



Hail Creek Eastern Margin Extension Project

Air Quality Impact Assessment – Dispersion Modelling

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Basis of Report

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Table of Contents

Basis of Report	i
Acronyms and Abbreviations	v
1.0 Introduction	1
1.1 Overview	1
1.2 Report Purpose and Structure	1
2.0 Project Overview	2
2.1 Project Description	2
2.2 Pollutants of Interest.....	4
3.0 Regulatory Framework.....	5
3.1 Queensland Environmental Protection Act 1994.....	5
3.2 Queensland Environmental Protection (Air) Policy 2019.....	5
3.3 Model Mining Conditions	7
3.4 EA EPML0661913 Air Quality Requirements.....	8
3.5 Adopted Air Quality Criteria	11
4.0 Existing Environment.....	12
4.1 Surrounding Sensitive Places.....	12
4.2 Topography and Land Use	14
4.3 Local Climate and Meteorology	16
4.3.1 Wind Speed and Direction.....	16
4.3.2 Rainfall	18
4.4 Existing Air Quality	19
4.4.1 Available Data	19
4.4.2 Suspended Particles	19
4.4.3 Dust Deposition	22
4.4.4 Adopted Background Levels.....	25
5.0 Estimation of Air Emissions	26
5.1 Modelling Scenarios	26
5.2 Emission Factors and Activity Data	26
5.3 Estimated Emissions	29
6.0 Modelling Methodology	37
6.1 Selection of Models	37
6.2 Selection of a Representative Modelling Year	37
6.3 Meteorological Modelling.....	37
6.3.1 Weather Research and Forecast.....	37



6.3.2 CALMET	38
6.4 Meteorological Data Used in the Dispersion Modelling	39
6.4.1 Wind Speed and Direction	39
6.4.2 Atmospheric Stability	41
6.4.3 Mixing Heights	42
6.5 Dispersion Model Configuration	43
7.0 Air Quality Impact Assessment	44
7.1 Residential Receptors	44
8.0 Monitoring and Mitigation	45
9.0 Conclusions	46
10.0 References	47

Tables

Table 1-1 Report Structure	1
Table 3-1 Air Quality Objectives for Particulate Matter – EPP (Air) 2019 – Human Health and Wellbeing	6
Table 3-2 Air Quality Criteria – EPP (Air) Amendment Policy 2024 – Human Health and Wellbeing	6
Table 3-3 HCOC EA Schedule B (Air Quality Condition Limits)	9
Table 3-4 EA Table B1 – Ambient Air Quality Limits	10
Table 3-5 Air Quality Criteria Considered in this Study	11
Table 4-1 Surrounding Sensitive Receptors Details	14
Table 4-2 PM _{2.5} /PM ₁₀ Ratios for DETSI-operated Stations	21
Table 4-3 PM _{2.5} Concentrations	21
Table 4-4 Background Concentrations Adopted for this Assessment	25
Table 5-1 Summary of Activity Data	27
Table 5-2 Dust Control Measures	29
Table 5-3 Estimated Annual Emissions (kg/y)	30
Table 6-1 Meteorological Parameters – WRF	38
Table 6-2 Meteorological Modelling Parameters – CALMET (2023 Calendar Year)	38
Table 6-3 Meteorological Conditions Defining PGT Stability Classes	41
Table 6-4 CALPUFF Domain Details and Model Settings	43
Table 7-1 Predicted Incremental and Cumulative PM _{2.5} Concentrations	44
Table 7-2 Predicted Incremental and Cumulative PM ₁₀ Concentrations	45
Table 7-3 Predicted TSP Concentrations and Deposition Rates	45



Figures

Figure 2-1 Proposed Amendment Areas and Site Layout	3
Figure 4-1 Hail Creek Meteorological and Ambient Air Quality Monitoring and Sensitive Receptor Locations.....	13
Figure 4-2 Surrounding Land Zoning	15
Figure 4-3 Annual and Seasonal Wind Roses for the Onsite AWS (2020 to 2024).....	17
Figure 4-4 Wind Speed Frequency Chart for the Onsite AWS – 2020-2024.....	18
Figure 4-5 Average Rainfall for the Onsite AWS – 2020 to 2025.....	19
Figure 4-6 2022 24-hour average PM ₁₀ concentrations – East and North BAMs.....	20
Figure 4-7 Comparison of PM ₁₀ Concentrations between Project BAMs and Moranbah Monitoring Stations.....	22
Figure 4-8 A1 Deposited Dust – Ash and Combustible (mg/m ² /day)	23
Figure 4-9 DDG A1 wind roses during exceedance periods, showing upwind conditions relative to mining areas.....	24
Figure 5-1 Estimated Annual Emissions (kg/y).....	36
Figure 6-1 CALMET Predicted Annual and Seasonal Wind Roses at the Project.....	40
Figure 6-2 Stability Class Distribution Predicted for the Site (CALMET, 2023).....	42
Figure 6-3 Mixing Heights Predicted for Project (CALMET, 2023).....	42

Appendices

Appendix A	Emission Factors
Appendix B	Variable Emission Compilation
Appendix C	Isopleths



Acronyms and Abbreviations

ACARP	Australian Coal Association Research Program
AHD	Australian Height Datum
AS/NZS	Australian/New Zealand Standard
AS3580	Australian Standard for air sampling
AWS	Automatic Weather Station
BAM	Beta Attenuation Monitor
CHPP	Coal Handling and Preparation Plant
CM	Coarse Matter
DDG	Dust Deposition Gauge
DETSI	Department of Environment, Tourism, Science and Innovation
DSEWPC	Dept. of Sustainability, Environment, Water, Population and Communities
EA	Environmental Authority
EP Act	Environmental Protection Act 1994
EPML	Environmental Authority Licence Number
EPP (Air)	Environmental Protection (Air) Policy
ERA	Environmentally Relevant Activity
FP	Fine Particulates
HCC	Hail Creek Coal Holdings Pty Limited
HCOO	Hail Creek Open Cut
HNP	Homevale National Park
MMC	Model Mining Conditions
NPI	National Pollutant Inventory
PGT	Pasquill-Gifford-Turner stability classes
PM10 / PM2.5	Particulate Matter $\leq 10 \mu\text{m}$ / $\leq 2.5 \mu\text{m}$
RE	Remainder (size fractions)
ROM	Run-of-Mine
RRTM	Rapid Radiative Transfer Model
SRTM	Shuttle Radar Topography Mission
TSP	Total Suspended Particulates
VKT	Vehicle Kilometres Travelled
WRF	Weather Research and Forecast model
WSM6	WRF Single-Moment 6-class microphysics scheme
YSU	Yonsei University planetary boundary layer scheme
bcm	Bank Cubic Metres
ha	Hectares
km	Kilometres
m	Metres



1.0 Introduction

1.1 Overview

Hail Creek Open Cut (HCOC) is an open cut coal mine located in the Bowen Basin in central Queensland. It is situated 85 kilometres (km) west of Mackay (150 km by road) and approximately 35 km northwest (50 km by road) of the township of Nebo. HCOC is a joint venture, majority owned by Hail Creek Coal Holdings Pty Limited (HCC), a subsidiary of Glencore Coal Assets Australia.

HCOC is authorised through Environmental Authority (EA) EPML00661913 and Mining Leases (MLs) 4738 and 700026. Coal is mined using conventional open-cut strip-mining methods and has approval to mine up to 20 million tonnes of run-of-mine (ROM) coal per annum (Mtpa). Due to changes in mine sequencing, improvements in mining efficiency and further resource definition, an extension to the approved mining footprint of the Carrinyah and Exevale Pits is required to continue mining at HCOC (the Project). The Project will extend the life of mine by 3 years to 2038.

1.2 Report Purpose and Structure

An EA Amendment application was submitted by HCC for the Project on 11 January 2024. An Air Quality Impact Assessment (AQIA) was submitted with the EA Amendment application on 15 April 2025 (SLR 2025). The AQIA included a qualitative assessment based on previous air modelling undertaken for the HCOC Eastern Margin approval in 2015.

An additional Information Request (IR) was issued by the Department of Environment, Tourism, Science and Innovation (DETSI) on 31 July 2025. The additional IR requested dispersion modelling be undertaken for the Project. This report has been developed to address IR item 29 relating to air dispersion modelling. The structure of the report is outlined in **Table 1-1**.

Table 1-1 Report Structure

Section	Description
1.0: Introduction	Provides an overview of the purpose of the report and outlines the structure and supporting documentation.
2.0: Project Overview	Provides a description of the Project and identifies air pollutants of interest.
3.0: Regulatory Framework	Provides an overview of the relevant regulations, including the current EA conditions relevant to air quality.
4.0: Existing Environment	Provides an overview of the local topography, meteorology, and an assessment of the current ambient air quality in the context of the nearest sensitive receptors.
5.0: Estimation of Emissions to Air	Presents the details of the Project operating scenarios assessed and the emission estimation.
6.0: Modelling Methodology	Presents the details of the modelling methodology for the air quality impact assessment for the Project.
7.0: Assessment	Presents the air quality impact assessment for the Project.
8.0: Mitigation & Monitoring	Presents an overview of requirements for dust mitigation and ambient air monitoring.
9.0: Conclusion	Summarises the key findings of the assessment.



2.0 Project Overview

2.1 Project Description

Figure 2-1 shows the currently authorised extent of disturbance (green) for HCOC and the Project area (purple). The Project includes the following components:

- Kemmis Pit Extension (Area 1) - clearing and mining of an additional 6.3 ha (two small polygons of approximately 4.5 ha and approximately 1.8 ha) of surface disturbance to extend the currently approved footprint of Kemmis Pit;
- Homevale Pit (Area 2) - clearing and mining of 136.6 ha for a new 'Homevale Pit' located in the corner of ML4738 to the north;
- Exevale Pit Extension (Area 3) - clearing and mining of an additional 140.3 ha of surface disturbance to extend the currently approved footprint of Exevale Pit; and
- Carrinyah Pit Extension (Area 4) - clearing and mining of an additional 396.0 ha of surface disturbance to extend the currently approved footprint of Carrinyah Pit.

The mining of the currently authorised Kemmis, Carrinyah and Exevale Pits has already been assessed previously in support of prior approvals application. Therefore, this air quality impact assessment considers the potential impacts of the increased disturbance area due to the Project on local air quality. It also identifies the need for any further air quality management or mitigation practices to be adopted for the Project. No changes to the mining method, approved annual extraction rate or coal processing/handling activities are proposed for the Project.



HAIL CREEK

MAJOR EA AMENDMENT

FIGURE 2-1
PROPOSED AMENDMENT AREAS
AND SITE LAYOUT

LEGEND

- Watercourse
- EA Amendment
Proposed Extent of Disturbance
- EA Authorised Extent of Disturbance
- Mining Lease



0 0.5 1 km

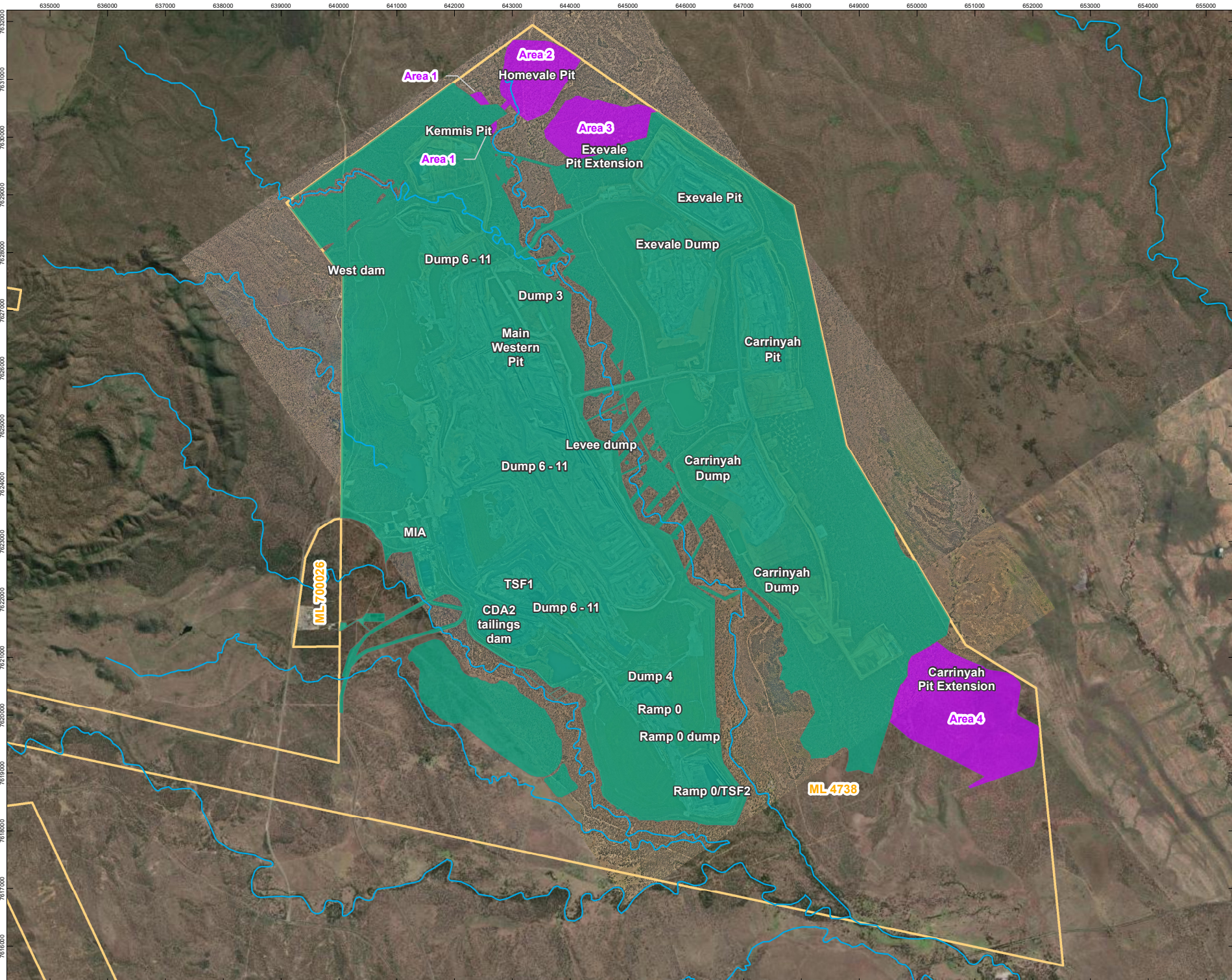
Coordinate System: GDA2020 MGA Zone 55

Scale: 1:60,000 at A3

Project Number: 626.30128

Date: 03-Oct-2025

Drawn by: AS



2.2 Pollutants of Interest

The key air emissions from current operations at HCOC and the Project are fugitive emissions of particulate matter associated with the mining activities, including drilling and blasting, bulldozer operation and handling and transport of spoil and ROM coal. Wind erosion of pit and spoil dump areas and ROM stockpiles also has the potential to generate dust emissions under dry and windy conditions.

To assess potential health and nuisance impacts of dust emissions, particles are classified primarily by size, as total suspended particulates (TSP), particulate matter with an aerodynamic diameter up to 10 μm (PM_{10}) and particulate matter with an aerodynamic diameter up to 2.5 μm ($\text{PM}_{2.5}$).

Human health effects of dust tend to be associated with particles with an aerodynamic diameter of 10 μm or less ($\leq \text{PM}_{10}$). These smaller particles tend to remain suspended in the air for longer periods and can be respirable. The $\text{PM}_{10-2.5}$ fraction (coarse fraction) can be inhaled into the upper part of the airways and lung. $\text{PM}_{2.5}$ particles are fine particles that are inhaled more deeply and can lodge in the gas exchange region of the human lung and are termed “respirable dust”.

TSP comprise airborne dust particles up to about 100 μm in diameter that eventually settle onto surfaces through dust deposition. While larger particles generally do not pose direct health risks, emissions of TSP can cause nuisance impacts such as increased dust deposition and dust accumulation in surrounding areas.

Based on the discussion above, this report focusses on the following key pollutants of interest:

- $\text{PM}_{2.5}$;
- PM_{10} ; and
- TSP (Dust Deposition).



3.0 Regulatory Framework

3.1 Queensland Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) enables the framework for environmental assessments to be developed in Queensland. The EP Act is applicable to all members and bodies in the community, including industry and government. It provides a method for government departments to incorporate environmental factors into their decision-making process.

There is a general environmental duty to prevent and minimise environmental harm under section 319 of the EP Act. The EP Act specifically states:

A person must not carry out an activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm (the general environment duty).

To decide the measures required to meet the general environmental duty in accordance with the EP Act, regard must be had to:

- The nature of the harm or potential harm;
- The sensitivity of the receiving environment;
- The current state of technical knowledge for the activity;
- The current state of successful application of the different measures that might be taken; and
- The financial implications of the different measures as they would relate to the type of activity.

The EP Act allows the environment minister to produce Environmental Protection Policies, designed to protect environmental aspects in Queensland. The Environmental Protection (Air) Policy (EPP (Air)) was developed under this framework in 2008, with the most recent revision being published in August 2019 and coming into force as of 1st September 2019.

3.2 Queensland Environmental Protection (Air) Policy 2019

The EPP (Air) is designed to achieve the objectives of the EP Act in relation to the air environment. The purpose of the EPP (Air) is achieved by identifying environmental values to be enhanced or protected, outlining indicators and air quality objectives for enhancing or protecting these values and providing a framework for making consistent, equitable and informed decisions about the air environment.

The environmental values listed in the EPP (Air) that are to be enhanced or protected under the policy are:

- The qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems;
- The qualities of the air environment that are conducive to human health and wellbeing;
- The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property; and
- The qualities of the air environment that are conducive to protecting agricultural use of the environment.



Air quality objectives are outlined within Schedule 1 of the EPP (Air) for a range of air pollutants to protect these environmental values. Those related to human health and wellbeing are reproduced in **Table 3-1**.

Table 3-1 Air Quality Objectives for Particulate Matter – EPP (Air) 2019 – Human Health and Wellbeing

Pollutant	Averaging Period	Air Quality Objective (µg/m³)	Environmental Values
Particulate Matter as PM ₁₀	24-Hours	50	Health and wellbeing
	Annual	25	Health and wellbeing
Particulate Matter as PM _{2.5}	24-Hours	25	Health and wellbeing
	Annual	8	Health and wellbeing
Total Suspended Particulate Matter (TSP)	Annual	90	Health and wellbeing

Environmental Protection (Air) Amendment Policy 2024 (EPP Air Amendment 2024) (commenced on 1 January 2025) has updated the criteria for PM_{2.5} as presented in **Table 3-2**.

Table 3-2 Air Quality Criteria – EPP (Air) Amendment Policy 2024 – Human Health and Wellbeing

Pollutant	Averaging Time	Environmental Value Protected	Criteria Including Background
			µg/m³
PM _{2.5}	24 hours	Health and wellbeing	20
	Annual	Health and wellbeing	7

No air quality objectives are prescribed in the EPP (Air) for deposited dust. The Department of Environment and Science (DES) guideline: Application requirements for activities with impacts to air (DES 2024a) provides the following guidance for environmentally relevant activities (ERAs) with the potential to give rise to elevated dust deposition rates:

There are no national air quality guideline values for the nuisance dust effect that can be used to assess the impact of dust on the receiving environment. However, there are a number of criteria commonly used by regulatory agencies in Australia. Generally, the criteria have been derived from subjective observations and investigation of dust levels and nuisance effects. A dust deposition limit of 120 milligrams per square metre per day, averaged over 1 month, when monitored in accordance with 'AS3580.10.1 Methods for sampling and analysis of ambient air – Determination of Particulates – Deposited Matter – Gravimetric method of 1991', is frequently used in Queensland.

In some areas there may already be relatively high background levels of dust. If dust is a potential concern, deposition gauges should be used by the applicant to collect data near sensitive receptors and the proposed ERA site. The dust deposition data collected from the Project area can be analysed and the results compared against the above standards. The dust deposition rate could also be estimated at the sensitive receptors using the dispersion



models and the cumulative effect can be determined by considering the background dust deposition data of the Project area.

3.3 Model Mining Conditions

The purpose of the Model Mining Conditions (MMC) (DESI 2024b) is to provide a set of model conditions to form general environmental protection commitments and to expedite the process of developing appropriate conditions for an EA for a mining project in consultation with the administering authority under the EP Act.

Schedule B of the MMC addresses air emissions, with draft Condition B4 setting out the following requirements:

- B4** The environmental authority holder shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:
- a) dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of *Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method*.
 - b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM₁₀) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, for no more than five exceedances recorded each year, when monitored in accordance with the most recent version of either:
 - 1. *Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM₁₀ high volume sampler with size-selective inlet – Gravimetric method*, or
 - 2. *Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – PM₁₀ low volume sampler - Gravimetric method*.
 - c) a concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM_{2.5}) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of *AS/NZS3580.9.10 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM_{2.5} low volume sampler - Gravimetric method*.
 - d) a concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1 year averaging time, when monitored in accordance with the most recent version of *AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method*.

In relation to the PM₁₀ requirements, the MMC notes that:

The five exceedances for the PM₁₀ standard outlined in B4 (b) were introduced to account for the impact of bushfires, dust storms and fuel reduction burning for fire management purposes. The five exceedances are in essence arbitrary in that the number was chosen as it is difficult to determine exactly the number of times these



events may happen in any one year. More than five exceedances as a result of one or more of these events would not be considered to be a breach of condition.

In relation to the PM_{2.5} requirements, the MMC notes that:

Sources of PM_{2.5} are primarily from combustion sources and PM_{2.5} is unlikely to be elevated if significant combustion sources are not present. Condition B4 (c) will therefore only be required if there is a significant source of air emissions from combustion sources.

3.4 EA EPML0661913 Air Quality Requirements

Under EA EPML0661913 (dated 13 June 2025), with respect to air quality, HCC is required to operate in accordance with Schedule B Air Conditions B1 to B6, reproduced below in **Table 3-3** and **Table 3-4**.

Condition C3 also requires that tailings must be managed in accordance with procedures contained within the Tailings Management Plan, which must include provisions for the control of fugitive emissions to air.



Table 3-3 HCOC EA Schedule B (Air Quality Condition Limits)

Condition Number	Condition
B1	Unless authorised by this environmental authority, the release of contaminants to air must not cause environmental harm or an exceedance of the limits in <i>Table B1 – Ambient air quality limits</i> ^(a) at a sensitive or commercial place.
B2	The measurement of air emissions for a sensitive place or commercial place is either: a) at that place (if measured there); or b) at the monitoring location representative (whether by reason of correlation or otherwise) of the sensitive place or commercial place (where there is no measure at the sensitive place or commercial place).
B3	When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer), air quality monitoring must be undertaken, and the results thereof notified to the administering authority within 14 days following completion of monitoring. Monitoring must be carried out at a place or places relevant to the potentially affected sensitive place as agreed upon with the administering authority.
B4	Dust and particulate matter monitoring Air emissions and meteorological conditions must be monitored in accordance with <i>Table B1 – Ambient air quality limits</i> ^(a) .
B5	Air quality monitoring exceedance If monitoring indicated the potential for exceedance of the relevant limits in <i>Table B1 – Ambient air quality limits</i> ^(a) , then the environmental authority holder must immediately implement dust abatement measures to avoid exceeding the relevant limits; or address the complaint using dispute resolution if required.
B6	Where monitoring identifies instances where a concentration specified in <i>Table B1 – Ambient air quality limits</i> ^(a) is exceeded at any sensitive place or commercial place, the environmental authority holder must report to the administering authority within ten (10) business days: a) the air quality data at the sensitive place or commercial place; b) a description of meteorological conditions recorded in accordance <i>Table B1 – Ambient air quality limits</i> ^(a) occurring at the time; c) the air quality data upwind of the mining activities (if known); d) measures taken to reduce dust generated by the mining activities; and e) the contribution of the mining activities to the concentration of the exceeded air quality indicator(s) at the sensitive or commercial place.
^(a) <i>Table B1 – Ambient air quality limits</i> is replicated below as Table 3-4.	



Table 3-4 EA Table B1 – Ambient Air Quality Limits

Air Quality Indicator	Air Quality Limit	Averaging Period	Monitoring Method
Particulate matter less than 10µm in aerodynamic diameter (PM ₁₀)	50 µg/m ³	24-hours	1. Australian Standard AS3580.9.6 <i>Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM₁₀ high volume sampler with size selective inlet – Gravimetric method</i>; 2. Australian Standard AS3580.9.9 <i>Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM₁₀ low volume sampler - Gravimetric method</i>; or 3. Australian Standard AS3580.9.11 <i>Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM₁₀ beta attenuation monitors</i>
Dust deposition	120 mg/m ² /day	Monthly	Australian Standard AS3580.10.1 <i>Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method</i>
Total suspended particulate matter (TSP)	90 µg/m ³	1 year	AS/NZS3580.9.3:2003 <i>Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method</i>
Weather including: a) Wind speed and direction b) Temperature c) Precipitation d) Relative humidity			AS/NZS 3850.14:2014



3.5 Adopted Air Quality Criteria

Table 3-5 summarises the air quality criteria adopted for use in this assessment.

Table 3-5 Air Quality Criteria Considered in this Study

Indicator	Assessment Criteria ($\mu\text{g}/\text{m}^3$)	Averaging Period	Purpose	Sources
PM _{2.5}	20	24-hours	Human health and wellbeing	EPP Air 2024
	7	Annual		EPP Air 2024
PM ₁₀	50	24-hours		EPP Air 2019 EPML0661913
	25	Annual		EPP Air 2019
TSP	90	Annual		EPP Air 2019
Insoluble dust deposition	120 mg/m ² /month	Monthly		EPML0661913



4.0 Existing Environment

4.1 Surrounding Sensitive Places

A “sensitive place” is defined in the EA as follows:

‘sensitive place’ means:

- (a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or*
- (b) a motel, hotel or hostel; or*
- (c) an educational institution; or*
- (d) a medical centre or hospital; or*
- (e) a protected area under the Nature Conservation Act 1992, the Marine Parks Act 1992 or a World Heritage Area; or*
- (f) a public park or gardens.*

As shown in **Figure 4-1** and listed in **Table 4-1**, the nearest sensitive places are located approximately 4 km or greater from any of the Project Areas:

- R1 (Fort Cooper Homestead) is located approximately 4 km south of Carrinyah Pit Extension (Area 4).
- R2 (Carrinyah Station) is located approximately 8 km east of Carrinyah Pit Extension (Area 4).
 - A pseudo-receptor (R2a) was used instead of Carrinyah Station because it is located beyond the primary modelling domain.
- R3 (Kemmis Creek Station) is located approximately 11 km south-southwest of Carrinyah Pit Extension (Area 4).
- R4 (Moonlight Dam Campground in Homevale National Park (HNP)) is located approximately 11 km east of Exevale Pit Extension (Area 3).

