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LANG LANG SAND RESOURCES PTY LTD

LANG LANG SAND QUARRY

AIR QUALITY IMPACT ASSESSMENT

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AUGUST 2022

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Lang Lang Sand Quarry
Air Quality Impact Assessment

Lang Lang Sand Resources Pty Ltd

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REV	DATE	DETAILS
A	2 June 2021	Draft for Client Review
B	29 July 2021	Client comments
C	25 March 2022	Updated Site Layout Plan
D	25 August 2022	Report addressing Earth Resources comments
E	31 August 2022	Final

	NAME	DATE	SIGNATURE
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Reviewed by:	John Conway	31 August 2022	

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Approved by:	John Conway	31 August 2022	

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ABBREVIATIONS

AAQMS	Ambient Air Quality Monitoring Station
Air NEPM	*National Environment Protection Council (Ambient Air Quality) Measure*
APAC	Air pollution assessment criterion
AQIA	Air Quality Impact Assessment
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
DEM	Digital elevation model
EPA	Environment Protection Authority
ERS	Environment Reference Standard
GED	General environmental duty
GLCs	Ground Level Concentrations
LLSR	Lang Lang Sand Resources Pty Ltd
NATA	National Association of testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NPI	National Pollutant Inventory
$PM_{2.5}$	Particles with an aerodynamic diameter of 2.5 micrometres or less
PM_{10}	Particles with an aerodynamic diameter of 10 micrometres or less
RCS	Respirable crystalline silica
SPCC	State Pollution Control Commission
SRTM	Shuttle Radar Topography Mission
TSP	Total Suspended Particulates
TAPM	The Air Pollution Model
USEPA	United States Environmental Protection Agency
WSP	WSP Australia Proprietary Limited
Units	
ºC	Degree Celsius
ha	Hectares
km	kilometre
km/h	kilometre per hour

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kg/VKT	kilogram per vehicle kilometres travelled
kg/t	kilogram per tonne
g/s	gram per second
g/m^2	Grams per square metre
g/m^2/month	Grams per square metre per month
m	Metre
mm	Millimetres
m^2	Metres squared
m^3	Cubic metre
m/s	metres per second
t/a	tonne per annum
tpa	tonnes per annum
$\mu g/m^3$	Microgram per cubic meter
%	per cent

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EXECUTIVE SUMMARY

Lang Lang Sand Resources Pty Ltd (LLSR) propose to develop a sand extraction and processing operation located at 5575 South Gippsland Highway, Victoria (the Project). WSP Australia Pty Ltd (WSP) was engaged by LLSR to prepare an air quality impact assessment (AQIA) report in support of a Workplan for the new sand quarry development for a production output of up to 300,000 tonnes per annum (tpa).

Climate data collected at Rhyll Automatic Weather Stations (AWS) were analysed and site-specific meteorological data (i.e., wind conditions, rainfall and mixing height) predicted by The Air Pollution Model (TAPM) for the period 2016 to 2020 were analysed and presented in this report.

Background PM_{10} and $PM_{2.5}$ data collected at the Traralgon ambient air quality monitoring station (AAQMS) for 2016 to 2020 were analysed and adopted as background for this assessment. Respirable crystalline silica (as $PM_{2.5}$) and dust deposition is not monitored at any AAQMS in Victoria. As such, incremental impacts only were assessed.

Five sensitive receptors were identified near the Project site and included in the modelling.

Site-specific meteorological files for the period 2016 to 2020 were generated using TAPM. AERMOD compatible meteorological files were generated using AERMET taken account of surface roughness, albedo, and Bowen Ratio values around the Project site.

Air dispersion modelling using AERMOD was conducted for the following two scenarios to assess potential air quality impacts from the Project:

- Scenario 1: sand extraction at stage 1 while the screening bund is under construction (in the first three years of site operation).
- Scenario 2: sand extraction at stage 3 following completion of the screening bund (more than five years following commencement of site operations).

Air emission sources considered for each scenario are as follows:

- Scenario 1:
- machinery operation (i.e. excavators, scrapers and dozers)
- materials handling (loading and unloading trucks)
- wheel generated dust from unpaved roads
- wind erosion from stockpiles and other exposed areas.
- Scenario 2:
- machinery operation (i.e., excavators, scrapers and dozers)
- materials handling (loading and unloading trucks)
- wheel generated dust from unpaved roads
- dry screening and associated activities
- wind erosion from stockpiles and other exposed areas.

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Contemporaneous (i.e., the same time period) background data were added to the predicted contribution from the Project to determine cumulative impacts. The modelling results indicate that:

Scenario 1 (2016 to 2020):

- The cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) at five receptors are predicted to be below the relevant assessment criteria.

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- The cumulative annual average PM_{10} concentrations (maximum project contribution plus contemporaneous background) are predicted to be below the assessment criteria at four receptors and exceeds the criterion at R3 due to high background concentrations (the background accounts for 96% of the criterion).
- The cumulative annual average $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) are predicted to exceed the assessment criterion at all five receptors due to existing background exceedances.
- A 24-hour PM_{10} time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by two days at receptors R1, R2 and R3 and by one day at receptors R4 and R5
- A 24-hour $PM_{2.5}$-time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by one day at receptor R1 only
- The maximum increase in dust deposition levels at all receptors are below the assessment criterion of 2 g/m^2/month.
- The maximum annual RCS concentrations at all receptors are estimated to be below the air pollution assessment criterion (APAC).

Scenario 2 (2016 to 2020):

- The cumulative 24-hour average PM_{10} concentrations (maximum project contribution plus contemporaneous background) at five receptors are predicted to be below the assessment criterion.
- The cumulative 24-hour average $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) are predicted to exceed the assessment criterion at R2 and R4 with the background concentration accounting for 90% of the criterion.
- The cumulative annual average PM_{10} concentrations (maximum project contribution plus contemporaneous background) are predicted to be below the assessment criteria at all five receptors,
- The cumulative annual average $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) are predicted to exceed the assessment criterion at all five receptors due to existing background exceedances.
- A 24-hour PM_{10} time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by three days at receptor R2 and by two days at receptors R3 and R4
- A 24-hour $PM_{2.5}$-time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by three days at receptor R2 and by 2 days at receptor R4
- The maximum increase in dust deposition levels at all receptors are below the assessment criterion of 2 g/m^2/month.
- The maximum annual RCS concentrations at all receptors are estimated to be below the APAC.

The assessment was conducted based on conservative assumptions including, but not limited to:

- The emission sources were configured at locations close to the sensitive receptors.
- All emission sources were configured on or above ground level. In practice, some sources would be below ground level especially for sources at the extraction pits.
- Sand extraction for the top 6 metres (above groundwater level) was modelled for a whole year while in practice it is not likely to continue for a full year.
- The exposed areas at the extraction pits are likely to be smaller than the modelled area of 40,000 m^2.

Given these assumptions, actual emissions from both scenarios are expected to be lower than predicted. In addition, the predicted cumulative exceedances are mainly due to high background concentrations or existing background exceedances.

Implementation of an air quality management plan that focusses on a risk-based approach to minimising dust so far as reasonably practical together with a monitoring program that would assist in evaluating the proposed control measures and confirm the level of impact that has been predicted for the two scenarios assessed.

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1 INTRODUCTION

1.1 BACKGROUND

Lang Lang Sand Resources Pty Ltd (LLSR) propose to develop a sand extraction and processing operation located at 5575 South Gippsland Highway, Victoria (the Project), approximately 5.5 kilometres (km) south of the township of Lang Lang, 7 km west of Nyora and 80 km southeast of Melbourne.

WSP Australia Pty Ltd (WSP) was engaged by LLSR to prepare an air quality impact assessment (AQIA) report in support of a Workplan for the new sand quarry development.

1.2 PROJECT DESCRIPTION

The subject property is currently used for dairy farming and grazing and LLSR holds a caveat over the land through a purchase agreement with the owner. The proposed Work Authority area is approximately 118 hectares (ha) consisting of four separate Crown allotments:

- Lot 1 LP91815
- Lot 1 PS312674
- Lot 2 PS312674
- Lot 1 TP23467

The proposed development involves the following:

- Production output of the sand quarry of up to 300,000 tonnes per annum (tpa)
- A sand processing plant and stockpile area covering approximately 4.6 ha
- A sealed access road from the site entrance to the processing plant and stockpile area. A wheel wash facility would be located near the stockpile area so that all truck wheels are washed before leaving the site.
- An internal haul road, approximately 30 metres (m) wide and 1.5 km long would be constructed with crushed rock.
- Screening bunds, approximately 5 m high and 25 m wide would be constructed along the western, southern and part of the eastern site boundary.
- Other site infrastructure includes a weighbridge, office, amenities, workshop, fuel storage, oil and grease storage and a laydown area.

The Project site would be developed in five stages and the site plant layout is presented in Figure 1-1.

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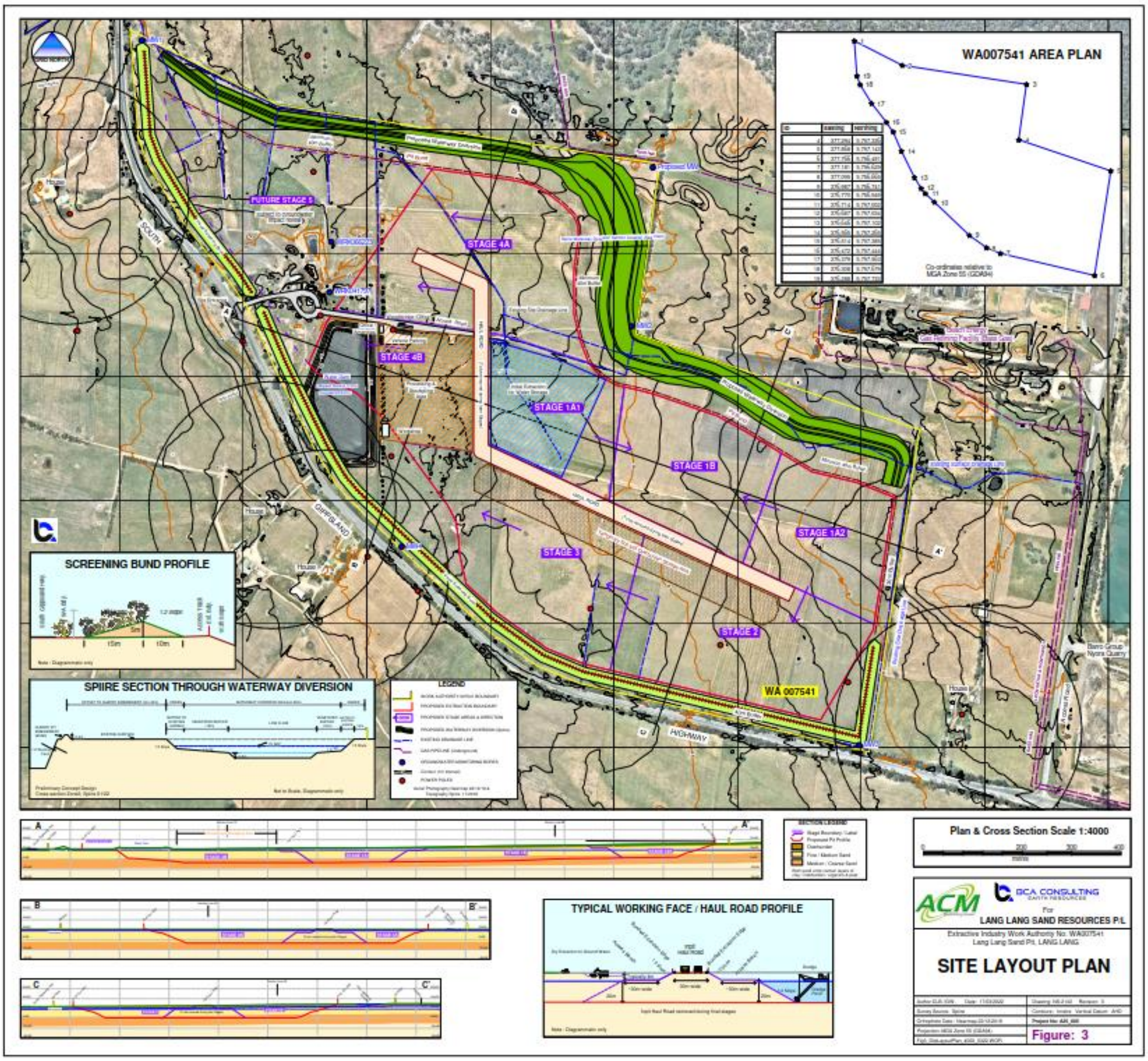

Figure 1-1 Site plant layout

1.3 SCOPE OF WORKS

The scope of works for preparation of the air quality impact assessment report includes:

- review relevant legislation, policy and standards and establish appropriate air pollution assessment criteria for the Project
- characterise the existing ambient air quality and meteorological conditions for the Project using publicly available information, and analyse appropriate ambient air quality data to be used as background for the assessment
- determine the operational scenarios to be modelled (up to two), identify the main sources of air emissions and generate an emission inventory for each model scenario
- generate site specific meteorological files for 5 years in accordance with the EPA Victoria Publication 1550 '*Construction of Input Meteorological Data Files for EPA Victoria's Regulatory Air Pollution Model (AERMOD)* [EPA Victoria 2103a)

- predict incremental and cumulative ground level concentrations (GLCs) for the key pollutants modelled using AERMOD in accordance with the EPA Victoria Publication 1551 '*Guidance Notes for Using the Regulatory Air Pollution Model AERMOD in Victoria'* (EPA Victoria 2013b) for two scenarios and compare to the applicable assessment criteria
- prepare contour plots (and other relevant visual graphs) illustrating the extent of pollutant dispersal
- propose management measures to minimise air quality impacts
- provide details of an air monitoring program for implementation during operations
- prepare an AQIA report in support of the Work Plan.

1.4 AIR QUALITY INDICATORS

The main air quality indicators associated with quarrying operations at the Lang Lang sand quarry include:

- particulate matters equal to or less than 10 micrometres in diameter (PM_{10})
- particulate matters equal to or less than 2.5 micrometres in diameter ($PM_{2.5}$)
- deposited dust
- respirable crystalline silica (RCS)

These indicators were included in the modelling assessment.

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2 LEGISLATIVE CONTEXT

2.1 MINERAL RESOURCES (SUSTAINABLE DEVELOPMENT) ACT 1990

The Mineral Resources (Sustainable Development) Act 1990 (MRSD Act 1990) aims to encourage and facilitate exploration for minerals that is compatible with the economic, social, and environmental objectives of the State. The MRDS Act 1990 establishes a legal framework to ensure risk to the environment, the public, land property or infrastructure by work conducted under a licence or extractive industry work authority are eliminated or minimised as far as reasonably practicable.

The MRSD Act 1990 prescribes the requirements for a work authority and a work plan.

2.2 ENVIRONMENT PROTECTION ACT 2017

The *Environment Protection Act 2017* (EP Act 2017) is the current primary legislative instrument that governs protection of the environment in Victoria. The objective of the EPA Act 2017 is to protect human health and the environment by reducing the harmful effects of pollution and waste.

The EP Act 2017 introduces a duty focussed on prevention, known as the *general environmental duty* (GED). This duty requires a business (duty holders) to manage the risks of harm to the environment proactively together with addressing the impacts of pollution and waste after they have occurred.

Pursuant to the EP Act 2017, the following relevant subordinate legislation and guideline are:

- Environment Reference Standard, 2021
- Guideline for assessing and minimising air pollution in Victoria, 2022.

2.3 ENVIRONMENT REFERENCE STANDARD 2021

The Environment Reference Standard (ERS) is a legislative instrument made under the EP Act 2017 (ERS 2021). The ERS is an environmental benchmark which '*brings together a collection of environmental value, indicators and objectives that describe environmental and human health outcomes to be achieved or maintained in the whole or in parts of Victoria*'. They are used to assess and report on changing environmental conditions in Victoria by providing a reference point that supports the GED for decision makers to consider whether a proposal or activity is consistent with the environmental values of the ERS. The ERS also allows the evaluation of potential impacts on human health and the environment that may result from a proposal or activity. The ERS is intended as a reference standard and is not a compliance standard for duty holders (businesses).

The ambient air quality indicators in the ERS cover common pollutants in Victoria including PM_{10} and $PM_{2.5}$ (criteria pollutants) which are likely to be emitted from activities at the Lang Lang sand quarry.

Objectives for key air quality indicators relevant to the Lang Lang sand quarry are presented in Table 2.1.

Table 2.1 ERS objectives

Air quality indicator	Averaging period	Objectives
Particles as PM_{10}	24-hour	50 $\mu g/m^3$
	Annual	20 $\mu g/m^3$

Air quality indicator	Averaging period	Objectives
Particles as $PM_{2.5}$[1]	24-hour	25 µg/m^3
	Annual	8 µg/m^3

2.4 GUIDELINE FOR ASSESSING AND MINIMISING AIR POLLUTION IN VICTORIA 2022

The Guideline for assessing and minimising air pollution in Victoria, 2022 (EPA Victoria 2022) provides a framework to assess and control risk associated with air pollution. The Guideline states: '*Emitters of pollution to air have a responsibility under the general environmental duty to apply controls to eliminate or minimise risks to human health or the environment, so far as reasonably practicable. This requires duty holders to understand their risks, implement controls and review performance of controls.*'

The guideline adopts a risk-based management approach that involves identifying hazards, assessing risk, implementing controls and checking controls.

The Guideline introduces air pollution assessment criteria (APAC) which are concentrations of air pollutants that provide a benchmark to understand potential risks. They are risk-based concentrations that help identify when or if an activity is likely to pose an unacceptable risk to human health and the environment.

The Guideline (EPA Victoria 2022), '*historically, threshold figures of 4g/m^2/month (no more than 2 g/m^2/month above background), as a monthly average, taken at the boundary of the industrial premises, have been used. These figures can be used as a rule of thumb level for requiring further investigation and addressing dust issues, but not as a level up to which industry is allowed to pollute up to*'. As the background dust deposition level is not known for the local area, an assessment criterion of 2 g/m^2/month has been adopted as indicative of a nuisance value for deposited dust.

For criteria pollutants including PM_{10} and $PM_{2.5}$, the objectives specified in the ERS are required to be adopted as APACs. Table 2.2 presents the relevant APACs adopted for the Lang Lang sand quarry.

Table 2.2 APACs for relevant air quality indicators

Air quality indicator	Averaging period	APAC (µg/m^3)	Reference
Particles as PM_{10}	1 day	50	ERS
	1 year	20	
Particles as $PM_{2.5}$	1 day	25	ERS
	1 year	8	
Deposited dust	Monthly	2 g/m^2/month (incremental) 4 g/m^2/month (cumulative)	Guideline for assessing and minimising air pollution in Victoria
Respirable crystalline silica	1 year	3	

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3 EXISTING ENVIRONMENT

3.1 CLIMATE AND METEOROLOGY

3.1.1 CLIMATE

The Bureau of Meteorology (BoM) collects climate statistics at Automatic Weather Stations (AWS) across Australia and can be used for determining climate statistics over standard periods, such as 30 years, known as a climate normal.

The Rhyll AWS (site number: 086373) is the closest AWS to the Project site, located approximately 29 km south-west of the site. Table 3.1 provides an overview of the climatic data recorded by BoM between 1991 to 2021 at Rhyll AWS. In summary, the local climate is characterised by:

- Annual average rainfall of 699.8 mm and average rainy days (rain ≥ 1 mm) of 106.1;
- Average maximum temperature of 24.4 ºC in February;
- Average minimum temperature of 8.2ºC in July;
- Average maximum 9 am relative humidity of 84 per cent (%) in June and July; and
- Average minimum 3 pm relative humidity of 60% in February and March.

