Attachment 13

Additional Information - Air Quality and Greenhouse Gas

WINCHESTER SOUTH PROJECT

Environmental Impact Statement

Additional Information

WHITEHAVEN COAL

Resource Strategies

Air Quality and Greenhouse Gas Assessment of the Winchester South Project

Prepared for:

Whitehaven WS Pty Ltd

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Final

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Glossary

Term	Definition
µg/m³	micrograms per cubic metre
µm	microns/micrometres
°C	degrees Celsius
%	percent
GJ/kL	gigajoules per kilolitre
GJ/t	gigajoules per tonne
ha	hectares
hr.op/year/vehicle	total hours of operation per vehicle per year
kg CO_2-e/GJ	kilograms of carbon dioxide equivalent per gigajoule
kg CO_2-e/kWh	kilograms of carbon dioxide equivalent per kilowatt hour
kg CO_2-e/t.km	kilograms of carbon dioxide equivalent per tonne per kilometre
km	kilometres
km/h	kilometres per hour
kt CO_2-e	kilotonnes of carbon dioxide equivalent
kt CO_2-e/y	kilotonnes of carbon dioxide equivalent per year
kV	kilovolt
m	metres
mm	millimetres
m/s	metres per second
m^2	square metres
m^3	cubic metres
mg/m²/day	milligrams per square metre per day
MJ/kWh	megajoules per kilowatt hour
MJ/m^2	megajoules per square metre
Mtpa	million tonnes per annum
Mt CO_2-e	million tonnes of carbon dioxide equivalent
t CO_2-e	tonnes of carbon dioxide equivalent
t CO_2-e/tANFO	tonnes of carbon dioxide equivalent per tonne of ANFO
t CO_2-e/tROM	tonnes of carbon dioxide equivalent per tonne of ROM coal
tonne.km/L	tonne-kilometres per litre
TJ	terajoules
t/year	tonnes per year
VKT/year	vehicle kilometres travelled per year
Nomenclature	**Definition**
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
NOx	oxides of nitrogen
N_2O	nitrous oxide
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
SO_2	sulfur dioxide
TSP	total suspended particles
Abbreviations	**Definition**
AHD	Australian Height Datum
Air EPP	*Environmental Protection (Air) Policy 2019*
ANFO	Ammonium Nitrate Fuel Oil
AQMP	Air Quality Management Plan
BG	background

Term	Definition
BMA	Billiton Mitsubishi Alliance
BoM	Bureau of Meteorology
CHPP	coal handling and preparation plant
CM	Reduction in emissions due to the implementation of dust control measures
DBCT	Dalrymple Bay Coal Terminal
DES	Department of Environment and Science
EIS	Environmental Impact Statement
EF	emission factor
EP Act	*Environmental Protection Act 1994*
ER	emission rate of dust
ERF	Emissions Reduction Fund
ETL	electricity transmission line
GHG	greenhouse gas
GWP	Global Warming Potential
MIA	mine infrastructure area
MLA	mining lease application
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NPI	National Pollutant Inventory database
OCG	Office of the Coordinator-General
Quarrico	Quarrico Products Pty Ltd
ROM	run-of-mine
SDPWO	*State Development and Public Works Organisation Act 1971*
TAPM	The Air Pollution Model
the Project	Winchester South Project
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
Whitehaven	Whitehaven Coal Limited
Whitehaven WS	Whitehaven WS Pty Ltd

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Whitehaven WS Pty Ltd (Whitehaven WS) to complete an air quality and greenhouse gas assessment for the Winchester South Project (the Project), a proposed coal mine, located approximately 30 kilometres (km) south-east of Moranbah. The Project is forecast to extract approximately 15 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal (and up to 17 Mtpa), for approximately 28 years.

An air quality assessment has investigated the potential for the Project to affect air quality in the region. Four scenarios (Years 5, 9, 19, and 27) have been considered that represent various stages of the Project life and potential worst-case impacts.

The assessment has used meteorological and dispersion models to assess the effect of emissions of particulate matter on concentrations of total suspended particulates (TSP), particulate matter with a diameter less than 10 micrometres (PM_{10}), particulate matter with a diameter less than 2.5 micrometres ($PM_{2.5}$) and dust deposition rate on the surrounding region due to the Project.

Air quality levels due to operations of the Project in isolation, and with the inclusion of background levels of dust, were determined at identified sensitive receptors and on a grid of evenly spaced receptors covering the region. Predicted ground-level concentrations and deposition rates were compared with the relevant air quality objectives and guidelines.

The air quality assessment of the Project found the following:

TSP

- Predicted concentrations of TSP ***comply*** with the relevant air quality objective at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.

PM_{10}

- Predicted 24-hour average and annual concentrations of PM_{10} due to the Project in isolation ***comply*** with the relevant air quality objectives at all sensitive receptors, in all modelled Project scenarios, with the application of the proactive dust management system.
- Predicted cumulative concentrations of PM_{10} were found to be elevated at the closest sensitive receptor and comply with the relevant air quality objectives at all other sensitive receptors, with the application of the proactive dust management system.
- To further address the risk of elevated cumulative concentrations of PM_{10}, Project dust emissions will be managed using a proactive dust management system whereby background dust levels in the region will be monitored and mine operations will be altered when background levels are elevated, such as during bushfires, dust storms and regional dust events.
- South32's Eagle Downs mine assets are workplaces and, therefore, any potential particulate matter exposure should be considered as a workplace exposure matter.

$PM_{2.5}$

- Predicted 24-hour average and annual concentrations of $PM_{2.5}$ due to the Project ***comply*** with the relevant air quality objective at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.

Dust Deposition

- Predicted dust deposition rates due to the Project ***comply*** with the guideline at all sensitive receptors, for all modelled Project scenarios, in isolation and cumulatively.

With reference to the environmental values for health and wellbeing, it is noted that the Project complies with the *Environmental Protection (Air) Policy 2019* objectives for project-only contribution at all sensitive receptors. However, when considering the background levels, the Project is predicted to exceed the 24-hour and annual average objectives for PM_{10} at the Olive Downs Homestead. Whilst PM_{10} is less of a health concern relative to $PM_{2.5}$, in recognition of this potential impact, Whitehaven WS intends to reach a mutually beneficial agreement with the land-owner of the Olive Downs Homestead in order to mitigate the potential impact.

Greenhouse gases

Average annual GHG emissions associated with the Project have been estimated to be:

- 498,605 t CO_2-e excluding GHG emissions associated with land clearing
- 531,275 t CO_2-e including GHG emissions associated with land clearing

Maximum annual GHG emissions associated with the Project occur in Year 6. Emissions in Year 6 have been estimated to be:

- 642,427 t CO_2-e excluding GHG emissions associated with land clearing
- 675,097 t CO_2-e including GHG emissions associated with land clearing

Compared to National and State GHG inventory levels, the estimated maximum annual GHG emissions from the Project would account for approximately 0.12 percent (%) and 0.43%, respectively.

1. INTRODUCTION

Whitehaven WS Pty Ltd (Whitehaven WS), a wholly owned subsidiary of Whitehaven Coal Limited (Whitehaven) proposes to develop the Winchester South Project (the Project), a coal mine and associated infrastructure within the Bowen Basin, located approximately 30 kilometres (km) south-east of Moranbah, within the Isaac Regional Council Local Government Area.

The Project involves the development of an open cut coal mine in an existing mining precinct for export of coal products. The Project would include construction and operation of a mine infrastructure area (MIA), including a coal handling and preparation plant (CHPP), train load-out facility and rail spur, which would be used for the handling, processing and transport of coal. An infrastructure corridor would also form part of the Project, including a raw water supply pipeline connecting to the Eungella pipeline network, an electricity transmission line (ETL) and mine access road. The Project is forecast to extract approximately 15 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, with a forecast peak extraction of up to 17 Mtpa, for approximately 28 years. The coal resource would be mined by open cut mining methods, with product coal to be transported by rail to port for export.

In April 2019, following submission of the Project's Initial Advice Statement, the Coordinator-General declared the Project a *coordinated project* for which an Environmental Impact Statement (EIS) is required under the *State Development and Public Works Organisation Act 1971* (SDPWO Act). The Terms of Reference (ToR) for the Project were issued in September 2019.

In 2021, Whitehaven WS submitted the EIS for assessment under the SDPWO Act. The EIS was placed on public notification by the Office of the Coordinator-General (OCG) from 4 August until 15 September 2021. During and following this period, government agencies, organisations and members of the public provided submissions on the EIS to the OCG.

Subsequent to the public notification of the Draft EIS, Whitehaven WS reviewed the mine plan and mine schedule with the aim of reducing environmental impacts of the Project and challenging the Project final landform in response to comments raised in submissions. This review also considered new geological data, new coal quality and the outcomes of processing trials to further refine the mine plan.

On 3 December 2021, the Coordinator-General formally requested (in accordance with section 34A of the SDPWO Act) Additional Information on the environmental effects of the Project and other matters relating to the Project (referred to as Additional Information).

Katestone Environmental Pty Ltd (Katestone) was commissioned by Whitehaven WS to complete an Air Quality and Greenhouse Gas Assessment of the optimised mine plan and responses to issues raised in submissions for inclusion the Additional Information, which has been prepared in accordance with Part 4 of the SDPWO Act. This air quality and greenhouse gas (GHG) assessment has been carried out in accordance with the ToR and the Queensland Department of Environment and Science (DES) document titled *Application requirements for activities with impacts to air* (DES, 2021).

The scope of works for the assessment includes the following:

- Description of regulatory requirements for air relevant to the Project, including air quality objectives and indicators in the *Environmental Protection (Air) Policy 2019* (Air EPP) and the *National Environmental Protection (Ambient Air Quality) Measure 2016*.
- Description of the environmental values in and surrounding the Project areas including site topography and built environment, ambient air quality, climatic patterns and local meteorology.
- Identification of nearby sensitive receivers that could be impacted by the Project.
- Description of the sources of air pollutants associated with the Project and development of annual air pollutant emission inventories for scenarios during the life of the Project.

- Assessment of meteorology, including wind speed and direction, temperature, atmospheric stability, mixing depth and any other necessary parameters that are required for dispersion modelling.
- Conduct dispersion modelling to assess potential air quality impacts of the Project.
- Conduct a cumulative air quality assessment to account for other air pollutant generating activities operating in the Moranbah region.
- Analysis of the incremental and cumulative air quality impact of the Project against the relevant air quality criteria and objectives, including those related to the protection of human health and amenity values.
- Consideration of management and mitigation measures for minimising air quality impacts.
- Preparation of an air quality assessment report for inclusion in the Additional Information.
- Preparation of a GHG assessment that includes identification of measures to manage, mitigate or avoid GHG emissions.

2. PROJECT DESCRIPTION

The Project is located approximately 30 km south-east of Moranbah, within the Bowen Basin (Figure 1). The Project provides an opportunity to develop a metallurgical open cut coal mine and associated infrastructure (Figure 2) in an existing mining precinct for export of a mix of coal products including metallurgical coal for use in the steel production industry and thermal coal for energy production.

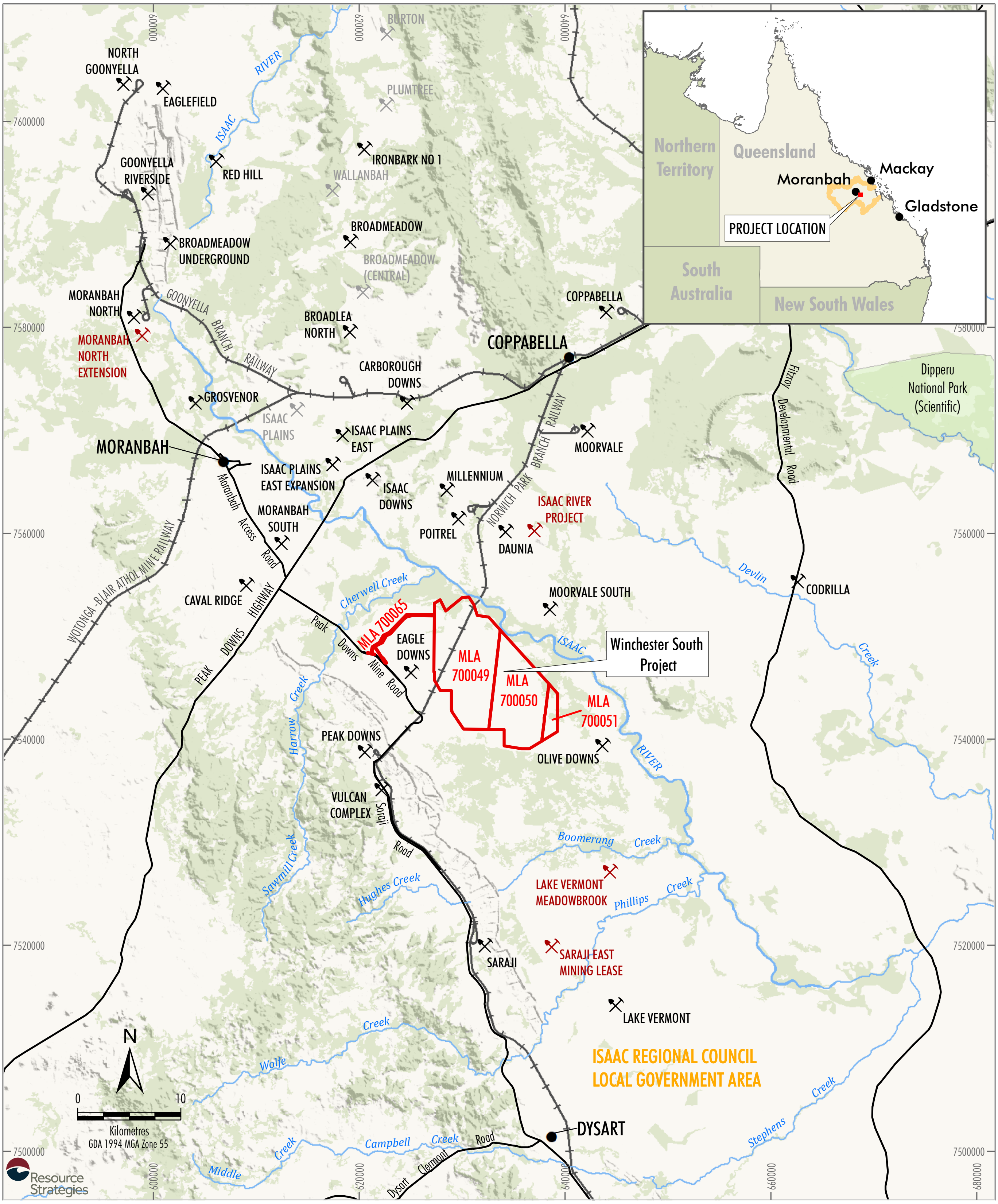
The main activities associated with the Project include:

- development and operation of an open cut coal mine within mining lease application (MLA) 700049, MLA 700050 and MLA 700051
- development and operation of an infrastructure corridor within MLA 700065, located outside mineral development licence (MDL) 183
- extraction of ROM coal with a current forecast rate of approximately 15 Mtpa, with a peak forecast rate of approximately 17 Mtpa, for approximately 28 years
- placement of waste rock (i.e. overburden and interburden) in out-of-pit waste rock emplacements and within the footprint of the open cut voids
- construction and operation of the MIA, including a CHPP, ROM pads, workshops, offices, raw and product handling systems, coal processing plant and train load-out facility
- construction and operation of a Project rail spur and loop to connect the Project to the Norwich Park Branch Railway, including product coal stockpiles for loading of product coal to trains for transport to ports
- progressive rehabilitation of out-of-pit waste rock emplacement areas
- progressive backfilling and rehabilitation of the mine voids with waste rock behind the advancing open cut mining operations (i.e. in-pit emplacements)
- installation of a raw water supply pipeline
- construction of a 132 kilovolt (kV)/22 kV electricity switching/substation and 132 kV ETL to connect to the existing regional power network
- on-site excavation, if suitable, and/or the use of the existing hard rock quarry for construction activities
- drilling and blasting of competent overburden/waste rock material
- construction of a mine access road (including associated railway crossing) from the Eagle Downs Mine Access Road, off Peak Downs Mine Road, to the MIA
- construction and operation of ancillary infrastructure in support of mining, including electricity supply, consumable storage areas and explosives storage facilities
- connection to the existing telecommunications network
- co-disposal of coal rejects from the Project CHPP within the footprint of the open cut voids and/or out-of-pit emplacement areas
- progressive development and augmentation of sediment dams and storage dams, pumps, pipelines and other water management equipment and structures (including up-catchment diversions, drainage channel realignments and levees)
- progressive construction and use of soil stockpile areas, laydown areas and gravel/borrow areas (e.g. for road base and ballast material)
- progressive development of haul roads, light vehicle roads and services
- wastewater and sewage treatment by a sewage treatment plant

- discharge of excess water off-site in accordance with relevant principles and conditions of the *Guideline – Model water conditions for coal mines in the Fitzroy basin* (DES, 2013)
- an on-site landfill for the disposal of selected waste streams generated on-site
- ongoing exploration activities
- other associated minor infrastructure, plant and activities.

The proposed open cut mining areas are generally aligned from north to south in the Project mining lease application areas. Open cut mining areas would be developed and rehabilitated in a progressive manner over the life of mine.

Existing local and regional infrastructure would be used to transport product coal via rail to the port for export, including the Goonyella rail system to the Dalrymple Bay Coal Terminal (DBCT), or the Abbot Point Coal Terminal (via the Newlands rail system) and/or the Blackwater rail system to the Gladstone coal port.



LEGEND
- Mining Lease Application Boundary
- Approved/Operating
- Proposed
- Care and Maintenance
- Local Government Area Boundary
- Railway
- Road

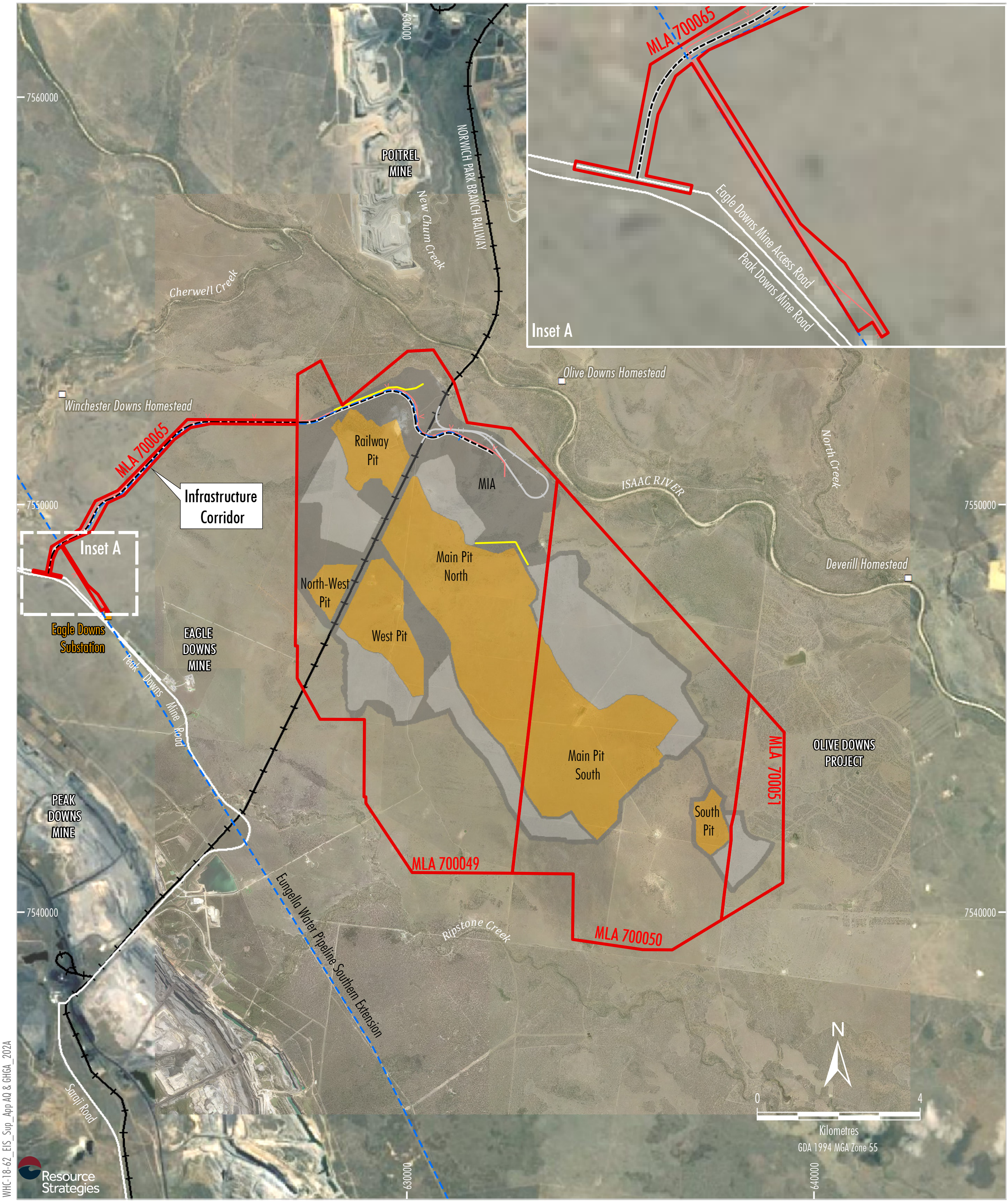
Source: The State of Queensland (2018 - 2020); Geoscience Australia (2018)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Project Location

Figure 1



LEGEND

- Mining Lease Application Boundary
- Eungella Water Pipeline Southern Extension
- Railway
- Substation

Project Component*

- Indicative Infrastructure Area
- Indicative Out-of-pit Waste Rock Emplacement
- Indicative Open Cut Pit Including In-pit Waste Rock Emplacement
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

*Note: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

Source: The State of Queensland (2018 - 2020); Whitehaven (2020)
Orthophoto: Google Image (2019); Whitehaven (2017)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Project General Arrangement

Figure 2

3. OVERVIEW OF THE ASSESSMENT METHODOLOGY

The purpose of this air quality and greenhouse gas assessment is to address the requirements of the Project's ToR and the DES's *Application requirements for activities with impacts to air* (2021). The assessment will form part of the Project's EIS.

The following sections outline the methodologies adopted for the air quality and greenhouse gas assessment.

3.1 Air Quality Assessment

3.1.1 Assessment scenarios

Four scenarios were selected for the air quality assessment to represent potential worst-case impacts in regard to the quantity of material (waste rock and ROM coal) extracted and handled in each year, the location of the activity/operation and the potential to generate dust at the sensitive receptor locations, and also to cover different stages of the Project to capture the dust emissions predicted over the operational life of the Project. The scenarios include one representing a worst-case year with the largest estimated emissions to air, and three others representing different geographical stages of operations accounting for mine progression (generally from northern parts of the Project area to south). The schedule for each scenario is provided in Table 1 and a summary of the scenarios are as follows:

- Year 5: Representative of typical mining conditions, with mining generally spread between north-west and south-east of the Project area. Mining operations would occur in the Railway Pit, Main Pit North and Main Pit South.
- Year 9: Representative of typical mining conditions, with operations generally spread over a similar area as Year 5. Mining operations would occur in Main Pit North and Main Pit South.
- Year 19: Worst-case scenario, involving the maximum waste rock and ROM coal removal from all years (i.e. maximum scheduled waste rock and ROM coal removal in Year 14 and Year 16 respectively, have been conservatively assumed to occur in Year 19) and with operations occurring generally towards the north, near to sensitive receptors. Mining operations would occur in Main Pit North and Main Pit South.
- Year 27: Indicative of impacts late in the mine life associated with predominantly southern and western operations. Mining operations would occur in the West Pit and South Pit.

Dust emissions generated from construction (Years 1 to 3) and mine closure activities (Years 30 to 31) have not been selected in the above scenarios, as these activities would generate lower dust emissions than the chosen operational scenarios. Given the impacts assessed include the worst-case scenario, it is considered that any impacts associated with construction and mine closure activities would be lower than those considered as part of the assessment of the selected scenarios.

Table 1 Project schedule for assessment scenarios (Mtpa)

Project Year	ROM coal	Product coal	Waste rock
Year 5	15	9.3	185
Year 9	15.5	9.5	175
Year 19	17	9.6	194
Year 27	10	5.5	133

3.1.2 Considerations for assessing air quality

Air pollutants likely to be emitted from the Project have been identified and the current regulatory requirements pertaining to these air pollutants in Queensland have been reviewed and relevant objectives presented (Section 4). Results of the dispersion modelling of air emissions from the Project have been assessed against the air quality objectives.

3.1.3 Existing environment

The assessment includes an analysis of the characteristics of the existing environment in the Project area that are important for the dispersion of air pollutants from the site and that may influence the level of air pollutants in the surrounding area (Section 5). Characteristics include the climate and local meteorology (temperature, wind, humidity and rainfall), any terrain features, the neighbouring land uses and the location of sensitive receptors. The existing air quality in the Project region has been quantified through analysis of available ambient air quality monitoring data. Existing sources of similar air pollutants to the air pollutants likely to be released by the Project have been identified.

3.1.4 Emissions

Emissions to the atmosphere associated with the four Project scenarios have been estimated (Section 6 and Appendix B). The primary air pollutant emitted from mining operations is particulate matter (PM) made up of various sized particles, including: TSP (total suspended particulates), PM_{10} (particulate matter with an aerodynamic diameter less than 10 microns) and $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than 2.5 microns).

3.1.5 Dispersion modelling

The CALPUFF model (version 7.2.1) was used for dispersion modelling. CALPUFF is an advanced non-steady-state air quality modelling system. Twelve months of modelled meteorological data was used as input for the dispersion model in order to include all weather conditions likely to be experienced in the region during a typical year. The modelling has been used to predict ground-level concentrations of air pollutants across a Cartesian grid and at the locations of the nearest sensitive receptors.

Dust emissions have been modelled over a full year for each scenario.

3.1.6 Impact assessment

To determine the potential impact of the Project upon the surrounding environment, a representative background concentration for relevant air pollutants is required. Background levels of TSP, PM_{10}, $PM_{2.5}$ and dust deposition have been added to the dispersion modelling results to provide a cumulative impact that is presented in Section 5.5.3.

Results are presented at sensitive receptor locations and across a grid centred on the Project in Section 7 and Appendix A.

3.2 Greenhouse Gas Assessment

A GHG assessment has been undertaken for the Project in accordance with the ToR requirements. The approach to the GHG assessment and results are presented in Section 8 of the report.

4. CONSIDERATIONS FOR ASSESSING AIR QUALITY

4.1 Pollutants

Particulate matter (i.e. dust) will be the key air pollutant generated by activities on the Project site. The characteristics and potential impacts of particulate matter is discussed further in Section 4.1.1, and that of other potential pollutants are discussed in Section 4.1.2.

