AIR QUALITY IMPACT ASSESSMENT
MAROOTA SANDS PROJECT

Design Collaborative

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Air Quality Impact Assessment
Maroota Sands Project

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Design Collaborative on behalf of the Deerubbin Local Aboriginal Land Council (DLALC) for the proposed Maroota Sands Project at Maroota, New South Wales (NSW) (hereafter referred to as the Project). The report presents an assessment of potential air quality impacts associated with the Project.

The Project is seeking to develop a sand quarry to extract and process friable sandstone and sand deposits at a rate of up to 500,000 tonnes per annum (tpa) from an extraction zone of approximately 50 hectares (ha).

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

To assess the potential air quality impacts associated with the Project, this report comprises:

- 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 located approximately 26.6 kilometres (km) northeast of Richmond and approximately 23km northwest of Berowra off Wiseman's Ferry Road, Maroota. The area surrounding the Project site is predominately comprised of a mix of rural agricultural land, bushland and other extractive industries (sand quarries). These sand quarries include the Old Northern Road Quarry, Haerses Quarry, Hitchcock Road Quarry, Roberts Road Quarry and Telegraph Road Sand Quarry.

Figure 2-1 presents the location of the Project with reference to the identified sensitive receptors of relevance to this study including nearby quarry operations. **Appendix A** provides a detailed list of all the sensitive receptors considered in this assessment.

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. The local topography is undulating, with increasing elevations moving east of the site. Multiple tributaries drain into the Hawkesbury river located to the north.

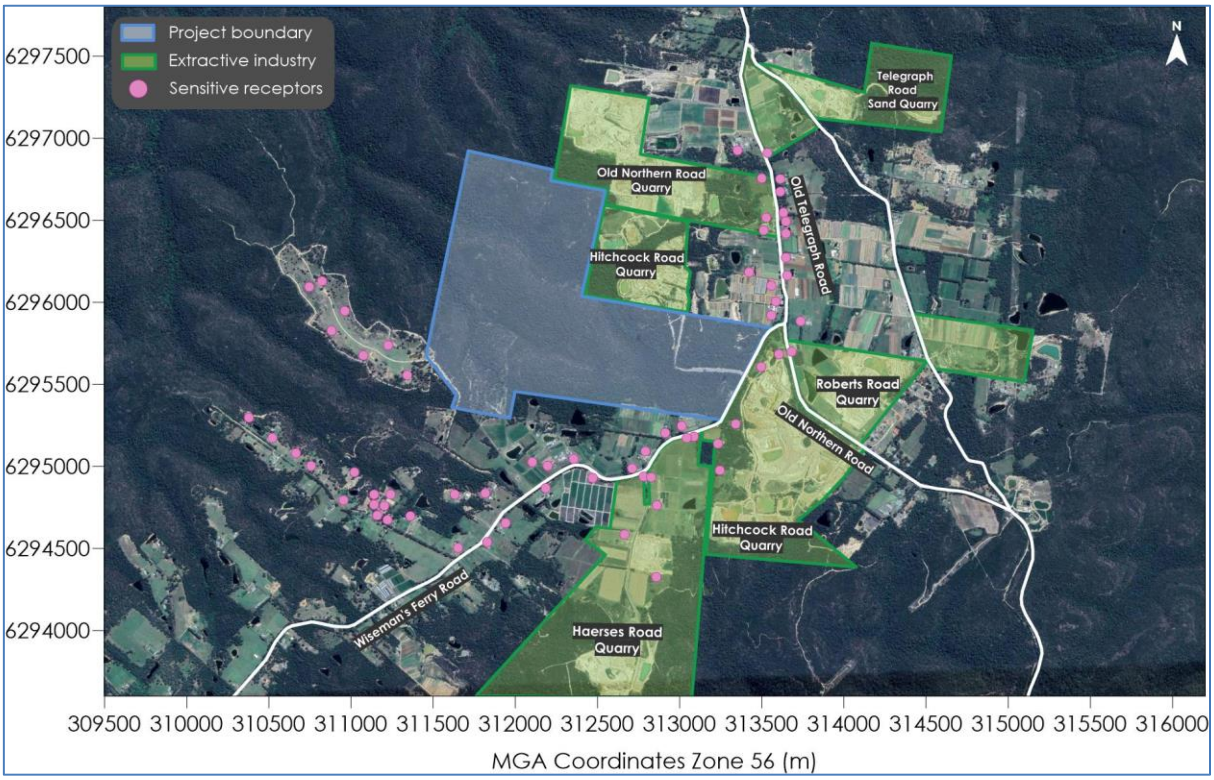

Figure 2-1: Project setting

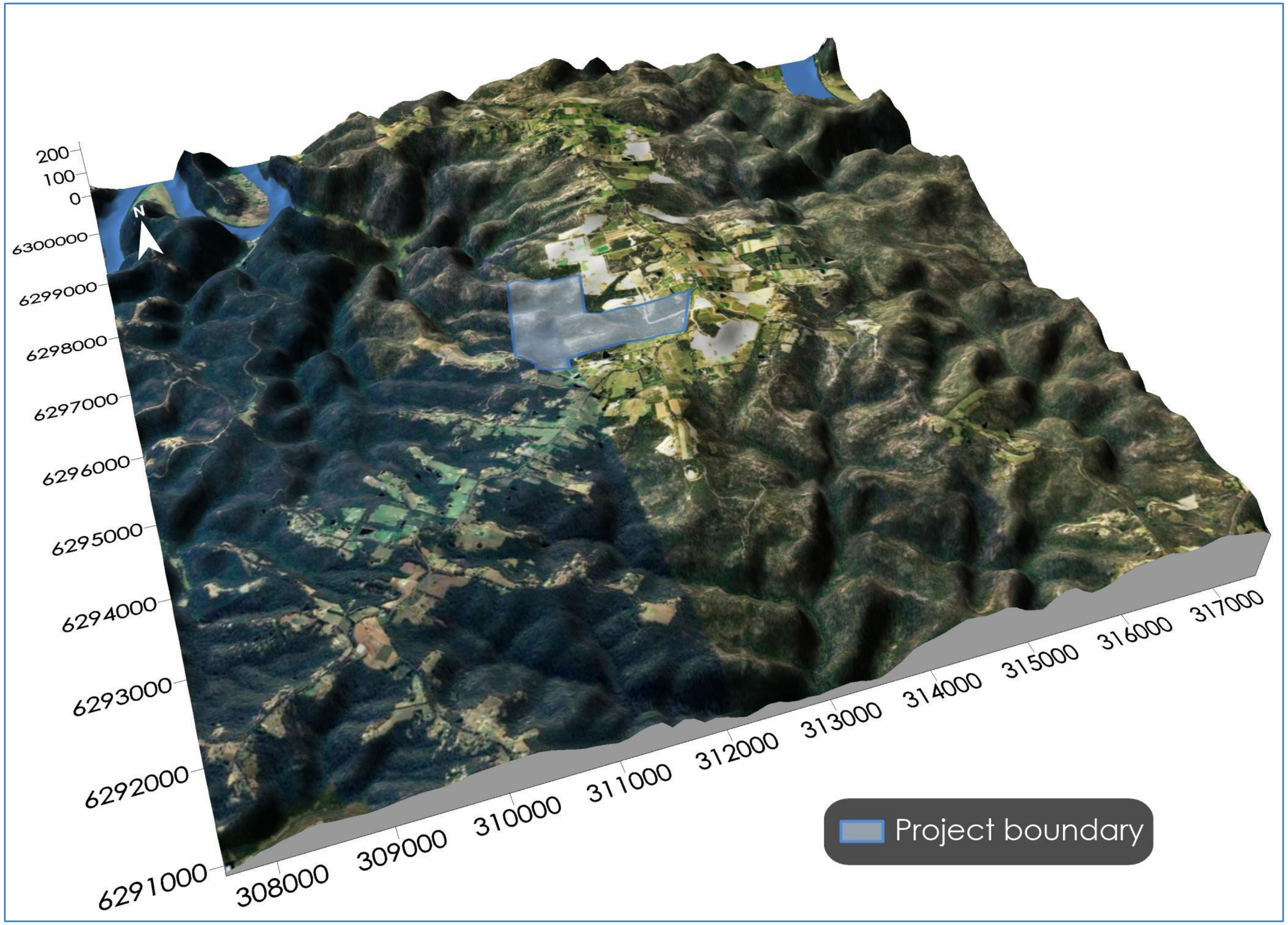

Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Project description

The proposed subject site occupies an area of approximately 180.7ha, and contains approximately 20 million tonnes of friable sandstone, which is planned to be quarried over a 30-year period. The Project seeks to establish a sand quarry using 50ha of the subject site to extract and process friable sandstone and sand deposits at a rate of up to 500,000tpa.

The extraction and processing of friable sandstone and sand would occur using standard truck and shovel extraction with processing of the extracted material applying crushing and screening techniques at the on-site processing plant. Transport of processed material from the Project site would occur via an internal haul road to the existing site access road at Wiseman's Ferry Road and Old Northern Road.

Table 2-1 presents the proposed operating hours for the Project.

Table 2-1: Proposed operating hours

Activity	Monday to Friday	Saturday	Sunday
Sand sales	6:00am to 6:00pm	6:00am to 6:00pm	-
Quarry operations	6:00am to 7:00pm	6:00am to 7:00pm	-

Figure 2-3 provides an indicative site layout of the Project.

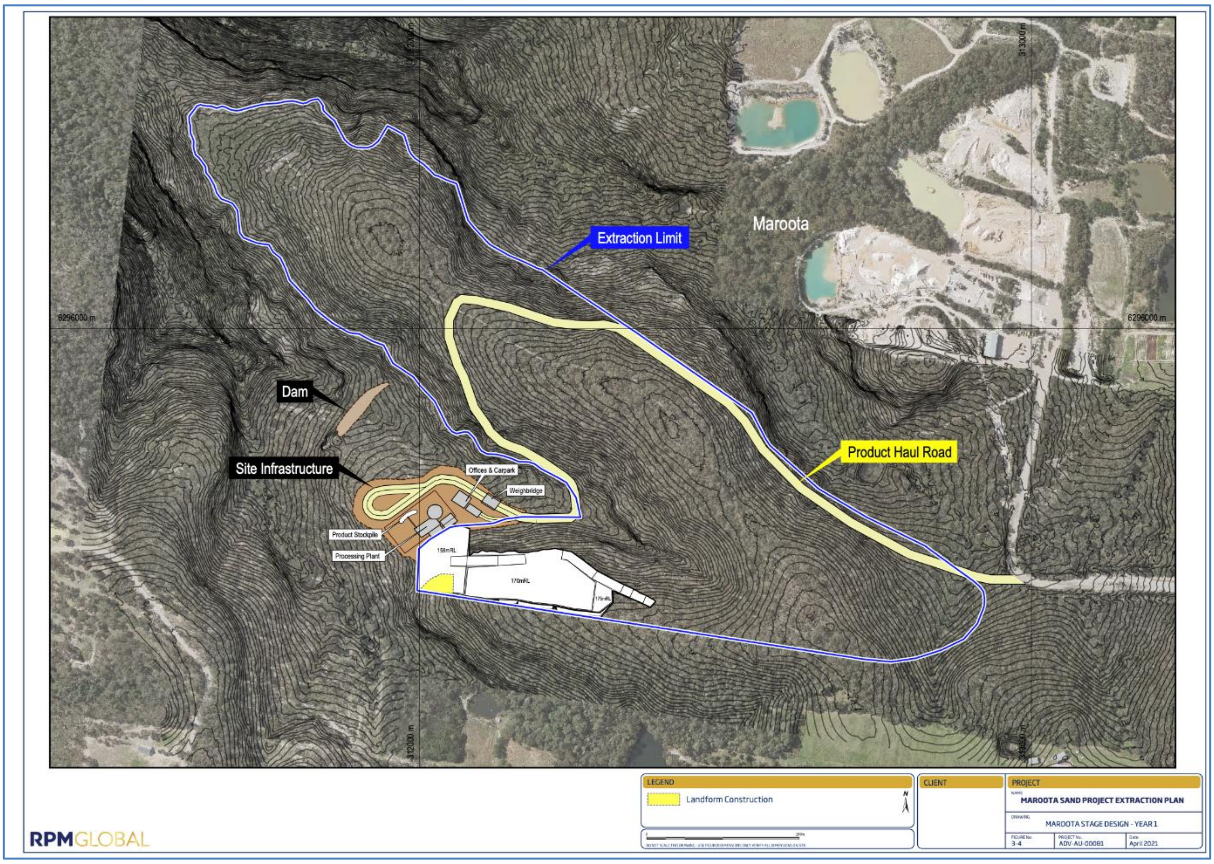

Figure 2-3: Site layout for the Project

3 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the likely effects on air quality which may arise from the Project. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

3.1 Secretary's Environmental Assessment Requirements

In preparing this Air Quality Impact Assessment, the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project in February 2020 have been addressed and the key matters raised for consideration in the Air Quality Impact Assessment are outlined in **Table 3-1** along with a reference as to where the requirements are addressed in the report.

Table 3-1: Secretary's Environmental Assessment Requirements (SEAR Number SSD-10410)

Aspect	Requirement	Section
Air Quality & Odour	Sources of all potential air emissions from the site during works, including vehicle movements.	6, 7 & App. C
	Identification of sensitive receivers potentially impacted by air emissions during works.	App. A
	Assessment of potential impacts on identified sensitive receivers.	7.1 & 7.2
	Details of air quality management and monitoring procedures proposed to minimise any impacts to the environment and human health during works.	9

3.2 NSW EPA

This Air Quality Impact Assessment has been prepared in general accordance with the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**) and the specific requirements outlined therein as well as the SEARs requested by the NSW EPA as outlined in **Table 3-2**.

Table 3-2: NSW EPA agency comments for air quality (SEAR Number SSD-10410)

Air quality and Odour	Section
The AQIA should include: • Sources of all potential air emissions from the site during works, including vehicle movements. • Identification of sensitive receivers potentially impacted by air emissions during works. • Assessment of potential impacts on identified sensitive receivers. • Details of air quality management and monitoring procedures proposed to minimise any impacts to the environment and human health during works.	6.5, App. A, 7 & 8
The EIS should also undertake an assessment of odour impacts, in accordance with the '*Technical framework for the assessment and management of odour from stationary sources in NSW*'. The AQIA must describe the methodology used and any assumption made to predict the impacts. Air pollutant emission rates, ambient air quality data and meteorological data used in the assessment must be clearly stated and justified.	4
An Odour Management Plan should also be prepared to respond to any unexpected odour finds and generation.	8

3.3 The Hills Shire Council

This Air Quality Impact Assessment has been prepared in consideration of the input from The Hills Shire Council to the SEARs, outlined in **Table 3-3**.

Table 3-3: The Hills Shire Council input to the SEARs for air quality

Comments	Section
The submission of an assessment of dust emissions from the site, addressing existing and anticipated dust impacts.	This report

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4 AIR QUALITY CRITERIA

4.1 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.

4.2 NSW EPA impact assessment criteria

Table 4-1 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 pollutant burden in the air and not just the contribution from the Project. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 4-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m³
PM_{10}	Annual	Total	25 µg/m³
	24 hour	Total	50 µg/m³
$PM_{2.5}$	Annual	Total	8µg/m³
	24 hour	Total	25 µg/m³
Deposited dust	Annual	Incremental	2 g/m²/month
		Total	4 g/m²/month

Source: **NSW EPA, 2017**
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

4.3 NSW Voluntary Land Acquisition and Mitigation Policy

Part of the NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP) dated September 2018 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-2** at any residence on privately owned land or workplace on privately owned land.[1]

Table 4-2: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	30 µg/m³*		Human health
PM_{10}	24 hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: **NSW Government (2018)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-3** at any residence on privately owned land, workplace on privately owned land or on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 4-3: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	30 µg/m³*		Human health
PM_{10}	24-hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: **NSW Government (2018)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

4.4 Crystalline silica

Silica occurs in nature in a crystalline or amorphous form and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

Various jurisdictions have developed criteria for acceptable levels of exposure to crystalline silica. These include the Victorian criterion adopted from Californian reference exposure level values, and occupational standards. **Table 4-4** presents the Victorian impact assessment criteria (**VIC EPA, 2007**)

[1] Where any exceedance would be unreasonably detrimental to workers health or carrying out of the business at that workplace.

which are the most stringent available standards for respirable crystalline silica, and which are applied to the Project.

Table 4-4: Air Quality Criterion for Respirable Silica

Pollutant	Averaging period	Criterion (µg/m³)	Organisation
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3	VIC EPA

Source: **VIC EPA (2007)**

4.5 Odour emissions

Odour emissions have some potential to arise from the diesel exhaust emissions of on-site plant equipment. These odorous emissions are generally considered to be too low to generate any significant off-site pollutant concentrations and have not been assessed further in this study.

5 EXISTING ENVIRONMENT

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

5.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at Richmond RAAF (Site No. 067105) were analysed to characterise the local climate in the proximity of the Project. Richmond RAAF is located approximately 24.7km southwest of the Project.

Table 5-1 and **Figure 5-1** present a summary of data from the Richmond RAAF collected over a 16 to 27 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 30.5 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 3.5°C.

Rainfall decreases during the cooler months, with an annual average rainfall of 719.1 millimetres (mm) over 72.0 days. The data indicate that February is the wettest month with an average rainfall of 116.7mm over 8.2 days and July is the driest month with an average rainfall of 27.0mm over 3.9 days.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity ranges from 58% in October to 83% in June. Mean 3pm relative humidity levels range from 39% in August and September to 53% in May and June.

Wind speeds exhibit seasonal variations with lower wind speed records for the first half of the year and higher observations for the latter. Mean 9am wind speeds range from 5.7 kilometres per hour (km/h) in May to 10.3km/h in October. Mean 3pm wind speeds range from 12.6km/h in May to 19.4km/h in September.