Table 3.1 Summary of climate statistics at the Rhyll AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Rainfall (1994 to 2021)													
Mean rainfall (mm)	39	40.2	39.8	60.2	75.6	64	68.9	80.3	68.5	59.3	58.9	45.4	699.8
Mean days of rain (≥1 mm)	5.3	4.6	6.3	8.3	10.9	9.9	12.3	13.1	11.6	9.4	7.9	6.5	106.1
Daily temperature (1991 to 2021)													
Max (ºC)	24	24.4	22.6	19.6	16.3	14	13.4	14.3	16.1	18.1	20.2	22	18.7
Min (ºC)	15.6	15.9	14.7	12.7	10.8	8.9	8.2	8.4	9.5	10.6	12.4	13.8	11.8
Mean 9 am conditions (1991 to 2010)													
Temperature (ºC)	18.3	18.4	16.9	15.1	12.6	10.4	9.6	10.4	12.2	13.9	15.4	16.9	14.2
Relative humidity (%)	72	75	76	77	82	84	84	81	77	73	74	71	77
Wind speed (km/h)	17	16	15.1	15.6	16	17.8	18.3	18.8	19	17.2	16.7	17	17
Mean 3 pm conditions (1991 to 2010)													
Temperature (ºC)	21.8	22.6	20.8	17.9	15.1	12.8	12.2	13.1	14.5	16	18.2	19.9	17.1
Relative humidity (%)	61	60	60	64	70	74	73	68	66	64	64	61	65
Wind speed (km/h)	20.8	20	18.8	17.4	16.3	18.2	18.5	19.5	19.9	19.4	20	21.1	19.2

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3.1.2 LOCAL METEOROLOGY

3.1.2.1 WIND CONDITIONS

Figure 3-1 provides seasonal and annual wind roses showing the frequency of strength and direction of winds for the past five years (2016 to 2020) at the Project site. The wind roses indicate that typically winds at the Project site are:

- During spring, the wind was most frequently from the west, moderately ranging from west north-west to south-east and southwest to west-southwest with an average wind speed of 3.3 m/s;
- During summer, the winds were most frequently originating from the southwest with an average wind speed of 3.1 m/s;
- During autumn, winds originated from most directions and less frequently from the south with an average wind speed of 2.9 m/s;
- During winter, the most dominant winds ranged from the west to northeast with an average wind speed of 3.2 m/s;
- Over the five years:
  - the annual winds were moderately from most of the directions and less frequently from the south;
  - high winds (greater than 8 m/s) were more likely originating from the westerly directions; and
  - average wind speed of 3.1 m/s and calm winds (wind speeds of less than 0.5 m/s) of 0.7% were predicted over the 5-year period.

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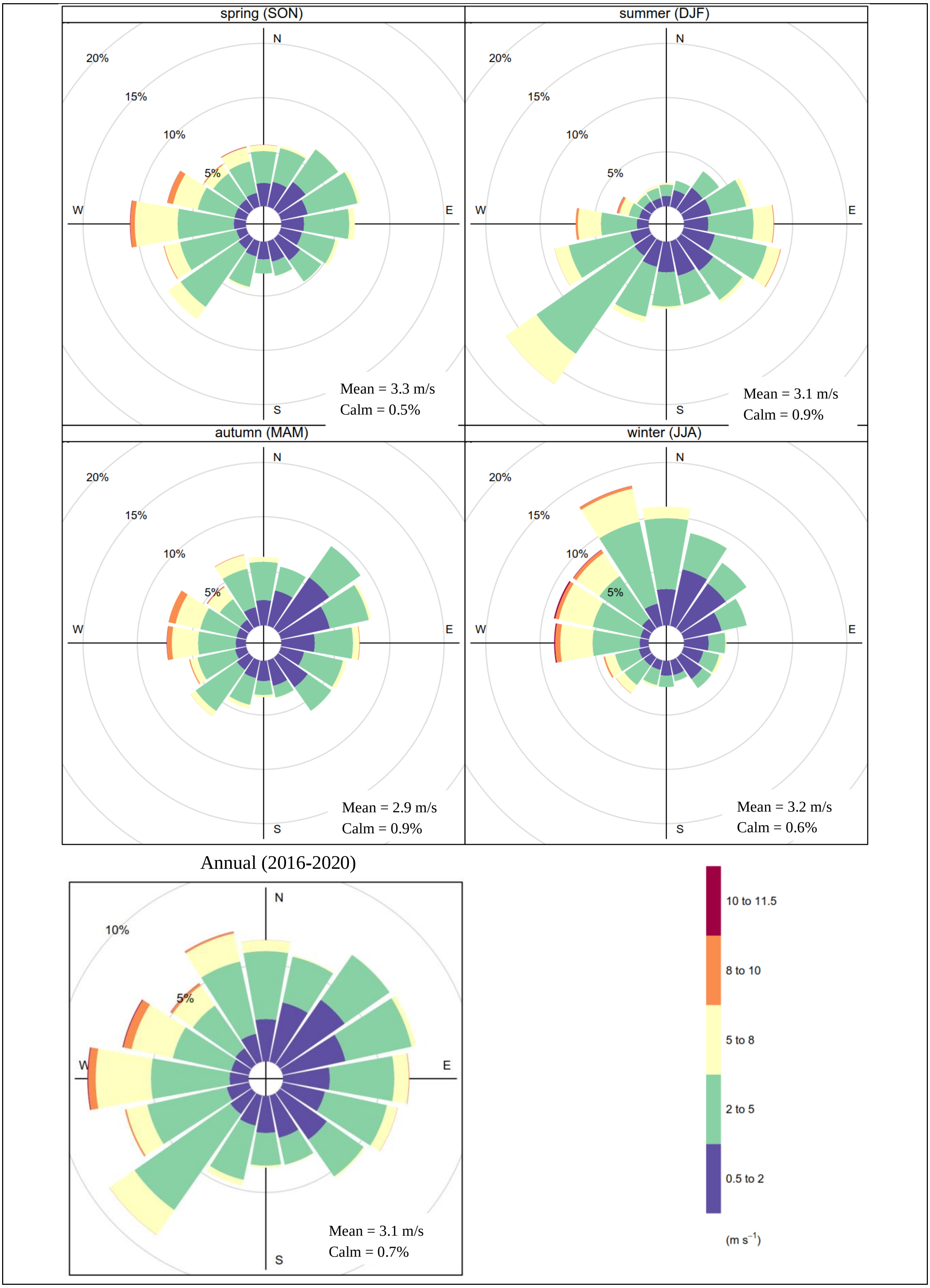


Figure 3-1 Site-specific annual and seasonal wind roses (2016 - 2020)

3.1.2.2 RAINFALL

Annual total rainfall predicted by TAPM at the Project site for the period 2016 to 2020 are presented in Table 3.2 and monthly rainfall over the five years are presented in Table 3.3.

The rainfall data indicates that:

— Rainfall data are relatively stable over five years ranging from 636 mm to 872 mm.

— More rainfall is predicted in winter than in summer.

Table 3.2 Annual total rainfall predicted by TAPM at the Project site for the period 2016 to 2020

Parameter	**2016**	**2017**	**2018**	**2019**	**2020**
Total rainfall (mm)	679	802	636	647	872

Table 3.3 Monthly average rainfall predicted by TAPM at the Project site for the period 2016 to 2020

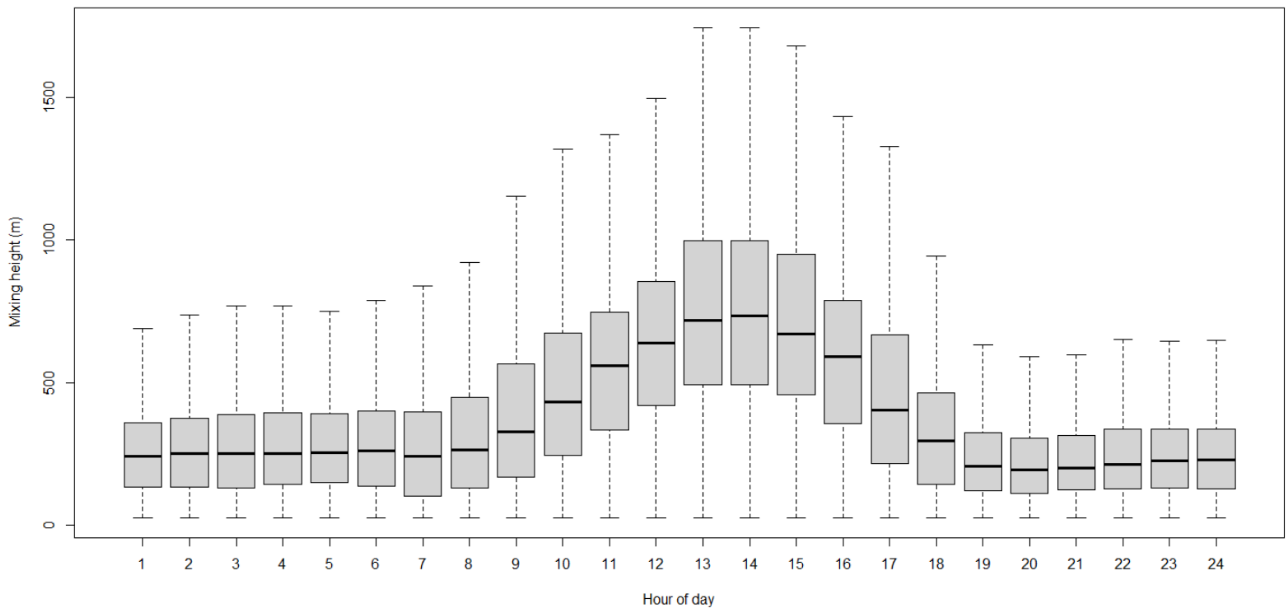
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean rainfall (mm)	40.8	36.5	42.4	62.3	88.9	66.0	69.1	90.9	74.5	58.5	47.2	50.2

3.1.2.3 MIXING HEIGHT

Diurnal variations in mixing heights predicted by TAPM at the Project site for the period 2016 to 2020 are illustrated in Figure 3-2. The results indicate that:

— Mixing heights start to increase in the morning and decrease in the evening.

— The maximum mixing heights occur in the early to mid-afternoon.



From bottom to top: minima, 25th percentile, 50th percentile, 75th percentile and maxima, outliers have been removed.

Figure 3-2 TAPM predicted diurnal variation in mixing height for the Project site during 2016 to 2020

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3.2 TOPOGRAPHY

One-second Shuttle Radar Topography Mission (SRTM) derived Digital Elevation Model (DEM) data from Geoscience Australia (source: https://elevation.fsdf.org.au/) was used in this assessment. Figure 3-3 displays a topographic map of the Project site and surrounding area.

The Project site is situated approximately 4 km east of Western Port Bay. The immediate surrounding topography is relatively flat with predominantly grassland, forest, industrial development (e.g., sand quarries) and residential land uses near the Project site.

Mount Worth State Park lies approximately 30 km to the east and Bunyip State Park approximately 33km to the north of the Project site.

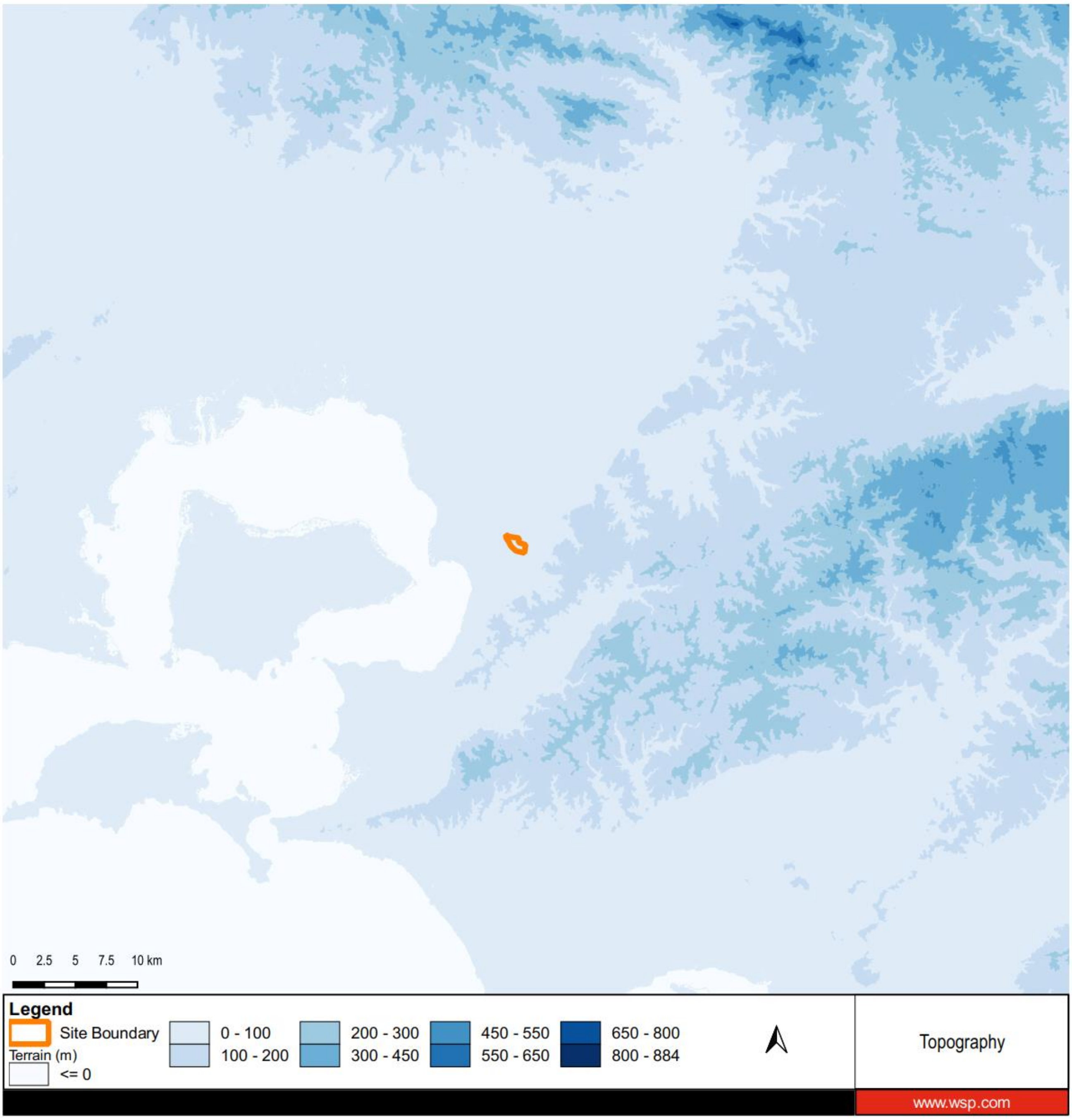

Figure 3-3 Topography of the Project site and surrounding area

3.3 BACKGROUND AIR QUALITY

3.3.1 EXISTING EMISSIONS

The Project site is located in a rural area and existing air emission sources include:

- other surrounding sand quarries
- vehicles travelling on the local road network
- industrial facilities e.g., sand quarries and gas extraction facility
- domestic fuel burning (gas, liquid, solid)

A National Pollutant Inventory (NPI) database review was conducted to further identify existing emission sources near the Project. Five facilities located within a radius of 5 km of the Project reported their emissions to the NPI database for the 2019/2020 reporting period. A summary of these facilities is presented in Table 3.4. Emissions from these facilities will contribute to the local airshed.

In addition, a small sand quarry located approximately 320 m north of the Project site is not required to report its emissions to the NPI. This sand quarry current operates at a very low output and not likely to contribute to the local air shed at the Project site to any significant extent.

Table 3.4 Nearby facilities reporting to the NPI database for the 2019/2020 period

Company	Address	Distance and direction to the Project site	Main activity	Main reported substances
Metro Quarry Group	5875 South Gippsland Highway, Nyora	1,050 m, east	Gravel and sand quarrying	CO: 12 t/a NO_x: 39 t/a PM_{10}: 3.1 t/a $PM_{2.5}$: 2.9 t/a
GM Holden	Holden Proving Ground, Bass Highway, Lang Lang	2,600 m, south-west	Motor vehicle manufacturing	VOCs: 510 kg/a
Beach Energy Limited	5755 South Gippsland Highway, Lang Lang	125 m, north-east	Natural gas extraction	CO: 220 t/a Formaldehyde: 16 t/a NO_x: 310 t/a PM_{10}: 9 t/a $PM_{2.5}$: 6.6 t/a SO_2: 25 t/a VOCs: 58 t/a
HOLCIM (AUSTRALIA)	870 McDonalds Track, Lang Lang	3,000 m, north-east	Gravel and sand quarrying	CO: 26 t/a NO_x: 69 t/a PM_{10}: 45 t/a $PM_{2.5}$: 4.4 t/a SO_2: 18t/a VOCs: 4.9 t/a
Hanson Construction Materials	760 McDonalds Track, Lang Lang	2,500 m, north, north-east	Gravel and sand quarrying	CO: 11 t/a NO_x: 35 t/a PM_{10}: 9.1 t/a $PM_{2.5}$: 2.4 t/a VOCs: 3.6 t/a

3.3.2 AMBIENT AIR QUALITY DATA

Ambient air quality is monitored by the EPA Victoria at ambient air quality monitoring stations (AAQMS) across Victoria to assess air quality against objectives set in the ERS (ERS 2021).

The nearest AAQMS to the Project site is the Dandenong AAQMS, located approximately 51 km northwest of the Project. However, the Dandenong AAQMS is located in an urban area and not representative of the Project's rural location. EPA Victoria recommended to use the monitoring data collected at the Traralgon AAQMS given the Project's similar rural setting. The Traralgon AAQMS is located approximately 83 km east-northeast of the Project.

It is noted that given the presence of coal mining and coal power plants surrounding the Traralgon AAQMS, the measured data at this station are expected to be higher than that likely to be experienced at the Project site. As such, the adopted background data at the Traralgon AAQMS is considered to be an over-estimate of background concentrations.

No ambient air quality data have been collected for RCS and deposited dust at any EPA AAQMS in Victoria. Background data was therefore not discussed in this section.

3.3.2.1 PARTICLES AS PM_{10}

24-hour and annual average PM_{10} concentrations measured at the Traralgon AAQMS over the period of 2016 to 2020 are presented in Table 3.5 and Figure 3-4. Exceedances analyses are summarised in Table 3.6. The monitoring results indicate that:

- The maximum 24-hour average PM_{10} concentrations exceeded the ERS objective of 50 µg/m^3 in 2019 and 2020 and were compliant with the ERS objective in other years. The exceedances were caused by windblown dust or bushfires.
- Annual average PM_{10} concentrations are below the ERS objective of 20 µg/m^3 in all five years.