There are no sensitive places in the vicinity of the other Project areas.

The Moonlight Dam Campground has been used to represent the HNP as it is a public place of amenity.



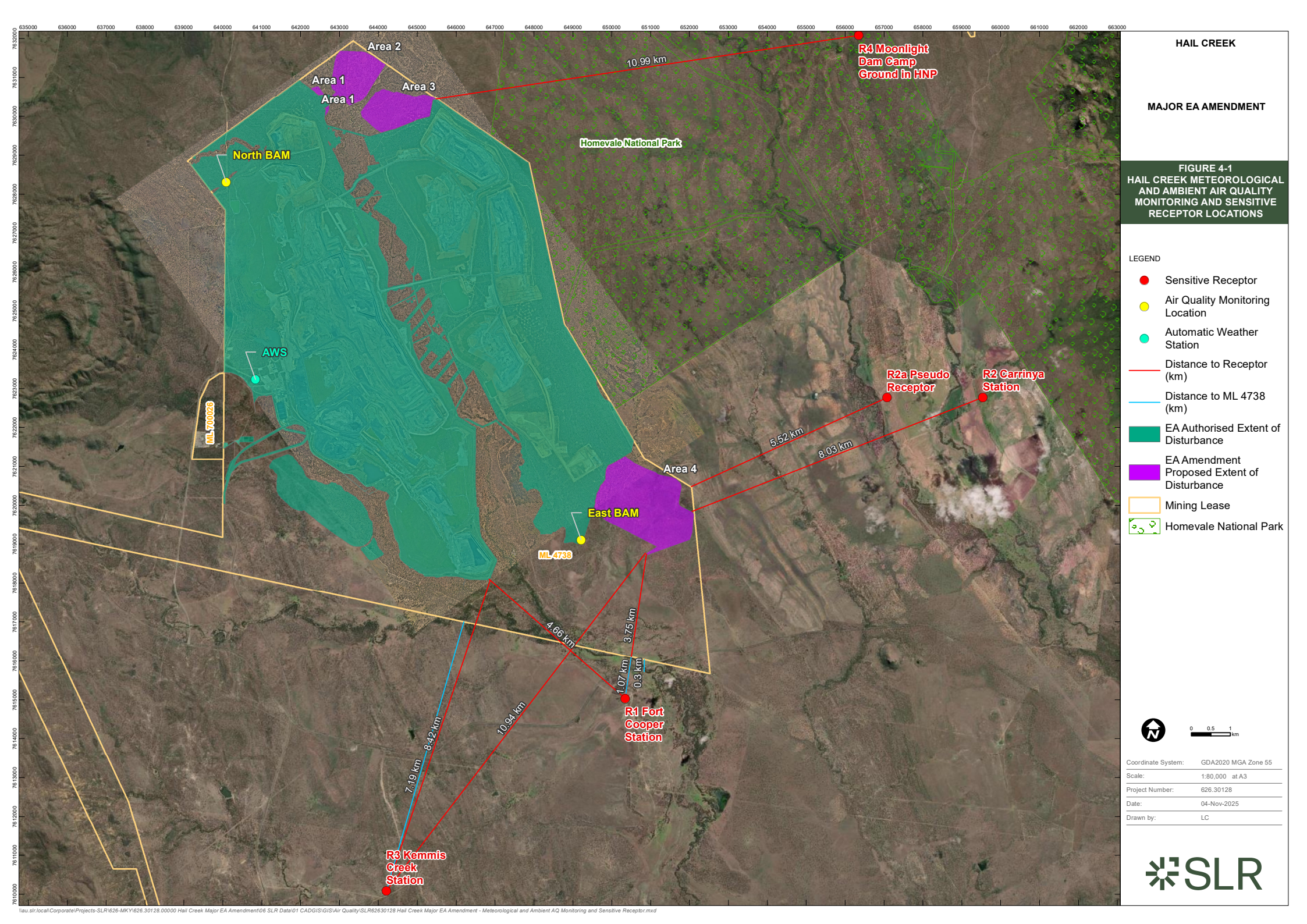


Table 4-1 Surrounding Sensitive Receptors Details

Receptor ID	Easting (m)	Northing (m)	Description
R1	650,348	7,615,031	Fort Cooper Station
R2	659,547	7,622,776	Carrinyah Station
R2a	657,078	7,622,767	Pseudo Receptor for R2
R3	644,206	7,610,085	Kemmis Creek Station
R4	656,352	7,632,083	Moonlight Dam Campground in HNP

4.2 Topography and Land Use

The terrain of the surrounding area is characterised by gently undulating plains, interspersed with localised areas of higher elevation to the west and northwest. More rugged terrain is present towards the west of the current operations.

The elevation ranges from approximately 240 metres (m) to 660 m Australian Height Datum (AHD), as shown in **Figure 4-2**. The ML itself is situated on gently elevated ground relative to the surrounding landscape. Areas of higher relief are evident to the west, while more open and lower-lying areas extend to the east.

For the air dispersion modelling, topographical data was sourced from the Shuttle Radar Topography Mission (SRTM) database, which provides elevation data at a near-global scale to generate a high-resolution digital topographic dataset. SRTM data with a 30 m resolution was applied within the CALMET model to characterise terrain heights within the model domain.

As presented in **Figure 4-2**, the Project is located within the existing ML. The surrounding land use is predominantly rural in nature, with extensive areas of grazing native vegetation occurring to the south and northwest of the ML. Smaller areas of “other minimal use” are present to the west and southwest, while areas of nature conservation are located further to the northeast and east.

Production native forests occur to the far northeast of the ML, and scattered parcels of residential land use and waste treatment and disposal are also mapped within the broader region. Several small reservoirs/dams and marsh/wetland areas are also present within the mapped extent, providing localised water storage and habitat features.

Transport and communication corridors traverse the southern extent of the mapped area, providing access to and from HCOC and surrounding rural properties. Overall, the ML is situated within a landscape that is primarily used for pastoral activities, with small areas of conservation and forestry values located further afield.



Figure 4-2 Local Topography

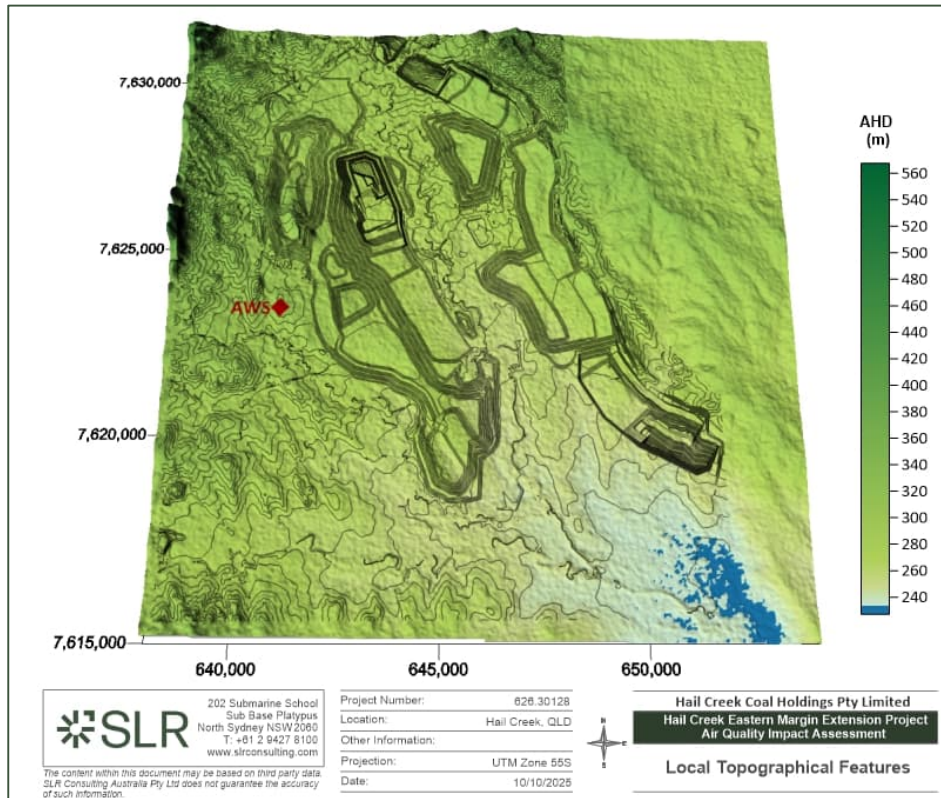
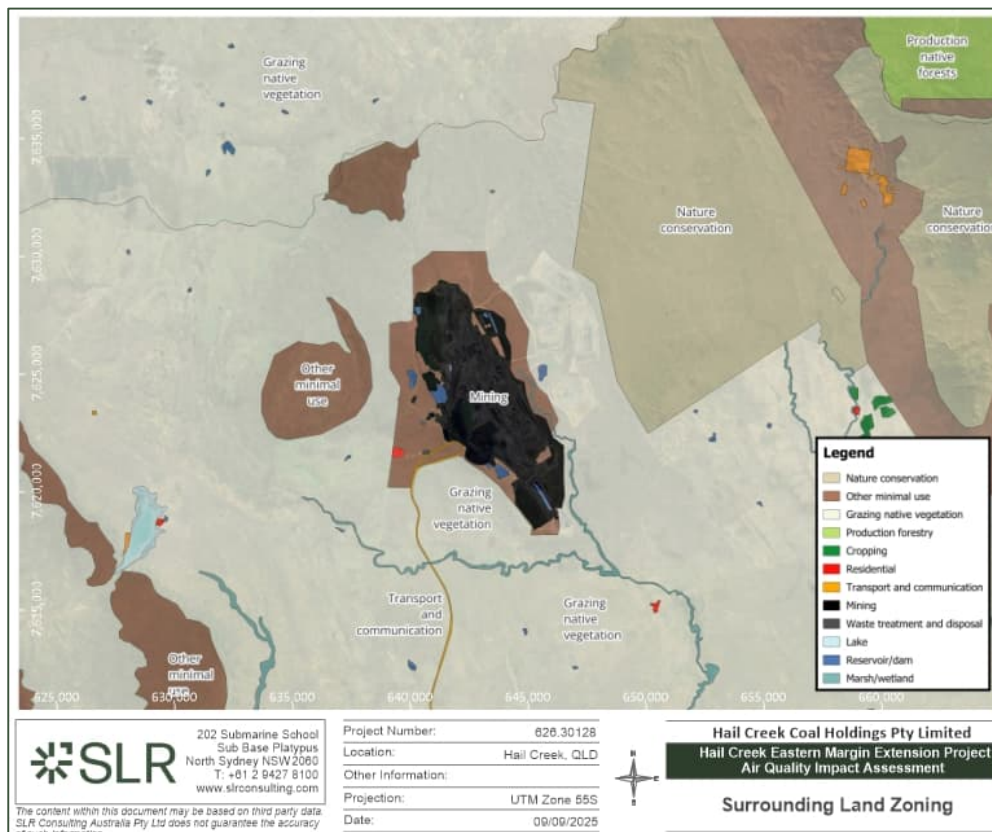


Figure 4-2 Surrounding Land Zoning



4.3 Local Climate and Meteorology

4.3.1 Wind Speed and Direction

Local wind speed and direction influence the dispersion of air pollutants. Wind speed determines both the distance of downwind transport and the rate of dilution as a result of 'plume' stretching. Wind direction, and the variability in wind direction, determines the general path pollutants will follow and the extent of crosswind spreading. Surface roughness, characterised by features such as the topography of the land and the presence of buildings, structures and trees, also influences dispersion.

As detailed in **Section 4.4.1**, HCOC operates an automatic weather station (AWS) measuring a range of meteorological parameters. This section summarises the monitoring results most important for dust assessment: wind speed (m/s) and wind direction (degrees clockwise from true north), and rainfall (mm).

Annual and seasonal wind roses for the years 2020 to 2024 compiled from data recorded by the onsite AWS are presented in **Figure 4-3**.

The annual wind rose indicates that winds predominantly blow from southeastern quadrant towards the northwestern quadrant (**Figure 4-3**). Dust impacts from mining operations are minimal under this wind direction, as prevailing winds do not carry emissions toward sensitive receptors. Calm wind conditions (wind speed less than 0.5 m/s) were recorded 4.0% of the time throughout the five-year period reviewed.

The average seasonal wind roses for the years 2020-2024 (**Figure 4-3**) indicate that:

- In summer, wind speeds ranged from calm to strong winds (between 0.5 m/s and 9.6 m/s). The majority of winds originated from south-eastern and northern quadrants. Calm wind conditions were recorded approximately 2.1% of the time during summer.
- In autumn, wind speeds ranged from calm to strong winds (between 0.5 m/s and 9.0 m/s). The majority of winds originated from south-eastern quadrant. Calm wind conditions were observed to occur approximately 4.2% of the time during autumn.
- In winter, wind speeds ranged from calm to strong winds (between 0.5 m/s and 9.1 m/s) and were generally evenly spread from each direction except for northeastern and north-western quadrants. Calm wind conditions were observed to occur approximately 7.0% of the time during winter.
- In spring, wind speeds ranged from calm to strong winds (between 0.5 m/s and 8.8 m/s) and were predominantly blowing from between north to southeast directions. Calm wind conditions were observed to occur approximately 2.8% of the time during spring.

Winds that blow from HCOC towards the nearest sensitive receptors located to the south (R1 and R2) and east (R2 and R4) of the site only occur approximately 12% the time.

Wind erosion of dust from exposed surfaces is usually initiated when wind speeds exceed the threshold friction velocity for a given surface or material, however, a general rule of thumb is that wind erosion can be expected to occur above 5 m/s (USEPA 2006). The frequency of wind speeds for the period of 2020-2024 is presented in **Figure 4-4**. The plot showed that the frequency of wind speeds exceeding 5 m/s for the period 2020-2024 at the onsite AWS was approximately 7.9%.



Figure 4-3 Annual and Seasonal Wind Roses for the Onsite AWS (2020 to 2024)

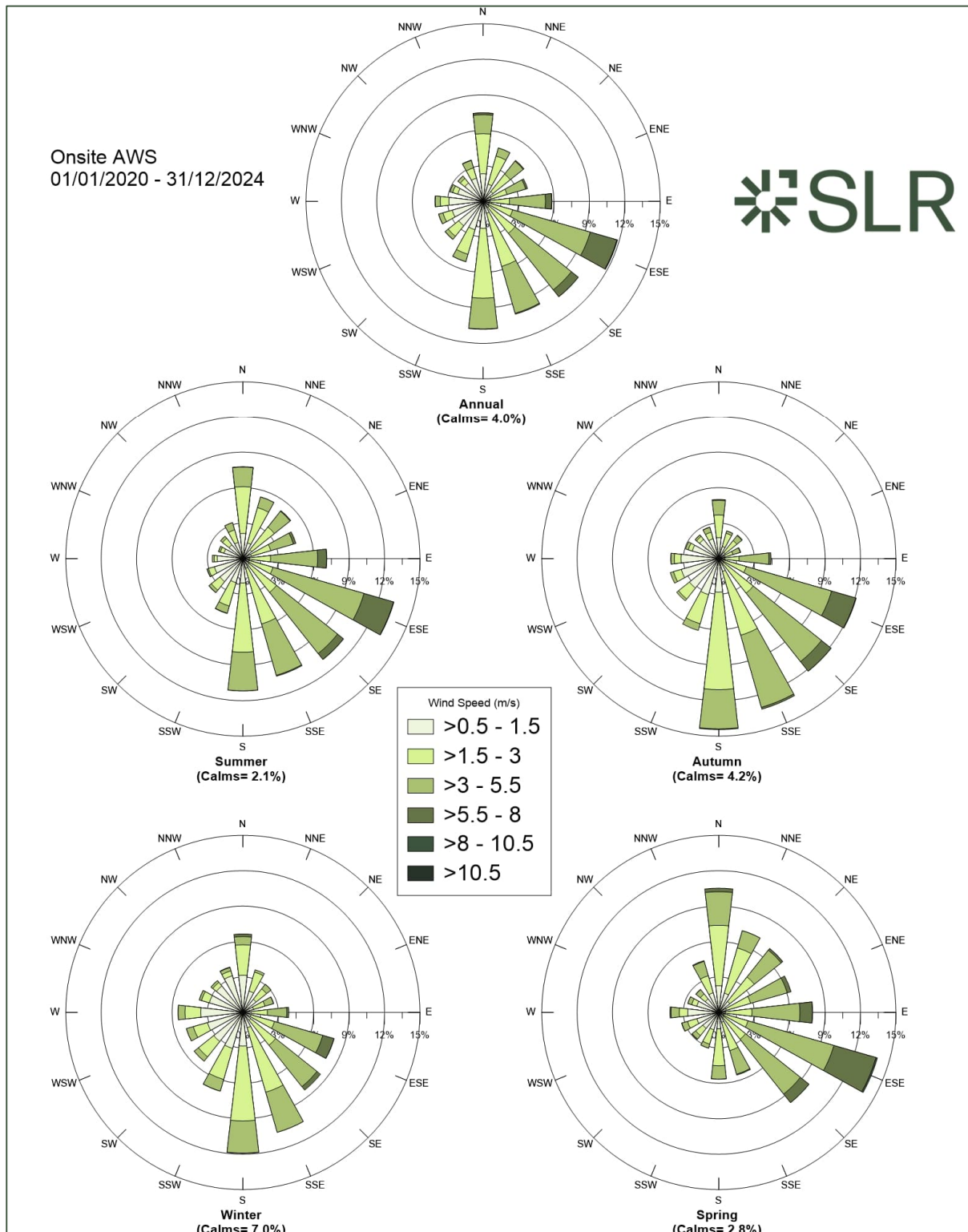
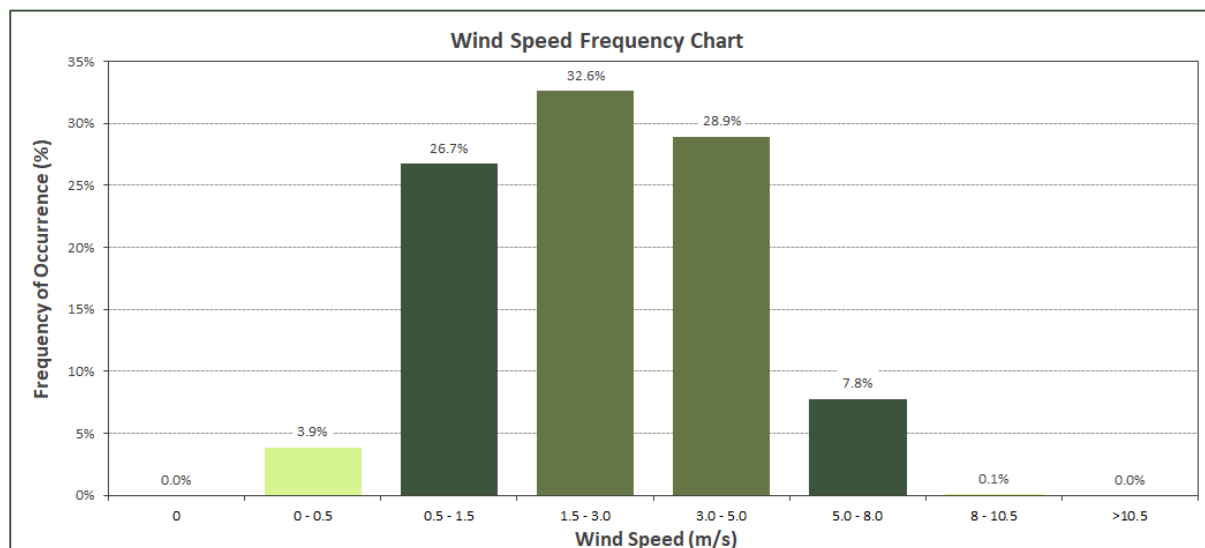


Figure 4-4 Wind Speed Frequency Chart for the Onsite AWS – 2020-2024

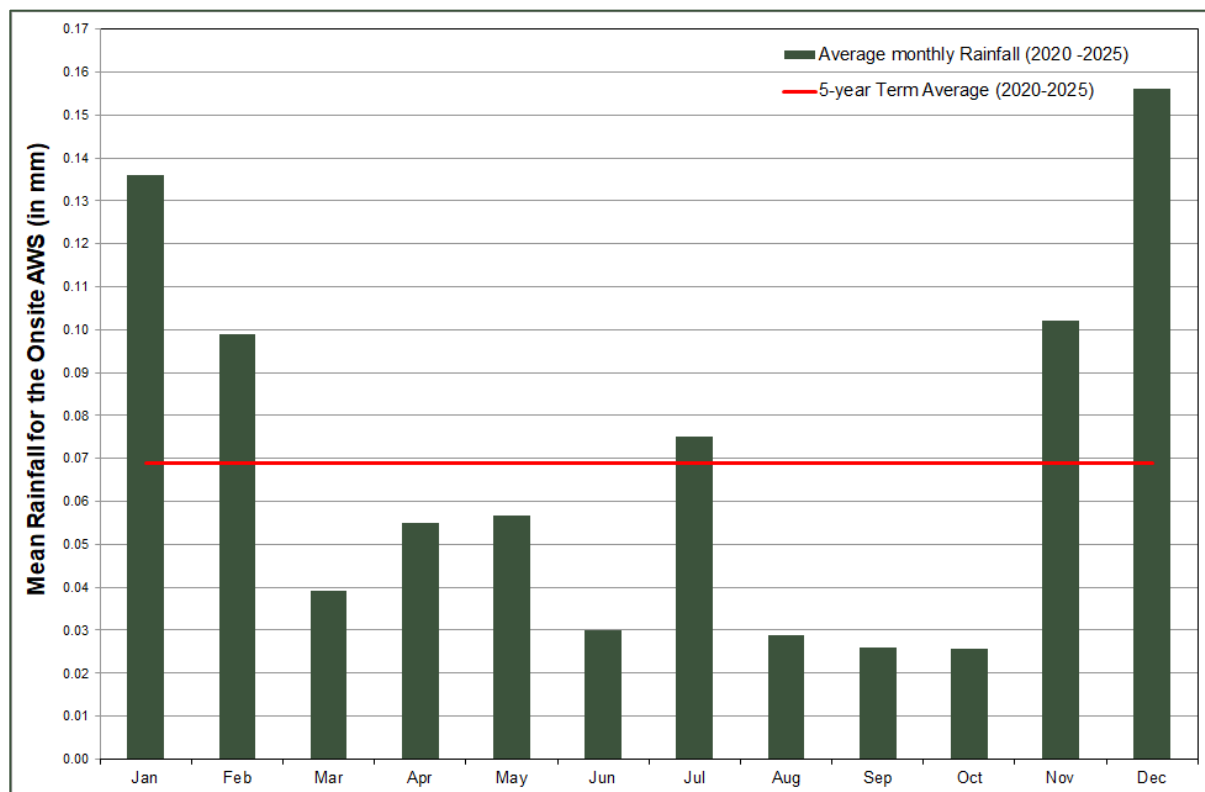


4.3.2 Rainfall

Dry periods (no rainfall) have the highest potential for fugitive dust emissions during the operation of the Project. The long-term monthly rainfall averages recorded at the onsite AWS rain gauge are shown in **Figure 4-5**. It is noted that generally rainfall is relatively low in early-autumn to late-winter and mid-winter to mid-spring periods. This rainfall pattern suggests that dust emissions from the Project have the highest potential to impact on receptors for the period of early-autumn to mid-spring.



Figure 4-5 Average Rainfall for the Onsite AWS – 2020 to 2025



4.4 Existing Air Quality

4.4.1 Available Data

HCOC operates a comprehensive monitoring network to assist with the environmental management of site operations. For the purposes of this assessment the data considered has been limited to the data from the following equipment which is compliant with the relevant Australian Standards and for which data was available during 2020 to 2024. The locations of each are shown on **Figure 4-1**:

- One AWS measuring a range of parameters, with wind speed and wind direction being the most relevant data to this assessment;
- Two Beta Attenuation Monitors (BAMs) measuring 24-hour average PM₁₀ concentrations; and
- Four dust deposition gauges (DDGs).

4.4.2 Suspended Particles

As outlined in **Section 4.4.1**, two BAMs are operated by HCOC (East BAM and North BAM) that measure 24-hour average PM₁₀ concentrations.

Both BAMs operated by HCOC exhibited low data availability for 2023, which is the year the meteorological modelling was undertaken (refer to **Section 6.2** for details). To identify a suitable dataset for use as representative background conditions in the cumulative assessment, data from the previous five years were reviewed. Of these, only 2020 and 2022 demonstrated satisfactory data completeness. Given that 2020 data were significantly



influenced by the ‘Black Summer’ bushfire events, the year 2022 was selected as the most representative period for background air quality characterisation.

Figure 4-6 presents the 24-hour average PM₁₀ concentrations recorded during 2022 by the East and North BAMs. The East BAM recorded three elevated dust levels above the 50 µg/m³ 24-hour average criterion, while the North BAM recorded two elevated dust levels.