Table 5-1: Monthly climate statistics summary – Richmond RAAF

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	30.5	29.3	27.1	24.2	20.9	18.0	17.8	19.8	22.9	25.4	27.2	29.1	24.4
Mean min. temp. (°C)	17.9	17.8	15.8	11.8	7.5	5.3	3.5	4.4	7.9	11.1	14.2	16.2	11.1
Rainfall													
Rainfall (mm)	81.6	116.7	81.1	53.9	43.4	55.9	27.0	31.2	44.6	50.0	75.3	67.1	719.1
No. of rain days (≥1mm)	7.8	8.2	8.3	5.8	4.9	5.8	3.9	3.5	4.5	5.6	7.2	6.5	72.0
9am conditions													
Mean temp. (°C)	22.1	21.3	19.1	17.0	13.1	10.0	8.9	11.4	15.4	18.3	19.2	20.9	16.4
Mean R.H. (%)	72	78	80	76	82	83	80	69	63	58	68	68	73
Mean W.S. (km/h)	9.1	8.1	6.6	6.9	5.7	6.3	5.9	8.1	9.9	10.3	9.9	8.9	8.0
3pm conditions													
Mean temp. (°C)	28.5	27.4	25.8	23.0	19.7	17.0	16.5	18.7	21.5	23.5	25.2	27.5	22.9
Mean R.H. (%)	47	52	52	49	53	53	48	39	39	40	46	44	47
Mean W.S. (km/h)	16.6	15.6	14.7	14.4	12.6	13.5	14.3	17.7	19.4	19.1	19.0	17.7	16.2

Source: **Bureau of Meteorology, 2020 (May 2020)**

R.H. – Relative Humidity, W.S. – wind speed

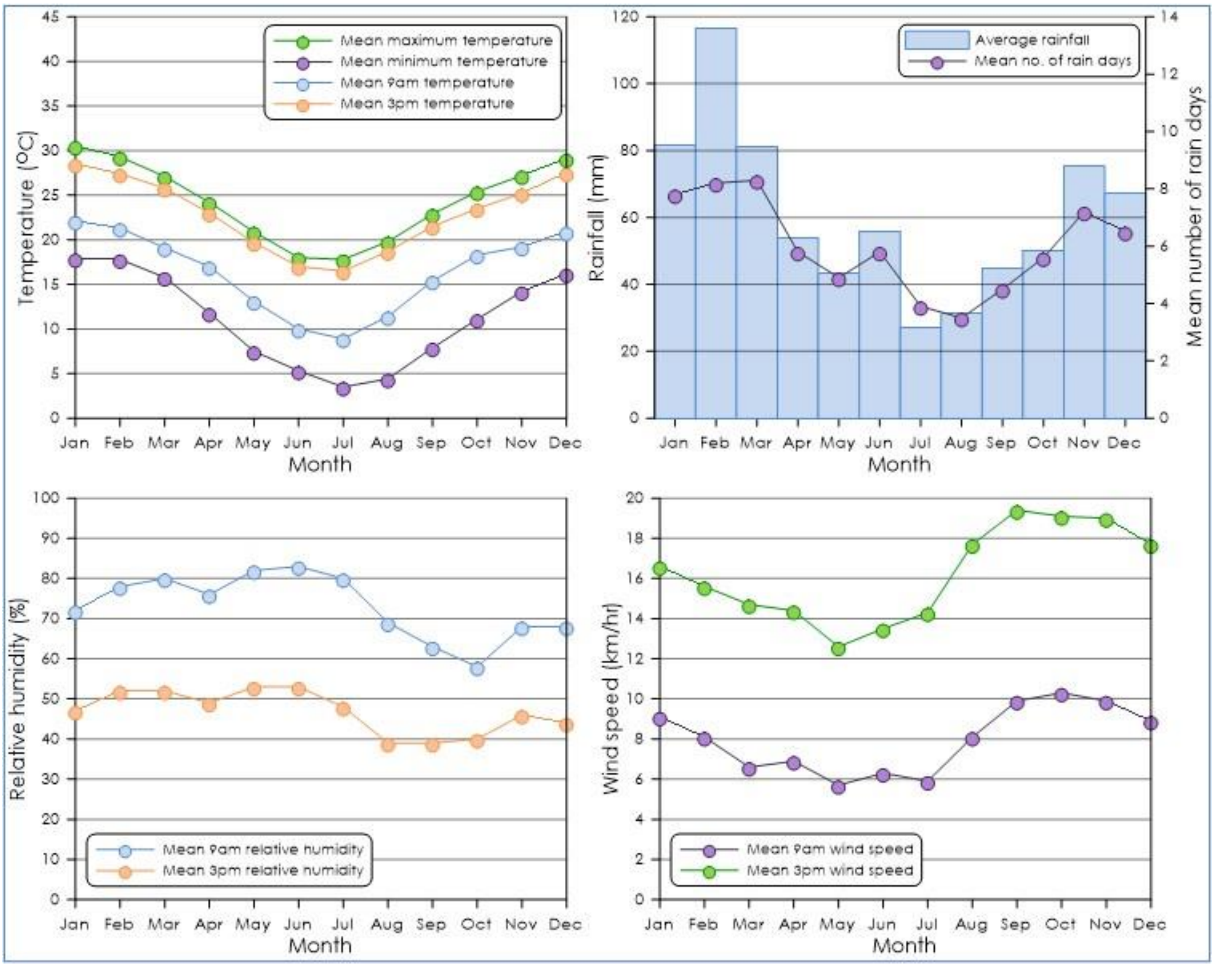

Figure 5-1: Monthly climate statistics summary – Richmond RAAF

5.2 Local meteorological conditions

Annual and seasonal windroses for the Richmond RAAF during the 2017 calendar period are presented in **Figure 5-2**.

The 2017 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 and appropriate monitoring data for the area as outlined in **Appendix B**.

Analysis of the windroses shows that the wind directions are generally evenly distributed on an annual basis with winds greatest to the northeast and southwest. The summer windrose shows a similar distribution pattern as the annual windrose with winds greatest from the east-northeast and southwest. In Autumn, winds from the south to the southwest are most frequent. During winter, winds from the southwest to the west are most frequent. During spring, winds are predominately from the east and west.

Figure 5-2 : Annual and seasonal windroses – Richmond RAAF (2017)

5.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project would include emissions from active extraction operations, agricultural activities and other anthropogenic activities such as various commercial activities and motor vehicle exhaust.

Ambient air quality monitoring data from the Maroota Public School TEOM and the Haerses Road Quarry D08 and D10 deposited dust gauges were used to quantify the background levels for the Project site. **Figure 5-3** shows the approximate location of each of the monitoring stations reviewed.

Ambient PM_{10} and $PM_{2.5}$ monitoring data from the nearest air quality monitor operated by the New South Wales (NSW) Department of Planning, Industry and Environment (DPIE) at Richmond were also reviewed and compared with the levels measured near to the Project.

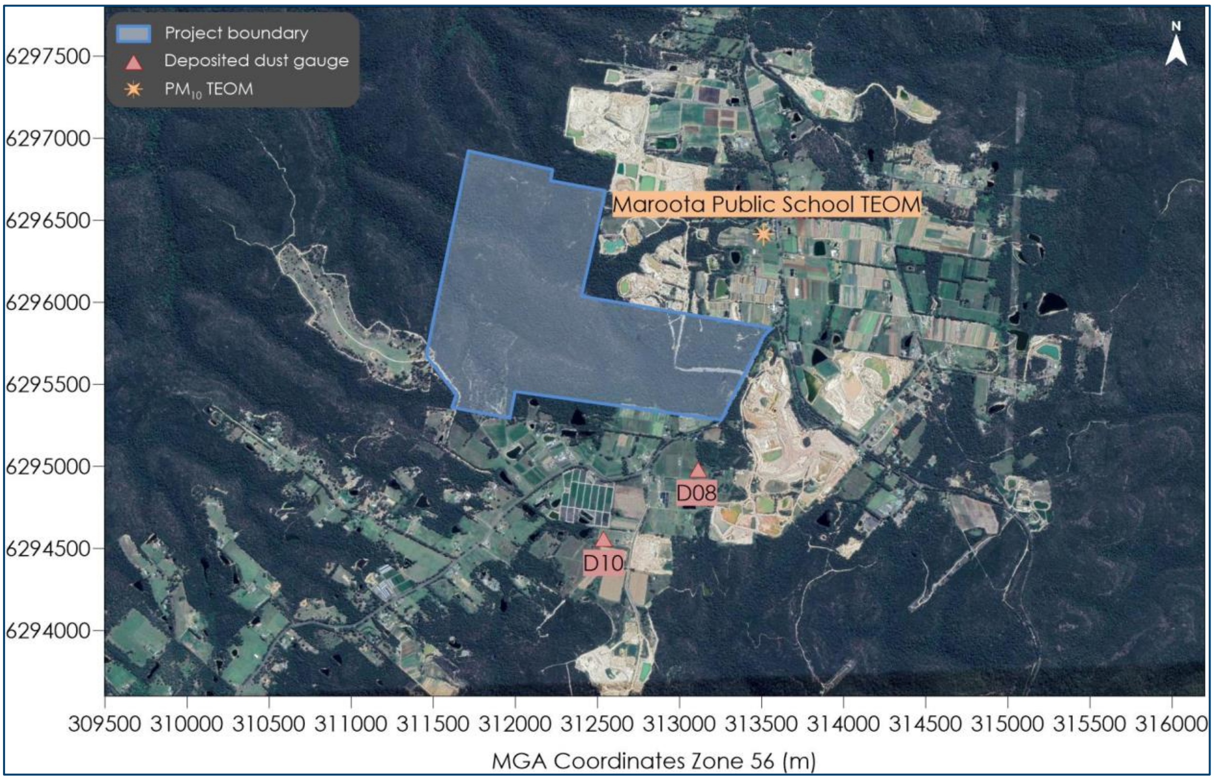

Figure 5-3: Air quality monitoring locations

5.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from 2015 to 2020 for the Richmond and Maroota Public School TEOM monitoring stations is presented in **Table 5-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 5-4**.

A review of **Table 5-2** indicates that the annual average PM_{10} concentrations for both monitoring stations were below the relevant criterion of 25µg/m^3 for all years of the review period. It should be noted that annual periods which contain less than 75% data are excluded when estimating an annual average in **Table 5-2**. The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m^3 on occasion from 2016 to 2020 at Richmond and on all occasions at the Maroota Public School TEOM.

Figure 5-4 shows both the Richmond and Maroota Public School TEOM following similar trends with regional events recorded at both monitoring stations.

Anomalously high PM_{10} concentrations recorded in May 2016 at Richmond and May 2018 at both monitors have been attributed to hazard reduction burns in the Sydney region and Blue Mountains (**NSW OEH 2017 & NSW DPIE 2020b**). In November 2018, a significant dust storm event transported dust from western NSW and the Mallee region of Victoria to the Sydney region resulting in high PM_{10} concentrations at the monitors (**NSW DPIE 2020b**). The high PM_{10} concentration recorded at both monitors in November 2019 and January 2020 is attributed to wildfires and the drought period (**NSW DPIE 2019 & NSW DPIE 2020a**).

Table 5-2: Summary of PM_{10} levels from Richmond and Maroota Public School TEOM monitoring (µg/m³)

Year	Richmond	Maroota Public School TEOM	Criterion
	Annual average		
2015	12.8	-	**25**
2016	16.0	-	**25**
2017	16.0	12.9	**25**
2018	18.7	17.3	**25**
2019	24.2	21.9	**25**
2020	-	-	**25**
Year	**Maximum 24-hour average**		**Criterion**
2015	49.3	-	**50**
2016	**102.8**	-	**50**
2017	**51.5**	**51.1**	**50**
2018	**116.3**	**105.5**	**50**
2019	**193.4**	**151.8**	**50**
2020	**237.7**	**151.8**	**50**

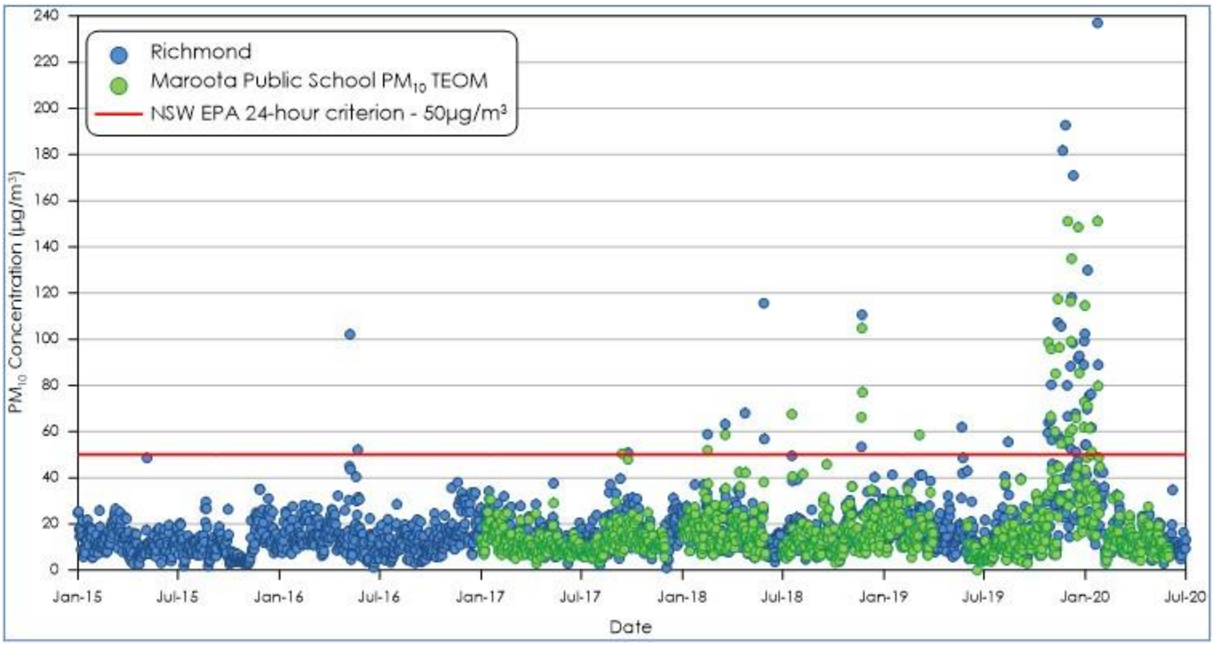

Figure 5-4: 24-hour average PM_{10} concentrations

5.3.2 $PM_{2.5}$ monitoring

A summary of the available data from 2015 to 2020 for the Richmond monitoring station is presented in **Table 5-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 5-5**.

Table 5-3 indicates that the annual average $PM_{2.5}$ concentrations for the monitoring station were below the annual average criterion of 8µg/m^3 for all years with the exception of 2018 and 2019. It should be noted that annual periods which contain less than 75% data are excluded for estimating an annual average in **Table 5-3**.

The maximum 24-hour average $PM_{2.5}$ concentrations at the Richmond monitoring station were found to be above the relevant criterion of 25µg/m^3 from 2016 to 2020. Similar to the PM_{10} monitoring data, the hazard reduction burning in 2016 and the mass bushfires affecting NSW in 2019 and 2020 are seen in the $PM_{2.5}$ monitoring data. Also, in September 2017 and April 2018, multiple hazard reduction burning activities were conducted, resulting in elevated $PM_{2.5}$ concentrations at the Richmond monitoring station (**NSW OEH 2019** & **NSW DPIE 2020b**). These events were recorded as exceptional events and have been excluded from determining cumulative impacts.

Table 5-3: Summary of $PM_{2.5}$ levels from Richmond monitoring (µg/m^3)

Year	Annual average	Criterion
2015	7.7	**8**
2016	7.9	**8**
2017	7.0	**8**
2018	**8.1**	**8**
2019	**13.1**	**8**
2020	-	**8**
Year	**Maximum 24-hour average**	**Criterion**
2015	24.5	**25**
2016	**83.4**	**25**
2017	**34.3**	**25**
2018	**123.9**	**25**
2019	**141.2**	**25**
2020	**93.0**	**25**

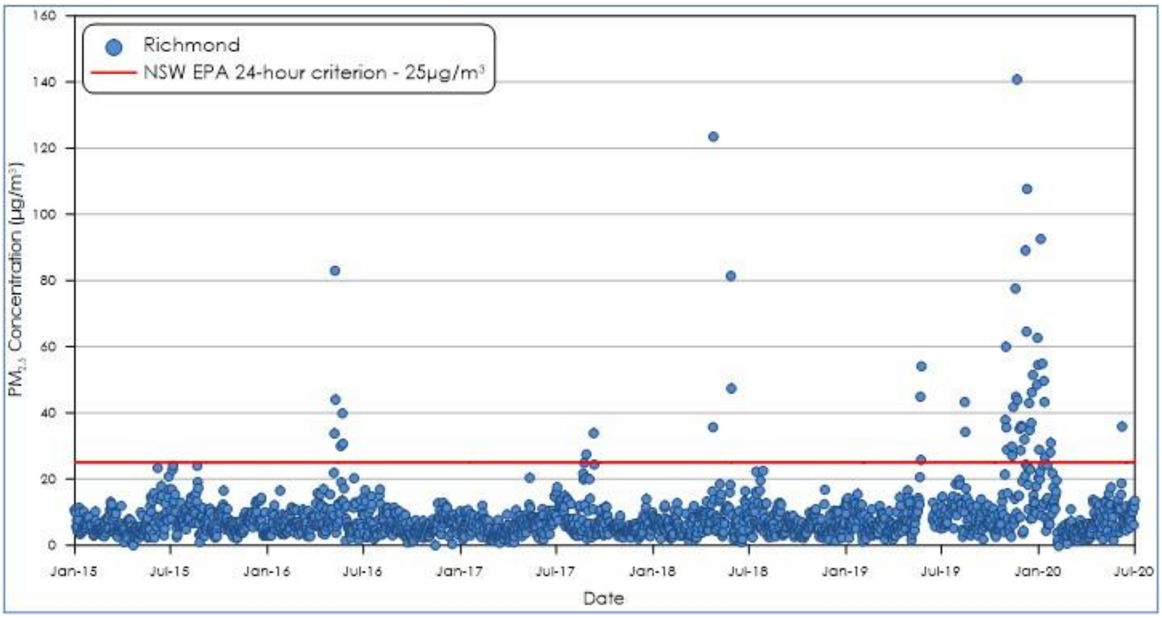

Figure 5-5: 24-hour average $PM_{2.5}$ concentrations

5.3.3 Deposited Dust

A summary of the available data from 2017 to 2018 for the Haerses Road Quarry D08 and D10 dust deposition gauges is presented in **Table 5-4**. Recorded deposited dust annual averages are presented in **Figure 5-6**.