Table 3.5 PM_{10} concentrations at Traralgon AAQMS

Year	Availability (% day)	Annual average (µg/m^3)	24-hour average (µg/m^3)							
			Max	99%ile	98%ile	95%ile	90%ile	75%ile	70%ile	50%ile
2016	97.5%	13.8	49.2	35.7	30.2	25.0	20.2	16.5	15.7	12.6
2017	92.1%	14.3	42.8	30.0	27.8	22.5	20.3	16.7	15.8	12.9
2018	95.6%	14.5	47.4	30.8	27.2	24.0	21.3	16.8	15.7	13.5
2019	95.3%	17.6	**78.0**	52.0	42.6	35.8	28.5	21.1	19.2	14.9
2020	94.3%	19.2	**236.3**	134.2	56.6	31.7	24.1	19.8	18.7	15.0
Objective		***20***	***50***							

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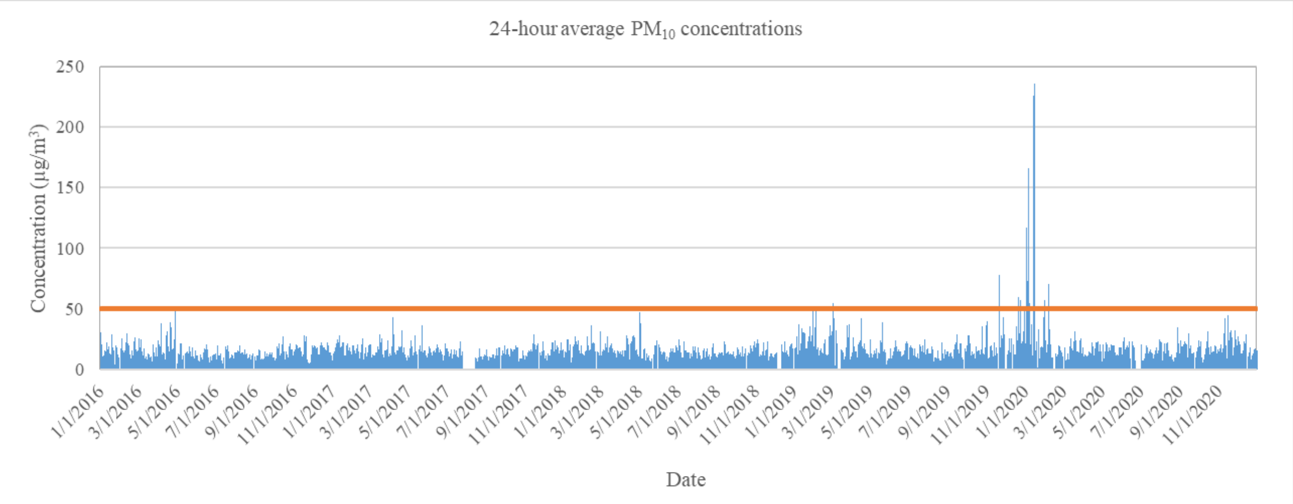

Figure 3-4 24-hour average PM_{10} measured concentrations

Table 3.6 24-hour average PM_{10} exceedances summary

Year	Number of exceedances	Date of exceedances	Reason
2019	5	30 January, 21 November,	Windblown dust
		3 March 20 and 23 December,	Smoke from bushfires
2020	9	3, 4, 6, 7, 13-15 and 31 January, 6 February	

3.3.2.2 PARTICLES AS $PM_{2.5}$

24-hour and annual average $PM_{2.5}$ concentrations measured at the Traralgon AAQMS over the period of 2016 to 2020 are presented in Table 3.7 and Figure 3-5. Exceedances analyses are summarised in Table 3.8. The monitoring results indicate that:

— The maximum 24-hour average $PM_{2.5}$ concentrations exceeded the ERS objective of 25 µg/m³ in all five years. The exceedances were caused by planned burns, bushfires, or domestic wood heaters.

— Annual average $PM_{2.5}$ concentrations exceeded the ERS objective of 8 µg/m³ for the years 2017 to 2020 and were below the ERS objective in 2016.

Table 3.7 $PM_{2.5}$ concentrations at Traralgon AAQMS

Year	Availability (% day)	Annual average (µg/m³)	24-hour average (µg/m³)							
			Max	99%ile	98%ile	95%ile	90%ile	75%ile	70%ile	50%ile
2016	95.1%	7.8	**25.7**	23.2	20.3	14.8	12.4	9.1	8.6	6.8
2017	87.7%	**8.4**	**32.3**	26.3	21.0	16.8	14.1	9.2	8.7	6.9
2018	87.1%	**8.1**	**30.1**	23.1	21.6	17.5	13.0	9.0	8.4	6.1
2019	95.3%	**8.9**	**37.4**	30.8	23.5	19.2	14.8	10.4	9.8	7.3
2020	93.2%	**8.8**	**236.0**	28.3	22.1	17.9	13.8	9.2	8.2	6.3
Objective		***8***	***25***							

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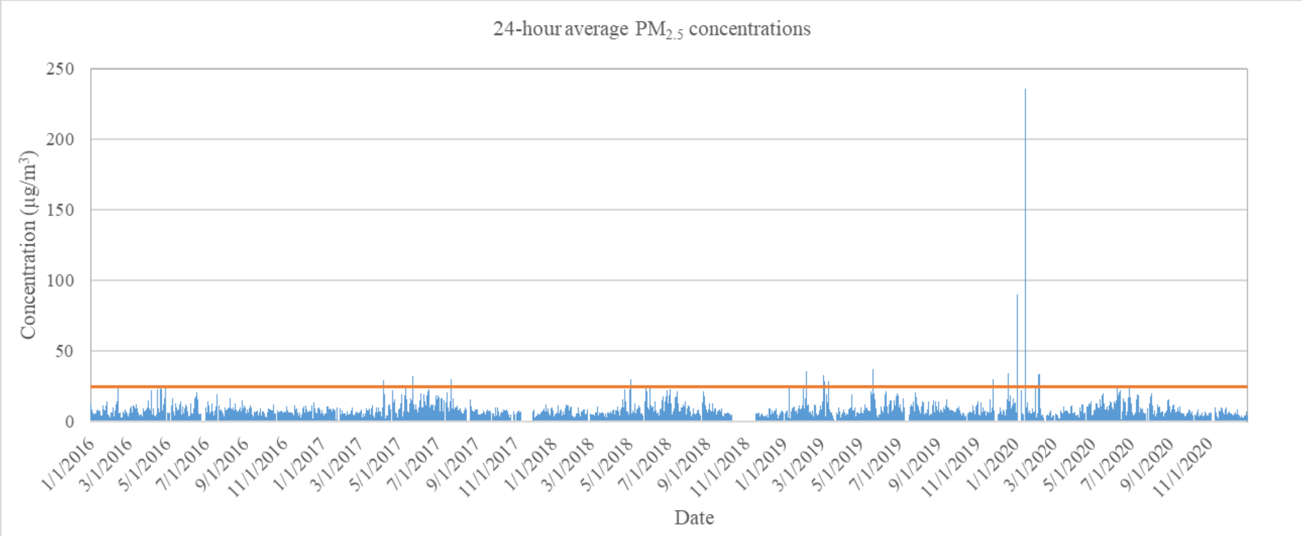

Figure 3-5 24-hour average $PM_{2.5}$ measured concentrations

Table 3.8 24-hour average $PM_{2.5}$ exceedances summary

Year	Number of exceedances	Date of exceedances	Reasons
2016	1	20 April	Planned burns
2017	5	6-7 April, 12 and 23 May	Planned burns
		22 July	Domestic wood heaters
2018	2	2 May	Planned burns
		2 June	Domestic wood heaters
2019	7	4 February	Smoke from bushfires
		20 May	Planned burns
		3, 4 and 10 March, 26 November, 20 December	Smoke from bushfires
2020	5	3, 15 and 31 January, 6 and 7 February	

3.3.2.3 ADOPTED BACKGROUND DATA

The Air Pollution guideline (EPA Victoria 2022) requires cumulative concentrations (contribution from the Project plus background) to be assessed against corresponding criteria for each pollutant. Time-varying 24-hour average data for PM_{10} and $PM_{2.5}$ were used as background. Where data are missing, the 70th percentile concentrations for that year were used to fill that data gap for development of a continuous background dataset.

The background data adopted for the assessment are summarised in Table 3.9.

Table 3.9 Adopted background data

Pollutant	Averaging period	Background (µg/m³)
PM_{10}	24-hour Annual	Time-varying Time-varying
$PM_{2.5}$	24-hour	Time-varying

	Annual	Time-varying
Deposited dust	Annual average	None
RCS	Annual average	None

3.4 SENSITIVE RECEPTORS

The Guideline for assessing and minimising air pollution in Victoria (EPA 2021) describes a sensitive land use as:

'*A land use where it is plausible for humans to be exposed over durations greater than 24 hours, such as residential premises, education and childcare facilities, nursing homes, retirement villages, hospitals*'.

Table 3.10 presents the nearest sensitive receptors identified in this assessment and Figure 3-6 shows the receptor locations. These sensitive receptors are intended to be representative of the residences in proximity to the Project site. The modelled grid provides assessment for all other receptors not specifically included in the dispersion model.

Table 3.10 Modelled sensitive receptors

Sensitive receptor ID	Location		Approximate Distance from site boundary (M)	Direction from site	Type
	Easting (m)	Northing (m)			
R1	377923	5756572	142	East	Residential
R2	376675	5756864	127	Southwest	Residential
R3	376574	5757001	114	Southwest	Residential
R4	376539	5756864	223	Southwest	Residential
R5	376151	5757617	169	West	Residential

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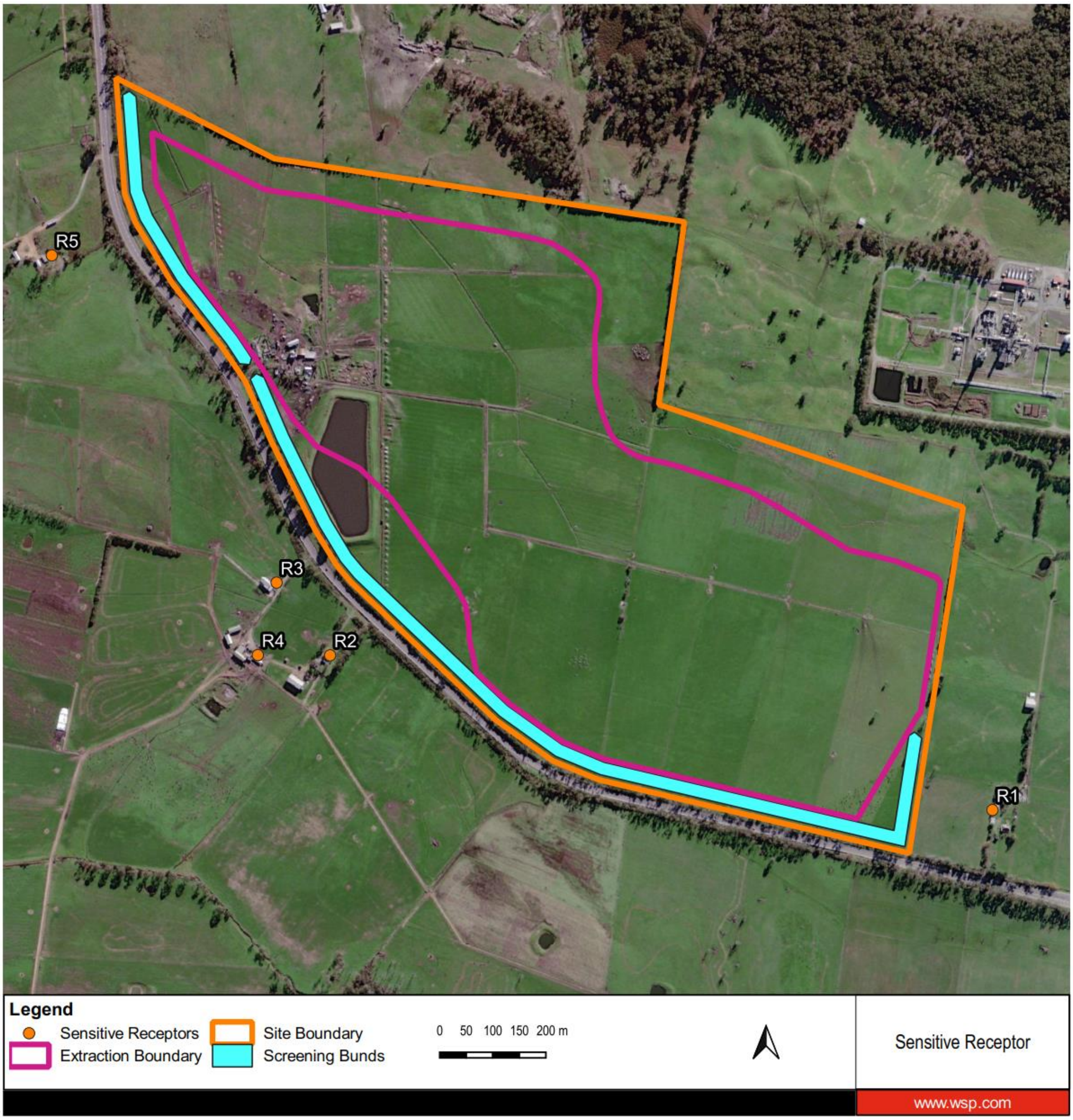

Figure 3-6 Sensitive receptors

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4 Air Quality Impact Assessment

4.1 ASSESSMENT APPROACH

The assessment methodology was conducted with consideration to the EPA Victoria draft *Guidance Notes for Using the Regulatory Air Pollution Model AERMOD in Victoria*, Publication 1551, October 2013 (EPA Victoria 2013). EPA Victoria has adopted the USEPA regulatory air dispersion model, AERMOD, as the approved regulatory air dispersion model for impact assessments in Victoria. As such, the following modelling approach was conducted for the assessment of potential dust impacts associated with the Project operation:

- Using TAPM and AERMET to develop meteorological input files for AERMOD.
- Using AERMOD to predict GLCs for dust emissions generated from the Project operation.
- Compare cumulative concentrations against assessment criteria for compliance assessment.

4.2 MODEL CONFIGURATION

4.2.1 METEOROLOGICAL MODELLING

Meteorological data files were developed in accordance with draft EPA Publication 1550 '*Guidelines for Input Meteorological Data AERMOD*', October 2013, Publication No. 1550 (EPA Victoria 2013).

The simulation of air quality impacts from the Project site requires the use of representative hourly meteorological data spanning five calendar years for surface and upper air observations. The closest BoM station where surface observations are available is located at the Rhyll AWS approximately 29 km southwest of the site. There is no BoM station within 5 km of the Project site. As such, site-specific surface and upper meteorological data was developed using the Commonwealth Scientific and Industrial Research Organisation (CSIRO) meteorological and prognostic air pollution model, TAPM.

4.2.1.1 TAPM

The meteorological component of TAPM is an incompressible, optionally non-hydrostatic, primitive equation model with a terrain-following vertical co-ordinate for three dimensional simulations. The model is connected to '*databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature and synoptic –scale meteorological analysis for various regions around the world*'. Updated terrain and land use data together with other default dataset were used to generate synthetic meteorological files for the period 1 January 2016 to 31 December 2020.

TAPM was run adopting the setup prescribed by EPA publication 1550 and used the following parameters:

- Outer grid resolution of 30 km with nesting grids 10 km, 3 km, 1 km and 0.3 km.
- Grid centre of 38º19.5' S, 145º35.5' E (MGA Zone 55H 376893 m E, 5757320 m S).
- 41 by 41 horizontal grid points.
- 25 vertical levels (10 m, 25 m, 50 m, 100 m, 150 m, 200 m, 250 m, 300 m, 400m, 500 m, 600 m, 750 m, 1000 m, 1250 m, 1500 m, 1750 m, 2000 m, 2500 m, 3000 m, 3500 m, 4000 m, 5000 m, 6000 m, 7000 m and 8000 m).
- 9-Second terrain height database.
- National Dynamic Land Cover Dataset 2.1.
- Synoptic analysis data for the period 1 January 2016 to 31 December 2020.
- TAPM default databases for soil type and leaf area index.

TAPM's output was exported as a surface and upper air station file at MGA Zone 55H 376893 m E, 5757320 m S for incorporation into AERMET.

4.2.1.2 AERMET

To construct site-specific surface file for AERMET, the following TAPM-generated parameters extracted at the site location (MGA Zone 55H 376893 m E, 5757320 m S) were used in accordance with the requirements of the EPA publication 1550:

- wind speed at 10 m
- wind direction at 10 m
- screen level temperature (i.e., 2 m)
- screen level relative humidity (i.e., 2 m)
- net radiation
- mixing height.

In the absence of a TAPM output for some surface meteorological parameters, measured data were adopted at the nearest AWS station. Station pressure and precipitation data from the nearest AWS station at Rhyll, and cloud cover at the Moorabbin Airport station, the nearest AWS station that collects cloud data, were used.

Table 4.1 presents surface roughness, albedo and Bowen Ratio values used in AERMET for generating AERMOD compatible surface meteorological files.

Upper air data extracted from TAPM was reconfigured to provide a profile file in AERMOD compatible format.

Table 4.1 Surface roughness, albedo and Bowen Ratio values used in AERMET

Parameter	**Season**	**Sector**			
		0º-55º	**55º-95º**	**95º-145º**	**145º-360º**
Surface roughness	Summer	0.4	0.12	0.3	0.16
	Autumn	0.4	0.12	0.3	0.16
	Winter	0.275	0.039	0.3	0.097
	Spring	0.335	0.075	0.3	0.125
Albedo	Summer	0.169			
	Autumn	0.169			
	Winter	0.179			
	Spring	0.169			
Bowen Ratio	Summer	0.42			
	Autumn	0.5225			
	Winter	0.5225			
	Spring	0.405			

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4.2.2 DISPERSION MODELLING

4.2.2.1 AIR DISPERSION MODEL

Atmospheric dispersion modelling mathematically simulates the transport and fate of pollutants emitted from a source into the atmosphere. Sophisticated software with algorithms that incorporate source quantification, surface contours and topography, as well as meteorology can reliably predict the downwind concentrations of these pollutants.

AERMOD is a new generation air dispersion model designed for short-range dispersion of airborne pollutants in steady state plumes that uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour. The model produces output maps of GLCs, as a function of plume spread, which facilitated visual interpretation of key pollutant concentration isopleths. The model enables, through its statistical output, direct comparisons with national ambient air quality standards for compliance testing.

Air dispersion modelling was undertaken using the latest version of EPA regulatory model AERMOD (Version 19191) in Victoria, in accordance with the requirements of the EPA Publication 1551 (EPA Victoria, 2013).

4.2.2.2 MODELLED RECEPTORS

The AERMOD receptor grid was centred at the centre of the Project site of 377197 m E and 5757046 m S. To provide a representative receptor grid and a reasonable model run time, a multi-tier grid was used in this assessment. The grid setup listed in Table 4.2 is illustrated in Figure 4-1.

The sensitive receptors identified in Table 3.10 were also included in the model.

Table 4.2 Multi-tier grid setup in AERMOD

Tier	Distance from centre (m)	Tier spacing (m)
1	1500	50
2	3000	100

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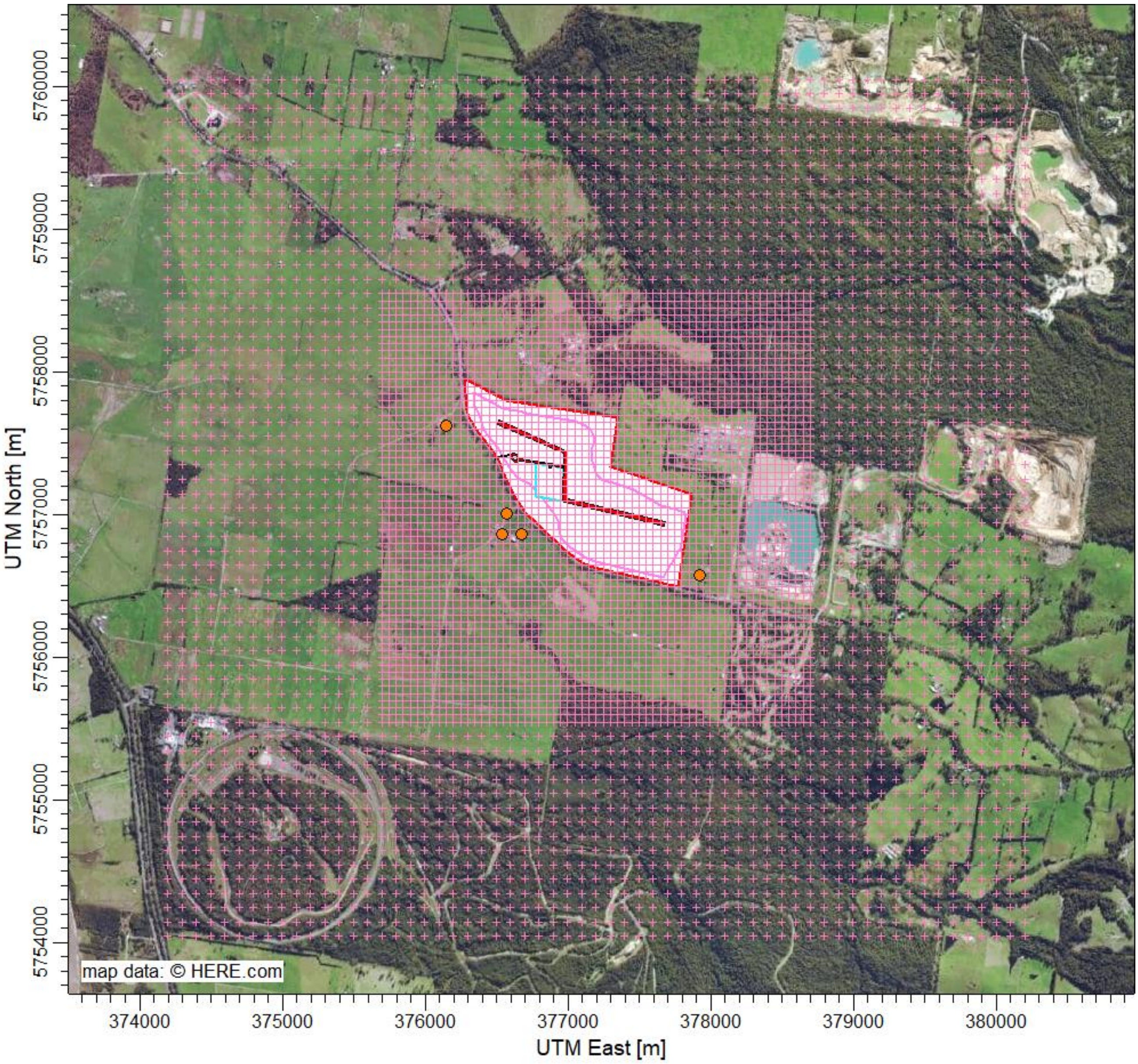

Figure 4-1 Modelled grid receptors in AERMOD

4.3 EMISSION ESTIMATION

4.3.1 METHODOLOGY

Emission rates for activities at the Project site were determined using National Pollutant Inventory (NPI) emission factors or formula and the United States Environmental Protection Agency (USEPA) AP-42. An emission factor is a value representing the relationship between an activity and the rate of emissions of a specified pollutant. Emission factors are developed based on test data, material mass balance studies and engineering estimates.