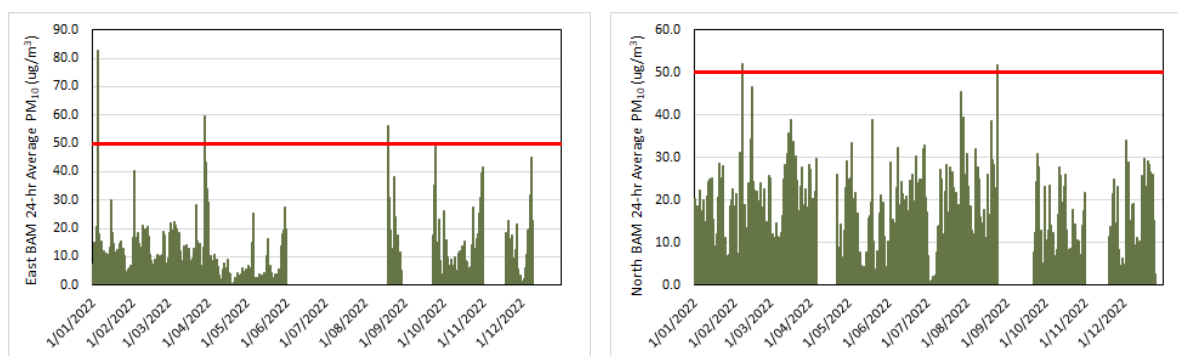
As the BAM monitors are located within the mine lease boundary, and not at any of the identified sensitive receptors, elevated dust levels are due to activities at the mine and allow for dust mitigation measures to be implemented before any potential impacts occur at those receptors. Accordingly, these exceedances are not considered problematic or indicative of adverse impacts at sensitive locations.

The elevated dust levels represent isolated events not reflective of typical background conditions. The calculation of background concentrations and the cumulative assessment has conservatively included all data.

The likely causes of these elevated readings are summarised below:

- East BAM: All three exceedances (recorded on 5 January, 29 March and 24 August 2022) are attributable to localised events within the ML.
- North BAM
 - 7 February 2022: Elevated concentrations likely influenced by rehabilitation works completed nearby in late 2021. Exposed topsoil from the recently rehabilitated area may have contributed to higher particulate levels over an acute duration.
 - 24 August 2022: The instrument appears to have malfunctioned, as it failed on 25 August 2022 immediately following the anomalous reading.

Figure 4-6 2022 24-hour average PM₁₀ concentrations – East and North BAMs



HCOC does not monitor ambient concentrations of PM_{2.5} as this is not required under the EA and the nearest DETSI-operated ambient air quality monitoring stations are located in Moranbah township (Cunningham Way and Utah Drive), approximately 66 km southwest of the Project. The DETSI stations record both PM₁₀ and PM_{2.5} concentrations.

To estimate background PM_{2.5} concentrations from the BAMs, PM_{2.5}/ PM₁₀ ratios were derived from the Moranbah monitoring station data as detailed in **Table 4-2** and **Table 4-3**.



Table 4-2 PM_{2.5}/PM₁₀ Ratios for DETSI-operated Stations

Parameter	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM _{2.5} /PM ₁₀ Ratio
Moranbah East			
Maximum	43.5	18.1	0.4
90 th Percentile	26.5	7.3	0.3
70 th Percentile	22.0	6.0	0.3
Median	19.1	5.4	0.3
Average	18.9	5.4	0.3
Moranbah West			
Maximum	50.7	22.5	0.4
90 th Percentile	30.3	7.5	0.2
70 th Percentile	24.9	6.3	0.3
Median	21.0	5.5	0.3
Average	21.1	5.6	0.3

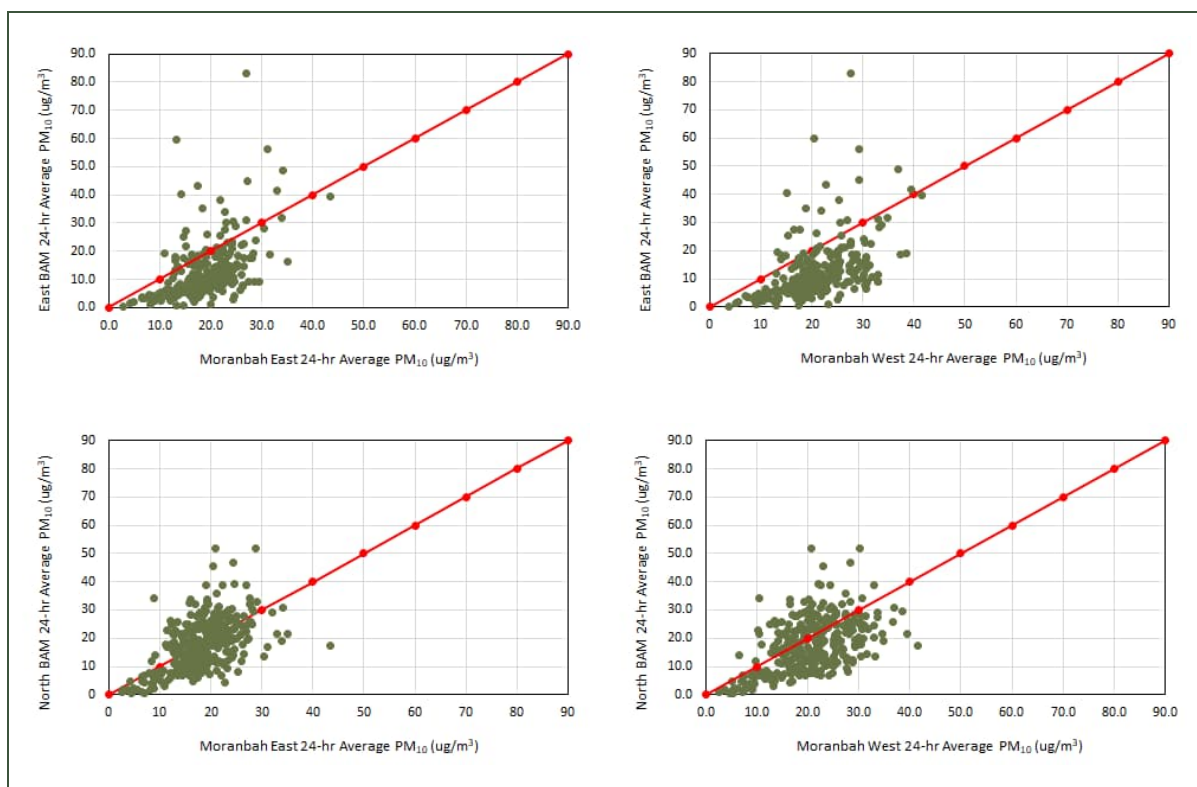
Table 4-3 PM_{2.5} Concentrations

Parameter	East BAM		North BAM	
	PM ₁₀ (µg/m ³)	Scaled PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	Scaled PM _{2.5} (µg/m ³)
Maximum	83.0	35.7	51.9	22.3
90 th Percentile	25.0	6.6	29.0	7.6
70 th Percentile	15.5	4.1	23.1	6.1
Median	10.7	2.9	18.1	4.9
Average	13.4	3.7	18.1	5.0

As presented in **Figure 4-7**, comparative analysis of concurrent Moranbah and HCOC BAM 24-hour average PM₁₀ concentrations indicates that the Moranbah data generally report higher PM₁₀ concentrations than the HCOC BAMs, suggesting that the adopted background concentrations are conservative for cumulative impact assessment purposes.



Figure 4-7 Comparison of PM₁₀ Concentrations between Project BAMs and Moranbah Monitoring Stations



For the cumulative assessment, data from the East BAM was applied to receptors R1, R2a, and R3, while data from the North BAM was used for receptor R4.

4.4.3 Dust Deposition

As outlined in **Section 4.4.1**, HCOC operates a network of four dust deposition gauges as part of its ambient air quality monitoring program. Three of these gauges are located within the ML, in close proximity to intensive mining operations and well away from any sensitive receptors; therefore, the data from these locations are not considered suitable for establishing background dust deposition levels for the cumulative assessment.

One gauge, DDG A1, is positioned outside the ML, predominantly upwind of both past and proposed mining activities. Consequently, DDG A1 is considered representative of background dust deposition conditions for the purpose of the cumulative assessment.

The combustible portion of the deposited dust was determined by subtracting the ash content from the total insoluble solids. Valid dust deposition results recorded between January 2020, and July 2025 are presented in **Figure 4-8**.

Over this period, DDG A1 recorded eight elevated levels of the Queensland nuisance dust deposition guideline of 120 mg/m²/day (insoluble solids).

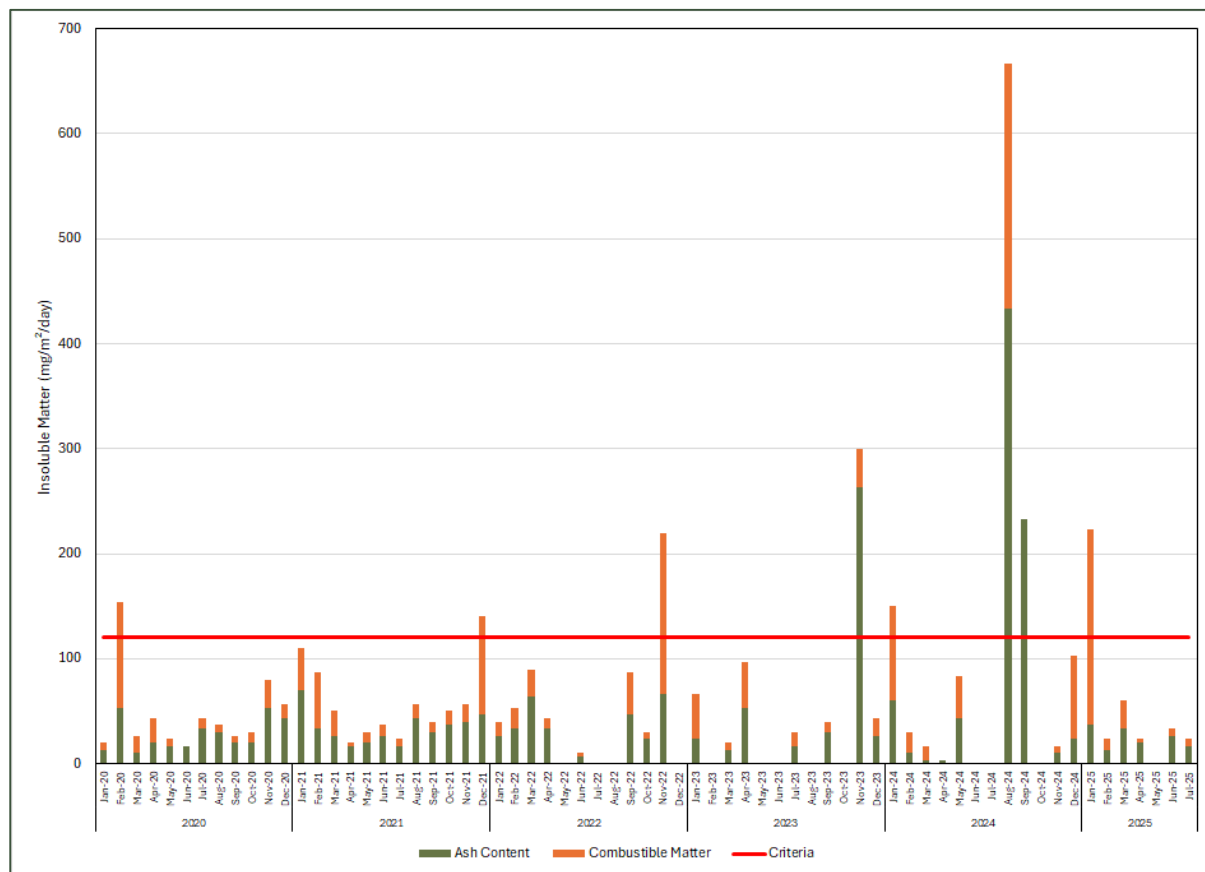
Five of these elevated levels were found to be dominated by combustible matter, which is not associated with mining activities. These instances occurred in:

- February 2020 (approximately 65% combustible matter);
- December 2021 (approximately 70% combustible matter);
- November 2022 (approximately 70% combustible matter);



- January 2024 (approximately 60% combustible matter); and
- January 2025 (approximately 84% combustible matter).

Figure 4-8 A1 Deposited Dust – Ash and Combustible (mg/m²/day)

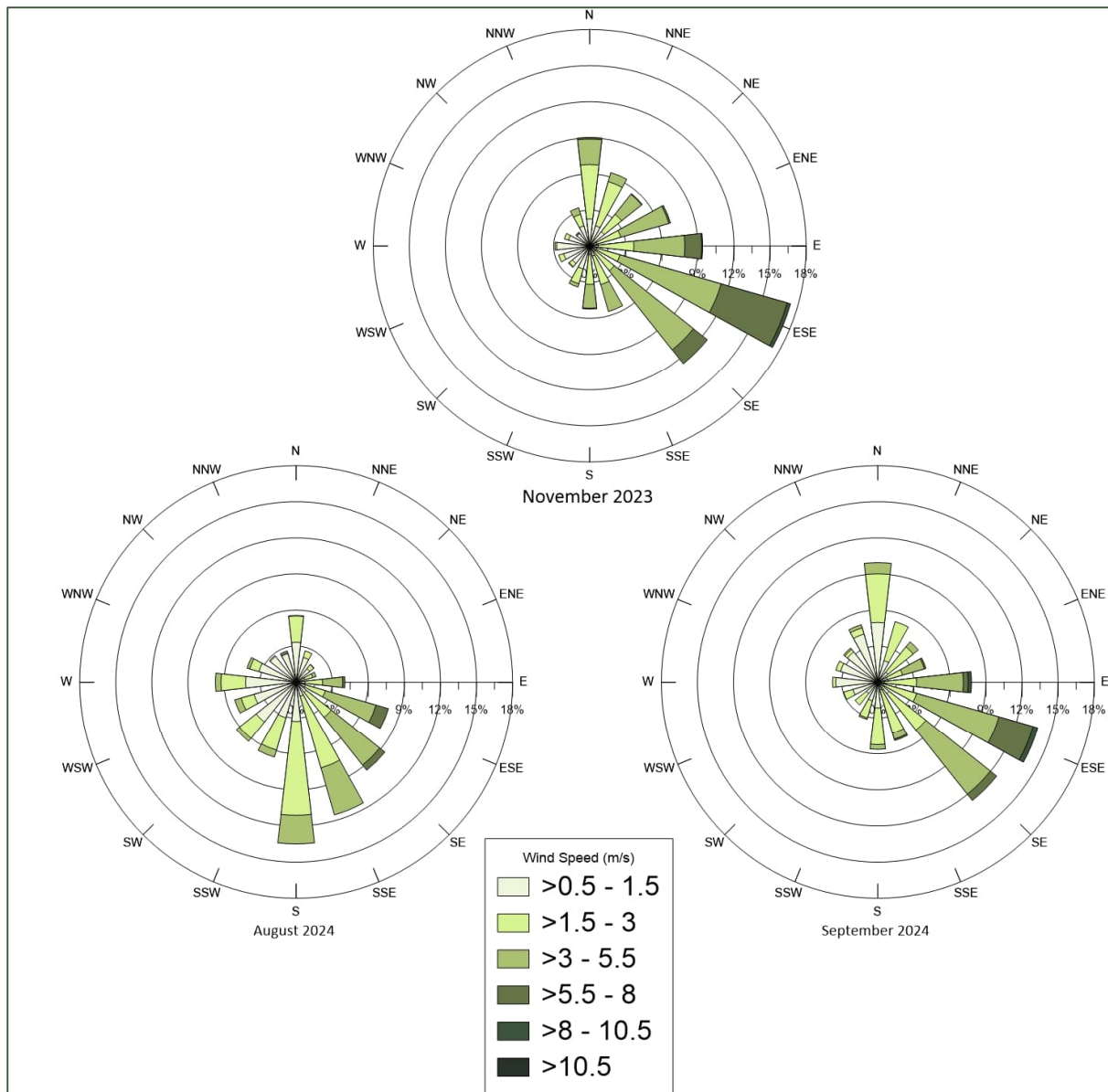


For the remaining three elevated levels, wind roses corresponding to each period were analysed to determine the potential contribution from mining operations. As shown in **Figure 4-9**, the wind roses indicate that during all three events, DDG A1 was upwind of the active mining areas, with prevailing winds predominantly from the southeast. Given that the mine is located to the northwest of DDG A1, it is unlikely that mine-related activities contributed significantly to these elevated results, which are therefore attributed to alternative external dust sources.

To ensure a conservative assessment, all three of these elevated levels have been included in calculating the background dust deposition level. The resulting background dust deposition rate, inclusive of these events, is 63.3 mg/m²/day.



Figure 4-9 DDG A1 wind roses during exceedance periods, showing upwind conditions relative to mining areas



4.4.4 Adopted Background Levels

The background levels adopted for each air quality indicator and each averaging period, along with the basis of the estimated values, are presented in **Table 4-4**.

Table 4-4 Background Concentrations Adopted for this Assessment

Pollutant	Averaging Period	Receptors	Background Value	Basis for Revised Background Levels
PM ₁₀ (µg/m ³)	24-hour	R1, R2a, R3	15.5	70 th percentile of East BAM and North BAM data for calendar year 2022.
		R4	23.1	
	Annual	R1, R2a, R3	13.4	Annual average of East BAM and North BAM data for calendar year 2022.
		R4	18.1	
PM _{2.5} (µg/m ³)	24-hour	R1, R2a, R3	4.1	70 th percentile of East BAM and North BAM data for calendar year 2022, scaled using Moranbah stations.
		R4	6.1	
	Annual	R1, R2a, R3	3.7	Annual average of Moranbah data for calendar year 2022, scaled using Moranbah stations.
		R4	5.0	
TSP (µg/m ³)	Annual	R1, R2a, R3	33.4	Scaled from annual average PM ₁₀ using a PM ₁₀ /TSP ratio of 0.4 based on data collected in the vicinity of coal mines (Richardson 2000).
		R4	45.1	
Dust Deposition mg/m ² /day	1-Month	R1, R2a, R3 and R4	63.3	Conservative estimate based on A1 DDG records.



5.0 Estimation of Air Emissions

5.1 Modelling Scenarios

Based on a review of available Project information, including mine plans and analysis of projected annual ROM coal and overburden throughputs for each operational year, emission inventories for the three operational scenarios detailed below were prepared:

- 2027 – Approved Operations: Maximum amount of combined overburden and ROM material movement currently approved (Scenario 1).
- 2027 – Approved Operations and Project: Maximum amount of combined overburden and ROM material movement as proposed (Scenario 2).
- 2036 – Approved Operations and Project: Closest activity to a sensitive receptor (R1 - Fort Cooper Homestead) (Scenario 3).

As shown in **Section 5.3**, the emission inventories for 2027 for Scenario 1 and Scenario 2 show that emissions from the Scenario 2 are estimated to be up to 7.6% higher than the Approved Operations in 2027. As such, dispersion modelling has been completed for the following operational scenarios:

- 2027 – Approved Operations and Project: Maximum amount of combined overburden and ROM material movement as proposed (Scenario 2).
- 2036 – Approved Operations and Project: Closest activity to a sensitive receptor (R1 - Fort Cooper Homestead) (Scenario 3).

5.2 Emission Factors and Activity Data

Fugitive dust emissions associated with mining activities for the scenarios outlined in **Section 5.1** were estimated using relevant emission factors sourced from the USEPA's AP42 Emission Factor Handbook (US EPA 2006 and updates), Australian Coal Association Research Program (ACARP) emission factors (ACARP 2015) and the National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Mining (DSEWPC 2012) (refer to **Appendix A** for details).

A summary of the activity data used to estimate the potential particulate emissions for each of the operating scenarios listed in **Section 5.1** is presented in **Table 5-1**.



Table 5-1 Summary of Activity Data

Parameter	2027		2036	Unit
	Scenario 1	Scenario 2	Scenario 3	
Site Preparation				
Scraper (total)*	4,840	4,840	0	hrs/annum
Active area - Kemmis	469	493	-	
Active area - Carrinyah	1,430	1,504	-	
Active area - Exevale	481	255	-	
Active area - Western Margin	2,460	2,588	-	
Overburden				
Kemmis - Truck and shovel	22,634,853	22,634,853	0	bcm/annum
Carrinyah - Truck and shovel	30,441,470	30,441,470	35,354,658	
Exevale - Truck and shovel	6,323,922	14,022,763	0	
Western Margin - Dragline	9,221,592	9,221,592	0	
Western Margin - Truck and shovel	20,441,951	20,441,951	0	
Dragline drop height	10	10	10	m
ROM				
Kemmis	1,622,481	1,622,481	-	t/annum
Carrinyah	2,817,882	2,817,882	4,252,443	
Exevale	1,435,821	2,007,489	-	
Western Margin	3,180,221	3,180,221	-	
Haul Truck - ROM and Overburden				
Haul truck gross weight - ROM	391	391	391	tonnes
Haul truck empty weight - ROM	161	161	161	
Haul truck gross weight - Overburden	576	576	576	
Haul truck empty weight - Overburden	249	249	249	
Haul Truck - Tailings				
Haul truck gross weight	386	386	386	tonnes
Haul truck empty weight	159	159	159	
Haul Road Length (one-way) - ROM				
Kemmis	9.3	9.3	-	km
Carrinyah	11.7	11.7	12.8	
Exevale	12.5	11.0	-	
Western Margin	6.9	6.9	-	
CHPP to Tailings Storage Facilities	6.6	6.6	6.6	
Haul Road Length (one-way) - Overburden				
Kemmis	2.9	2.9	-	km
Carrinyah	3.7	3.7	3.3	
Exevale	3.8	4.0	-	
Western Margin	3.5	3.5	-	



Parameter	2027		2036	Unit
	Scenario 1	Scenario 2	Scenario 3	
Dozers				
Dozers - Kemmis	15,117	15,117	-	hr/annum
Dozers - Carrinyah	32,600	32,600	40,876	
Dozers - Exevale	28,846	28,846	-	
Dozers - Western Margin	19,402	19,402	-	
Dozers - ROM stockpiles	6,227	6,227	3,032	
Dozers - Product coal stockpiles	21,600	21,600	10,379	
Grader				
Speed of grader	15	15	15	km/hr
Grader VKT	6,327	6,199	2,352	VKT/annum
CHPP				
ROM Throughput	9,056,405	9,628,074	4,252,443	tonnes
Product throughput - coking coal	5,293,759	5,586,995	2,718,433	
Product throughput - thermal coal	2,443,669	2,606,431	1,125,793	
Final Rejects (to dump in west pit)	1,579,118	1,689,004	530,463	
Wind Erosion				
Active area - Kemmis	43	43	-	ha
Active area - Carrinyah	132	132	149	
Active area - Exevale	44	22	-	
Active area - Western Margin	226	226	-	
ROM stockpile	54	54	54	
Product stockpile	9	9	9	
Reject Stockpile	24	24	24	
Tailing Storage Facility (20% of total area)	3	3	3	
Drilling and Blasting				
Number of blasts (total)*	88	88	34	blasts/annum
Active area - Kemmis	9	9	-	
Active area - Carrinyah	26	27	34	
Active area - Exevale	9	5	-	
Active area - Western Margin	45	47	-	
Number of drill holes (total)*	75,944	75,944	35,972	holes/annum
Active area - Kemmis	7,354	7,736	-	
Active area - Carrinyah	22,439	23,603	35,972	
Active area - Exevale	7,553	4,005	-	
Active area - Western Margin	38,598	40,600	-	
Average blast area (per blast)	42,532	42,532	42,532	m²



Parameter	2027		2036	Unit
	Scenario 1	Scenario 2	Scenario 3	
Moisture Content and Silt Content				
ROM Moisture Content	5	5	5	%
Overburden Moisture Content	3	3	3	
Product Coal Moisture Content	10	10	10	
*Scraper hours, number of drill holes and number of blasts by pit were calculated based on the relative pit sizes.				

The dust control measures employed are detailed in **Table 5-2**.

Table 5-2 Dust Control Measures

Mining Activity	Dust Control Measure
Drilling	Water Spray
Hauling/Grader & Bulldozer Routes	Level 1 watering
Unloading to stockpiles	Water Spray
Primary crushing	Water Spray + Enclosure
Transfer points	Water Spray + Enclosure
Exposed areas (active pit, stockpiles, MIA)	Level 1 watering
Unloading to crusher	Water Spray
Loading ROM to conveyor	Three-sided wind fence + water sprays

5.3 Estimated Emissions

Estimated annual incremental emissions for each of the operating scenarios listed in **Section 5.1** are presented in **Table 5-3** and graphically shown in **Figure 5-1**.

Details of the emission factor calculations and estimated emissions for each activity are presented in **Appendix A**.