Table 5-4 indicates that the annual average deposited dust levels for the D08 dust gauge were below the annual average criterion of 4 g/m^2/month for all years of the review period. The D10 dust gauge recorded exceedances in 2015 and 2017.

The high annual average deposited dust level recorded in 2015 at the D10 dust gauge is attributed to multiple hazard reduction burns during August 2015 **(PES, 2016)**, while the 2017 exceedance was primarily caused by agricultural activities and earthworks occurring adjacent to the monitor as well as extended dry weather periods **(PES, 2017)**.

Table 5-4: Summary of Haerses Road Quarry deposited dust gauges (g/m^2/month)

Year	Annual average		Criterion
	D08	D10	
2015	0.5	**4.8**	**4**
2016	0.6	2.0	**4**
2017	0.6	**12.4**	**4**
2018	1.3	1.2	**4**

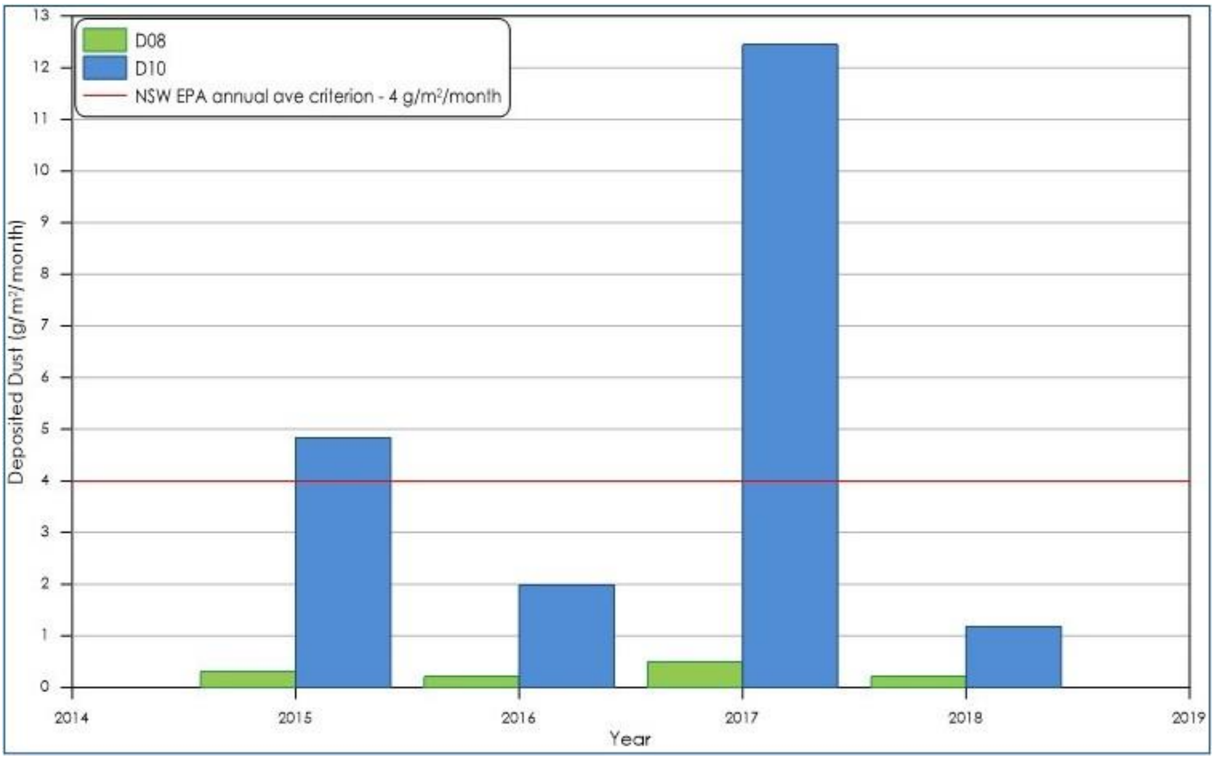

Figure 5-6: Annual average deposited dust levels

5.3.4 Estimated background levels

The measured PM_{10} levels from the Maroota Public School TEOM, $PM_{2.5}$ levels from the Richmond monitor and the deposited dust levels from the D08 dust gauge during the 2017 calendar period were used to represent the background levels for the Project. The 2017 calendar period corresponds to the period of meteorological modelling based on an analysis of long-term data trends in meteorological data and appropriate monitoring data recorded for the area as outlined in **Appendix B**.

The Maroota Public School TEOM monitor and the D08 dust gauge are in the vicinity of the Project site, close to existing extractive industries and would measure particulate levels due to these local sources. The Richmond monitor is in a more suburban setting and would be expected to experience moderate fine particulate levels due to a higher density of anthropogenic sources. Therefore, the monitors would present a suitable estimate of PM_{10} and $PM_{2.5}$ background levels for the Project site used to assess the cumulative impacts.

In the absence of available data, estimates of the annual average background TSP concentrations can be determined from a relationship between $PM_{10,}$ TSP 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. This assumption is based on the NSW EPA air quality impact criteria. Applying this relationship with the measured annual average PM_{10} concentration of 12.9µg/m^3 indicates an approximate annual average TSP concentration of 46.4µg/m^3.

5.3.4.1 Summary of background levels

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

- 24-hour average $PM_{2.5}$ concentrations – daily varying;
- 24-hour average PM_{10} concentrations – daily varying;
- Annual average $PM_{2.5}$ concentrations – 7.0 µg/m^3;
- Annual average PM_{10} concentrations – 12.9µg/m^3;
- Annual average TSP concentrations – 46.4 µg/m^3; and,
- Annual average deposited dust levels – 0.6 g/m^2/month

6 DISPERSION MODELLING APPROACH

6.1 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**).

6.2 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.

6.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 33deg 27min south and 150deg 58min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

The CALMET domain was run on a domain of 10 x 10km with a 0.1km grid resolution. The available meteorological data for January 2017 to December 2017 from two surrounding meteorological monitoring sites were included in the simulation. The 2017 calendar year was selected as the period for modelling the Project based on an analysis of five consecutive years as outlined in **Appendix B**.

Table 6-1 outlines the parameters used from each station.

Table 6-1: Surface observation stations used in modelling

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Richmond RAAF (BoM) (Station No. 067105)	✓	✓	✓	✓	✓	✓	✓
Mangrove Mountain AWS (BoM) (Station No. 061375)	✓	✓			✓	✓	

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

Local land use and detailed topographical information was included to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 6-1**.

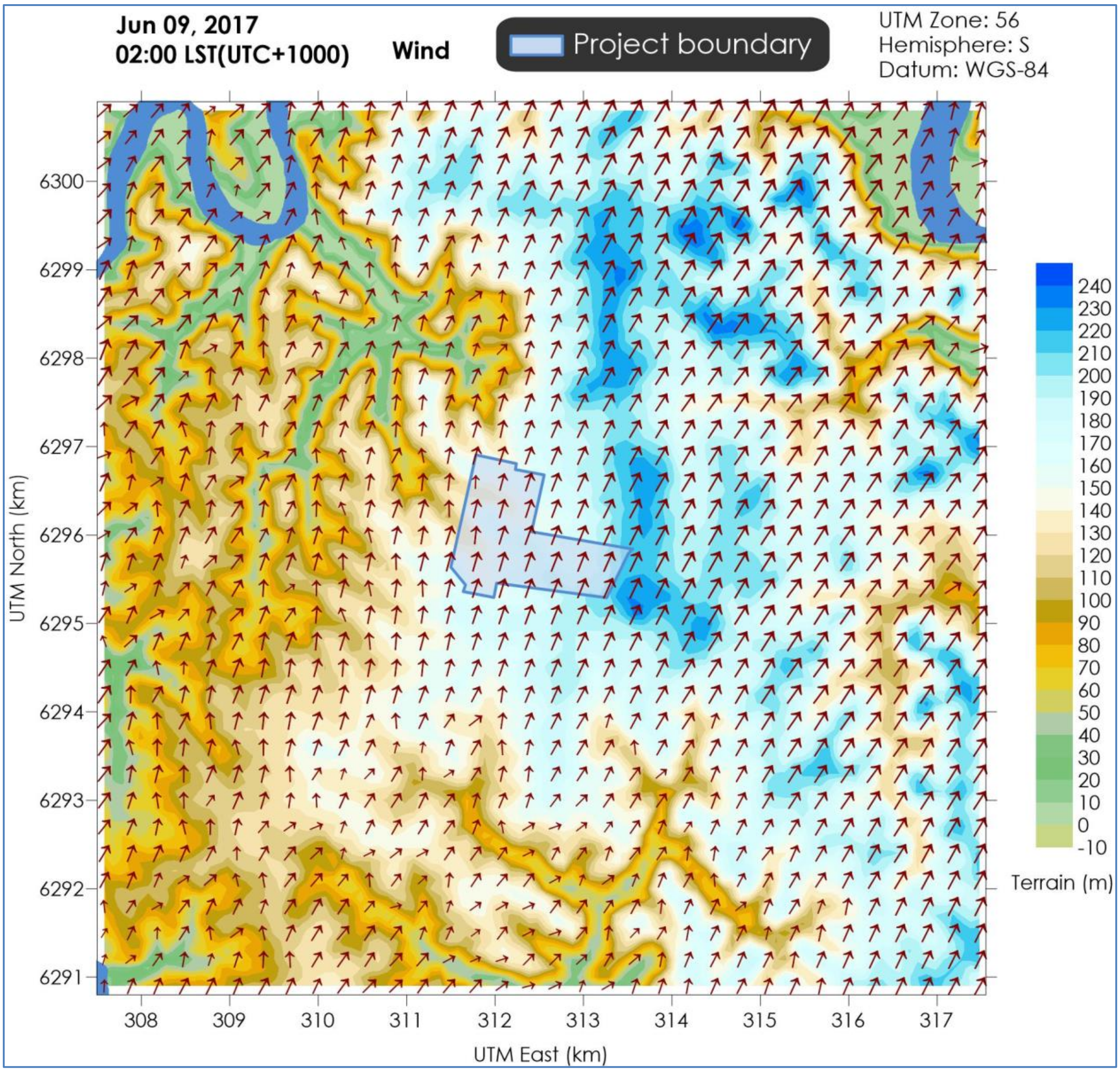

Figure 6-1: Representative 1-hour average snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-2** and **Figure 6-3**.

Figure 6-2 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 6-3** includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

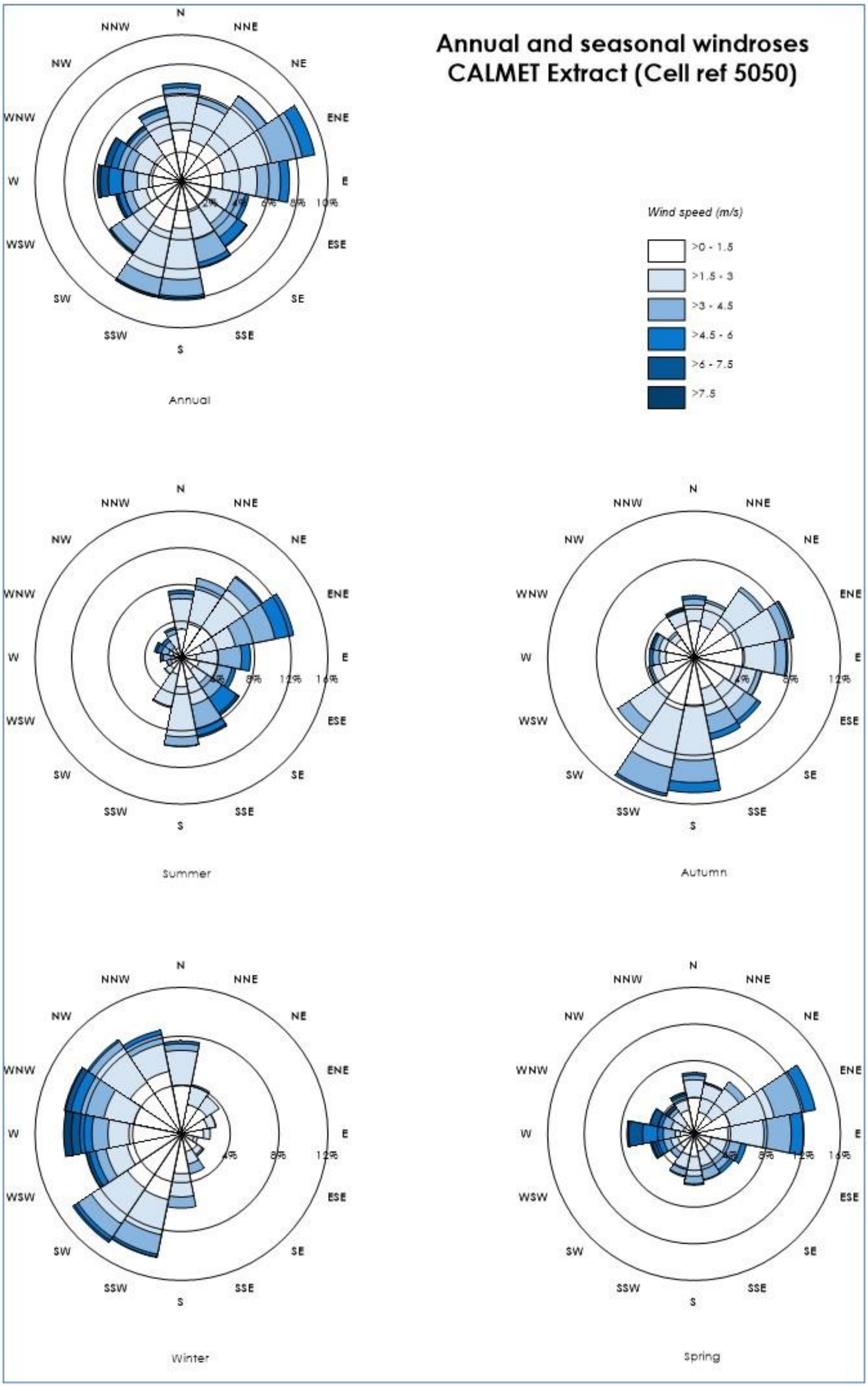

Figure 6-2: Annual and seasonal windroses from CALMET (Cell ref 5050)

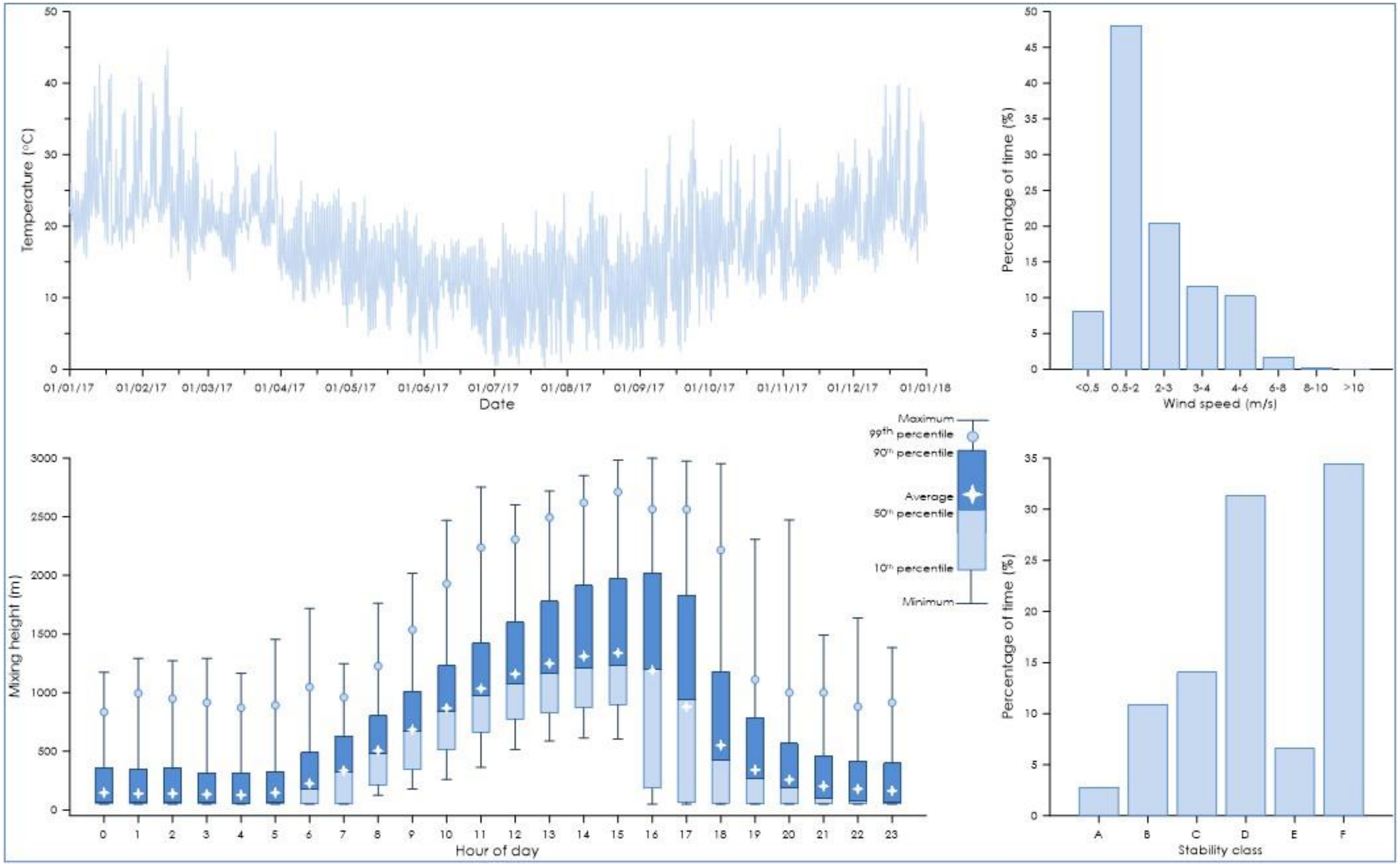

Figure 6-3: Meteorological analysis of CALMET (Cell Ref 5050)

6.3 Dispersion modelling

Dust 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.

