4	40.9	30/06/2015	9.2	4.5	13.7
7/10/2015	37.8	0.2	38.0	23/06/2015	6.2	4.5	10.7
9/02/2015	36.3	0.2	36.5	25/05/2015	10.7	4.4	15.1
30/09/2015	36.3	0.7	37.0	15/07/2015	5.3	4.3	9.6
11/03/2015	35.7	0.4	36.1	22/07/2015	12.6	4.2	16.8
2/10/2015	35.0	0.2	35.2	27/06/2015	9.5	4.2	13.7