4.1.1 Particulate matter

Mining can give rise to dust that, in elevated concentrations, has the potential to cause adverse impacts on the amenity and health of people living in the vicinity.

Dust can affect communities in various ways, depending upon the source and size of particles present. Dust typically emitted as a result of coal mining operations is assessed in terms of TSP, dust deposition, PM_{10} and $PM_{2.5}$.

Dust from mining consists primarily of larger particles generated through the handling of rock and soil, as well as through wind erosion of stockpiles and exposed ground. Larger particles (measured as dust deposition) are mostly associated with dust nuisance or amenity impacts in residential areas, through settling or deposition of the particles. Elevated dust deposition rates can reduce public amenity, through soiling of clothes, buildings and other surfaces in the area.

Smaller particles such as PM_{10} and $PM_{2.5}$ can also be generated through mining activities. Elevated levels of PM_{10} and $PM_{2.5}$ have the potential to affect human health as these particles can be trapped in the nose, mouth or throat, or be drawn into the lungs. Fine particles (i.e. $PM_{2.5}$) are typically generated through combustion processes.

4.1.2 Other pollutants

Quantities of other air pollutants, such as oxides of nitrogen (NO_x), carbon monoxide (CO) and sulfur dioxide (SO_2), may also be emitted from the mining fleet and blasting within the Project site. The emission rates of these air pollutants are low compared to the emission rates of particulate matter from mining activities.

It is noted that the Eagle Downs underground mine is located in close proximity to the open cut areas of the Project. It is understood that Whitehaven WS intends to consult with the proponents of the Eagle Downs underground mine regarding operational blasting procedures that may be implemented at the Project (e.g. consideration of prevailing and forecast wind direction prior to blasting in proximity to Eagle Downs' ventilation intakes) with the aim of reducing the potential risk of blast fume impacts at the Eagle Downs underground mine.

Overall, these air pollutants are transient in nature and are likely to have negligible impact outside of the roads and open-cut pits within the Project site. Hence, particulate matter is considered the critical air pollutant for this assessment. Compliance with air quality objectives for particulate matter at the nearest sensitive receptors will, as a consequence, demonstrate compliance with air quality standards for NO_x, CO and SO_2. Therefore, these air pollutants do not require further assessment.

Odour is unlikely to be emitted from typical mining activities. Spontaneous combustion is a potential source of odour from mining activities but the potential for this is low, therefore, odour has not been assessed further in this assessment. Carbon dioxide (CO_2) emissions are considered in Section 8.

4.2 Legislative Framework for Air Quality in Queensland

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. The EP Act gives the DES the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and wellbeing of humans and biological integrity. The Air EPP was made under the EP Act and was originally gazetted in 1997; the Air EPP was revised and reissued in 2019.

The purpose of the Air EPP is to identify the environmental values of the air environment to be enhanced or protected and to achieve the objective of the EP Act, which is ecologically sustainable development, in relation to the air environment.

The environmental values to be enhanced or protected under the Air EPP are the qualities of the air environment that are conducive to:

- protecting the health and biodiversity of ecosystems
- human health and wellbeing
- protecting the aesthetics of the environment, including the appearance of buildings, structures and other property
- protecting agricultural use of the environment.

The Air EPP defines air quality objectives for enhancing or protecting the environmental values. The objectives that are relevant to the key air pollutants that may be generated from the Project are presented in Table 2.

Table 2 also shows the dust deposition guideline commonly used in Queensland as a benchmark for avoiding amenity impacts due to dust. The dust deposition guideline is not defined in the Air EPP but is contained within the DES's *Guideline – Model mining conditions* (DES, 2017), and is therefore adopted for this Project.

Table 2 Ambient air quality objectives for the Project

Pollutant	Environmental Value	Averaging Period	Air Quality Objective (µg/m³)
$PM_{2.5}$	Health and wellbeing	24-hour	25
		1-year	8
PM_{10}		24-hour	50
		1-year	25
TSP		1-year	90
Dust deposition rate for total insoluble solids	Amenity guideline[1]	Monthly	120 mg/m²/day

Note:
[1] DES's *Guideline – Model mining conditions* (2017), not an air quality objective from the Air EPP.
µg/m³ = micrograms per cubic metre.
mg/m²/day = milligrams per square metre per day.

5. EXISTING ENVIRONMENT

5.1 Climate

The Project is located in central Queensland, which has a sub-tropical climate characterised by high variability in rainfall, temperature and evaporation. The region can experience droughts, floods, heatwaves and frosts. In general, winter days are warm and nights are cool, while summer days are hot and nights are warm. Rainfall is summer-dominant with almost half of the average annual rainfall occurring from December to February due to storms and tropical lows.

The nearest Bureau of Meteorology (BoM) weather monitoring station to the Project is located at Moranbah Airport, approximately 30 km north-west. However, this weather station has only been in operation since 2012. Long-term climate data in the Project region, from 1972 to 2012, have been collected from the (now decommissioned) BoM weather monitoring station located at Moranbah Water Treatment Plant. These data are described in the sections below.

5.1.1 Temperature and solar exposure

The mean daily maximum and minimum temperatures by month at the Moranbah Water Treatment Plant are presented in Figure 3. Temperature and solar exposure data at the Moranbah Water Treatment Plan was recorded between 1986 and 2012. The analysis identifies a seasonal temperature profile typical of the sub-tropical Queensland climate, with cooler winter months of June to August and warmer summer months of December to February. The mean maximum daily temperature at the Moranbah monitoring station was 33.8 degrees Celsius (°C), recorded during the summer season. The mean minimum daily temperature at the monitoring station was 9.9°C, recorded during winter.

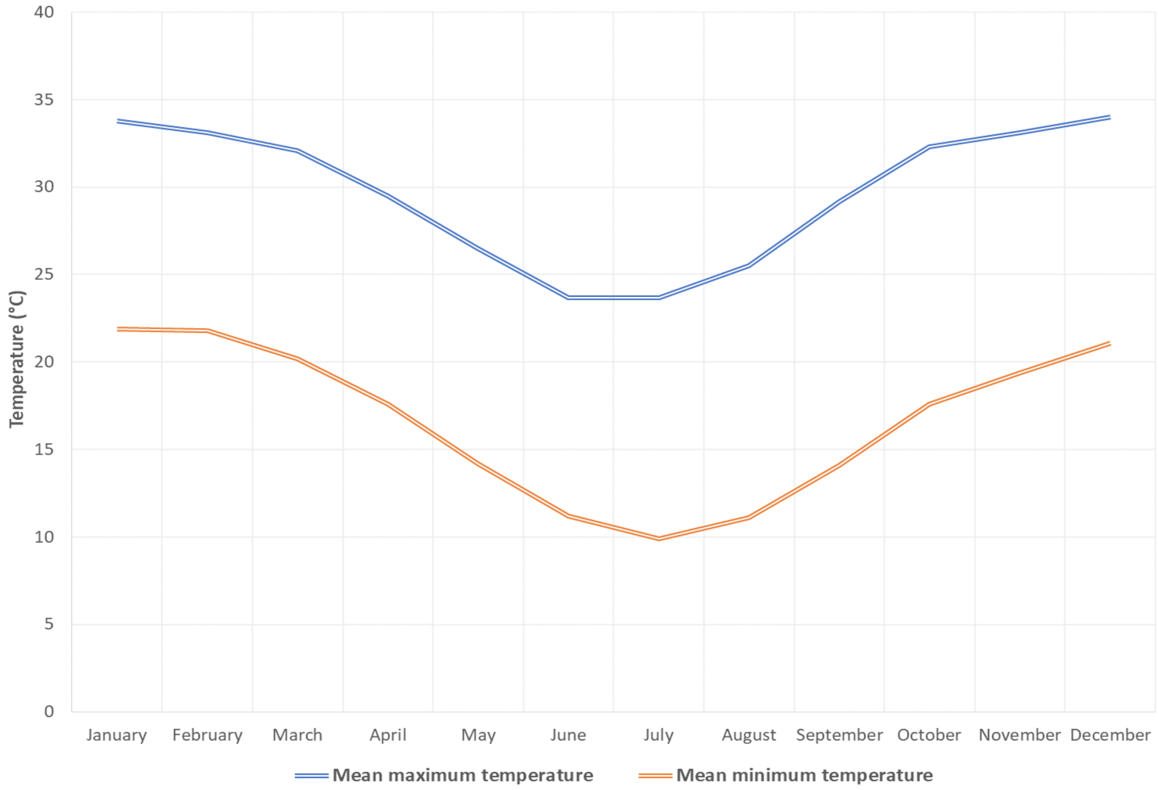


Figure 3 **Monthly mean temperature (°C) measured at Moranbah Water Treatment Plant (1986-2012)**

The amount of solar radiation received at ground-level is a primary driver for the weather patterns and climatic cycles that influence central Queensland. The average daily solar radiation in megajoules per square metre (MJ/m²) by month is presented in Figure 4. This figure illustrates a clear seasonal pattern whereby summer solar radiation is much greater than during the winter months.

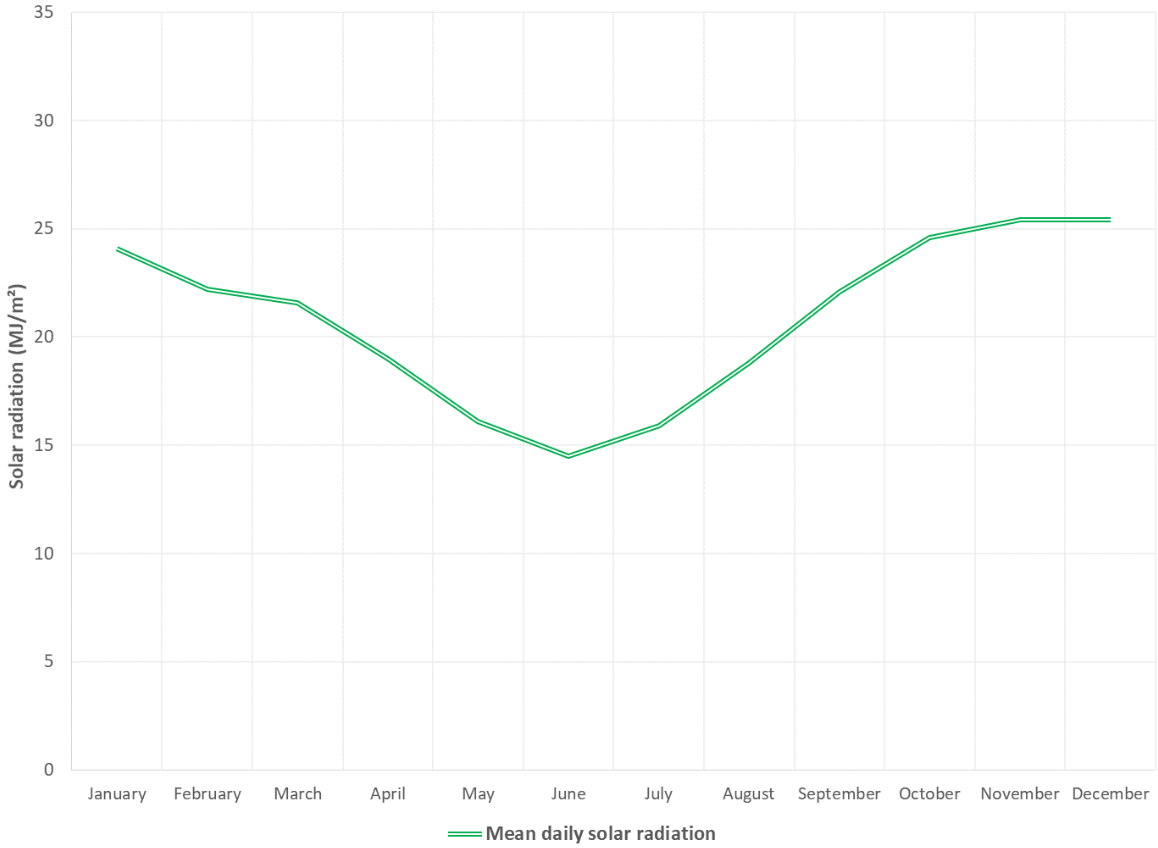


Figure 4 **Mean daily solar radiation (MJ/m²) by month at Moranbah Water Treatment Plant (1986-2012)**

5.1.2 Rainfall

The range of total monthly rainfall (mean and highest) at the Moranbah Water Treatment Plant for 1986-2012 is illustrated in Figure 5. The annual average rainfall is 614 millimetres (mm), with the wettest period occurring during the warmer months from December to February when, on average, 50% of the annual rainfall occurs.