Emission estimates for the Project were based on the following NPI and USEPA AP-42 references:

- NPI Emission Estimation Technique Manual for Mining Version 3.1 (NPI Mining)
- AP-42 Section 11.19.2: Crushed Stone Processing and Pulverized Mineral Processing
- AP-42 Section 13.2.2: Unpaved Roads

— AP-42 Section 13.2.4 Aggregate Handling and Storage piles.

The emission calculations and resultant emission rates are discussed in the following sections using the equation presented below and information provided by LLSR.

Emission factors are expressed as a function of the weight, volume, distance, or duration of the activity emitting the pollutant. The general equation used for the estimation of emissions is:

$$E = A \times EF \times \left(1 - \frac{ER}{100}\right)$$

Where:

E = emission rate
A = activity rate
EF = emission factor
ER = overall emission reduction efficiency (%)

4.3.2 MODELLING SCENARIOS

The screening bund along the site boundary would be built up in the first two to three years of site operations using on-site topsoil and overburden materials. After the screening bund is completed, excessive topsoil and overburden would be placed at temporary dumps for backfill. Dry screening would also be used intermittently to process some topsoil for sale and for screening and blending mortar sands at this stage.

To capture the worst impacts from site operations at different stages, two scenarios were considered in this assessment:

- Scenario 1: sand extraction at stage 1 while the screening bund is under construction (in the first three years of site operations)
- Scenario 2: sand extraction at stage 3 following completion of the screening bund (more than five years following commencement of site operations)

The emission sources for each scenario have been conservatively placed at locations close to sensitive receptors.

It is noted that the total depth of extraction is expected to be approximately 30 m below the current surface level, and the preliminary groundwater assessment indicates the depth of groundwater is approximately 6 m below the natural surface level. As dust generated during underwater sand extraction is expected to be negligible, sand extraction activities above the groundwater level only have been considered in this assessment.

4.3.3 EMISSION SOURCES

Fugitive emissions at the Project site have the potential to arise from the following sources:

SCENARIO 1:

- machinery operation (i.e., excavators, scrapers and dozers)
- materials handling (loading and unloading trucks)
- wheel generated dust from unpaved roads
- wind erosion from stockpiles and other exposed areas.

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SCENARIO 2:

- machinery operation (i.e., excavators, scrapers and dozers)
- materials handling (loading and unloading trucks)
- wheel generated dust from unpaved roads
- dry screening and associated activities

— wind erosion from stockpiles and other exposed areas.

4.3.4 EMISSION INVENTORY

Most of the dust emissions are expected to be generated during working hours except for wind erosion which would occur at any time dependent on meteorological conditions. Standard working hours for site operations are as follows:

- Sand extraction and related activities:
  - Monday to Friday: 7:00 am to 5:00 pm. 48 weeks per year.
- The sale of sand product:
  - Monday to Friday: 6:00 am to 6:00 pm.
  - Saturday: 6:00 am to 1:00 pm.

AERMOD was configured based on the above working hours. For 24-hour average modelling, it is assumed air emissions would be emitted every working day to capture the worst impacts.

As emissions associated with topsoil and overburden removal would only occur for a short period of time each year, emission rates presented in the following sections were adjusted using a factor determined by the actual emission period across the one-year modelling period to achieve a representative level of the annual average PM_{10} and $PM_{2.5}$ concentrations.

Under scenario 2, the screening bund, which would be 5 m high, 25 m wide and fully vegetated along the Project boundary would act as a windbreak. Therefore, a 30% emission reduction rate was adopted for all sources for scenario 2.

Silt content and moisture content used in the assessment are presented in Table 4.3.

Table 4.3 Parameters used for emission estimation

Material	Silt content (%)	Moisture Content (%)
Raw material	8[1]	4[1]
Topsoil	8[1]	4[1]
Overburden	15[2]	10[1]
Haul roads	4.8[3]	N/A

Note: 1. Conservative assumption based on data provided by BCA consulting.
2. Conservative assumption based on Metro Sand Quarry, Nyora Air Quality Impact Assessment Report *(SLR, 2017)*.
3. Average silt content for roads in sand and gravel processing plant listed in AP-42 Section 13.2.2.

4.3.4.1 MACHINERY OPERATION

During operation, one scraper would be used for topsoil removal, one excavator would be used for sand extraction and overburden removal, and one dozer would be working on the screening bund or temporary dump.

Emission factors and equations used for machinery operation are presented in Table 4.4. The emission inventory developed for this modelling assessment is presented in Table 4.5 and Table 4.6.

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Table 4.4 Emission factor equations

Machinery	Emission factor equation	Units	Source	Variables
SCRAPERS (REMOVING TOPSOIL)	$EF_{TSP} = 0.029$ $EF_{PM_{10}} = 0.0073$ $EF_{PM_{2.5}} = 0.047 \times EF_{TSP}$	KG/T	NPI MINING SPCC (1986) DATA	--
Excavators	$EF_{TSP} = \mathrm{k} \times 0.0016 \times \left(\frac{\mathrm{U}}{2.2}\right)^{1.3} \Big/ \left(\frac{\mathrm{M}}{2}\right)^{1.4}$	kg/t	AP-42 Section 13.2.4	k=0.74 (TSP) k=0.35 (PM_{10}) k=0.053($PM_{2.5}$) U: average wind speed (m/s), 3.1m/s M: moisture content (%)
Dozers	$EF_{TSP} = 2.6 \times \left((s)^{1.2} / (M)^{1.3}\right)$ $EF_{PM_{10}} = 0.34 \times \left((s)^{1.5} / (M)^{1.4}\right)$ $EF_{PM_{2.5}} = 0.047 \times EF_{TSP}$	kg/h/vehicle	NPI Mining SPCC (1986) data	s: silt content (%) M: moisture content (%)

Table 4.5 Emission inventory for excavators and scrapers

Machinery	Location	Operation period	Emission factors (kg/t)			Throughput (t/h)	Control measures and reduction rate	Modelled emission rates (g/s)		
			TSP	PM_{10}	$PM_{2.5}$			TSP	PM_{10}	$PM_{2.5}$
Scenario 1										
Scraper	Topsoil	4 days/yr	0.029	0.0073	0.0014	90	Water spray (wet surface) (50%)	0.363	0.091	0.017
Excavator	Overburden	28 days/yr	1.94E-04	9.19E-05	1.39E-05	600	No control	0.032	0.015	0.0023
Excavator	Extraction	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	125	No control	0.024	0.012	0.0017
Scenario 2										
Scraper	Topsoil	4 days/yr	0.029	0.0073	0.0014	90	Water spray + windbreaks (65%)	0.254	0.064	0.0119
Excavator	Overburden	28 days/yr	1.94E-04	9.19E-05	1.39E-05	600	Windbreaks (30%)	0.023	0.011	0.0016
Excavator	Extraction	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	125	Windbreaks (30%)	0.017	0.008	0.0012

Table 4.6 Emission inventory for the dozer

Machinery	Modelled location	Operation period	Emission factors (kg/h/vehicle)			Control measures and reduction rate	Modelled emission rates (g/s)		
			TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Scenario 1									
Dozer	Screening bund	32 days/yr	3.36	0.79	0.1579	No control	0.933	0.218	0.044

Machinery	Modelled location	Operation period	Emission factors (kg/h/vehicle)			Control measures and reduction rate	Modelled emission rates (g/s)		
			TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Scenario 2									
Dozer	Temporary dump	32 days/yr	3.36	0.79	0.1579	Windbreaks (30%)	0.653	0.1529	0.0307

4.3.4.2 MATERIAL HANDLING

Material handling operations at the Project site include the transfer of material by means of loading and unloading trucks, loading and dumping at stockpiles. Emission equations used for material handling is presented Table 4.7 and the emission inventory is presented in Table 4.8.

Table 4.7 Emission factor equations

Activity	Emission factor equation	Units	Source	Variables
Materials handling	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} / \left(\frac{M}{2}\right)^{1.4}$	kg/t	AP-42 Section 13.2.4	k=0.74 (TSP) k=0.35 (PM_{10}) k=0.053($PM_{2.5}$) U: average wind speed (m/s), 3.1m/s M: moisture content (%)

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Table 4.8 Emission inventory for material handling

Scenario	Activities	Operation period	Emission factors (kg/t)			Throughput (t/h)	Control measures and reduction rate	Modelled emission rates (g/s)		
			TSP	PM_{10}	$PM_{2.5}$			TSP	PM_{10}	$PM_{2.5}$
Scenario 1	Loading trucks at stage 1	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	125	No control	0.0243	0.0115	0.00174
	Loading trucks at overburden	28 days/yr	1.94E-04	9.19E-05	1.39E-05	600	No control	0.0324	0.0153	0.00232
	Loading sand product to trucks for sale	48 weeks/yr	5.13E-04	2.42E-04	3.67E-05	105	No control	0.0150	0.0071	0.00107
	Loading at raw stockpile	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	105	No control	0.0204	0.0097	0.00146
	Dumping to raw stockpile	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	125	No control	0.0243	0.0115	0.00174
	Dumping sand to wet processing plant	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	105	No control	0.0204	0.0097	0.00146
	Dumping topsoil to bund	4 days/yr	7.01E-04	3.31E-04	5.02E-05	90	No control	0.0175	0.0083	0.00125
	Dumping overburden to bund	28 days/yr	1.94E-04	9.19E-05	1.39E-05	600	No control	0.0324	0.0153	0.00232
Scenario 2	Loading trucks at stage 3	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	125	Windbreaks (30%)	0.0170	0.0081	0.00122
	Loading trucks at overburden	28 days/yr	1.94E-04	9.19E-05	1.39E-05	600	Windbreaks (30%)	0.0227	0.0107	0.00162
	Loading sand product to trucks for sale	48 weeks/yr	5.13E-04	2.42E-04	3.67E-05	105	Windbreaks (30%)	0.0105	0.0050	0.00075
	Loading screening product to trucks for sale	24 days/yr	7.01E-04	3.31E-04	5.02E-05	100	Windbreaks (30%)	0.0136	0.0064	0.00098
	Loading at raw stockpile	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	105	Windbreaks (30%)	0.0143	0.0068	0.00102
	Dumping to raw stockpile	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	125	Windbreaks (30%)	0.0170	0.0081	0.00122
	Dumping to dry screening stockpile	24 days/yr	7.01E-04	3.31E-04	5.02E-05	100	Windbreaks (30%)	0.0136	0.0064	0.00098
	Dumping sand to wet processing plant	48 weeks/yr	7.01E-04	3.31E-04	5.02E-05	105	Windbreaks (30%)	0.0143	0.0068	0.00102
	Dumping topsoil to temporary dump	4 days/yr	7.01E-04	3.31E-04	5.02E-05	90	Windbreaks (30%)	0.0123	0.0058	0.00088
	Dumping overburden to temporary dump	28 days/yr	1.94E-04	9.19E-05	1.39E-05	600	Windbreaks (30%)	0.0227	0.0107	0.00162

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4.3.4.3 WHEEL GENERATED DUST FROM UNPAVED ROADS

Vehicles moving on unpaved haulage roads would generate dust by the force of the wheels on the road surface. A scraper would be used for topsoil transportation and trucks would be used for sand and overburden transportation.

Emission equations used in this assessment are presented in Table 4.9 and the emission inventory for wheel generated dust from unpaved roads is presented in Table 4.10.

Table 4.9 Emission factor equations

Activity	Emission factor equation	Units	Source	Variables
Trucks travelling on unpaved roads	$EF_{TSP} = \frac{0.4536}{1.6093} \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$ $EF_{PM_{10}} = \frac{0.4536}{1.6093} \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$ $EF_{PM_{2.5}} = 0.1 \times EF_{PM_{10}}$	kg/VKT	NPI Mining AP-42 Section 13.2.2	s: silt content (%) W: vehicle gross mass (t)
Scrapers (travel mode)	$EF_{TSP} = 9.6 \times 10^{-6} \times s^{1.3} \times W^{2.4}$ $EF_{PM_{10}} = 1.32 \times 10^{-6} \times s^{1.3} \times W^{2.4}$ $EF_{PM_{2.5}} = 0.1 \times EF_{PM_{10}}$	kg/VKT	NPI Mining AP-42 Section 13.2.2	s: silt content (%) W: vehicle gross mass (t)

Table 4.10 Emission inventory for wheel generated dust from unpaved roads

Roads	Operation period	Average weight(t)	Emission factors (kg/VKT)			Single Trips/hour	Road length (m)	Control measures and reduction rate	Modelled emission rates (g/s)		
			TSP	PM_{10}	$PM_{2.5}$				TSP	PM_{10}	$PM_{2.5}$
Scenario 1											
Stage 1 to haul road	48 weeks/yr	52	3.92	1.11	0.11	6.3	176	Level 2 watering (75%)	0.300	0.085	0.0085
Haul road	48 weeks/yr	52	2.74	0.70	0.07	6.3	843		1.004	0.256	0.0256
Haul road to processing plant	48 weeks/yr	52	2.74	0.70	0.07	6.3	100		0.119	0.030	0.0030
Topsoil to bund (scraper)	4 days/yr	74	4.39	0.60	0.06	6	377		0.690	0.095	0.0095
Overburden to bund	28 days/yr	52	6.09	1.95	0.19	30	207		2.626	0.841	0.0841
Scenario 2											
Stage 3 to haul road	48 weeks/yr	52	3.92	1.11	0.11	6.3	144	Level 2 watering + windbreaks (82.5%)	0.172	0.048	0.0048
Haul road	48 weeks/yr	52	2.74	0.70	0.07	6.3	253		0.211	0.054	0.0054
Haul road to processing plant	48 weeks/yr	52	2.74	0.70	0.07	6.3	100		0.083	0.021	0.0021
Topsoil to dump (scraper)	4 days/yr	74	4.39	0.60	0.06	6	104		0.133	0.018	0.0018
Overburden to dump	28 days/yr	52	6.09	1.95	0.19	30	123		1.096	0.351	0.0351

4.3.4.4 WIND EROSION

Dust emissions are expected to occur due to the wind erosion of stockpiles and exposed areas. The following sources potentially subject to wind erosion were identified:

- Extraction pit (scenario 1 and 2)
- Product stockpile (scenario 1 and 2)
- Raw material stockpile (scenario 1 and 2)
- Screening bund (scenario 1)
- Temporary dump (scenario 2)
- Dry screening stockpile (scenario 2)

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Sand extraction would be conducted in stages, and an area of approximately 30,000 m^2 would be initially developed and an extraction area of 10,000 m^2 would be extended each year to maintain production. A total area of 40,000 m^2 was conservatively modelled in this assessment.

The screening bunds would be formed in segments in the first two to three years' operation. Each segment, approximately 100 m long, would be covered with soil and grassed as soon as practicable once completed. For assessment purpose, one segment of the screening bund was conservatively placed at the location closest to the sensitive receptor R1 for the whole year.

Default emission factors for wind erosion from the NPI Emission Estimation Technique Manual for Mining 2012 (NPI Mining 2012) was adopted in this assessment and the emission inventory is presented in Table 4.11.

Table 4.11 Emission inventory for wind erosion

Sources	Emission factors ($g/m^2/s$)			Area (m^2)	Control measures and reduction rate	Modelled emission rates (g/s)		
	TSP	PM_{10}	$PM_{2.5}$			TSP	PM_{10}	$PM_{2.5}$
Scenario 1								
Extraction pit-stage 1	1.11E-05	5.56E-06	5.22E-07	40000	Water spray/wet surface (50%)	0.222	0.111	0.0104
Screening bund	1.11E-05	5.56E-06	5.22E-07	2500	Water spray+ revegetation (50%)	0.014	0.007	0.0007
Product Stockpile	1.11E-05	5.56E-06	5.22E-07	3600	Water spray/wet (50%)	0.020	0.010	0.0009
Raw material stockpile	1.11E-05	5.56E-06	5.22E-07	11905	Water spray/wet (50%)	0.066	0.033	0.0031
Scenario 2								
Extraction pit-stage 3	1.11E-05	5.56E-06	5.22E-07	40000	Water spray/wet + windbreaks (65%)	0.156	0.078	7.31E-03
Temporary dump	1.11E-05	5.56E-06	5.22E-07	1500	Water spray + windbreaks (65%)	0.006	0.003	2.74E-04
Product Stockpile	1.11E-05	5.56E-06	5.22E-07	3600	Water spray/wet + windbreaks (65%)	0.014	0.007	6.58E-04
Dry screening stockpile	1.11E-05	5.56E-06	5.22E-07	200	Water spray/wet + windbreaks (65%)	0.001	0.0004	3.66E-05
Raw material stockpile	1.11E-05	5.56E-06	5.22E-07	11905	Water spray/wet + windbreaks (65%)	0.046	0.023	2.18E-03

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4.3.4.5 SCREENING

Sand processing would mainly be wet processing. Dry screening would be used for some topsoil processing after the screening bund is fully formed. This activity would only occur in scenario 2. The operational frequency would be less than one day per fortnight.

Other activities associated with screening include:

- Loading to the screen
- Conveyor transfer point
- Conveyor dropping point
- Unloading from stockpiles

Emission factors for screening and conveyor transfer point were obtained from AP-42 Section 11.19.2. Emission equations (refer to Table 4.7) for other associated activities were adopted from AP-42 Section 13.2.4.

Given the small footprint of the screening plant and multiple emission sources contained within the plant, all sources associated with dry screening were combined and modelled as one volume source.

The emission inventory for dry screening and associated activities is presented in Table 4.12.

Table 4.12 Emission inventory for dry screening and associated activities

Sources	Emission factors (kg/t)			Throughput (t/h)	Control measures and reduction rate	Modelled emission rates (g/s)		
	TSP	PM_{10}	$PM_{2.5}$			TSP	PM_{10}	$PM_{2.5}$
Loading to screen	7.01E-04	3.31E-04	5.02E-05	100	Windbreaks (30%)	0.014	0.006	0.001
Screening (Controlled)	0.0011	0.00037	0.000025	100		2.14E-02	0.007	0.000
Conveyor transfer point (controlled)	0.00007	2.30E-05	6.50E-06	100		1.36E-03	0.000	0.000
Conveyor dropping point	7.01E-04	3.31E-04	5.02E-05	100		0.014	0.006	0.001
Unloading from stockpiles	7.01E-04	3.31E-04	5.02E-05	100		0.014	0.006	0.001
Total						0.064	0.027	0.0035

4.3.4.6 ASSUMPTIONS

The assessment was conducted based on the following assumptions:

- Time-varying 24-hour average data for PM_{10} and $PM_{2.5}$ were used as background, and where data are missing, the 70th percentile concentrations for that year were used to fill that gap to develop a continuous background dataset.
- Dry screening operations would be used intermittently, approximately one day per fortnight.
- Construction of the screening bunds would be complete within the first two to three years of site operations.
- Emission sources were conservatively placed at locations close to sensitive receptors.
- The sand extraction depth would be up to 30 m below the current surface level and only the top 6 m would be above groundwater level. This assessment conservatively configured all emission sources on and above ground level.