6.4 Modelling scenario

The assessment considers one indicative quarry plan year (scenario) to represent the potential worst-case impacts in regard to the quantity of material extracted and handled in each year, the location of the activity and the potential to generate dust at the receptor locations.

The scenario selected for the assessment is based on the Year 6-10 quarry plan to represent the locations of the activities that will generate maximum dust at the nearest receptor locations coupled with the Year 4 extraction rate to represent the maximum amount of material handled annually during the life of the quarry. During this scenario extraction occurs in the southeastern most point of the extraction area closest to the nearest receptor locations with overburden material emplaced behind the progression of the quarry. The extraction rate is relatively constant throughout the life of the quarry with the maximum material handling occurring in Year 4.

Indicative locations for the respective scenario are presented in **Figure 6-4**.

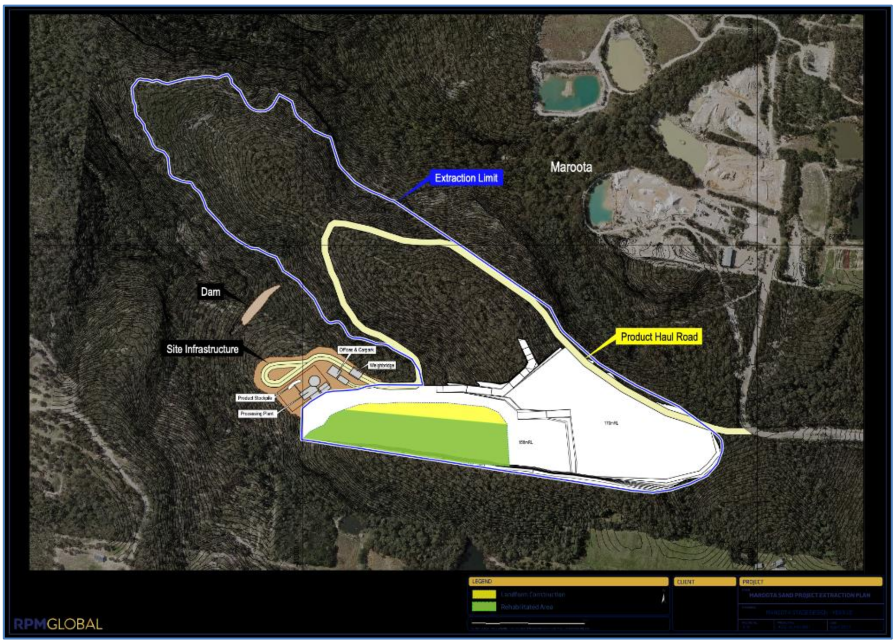

Figure 6-4: Modelling scenario

6.5 Emission estimation

The significant dust generating activities associated with operation of the Project are identified as the loading/unloading of material, vehicles travelling on-site and off-site, crushing and screening processes, and windblown dust from exposed areas and stockpiles. The 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.

The maximum production rate of 500,000tpa for the Project is applied in the emission estimates and is based on the maximum daily truck movements of 55 loads per day occurring over 48 weeks a year. To assess the maximum 24-hour impacts from the Project for trucks delivering material off-site, a maximum scenario of 1,736 tonnes per day (approx. 55 loads with 32 tonne payload) occurring for 7 days a week (365 days) has been applied. This results in an equivalent annual tonnage of 633,681tpa for the worst-case scenario for the activity of trucks delivering material off-site.

A summary of the estimated TSP, PM_{10} and $PM_{2.5}$ emissions is presented in **Table 6-2**. Detailed calculations of the dust emission estimates are provided in **Appendix C**.

Table 6-2: Summary of estimated dust emissions for the Project (kg/yr)

Activity	TSP emission	PM_{10} emission	$PM_{2.5}$ emission
Topsoil removal with a dozer	19	5	2
Loading topsoil to truck	0.05	0.02	0.004
Hauling topsoil to stockpile	1	0.2	0.02
Unloading topsoil to stockpile	0.05	0.02	0.004
Loading waste material to haul truck	77	37	6
Hauling waste material to emplacement area	1,077	275	27
Unloading waste material at emplacement area	77	37	6
Dozer working on waste material	30,429	7,110	3,195
Loading sandstone material to haul truck	447	211	32
Hauling material to processing plant	12,797	3,261	326
Loading material to hopper	447	211	32
Crushing	333	150	28
Screening	999	611	275
Unloading material to stockpile	402	190	29
Rehandle processed material	80	38	6
Loading processed material to truck	510	241	37
Hauling processed material offsite	36,890	9,402	940
Loading tailings material to truck	49	23	4
Hauling tailings to emplacement area	702	179	18
Unloading tailings at emplacement area	49	23	4
Wind erosion - exposed areas and stockpiles	4,517	2,258	339
Grading roads	13,874	4,847	430
Exhaust emissions	544	544	527
Total emissions	**104,321**	**29,653**	**6,261**

6.6 Emissions from other sand quarry operations

In addition to the emissions from the Project, emissions from nearby sand quarry operations would also contribute to the total background (residual) dust level. As the Maroota Public School TEOM is in the vicinity of nearby extractive industries, the TEOM measurements are inclusive of all operating sand quarries and as such provides sufficient data to represent the existing background levels for the Project. Therefore, modelling the surrounding quarries is not necessary for this assessment as the applied background levels are inclusive of the nearby sand quarry operations.

7 DISPERSION MODELLING RESULTS

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) during the one year long modelling period.

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

Table 7-1 presents the predicted incremental and cumulative particulate dispersion modelling results at each of the assessed residential receptor locations. 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 5.3.4**.

The predicted incremental results show that minimal incremental effects would arise at the receptor locations due to the Project. The predicted cumulative results indicate that all of the assessed receptors are predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

Table 7-1: Dust dispersion modelling results for residential receptors

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD* (g/m²/mth)
	Incremental						Cumulative			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
ED01	2.1	0.1	8.7	0.5	0.9	<0.1	7.1	13.4	47.3	0.6
FR01	1.2	0.1	5.0	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
FR02	1.2	0.1	4.9	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
FR03	1.1	0.1	4.5	0.4	0.8	<0.1	7.1	13.3	47.2	0.6
FR04	3.5	0.2	15.8	1.0	2.1	<0.1	7.2	13.9	48.5	0.7
FR05	1.8	0.1	8.4	0.6	1.2	<0.1	7.1	13.5	47.6	0.6
FR06	1.0	0.1	4.8	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
FR07	0.6	0.1	2.7	0.2	0.5	<0.1	7.1	13.1	46.9	0.6
FR08	0.6	0.1	2.8	0.2	0.5	<0.1	7.1	13.1	46.9	0.6
FR09	0.9	0.1	4.5	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
FR10	2.2	0.2	10.3	0.7	1.5	<0.1	7.2	13.6	47.9	0.7
R01	1.7	0.1	7.1	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R02	1.5	0.1	6.4	0.3	0.6	<0.1	7.1	13.2	47.0	0.6
R03	1.7	0.1	7.2	0.4	0.7	<0.1	7.1	13.3	47.1	0.6

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD* ($g/m^2/mth$)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD* ($g/m^2/mth$)
	Incremental						Cumulative			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R04	1.7	0.1	7.0	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R05	1.8	0.1	7.4	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R06	1.9	0.1	7.8	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R07	2.0	0.1	8.4	0.5	0.9	<0.1	7.1	13.4	47.3	0.6
R08	1.9	0.1	7.8	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R09	1.9	0.1	7.8	0.4	0.8	<0.1	7.1	13.3	47.2	0.6
R10	1.8	0.1	7.3	0.4	0.8	<0.1	7.1	13.3	47.2	0.6
R10-A	1.6	0.1	6.5	0.5	0.9	<0.1	7.1	13.4	47.3	0.6
R11	2.2	0.1	9.2	0.6	1.2	<0.1	7.1	13.5	47.6	0.6
R12	1.7	0.1	7.2	0.5	1.0	<0.1	7.1	13.4	47.4	0.6
R13	1.6	0.1	7.4	0.6	1.1	<0.1	7.1	13.5	47.5	0.6
R14	1.4	0.1	6.6	0.4	0.8	<0.1	7.1	13.3	47.2	0.6
R15	1.9	0.1	8.7	0.5	1.0	<0.1	7.1	13.4	47.4	0.6
R16	2.6	0.2	11.7	0.7	1.4	<0.1	7.2	13.6	47.8	0.6
R17	3.2	0.2	14.0	0.8	1.6	<0.1	7.2	13.7	48.0	0.6
R18	3.0	0.2	12.5	0.7	1.3	<0.1	7.2	13.6	47.7	0.6
R19	4.2	0.2	17.9	1.1	2.2	<0.1	7.2	14.0	48.6	0.7
R20	4.4	0.3	18.7	1.1	2.3	<0.1	7.3	14.0	48.7	0.7
R21	4.9	0.3	20.9	1.4	2.8	<0.1	7.3	14.3	49.2	0.7
R22	5.6	0.3	22.6	1.5	3.1	<0.1	7.3	14.4	49.5	0.7
R23	5.7	0.4	21.4	1.5	3.1	<0.1	7.4	14.4	49.5	0.7
R23A	5.0	0.3	18.5	1.4	2.8	<0.1	7.3	14.3	49.2	0.7
R24	4.5	0.3	17.0	1.2	2.4	<0.1	7.3	14.1	48.8	0.6
R25	4.4	0.3	16.7	1.1	2.3	<0.1	7.3	14.0	48.7	0.6
R25A	3.5	0.2	13.1	0.9	1.7	<0.1	7.2	13.8	48.1	0.6
R26	2.1	0.1	8.3	0.5	0.9	<0.1	7.1	13.4	47.3	0.6
R27	3.0	0.2	11.5	0.8	1.5	<0.1	7.2	13.7	47.9	0.6
R28	4.7	0.4	17.1	1.4	2.9	<0.1	7.4	14.3	49.3	0.7
R29	5.3	0.5	19.5	1.8	3.8	<0.1	7.5	14.7	50.2	0.7
R30	4.5	0.4	16.3	1.6	3.3	<0.1	7.4	14.5	49.7	0.7
R31	3.6	0.3	13.5	1.2	2.4	<0.1	7.3	14.1	48.8	0.7
R32	4.4	0.4	16.4	1.6	3.3	<0.1	7.4	14.5	49.7	0.7
R33	2.2	0.2	8.8	0.7	1.3	<0.1	7.2	13.6	47.7	0.6
R34	2.3	0.2	9.6	0.8	1.7	<0.1	7.2	13.7	48.1	0.6
R35	2.1	0.2	7.8	0.7	1.3	<0.1	7.2	13.6	47.7	0.6
R36	1.3	0.1	5.5	0.4	0.8	<0.1	7.1	13.3	47.2	0.6
R37	1.2	0.1	4.9	0.4	0.8	<0.1	7.1	13.3	47.2	0.6
R37A	1.2	0.1	4.8	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R38	1.2	0.1	5.0	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R39	1.2	0.1	4.9	0.4	0.7	<0.1	7.1	13.3	47.1	0.6
R40	1.2	0.1	5.0	0.3	0.6	<0.1	7.1	13.2	47.0	0.6
R41	0.7	0.1	3.3	0.3	0.6	<0.1	7.1	13.2	47.0	0.6
R42	0.9	0.1	4.3	0.3	0.6	<0.1	7.1	13.2	47.0	0.6

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD* (g/m²/mth)
	Incremental						Cumulative			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R43	0.8	0.1	3.8	0.3	0.5	<0.1	7.1	13.2	46.9	0.6
R44	0.6	0.1	2.5	0.2	0.4	<0.1	7.1	13.1	46.8	0.6
R44A	0.4	<0.1	1.8	0.2	0.4	<0.1	7.0	13.1	46.8	0.6

*Deposited dust

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

The results for incremental 24-hour average $PM_{2.5}$ and PM_{10} concentrations indicate there are no predicted exceedances of the relevant criteria at the receptors for the assessed scenario.

When assessing the total (cumulative) 24-hour average impacts based on model predictions an assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA**, **2017**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts for $PM_{2.5}$ and PM_{10}.In simple terms, the Level 2 assessment involves matching one year of ambient air quality monitoring data with meteorological data representing the same period.

Table 7-2 provides a summary of the findings from the Level 2 assessment for the nearest residential receptors (FR04, FR10, R21, R22, R23 and R29) for both $PM_{2.5}$ and PM_{10}. The results in **Table 7-2** indicate that the Project does not increase the number of days above the 24-hour average criterion at the assessed receptors for $PM_{2.5}$ and PM_{10}. Based on this result it can be inferred that the Project does not increase the number of days above the 24-hour average $PM_{2.5}$ and PM_{10} criterion at any of the receptor locations surrounding the Project.

Detailed tables of the contemporaneous assessment results are provided in **Appendix E**.

Table 7-2: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
FR04	0	0
FR10	0	0
R21	0	0
R22	0	0
R23	0	0
R29	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for the Receptors FR04 and R21 are presented in **Figure 7-3** to **Figure 7-2**.

The orange bars in the figures represent the contribution from the Project and the blue bars represent the applied background levels. It is clear from the figures that the Project has a small influence at the assessed receptor locations and in most cases would be difficult to discern beyond the existing background level.

It is to be noted that days with missing background data for $PM_{2.5}$ and PM_{10} have been substituted with the 70th percentile of the background monitoring data for 2017 calendar period.