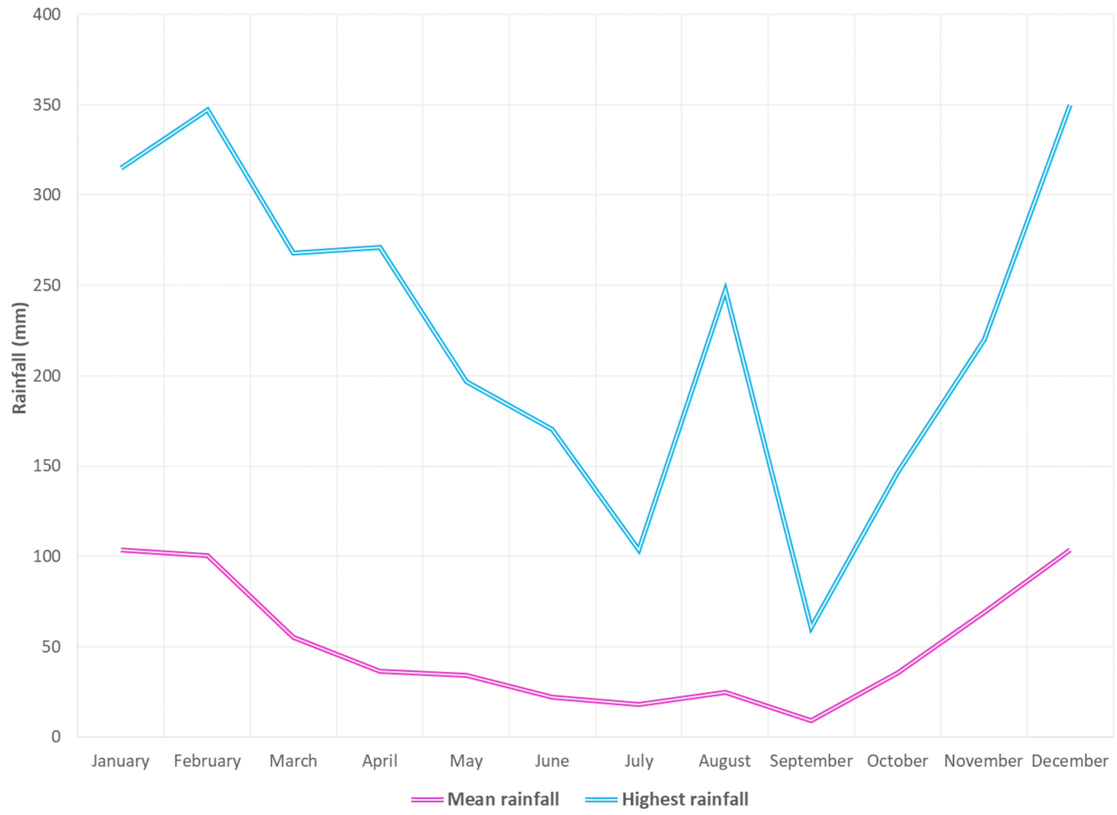


Figure 5 **Range of total monthly rainfall measured at Moranbah Water Treatment Plant (1986-2012)**

5.2 Local Meteorology

The following sections describe the local meteorology of the Project area, focusing on parameters that are important for dispersion of air pollutants generated by the Project's activities: namely, wind speed, wind direction, atmospheric stability and boundary layer mixing height.

Local meteorological data has been generated for the year 2015 by the coupled The Air Pollution Model (TAPM)/CALMET meteorological models at the location of the Project and used in the dispersion model assessment. The detailed meteorological model configuration is described in Appendix C.

5.2.1 Wind speed and wind direction

Wind speed and wind direction influence the rate of dispersion of dust emissions from sources such as wheel-generated dust, material transfers, material processing and wind erosion. Wind speed also determines the amount of dust lifted into the air by wind erosion. The 2015 annual, seasonal and diurnal frequencies of winds at the Project site are shown as wind roses in Figure 6, Figure 7 and Figure 8, respectively.

On average, approximately 72% of winds at the site are from the north-east through to the south-east. Winds vary with the seasons, with south-easterlies most frequent during autumn and winter, and north-easterlies most frequent during spring. The highest frequency of winds above 6 metres per second (m/s) occurs during summer, from the east and east-southeast, which are also the most frequent wind directions. There is a diurnal variation in the wind distribution, with a higher frequency of light winds occurring overnight (6 pm to 6 am) compared to the day. Winds from the east and east-southeast are most frequent during the afternoon (midday to 6 pm), whilst winds from the north-east quadrant are most frequent during the evening (6 pm to midnight). Winds from midnight to midday are predominantly from the south-east.

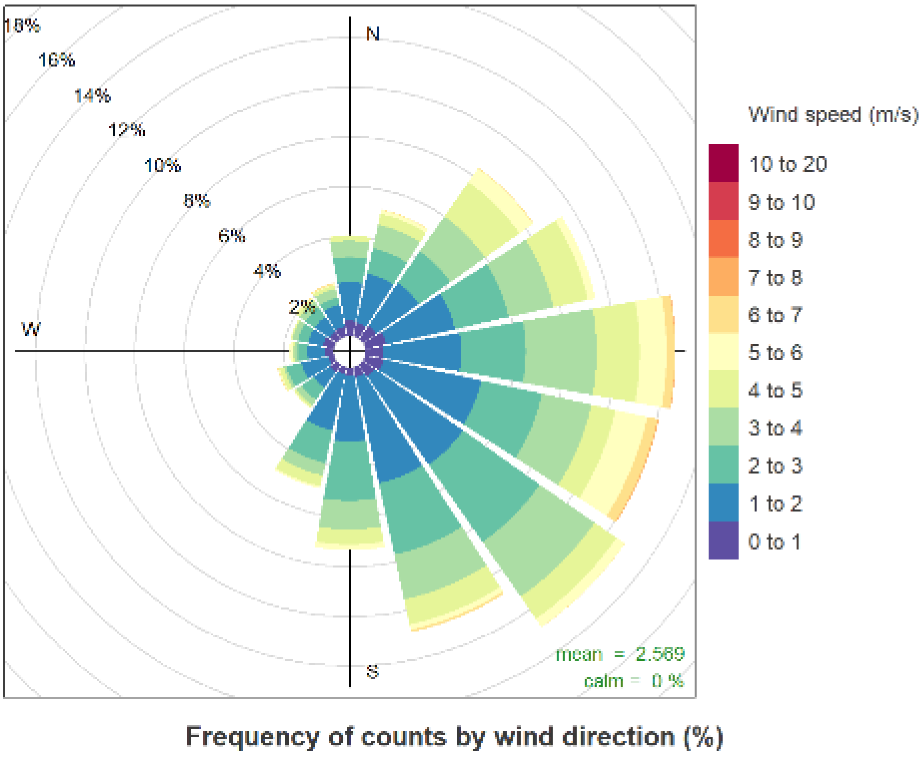


Figure 6 Annual wind rose for the Project site (extracted from CALMET) – 2015

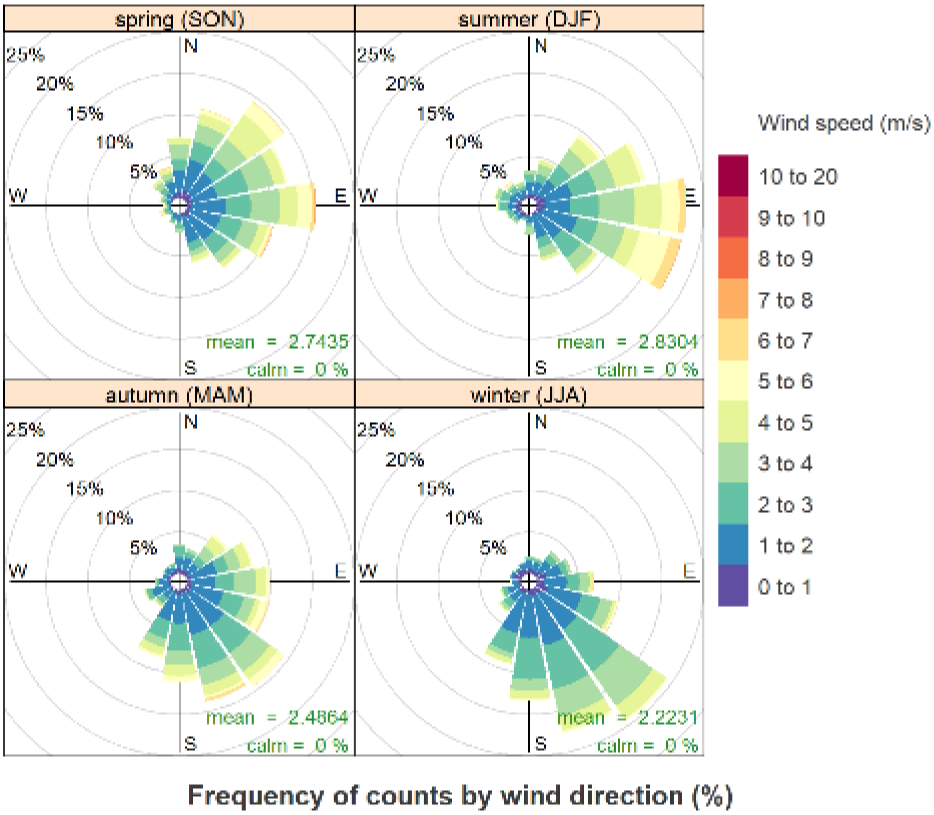


Figure 7 Seasonal wind roses for the Project site (extracted from CALMET) – 2015

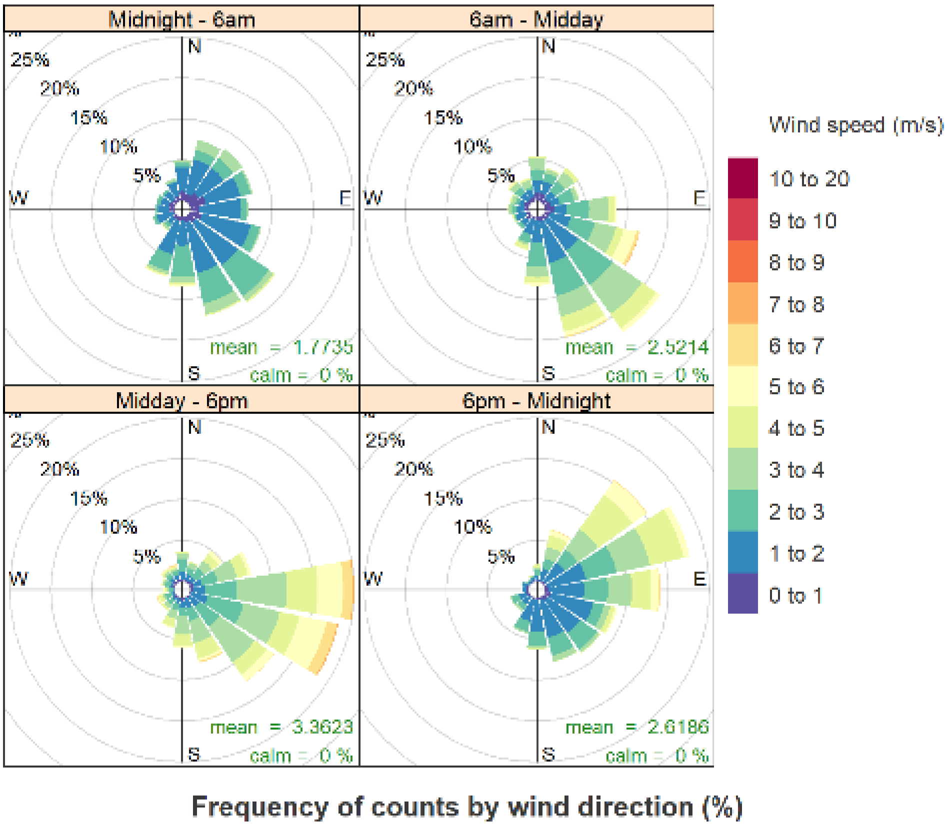


Figure 8 **Diurnal wind roses for the Project site (extracted from CALMET) – 2015**

5.2.2 Atmospheric stability and mixing height

Atmospheric stability class is a measure of the stability of the atmosphere. Stability classes range from A class to F class. Figure 9 shows the predicted annual frequency of stability classes in the Project area (taken from the meteorological dataset generated by the TAPM/CALMET models).

Class A represents the most unstable conditions and Class F the most stable conditions. Unstable conditions (Classes A to C) are characterised by strong to moderate solar heating of the ground. This induces turbulent mixing in the atmosphere close to the ground. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for the most frequently occurring Class D conditions are dominated by mechanical turbulence, generated as the wind passes over irregularities in the local surface. During light wind and clear sky conditions at night, the atmosphere is generally stable (Classes E and F). Strong winds and/or overcast conditions at night often lead to Class D conditions.

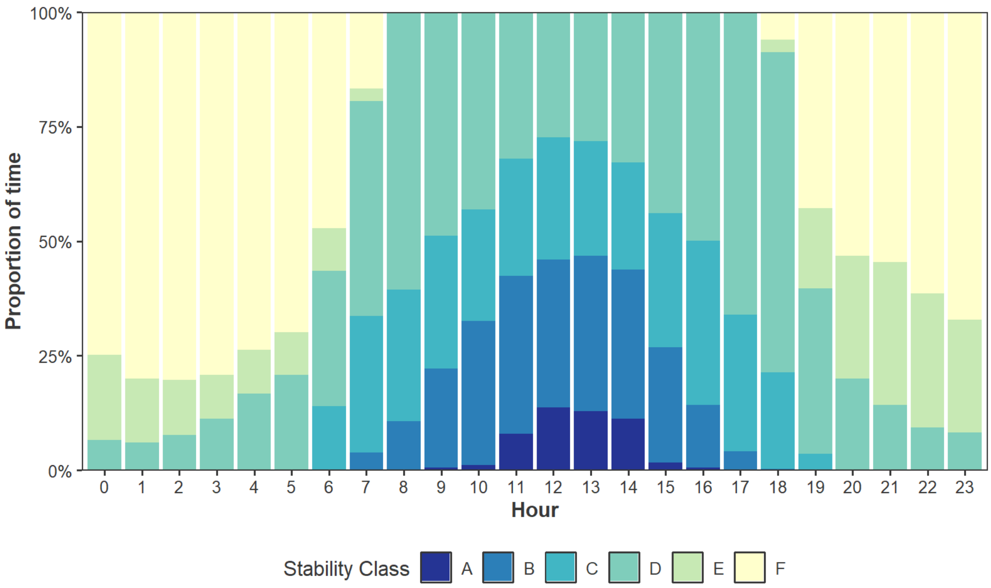


Figure 9 Stability class frequency for the Project site (extracted from CALMET) – 2015

The mixing height defines the height of the mixed atmosphere above the ground (mixed layer), which varies diurnally. Particulate matter, or other air pollutants that are released at or near the ground, will become dispersed within the mixed layer. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer. During the day, solar radiation heats the ground and causes the air above it to warm, resulting in convection and an increase to the mixing height. The growth of the mixing height is dependent on how well the warmer air from the ground can mix with the cooler upper level air and, therefore, depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speeds, the air will be well mixed, resulting in a high mixing height.