- For 24-hour average modelling, it is assumed air emissions would be emitted every working day to capture the worst-case impacts.
- For monthly and annual average modelling, adjusting factors determined by the actual emission period and across a one-year modelling period were applied to emission rates to achieve representative monthly and annual average concentrations.
- The screening bunds, which would be 5 m high, 25 m wide and fully vegetated along the Project boundary are considered to act as a windbreak and a 30% emission reduction rate was adopted for all sources of scenario 2.
- A total area of 40,000 m^2 was conservatively modelled in this assessment for sand pit extraction. In practice, the exposed area above groundwater level is expected to be lower than that.
- The screening bunds would be formed in segments in the first two to three years of operation. In this assessment, one segment of the screening bund was conservatively placed at the location closest to the sensitive receptor R1 for the whole year.
- The access road from site entrance to the processing plant would be sealed and a wheel washing facility would be located near the plant to ensure all truck wheels are washed before leaving the site. As such, no air emissions were considered from the sealed access road.
- At the time of preparing this report there was no information available on the proportion of RCS in the $PM_{2.5}$ fraction. It was conservatively assumed 100% of the $PM_{2.5}$ fraction is present as RCS.

4.3.4.7 SOURCE LOCATIONS

Indicative locations of emission sources modelled for each scenario are presented in Figure 4-2 and Figure 4-3.

It is noted that haul road sources were configured as line volume sources and wind erosion area sources were configured as separate volume sources in AERMOD.

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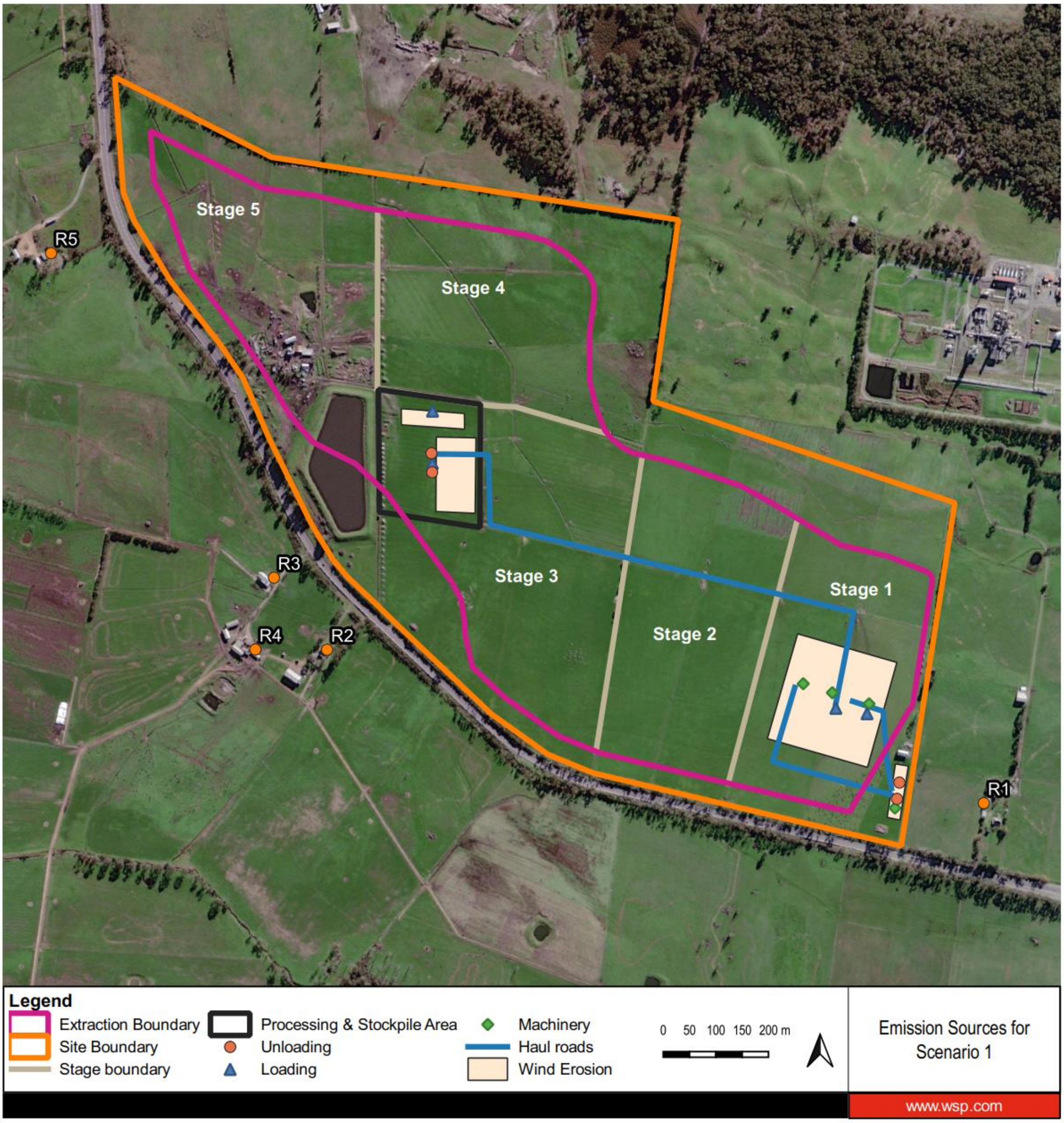

Figure 4-2 Location of modelled emission sources for scenario 1

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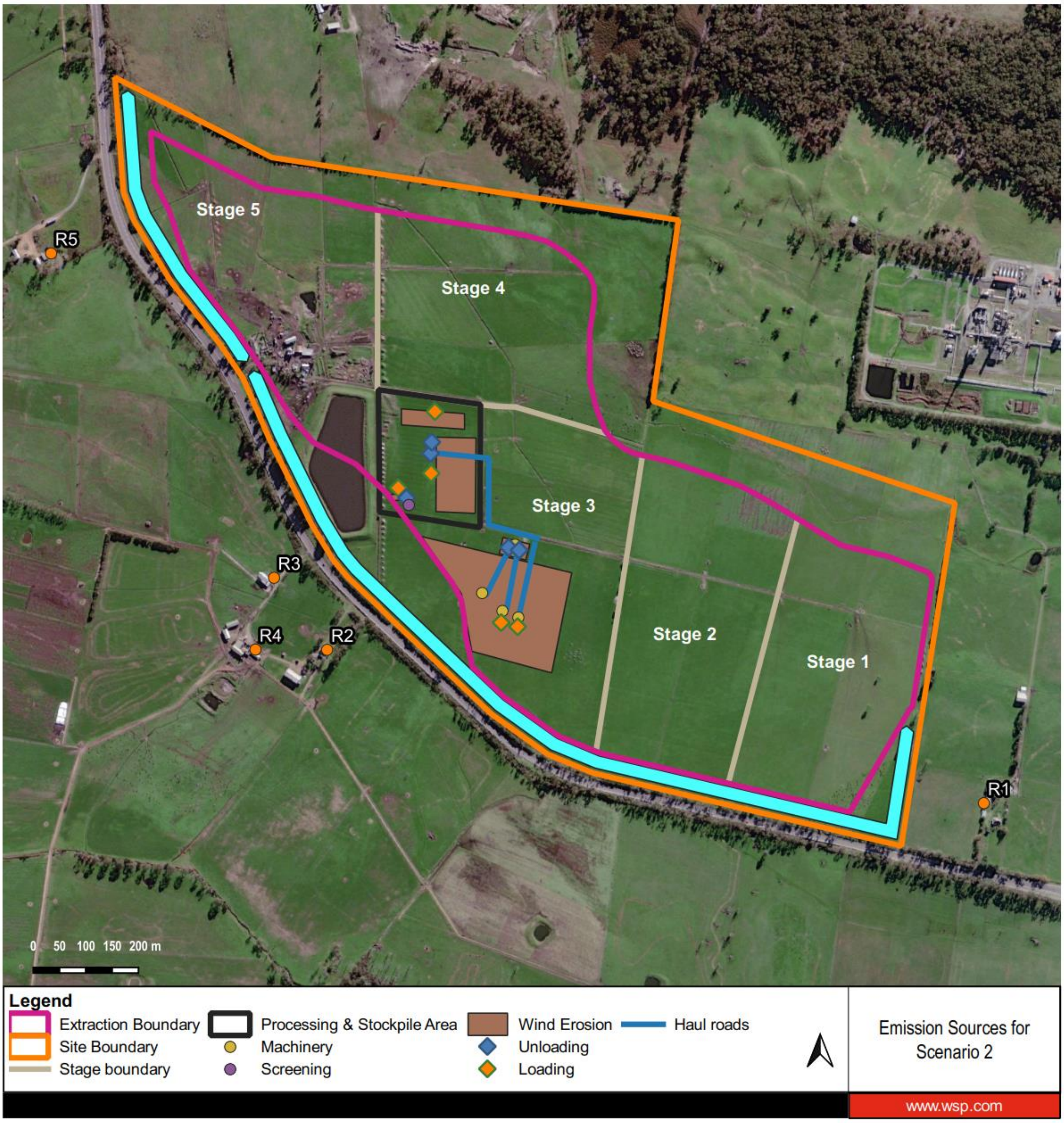

Figure 4-3 Location of modelled emission sources for scenario 2

4.4 PARTICLE SIZE DISTRIBUTION

PM_{10} and $PM_{2.5}$ were modelled as a gas, and TSP was modelled as particles to determine dust deposition levels. As site-specific particle size distribution was not available at the time of modelling, the distribution of particles has been derived from measurements in the State Pollution Control Commission (SPCC 1986) study and the data adopted in AERMOD are presented in Table 4.13.

Table 4.13 Particle size distribution

Particle diameter (µm)	Mass fraction	Particle density (g/cm^3)
2.5	0.0468	1.5

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10	0.344	1.5
30	0.609	1.5

4.5 DISPERSION MODELLING RESULTS

The maximum predicted incremental concentrations for PM_{10} and $PM_{2.5}$ for averaging periods consistent with the assessment criteria were extracted at modelled sensitive receptors. Background data were added to incremental concentrations to compare cumulative concentrations with relevant APACs.

4.5.1 SCENARIO 1

4.5.1.1 PM_{10}

24-hour average PM_{10} concentrations were extracted from the model outputs at sensitive receptors and added to contemporaneous background concentrations to assess compliance of the 24-hour average criterion. Predicted maximum incremental results over the five modelled years (2016 to 2020) are presented in Table 4.14. Contour plots for the 24-hour average and annual average PM_{10} incremental concentrations are presented in Appendix A.

The predicted maximum project contribution and corresponding cumulative concentrations indicate that the:

- The maximum incremental 24-hour average PM_{10} concentrations at all receptors is 26.5 µg/m^3 (R1) over the five modelled years, and cumulative concentrations (maximum project contribution plus contemporaneous background) are below the assessment criterion of 50 µg/m^3 at all five sensitive receptors.
- Maximum incremental annual average PM_{10} concentrations at all receptors is 1.73 µg/m^3 over the five modelled years, accounting for 8.7% of the assessment criterion. Cumulative concentrations (maximum project contribution plus contemporaneous background) are below the criterion at R1, R2, R4 and R5, and exceeds the criterion at R3 due to the high background concentration. At receptor R3, the background concentration is 19.2 µg/m^3, accounting for 96% of the criterion. The contribution from the Project is 0.95 µg/m^3, accounting for 4.8% of the criterion.

Table 4.14 Predicted 24-hour and annual average PM_{10} concentrations – scenario 1

Receptors	24-hour average (µg/m^3)			Annual average (µg/m^3)		
	Maximum incremental	Background	Cumulative	Maximum incremental	Background	Cumulative
R1	26.5	13.2	39.7	1.73	17.6	19.3
R2	7.6	14.2	21.9	0.76	14.3	15.1
R3	12.1	19.6	31.7	0.95	19.2	**20.2**
R4	6.6	14.2	20.9	0.64	14.3	14.9
R5	3.4	9.7	13.1	0.18	14.5	14.7
APAC			***50***			***20***

Note: Exceedances are highlighted in bold

A 24-hour PM_{10} time series analysis over the five modelled years (2016 to 2020) was undertaken at each of the nearest five sensitive receptors. The results are presented in Table 4.15 and show the increased number of days the 24-hour PM_{10} criterion is exceeded due to Project operations.

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The results indicate that the:

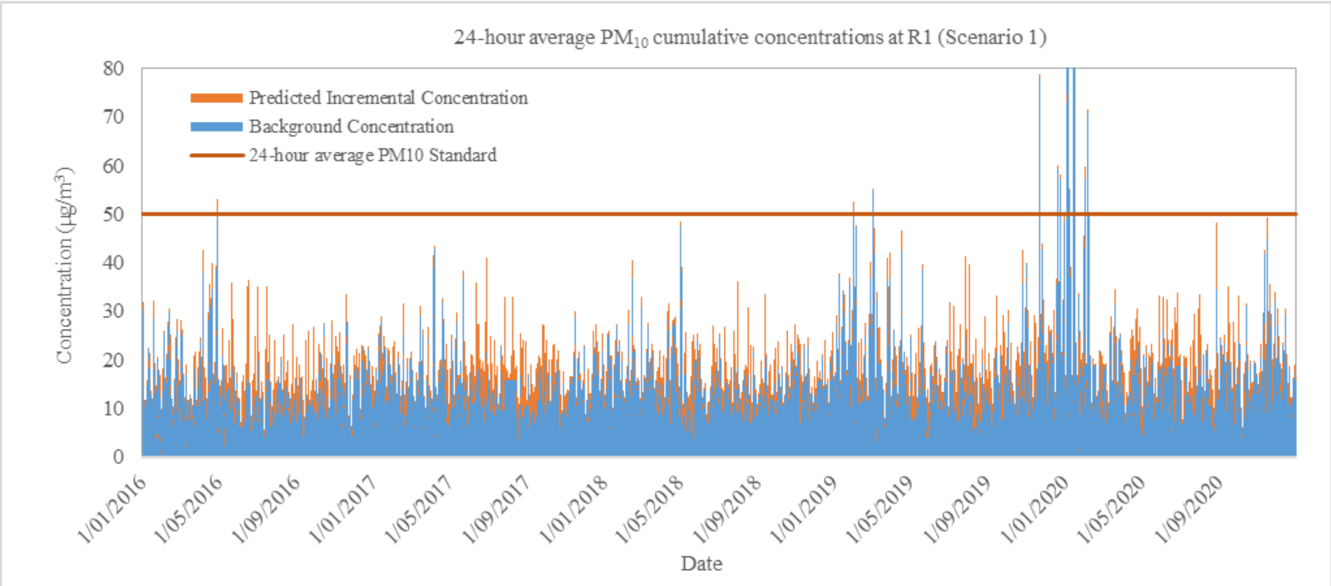
- number of exceedances predicted to occur over five years due to Project operations are increased by two days at receptors R1, R2 and R3. The background concentrations account for 98.4% and 99.5% of the criterion respectively.
- number of exceedances predicted to occur over five years due to Project operations are increased by one day at receptors R4 and R5. The background concentration accounts for 99.5% of the criterion.

Table 4.15 Summary of the number of increased exceedances of the 24-hour average PM_{10} criterion due to Project operations – scenario 1

Date	Background (µg/m³)	Receptors	Incremental (µg/m³)	Cumulative (µg/m³)
28/04/2016	49.2	R1	3.9	**53.1**
		R2	0.9	**50.1**
		R3	0.9	**50.1**
7/02/2020	49.8	R1	0.68	**50.4**
		R2	0.56	**50.3**
		R3	0.63	**50.4**
		R4	0.42	**50.2**
		R5	0.29	**50.1**
APAC				***50***

Note: Exceedances are highlighted in bold

A 24-hour PM_{10} time series plot for the most affected receptor (R1) showing the contribution from the Project and contemporaneous background data is presented in Figure 4-4.



Note: Background concentrations above 80 µg/m³ have been removed from the figure to aid visual representation. The complete background dataset is presented in section 3.3.2.1

Figure 4-4 24-hour average PM_{10} time-series concentrations at R1 (scenario 1)

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4.5.1.2 $PM_{2.5}$

24-hour average $PM_{2.5}$ concentrations were extracted from modelling outputs at sensitive receptors and added to contemporaneous background to assess compliance of the 24-hour average criterion. Predicted maximum incremental results over the five modelled years (2016 to 2020) are presented in Table 4.16. Contour plots for 24-hour average and annual average $PM_{2.5}$ incremental concentrations are presented in Appendix A.

The predicted maximum project contribution and corresponding cumulative concentrations indicate that the:

- Maximum incremental 24-hour average $PM_{2.5}$ concentration at all receptors is 4.4 µg/m³ (R1) over five modelled years, and cumulative concentrations (maximum project contribution plus contemporaneous background) are below the assessment criterion of 25 µg/m³ at all five receptors.
- Maximum incremental annual average $PM_{2.5}$ concentration at all receptors is 0.19 µg/m³ over the five modelled years, accounting for 2.4% of the assessment criterion. Cumulative concentrations (project contribution plus contemporaneous background) exceed the criterion at all five receptors for all modelled years due to existing exceedances of the background concentrations.

Table 4.16 Predicted 24-hour and annual average $PM_{2.5}$ concentrations – scenario 1

Receptors	24-hour average (µg/m³)			Annual average (µg/m³)		
	Maximum incremental	Background	Cumulative	Maximum incremental	Background	Cumulative
R1	4.4	6.8	11.2	0.19	**8.9**	**9.1**
R2	0.8	14.6	15.4	0.07	**8.4**	**8.5**
R3	1.2	13.8	15.0	0.09	**8.8**	**8.9**
R4	0.7	14.6	15.3	0.06	**8.4**	**8.5**
R5	0.4	4.7	5.1	0.02	**8.1**	**8.1**
APAC			***25***			***8***

Note: Exceedances are highlighted in bold

A 24-hour $PM_{2.5}$ time series analysis over the five modelled years (2016 to 2020) was undertaken at each of the nearest five sensitive receptors. The results are presented in Table 4.17 and show the increased number of days the 24-hour PM_{10} criterion is exceeded due to Project operations.

The results indicate that:

- The number of exceedances predicted to occur over five years due to Project operations are increased by one day at receptor R1. The background concentration accounts for 98% of the criterion.

Table 4.17 Summary of the number of increased exceedances of the 24-hour average $PM_{2.5}$ criterion due to Project operations – scenario 1

Date	Background (µg/m³)	Receptors	Incremental (µg/m³)	Cumulative (µg/m³)
9/06/2020	24.5	R1	0.7	**25.2**
APAC				***25***

Note: Exceedances are highlighted in bold.

A 24-hour $PM_{2.5}$ time series plot for the most affected receptor (R1) showing the contribution from the Project and contemporaneous background data is presented in Figure 4-5.