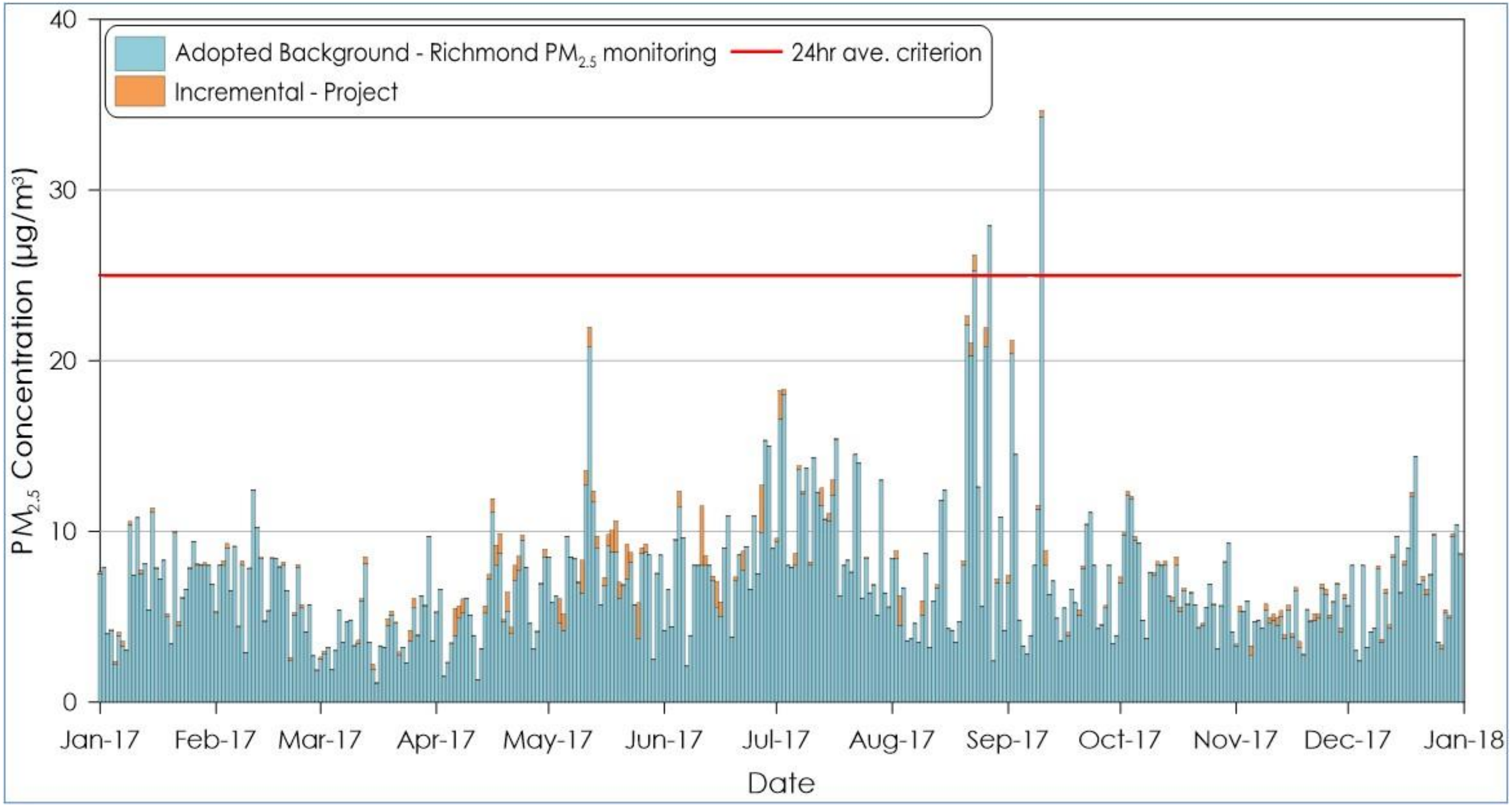

Figure 7-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for FR04

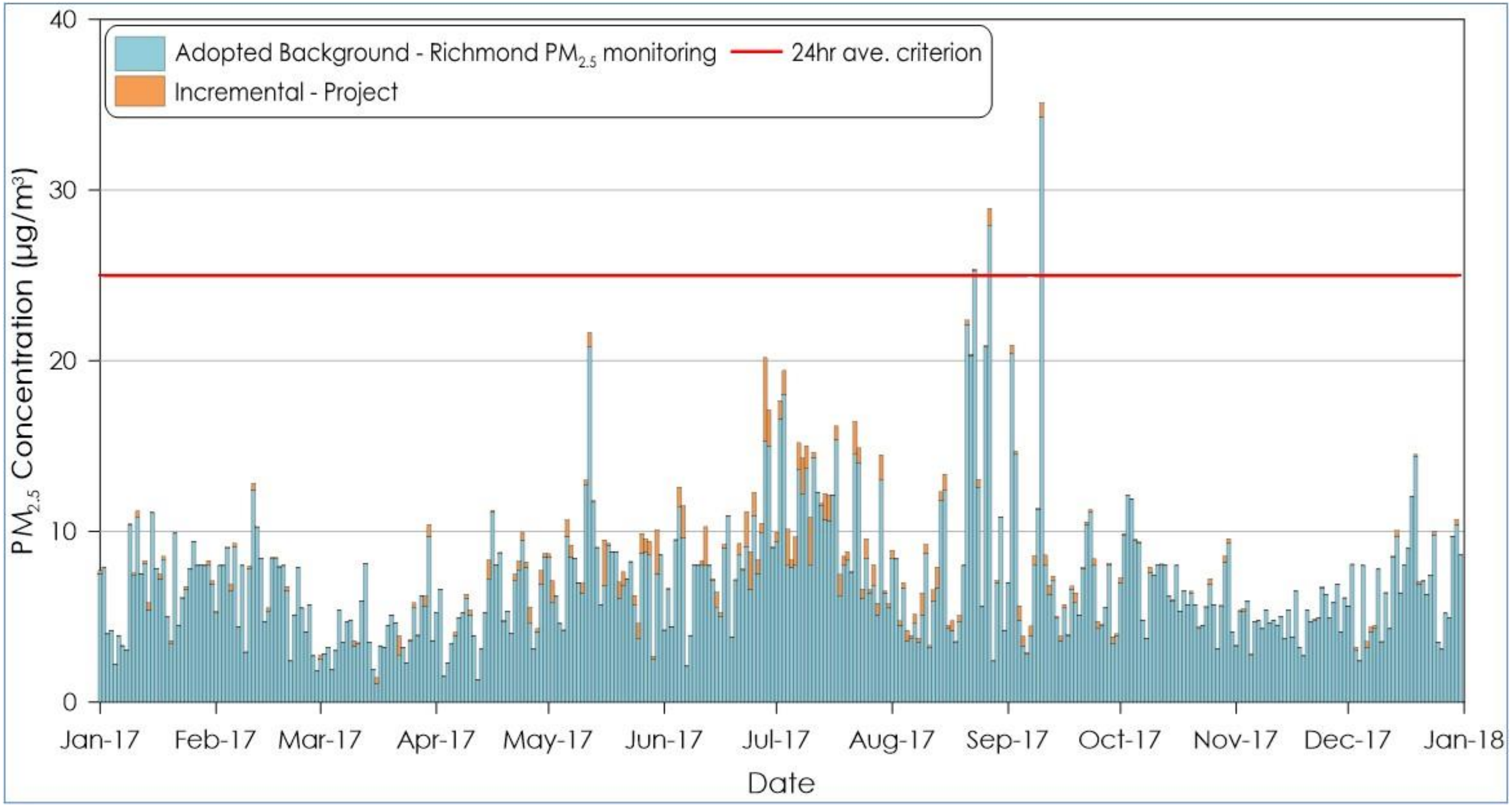

Figure 7-2: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R21

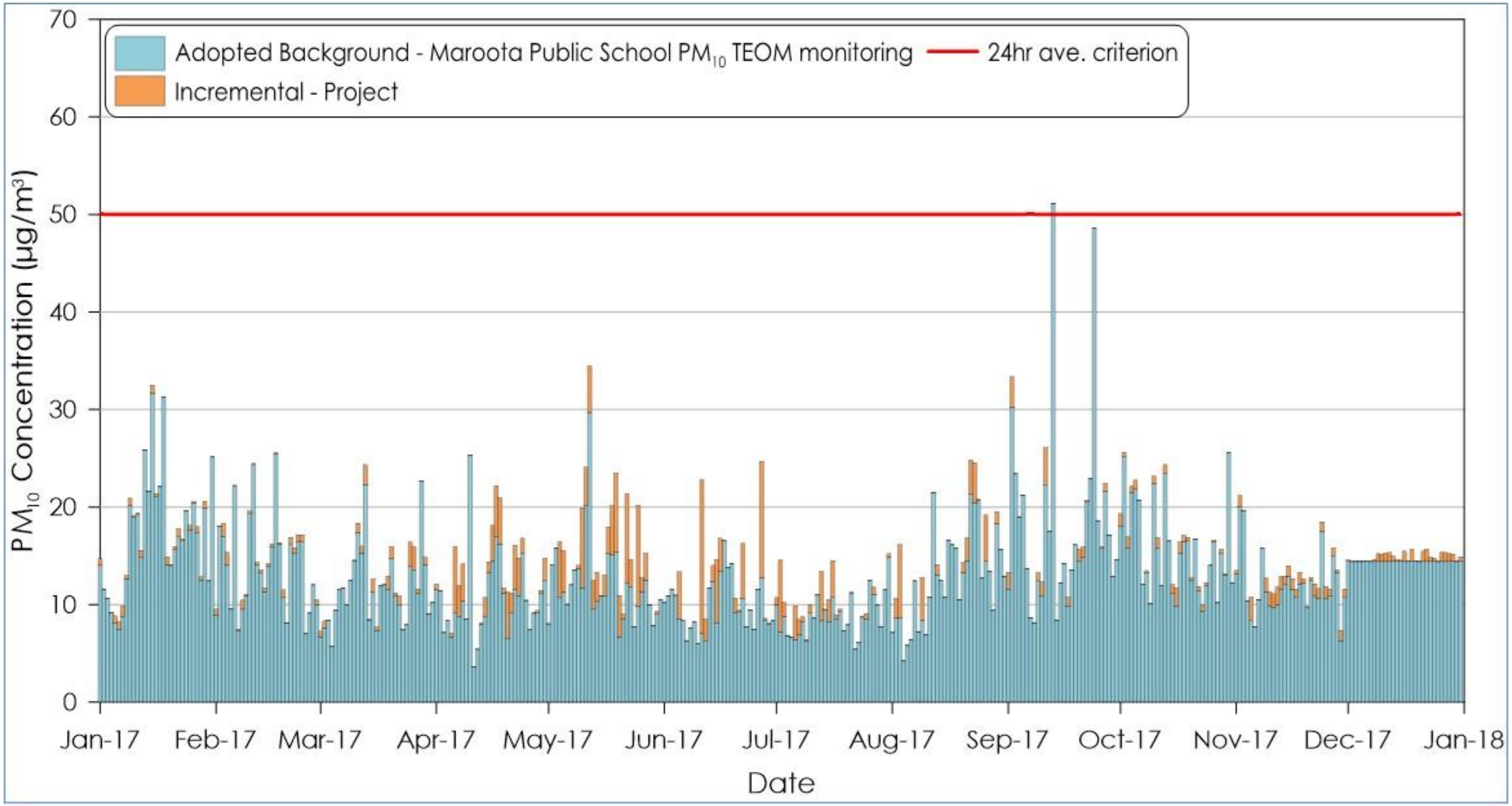

Figure 7-3: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for FR04

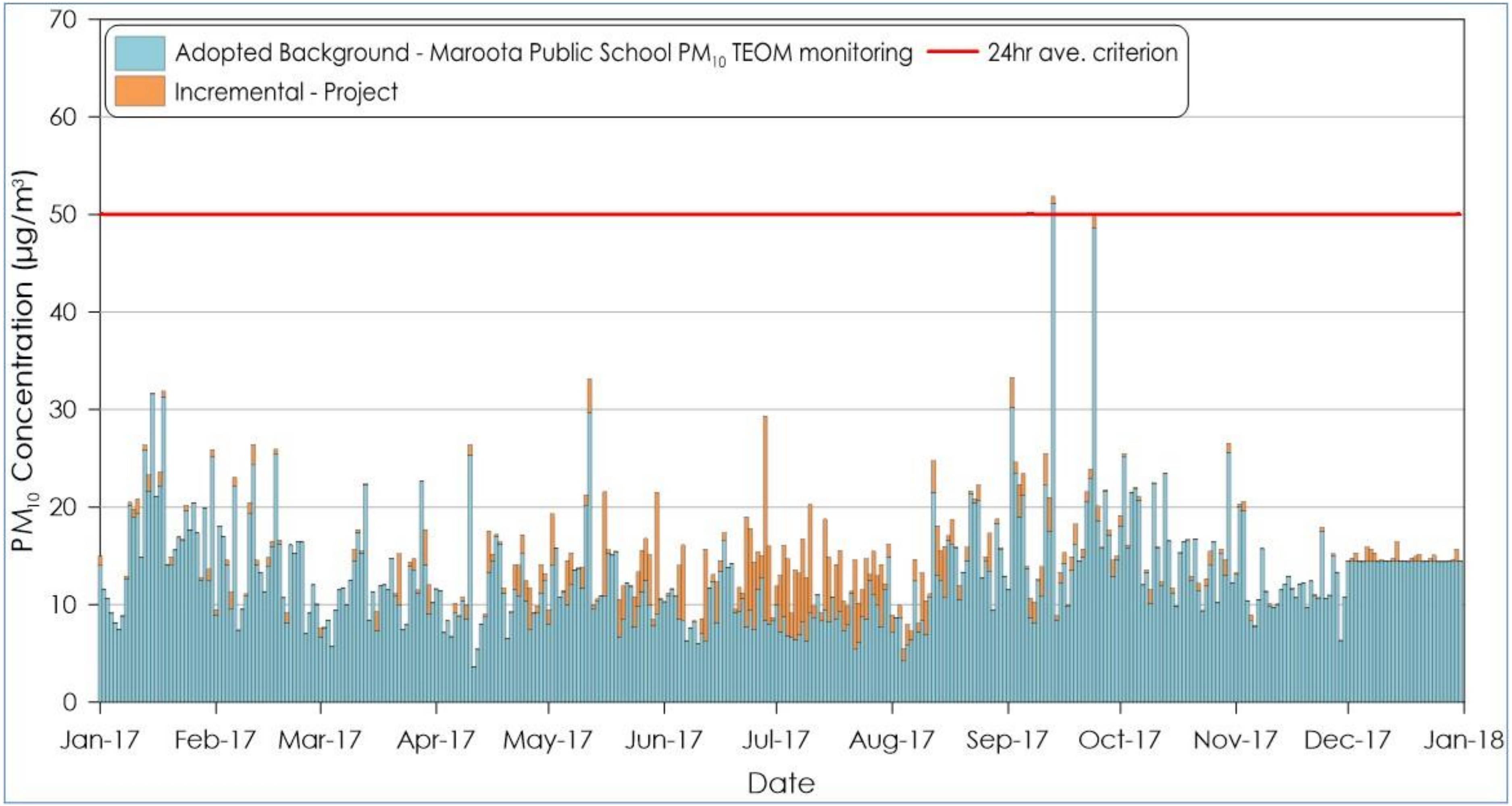

Figure 7-4: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R21

7.2 Assessment of impacts per VLAMP criteria

7.2.1 Summary of modelling predictions

The results in **Table 7-1** indicate the highest maximum predicted level at the assessed privately-owned receptors would be below the applicable VLAMP mitigation and acquisition criteria outlined in **Table 4-2** and **Table 4-3** respectively.

7.2.2 Dust impacts on privately-owned land

As required by the VLAMP, the potential impacts due to the Project, extending over more than 25% of any privately-owned land, have been evaluated using the predicted pollutant dispersion contours.

The results at the criteria level concentrations show the maximum 24-hour average PM_{10} predictions would have the most spatial extent, relative to any of the other assessed dust metrics and hence 24-hour average PM_{10} represents the most impacting parameter.

Based on the isopleth diagrams in **Appendix D**, the extent of the predicted maximum 24-hour average PM_{10} level of 50µg/m^3 would not extend over more than 25% of any privately-owned land parcels as a result of the Project, and as such the Project would not exceed this criterion.

7.3 Respirable crystalline silica

The assessment results show that the most affected residential receptor (R29) has a total maximum predicted incremental annual average $PM_{2.5}$ concentration level of less than 0.5µg/m^3. This level is due to the total dust from the site, and only a small portion of this dust would contain silica.

As the total level is over 6 times below the applicable VIC EPA criteria of 3µg/m^3 for respirable crystalline silica, the actual level from the Project would be significantly below the criteria and thus, the Project would not result in an unacceptable level of respirable crystalline silica in the ambient air at residential receptors.

8 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 residential receptor locations, it is recommended that all reasonable and practicable dust mitigation measures be utilised.

Suggested reasonable and practicable dust mitigation measures for the Project are listed in **Table 8-1**.

Table 8-1: Potential operational dust mitigation measures

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.
	Grassing of constructed landforms
Material handling	Reduce drop heights from loading and handling equipment where practical.
	Dampen material when excessively dusty during handling.
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.
	Regularly inspect haul roads and maintain surfaces to remove potholes or depressions
	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.
	Wheel wash for vehicles leaving the site.

9 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the proposed operations of sand extraction at the Maroota Sand 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 assessed 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 residential receptors in the surrounding environment.

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NSW OEH (2017)

"NSW Air Quality Statement 2016", prepared by NSW Office of Environment and Heritage, 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.

VIC EPA (2007)

"Protocol for Environmental Management – State Environment Protection Policy (Air Quality Management) – Mining and Extractive Industries", EPA Victoria, 40 City Road, Southbank, Victoria 3006.

US EPA (1985 and update)

"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

Sensitive Receptor Locations

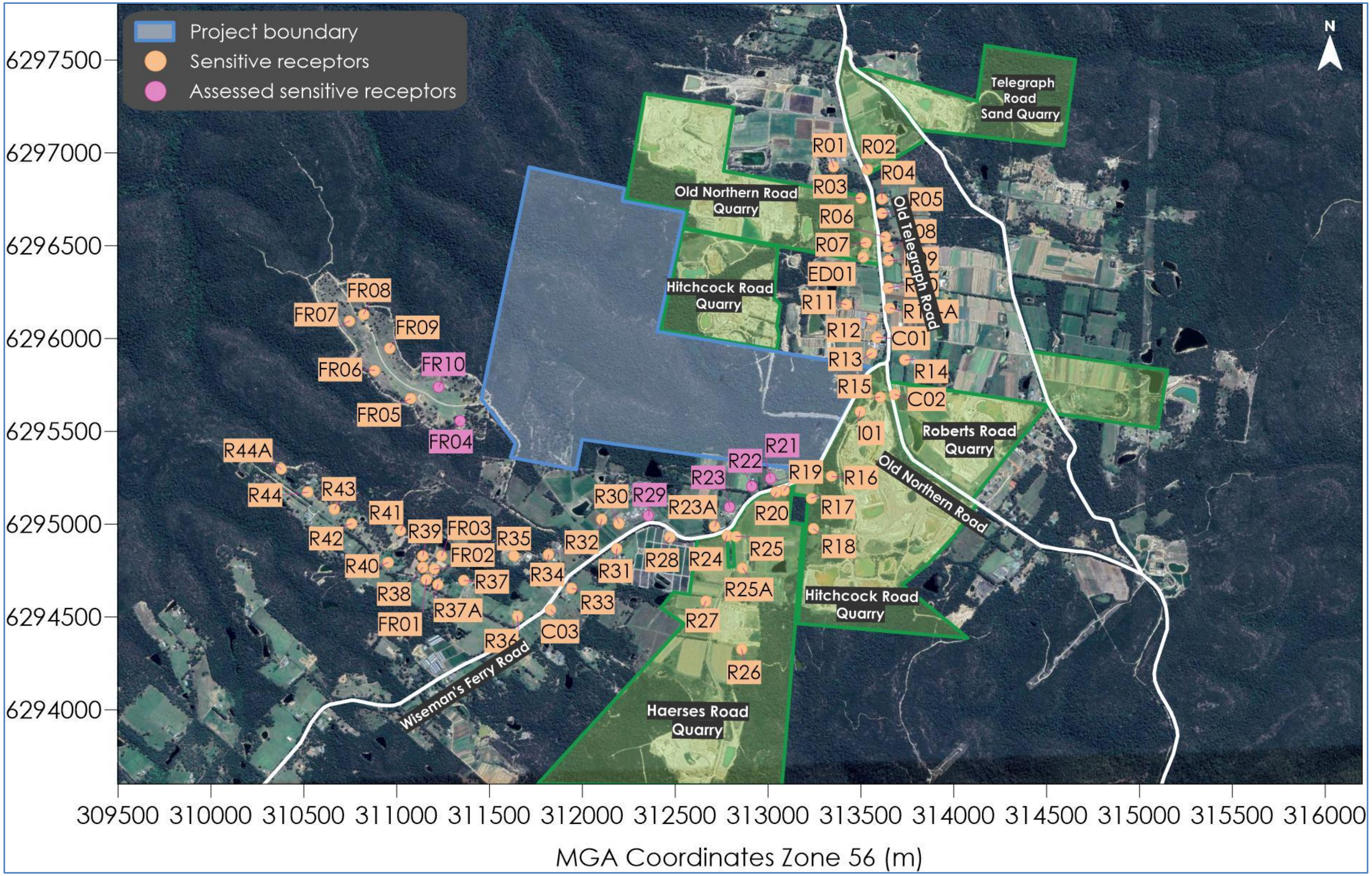

Figure A-1: Location of sensitive receptors assessed in this study

Table A-1: List of sensitive receptors assessed in this study

ID	Easting	Northing	Description	ID	Easting	Northing	Description
C01	313584	6296006	Commercial	R17	313232	6295140	Residential
C02	313683	6295700	Commercial	R18	313244	6294975	Residential
C03	311830	6294539	Commercial	R19	313085	6295179	Residential
ED01	313513	6296439	Educational	R20	313045	6295172	Residential
FR01	311161	6294703	Future Receiver	R21	313013	6295246	Residential
FR02	311201	6294758	Future Receiver	R22	312914	6295206	Residential
FR03	311242	6294828	Future Receiver	R23	312794	6295092	Residential
FR04	311340	6295556	Future Receiver	R23A	312712	6294986	Residential
FR05	311075	6295675	Future Receiver	R24	312779	6294937	Residential
FR06	310882	6295829	Future Receiver	R25	312827	6294935	Residential
FR07	310747	6296095	Future Receiver	R25A	312863	6294765	Residential
FR08	310822	6296131	Future Receiver	R26	312858	6294327	Residential
FR09	310964	6295948	Future Receiver	R27	312666	6294586	Residential
FR10	311227	6295739	Future Receiver	R28	312471	6294930	Residential
I01	313495	6295608	Industrial	R29	312356	6295046	Residential
R01	313355	6296925	Residential	R30	312198	6295004	Residential
R02	313535	6296910	Residential	R31	312187	6294869	Residential
R03	313498	6296757	Residential	R32	312104	6295026	Residential
R04	313614	6296750	Residential	R33	311943	6294655	Residential
R05	313613	6296675	Residential	R34	311818	6294835	Residential
R06	313630	6296546	Residential	R35	311631	6294830	Residential
R07	313526	6296516	Residential	R36	311649	6294506	Residential
R08	313647	6296494	Residential	R37	311362	6294697	Residential
R09	313648	6296418	Residential	R37A	311223	6294675	Residential
R10	313646	6296271	Residential	R38	311140	6294768	Residential
R10-A	313656	6296165	Residential	R39	311141	6294830	Residential
R11	313421	6296182	Residential	R40	310955	6294795	Residential
R12	313557	6296100	Residential	R41	311022	6294965	Residential
R13	313557	6295920	Residential	R42	310758	6295003	Residential
R14	313737	6295884	Residential	R43	310665	6295081	Residential
R15	313604	6295685	Residential	R44	310523	6295172	Residential
R16	313343	6295258	Residential	R44A	310378	6295295	Residential

Appendix B

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Richmond RAAF weather station, is presented in **Table B-1**.