Hourly mixing height information in 2015 has been extracted from the CALMET simulation over the Project area and is presented in Figure 10 as a diurnal frequency plot. The data shows that, on average, the mixing height develops around 7 am, ascends to a peak at 3 pm to 6 pm before descending rapidly after 6 pm.

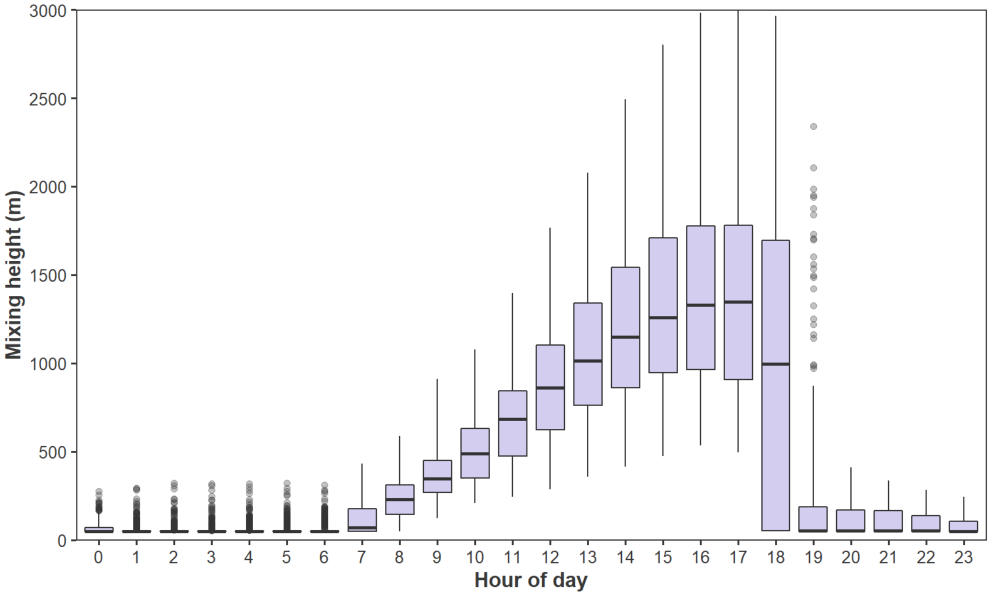


Figure 10 Diurnal variation in mixing height at the Project site (extracted from CALMET) – 2015

5.3 Local Terrain and Land-Use

The Project area is located approximately 200 km south-west of Mackay and 30 km south-east of Moranbah in central Queensland's Bowen Basin. The landscape has average elevations of approximately 210 metres (m) Australian Height Datum (AHD) and is generally flat to undulating. The Project area elevation ranges from approximately 185 m AHD in the north-east of the Project area to approximately 235 m AHD in the south-west of the Project area. Further afield, the terrain is elevated to the south-west.

The Project is located in a mining precinct comprising several existing nearby coal mining operations, with the township of Moranbah located to the north-west of the Project site. The region is predominantly rural, with low intensity grazing and coal mining the dominant land uses in the vicinity.

5.4 Receptors

Receptors in the vicinity of the Project have been identified. These are shown in Table 3 and Figure 11. R1 to R4 are sensitive receptors representing homesteads / residences. S32-1 and S32-2 represent two assets from South32's Eagle Downs mine. These assets are workplaces and, therefore, any potential exposure should be considered as a workplace exposure matter.

Table 3 Nearest receptors to the Project

Receptor ID	Description	Easting (km)	Northing (km)	Distance from the Project
R1	Residence – Olive Downs Homestead	633.81	7553.03	1.4 km north-east
R2	Residence – Winchester Downs Homestead	621.71	7552.80	6.5 km north-west
R3	Residence – Coolibah Homestead	614.00	7555.36	9.2 km north-west
R4	Residence – Vermont Park	647.21	7537.87	10 km south-east
S32-1	Eagle Downs Exploration Shed	628.095	7541.564	1.3 km south-west
S32-2	Eagle Downs Mine	624.072	7545.745	3.2 km west

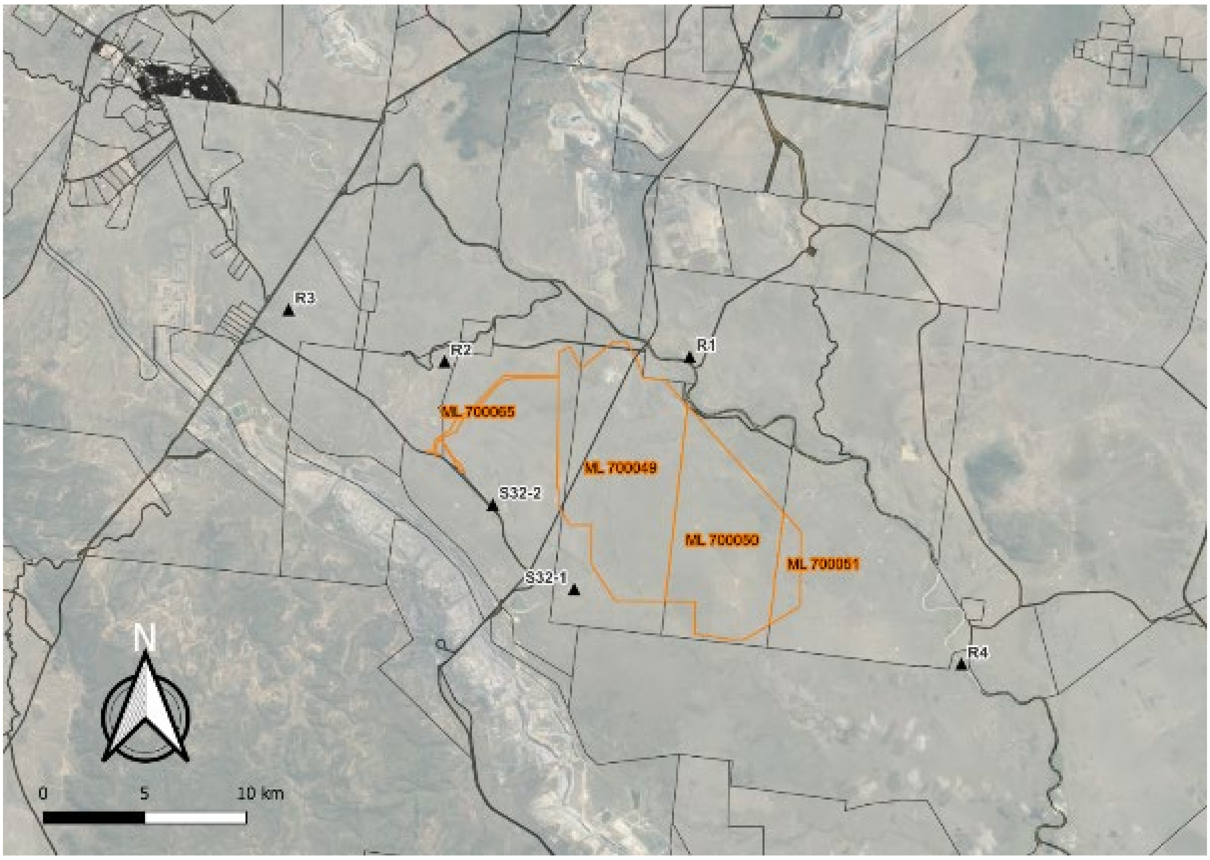


Figure 11 **Map of sensitive receptors**

5.5 Ambient Air Quality

There are several sources contributing to background levels of dust in the vicinity of the Project, including naturally generated dust in the environment such as pollen and grass seeds, dust from the use of dirt roads, agricultural activities, wind erosion of non-vegetated areas as well as contributions from a number of existing mines in the region. Activities in the township of Moranbah, such as construction, will also contribute to the ambient air quality levels in the Project region.

In addition, the Winchester Quarry is located in the northern part of the Project area and is operated by Quarrico Products Pty Ltd (Quarrico). Quarrico currently operates Winchester Quarry under an environmental authority (EPPR00930713), which allows for the extraction and screening of 5,000 tonnes (t) to 100,000 t of material per year.

The existing air quality has been characterised to indicate dust levels prior to operation of the Project, including the influence of natural dust sources and any dust arising from operations at the nearby mines. This has been characterised from a review of available information on dust emissions and representative ambient air quality monitoring data in the region.

5.5.1 Existing industries within the region

There are 15 currently operating and emitting sources of PM_{10} and $PM_{2.5}$ within 50 km of the Project according to National Pollutant Inventory (NPI) emissions data for the 2020-2021 reporting period. Ambient dust levels across the area are influenced by these existing anthropogenic sources. Within Moranbah township, some additional localised sources may also contribute to dust levels (e.g. construction sites and dust from the use of unpaved roads).

There are a number of existing coal mines in the region that may contribute to ambient dust concentrations. These are shown on Figure 1. Table 4 details the dust emissions (PM_{10} and $PM_{2.5}$) reported to the NPI database (NPI, 2022) for 2020/21 from identified industries in the Project region.

Table 4 Dust emissions reported to NPI for 2020/2021

Facility Name	Main Activities	Approximate Distance and Direction from the Project Boundary	PM_{10} (tonnes/year)	$PM_{2.5}$ (tonnes/year)
Grosvenor	Electricity generation using mineral gas including coal gas	30 km north-west	0.1	0.1
Dyno Nobel Moranbah	Gun cotton manufacturing	30 km north-west	10	10
Lake Vermont	Open cut coal mining	15.5 km south-east	20,356	776
Moranbah North	Electricity generation using mineral gas including coal gas	31 km north-west	0.2	0.2
Moorvale Coal Mine	Coal mining and coal preparation	14 km north	3,443	48
Coppabella Coal Mine	Black Coal mining, and processing	33 km north	8,009	74
Carborough Downs Coal Mine	Underground coal mine (development and longwall operations)	13 km north	1,495	4
Caval Ridge Mine	Coal Mining	7.5 km west	8,229	111
Daunia Mine	Coal Mining	2.5 km north	2,151	69
SEI Moranbah Power Station	Burning of coal seam methane to produce electricity	30 km north-west	0.02	0.02
Poitrel Coal Mine	Coal mining	8.9 km north	2,177	79
Saraji Mine	Coal Mining	23 km south	8,547	173
Moranbah Operations	Oil and Gas Extraction	30 km north-west	9	0.3
Peak Downs Mine	Coal Mining	3.5 km south-west	15,242	210
South Walker Creek Mine Operations	Coal Mining	38 km north-east	3,634	63
Goonyella Riverside and Broadmeadow Mine	Coal Mining	44 km north-west	11,000	240

Source: NPI (2022).

5.5.2 Existing ambient air quality

No ambient air quality monitoring is conducted at the Project site. Therefore, existing ambient air quality has been quantified through a summary of publicly available data.

5.5.2.1 PM_{10}

Long-term continuous PM_{10} monitoring data in the Project area is available from the DES monitoring station located at Utah Drive, Moranbah (approximately 30 km north-west). In June 2020, DES commenced monitoring of particulates at a second site at Cunningham Way, Moranbah. Data available for 2021 has not been considered as at the time of reporting the data has not been validated by DES. Relevant PM_{10} statistics from available validated data at DES's Moranbah monitoring sites are presented in Table 5 and Table 6 (Queensland Data, 2022).

The Moranbah PM_{10} data shows the following:

- The Utah Drive Moranbah monitoring station has recorded 109 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³ (Air EPP objective) over the ten years of monitoring. In particular, 2012, 2018 and 2019 show a large number of PM_{10} concentrations greater than 50 µg/m³.
    - In 2012, there were 36 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that, for a period of 4 months, housing construction work was occurring within 100 m of the monitoring station and was the likely cause of the elevated concentrations.
    - In 2017, there were 7 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that bushfires contributed to these elevated concentrations.
    - In 2018, there were 19 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that dust storms and bushfires contributed to these elevated concentrations.
    - In 2019, there were 32 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that a combination of emission sources including dust storms, bushfires, and hazard-reduction burning contributed to these elevated concentrations.
    - In 2020, there were 5 days when the 24-hour average concentrations of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that a combination of emission sources including dust storms, smoke, bushfires and local dust sources contributed to these elevated concentrations.
    - Annual average concentrations of PM_{10} at the Moranbah monitoring station were greater than the Air EPP objective of 25 µg/m³ for four of the nine years, 2012, 2017, 2018 and 2019.
- Data measured at Cunningham Way typically show higher concentrations than those measured at Utah Drive. It is possible that exposed ground near to Cunningham Way, which is evident in the aerial imagery, leads to overall higher levels of PM_{10}.

Table 5 Concentrations of PM_{10} at Utah Drive Moranbah monitoring station from 2011 to 2020 inclusive

Year	PM_{10} (µg/m³)			
	24-hour average (Maximum)	No. days above 50 µg/m³	24-hour average (70th percentile)	Annual average
2011	67.6	5	23.4	20.3
2012	492.8	36	29.5	27.9
2013	99.9	1	26.5	22.4
2014	49.9	0	24.0	20.4
2015	91.9	4	25.3	21.3
2016	49.5	0	27.2	22.1
2017	68.8	7	29.6	26.1
2018	113.6	19	34.6	30.3
2019	217.8	32	35.5	31.2
2020	89.8	5	23.4	21.1
Objective	50	-	-	25

Source: Queensland Data (2022).