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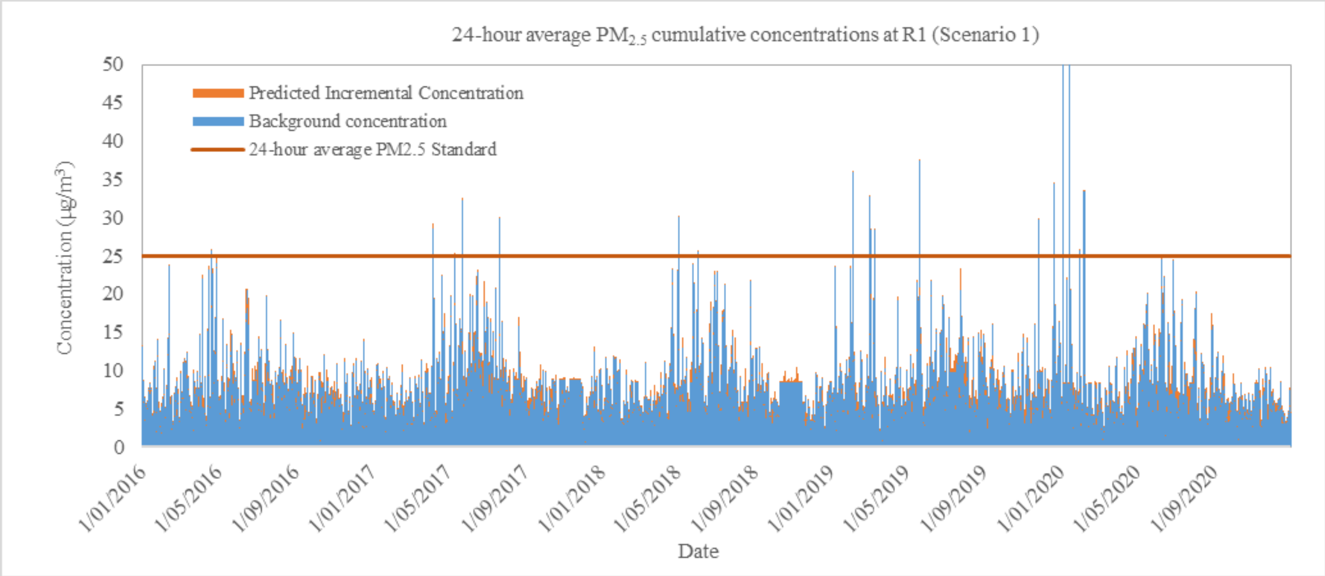

Note: Background concentrations above 50 µg/m³ have been removed from the figure to aid visual representation. The complete background dataset is presented in section 3.3.2.2.

Figure 4-5 24-hour average $PM_{2.5}$ time-series concentrations at R1 (Scenario 1)

4.5.1.3 DEPOSITED DUST

Predicted maximum monthly incremental (project contribution only) dust deposition levels for all sensitive receptors are presented in Table 4.18. Given there is no background monitoring data for dust deposition available at any AAQMS in Victoria, only incremental results are presented. The contour plot for predicted maximum monthly dust deposition levels is presented in Appendix A.

The modelling results indicate that the maximum increase in dust deposition levels at all receptors are below the assessment criterion of 2 g/m^2/month.

Table 4.18 Predicted maximum monthly deposited dust levels

Receptors	**Maximum incremental (g/m^2/month)**
R1	1.6
R2	0.11
R3	0.14
R4	0.09
R5	0.04
Maximum increase in deposited dust criterion	***2***

4.5.2 *SCENARIO 2*

4.5.2.1 PM_{10}

Predicted maximum incremental PM_{10} results over the five modelled years (2016 to 2020) are presented in Table 4.19. Contour plots for 24-hour average and annual average PM_{10} incremental concentrations are presented in Appendix A

The predicted maximum project contribution and corresponding cumulative concentrations indicate that the:

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- maximum incremental 24-hour average PM_{10} concentration at all receptors is 29.2 µg/m^3 (R2) over the five modelled years, and cumulative concentrations (maximum Project contribution plus contemporaneous background) are below the assessment criterion of 50 µg/m^3 at all five sensitive receptors.
- maximum incremental annual average PM_{10} concentration at all receptors is 1.9 µg/m^3 (R2) over the five modelled years, accounting for 9.5% of the assessment criterion. Cumulative concentrations (maximum project contribution plus contemporaneous background) are below the assessment criterion of 20 µg/m^3 at all five receptors.

Table 4.19 Predicted 24-hour and annual average PM_{10} concentrations – scenario 2

Receptors	24-hour average (µg/m^3)			Annual average (µg/m^3)		
	Maximum incremental	Background	Cumulative	Maximum incremental	Background	Cumulative
R1	3.3	19.3	22.6	0.1	17.6	17.7
R2	29.2	19.5	48.7	1.9	14.3	16.2
R3	17.8	14.2	32.1	1.3	14.3	15.6
R4	18.3	19.5	37.8	1.2	14.3	15.5
R5	3.4	8.6	12.0	0.2	19.2	19.4
APAC			***50***			***20***

Note: Exceedances are highlighted in bold

A 24-hour PM_{10} time series analysis over the five modelled years (2016 to 2020) was undertaken at each of the nearest five sensitive receptors. The results are presented in Table 4.20 and show the increased number of days the 24-hour PM_{10} criterion is exceeded due to Project operations.

The results indicate that:

- The number of exceedances predicted to occur over five years due to Project operations are increased by three days at R3. The background concentrations account for 98.4%, 97% and 99.5% of the criterion respectively.
- The number of exceedances predicted to occur over five years due to Project Operations are increased by two days at R3 and R4. The background concentrations account for 98.4% and 99.5% of the criterion respectively.

Table 4.20 Summary of the number of increased exceedances of the 24-hour average PM_{10} criterion due to Project operations – scenario 2

Date	Background (µg/m^3)	Receptors	Incremental (µg/m^3)	Cumulative (µg/m^3)
28/04/2016	49.2	R2	2.6	**51.8**
		R3	1.9	**51.1**
		R4	1.6	**50.8**
30/12/2019	48.5	R2	1.9	**50.4**
7/02/2020	49.8	R2	4.7	**54.5**
		R3	3.0	**52.8**
		R4	3.6	**53.4**
APAC				***50***

Note: Exceedances are highlighted in bold

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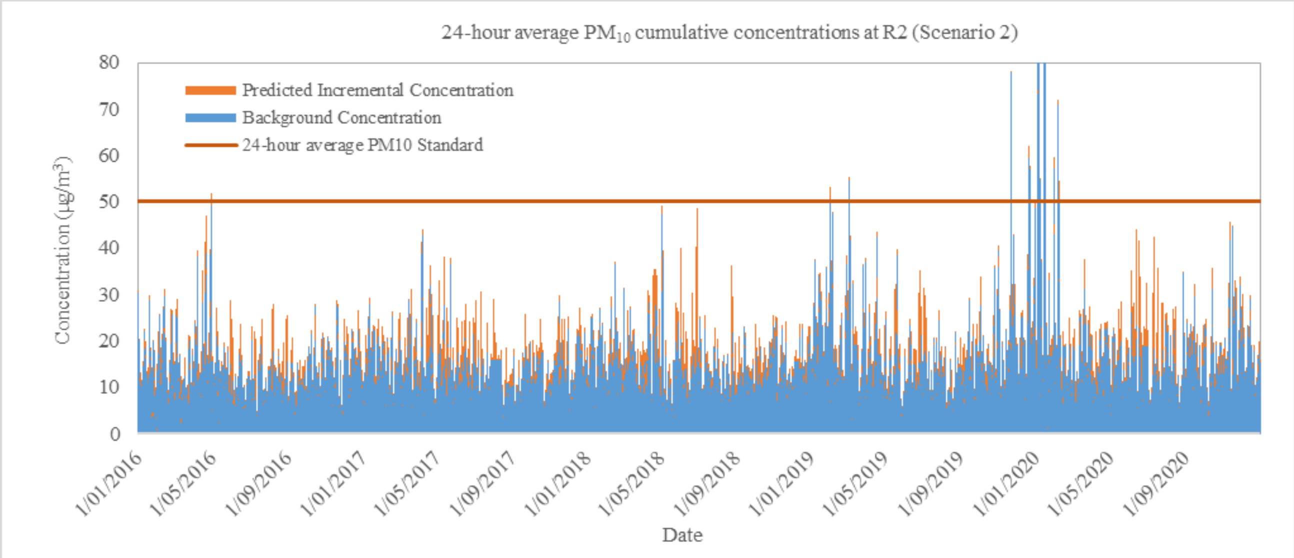
A 24-hour PM_{10} time series plot for the most affected receptor (R2) showing the contribution from the Project and contemporaneous background data is presented in Figure 4-6.



Note: Background concentrations above 80 µg/m³ have been removed from the figure to aid visual representation. The whole background dataset is presented in section 3.3.2.1.

Figure 4-6 24-hour average PM_{10} time-series concentrations at R2 (Scenario 2)

4.5.2.2 $PM_{2.5}$

Predicted maximum $PM_{2.5}$ incremental results over the five modelled years (2016 to 2020) are presented in Table 4.21. Contour plots for 24-hour average and annual average $PM_{2.5}$ incremental concentrations are presented in Appendix A.

The predicted maximum Project contribution and corresponding cumulative concentrations indicate that the:

- maximum incremental 24-hour average $PM_{2.5}$ concentration at all receptors is 4.2 µg/m³ over the five modelled years, and cumulative concentrations (maximum Project contribution plus contemporaneous background) are below the assessment criterion of 25 µg/m³ at R1, R3 and R5. At receptors R2 and R4 the criterion is exceeded with the background concentration accounting for 90% of the criterion.
- maximum incremental annual average $PM_{2.5}$ concentration at all receptors is 0.18 µg/m³ over the five modelled years, accounting for 2.3% of the assessment criterion. Cumulative concentrations (maximum project contribution plus contemporaneous background) exceed the criterion at all five receptors due to existing exceedances of the background.

Table 4.21 Predicted 24-hour and annual average $PM_{2.5}$ concentrations – scenario 2

Receptors	24-hour average (µg/m³)			Annual average (µg/m³)		
	Maximum incremental	Background	Cumulative	Maximum incremental	Background	Cumulative
R1	0.5	18.7	19.2	0.01	**8.9**	**8.9**
R2	4.2	22.5	**26.7**	0.18	**8.4**	**8.6**
R3	2.2	14.6	16.8	0.13	**8.4**	**8.5**
R4	2.6	22.5	**25.1**	0.11	**8.4**	**8.5**
R5	0.5	4.7	5.2	0.02	**8.8**	**8.8**
APAC			***25***			***8***

Note: Exceedances are highlighted in bold

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A 24-hour $PM_{2.5}$ time series analysis over the five modelled years (2016 to 2020) was undertaken at each of the nearest five sensitive receptors. The results are presented in Table 4.22 and show the increased number of days the 24 hour PM_{10} criterion is exceeded due to Project operations.

The results indicate that the

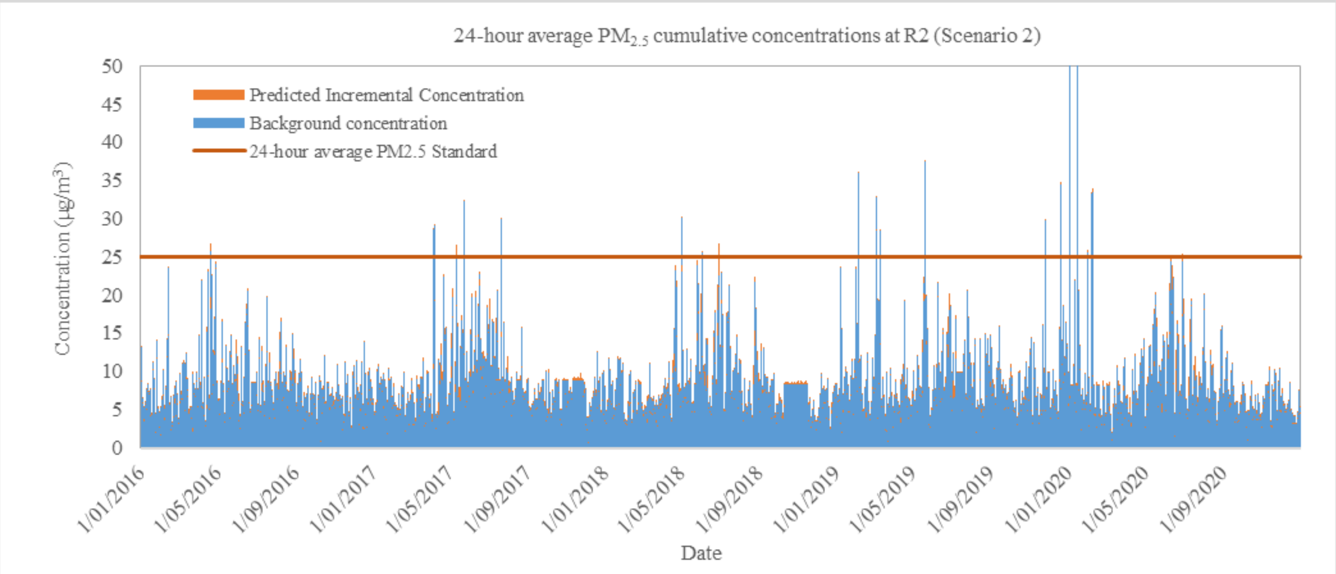
- number of exceedances predicted to occur over five years due to Project operations are increased by three days of at receptor R2. The background concentrations account for 90%, 98% and 97.6% of the criterion respectively.
- number of exceedances predicted to occur over five years due to Project operations are increased by two days of at receptor R4. The background concentrations account for 90% and 97.6% of the criterion respectively.

Table 4.22 Summary of the number of increased exceedances of 24-hour average $PM_{2.5}$ concentrations due to Project operations – scenario 2

Date	Background (µg/m³)	Receptors	Incremental (µg/m³)	Cumulative (µg/m³)
28/06/2018	22.5	R2	4.2	**26.7**
		R4	2.6	**25.1**
9/06/2020	24.5	R2	0.6	**25.1**
28/06/2020	24.4	R2	1.1	**25.5**
		R4	0.7	**25.1**
APAC				***25***

Note: Exceedances are highlighted in bold

A 24-hour $PM_{2.5}$ time series plot for the most affected receptor (R2) showing the contribution from the Project and contemporaneous background data is presented in Figure 4-7.



Note: Background concentrations above 50 µg/m3 have been removed from the figure to aid visual representation. The whole background dataset is presented in section 3.3.2.2

Figure 4-7 24-hour average $PM_{2.5}$ time-series concentrations at R2 (Scenario 2)

4.5.2.3 DEPOSITED DUST

Predicted maximum monthly incremental dust deposition levels are presented in Table 4.23. The contour plot for predicted maximum monthly dust deposition levels for scenario 2 is presented in Appendix A. The modelling results indicate that maximum increase in dust deposition levels for scenario 2 at all receptors are below the assessment criterion of 2 g/m^2/month.

Table 4.23 Predicted maximum monthly deposited dust levels

Receptors	**Maximum incremental (g/m^2/month)**
R1	0.05
R2	0.26
R3	0.20
R4	0.15
R5	0.04
Maximum increase in deposited dust criterion	***2***

4.5.3 RESPIRABLE CRYSTALLINE SILICA

At the time of preparing this report, there was no measured RCS (as $PM_{2.5}$) data available. It was conservatively assumed that 100% of $PM_{2.5}$ is present as RCS. The concentrations of RCS at the Project site and beyond the Site boundary are expected to be much lower.

The predicted annual $PM_{2.5}$ concentrations are as follows:

— Scenario 1: the maximum incremental annual $PM_{2.5}$ concentrations at all five receptors and all of the five modelled years is 0.19 µg/m^3.

— Scenario 2: the maximum incremental annual $PM_{2.5}$ concentrations at all five receptors and all of the five modelled years is 0.18 µg/m^3.

As such, the maximum annual RCS (as $PM_{2.5}$) under the two scenarios is 0.19 µg/m^3, accounting for 6.3% of the 3 µg/m^3 assessment criterion as prescribed in the Guideline for Assessing and Minimising Air Pollution in Victoria (EPA Victoria 2022). The actual proportion of RCS in the $PM_{2.5}$ fraction is expected to be lower during Project operations given that there are no on-site operations where RCS would be generated (i.e., crushing, grinding), the RCS concentrations under scenario 1 and scenario 2 are expected to be lower than the estimated concentrations and below the APAC. It is important to note that the RCS (as $PM_{2.5}$) criterion refers to off-site impacts on the receiving environment only.

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5 MANAGEMENT MEASURES

To minimise potential air quality impacts from air emissions generated from site activities, an Air Quality Management Plan (AQMP) would be developed prior to the commencing of site operations. This plan would identify the key sources (hazards) and types of air pollutants (i.e., PM_{10}, and $PM_{2.5}$) and include management measures to minimise air emissions during Project operations. The AQMP would be proactive focussing on identifying the hazards, assessing the risk, and implementing appropriate controls to ensure emissions are minimised so far as reasonably practical.

Table 5.1 presents management and mitigation measures that would be included in the AQMP, and these proposed controls are industry standards for quarrying operations.

Table 5.1 Proposed management measures

OPERATION	PROPOSED MANAGEMENT MEASURES
Machinery operation	— all plant and equipment to be maintained and regularly serviced in accordance with the manufacturer's instructions — all mobile plant and equipment would be restricted to designated areas
Material handling — Loading trucks — Loading/unloading from stockpiles — Transfer and conveying of material — Excavation works	— dry excavated material to be wetted in particular during dry conditions. — all trucks are not to be overloaded and are to be covered prior to leaving the site. — reduce or suspend operations where dust is observed to be leaving the Site during hot, dry and windy conditions
Wheel generated dust	— all vehicles to adhere to the site speed limit — all paved roads to be swept / cleaned as required — all vehicles to be restricted to designed routes — a water cart to be used on unpaved roads during dry and windy conditions — all trucks leaving the site to pass through an on-site wheel-wash/wheel bath. — all trucks and plant machinery to be maintained and regularly serviced in accordance with the manufacturer's instructions. — reduce or suspend truck movements where dust is observed to be leaving the site

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OPERATION	PROPOSED MANAGEMENT MEASURES
Wind erosion (exposed areas and stockpiles	— all internal haul roads, stockpiles and other exposed areas would be wet down using water trucks as required. — the access road from the site entrance to the processing plant would be sealed. — a wheel wash facility would be located near the stockpile area to ensure all truck wheels would be cleaned before leaving the site. — the screening bunds to be constructed in segments and would be covered with soil and grassed as soon as practicable. — all exposed / disturbed areas would be minimised and would comply with the maximum disturbed area at any given time. — temporary dumps would be soiled and grassed, if to be retained more than 6 months — topsoil and overburden bunds would be vegetated within 6 months of construction. — a water cart to be used to dampen exposed areas. — minimise open areas that may be exposed to wind erosion. — topsoil stripping to be avoided during periods of high winds.
Screening plant	— ensure the water bay bars are operational during screening activities — operations would be reduced or ceased where dust is observed to be leaving the Site — screening activities would cease during excessively windy conditions
Track-out	— tailgates to be locked — any spillage from side rails, tail gates and drawbars to be cleared immediately — all trucks to use the wheel wash prior to leaving the Site
Air monitoring	— daily visual dust monitoring by all staff — where dust is observed to be leaving the site, the Quarry Manager must be notified immediately for remedial action — implement an ambient air monitoring program (see section 5.1)

5.1 MONITORING PROGRAM

A monitoring program at the proposed quarry would be prepared for the Project. The following sections provide details of the program.

5.1.1 PARAMETERS TO BE MONITORED

The following parameters are proposed to be monitored:

- Monthly dust deposition
- Continuous PM_{10} and $PM_{2.5}$
- Continuous meteorological parameters i.e., wind speed and wind direction.

5.1.2 LOCATION OF AMBIENT AIR QUALITY MONITORING STATIONS

Where possible, the sampling equipment would be sited in accordance with Australian Standard AS 3580.1.1 – 2007 '*Methods for the Sampling and Analysis of Ambient Air- Guide to Siting Air Monitoring Equipment*'.

Air quality monitoring would be conducted at the following proposed locations as presented in Table 5.2 and Figure 5-1.

Table 5.2 Ambient air monitoring locations

Monitoring location	Monitoring parameter
Air monitoring location 1	Dust deposition PM_{10} and $PM_{2.5}$ Wind speed and wind direction
Air monitoring location 2	Dust deposition

5.1.3 SAMPLING METHODOLOGIES

5.1.3.1 DUST DEPOSITION

Dust deposition monitoring would be undertaken at two locations (Table 5.2 and Figure 5-1) in accordance with the sampling methodology AS/NZS: 3580.9.9 – 2017 'Methods for Sampling and Analysis of Ambient Air – *Determination of suspended particulate matter – Deposited matter – Gravimetric method*'.