The standard deviation of the latest five years of meteorological data spanning 2015 to 2019 was analysed against the available measured wind speed, wind direction, temperature and relative humidity. The analysis indicates that 2017 dataset is closest to the mean for wind speed, wind direction and relative humidity, while 2018 is closest for temperature. On the basis of a score weighting analysis, 2017 was found to be most representative.

Table B-1: Statistical analysis results for Richmond RAAF

Year	Wind speed	Wind direction	Temperature	Relative humidity
2015	1.46	0.18	0.25	0.47
2016	0.79	0.28	0.14	0.26
2017	0.38	0.11	0.20	0.17
2018	1.01	0.16	0.11	0.37
2019	0.91	0.24	0.16	0.33

Figure B-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2015 year compared with the mean of the 2015 to 2019 data set. The 2017 year data appear to be well aligned with the mean data.

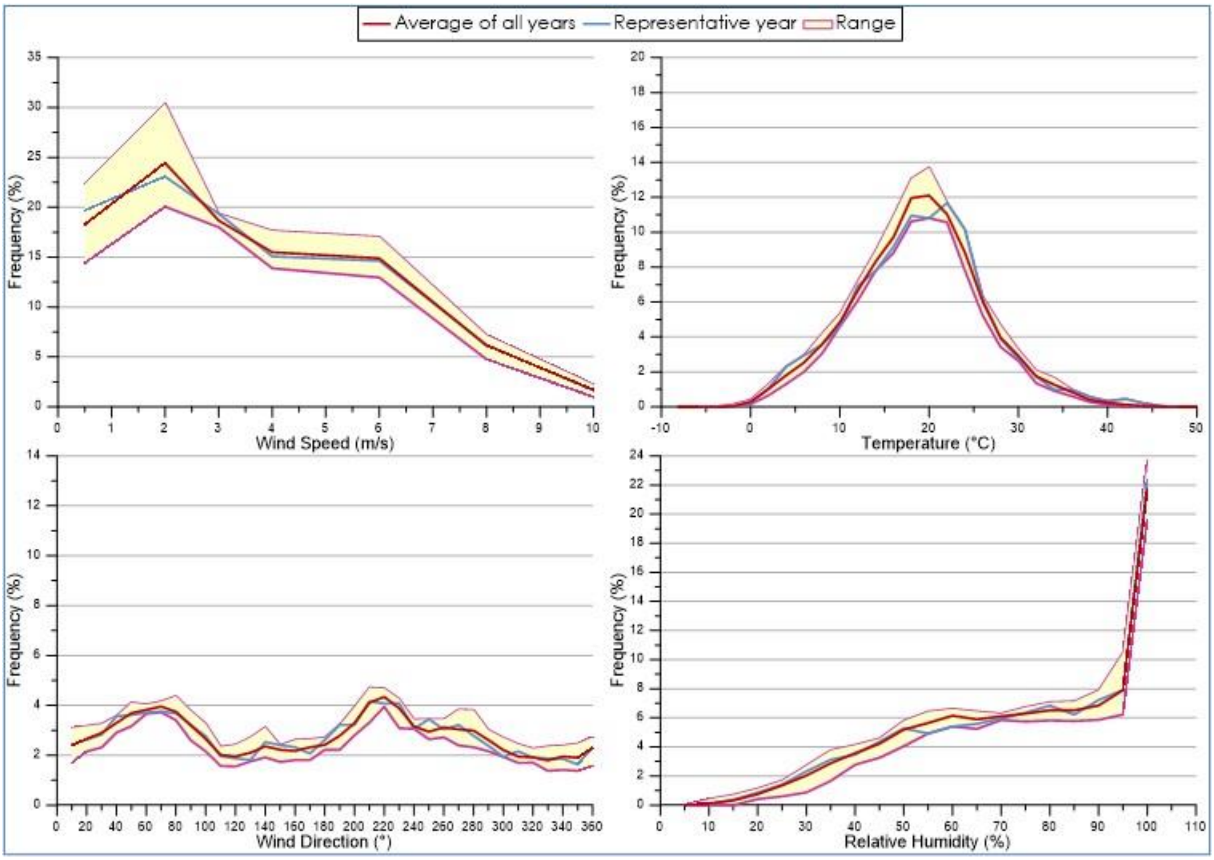

Figure B-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix C

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 and utilising suitable emission and load factors 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: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**NSW EPA, 2015**).

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

Control factors include the following:

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

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Table C-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	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$
Tertiary crushing (controlled)	0.0006	0.00027	0.00005
Fines screening (controlled)	$EF = 0.0018\, kg/tonne$	$EF = 0.0011\, kg/tonne$	$EF = 0.0005\, kg/tonne$
Dozers on overburden	$EF = 2.6 \times s^{1.2} / M^{1.3}\ kg/hr$	$EF = (0.45 \times s^{1.5} / M^{1.4}) \times 0.75\ kg/hr$	$EF = (2.6 \times s^{1.2} / M^{1.3}) \times 0.105\ kg/hr$
Grading roads	$EF = 0.0034 \times (S)^{2.5}$	$EF = 0.0056 \times (S)^{2} \times 0.6$	$EF = 0.0034 \times (S)^{2.5} \times 0.031$
Wind erosion on exposed areas, stockpiles	$EF = 850\, kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

A = horizontal area (m^2) with blasting depth ≤ 21m, EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), s.L. = silt loading (g/m^2), W = average weight of vehicle (tonne), VKT = vehicle kilometres travelled (km).

Table C-1: Dust Emissions Inventory

Activity	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Var. 1	Units	Var. 2	Units	Var. 3 - TSP	Var. 3 - PM10	Var. 3 - PM25	Units	Var. 4	Units	Var. 5	Units	Var. 6	Units
TS - Topsoil removal with a dozer	19	5	2	2	hr/yr	10.8	2.5	1.1	kg/h	10	S.C. %	2.8	M.C. %										
TS - Loading topsoil to truck	0.05	0.02	0.004	61	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
TS - Hauling topsoil to stockpile (unpaved)	1	0.2	0.02	61	t/yr	0.056	0.014	0.001	kg/t	32	t/load	0.8	km/return	2.3	0.6	0.1	kg/VKT	4.8	S.C. %	35	Ave weight (tonnes)	80	% C
TS - Unloading topsoil to stockpile	0.05	0.02	0.004	61	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
OB - Loading waste material to haul truck	77	37	6	96,000	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
OB - Hauling waste material to emplacement area (unpaved)	1,077	275	27	96,000	t/yr	0.056	0.014	0.001	kg/t	32	t/load	0.8	km/return	2.3	0.6	0.1	kg/VKT	4.8	S.C. %	35	Ave weight (tonnes)	80	% C
OB - Unloading waste material at emplacement area	77	37	6	96,000	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
OB - Dozer working on waste material	30,429	7,110	3,195	2816	hr/yr	10.8	2.52	1.13	kg/h	10	S.C. %	2.8	M.C. %										
Sand - Loading sandstone material to haul truck	447	211	32	555,000	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
Sand - Hauling material to processing plant (unpaved)	12,797	3,261	326	555,000	t/yr	0.115	0.029	0.003	kg/t	32	t/load	1.6	km/return	2.3	0.6	0.1	kg/VKT	4.8	S.C. %	35	Ave weight (tonnes)	80	% C
Sand - Loading material to hopper	447	211	32	555,000	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
Sand - Crushing	333	150	28	555,000	t/yr	0.00060	0.00027	0.00005	kg/t														
Sand - Screening	999	611	275	555,000	t/yr	0.0018	0.0011	0.0005	kg/t														
Sand - Unloading material to stockpile	402	190	29	500,000	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
Sand - Rehandle processed material	80	38	6	100,000	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
Sand - Loading processed material to truck	510	241	37	633,681	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
Sand - Hauling processed material offsite (unpaved)	36,890	9,402	940	633,681	t/yr	0.291	0.074	0.007	kg/t	32.0	t/load	4.0	km/return	2.3	0.6	0.1	kg/VKT	4.8	S.C. %	35	Ave weight (tonnes)	80	% C
T - Loading tailings material to truck	49	23	4	61,050	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
T - Hauling tailings to emplacement area	702	179	18	61,050	t/yr	0.058	0.015	0.001	kg/t	32.0	t/load	0.8	km/return	2.3	0.6	0.1	kg/VKT	4.8	S.C. %	35	Ave weight (tonnes)	80	% C
T - Unloading tailings at emplacement area	49	23	4	61,050	t/yr	0.00080	0.00038	0.00006	kg/t	1.09	ave. wind speed (m/s)	2.8	M.C. %										
Wind erosion - exposed areas and stockpiles	4,517	2,258	339	10.6	ha	850	425	64	kg/ha/year													50	% C
Grading roads	13,874	4,847	430	22,542	km/yr	0.62	0.22	0.02	kg/VKT	8	speed of graders (km/h)												
Exhaust emissions	544	544	527																				
Total TSP emissions (kg/yr.)	**104,321**	**29,653**	**6,261**																				