Table 5-3 Estimated Annual Emissions (kg/y)

Mining Activity	Emissions (kg/y)								
	Scenario 1			Scenario 2			Scenario 3		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Kemmis Pit (Area 1)									
Site preparation (Scraper)	2,888	884	88	2,766	846	85	-	-	-
Drilling	1,146	596	35	1,097	571	34	-	-	-
Blasting	14,476	7,528	434	13,864	7,209	416	-	-	-
Loading overburden from Kemmis Pit	219,860	32,979	15,830	219,860	32,979	15,830	-	-	-
Hauling overburden - Kemmis Pit	828,270	124,240	59,635	828,270	124,240	59,635	-	-	-
Unloading overburden - Kemmis Pit	219,860	32,979	15,830	219,860	32,979	15,830	-	-	-
Loading ROM from Kemmis Pit	2,812	422	53	2,812	422	53	-	-	-
Hauling ROM to ROM Pad from Kemmis Pit	113,721	17,058	2,161	113,721	17,058	2,161	-	-	-
Bulldozers - in pit	113,754	26,454	2,503	113,754	26,454	2,503	-	-	-
Carrinyah Pit (Area 4)									
Site preparation (Scraper)	8,812	2,696	270	8,439	2,582	258	-	-	-
Drilling	3,496	1,818	107	3,348	1,741	102	6,367	3,311	195
Blasting	44,168	22,967	1,325	42,301	21,996	1,269	65,611	34,118	1,968
Loading overburden from Carrinyah Pit	295,688	44,353	21,290	295,688	44,353	21,290	343,412	51,512	24,726



Mining Activity	Emissions (kg/y)								
	Scenario 1			Scenario 2			Scenario 3		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Hauling overburden - Carrinyah Pit	1,390,302	208,545	100,102	1,390,302	208,545	100,102	1,435,351	215,303	103,345
Unloading overburden - Carrinyah Pit	295,688	44,353	21,290	295,688	44,353	21,290	343,412	51,512	24,726
Loading ROM from Carrinyah Pit	4,884	733	93	4,884	733	93	7,371	1,106	140
Hauling ROM to ROM Pad from Carrinyah Pit	248,837	37,325	4,728	248,837	37,325	4,728	409,086	61,363	7,773
Bulldozers - in pit	245,317	57,050	5,397	245,317	57,050	5,397	307,595	71,534	6,767
Exevale Pit (Area 3)									
Site preparation (Scraper)	7,022	2,149	215	8,157	2,496	250	-	-	-
Drilling	2,786	1,449	85	3,236	1,683	99	-	-	-
Blasting	35,197	18,302	1,056	40,887	21,261	1,227	-	-	-
Loading overburden from Exevale Pit	61,426	9,214	4,423	136,208	20,431	9,807	-	-	-
Hauling overburden - Exevale Pit	298,088	44,713	21,462	697,114	104,567	50,192	-	-	-
Unloading overburden - Exevale Pit	25,759	3,864	1,855	57,119	8,568	4,113	-	-	-
Loading ROM from Exevale Pit	2,489	373	47	3,480	522	66	-	-	-
Hauling ROM to ROM Pad from Exevale Pit	135,111	20,267	2,567	167,043	25,057	3,174	-	-	-



Mining Activity	Emissions (kg/y)								
	Scenario 1			Scenario 2			Scenario 3		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Bulldozers - in pit	217,063	50,480	4,775	217,063	50,480	4,775	-	-	-
Western Margin Pit									
Site preparation (Scraper)	15,158	4,638	464	14,517	4,442	444	-	-	-
Drilling	6,014	3,127	184	5,760	2,995	176	-	-	-
Blasting	75,975	39,507	2,279	72,764	37,837	2,183	-	-	-
Loading overburden from Western Margin Pit	198,559	29,784	14,296	198,559	29,784	14,296	-	-	-
Hauling overburden - Western Margin Pit	1,284,260	192,639	92,467	1,284,260	192,639	92,467	-	-	-
Unloading overburden - Western Margin Pit	120,829	18,124	8,700	120,829	18,124	8,700	-	-	-
Overburden - Dragline on Western Margin	384,085	72,298	27,654	384,085	72,298	27,654	-	-	-
Loading ROM from Western Margin Pit	5,512	827	105	5,512	827	105	-	-	-
Hauling ROM to ROM Pad from Western Margin Pit	164,957	24,744	3,134	164,957	24,744	3,134	-	-	-
Bulldozers - in pit	146,004	33,954	3,212	146,004	33,954	3,212	-	-	-



Mining Activity	Emissions (kg/y)								
	Scenario 1			Scenario 2			Scenario 3		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Processing									
Unloading ROM at ROM Pad from pits	7,849	1,177	149	8,344	1,252	159	3,685	553	70
Bulldozers - ROM stockpile	46,857	10,897	1,031	46,857	10,897	1,031	22,815	5,306	502
Loading ROM at ROM Pad to truck for transfer to hopper	7,849	1,177	149	8,344	1,252	159	3,685	553	70
Haul to hopper from ROM pad	10,238	1,536	195	10,884	1,633	207	4,807	721	91
Unload ROM to hopper	7,849	1,177	149	8,344	1,252	159	3,685	553	70
Primary Crushing	5,434	2,445	453	5,777	2,600	481	2,551	1,148	213
Transfer points (5)	23,547	3,532	447	25,033	3,755	476	11,056	1,658	210
Secondary Crushing	5,434	2,445	453	5,777	2,600	481	2,551	1,148	213
Unloading from CHPP to Product Stockpile	13,412	2,012	255	14,202	2,130	270	6,663	999	127
Bulldozers - Product Coal	67	16	1	67	16	1	67	16	1
Loading Reject from CHPP	No emissions due to high moisture content								
Hauling Reject from CHPP to reject stockpile	755	113	14	822	123	16	234	35	4
Unloading Reject to reject stockpile	No emissions due to high moisture content								



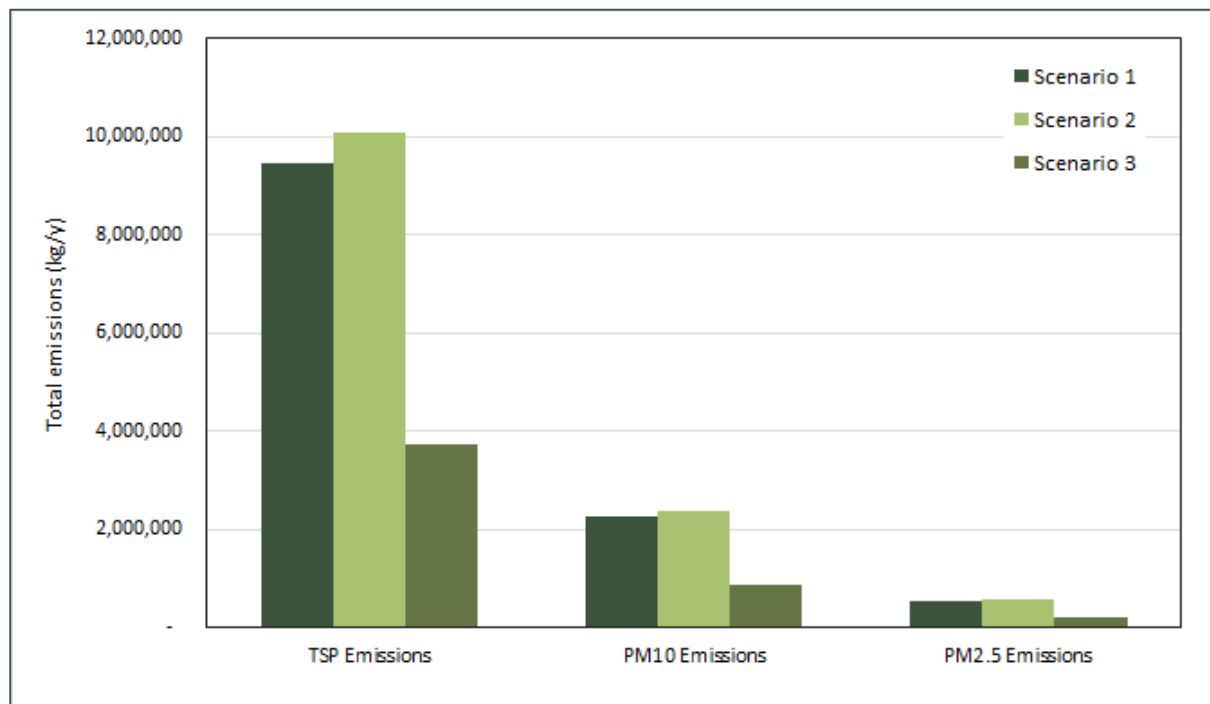
Mining Activity	Emissions (kg/y)								
	Scenario 1			Scenario 2			Scenario 3		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Hauling final final rejects to Western Margin	82,991	12,449	1,577	88,766	13,315	1,687	27,879	4,182	530
Underground reclaim product	No emissions due to high moisture content								
Loading to train	13,412	2,012	255	14,202	2,130	270	13,412	2,012	255
Grading - sitewide	9,397	2,398	291	9,206	2,349	285	9,397	2,398	291
Wind erosion									
Wind Erosion - Active area - Kemmis	151,022	75,511	7,068	151,022	75,511	7,068	-	-	-
Wind Erosion - Active area - Carrinyah	460,776	230,388	21,564	460,776	230,388	21,564	522,797	261,398	24,467
Wind Erosion - Active area - Exevale	367,184	183,592	17,184	445,372	222,686	20,843	-	-	-
Wind Erosion - Active area - Western Margin	792,605	396,302	37,094	792,605	396,302	37,094	-	-	-
Wind Erosion - ROM stockpile	94,844	47,422	4,439	94,844	47,422	4,439	94,844	47,422	4,439
Wind Erosion - Product stockpile	15,570	7,785	729	15,570	7,785	729	15,570	7,785	729
Wind Erosion - Reject Stockpile	82,387	41,194	3,856	82,387	41,194	3,856	82,387	41,194	3,856
Wind Erosion - Tailings Storage Facility	9,430	4,715	441	9,430	4,715	441	9,430	4,715	441



Mining Activity	Emissions (kg/y)								
	Scenario 1			Scenario 2			Scenario 3		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Total emissions (kg/y)	9,449,184	2,263,731	537,945	10,076,999	2,385,455	578,862	3,743,083	871,037	205,907



Figure 5-1 Estimated Annual Emissions (kg/y)



6.0 Modelling Methodology

6.1 Selection of Models

Emissions from the Project were modelled using a combination of the Weather Research and Forecast (WRF), CALMET and CALPUFF models. CALPUFF is a transport and dispersion model that ejects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so, it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period.

The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

6.2 Selection of a Representative Modelling Year

Meteorological data recorded by the onsite meteorological station for the last five years (2020-2024) were analysed to inform the selection of a representative modelling year (calendar year). The analysis showed that wind data recorded in 2023 are representative of the long term (5-year average) data and therefore suitable for use as the modelling year for this study.

6.3 Meteorological Modelling

Three-dimensional meteorological data for the Project and surrounding areas were generated using a combination of the WRF and CALMET models. Brief details of these models are provided in the following sections.

6.3.1 Weather Research and Forecast

The Weather Research and Forecast (WRF) model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting needs.

The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres. For this assessment, the WRF modelling system was used to produce the meteorological field required to provide the ‘initial guess’ field for the CALMET meteorological model. The WRF modelling was conducted for the 2023 calendar year using a nested approach, where the results from a coarser resolution grid run were used as the inputs into a finer resolution grid run. Parameters used in the WRF model for this assessment are presented in **Table 6-1**.



Table 6-1 Meteorological Parameters – WRF

Parameter	Domain 1	Domain 2	Domain 3	Domain 4
Modelling domain	837 km x 837 km	279 km x 279 km	93 km x 93 km	31 km x 31 km
Grid Resolution	27 km	9 km	3 km	1 km
Number of vertical levels	30	30	30	30
Microphysics	WSM6	WSM6	WSM6	WSM6
Cumulus parametrisation	Kain-Fritsch	Kain-Fritsch	Kain-Fritsch	Kain-Fritsch
Shortwave radiation physics	Dudhia	Dudhia	Dudhia	Dudhia
Longwave radiation physics	RRTM	RRTM	RRTM	RRTM
Planetary boundary layer	YSU	YSU	YSU	YSU

6.3.2 CALMET

In the simplest terms, CALMET is a meteorological model that develops hourly wind and other meteorological fields on a three-dimensional gridded modelling domain that are required as inputs to the CALPUFF dispersion model. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, sea breeze, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final hourly-varying wind field thus reflects the influences of local topography and land uses.

CALMET modelling was conducted using the ‘No Obs’ CALMET approach. WRF-generated three-dimensional meteorological data were used as the ‘initial-guess’ wind and local topography and land use information were used to refine the wind field predetermined by the WRF output.

Table 6-2 details the parameters used in the meteorological modelling to drive the CALMET model.

Table 6-2 Meteorological Modelling Parameters – CALMET (2023 Calendar Year)

Parameter	Data/Configuration Used
Modelling period	1 January 2023 to 31 December 2023
Meteorological grid	15 km × 15 km
Meteorological grid resolution	100 m
Initial guess field	3D output from WRF model
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data assimilation	None



6.4 Meteorological Data Used in the Dispersion Modelling

To provide a summary of the meteorological conditions predicted for the site area using the methodology described in **Section 6.4**, a single-point, ground-level meteorological dataset was extracted from the 3-dimensional dataset at the AWS site. Key features of the data set relevant to pollutant dispersion are presented and discussed below.

6.4.1 Wind Speed and Direction

A summary of the annual site-representative wind behaviour predicted by CALMET during 2023, based on wind data extracted at the location of the onsite AWS, is presented as annual and seasonal wind roses in **Figure 6-1**.

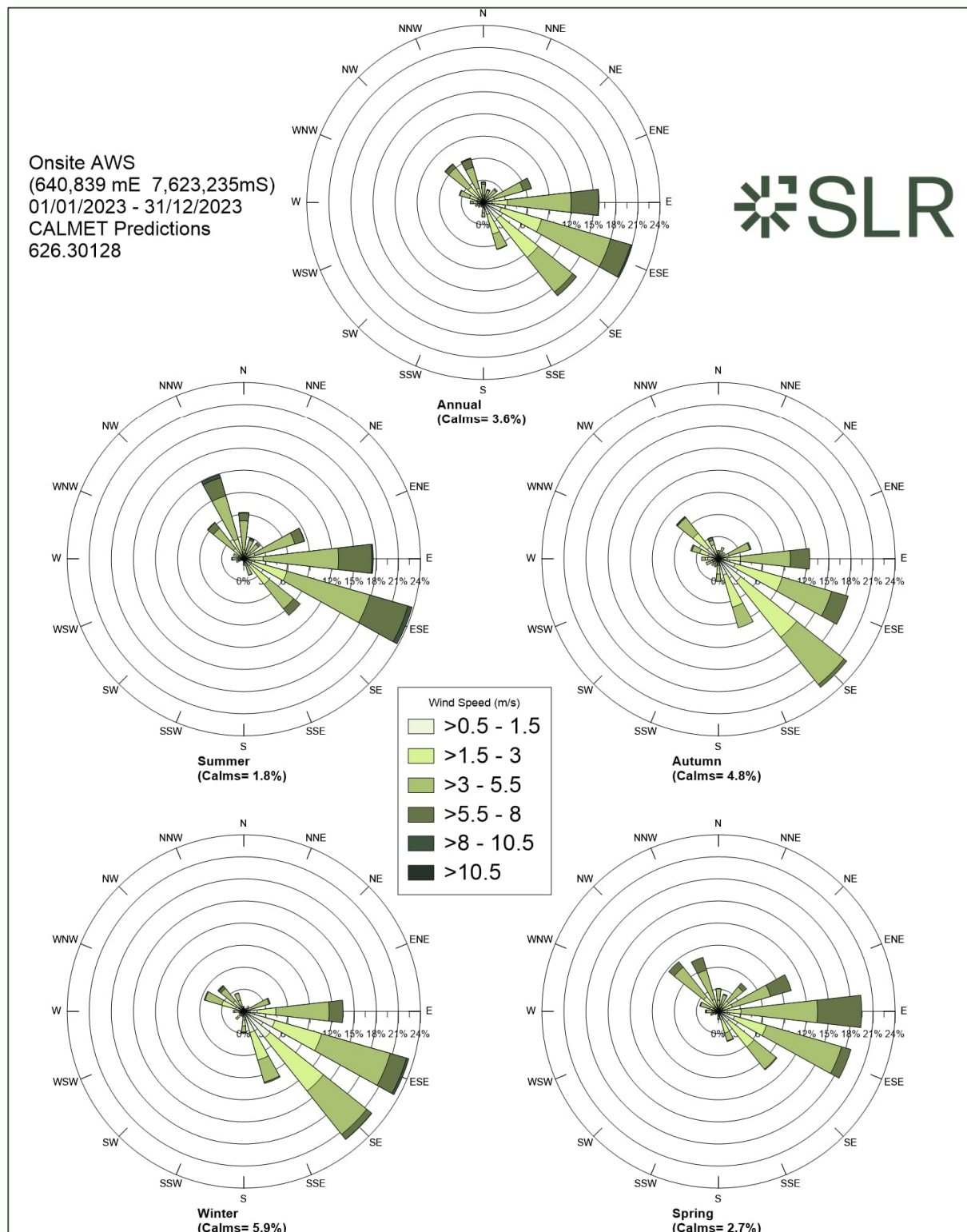
Figure 6-1 indicates that during the 2023 calendar year, the site experienced moderate winds (between 3 m/s and 8 m/s), predominantly from the southeastern quadrant and northwestern direction. Calm wind conditions (wind speeds less than 0.5 m/s) were predicted to occur approximately 4% of the time.

The seasonal wind roses indicate the following:

- Moderate winds from between southeast to east and north to north-northwest directions were predominant during summer. Winds from other directions were minimal during the summer period.
- Moderate winds from the southeastern quadrant were predominant during autumn and winter. Winds from the north-northwest direction were also notable.
- Moderate winds from the eastern quadrant and north-northwest direction were predominant during spring.



Figure 6-1 CALMET Predicted Annual and Seasonal Wind Roses at the Project



6.4.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Gifford-Turner (PGT) assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability as follows:

- A = Extremely unstable conditions;
- B = Moderately unstable conditions;
- C = Slightly unstable conditions;
- D = Neutral conditions;
- E = Slightly stable conditions; and
- F = Moderately stable conditions.

The meteorological conditions defining each PGT stability class are shown in **Table 6-3**.

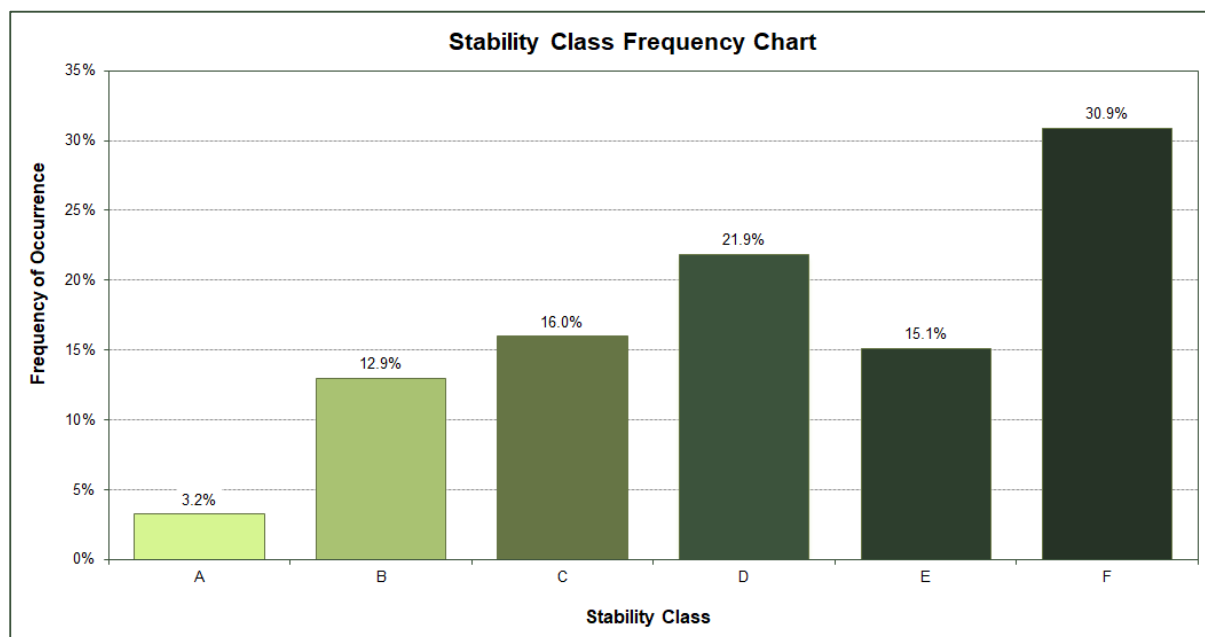
Table 6-3 Meteorological Conditions Defining PGT Stability Classes

Surface Wind Speed (m/s)	Daytime Insolation			Night-time Conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	≤ 4/8 Cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D
Notes: Strong insolation corresponds to sunny midday in midsummer in England; slight insolation to similar conditions in midwinter. Night refers to the period from 1 hour before sunset to 1 hour after sunrise. The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above. Source: (NOAA 2019).					

Figure 6-2 shows the frequency distribution of the atmospheric stability classes predicted for the site during 2023. The results indicate that stable conditions (Stability Class F) occurred most frequently. Stable conditions occurs at nighttime under low wind speed conditions and inhibit pollutant dispersion.



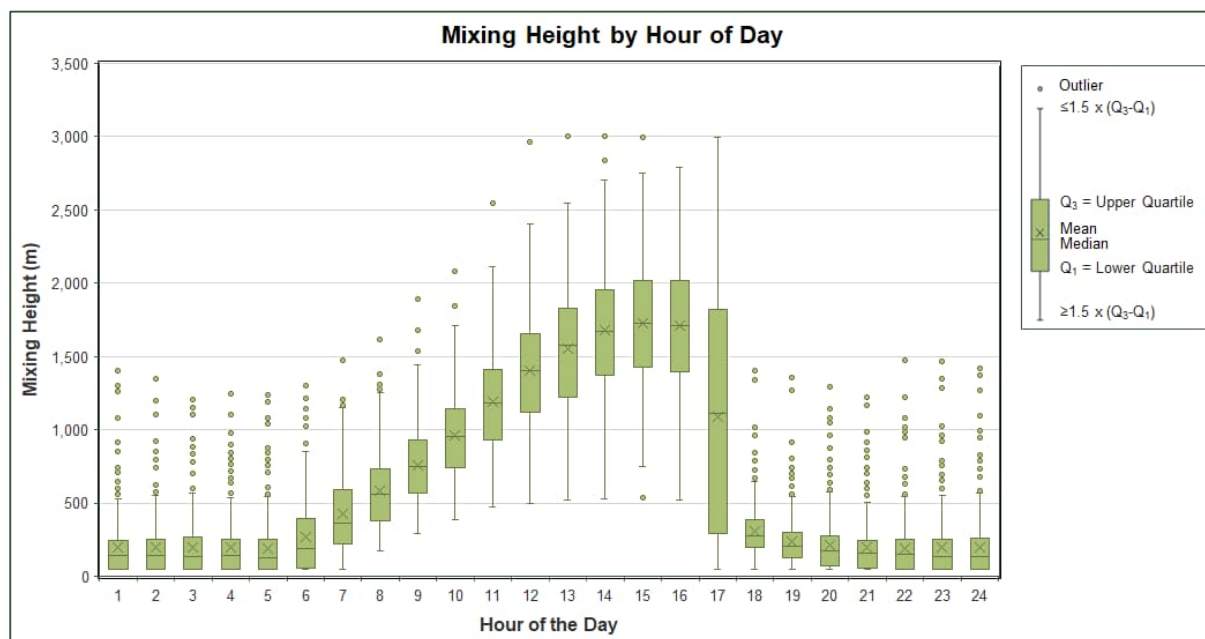
Figure 6-2 Stability Class Distribution Predicted for the Site (CALMET, 2023)



6.4.3 Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Project area for the 2023 calendar year are illustrated in **Figure 6-3**. As would be expected, an increase in the mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur mostly in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

Figure 6-3 Mixing Heights Predicted for Project (CALMET, 2023)



6.5 Dispersion Model Configuration

CALPUFF was used for the dispersion modelling and is widely used in Australia as a suitable model for a range of applications and conditions.

As with any air dispersion model, CALPUFF requires inputs in three major areas:

- Emission rates and source details;
- Meteorology; and
- Terrain and surface details, as well as specification of specific receptor locations.

A summary of the model details is provided in **Table 6-4**.

Table 6-4 CALPUFF Domain Details and Model Settings

Item	Details
Domain details	100 m resolution for 18 km by 25 km domain
Receptor details	100 m resolution
Emissions data	Varys by emission source. Refer to Appendix B for details.

Emissions from the mining and processing activities were represented within CALPUFF by a series of volume sources.

The estimated particulate emissions were modelled as:

- Fine Particulates (FP < 2.5 µm);
- Course Matter (2.5 µm < CM < 10 µm); and
- Remainder (RE > 10 µm).

These parameters were then grouped within the CALPUFF model to predict PM_{2.5}, PM₁₀ and TSP concentrations (and dust deposition rates) at surrounding receptor locations. This approach provides the most realistic treatment of the differing size fractions, with the lighter, finer particulate matter being dispersed further than the heavier size fraction that settles out of the air more rapidly.

Based on the sensitivity of each activity to wind speed, hourly varying emission files representing hourly FP, CM and RE emissions for each source were generated for each model scenario based on the annual average emission rates estimated for each activity. Details of the algorithm used to generate the variable emission files are presented in **Appendix B**.



7.0 Air Quality Impact Assessment

7.1 Residential Receptors

The incremental and cumulative impacts predicted by the modelling for Scenario 2 and Scenario 3 at each identified receptor surrounding HCOC are presented as follows:

- Maximum 24-hour average and annual average PM_{2.5} concentrations - **Table 7-1**;
- Maximum 24-hour average and annual average PM₁₀ concentrations - **Table 7-2**;
and
- Annual average TSP concentrations and maximum monthly dust deposition rates - **Table 7-3**.

The estimated background concentrations derived in **Section 4.4.1** were used to calculate the cumulative impacts at each identified surrounding receptor.

The modelling results show that the predicted cumulative maximum 24-hour and annual average PM_{2.5} and PM₁₀, annual average TSP concentrations, and maximum monthly dust deposition rates comply with the relevant criterion at each of the surrounding sensitive receptors.

Isopleths of the predicted cumulative impacts for each pollutant and each averaging period are presented in **Appendix C**.

Table 7-1 Predicted Incremental and Cumulative PM_{2.5} Concentrations

Receptor	Maximum 24-Hour Average (µg/m³)				Annual Average (µg/m³)			
	Increment		Cumulative ¹		Increment		Cumulative ²	
	Scenario 2	Scenario 3	Scenario 2	Scenario 3	Scenario 2	Scenario 3	Scenario 2	Scenario 3
R1	3.7	3.3	7.8	7.4	0.38	0.20	4.0	3.9
R2a	0.9	1.0	5.0	5.1	0.06	0.05	3.7	3.7
R3	0.7	0.4	4.8	4.5	0.05	0.03	3.7	3.7
R4	0.4	0.7	6.5	6.8	0.03	0.01	5.0	5.0
Criteria	-		20		-		7	
¹ Includes estimated background concentration of 4.1 µg/m³ for R1, R2a, and R3 and 6.1 µg/m³ for R4.								
² Includes estimated background concentration of 3.7 µg/m³ for R1, R2a, and R3 and 5.0 µg/m³ for R4.								



Table 7-2 Predicted Incremental and Cumulative PM₁₀ Concentrations

Receptor	Maximum 24-Hour Average (µg/m³)				Annual Average (µg/m³)			
	Increment		Cumulative ¹		Increment		Cumulative ²	
	2027 Proposed	2036 Proposed	2027 Proposed	2036 Proposed	2027 Proposed	2036 Proposed	2027 Proposed	2036 Proposed
R1	12.7	10.7	28.1	26.2	1.4	0.7	14.7	14.0
R2a	2.4	2.8	17.9	18.3	0.2	0.1	13.5	13.5
R3	2.6	1.5	18.1	17.0	0.2	0.1	13.6	13.5
R4	1.6	1.6	24.7	24.7	0.1	<0.1	18.1	18.1
Criteria	-		50		-		25	

¹ Includes estimated background concentration of 15.5 µg/m³ for R1, R2a, and R3 and 23.1 µg/m³ for R4.
² Includes estimated background concentration of 13.4 µg/m³ for R1, R2a, and R3 and 18.1 µg/m³ for R4.