Dust deposition gauges would initially be deployed at the two proposed monitoring locations. Following one month of sampling (30 days +/-2 days), the dust gauge bottles would be replaced with fresh bottles. The sampled bottles would be sent to a National Association of Testing Authorities (NATA) laboratory for deposition analysis (total insoluble solids).

5.1.3.2 CONTINUOUS PM_{10} AND $PM_{2.5}$

PM_{10} and $PM_{2.5}$ would be continuously sampled in real-time using a light scattering instrument. It is noted that this type of instrument does not comply with Australian Standards. However, they are widely used at construction and extractive sites for non-compliance monitoring.

5.1.3.3 CONTINUOUS METEOROLOGICAL MONITORING

The light scattering instruments would be fitted with meteorological sensors to monitor for wind speed and wind direction.

5.1.4 MONITORING FREQUENCY

Dust deposition monitoring would be conducted on a monthly basis at air monitoring locations 1 and 2 (Figure 5-1).

Continuous PM_{10}, $PM_{2.5}$ and meteorological monitoring (wind speed and wind direction) would be conducted at one location (air monitoring location 1).

5.1.5 QUALITY CONTROL/QUALITY ASSURANCE

Equipment calibration and maintenance would be conducted in accordance with the manufacturer's instructions, the EPA publication 440.1: A Guide to the Sampling and Analysis of Air Emissions and Air Quality, 2002 and the EPA publication 1955: Guide to ambient air pollution monitoring (to be published).

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Figure 5-1 Proposed air monitoring locations

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6 CONCLUSION

Air dispersion modelling using AERMOD was conducted for the following two scenarios to assess potential air quality impacts from the Project:

— Scenario 1: sand extraction at stage 1 while the screening bund is under construction (in the first three years of site operation).

— Scenario 2: sand extraction at stage 3 following completion of the screening bund (beyond five years following commencement of site operations).

Contemporaneous (i.e., the same time period) background data were added to the predicted contribution from the Project to determine cumulative impacts. The modelling results indicate that:

Scenario 1:

— The cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) at five receptors are predicted to be below the corresponding assessment criteria.

— The cumulative annual average PM_{10} concentrations (maximum project contribution plus contemporaneous background) are predicted to be below the assessment criteria at four receptors and exceeds the criterion at R3 due to high background (the background accounting for 96% of the criterion).

— The cumulative annual average $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) are predicted to exceed the assessment criterion at all five receptors due to existing background exceedances.

— A 24-hour PM_{10} time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by two days at receptors R1, R2 and R3 and by one day at receptors R4 and R5

— A 24-hour $PM_{2.5}$ time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by one day at receptor R1 only

— The maximum increase in dust deposition levels at all receptors are below the assessment criterion of 2 g/m^2/month.

— The maximum annual RCS concentrations at all receptors are estimated to be below the APAC.

Scenario 2:

— The cumulative 24-hour average PM_{10} concentrations (maximum project contribution plus contemporaneous background) at five receptors are predicted to be below the assessment criterion.

— The cumulative 24-hour average $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) are predicted to exceed the assessment criterion at R2 and R4 with the background concentration accounting for 90% of the criterion.

— The cumulative annual average PM_{10} concentrations (maximum project contribution plus contemporaneous background) are predicted to be below the assessment criteria at all five receptors

— The cumulative annual average $PM_{2.5}$ concentrations (maximum project contribution plus contemporaneous background) are predicted to exceed the assessment criterion at all five receptors due to existing background exceedances.

— A 24-hour PM_{10} time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by three days at receptor R2 and by two days at receptors R3 and R4

— A 24-hour $PM_{2.5}$ time series analysis at all five receptors indicated that the number of days the 24-hour PM_{10} criterion is exceeded is increased by three days at receptor R2 and by 2 days at receptor R4

- The maximum increase in dust deposition levels at all receptors are below the assessment criterion of 2 g/m^2/month
- The maximum annual RCS concentrations at all receptors are estimated to be below the APAC.

The assessment was conducted based on conservative assumptions (refer to section 4.3.4.6) including, but not limited to:

- The emission sources were configured at locations close to the sensitive receptors.
- All emission sources were configured on or above ground level. In practice, some sources would be below ground level especially for sources at the extraction pits.
- Sand extraction for the top 6 m (above groundwater level) was modelled for a whole year while in practice it is not likely to continue for a full year.
- The exposed areas at the extraction pits are likely to be smaller than the modelled area of 40,000 m^2.

Given these assumptions, actual emissions from both scenarios are expected to be lower than that predicted. In addition, the predicted cumulative exceedances are mainly due to high background concentrations or existing background exceedances.

Implementation of an air quality management plan that focusses on a risk-based approach to minimising dust so far as reasonably practical together with an ambient air monitoring program that would assist in evaluating the proposed control measures and confirm the level of impact that has been predicted for the two scenarios assessed.

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APPENDIX A

CONTOUR PLOTS

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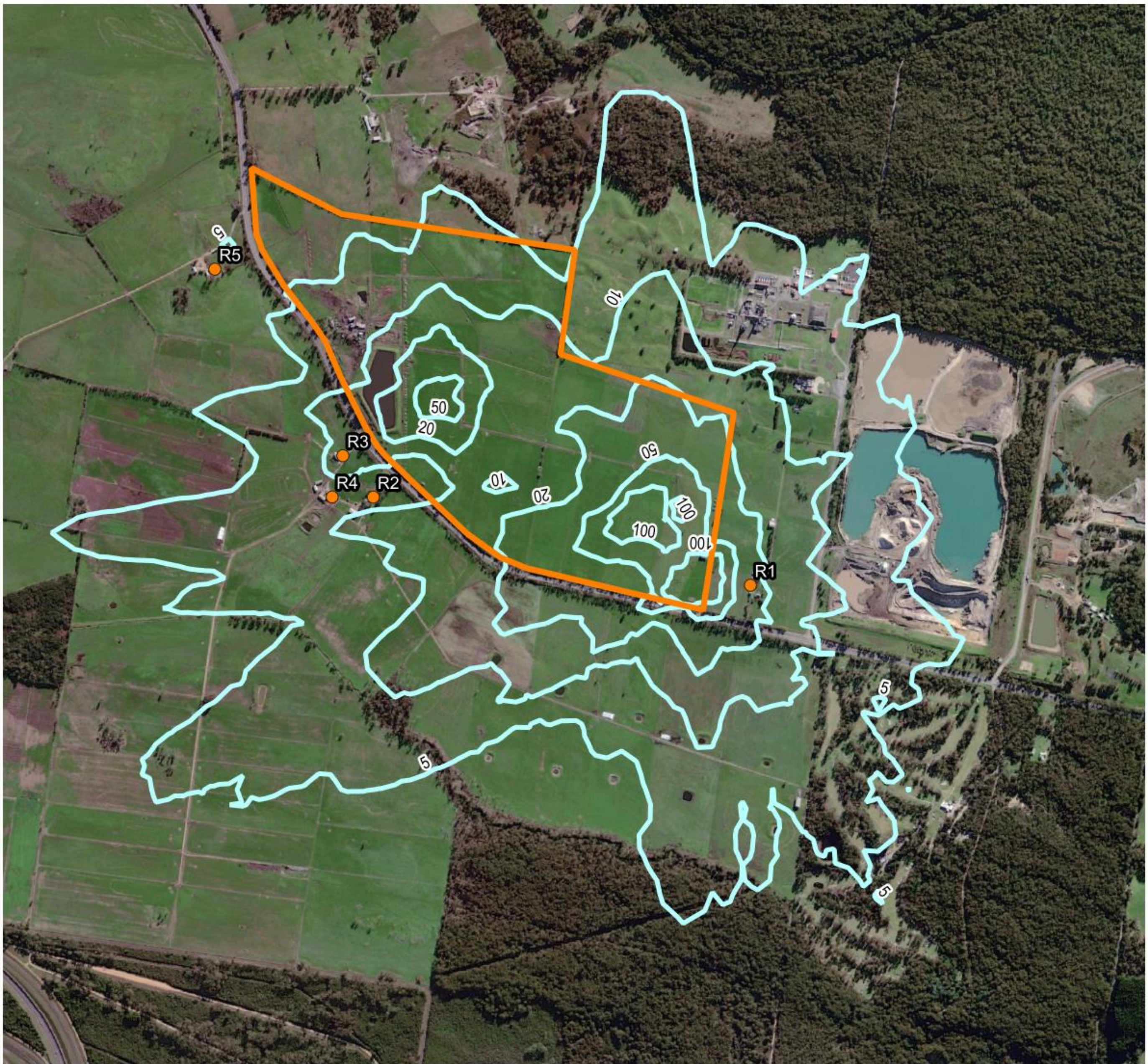

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Site Boundary

24hr average PM10 (µg/m3) - Scenario 1

Sensitive Receptors

0 100 200 300 400 m

24-hour average PM10 under scenraio 1

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Site Boundary

Sensitive Receptors

Annual average PM10 (µg/m3)

0 100 200 300 400 m

Annual average PM10 under scenraio 1

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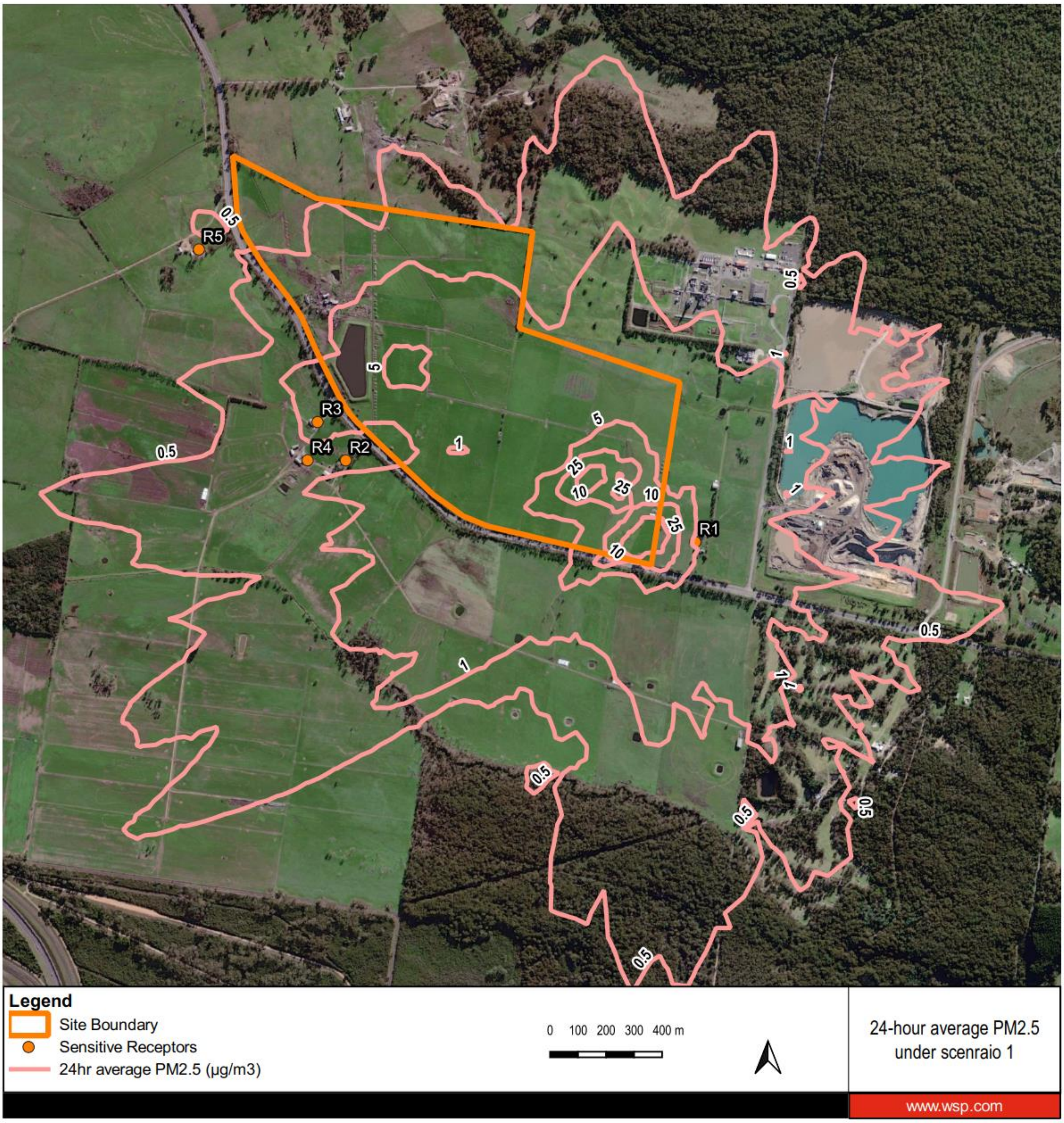

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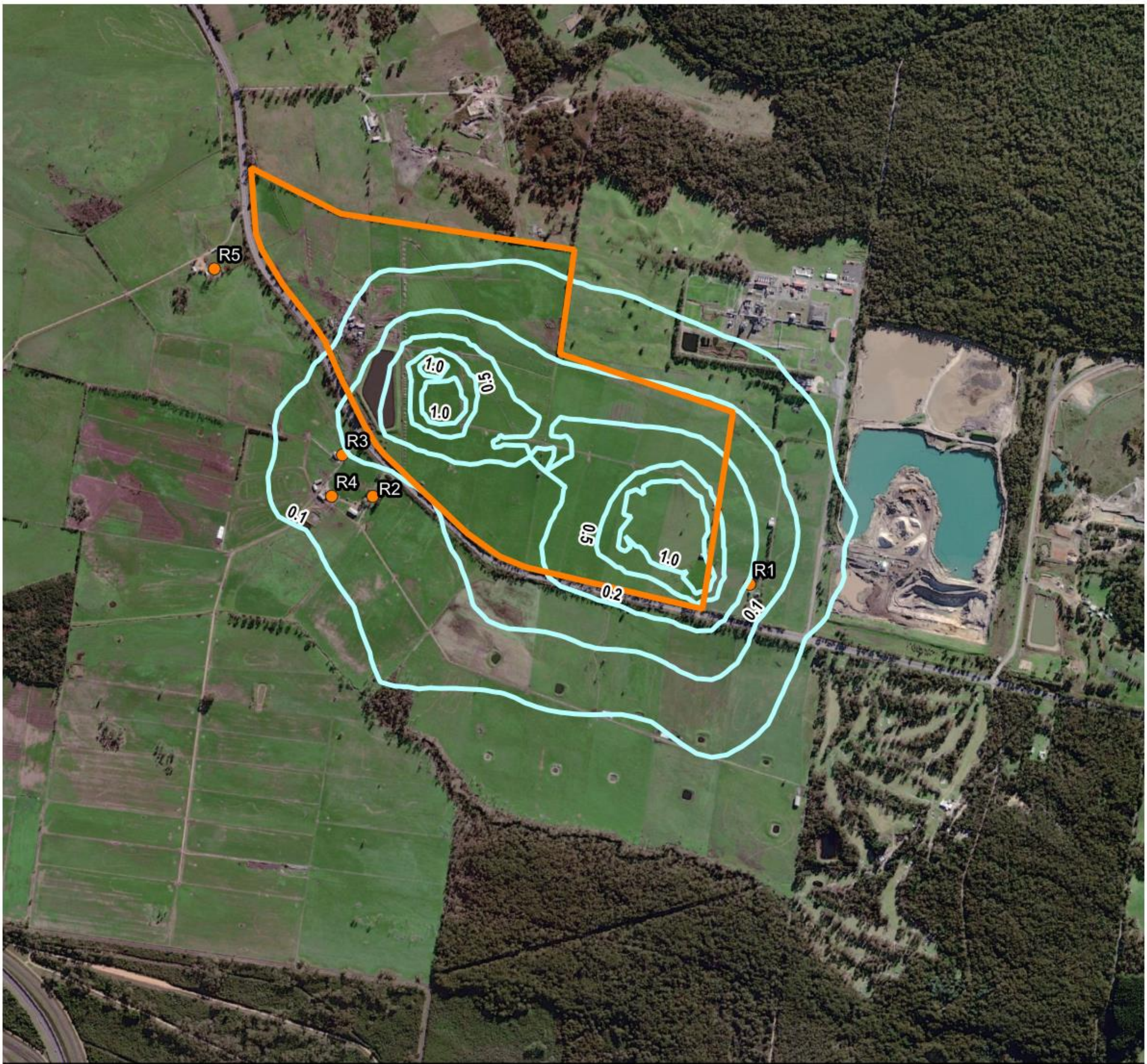

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Site Boundary

Sensitive Receptors

Annual average PM2.5 (µg/m3)

0 100 200 300 400 m

Annual average PM2.5 under scenraio 1

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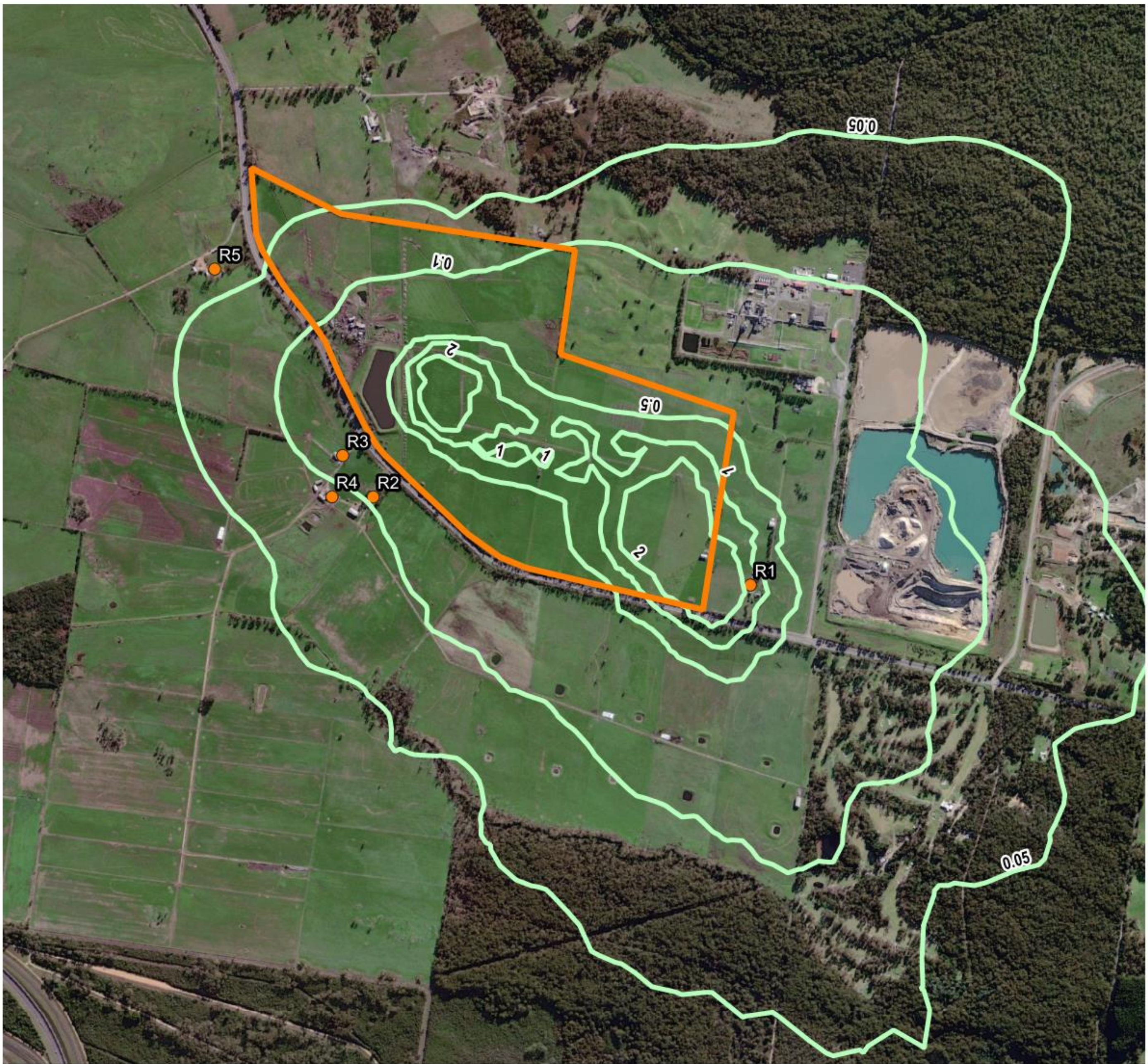