Appendix D

Isopleth Diagrams

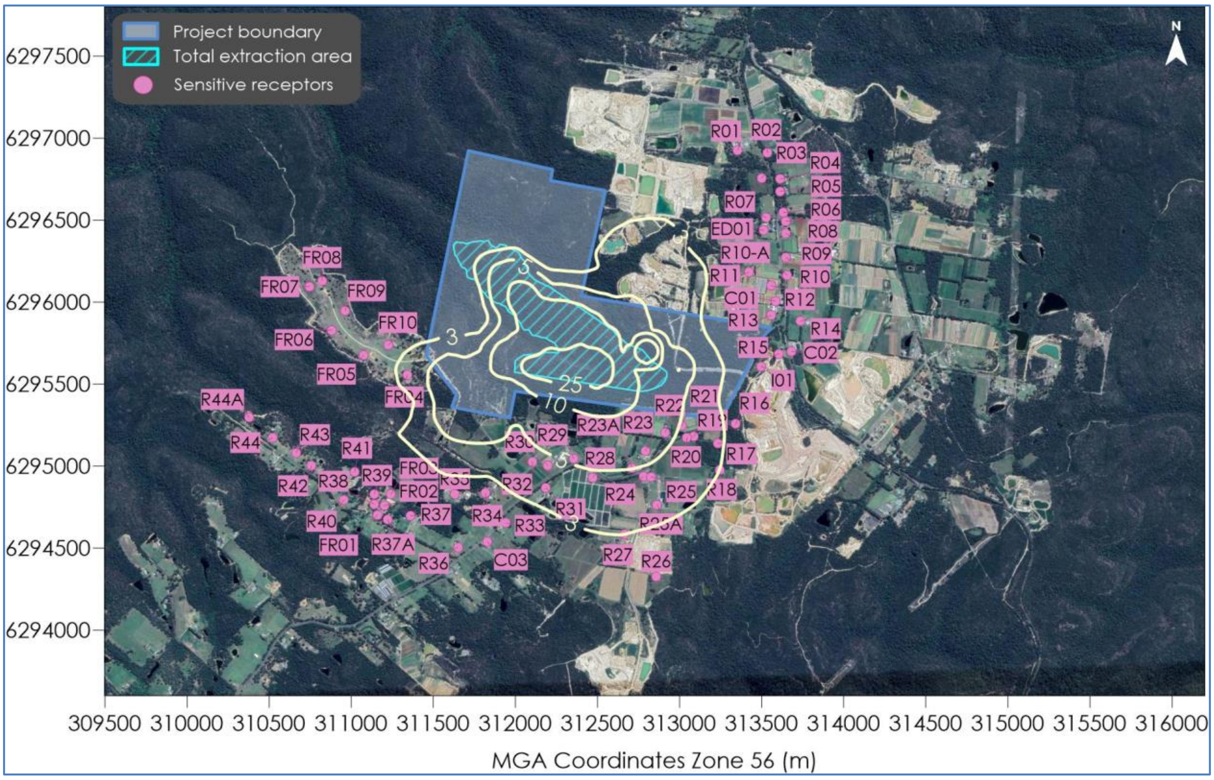

Figure D-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

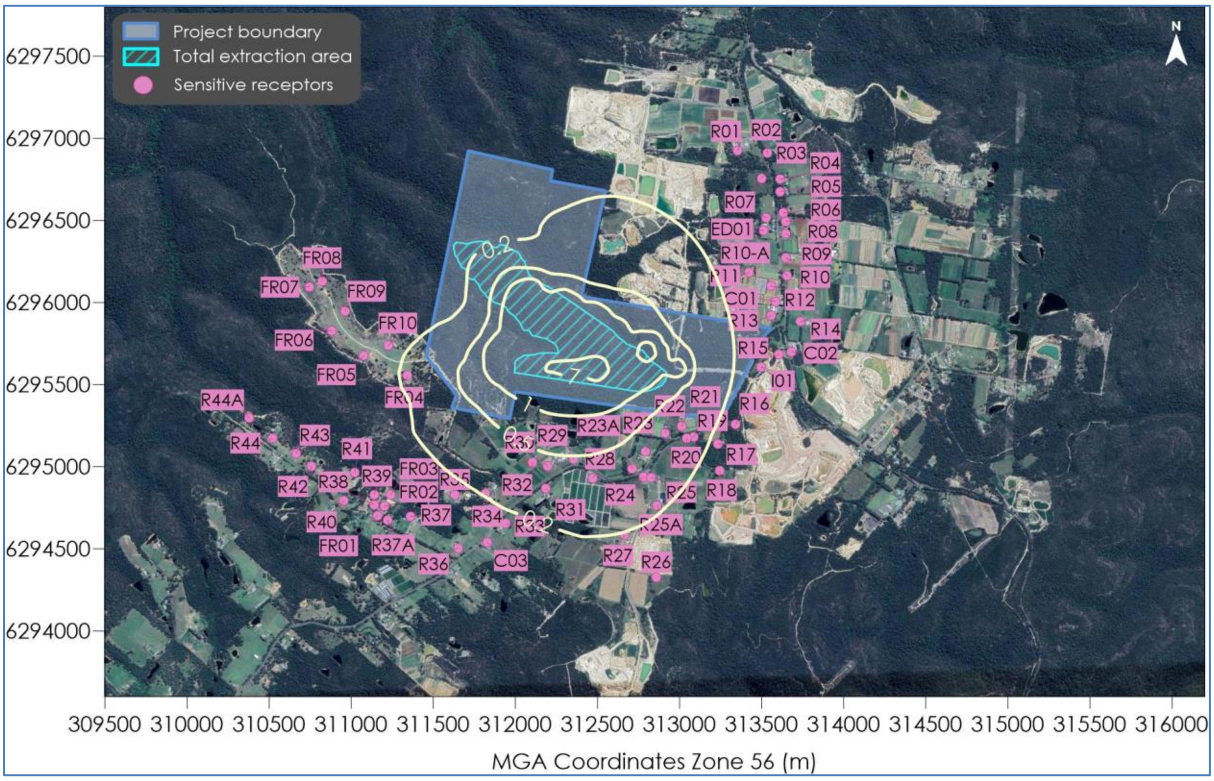

Figure D-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

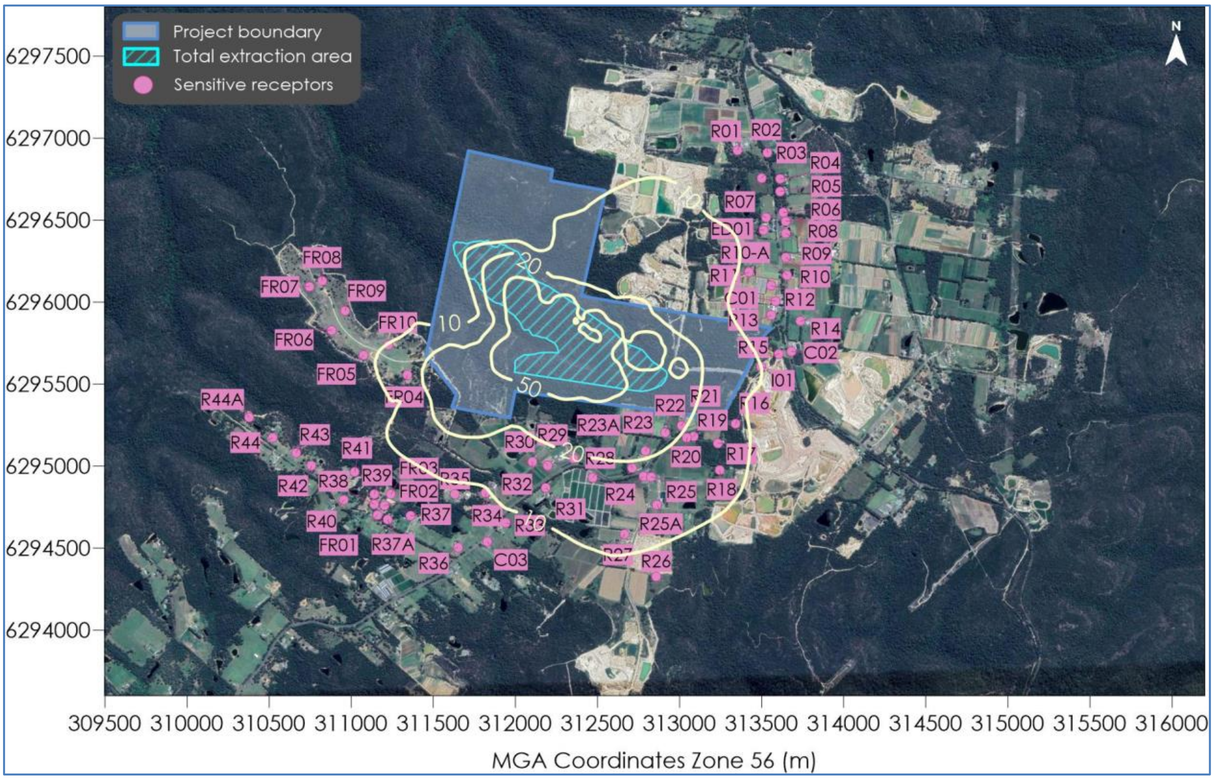

Figure D-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

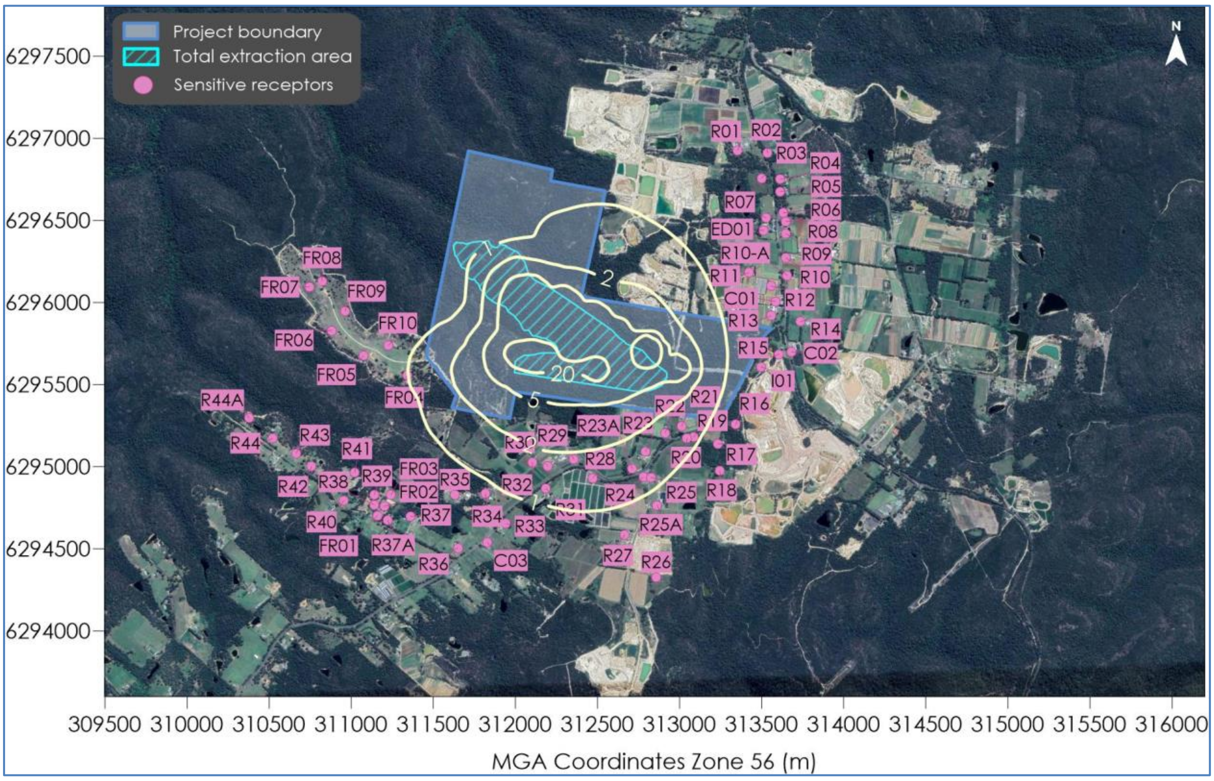

Figure D-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

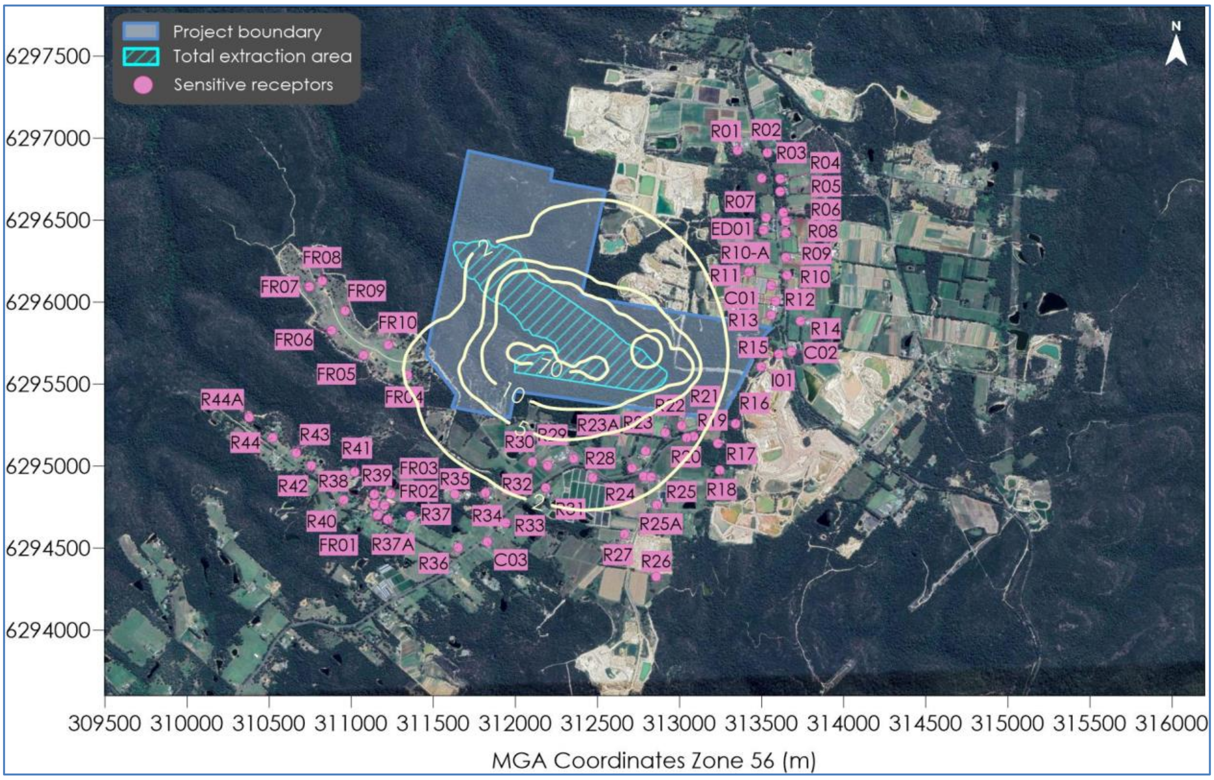

Figure D-5: Predicted incremental annual average TSP concentrations (µg/m³)

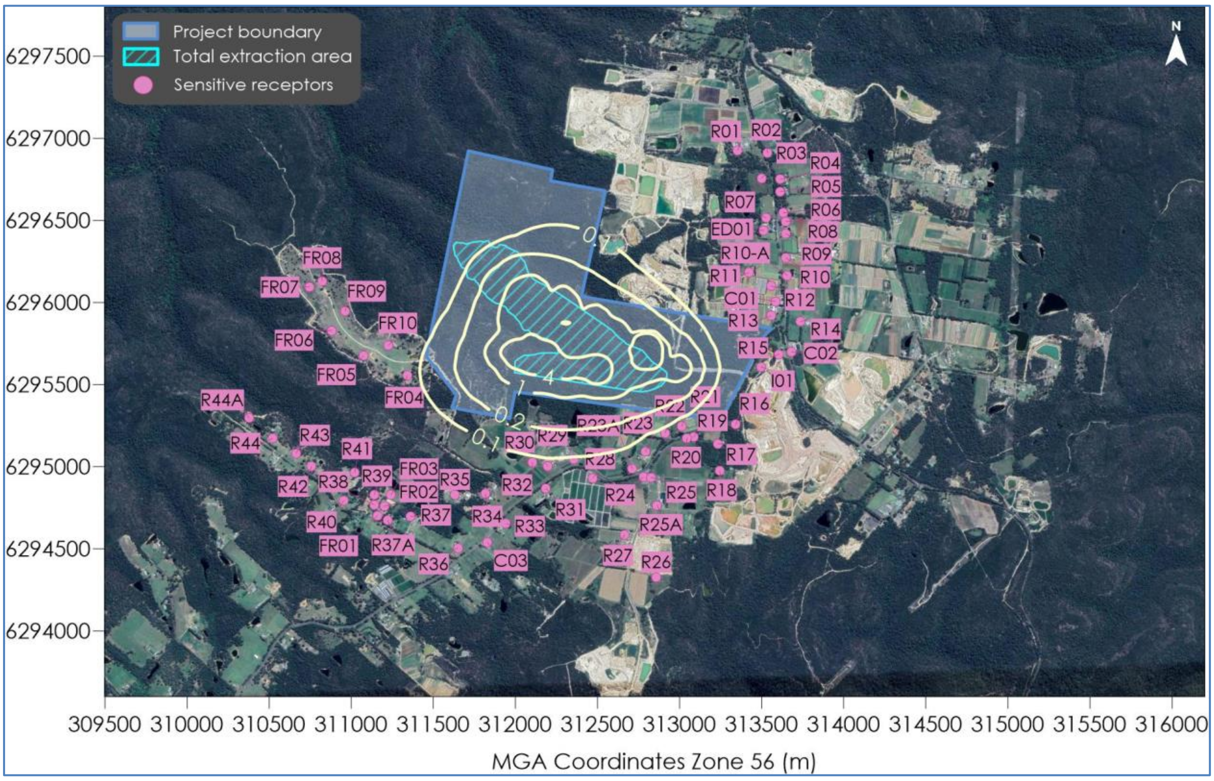

Figure D-6: Predicted incremental annual average dust deposition levels (g/m²/month)

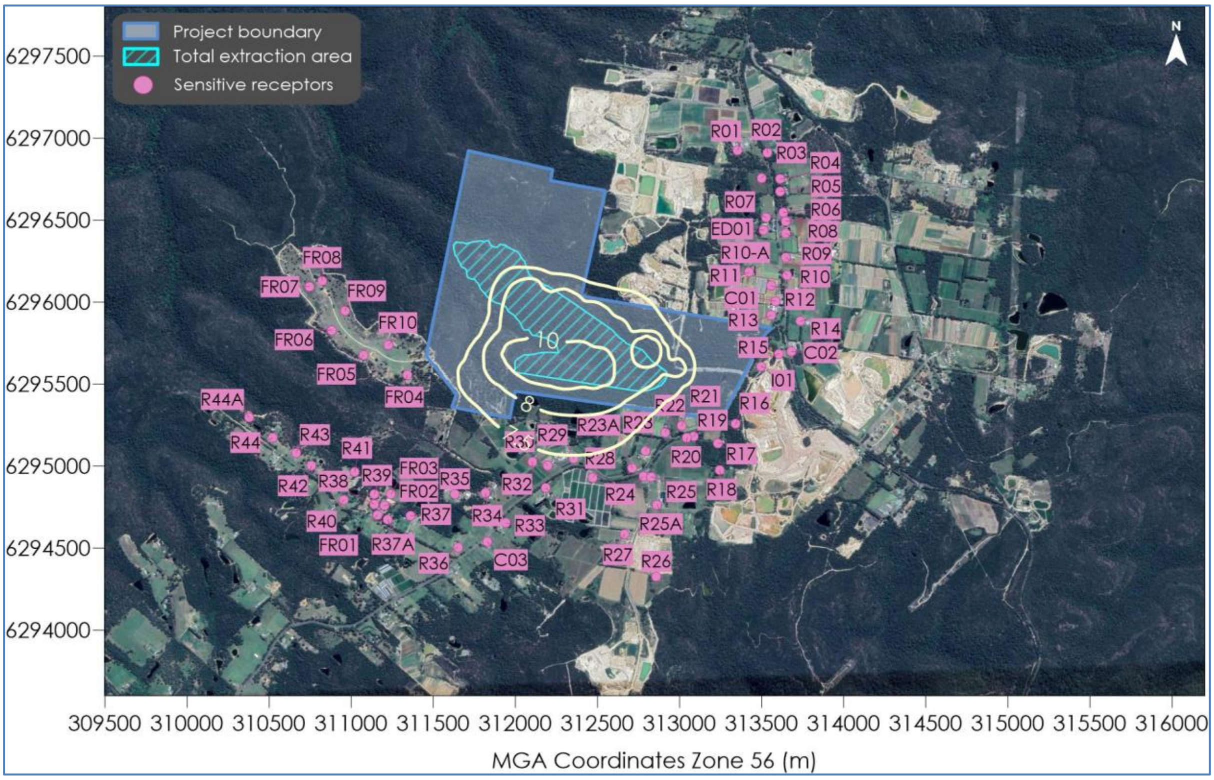

Figure D-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

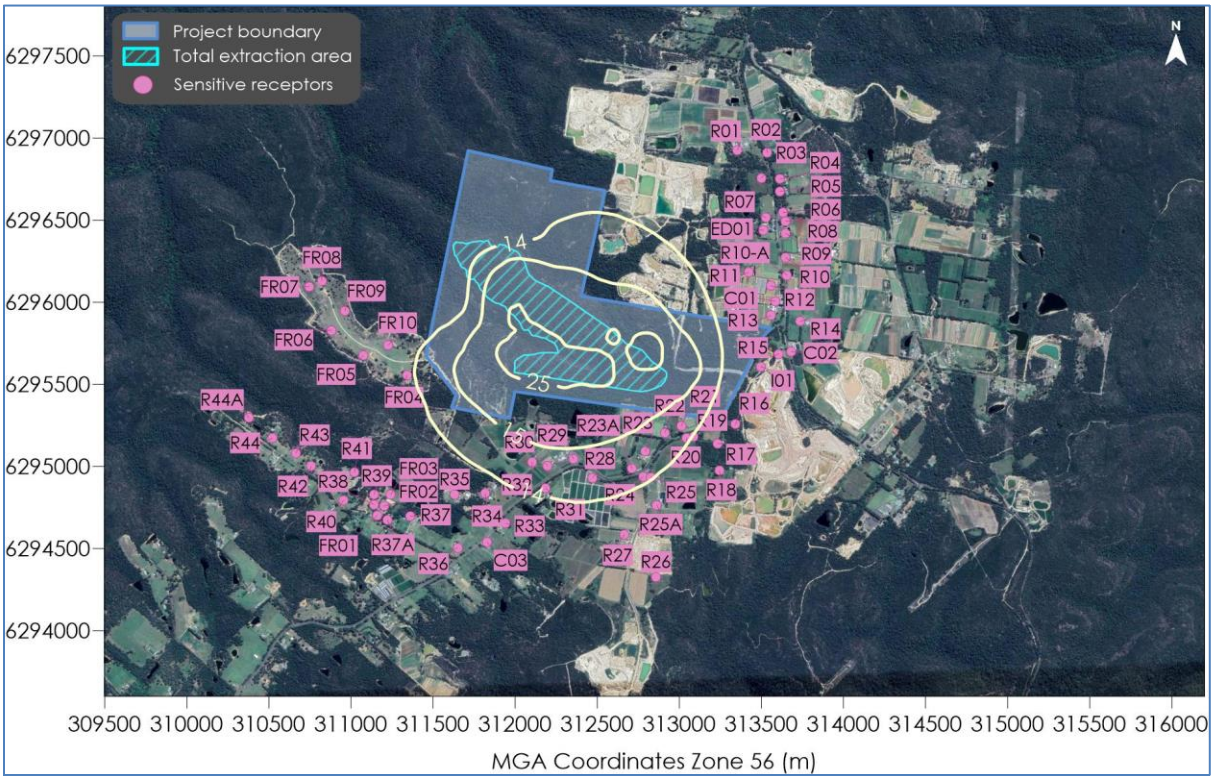

Figure D-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

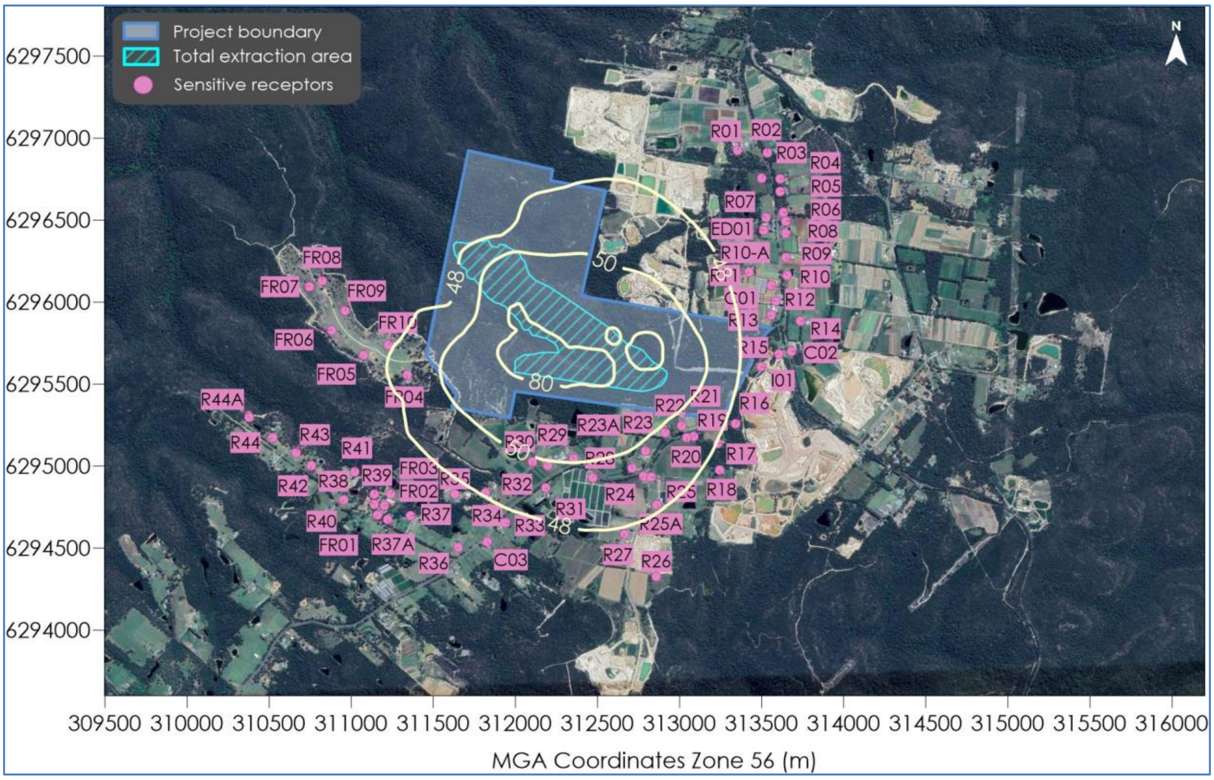

Figure D-9: Predicted cumulative annual average TSP concentrations (µg/m³)