Table 7-3 Predicted TSP Concentrations and Deposition Rates

Receptor	Annual Average TSP Concentrations (µg/m³)				Monthly Average Dust Deposition (mg/m²/day)			
	Increment		Cumulative ¹		Increment		Cumulative ²	
	Scenario 2	Scenario 3	Scenario 2	Scenario 3	Scenario 2	Scenario 3	Scenario 2	Scenario 3
R1	3.0	1.7	36.4	35.0	<0.1	<0.1	63.3	63.3
R2a	0.3	0.3	33.7	33.7	<0.1	<0.1	63.3	63.3
R3	0.4	0.2	33.8	33.6	<0.1	<0.1	63.3	63.3
R4	0.2	0.1	45.3	45.2	<0.1	<0.1	63.3	63.3
Criteria	-		90		-		120	

¹ Includes estimated background concentration of 33.4 µg/m³ for R1, R2a, and R3 and 45.1 µg/m³ for R4.
² Includes estimated background deposition rate of 63.3 mg/m²/day

As noted in **Section 4.1**, Carrinyah Station, located approximately 8 km east of the mining lease, was represented in the modelling by a pseudo-receptor (R2a) positioned about 2.5 km closer to the mining lease. As a result, the predicted concentrations at R2a are conservatively higher than those expected at Carrinyah Station itself, indicating that actual dust levels at Carrinyah Station are likely to be lower and below the relevant criteria.

8.0 Monitoring and Mitigation

Based on the review of ambient air quality monitoring data, and the predicted concentrations at the residences, it is concluded that current dust mitigation measures (outlined in **Section 5.2**) are adequate and should be adopted for the Project and no changes are required to the air quality monitoring network shown in **Figure 4-1**.



9.0 Conclusions

To evaluate the potential worst-case impacts at sensitive receptors relevant to the Project (including approved operations), particulate emissions associated with the proposed operations for the years 2027 and 2036 were quantified, modelled, and assessed against the applicable ambient air quality criteria for sensitive land uses.

Fugitive particulate emissions were estimated using established emission estimation methods, including USEPA AP-42, NPI emission factors for coal mining, and published Australian coal mine emission factors derived from ACARP.

Air dispersion modelling was undertaken for TSP, PM₁₀, PM_{2.5}, and deposited dust using the CALPUFF dispersion model, supported by a site-specific three-dimensional meteorological dataset for 2023 generated with the WRF and CALMET models.

Incremental ground-level concentrations and dust deposition rates were predicted for all identified sensitive receptors, and cumulative impacts were determined by incorporating background concentrations and deposition rates derived from regional ambient monitoring data.

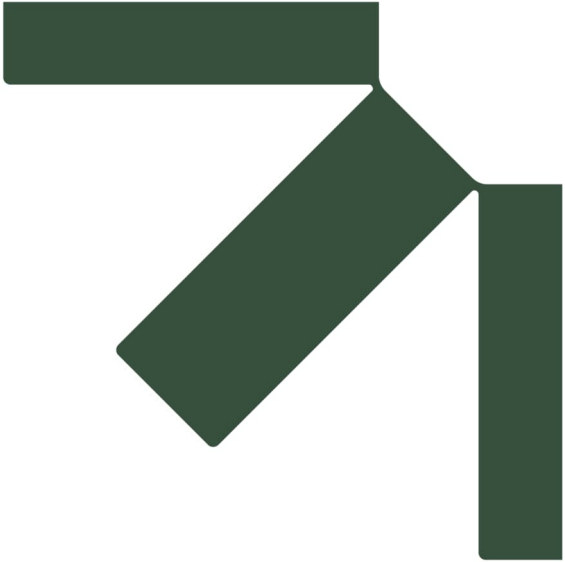
Based on the dispersion modelling outcomes, the cumulative predicted concentrations of TSP, PM₁₀, and PM_{2.5} and dust deposition levels due to the Project (including approved operations) and existing air quality are predicted to comply with the current EA conditions for air quality throughout the life of the Project (including approved operations). It is noted that the East BAM will serve as an early warning monitor for receptors R1, R2, and R3, while the North BAM will provide early warning coverage for receptor R4.



10.0 References

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Appendix A Emission Factors

Hail Creek Eastern Margin Extension Project

Air Quality Impact Assessment – Dispersion Modelling

Hail Creek Coal Holdings Pty Limited

SLR Project No.: 626.030128.00022

12 November 2025

Table A-1: Emission Factors

Source	Emission Factors			Units	Variables
	TSP	PM ₁₀	PM _{2.5}		
Kemmis Pt					
Site preparation (Scraper) ^a	14.0	4.3	0.4	kg/h	-
Drilling ^b	0.590	0.307	0.018	kg/hole	-
Blasting ^b	1,930	1,003	58	kg/blast	Area of blast = 42,532 m ²
Loading overburden from Kemmis Pit ^c	0.0041	0.0006	0.0003	kg/t	-
Hauling overburden - Kemmis Pit ^c	1.73	0.26	0.12	kg/km	Load weight = 327 tonnes Onsite travel distance (2027) = 5.9 km Onsite travel distance (2036) = -
Unloading overburden - Kemmis Pit ^c	0.0041	0.0006	0.0003	kg/t	-
Loading ROM from Kemmis Pit ^c	0.0017	0.0003	0.00003	kg/t	-
Hauling ROM to ROM Pad from Kemmis Pit ^c	1.73	0.26	0.03	kg/km	Load weight = 230 tonnes Onsite travel distance (2027) = 18.6 km Onsite travel distance (2036) = -
Bulldozers - in pit ^c	15.1	3.5	0.3	kg/h	-
Carrinyah Pit					
Site preparation (Scraper) ^a	14.0	4.3	0.4	kg/h	-
Drilling ^b	0.590	0.307	0.018	kg/hole	-
Blasting ^b	1,930	1,003	58	kg/blast	Area of blast = 42,532 m ²
Loading overburden from Carrinyah Pit ^c	0.0041	0.0006	0.0003	kg/t	-



Source	Emission Factors			Units	Variables
	TSP	PM ₁₀	PM _{2.5}		
Hauling overburden - Carrinyah Pit ^c	1.73	0.26	0.12	kg/km	Load weight = 327 tonnes Onsite travel distance (2027) = 7.3 km Onsite travel distance (2036) = -
Unloading overburden - Carrinyah Pit ^c	0.0041	0.0006	0.0003	kg/t	-
Loading ROM from Carrinyah Pit ^c	0.0017	0.0003	0.00003	kg/t	-
Hauling ROM to ROM Pad from Carrinyah Pit ^c	1.73	0.26	0.03	kg/km	Load weight = 230 tonnes Onsite travel distance (2027) = 23.4 km Onsite travel distance (2036) = -
Bulldozers - in pit ^c	15.1	3.5	0.3	kg/h	-
Exevale Pit					
Site preparation (Scraper) ^a	14.0	4.3	0.4	kg/h	-
Drilling ^b	0.59	0.3068	0.0181	kg/hole	-
Blasting ^b	1,930	1,003	58	kg/blast	Area of blast = 42,532 m ²
Loading overburden from Exevale Pit ^c	0.0041	0.0006	0.0003	kg/t	-
Hauling overburden - Exevale Pit ^c	1.73	0.26	0.12	kg/km	Load weight = 327 tonnes Onsite travel distance (2027) = 7.6 km Onsite travel distance (2036) = -
Unloading overburden - Exevale Pit ^c	0.0017	0.0003	0.0001	kg/t	-
Loading ROM from Exevale Pit ^c	0.0017	0.0003	0.00003	kg/t	-
Hauling ROM to ROM Pad from Exevale Pit ^c	1.73	0.26	0.03	kg/km	Load weight = 230 tonnes Onsite travel distance (2027) =



Source	Emission Factors			Units	Variables
	TSP	PM ₁₀	PM _{2.5}		
					25.0 km Onsite travel distance (2036) = -
Bulldozers - in pit ^c	15.1	3.5	0.3	kg/h	-
Western Margin Pit					
Site preparation (Scraper) ^a	14.0	4.3	0.4	kg/h	-
Drilling ^b	0.59	0.3068	0.0181	kg/hole	-
Blasting ^b	1,930	1,003	58	kg/blast	Area of blast = 42,532 m ²
Loading overburden from Western Margin Pit ^c	0.0041	0.0006	0.0003	kg/t	-
Hauling overburden - Western Margin Pit ^c	1.73	0.26	0.12	kg/km	Load weight = 327 tonnes Onsite travel distance (2027) = 7.0 km Onsite travel distance (2036) = -
Unloading overburden - Western Margin Pit ^c	0.0017	0.0003	0.0001	kg/t	-
Overburden removal - Dragline on Western Margin ^c	0.0417	0.00784	0.0030	kg/bcm	Overburden moisture content = 3% Drop height (2027) = 10 m Drop height (2036) = 10 m
Loading ROM from Western Margin Pit ^c	0.002	0.0003	0.00003	kg/t	-
Hauling ROM to ROM Pad from Western Margin Pit ^c	1.73	0.26	0.03	kg/km	Load weight = 230 tonnes Onsite travel distance (2027) = 13.8 km Onsite travel distance (2036) = -
Bulldozers - in pit ^c	15.1	3.5	0.3	kg/h	-
Processing					

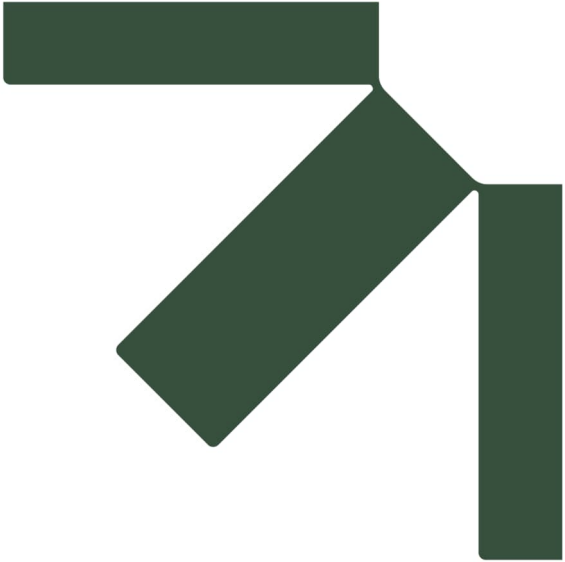


Source	Emission Factors			Units	Variables
	TSP	PM ₁₀	PM _{2.5}		
Unloading ROM at ROM Pad from pits ^c	0.0017	0.0003	0.00003	kg/t	-
Bulldozers - ROM stockpile ^c	15.1	3.5	0.3	kg/h	-
Loading ROM at ROM Pad to truck for transfer to hopper ^c	0.0017	0.0003	0.00003	kg/t	-
Haul to hopper from ROM pad ^c	1.7333	0.2600	0.0329	kg/km	Load weight = 230 tonnes Onsite travel distance (2027) = 0.3 km Onsite travel distance (2036) = 0.3 km
Unload ROM to hopper ^c	0.0017	0.0003	0.00003	kg/t	-
Primary Crushing ^d	0.0006	0.0003	0.00005	kg/t	-
Transfer points (5) ^c	0.0017	0.0003	0.00003	kg/t	-
Secondary Crushing ^d	0.0006	0.0003	0.00005	kg/t	-
Unloading from CHPP to Product Stockpile ^c	0.0017	0.0003	0.00003	kg/t	-
Bulldozers - Product Coal ^c	15.1	3.5	0.3	kg/h	-
Hauling Reject from CHPP to reject stockpile ^c	1.73	0.26	0.03	kg/km	Load weight = 227 tonnes Onsite travel distance (2027) = 0.2 km Onsite travel distance (2036) = 0.2 km
Hauling final rejects to Western Margin ^c	1.73	0.26	0.03	kg/km	Load weight = 227 tonnes Onsite travel distance (2027) = 14 km Onsite travel distance (2036) = 14 km
Loading to train ^c	0.0017	0.0003	0.00003	kg/t	-
Grading – sitewide ^b	2.96	0.76	0.09	kg/VKT	-



Source	Emission Factors			Units	Variables
	TSP	PM ₁₀	PM _{2.5}		
Wind erosion					
Wind Erosion - Active area – Kemmis ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - Active area - Carrinyah ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - Active area - Exevale ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - Active area - Western Margin ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - ROM stockpile ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - Product stockpile ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - Reject Stockpile ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
Wind Erosion - Tailings Storage Facility ^a	0.4	0.2	0.02	kg/ha/hour	8,760 h/y
References: ^a NPI Emission Estimation Technique Manual for Mining (DSEWPC 2012) ^b AP-42 Section 11.9 (USEPA 1998) ^c ACARP Emission Factors (ACARP 2015) ^d AP42 Section 11.19 (US EPA 2004)					
Note: As ACARP provides emission factors only for PM ₁₀ , factors for PM _{2.5} and TSP were derived using PM _{2.5} , PM ₁₀ , and TSP ratios from the Midwest Research Institute (Cowherd 2006).					





Appendix B Variable Emission Compilation

Hail Creek Eastern Margin Extension Project

Air Quality Impact Assessment – Dispersion Modelling

Hail Creek Coal Holdings Pty Limited

SLR Project No.: 626.030128.00022

12 November 2025

A brief summary of the steps used in calculating the hourly varying emission rates for each source are presented below.

Step 1: Calculate annual average emission rate (kg/year) for FP, CM and RE

$FP_{\text{annual}} = PM_{2.5, \text{annual}}$	(FP) Fine Particulate – particulate of size less than 2.5 µm
$CM_{\text{annual}} = PM_{10, \text{annual}} - PM_{2.5, \text{annual}}$	(CM) Coarse Particulate – particulate of size between 10 µm and 2.5 µm
$RE_{\text{annual}} = TSP_{\text{annual}} - PM_{10, \text{annual}}$	(RE) Remaining Particulate – particulate of size greater than 10 µm

Step 2: Identify the operating hours for each activity

Step 3: Classify the sensitivity of each type of activity to wind speed

- Wind insensitive: Activities with emission factor that is independent of wind speed (e.g. blasting)
- Wind sensitive: Activities with emission factor that is a function of (wind speed/2.2)^{1.3} (e.g. loading)
- Wind erosion: Emission from exposed areas/stockpiles

Step 4: Identify the number of sources associated with each activity

Note that each wind erosion source is modelled as an independent source.

Step 5: Calculate the hourly average emission rate for each activity per source

$FP_{AC,i,h} = \frac{FP_{\text{annual},i} \times 1000}{N_{\text{days}} \times OH_i \times 3600 \times N_{s,i}} \times WSFactor_{i,h}$ $CM_{AC,i,h} = \frac{CM_{\text{annual},i} \times 1000}{N_{\text{days}} \times OH_i \times 3600 \times N_{s,i}} \times WSFactor_{i,h}$ $RE_{AC,i,h} = \frac{RE_{\text{annual},i} \times 1000}{N_{\text{days}} \times OH_i \times 3600 \times N_{s,i}} \times WSFactor_{i,h}$ For wind insensitive activities $WSFactor_{i,h} = 1$ For wind sensitive activities $WSFactor_{i,h} = \frac{\left(\frac{WS_h}{2.2}\right)^{1.3}}{\frac{\sum_{j=1}^n \left(\frac{WS_j}{2.2}\right)^{1.3}}{n}}$ For wind erosion activities $WSFactor_{i,h} = \frac{(WS_h)^3}{\frac{\sum_{j=1}^n (WS_j)^3}{n}}$	Where: $FP_{AC,i,h}$ - Fine particulates emission rate for Activity i (g/s) at hour h $CM_{AC,i,h}$ - Fine particulates emission rate for Activity i (g/s) at hour h $RE_{AC,i,h}$ - Fine particulates emission rate for Activity i (g/s) at hour h OH_i - daily Operating hours (1- 24) for Activity i N_{days} - Number of days in the meteorological data file $N_{s,i}$ - Number of sources associated with Activity i WS_h - Wind speed at the hour n - number of hours in the meteorological data file
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Note: If the activity was modelled as area source, the equation on the left column of the table needs to be divided by the area of that activity

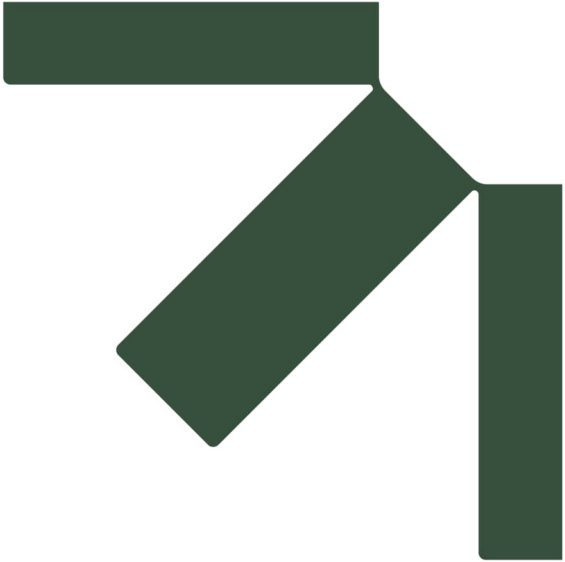
Step 5: Calculate hourly average emission rate for each source

To calculate the emission rate for a particular source for a particular hour, add up the calculated emission rate for each activity associated with that source.

For example, if Source 1 is associated with Activity 1, Activity 2 and Activity 3, then:

- $ER_{S1,h,FP} = FP_{AC,1,h} + FP_{AC,2,h} + FP_{AC,3,h}$
- $ER_{S1,h,CM} = CM_{AC,1,h} + CM_{AC,2,h} + CM_{AC,3,h}$
- $ER_{S1,h,RE} = RE_{AC,1,h} + RE_{AC,2,h} + RE_{AC,3,h}$





Appendix C Isopleths

Hail Creek Eastern Margin Extension Project

Air Quality Impact Assessment – Dispersion Modelling

Hail Creek Coal Holdings Pty Limited

SLR Project No.: 626.030128.00022

12 November 2025



Figure C-1: Predicted Cumulative 24-Hour Average PM_{2.5} Concentrations – Scenario 2 (R1 – R3)

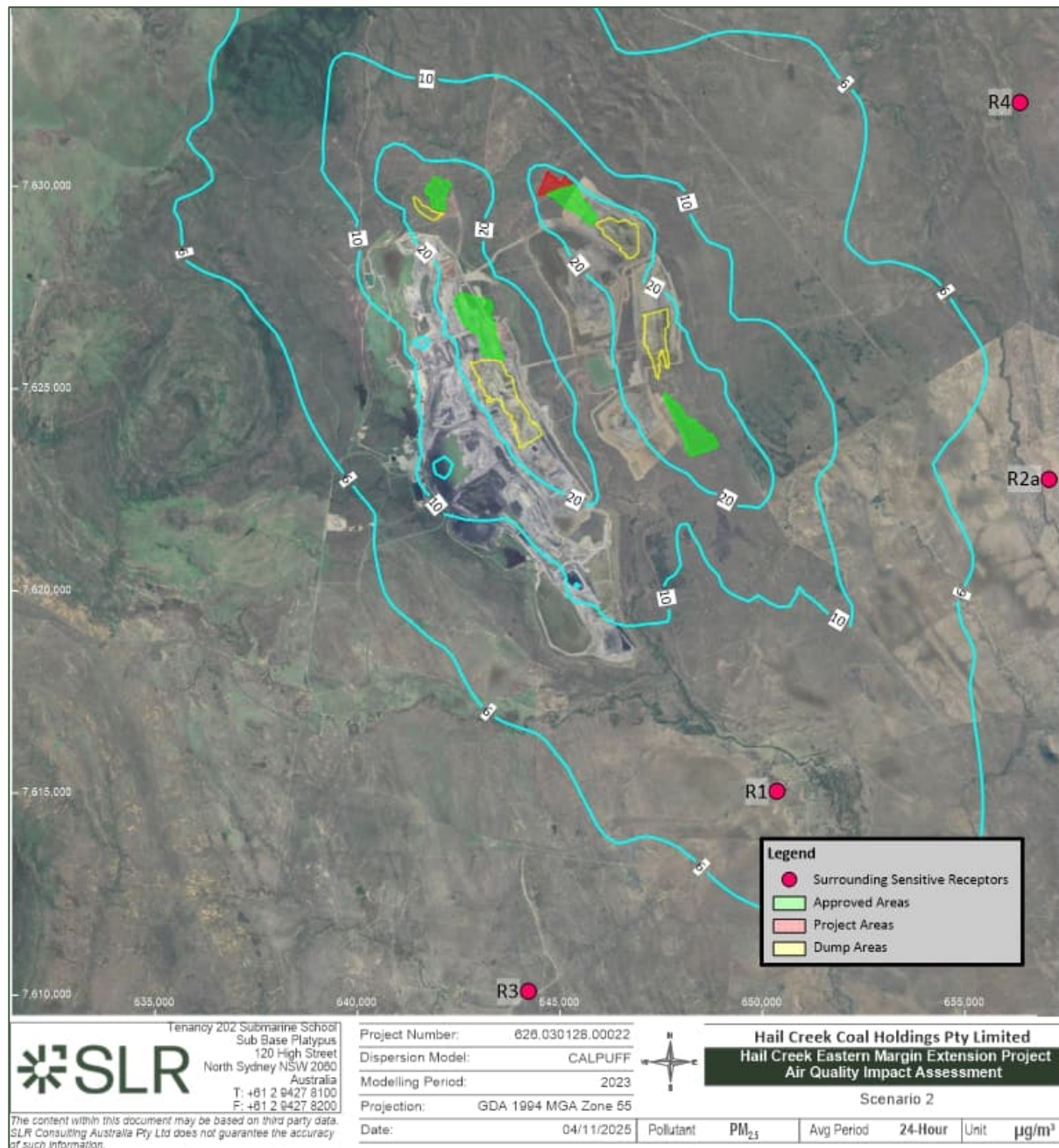


Figure C-2: Predicted Cumulative 24-Hour Average PM_{2.5} Concentrations – Scenario 2 (R4)

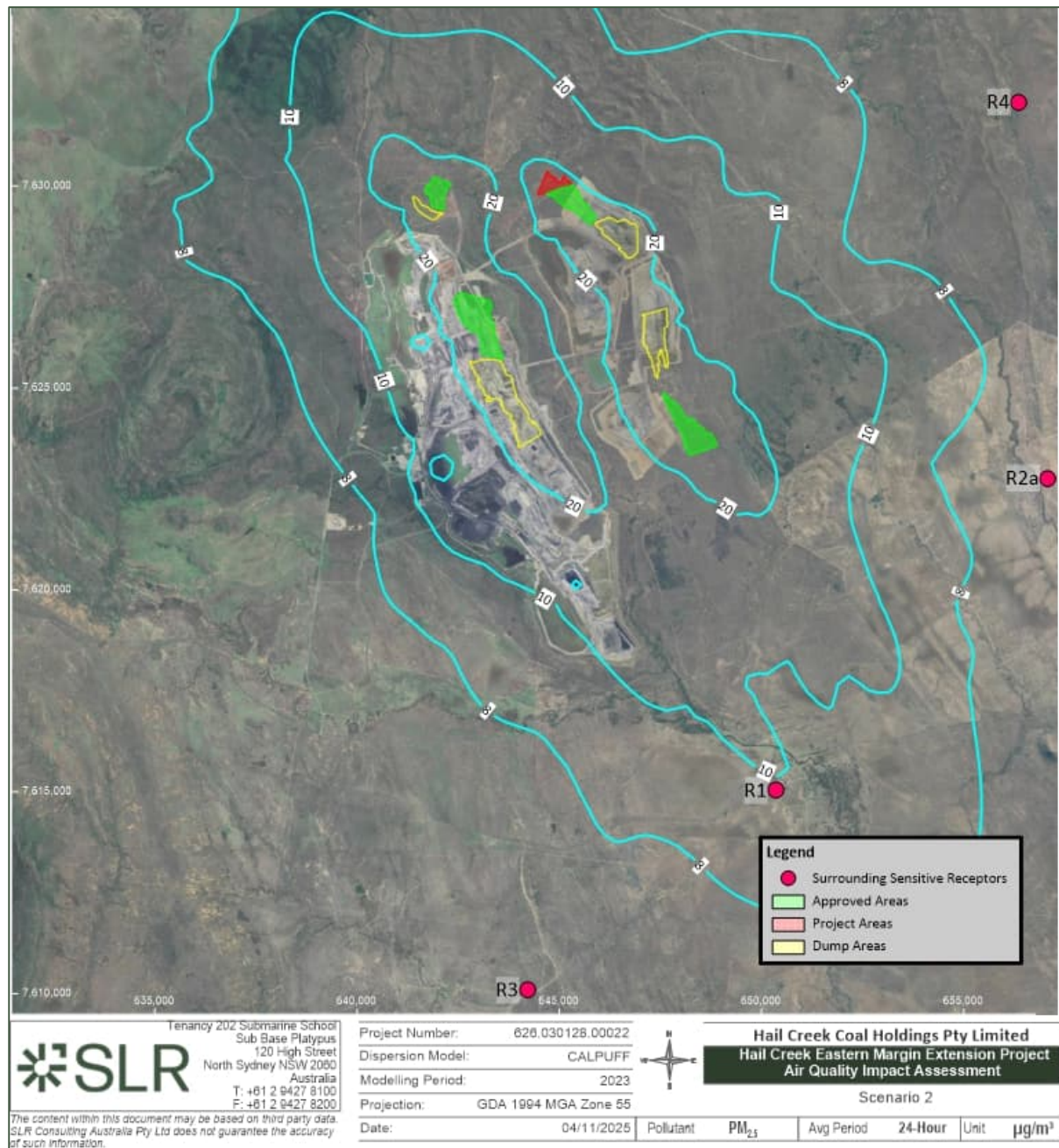


Figure C-3: Predicted Cumulative Annual Average PM_{2.5} Concentrations – Scenario 2 (R1 – R3)