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- Site Boundary
- Sensitive Receptors
- Dust deposition (g/m2/month)

0 100 200 300 400 m

Monthly dust deposition under scenraio 1

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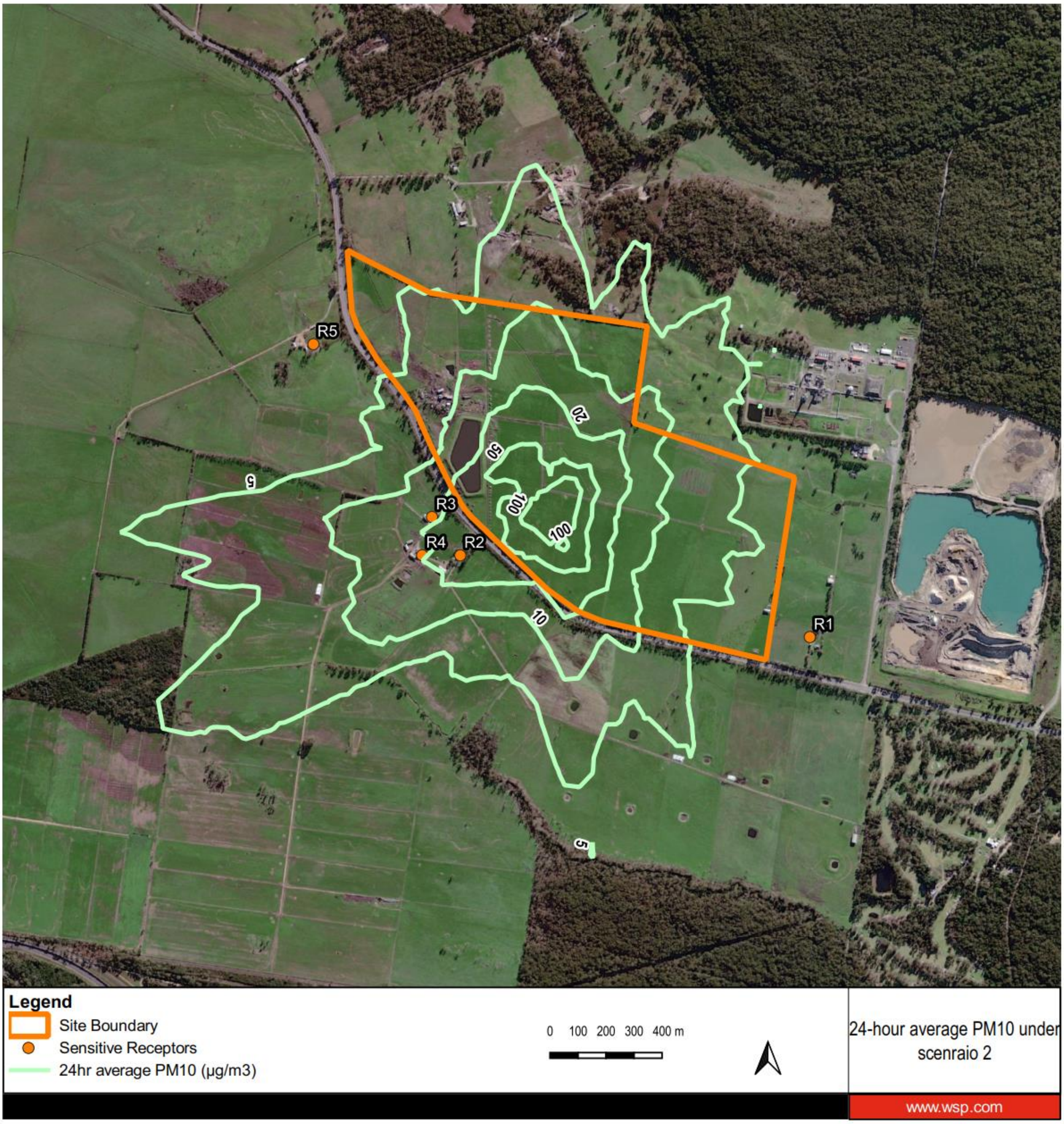

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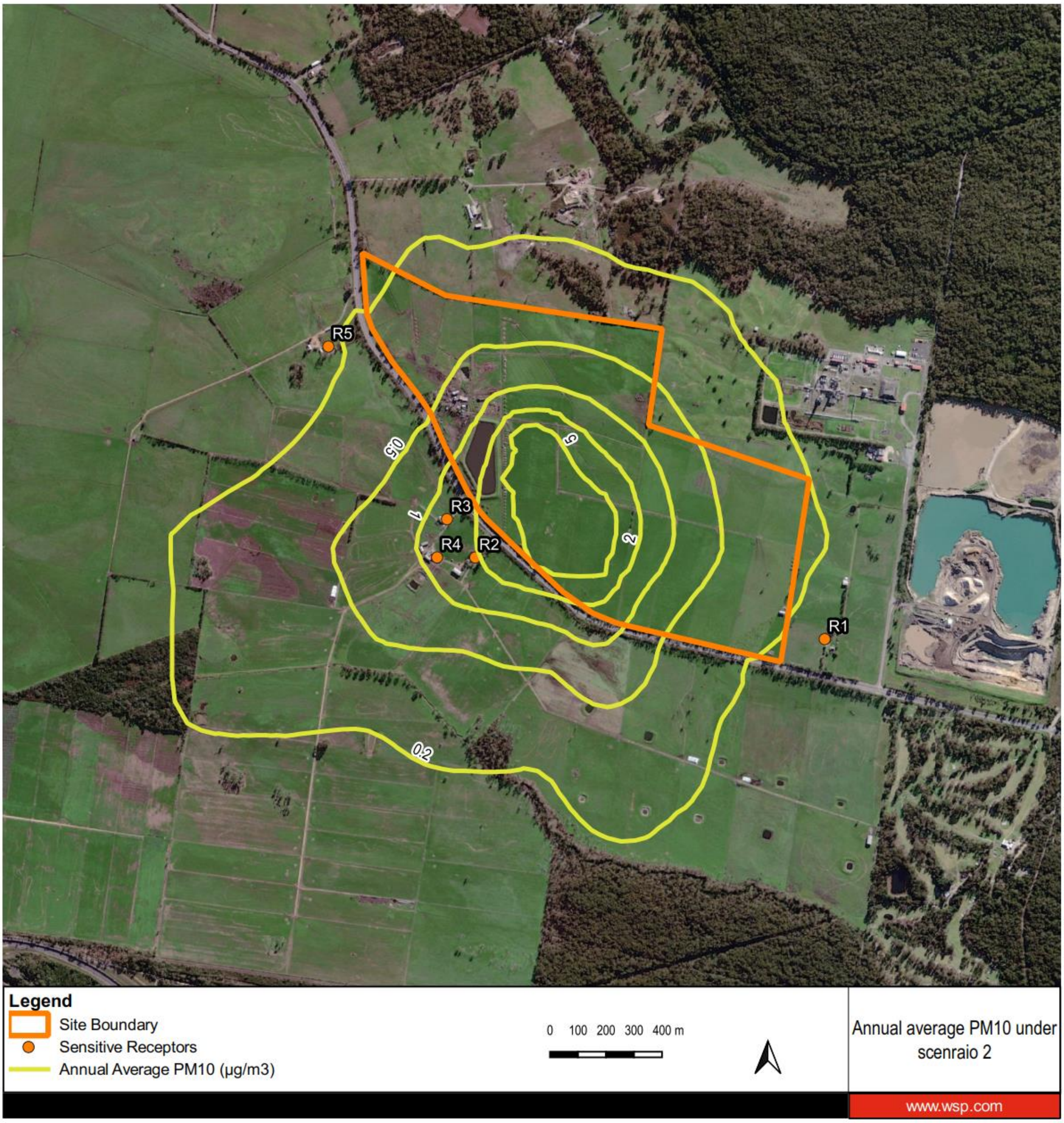

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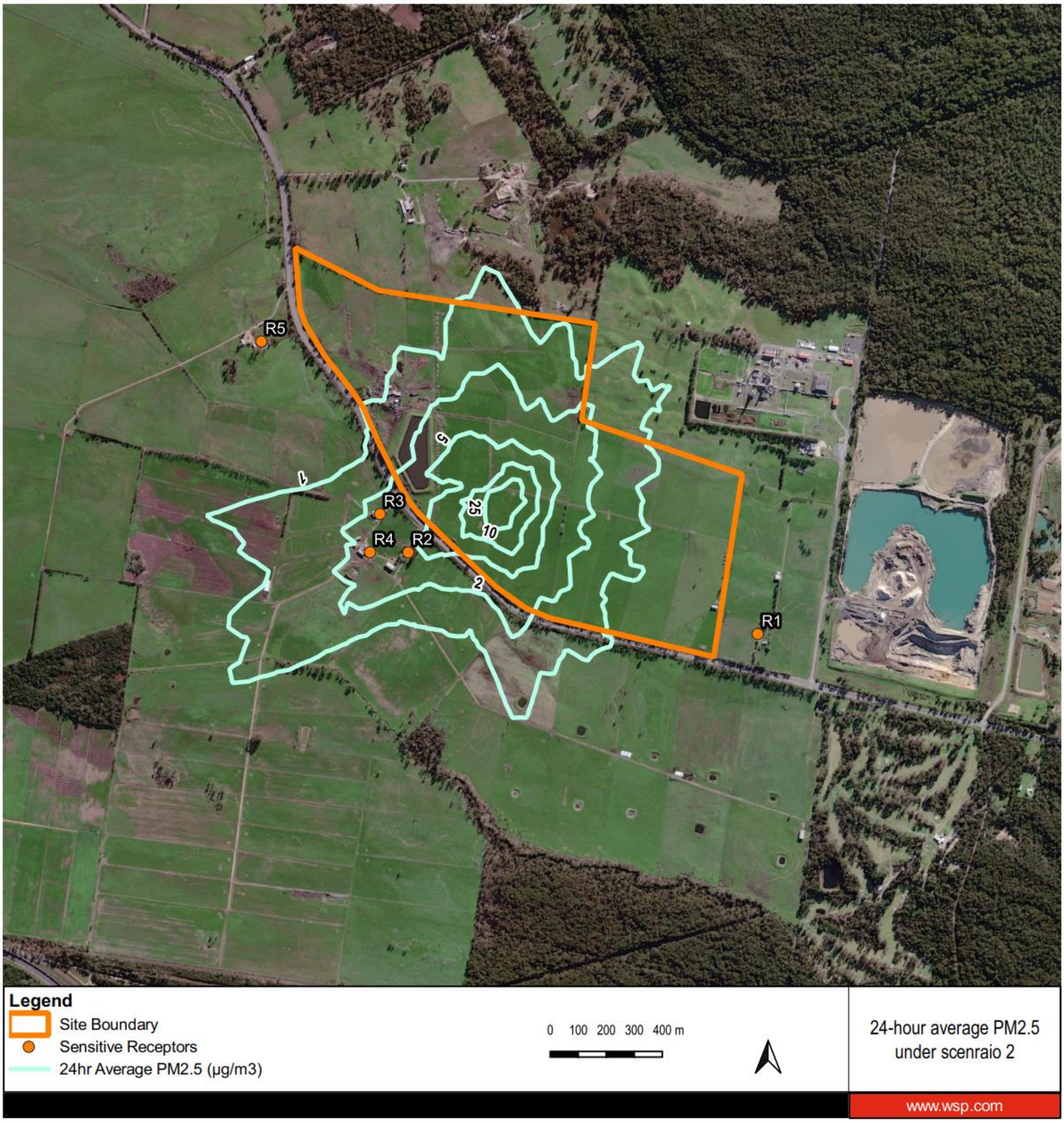

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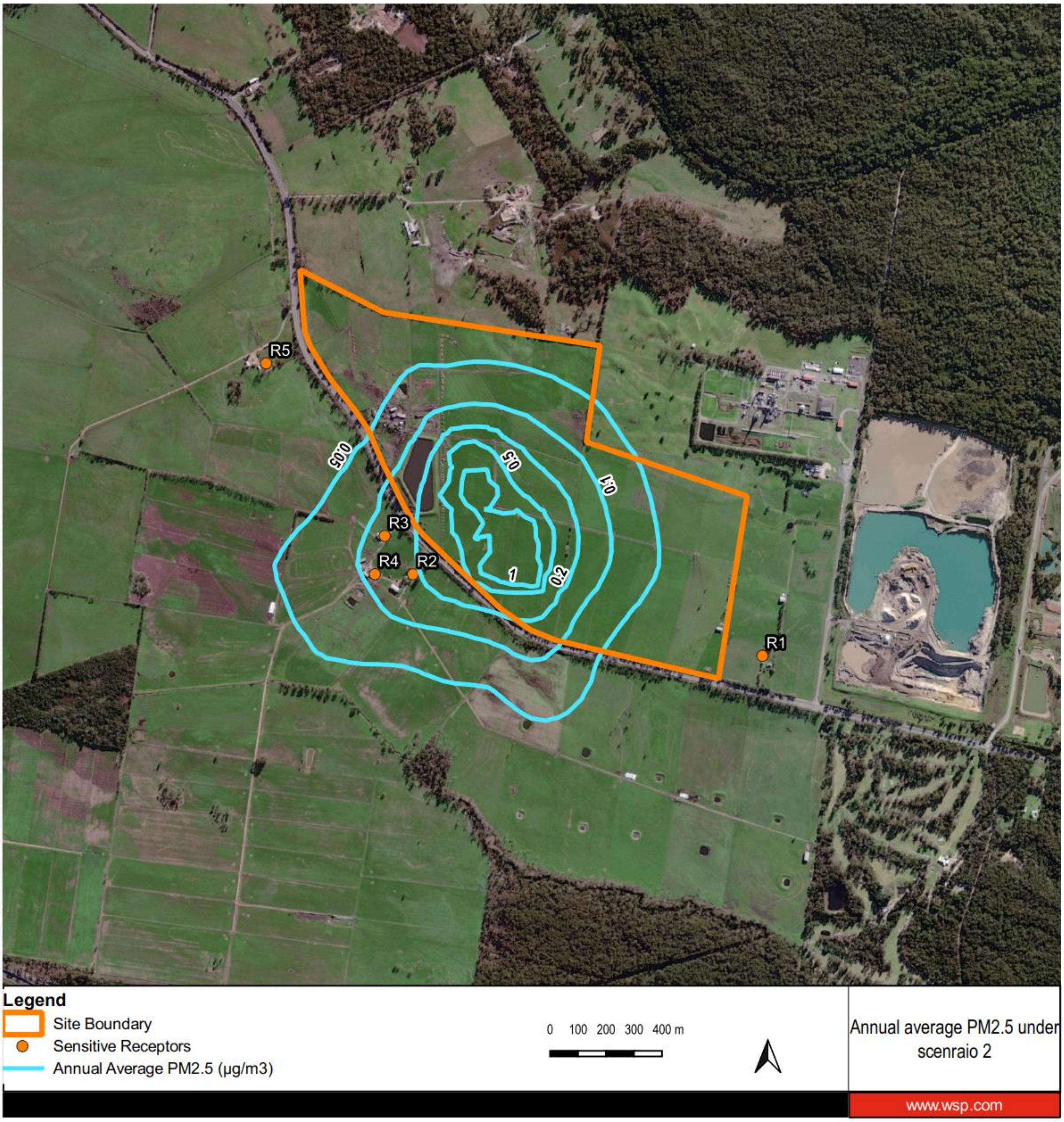

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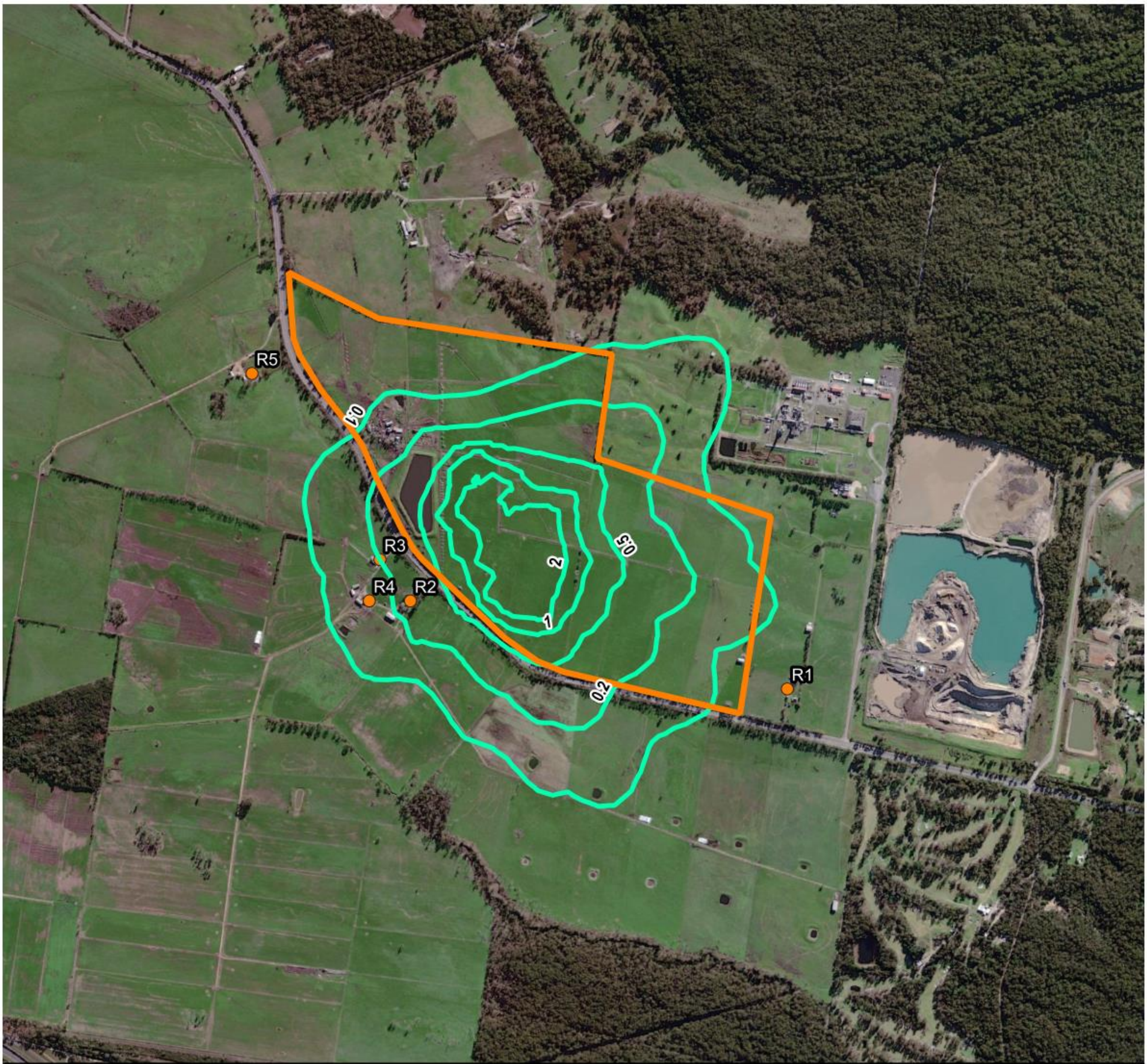

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Site Boundary

Sensitive Receptors

Dust deposition (g/m2/month)

0 100 200 300 400 m

Monthly dust deposition under scenraio 2

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