Table 6 Concentrations of available PM_{10} at Cunningham Way Moranbah monitoring station from June 2020 to December 2020

Year	PM_{10} (µg/m³)			
	24-hour average (Maximum)	No. days above 50 µg/m³	24-hour average (70th percentile)	Annual average
2020	93.6	5	32.8	28.8
Objective	50	-	-	25

Source: Queensland Data (2022).

5.5.2.2 $PM_{2.5}$

DES commenced monitoring of $PM_{2.5}$ at its Utah Drive monitor in October 2019 and at the Cunningham Way monitor in June 2020. Publicly available data for 2021 has not been validated by DES at the time of reporting, and so has not been considered in this assessment.

Summary statistics for the 2020 $PM_{2.5}$ data from the two monitoring stations is presented in Table 7. The data shows both sites measured exceedances of the 24-hour average air quality objective of 25 µg/m³. DES has attributed these to dust storms, windblown surface dust, local dust-generating activities and smoke from bushfires according to their air quality monthly bulletins.

Table 7 Concentrations of $PM_{2.5}$ at Moranbah monitoring stations from 2020 to 2021 inclusive

Year	Site	$PM_{2.5}$ (µg/m³)			
		24-hour average (Maximum)	No. days above 25 µg/m³	24-hour average (70th percentile)	Annual average
2020	Cunningham Way[1]	57.2	2	7.7	7.4
	Utah Drive	54.2	4	6.6	6.4
Objective			**25**	**-**	**-**

Table note:
[1] Six months of data only for Cunningham Way in 2020.

5.5.2.3 TSP

DES does not conduct monitoring for TSP at its Moranbah site. TSP has been calculated from DES Moranbah PM_{10} data, assuming TSP is twice the PM_{10}. This assumption is based on the TSP/PM_{10} ratios found in the NPI manual mining emission factors for fugitive dust that range from 25% to 52%.

5.5.2.4 Dust deposition rate

DES commenced dust deposition monitoring at Utah Drive in February 2020 and Cunningham Way in July 2020. The monthly dust deposition data is summarised in Table 8. Data was obtained from DES's monthly air quality bulletins.

That data shows that there has been no exceedances of DES's recommended dust deposition limit of 120 mg/m²/day, averaged over one month.

In order to establish background dust deposition levels for assessment purposes, Utah Drive has been used as close to a full year of data is available.

Table 8 Measured dust deposition at Moranbah (DES)

Month	Utah Drive (mg/m²/day)	Cunningham Way (mg/m²/day)
January 2020	NM	NM
February 2020	87	NM
March 2020	56	NM
April 2020	109	NM
May 2020	87	NM
June 2020	55	NM
July 2020	78	57
August 2020	64	51
September 2020	71	56
October 2020	94	79
November 2020	102	81
December 2020	74	54
Average*	80	35
Guideline	**120**	**120**

Table note:
* Average based on available months of data

5.5.3 Summary of background dust levels

Background levels of TSP, PM_{10}, $PM_{2.5}$ and dust deposition that have been derived from data presented in the previous sections and used in this assessment are summarised in Table 9.

Table 9 Ambient background concentrations used to assess cumulative impacts

Pollutant	Averaging Period	Concentration
TSP	Annual	44.2 µg/m^3
PM_{10}	24-hour	27.2 µg/m^3
	Annual	22.1 µg/m^3
$PM_{2.5}$	24-hour	6.6 µg/m^3
	Annual	6.4 µg/m^3
Dust deposition	Annual average	80 mg/m^2/day

6. DUST EMISSIONS INVENTORY

6.1 Overview

Key dust-generating activities likely to be associated with the Project include:

- drilling and blasting
- material extraction and handling (waste rock and ROM coal)
- dozer activity
- material haulage (waste rock and ROM coal)
- road grading
- train loading
- wind erosion of:
    - stockpiles
    - exposed areas
    - rehabilitated areas.

6.2 Mitigation measures

6.2.1 Routine

Dust mitigation and operational controls have been included in the Project design to minimise dust emissions, including application of water to haul roads, handling activities and stockpiles. Efficiency factors (reduction in dust emissions applied in this assessment) for these control measures are presented in Table 10.

Table 10 Standard dust control measures and relative reduction in emissions

Activity	Control measure	Reduction
ROM coal haulage	Watering	85%
Waste rock haulage	Watering	85%
Drilling	Drill dust suppression sprays	70%
ROM unloading at CHPP	Water sprays	50%
Crushing	Enclosure	100%
Product stockpile	Water sprays, reshaping/profiling	85%
Train loading	Telescopic chute with water spray	85%

These measures are examples of best practice for control of dust emissions.

6.2.2 Proactive

Whitehaven WS will operate the Project with a proactive dust management system to ensure dust generation during times of high potential for impact is minimised as far as practicable. The system would include the use of weather forecasting and real-time measurement of dust levels and meteorological conditions to identify opportunities to reduce the likely impacts with reference to applicable air quality objectives at the nearest sensitive receptors.

When air quality monitoring and meteorological forecasting indicate the potential for upcoming exceedances of the applicable air quality objectives, Whitehaven WS will seek to modify mining operations in accordance with an Air Quality Management Plan (AQMP). A hierarchy of proactive mitigative actions will be stated in the AQMP and will seek to reduce potential impacts, such as:

- applying additional dust controls such as using chemical suppressant (or alternative technologies with equivalent effectiveness) to haul roads;
- moving operations to areas of the mine with reduced dust emission potential; and/or
- reducing the intensity of certain operations.

6.3 Project emissions inventory

To assess potential air quality impacts due to the Project, potential dust emissions from individual mining activities for each operational scenario were calculated and have been modelled. Activity information that was used to calculate dust emission rates associated with individual activities was provided by Whitehaven WS.

Dust emission rates were estimated using the base equation:

$$ER = A \times EF \times (1 - CM)$$

where:

ER	emission rate of dust
A	activity / operations data
EF	emission factor
CM	reduction in emissions due to the implementation of dust control measures.

Emissions of TSP, PM_{10} and $PM_{2.5}$ from mining activities were estimated using recognised and accepted methods. These include NPI emissions estimation technique handbooks, Australian Coal Association Research Program (ACARP) emission studies and the United States Environmental Protection Agency (US EPA) AP42 emission handbooks (NPI, 2012; ACARP, 2015; US EPA, 1998; US EPA, 2006).

The emissions estimation techniques applied in this assessment are based on standard methods utilised in mining operations that are applied throughout Australia and in the United States, which incorporate the same excavation methods that would be used for the Project. The size distribution of dust particles was derived from the emission rates estimated for TSP, PM_{10}, and $PM_{2.5}$.

A summary of the dust emission rates estimated for Years 5, 9, 19, and 27 of the Project is presented in Table 11 and a detailed breakdown is provided in Table 12.

The corresponding emission source locations are illustrated schematically in Figure 12, Figure 13, Figure 14, and Figure 15. The activity data used to estimate dust emissions are detailed in Appendix B, Table B1.

Table 11 Summary of Project dust emissions inventory for Years 5, 9, 19 and 27

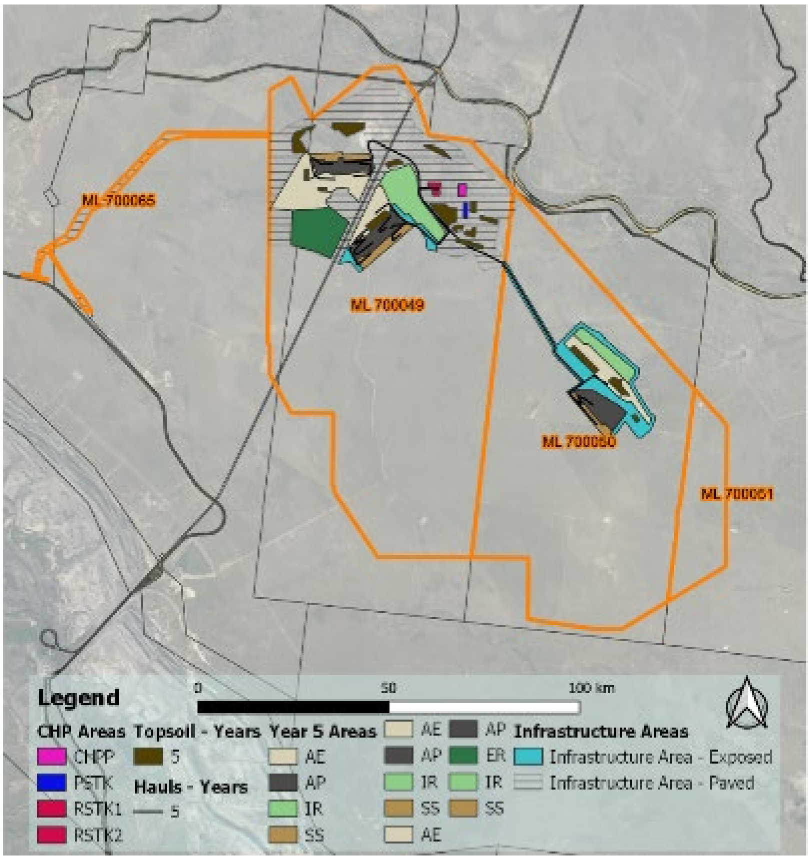
Activity	Year 5 (t/year)			Year 9 (t/year)			Year 19 (t/year)			Year 27 (t/year)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Total	5,157	1,634	209	5,616	1,781	224	7,212	2,270	287	6,138	2,025	263
Activity Contribution (tonnes)												
Pit Activities	912	280	45	817	256	39	893	278	46	719	224	37
CHPP	189	89	14	189	90	14	191	90	14	185	88	13
Hauling	3,107	791	80	3,515	888	89	4,678	1,177	118	3,598	895	90
Wind Erosion	948	474	71	1,095	548	82	1,451	725	109	1,636	818	123
Activity Contribution (% of total)												
Pit Activities	18%	17%	21%	15%	14%	17%	12%	12%	16%	12%	11%	14%
CHPP	4%	5%	6%	3%	5%	6%	3%	4%	5%	3%	4%	5%
Hauling	60%	48%	38%	63%	50%	40%	65%	52%	41%	59%	44%	34%
Wind Erosion	18%	29%	34%	20%	31%	37%	20%	32%	38%	27%	40%	47%

Note: Totals may not add exactly due to rounding.
t/year = tonnes per year

Table 12 Breakdown of Project dust emissions inventory for Years 5, 9, 19, and 27

Activity	Year 5 (t/year)			Year 9 (t/year)			Year 19 (t/year)			Year 27 (t/year)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Pit Activities												
Drilling	16	8	0.5	15	8	0.5	17	9	0.5	17	9	0.5
Blasting	86	44	3	81	42	2	88	46	3	93	48	3
Bulldozing – waste rock	12	2	1		-			-			-	
Bulldozing – ROM	443	102	10	398	92	9	398	92	9	310	72	7
Excavator – ROM removal	5	2	0.3	5	2	0.3	5	3	0.4	3	1	0.2
Excavator waste rock removal	98	46	7	93	44	7	103	49	7	71	33	5
Truck dumping (waste rock)	98	46	7	93	44	7	103	49	7	71	33	5
Truck dumping (reject coal)	3	1	0.2	3	2	0.2	4	2	0.3	3	1	0.2
Dozer on waste rock	105	18	11	59	10	6	70	12	7	59	10	6
Dozer on rehabilitation	23	4	2	23	4	2	70	12	7	70	12	7
Dozer on topsoil	23	4	2	12	2	1		-		12	2	1
Dozer on soil strip		-		35	6	4	35	6	4	12	2	1
CHPP												
Screens	Enclosed source											
Crushers Primary												
Crushers Secondary												
Crushers Tertiary												
Transfers (ROM)	2.8	1.3	0.2	2.9	1.4	0.2	3	2	0.2	2	1	0.1
Truck dumping	4.7	2.2	0.3	4.8	2.3	0.3	5	3	0.4	3	1	0.2
Load ROM to CHPP	2.3	1.1	0.2	2.4	1.1	0.2	3	1	0.2	2	1	0.1
Dozer reclaim	1.6	0.8	0.1	1.7	0.8	0.1	2	1	0.1	1	0.5	0.1
Transfers (Product)	Enclosed source											
Train loading from surge bin	1.0	0.5	0.1	1.0	0.5	0.1	1	0.5	0.1	1	0.5	0.1