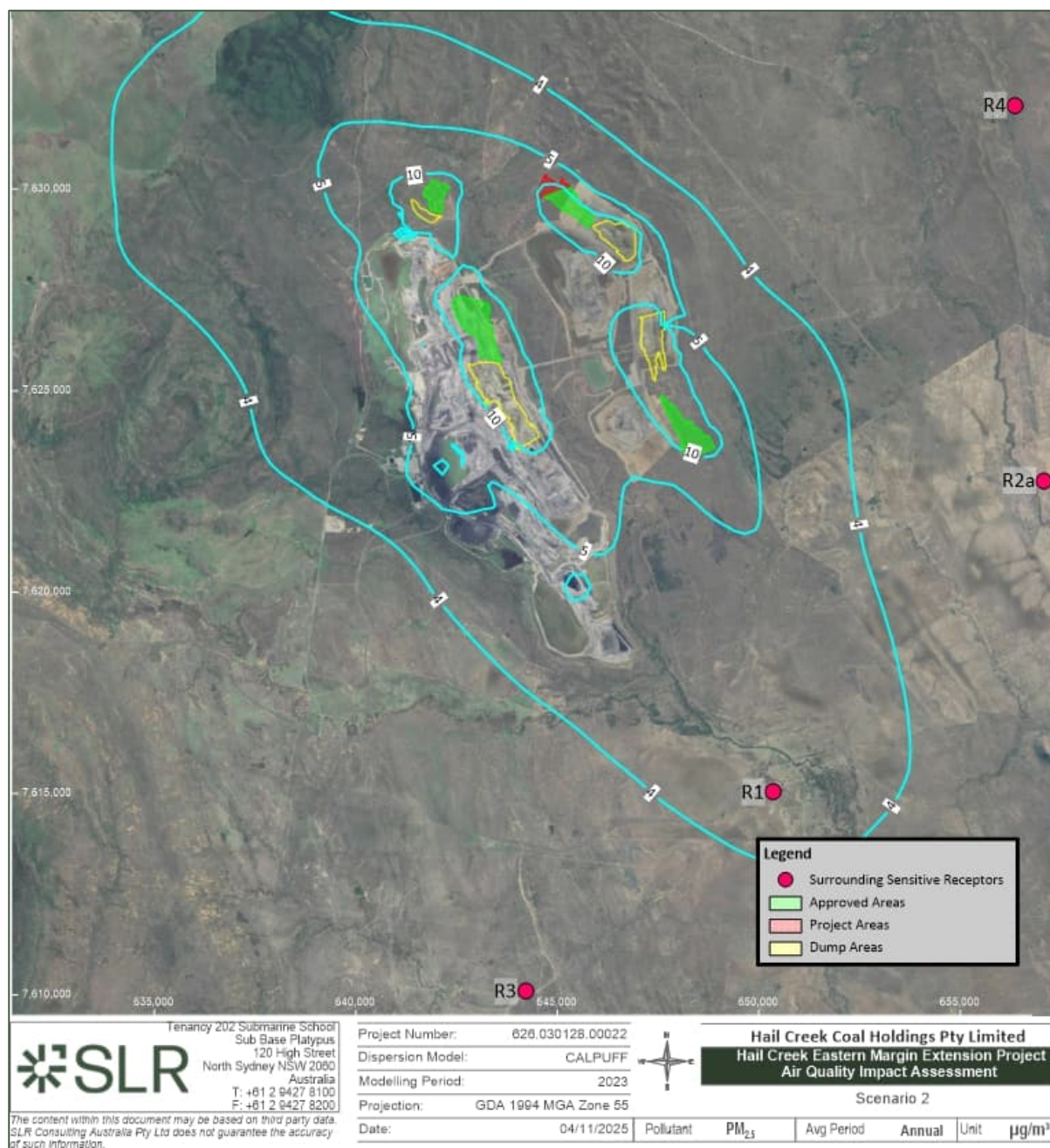


Figure C-4: Predicted Cumulative Annual Average PM_{2.5} Concentrations – Scenario 2 (R4)

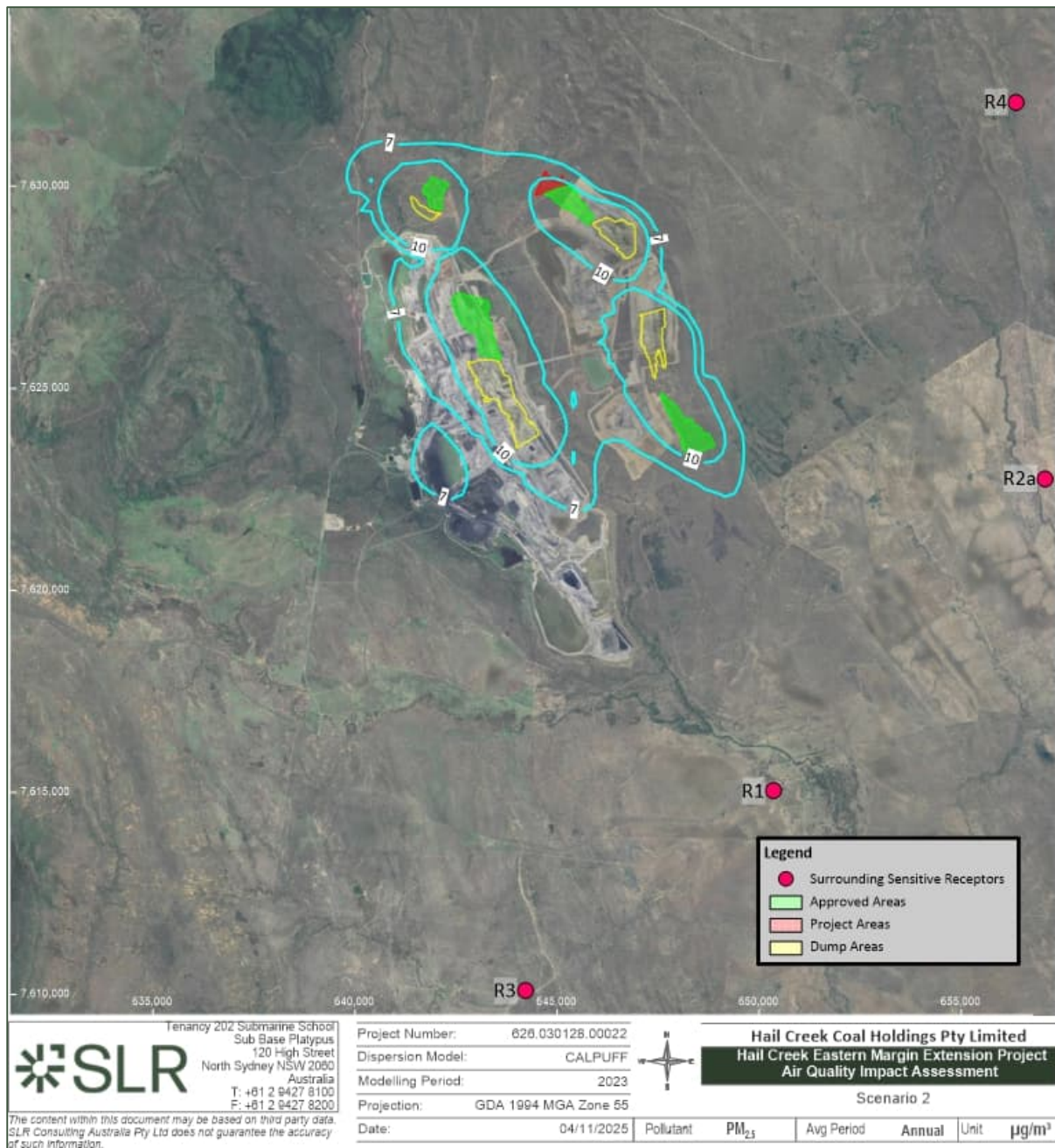


Figure C-5: Predicted Cumulative 24-Hour Average PM₁₀ Concentrations – Scenario 2 (R1 – R3)

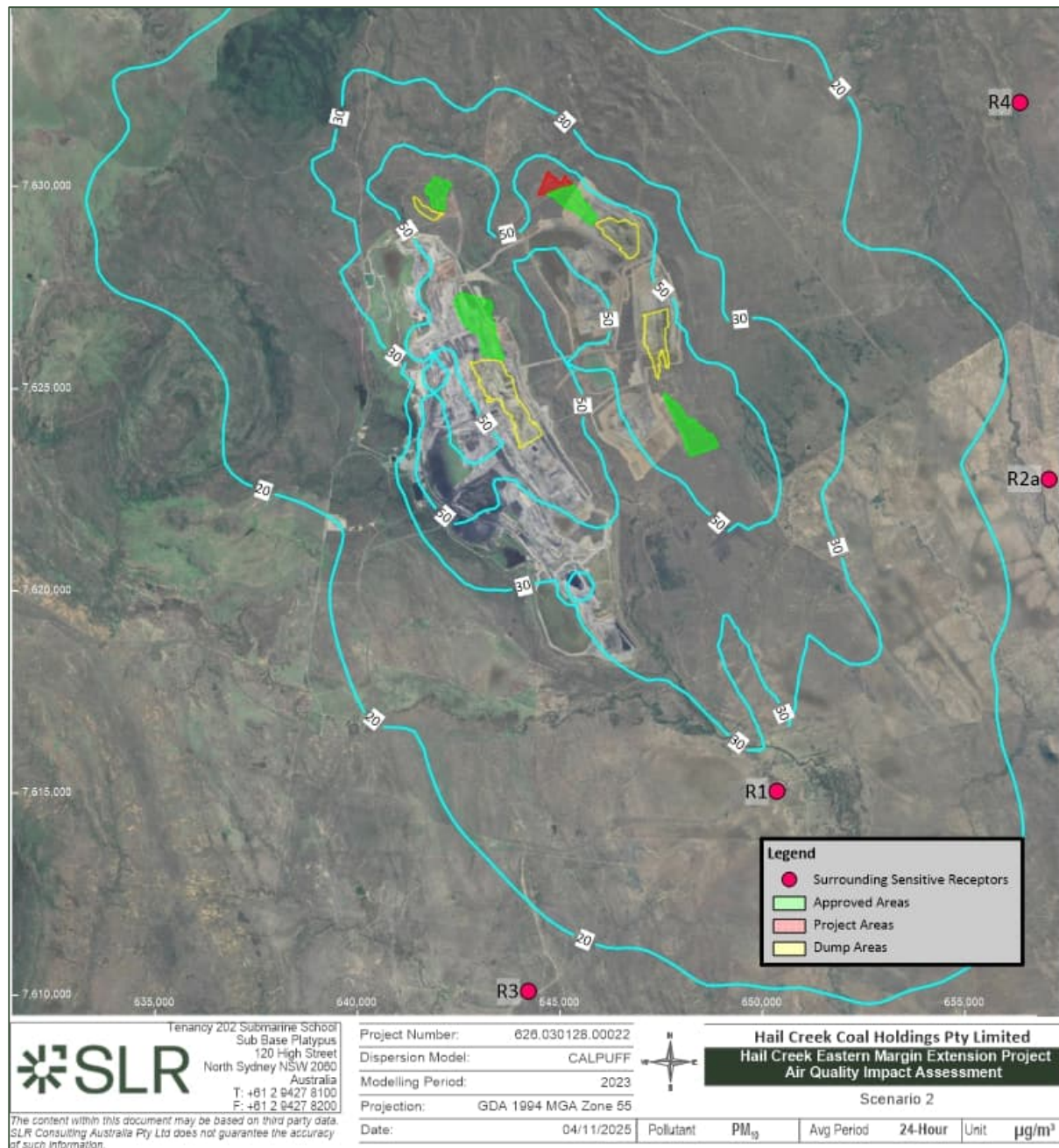


Figure C-6: Predicted Cumulative 24-Hour Average PM₁₀ Concentrations – Scenario 2 (R4)

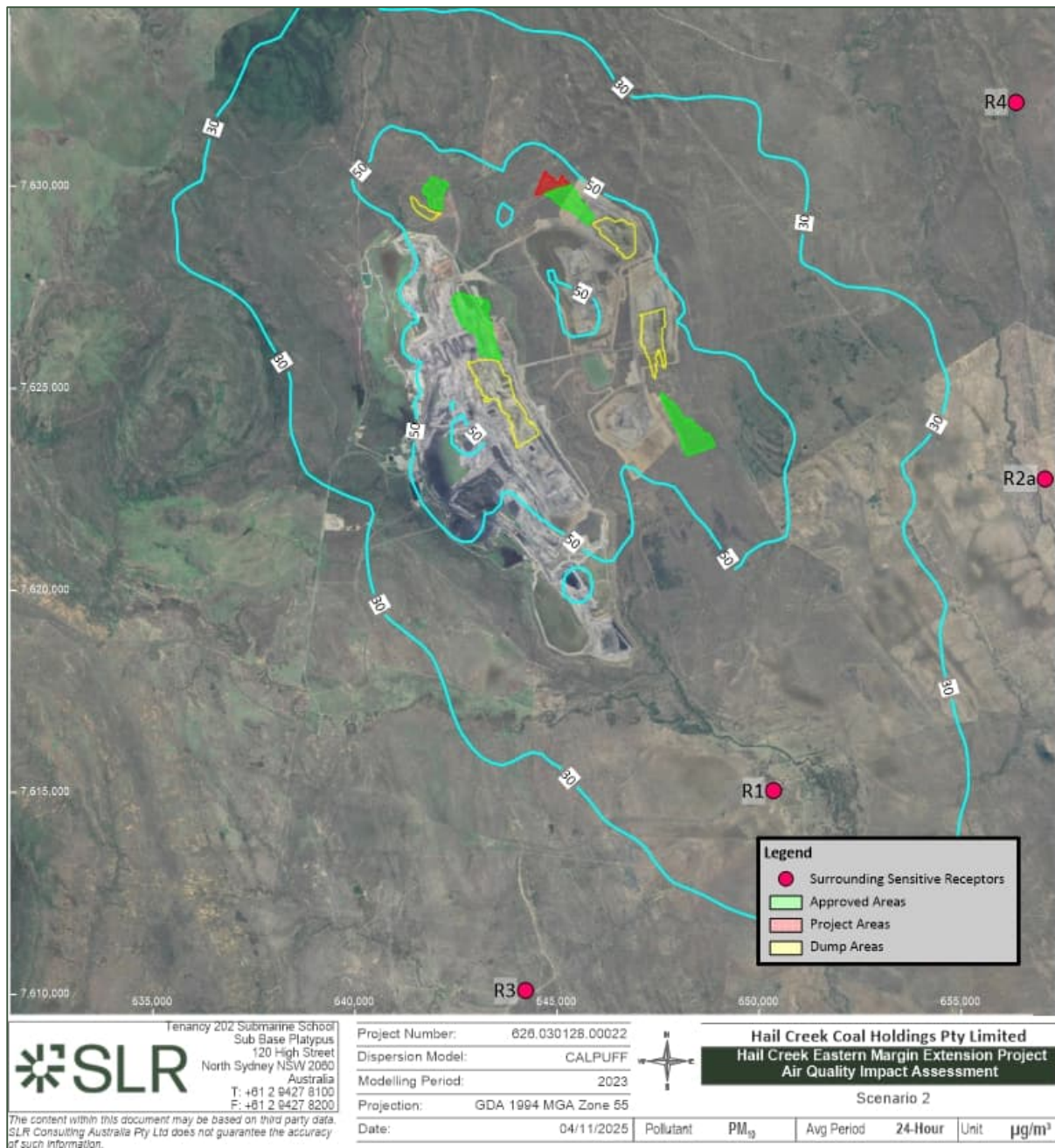


Figure C-7: Predicted Cumulative Annual Average PM₁₀ Concentrations – Scenario 2 (R1 – R3)

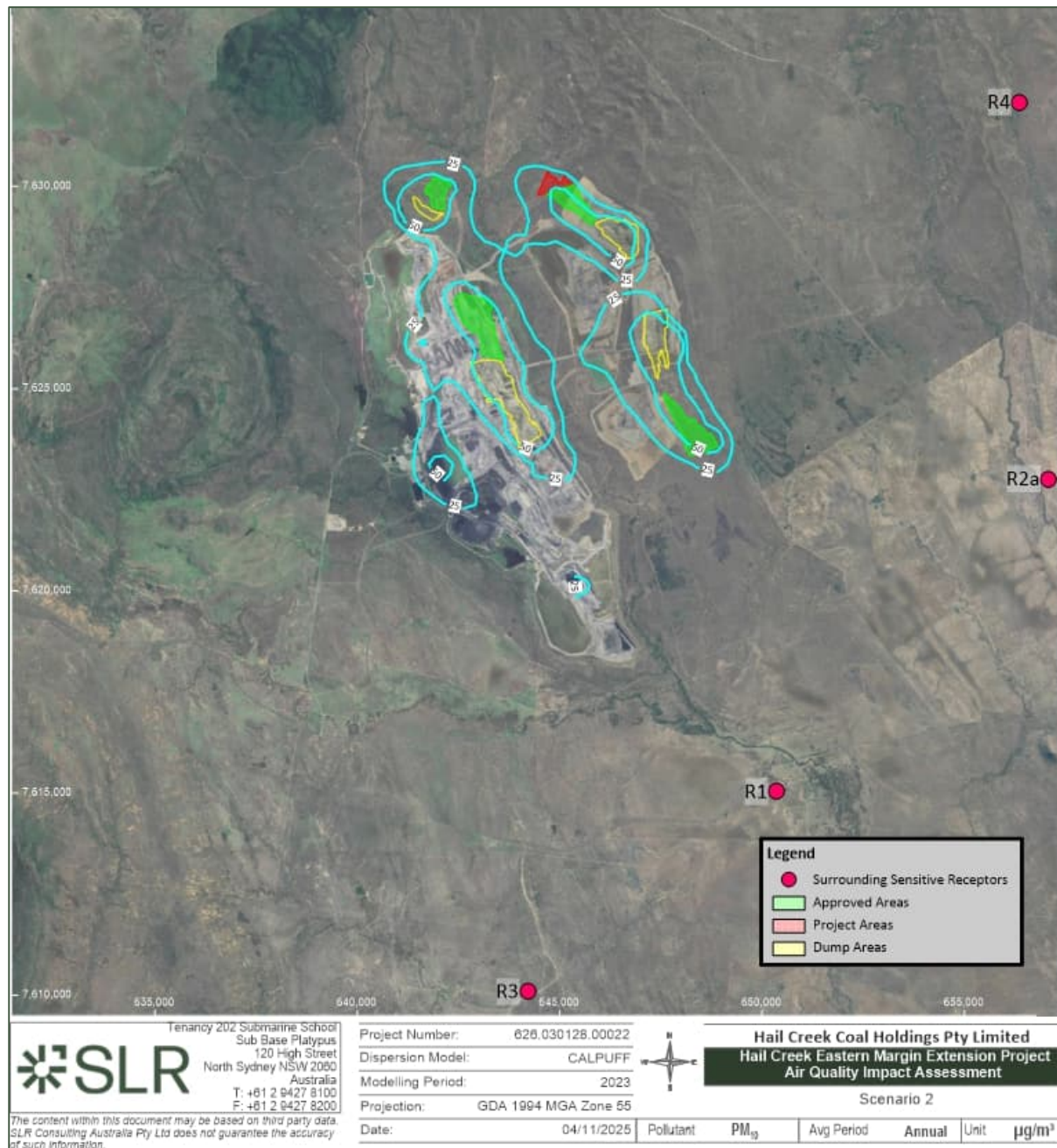


Figure C-8: Predicted Cumulative Annual Average PM₁₀ Concentrations – Scenario 2 (R4)

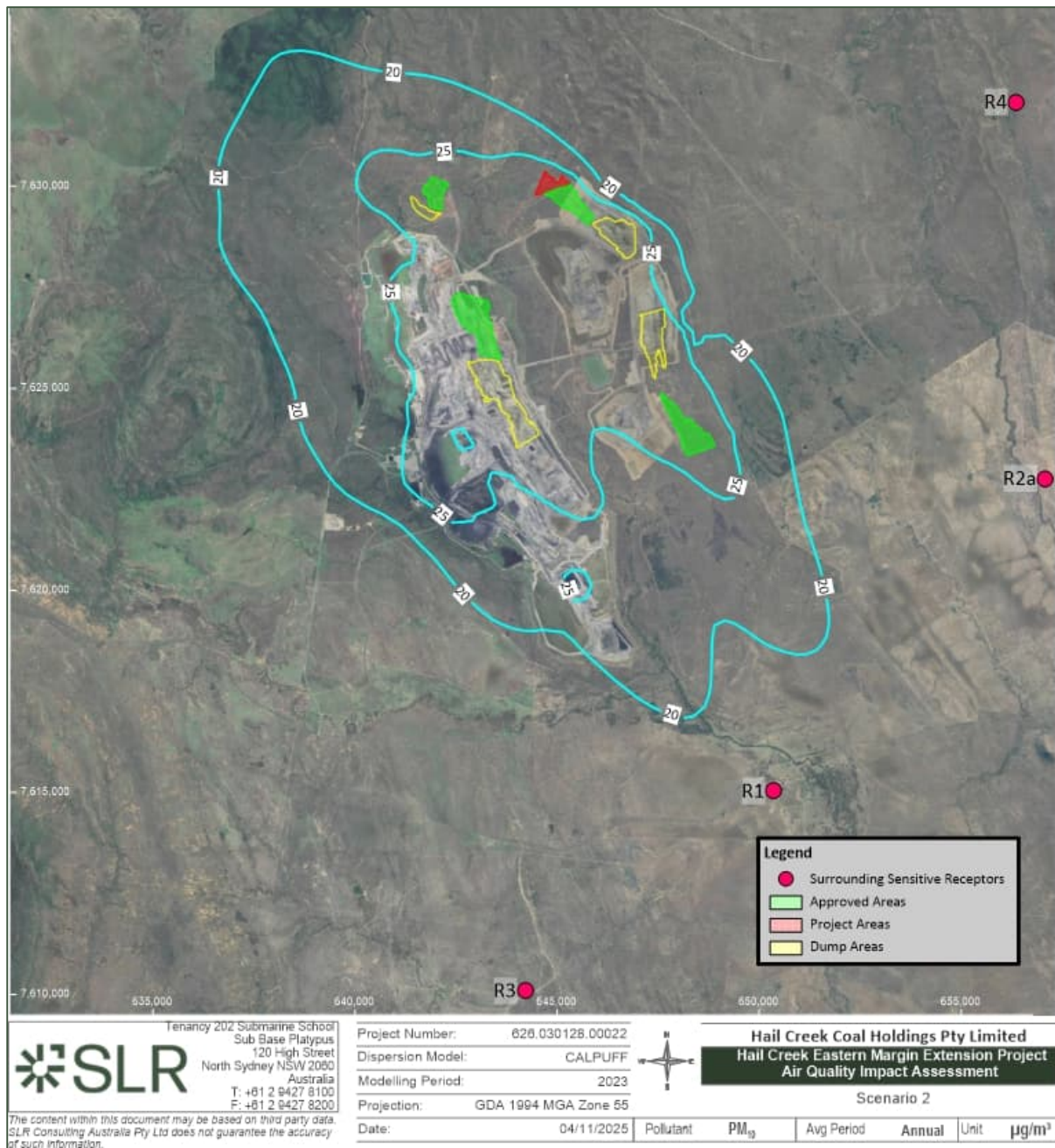


**Figure C-9: Predicted Cumulative Annual Average TSP Concentrations – Scenario 2
(R1 – R3)**

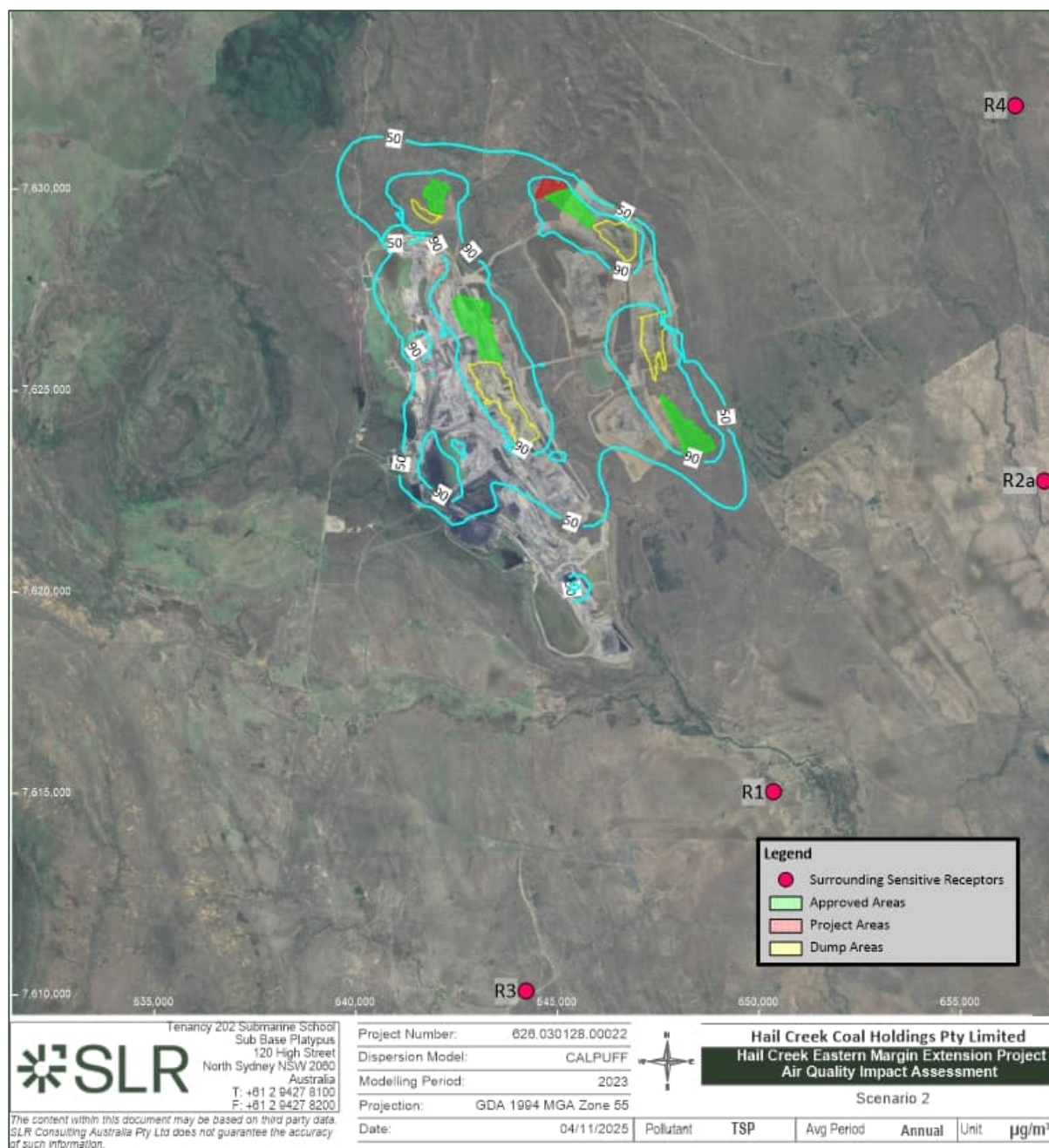


Figure C-10: Predicted Cumulative Annual Average TSP Concentrations – Scenario 2 (R4)