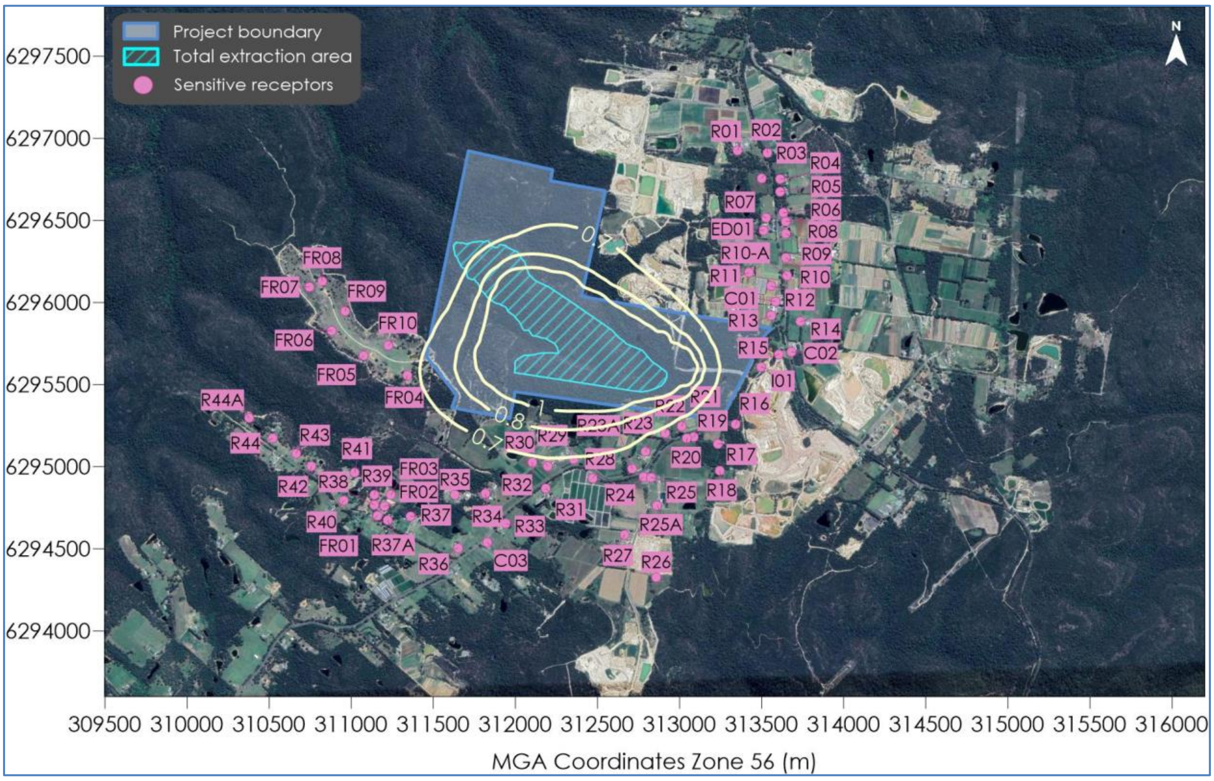

Figure D-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

Appendix E

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 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 the Richmond monitoring station for $PM_{2.5}$ or the Maroota Public School TEOM monitoring station for 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.

Table E-1 to **Table E-12** assesses selected receptors FR04, FR10, R21, R22, R23 and R29 and shows the predicted maximum cumulative levels at the selected receptors. 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.**

Table E-1: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor FR04

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
10/09/2017	**34.3**	0.4	**34.7**				
27/08/2017	**27.9**	0.0	**27.9**				
23/08/2017	**25.3**	0.9	**26.2**				
21/08/2017	22.1	0.5	22.6	11/06/2017	8.0	3.5	11.5
12/05/2017	20.8	1.2	22.0	27/06/2017	9.9	2.8	12.7
26/08/2017	20.8	1.1	21.9	25/05/2017	3.7	2.1	5.8
2/09/2017	20.4	0.8	21.2	22/05/2017	7.2	2.0	9.2
22/08/2017	20.3	0.7	21.0	10/05/2017	6.4	1.9	8.3
3/07/2017	18.0	0.3	18.3	19/05/2017	8.8	1.8	10.6
2/07/2017	16.6	1.6	18.2	3/08/2017	4.5	1.7	6.2
17/07/2017	15.4	0.1	15.5	2/07/2017	16.6	1.6	18.2
28/06/2017	15.3	0.0	15.3	6/04/2017	3.9	1.6	5.5
29/06/2017	15.0	0.0	15.0	15/06/2017	5.5	1.6	7.1

Table E-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor FR10

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
10/09/2017	**34.3**	0.2	**34.5**				
27/08/2017	**27.9**	0.0	**27.9**				
23/08/2017	**25.3**	0.7	**26.0**				
21/08/2017	22.1	0.3	22.4	11/06/2017	8.0	2.2	10.2
12/05/2017	20.8	1.0	21.8	27/06/2017	9.9	2.0	11.9
26/08/2017	20.8	0.6	21.4	4/05/2017	4.6	1.4	6.0
2/09/2017	20.4	0.9	21.3	10/05/2017	6.4	1.4	7.8
22/08/2017	20.3	0.3	20.6	18/05/2017	8.8	1.2	10.0
3/07/2017	18.0	0.2	18.2	15/06/2017	5.5	1.2	6.7
2/07/2017	16.6	0.8	17.4	22/05/2017	7.2	1.2	8.4
17/07/2017	15.4	0.0	15.4	6/04/2017	3.9	1.1	5.0
28/06/2017	15.3	0.0	15.3	19/05/2017	8.8	1.1	9.9
29/06/2017	15.0	0.0	15.0	18/04/2017	8.7	1.1	9.8

Table E-3: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R21

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
10/09/2017	34.3	0.8	35.1				
27/08/2017	27.9	1.0	28.9				
23/08/2017	25.3	0.1	25.4				
21/08/2017	22.1	0.3	22.4	28/06/2017	15.3	4.9	20.2
12/05/2017	20.8	0.8	21.6	10/07/2017	8.0	2.8	10.8
26/08/2017	20.8	0.1	20.9	16/05/2017	6.8	2.7	9.5
2/09/2017	20.4	0.5	20.9	30/05/2017	7.5	2.6	10.1
22/08/2017	20.3	0.1	20.4	12/06/2017	8.0	2.3	10.3
3/07/2017	18.0	1.4	19.4	24/06/2017	6.6	2.2	8.8
2/07/2017	16.6	1.0	17.6	4/07/2017	8.0	2.1	10.1
17/07/2017	15.4	0.8	16.2	29/06/2017	15.0	2.1	17.1
28/06/2017	15.3	4.9	20.2	8/07/2017	12.2	2.1	14.3
29/06/2017	15.0	2.1	17.1	23/06/2017	9.1	2.1	11.2

Table E-4: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R22

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
10/09/2017	34.3	0.7	35.0				
27/08/2017	27.9	1.1	29.0				
23/08/2017	25.3	0.1	25.4				
21/08/2017	22.1	0.3	22.4	28/06/2017	15.3	5.6	20.9
12/05/2017	20.8	1.0	21.8	10/07/2017	8.0	3.1	11.1
26/08/2017	20.8	0.1	20.9	30/05/2017	7.5	3.0	10.5
2/09/2017	20.4	0.7	21.1	23/06/2017	9.1	2.9	12.0
22/08/2017	20.3	0.1	20.4	16/05/2017	6.8	2.7	9.5
3/07/2017	18.0	1.8	19.8	22/07/2017	14.5	2.7	17.2
2/07/2017	16.6	1.4	18.0	12/06/2017	8.0	2.6	10.6
17/07/2017	15.4	1.1	16.5	8/07/2017	12.2	2.4	14.6
28/06/2017	15.3	5.6	20.9	6/06/2017	9.6	2.3	11.9
29/06/2017	15.0	1.8	16.8	24/06/2017	6.6	2.3	8.9

Table E-5: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R23

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
10/09/2017	34.3	0.4	34.7				
27/08/2017	27.9	0.9	28.8				
23/08/2017	25.3	0.1	25.4				
21/08/2017	22.1	0.4	22.5	28/06/2017	15.3	5.7	21.0
12/05/2017	20.8	0.9	21.7	23/06/2017	9.1	4.1	13.2
26/08/2017	20.8	0.1	20.9	30/05/2017	7.5	3.7	11.2
2/09/2017	20.4	1.1	21.5	14/07/2017	10.7	3.6	14.3
22/08/2017	20.3	0.1	20.4	22/07/2017	14.5	3.2	17.7
3/07/2017	18.0	2.2	20.2	10/07/2017	8.0	2.8	10.8
2/07/2017	16.6	2.0	18.6	12/06/2017	8.0	2.7	10.7
17/07/2017	15.4	1.9	17.3	25/06/2017	10.9	2.3	13.2
28/06/2017	15.3	5.7	21.0	16/05/2017	6.8	2.3	9.1
29/06/2017	15.0	1.0	16.0	6/06/2017	9.6	2.3	11.9

Table E-6: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R29

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
10/09/2017	34.3	0.2	34.5				
27/08/2017	27.9	0.4	28.3				
23/08/2017	25.3	0.3	25.6				
21/08/2017	22.1	1.2	23.3	14/07/2017	10.7	5.3	16.0
12/05/2017	20.8	1.0	21.8	17/07/2017	15.4	4.9	20.3
26/08/2017	20.8	0.1	20.9	3/07/2017	18.0	4.6	22.6
2/09/2017	20.4	1.4	21.8	28/06/2017	15.3	4.3	19.6
22/08/2017	20.3	0.1	20.4	25/07/2017	8.4	4.3	12.7
3/07/2017	18.0	4.6	22.6	30/05/2017	7.5	4.1	11.6
2/07/2017	16.6	2.4	19.0	23/06/2017	9.1	4.0	13.1
17/07/2017	15.4	4.9	20.3	28/05/2017	8.6	3.5	12.1
28/06/2017	15.3	4.3	19.6	5/06/2017	11.4	3.2	14.6
29/06/2017	15.0	0.3	15.3	15/08/2017	12.4	3.2	15.6

Table E-7: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor FR04

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
13/09/2017	**51.1**	0.0	**51.1**				
24/09/2017	48.6	0.0	48.6	11/06/2017	7.0	15.8	22.8
15/01/2017	31.6	0.9	32.5	27/06/2017	12.7	12.0	24.7
18/01/2017	31.3	0.0	31.3	25/05/2017	9.8	10.3	20.1
2/09/2017	30.2	3.1	33.3	22/05/2017	12.2	9.1	21.3
12/05/2017	29.7	4.7	34.4	10/05/2017	11.7	8.2	19.9
13/01/2017	25.8	0.0	25.8	19/05/2017	15.4	8.0	23.4
30/10/2017	25.6	0.0	25.6	3/08/2017	8.6	7.5	16.1
17/02/2017	25.4	0.2	25.6	2/07/2017	7.2	7.3	14.5
10/04/2017	25.3	0.0	25.3	6/04/2017	9.1	6.8	15.9
31/01/2017	25.1	0.0	25.1	15/06/2017	8.1	6.5	14.6

Table E-8: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor FR10

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
13/09/2017	**51.1**	0.0	**51.1**				
24/09/2017	48.6	0.0	48.6	11/06/2017	7.0	10.3	17.3
15/01/2017	31.6	0.7	32.3	27/06/2017	12.7	9.1	21.8
18/01/2017	31.3	0.0	31.3	10/05/2017	11.7	6.4	18.1
2/09/2017	30.2	3.9	34.1	4/05/2017	10.7	6.2	16.9
12/05/2017	29.7	4.4	34.1	22/05/2017	12.2	6.0	18.2
13/01/2017	25.8	0.0	25.8	19/05/2017	15.4	5.5	20.9
30/10/2017	25.6	0.0	25.6	25/05/2017	9.8	5.3	15.1
17/02/2017	25.4	0.1	25.5	6/04/2017	9.1	5.2	14.3
10/04/2017	25.3	0.0	25.3	15/06/2017	8.1	5.2	13.3
31/01/2017	25.1	0.0	25.1	18/05/2017	15.1	5.2	20.3

Table E-9: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R21

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
13/09/2017	**51.1**	0.7	**51.8**				
24/09/2017	48.6	1.1	49.7	28/06/2017	8.4	20.9	29.3
15/01/2017	31.6	0.0	31.6	30/05/2017	9.0	12.5	21.5
18/01/2017	31.3	0.6	31.9	23/06/2017	7.7	11.3	19.0
2/09/2017	30.2	3.0	33.2	10/07/2017	9.1	11.1	20.2
12/05/2017	29.7	3.4	33.1	16/05/2017	10.9	10.6	21.5
13/01/2017	25.8	0.5	26.3	12/06/2017	6.2	9.4	15.6
30/10/2017	25.6	0.9	26.5	14/07/2017	9.4	9.3	18.7
17/02/2017	25.4	0.5	25.9	22/07/2017	5.4	9.2	14.6
10/04/2017	25.3	1.1	26.4	8/07/2017	8.2	8.5	16.7
31/01/2017	25.1	0.8	25.9	24/06/2017	9.4	8.4	17.8

Table E-10: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R22

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
13/09/2017	**51.1**	1.0	**52.1**				
24/09/2017	48.6	0.8	49.4	28/06/2017	8.4	22.6	31.0
15/01/2017	31.6	0.0	31.6	23/06/2017	7.7	13.7	21.4
18/01/2017	31.3	0.5	31.8	30/05/2017	9.0	13.7	22.7
2/09/2017	30.2	3.6	33.8	14/07/2017	9.4	11.9	21.3
12/05/2017	29.7	3.7	33.4	10/07/2017	9.1	11.6	20.7
13/01/2017	25.8	0.8	26.6	22/07/2017	5.4	11.5	16.9
30/10/2017	25.6	1.0	26.6	16/05/2017	10.9	10.7	21.6
17/02/2017	25.4	0.7	26.1	12/06/2017	6.2	10.3	16.5
10/04/2017	25.3	1.1	26.4	8/07/2017	8.2	9.1	17.3
31/01/2017	25.1	0.8	25.9	3/07/2017	8.8	9.0	17.8

Table E-11: Cumulative 24-hour average PM_{10} concentration ($\mu g/m^3$) – Receptor R23

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
13/09/2017	**51.1**	0.9	**52.0**				
24/09/2017	48.6	0.2	48.8	28/06/2017	8.4	21.4	29.8
15/01/2017	31.6	0.0	31.6	23/06/2017	7.7	15.9	23.6
18/01/2017	31.3	0.3	31.6	14/07/2017	9.4	15.1	24.5
2/09/2017	30.2	4.2	34.4	30/05/2017	9.0	14.3	23.3
12/05/2017	29.7	3.3	33.0	22/07/2017	5.4	12.5	17.9
13/01/2017	25.8	0.8	26.6	3/07/2017	8.8	10.0	18.8
30/10/2017	25.6	1.1	26.7	10/07/2017	9.1	9.8	18.9
17/02/2017	25.4	0.8	26.2	12/06/2017	6.2	9.8	16.0
10/04/2017	25.3	1.1	26.4	17/07/2017	8.5	9.6	18.1
31/01/2017	25.1	0.8	25.9	16/05/2017	10.9	8.8	19.7

Table E-12: Cumulative 24-hour average PM_{10} concentration ($\mu g/m^3$) – Receptor R29

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
13/09/2017	**51.1**	1.2	**52.3**				
24/09/2017	48.6	0.0	48.6	14/07/2017	9.4	19.5	28.9
15/01/2017	31.6	0.0	31.6	17/07/2017	8.5	17.4	25.9
18/01/2017	31.3	0.0	31.3	28/06/2017	8.4	16.6	25.0
2/09/2017	30.2	5.3	35.5	3/07/2017	8.8	16.4	25.2
12/05/2017	29.7	3.6	33.3	30/05/2017	9.0	15.7	24.7
13/01/2017	25.8	1.1	26.9	23/06/2017	7.7	15.4	23.1
30/10/2017	25.6	1.2	26.8	25/07/2017	8.5	15.1	23.6
17/02/2017	25.4	1.9	27.3	28/05/2017	9.9	12.6	22.5
10/04/2017	25.3	0.3	25.6	5/06/2017	8.5	11.8	20.3
31/01/2017	25.1	1.1	26.2	15/08/2017	10.7	11.2	21.9