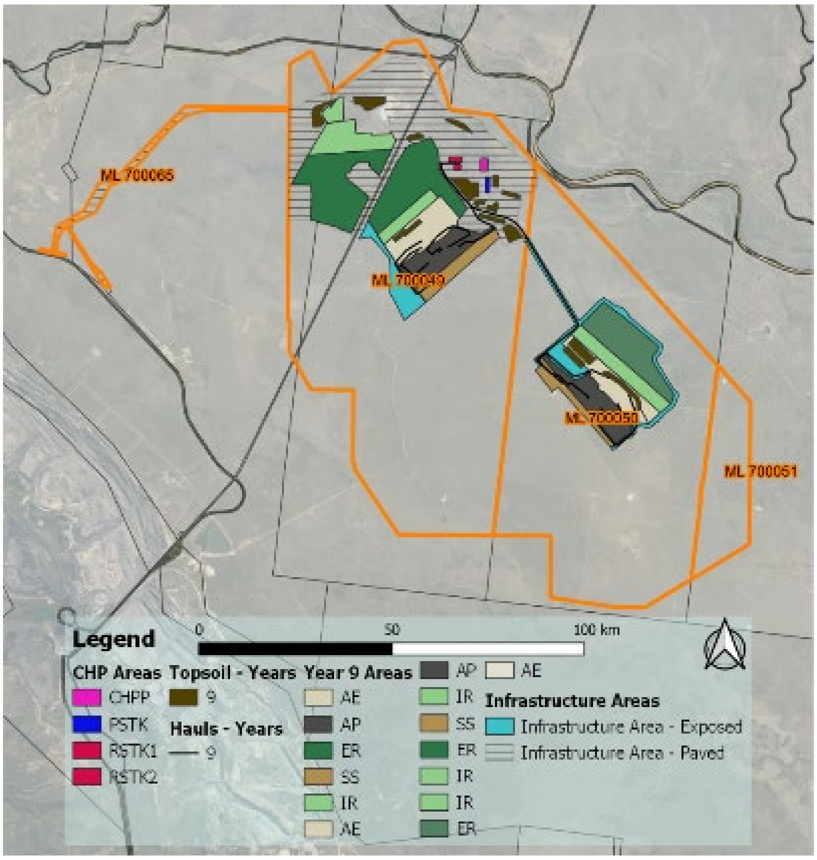
Activity	Year 5 (t/year)			Year 9 (t/year)			Year 19 (t/year)			Year 27 (t/year)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Train load-out conveyor	176.4	83.5	12.6	176.5	83.5	12.6	176	83	12.6	176	83	13
Transfer to rejects bin	0.2	0.1	0.01	0.2	0.1	0.01	0.21	0.10	0.02	0.1	0.1	0.01
Hauling												
Waste rock hauling	1,827	449	45	1,910	469	47	2,790	686	69	2,343	564	56
ROM hauling	742	182	18	906	223	22	1,349	332	33	806	198	20
Grader waste rock hauls	380	112	12	526	145	15	364	108	11	330	98	10
Grader ROM hauls	159	47	5	172	51	5	175	52	5	119	35	4
Wind Erosion												
Initial rehabilitation	98	49	7	145	73	11	213	107	16	226	113	17
Active emplacements	280	140	21	228	114	17	333	167	25	571	286	43
Active pit	158	79	12	242	121	18	292	146	22	109	55	8
ROM stockpiles	3	2	0.2	3	2	0.2	3	2	0.2	3	2	0.2
Product stockpiles	3	2	0.3	3	2	0.3	3	2	0.3	3	2	0.3
Topsoil stockpiles	119	60	9	135	68	10	115	57	9	91	46	7
Exposed areas	211	105	16	212	106	16	375	188	28	565	283	42
Soil stripping	76	38	6	126	63	9	116	58	9	67	33	5



Legend Key:

Coal handling and processing plant (CHPP); Product stockpile (PSTK); ROM coal stockpiles (RSTK1 and RSTK2); Active emplacement (AE); Active pit (AP); Initial rehabilitation (IR); Established rehabilitation (ER); Soil stripping area (SS)

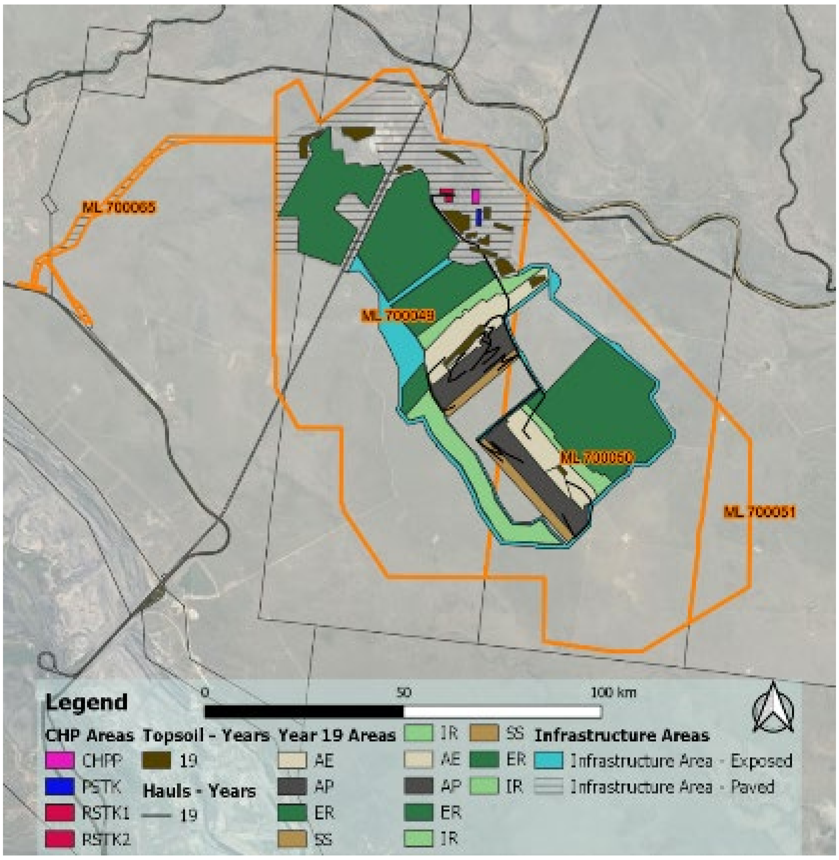
Figure 12 Year 5 – Dust emission source areas



Legend Key:

Coal handling and processing plant (CHPP); Product stockpile (PSTK); ROM coal stockpiles (RSTK1 and RSTK2); Active emplacement (AE); Active pit (AP); Initial rehabilitation (IR); Established rehabilitation (ER); Soil stripping area (SS)

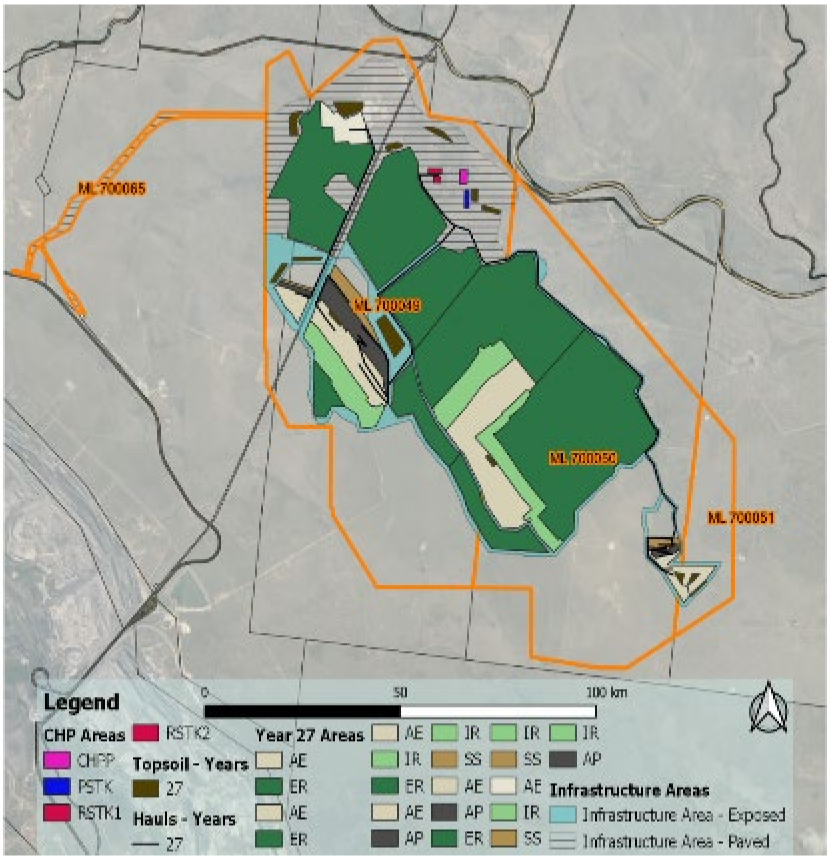
Figure 13 Year 9 – Dust emission source areas



Legend Key:

Coal handling and processing plant (CHPP); Product stockpile (PSTK); ROM coal stockpiles (RSTK1 and RSTK2); Active emplacement (AE); Active pit (AP); Initial rehabilitation (IR); Established rehabilitation (ER); Soil stripping area (SS)

Figure 14 Year 19 – Dust emission source areas



Legend Key:

Coal handling and processing plant (CHPP); Product stockpile (PSTK); ROM coal stockpiles (RSTK1 and RSTK2); Active emplacement (AE); Active pit (AP); Initial rehabilitation (IR); Established rehabilitation (ER); Soil stripping area (SS)

Figure 15 Year 27 – Dust emission source areas

7. AIR QUALITY IMPACT ASSESSMENT

The results of the dispersion modelling assessment of the Project are presented in the following sub-sections. Modelling results associated with each scenario have been presented as predicted ground-level concentrations or dust deposition rates at sensitive receptors as well as contours across the modelling domain.

Background dust levels have been added to the incremental model predictions in order to obtain an estimate of the potential cumulative impacts of the Project. Results have been assessed by comparing the predicted concentrations and dust deposition rates with the relevant air quality objectives.

When considering the results, it is important to note the 24-hour average dispersion modelling results are based on the concentration of each pollutant predicted at the receptors over the one-year period and thus represent a peak-impact scenario. The contour plots are constructed such that the highest value is obtained and stored from each point in the modelled domain. As these values may occur at different times at different grid points, these figures do not represent a single snapshot of conditions at any given time.

7.1 TSP

Table 13 provides the predicted annual average ground-level concentrations of TSP for each Project scenario in isolation (i.e. without the background) and with background levels applied (cumulative assessment).

Contours of the predicted annual average ground-level concentrations of TSP for each Project scenario in isolation are presented in Plate 1 to Plate 4.

The results show that:

- Predicted concentrations of TSP ***comply*** with the relevant air quality objective at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.
- Predicted concentrations of TSP ***comply*** with the relevant air quality objective at South32's Eagle Downs mine assets, in all modelled Project scenarios, in isolation and cumulatively.

Table 13 Predicted annual average ground-level concentrations of TSP (µg/m³)

Receptor	Year 5		Year 9		Year 19		Year 27	
	Annual avg TSP		Annual avg TSP		Annual avg TSP		Annual avg TSP	
	Project	Project + BG	Project	Project + BG	Project	Project + BG	Project	Project + BG
R1	5.9	50.1	6.9	51.1	9.4	53.6	3.7	47.9
R2	4.4	48.6	3.6	47.8	4.1	48.3	5.0	49.2
R3	1.3	45.5	1.2	45.4	1.5	45.7	1.6	45.8
R4	0.3	44.5	0.3	44.5	0.4	44.6	0.2	44.4
S32-1	4.1	48.3	5.3	49.5	10.5	54.7	6.3	50.5
S32-2	5.1	49.3	5.5	49.7	6.9	51.1	10.3	54.5
Objective	**90**							
Note: BG = background.								

7.2 PM_{10}

The predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} for each Project scenario in isolation (i.e. without the background) and with background levels applied (cumulative assessment) are presented in Table 14 and Table 15, respectively.

Contours of the predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} for all Project scenarios in isolation are presented in Plate 5 to Plate 12.

The results show that:

- Predicted 24 hour and annual average concentrations of PM_{10} ***comply*** with the relevant air quality objectives at all sensitive receptors, in all modelled Project scenarios, for the Project in isolation.
- The predicted 24-hour average concentrations of PM_{10} at R1 due to the project in isolation include the effect of proactive mitigations measures that are discussed in Section 6.2.2. Inclusion of the following proactive measures achieves compliance with the air quality objectives at R1 for 24-hour PM_{10}:
    - Application of chemical suppressants on hauls for 5 nights in Year 9.
    - Application of chemical suppressants on hauls for a total of 8 days and 8 nights in Year 19.
- The cumulative assessment results show that for R1 the predicted 24-hour average and annual average concentrations of PM_{10} have the potential to exceed the air quality objectives for PM_{10} for all assessment years. R1 is located 1.4 km from the Project.
- The predicted 24-hour average concentrations of PM_{10} at R2 due to the project in isolation comply with the air quality objective. The cumulative assessment results show that for R2 (located 6.5km from the Project), application of proactive mitigation measures are required to ensure compliance with the predicted 24-hour average and annual average concentrations of PM_{10}.These mitigation measures are as follows:
    - For compliance with 24-hour average concentrations, application of chemical suppressants on hauls for 4, 2, 1 and 4 nights for Years, 5, 9, 19 and 27, respectively.
    - For compliance with annual average concentrations, application of chemical suppressants on hauls for 165, 42, 76 and 125 nights for Years, 5, 9, 19 and 27, respectively.
- South32's Eagle Downs mine assets assets are workplaces and, therefore, any potential exposure should be considered as a workplace exposure matter. Notwithstanding, this the mine assets have been assessed against the Air EPP objectives which provides a conservative estimate of air quality risk.
- Predicted concentrations of PM_{10} at South32's Eagle Downs mine assets comply with the relevant air quality objectives for the Project in isolation in all modelled Project scenarios, with the exception of Year 19 (S32-1 only).
- To address the risk of elevated cumulative concentrations of PM_{10} in close proximity to the Project, dust emissions will be managed using a proactive dust management system whereby background dust levels in the region will be monitored and mine operations will be altered when levels are elevated. Further discussion on the potential for cumulative impacts is provided in Section 7.6.