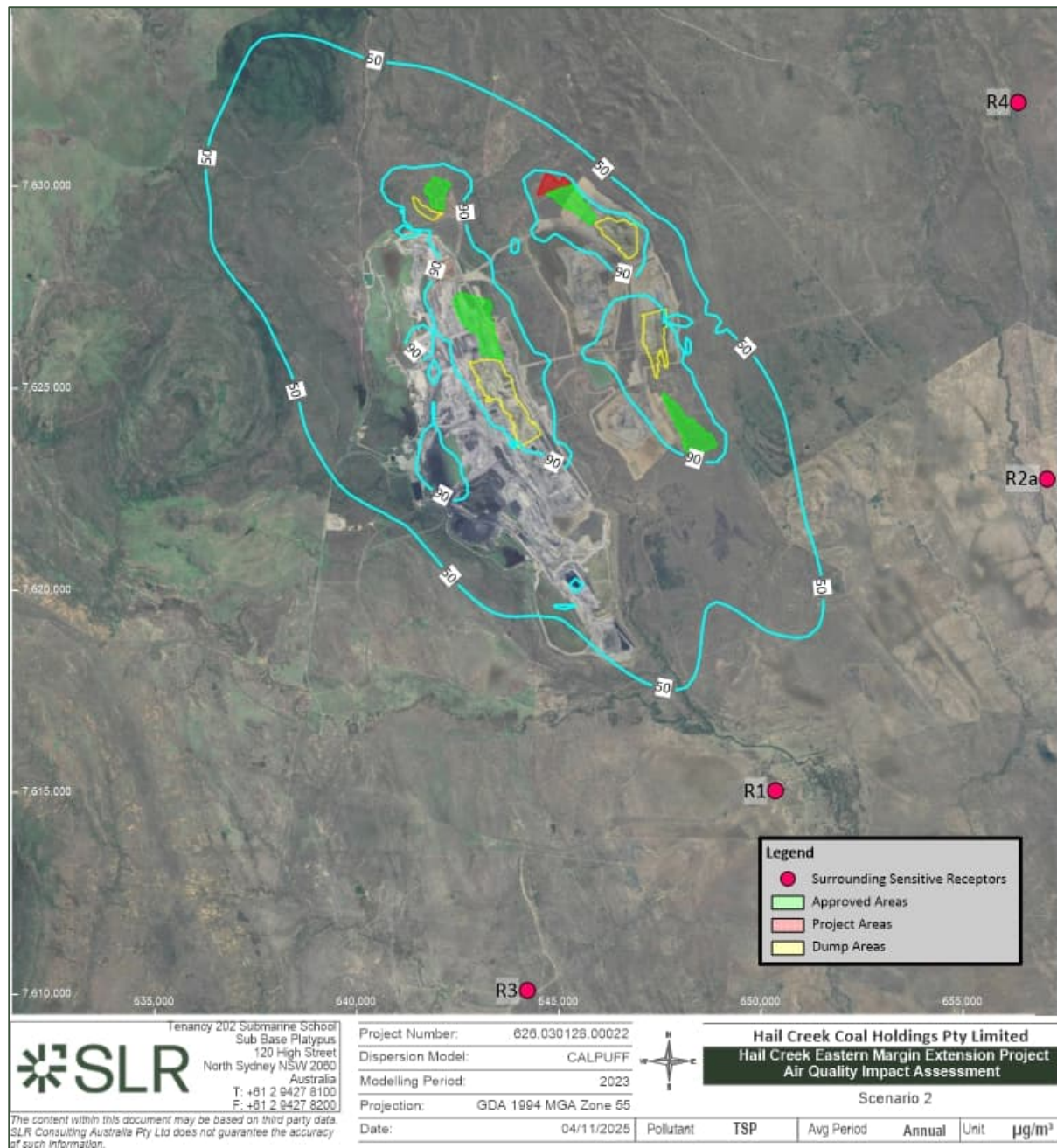


Figure C-11: Predicted Cumulative 1-Month Average Dust Deposition Rates – Scenario 2

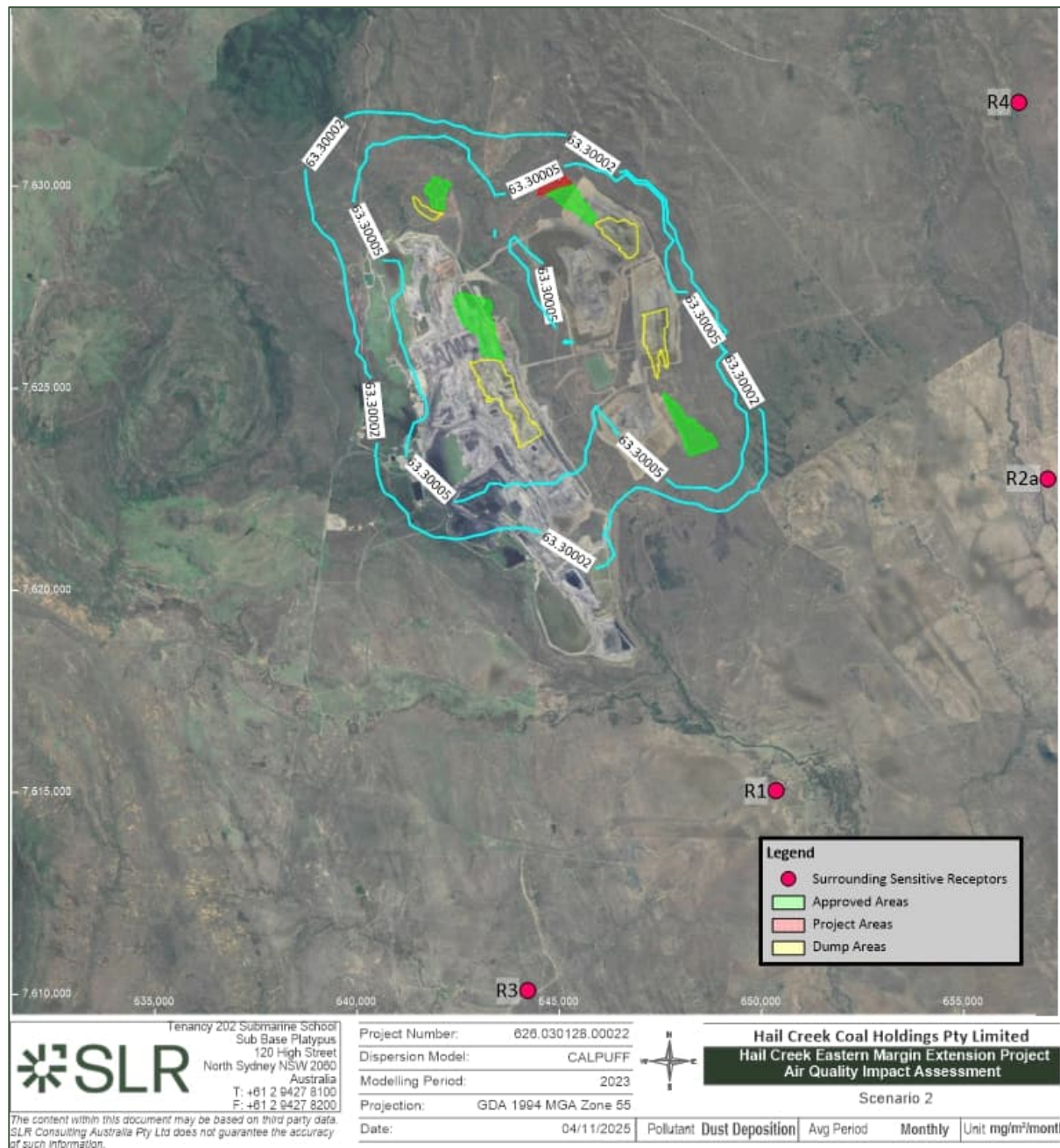
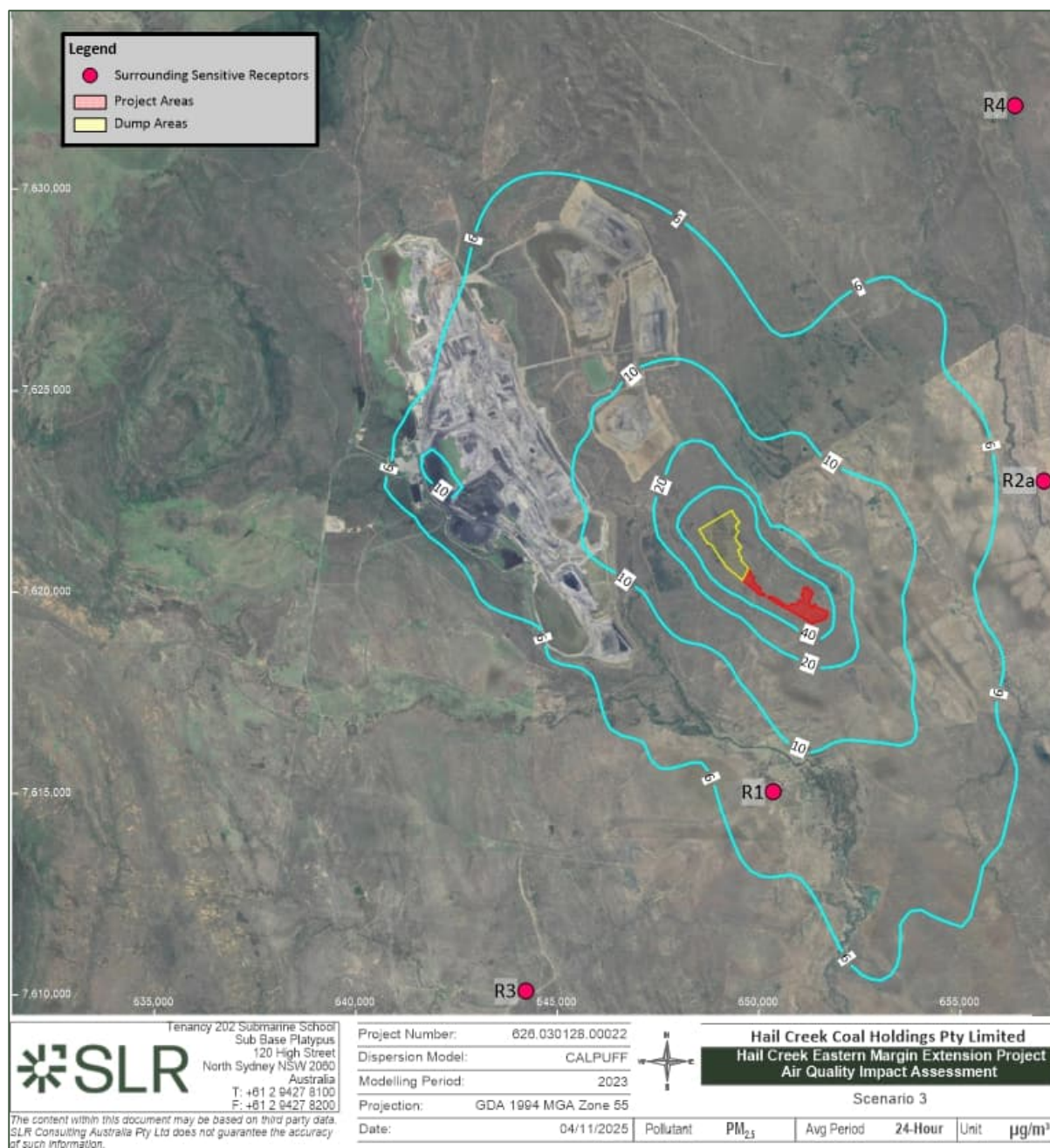


Figure C-12: Predicted Cumulative 24-Hour Average PM_{2.5} Concentrations – Scenario 3 (R1 – R3)



Legend

- Surrounding Sensitive Receptors
- Project Areas
- Dump Areas

Map Data:

- Project Number: 626.030128.00022
- Dispersion Model: CALPUFF
- Modelling Period: 2023
- Projection: GDA 1994 MGA Zone 55
- Date: 04/11/2025
- Pollutant: $PM_{2.5}$
- Avg Period: 24-Hour
- Unit: $\mu g/m^3$

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 Hail Creek Eastern Margin Extension Project
 Air Quality Impact Assessment
 Scenario 3

Figure C-14: Predicted Cumulative Annual Average PM_{2.5} Concentrations – Scenario 3 (R1 – R3)

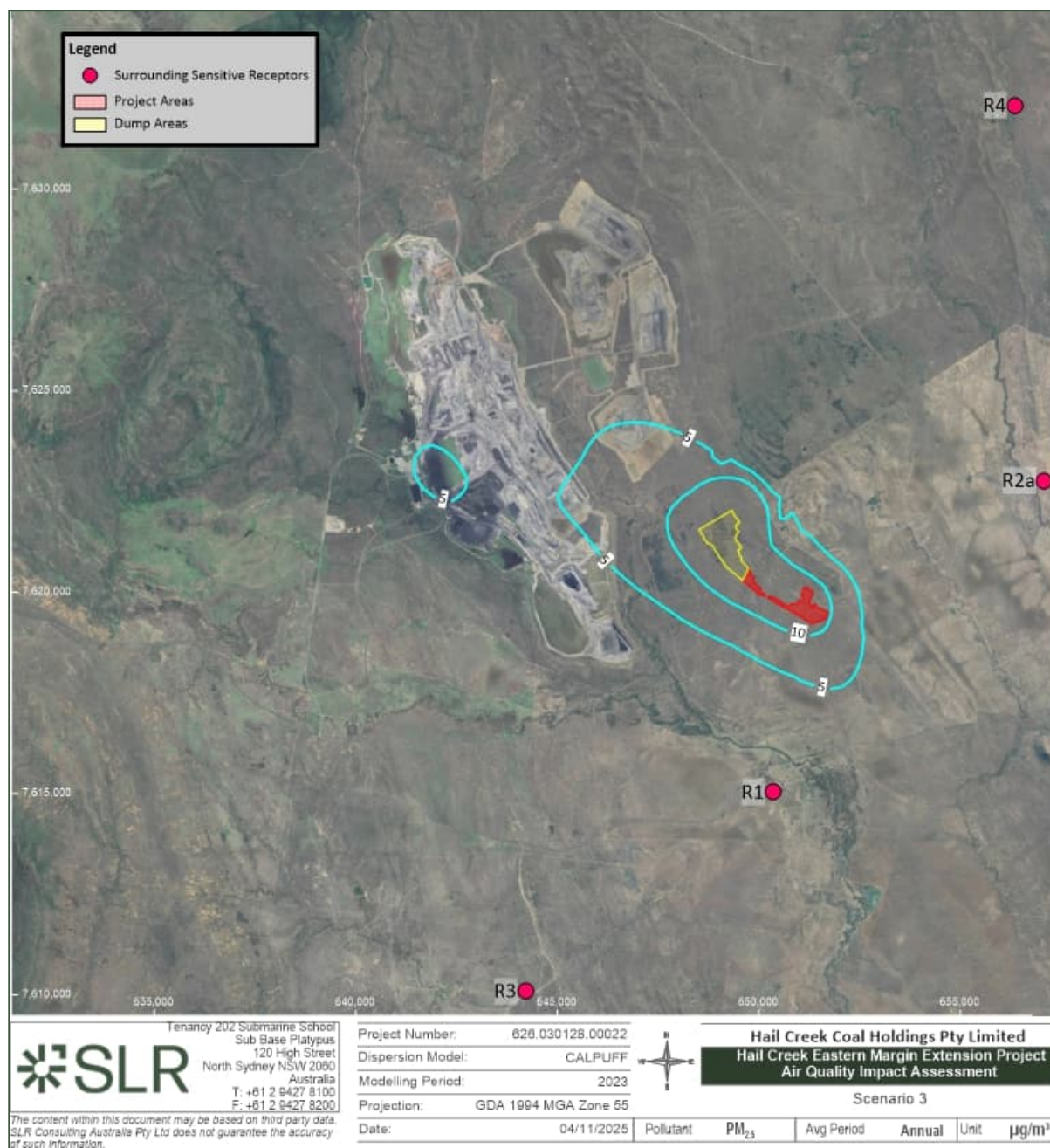


Figure C-15: Predicted Cumulative Annual Average PM_{2.5} Concentrations – Scenario 3 (R4)

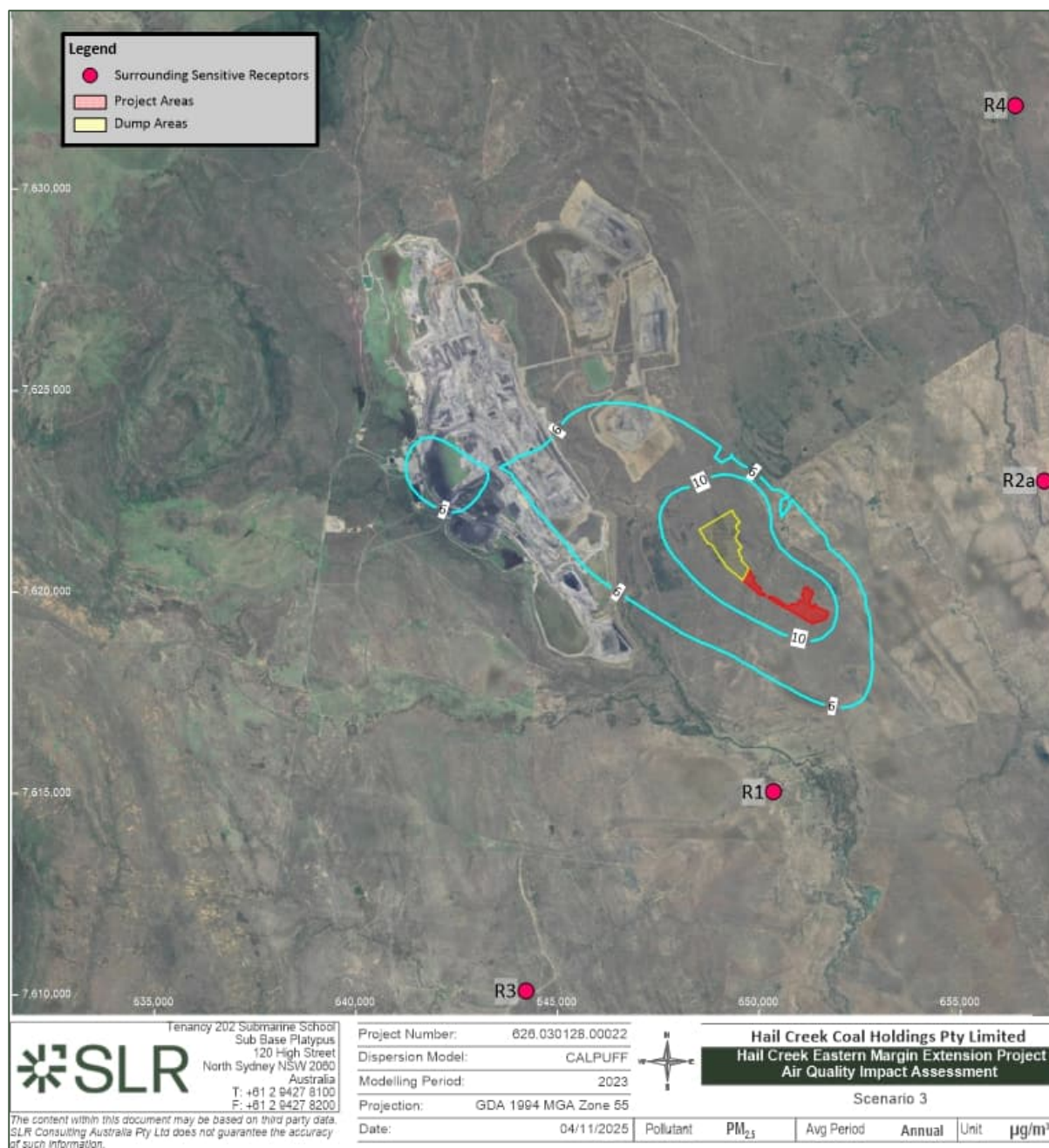


Figure C-16: Predicted Cumulative 24-Hour Average PM₁₀ Concentrations – Scenario 3 (R1 – R3)

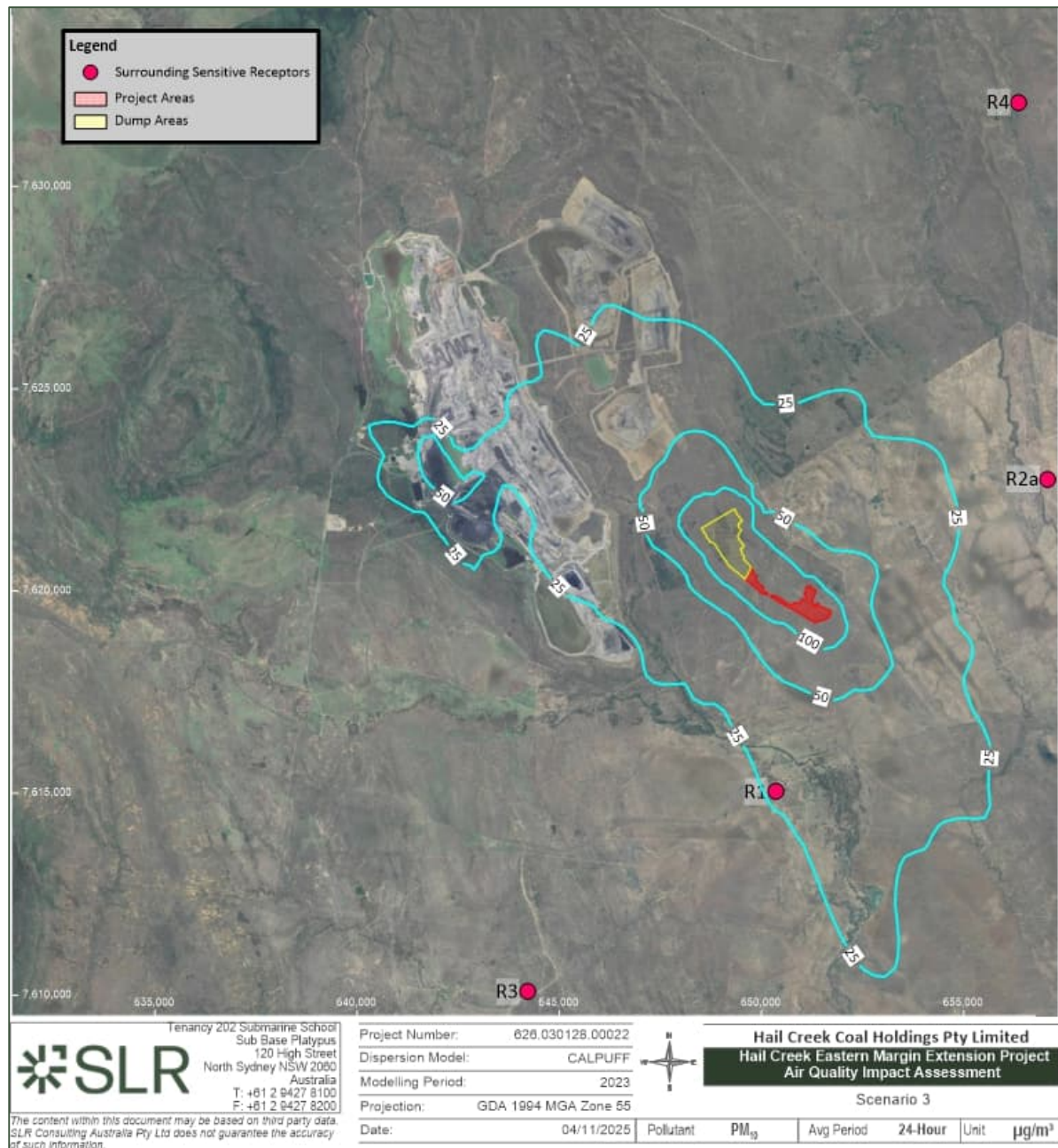


Figure C-17: Predicted Cumulative 24-Hour Average PM₁₀ Concentrations – Scenario 3 (R4)

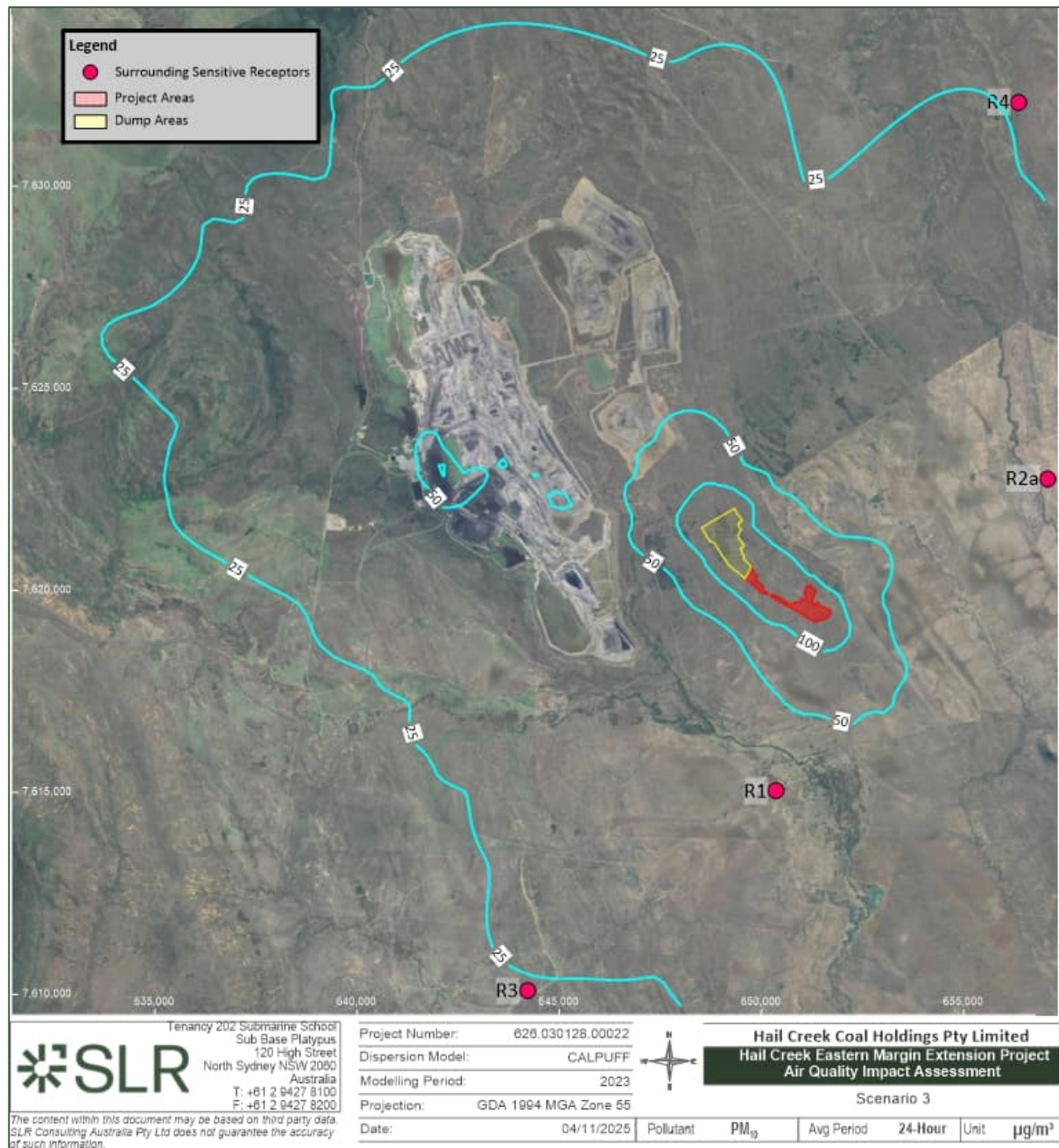


**Figure C-18: Predicted Cumulative Annual Average PM₁₀ Concentrations – Scenario 3
(R1 – R3)**

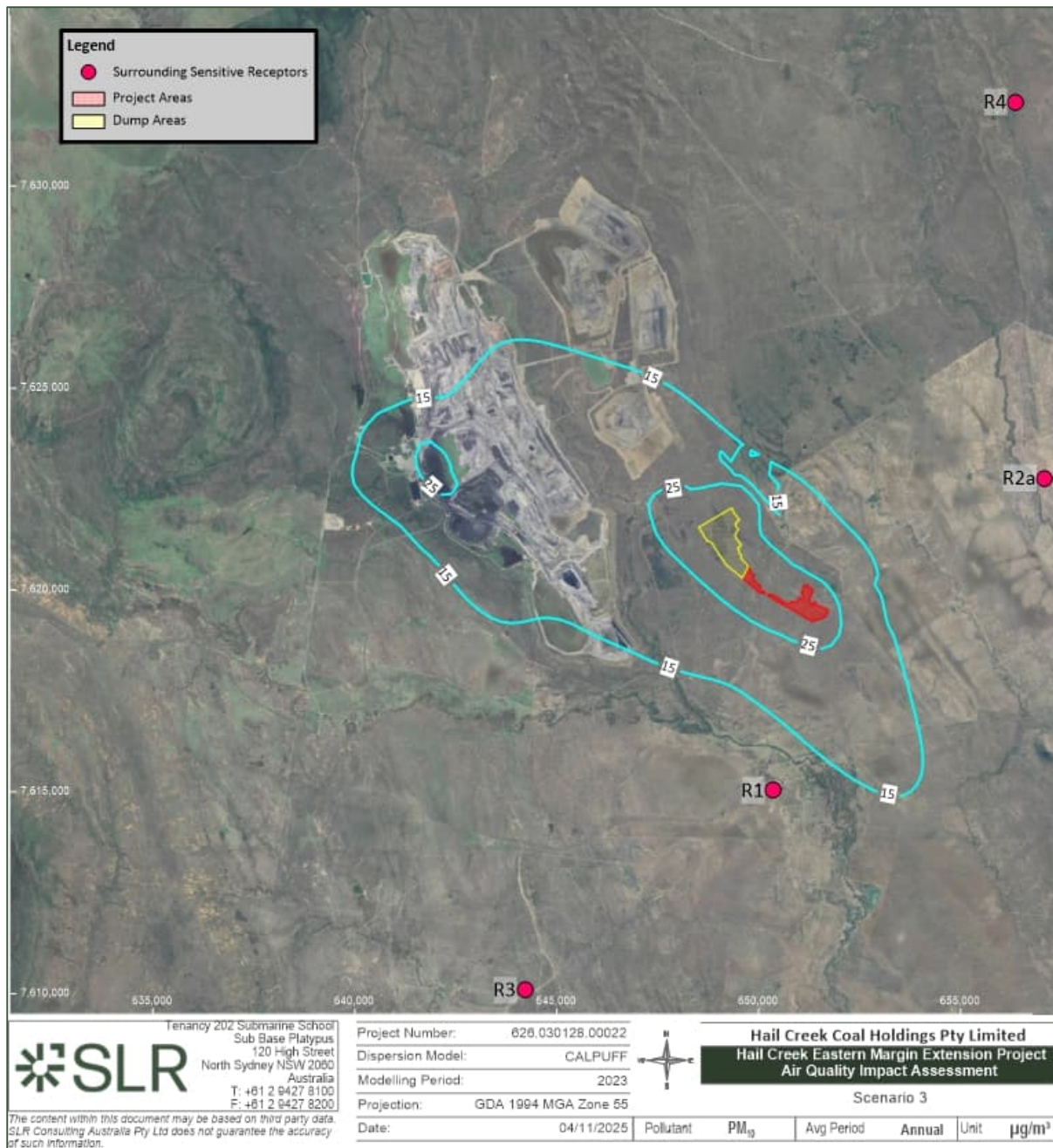


Figure C-19: Predicted Cumulative Annual Average PM₁₀ Concentrations – Scenario 3 (R4)

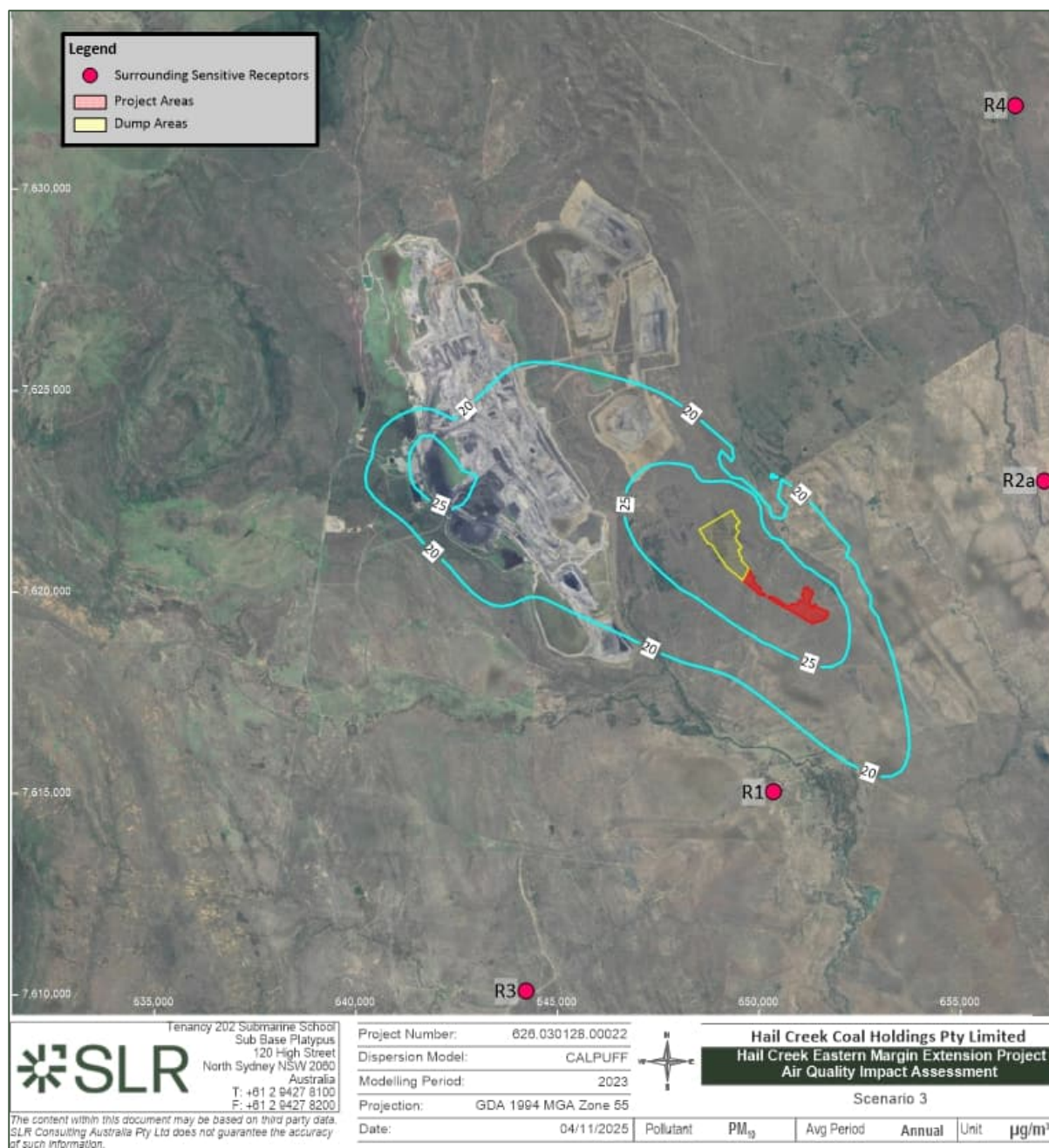


**Figure C-20: Predicted Cumulative Annual Average TSP Concentrations – Scenario 3
(R1 – R3)**

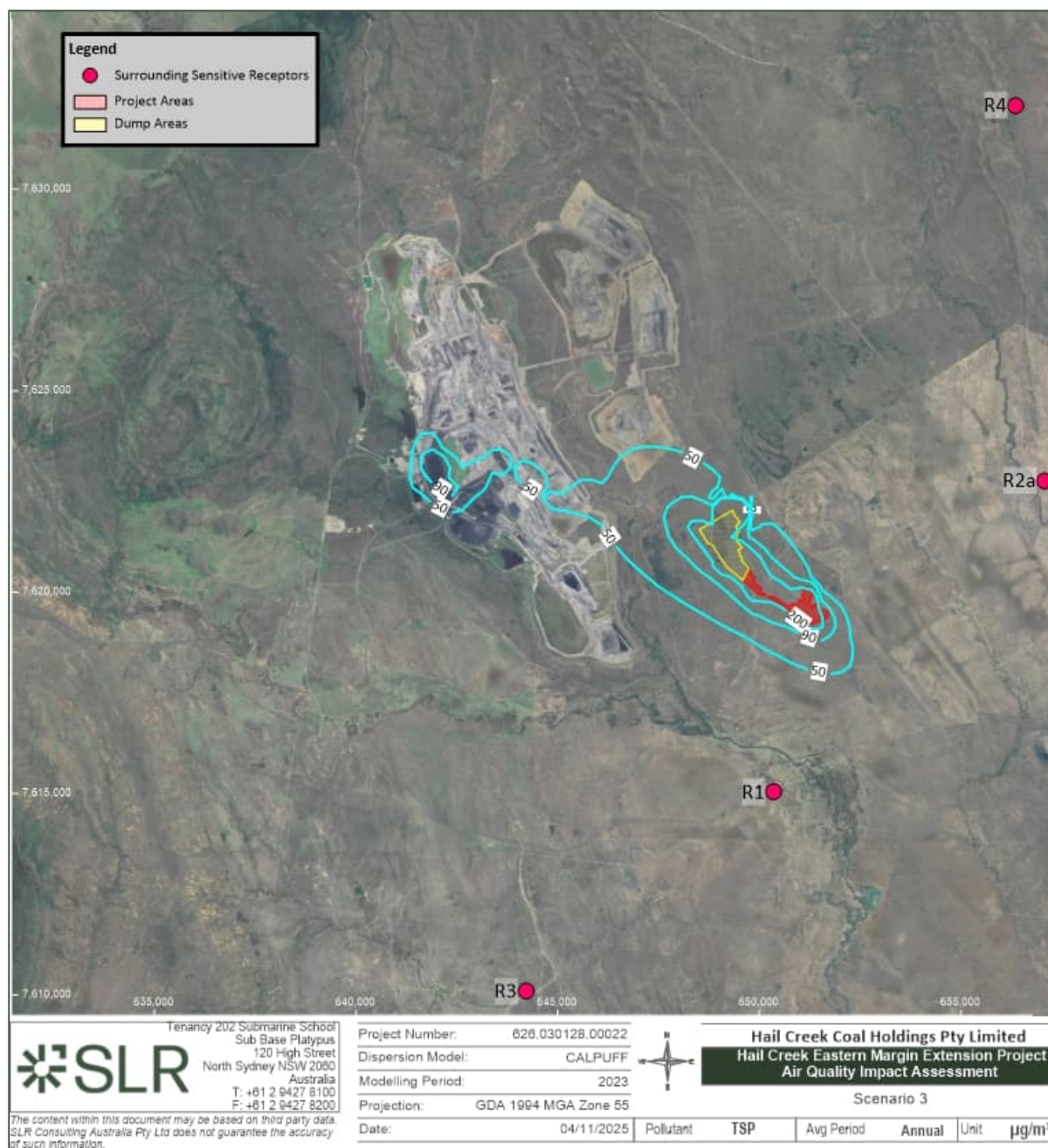


Figure C-21: Predicted Cumulative Annual Average TSP Concentrations – Scenario 3 (R4)

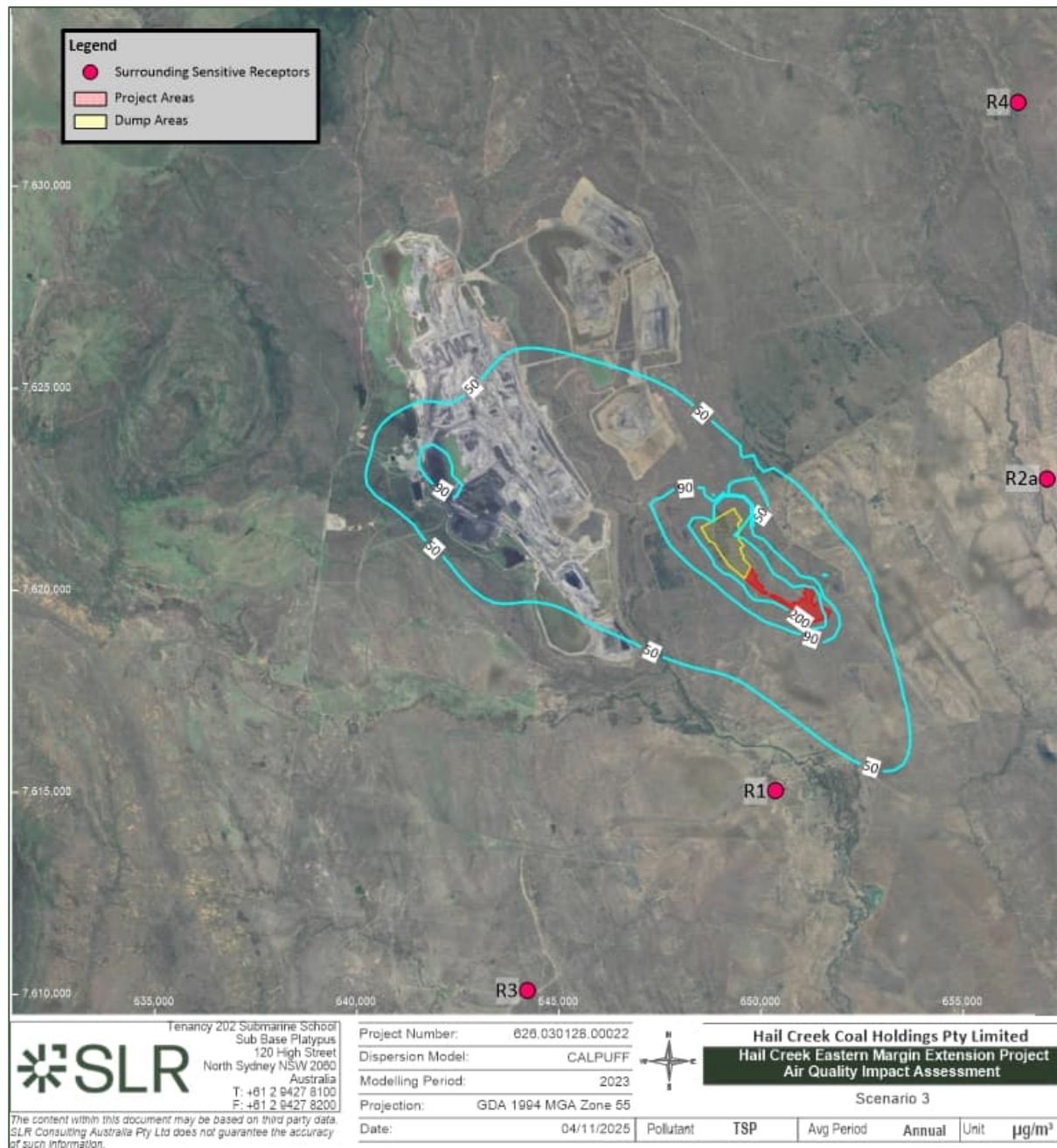
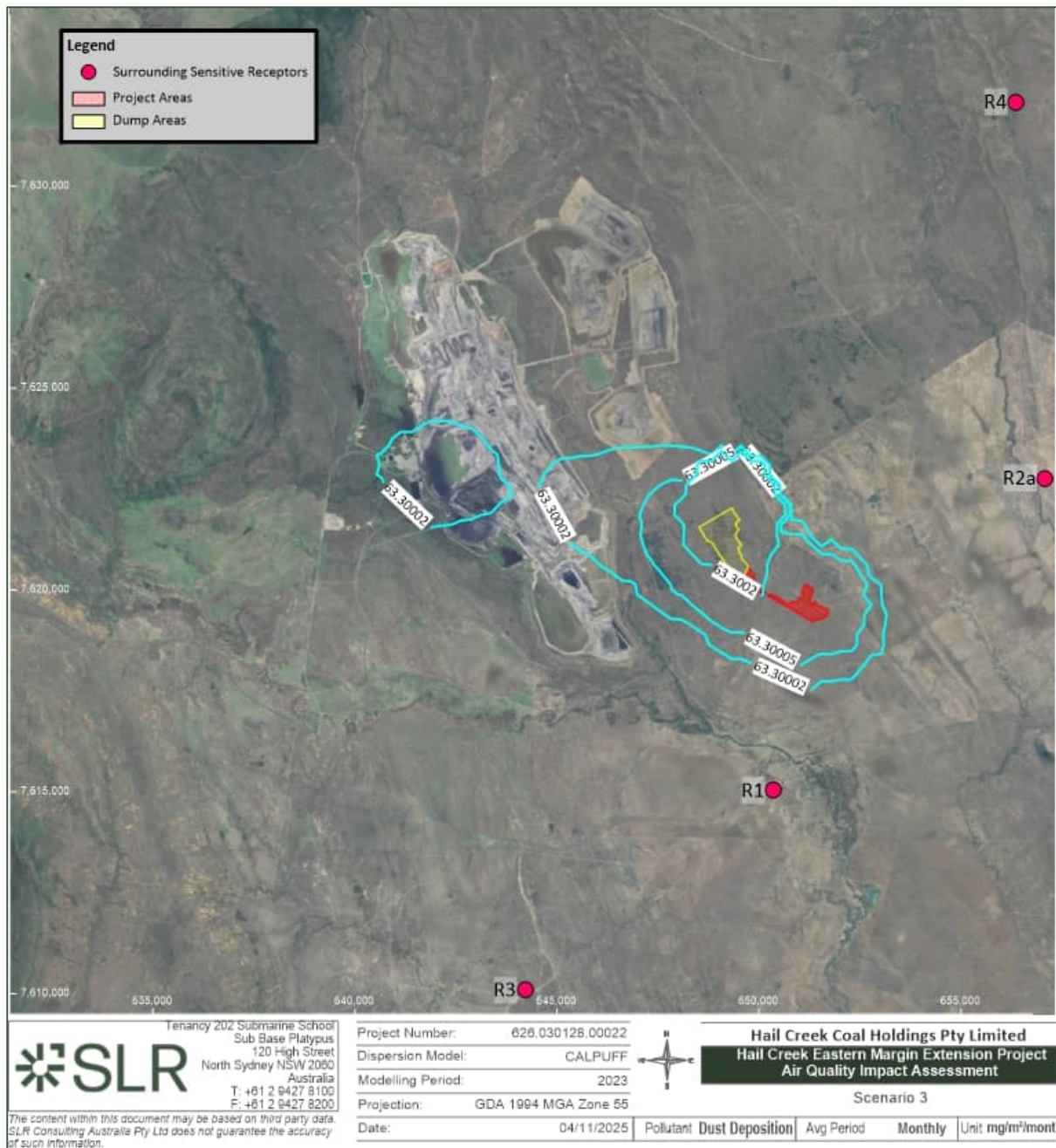
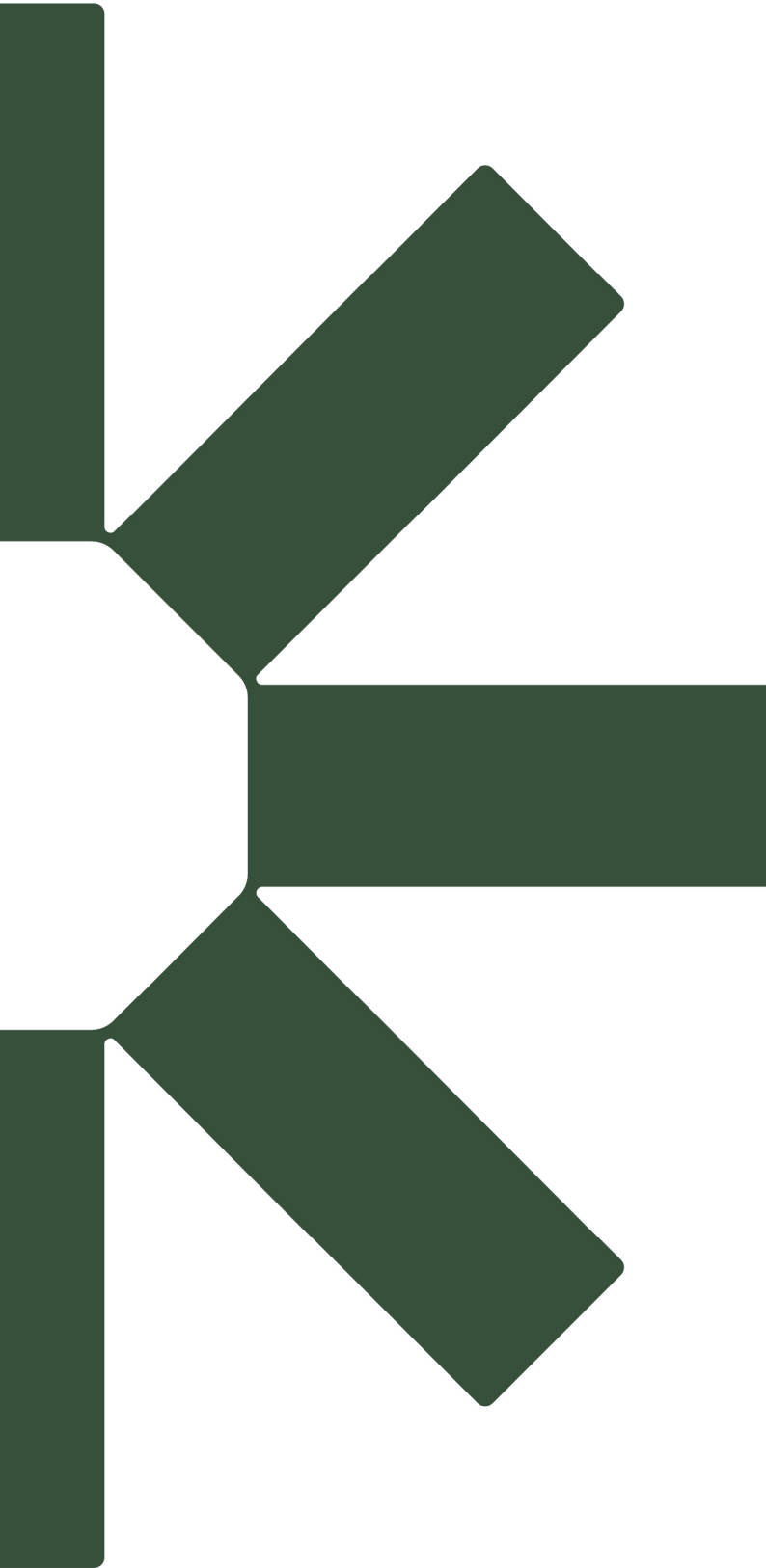


Figure C-22: Predicted Cumulative 1-Month Average Dust Deposition Rates – Scenario 3





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