Table 14 **Predicted maximum 24-hour average ground-level concentrations of PM_{10} (µg/m³)**

Receptor	Year 5		Year 9		Year 19		Year 27	
	Max 24h PM_{10}		Max 24h PM_{10}		Max 24h PM_{10}		Max 24h PM_{10}	
	Project	Project + BG	Project	Project + BG	Project	Project + BG	Project	Project + BG
R1	37.7	**64.9**	48.5[B]	**89.7**	49.1[D]	**76.3**	44.5	**71.7**
R2	29.8	49.2[A]	30.3	48.3[C]	30.0	48.0[E]	31.1	48.0[F]
R3	9.5	36.7	8.5	35.7	10.6	37.8	13.8	41.0
R4	9.8	37.0	11.5	38.7	13.0	40.2	6.7	33.9
S32-1	24.9	**52.1**	33.6	**60.8**	**58.1**	**85.3**	46.5	**73.7**
S32-2	35.3	**62.5**	31.6	**58.8**	27.7	**54.9**	43.2	**70.4**
Objective	**50**							

Table note:
[A] Predicted concentration accounts for the application of chemical suppressant on hauls for 4 nights
[B] Predicted concentration accounts for the application of chemical suppressant on hauls for 5 nights
[C] Predicted concentration accounts for the application of chemical suppressant on hauls for 2 nights
[D] Predicted concentration accounts for the application of chemical suppressant on hauls for 8 nights and during daylight hours for an additional 8 days.
[E] Predicted concentration accounts for the application of chemical suppressant on hauls for 1 night
[F] Predicted concentration accounts for the application of chemical suppressant on hauls for 4 nights

Table 15 **Predicted annual average ground-level concentrations of PM_{10} (µg/m³)**

Receptor	Year 5		Year 9		Year 19		Year 27	
	Annual avg PM_{10}		Annual avg PM_{10}		Annual avg PM_{10}		Annual avg PM_{10}	
	Project	Project + BG	Project	Project + BG	Project	Project + BG	Project	Project + BG
R1	4.5	**26.6**	5.4	**27.5**	6.8	**28.9**	2.8	**25.0**
R2	3.9	24.9[A]	3.0	24.9[B]	3.4	24.9[C]	4.3	24.9[D]
R3	1.1	23.2	1.0	23.1	1.3	23.4	1.4	23.5
R4	0.2	22.3	0.3	22.4	0.3	22.4	0.2	22.3
S32-1	3.5	**25.6**	4.4	**26.5**	8.3	**30.4**	5.2	**27.3**
S32-2	4.3	**26.4**	4.7	**26.8**	5.9	**28.0**	8.4	**30.5**
Objective	**25**							

Table note:
[A] Predicted concentration accounts for the application of chemical suppressant on hauls for 165 nights
[B] Predicted concentration accounts for the application of chemical suppressant on hauls for 42 nights
[C] Predicted concentration accounts for the application of chemical suppressant on hauls for 76 nights
[D] Predicted concentration accounts for the application of chemical suppressant on hauls for 125 nights

7.3 $PM_{2.5}$

Table 16 and Table 17 provide the predicted 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ for each Project scenario in isolation (i.e. without the background) and with background levels applied (cumulative assessment).

Contours of the predicted 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ for each Project scenario in isolation are presented in Plate 13 to Plate 20.

The results show that:

- Predicted concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.
- Predicted concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at South32's Eagle Downs mine assets, in all modelled Project scenarios, in isolation and cumulatively, with the exception of Project Year 27 (S32-2 only).

Table 16 Predicted 24-hour average ground-level concentrations of $PM_{2.5}$ (µg/m^3)

Receptor	Year 5		Year 9		Year 19		Year 27	
	Max 24h $PM_{2.5}$		Max 24h $PM_{2.5}$		Max 24h $PM_{2.5}$		Max 24h $PM_{2.5}$	
	Project	Project + BG	Project	Project + BG	Project	Project + BG	Project	Project + BG
R1	6.7	13.3	9.8	16.4	12.4	19.0	6.6	13.2
R2	8.3	14.9	8.8	15.4	7.8	14.4	7.6	14.2
R3	3.8	10.4	3.5	10.1	3.7	10.3	4.7	11.3
R4	2.0	8.6	2.4	9.0	2.7	9.3	1.6	8.2
S32-1	6.8	13.4	8.4	15.0	12.6	19.2	10.4	17.0
S32-2	8.0	14.6	8.1	14.7	8.2	14.8	10.3	16.9
Objective	**25**							

Table 17 Predicted annual average ground-level concentrations of $PM_{2.5}$ (µg/m^3)

Receptor	Year 5		Year 9		Year 19		Year 27	
	Annual avg $PM_{2.5}$		Annual avg $PM_{2.5}$		Annual avg $PM_{2.5}$		Annual avg $PM_{2.5}$	
	Project	Project + BG	Project	Project + BG	Project	Project + BG	Project	Project + BG
R1	0.7	7.1	0.9	7.3	1.0	7.4	0.5	6.9
R2	1.0	7.4	0.8	7.2	0.8	7.2	1.0	7.4
R3	0.4	6.8	0.3	6.7	0.4	6.8	0.4	6.8
R4	0.1	6.5	0.1	6.5	0.1	6.5	0.05	6.4
S32-1	0.8	7.2	1.0	7.4	1.6	8.0	1.1	7.5
S32-2	1.0	7.4	1.1	7.5	1.4	7.8	1.7	**8.1**
Objective	**8**							

7.4 Dust Deposition

Table 18 provides the predicted maximum monthly dust deposition rates for each Project scenario in isolation (i.e. without the background) and with background levels applied (cumulative assessment).

Contours of the predicted maximum monthly dust deposition rates for each Project scenario are presented in Plate 21 to Plate 24 and provide the results of the cumulative assessment.

The results show that:

- Predicted dust deposition rates due to the Project ***comply*** with the guideline at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.
- Predicted dust deposition rates due to the Project ***comply*** with the guideline at South32's Eagle Downs mine assets.

Table 18 Predicted maximum monthly dust deposition rates (mg/m²/day)

Receptor	Year 5		Year 9		Year 19		Year 27	
	Max monthly Dust Dep		Max monthly Dust Dep		Max monthly Dust Dep		Max monthly Dust Dep	
	Project	Project + BG	Project	Project + BG	Project	Project + BG	Project	Project + BG
R1	14.1	94.1	14.8	94.8	21.8	101.8	7.4	87.4
R2	11.8	91.8	8.0	88.0	6.6	86.6	7.4	87.4
R3	3.6	83.6	3.2	83.2	3.2	83.2	3.5	83.5
R4	0.6	80.6	0.6	80.6	0.8	80.8	0.4	80.4
S32-1	5.4	85.4	9.1	89.1	22.8	102.8	17.9	97.9
S32-2	11.0	91.0	8.3	88.3	11.9	91.9	20.4	100.4
Objective	**120**							

7.5 Railway Operations

The Project's rail operations, from mine site to port, have not been assessed explicitly. Notwithstanding this, rail operations have the potential to generate localised dust along the rail corridor. Potential sources of dust emissions from coal train operations include:

- The exposed coal surface of loaded wagons
- Leakage of coal from unloading doors in the bottom of wagons
- Wind erosion of spilled coal in the corridor
- Leakage of residual coal from doors of unloaded wagons.

For the majority of dust producing activities associated with rail operations, the dust emission rate is dependent on the speed of the air passing over the coal surface, which is influenced by the ambient wind speed and the train speed. Other factors are also important, such as: coal moisture content, particle size distribution, dustiness of the coal, wagon vibration, frequency of train movements, the profile of the coal load, rainfall and distance travelled.

Katestone has conducted several studies involving both ambient air quality monitoring and modelling of emissions from coal trains (Katestone, 2008a; Katestone, 2008b). These studies focused on railway corridors that transport between 10 and 125 Mtpa of coal, which is associated with 5 to 35 trains per day (travelling to the unloading facilities and returning to the mines).

These studies found the influence of coal trains on ambient dust levels is very localised. Monitoring and modelling at distances of 50 m to 100 m from railway lines failed to find evidence of significant dust levels. Dust measurements found the increase in dust levels from passing trains was short-lived and dependent on the type of train and meteorological conditions.

In addition, several monitoring studies have been undertaken by the Queensland Government to investigate coal dust from rail transport (Department of Science, Information Technology, Innovation and the Arts, 2013 and Department of Science, Information Technology and Innovation, 2016). These studies showed that ambient particle concentrations did not exceed air quality objectives at the monitoring sites and rail transport emissions were a minor contributor to overall particle levels at the monitoring site.

Notwithstanding the above, a number of management measures to minimise the generation of coal dust from rail loading and transport will be implemented by Whitehaven WS, consistent with the dust mitigation activities presented in the *Coal Dust Management Plan* (Aurizon, 2020), including:

- Profiling of coal in wagons to a “garden bed” shape profile
- Veneering system using a biodegradable spray after profiling to reduce coal dust generation during transit to port.

7.6 Potential for cumulative dust impacts with other mining operations

The cumulative air quality assessment of PM_{10} has indicated the potential for elevated levels to occur at R1 (Olive Downs Homestead) and requires the Project to use a proactive mitigation system to manage dust. The cumulative assessment added the Project PM_{10} contributions to a background concentration derived from existing monitoring data in Moranbah township, located 30 km from the Project.

The background concentration used in the cumulative assessment encompasses dust levels from existing sources in the region including activities in Moranbah (construction and vehicle use), regional industrial activities (existing coal mines, quarries and dumps) and natural dust (bush fires and dust storms).

There are a number of existing coal mines in the region that have been approved to operate in locations closer to the Project than they are currently (Poitrel Mine and Daunia Mine), as well as new mines that have been approved but are not yet operating (Moorvale South Project and Olive Downs Project). The potential for cumulative impacts from these operations are discussed below.

The Poitrel Mine and Daunia Mine are existing facilities and, therefore, the dust emissions from their activities will have been captured in the background concentration derived from Moranbah to some extent. Notwithstanding this, review of their respective EIS documentation indicates that mining activities are proposed to move closer to the Project than current locations.

The existing Poitrel Mine is located 5.8 km north-west of R1 with future mining areas located approximately 3 km from R1. There is a low potential for dust from the Poitrel Mine and the Project to affect R1 at the same time due to the mines being located in different directions relative to the receptor.

The existing Daunia Mine is located 5.6 km north of R1 with mining forecast until 2029 (approximately Project Year 9). There is a low potential for dust from the Daunia Mine and the Project to affect R1 at the same time due to the mines being located in different directions relative to the receptor. Further to this, dust emissions from the Daunia Mine will be significantly reduced after it ceases operations after approximately Project Year 9.

The Moorvale South Coal Mine is to be located approximately 4 km east of R1 and is proposed to extract 1 Mtpa of ROM coal for 10 years. There is a low potential for dust from the Moorvale South Coal Mine and the Project to affect R1 at the same time due to the mines being located in different directions relative to the receptor. Moorvale is also significantly smaller than other mines in the region and will, therefore, generate less dust.

The Olive Downs Project is located adjacent to the east and south-east of the Project and will extract up to 20 Mtpa of ROM over a mine life of 79 years. The Air Quality and Greenhouse Gas Assessment of the Olive Downs Coal Project (Katestone, 2018) showed that dust levels at R1 (Olive Downs Homestead) would comply with the air quality objectives across the life of mine. Similarly to that proposed for the Project, the Olive Downs Project will operate a proactive dust mitigation system to manage dust. There is a low potential for dust from the Olive Downs Project and the Project to affect R1 at the same time due to the mines being located in different directions relative to the receptor. Further to this, mining operations at Olive Downs start in the north-west of their mine leases, closest to R1 (Olive Downs Receptor) and move in a general south-east direction and away from the receptor.

More recently, BM Alliance Coal Operations Pty Ltd (BMA) have made an application to extend its Caval Ridge Mine (the Caval Ridge Mine Horse Pit Extension Project), which is located to the west of the Project. Of relevance to the Project, the Winchester Downs Receptor (R2) was modelled for the Caval Ridge Mine Horse Pit Extension Project. From review of the air quality assessment (Advanced Environmental Dynamics, 2021), some occasional exceedances of the 24-hour average PM_{10} criteria are predicted. There is a low potential for dust from the Caval Ridge Mine Horse Pit Extension Project and the Project to affect R2 at the same time due to the mines being located in different directions relative to the receptor.

7.7 Potential impacts on environmental values

Smaller particles such as $PM_{2.5}$, are seen as more significant with respect to evaluating health effects than larger particles (e.g. PM_{10} and TSP), as a higher proportion of these particles penetrate into the lungs (Environmental Risk Sciences, 2019). There are no $PM_{2.5}$ exceedances predicted at residential receptors for the Project.

With reference to the environmental values of health and wellbeing for which objectives are listed in Table 2, the Project's contribution when considering the background levels, is predicted to exceed the 24-hour and annual average objectives for PM_{10} at the Olive Downs Homestead. Whilst PM_{10} is less of a health concern relative to $PM_{2.5}$, in recognition of this potential impact, Whitehaven WS intends to reach a mutually beneficial agreement with the land-owner of the Olive Downs Homestead.

7.8 Summary

Overall, the air quality assessment of the Project found that predicted concentrations of TSP, $PM_{2.5}$ and dust deposition were below the air quality criteria, when assessed for the Project in isolation.

Predicted cumulative concentrations of PM_{10} were found to be elevated at the closest sensitive receptor. Whitehaven WS would use a proactive dust management system whereby dust levels in the region will be monitored and the mine operation will be altered when levels are elevated.

8. GREENHOUSE GAS ASSESSMENT

8.1 Background

The term GHG (greenhouse gas) comes from the 'greenhouse effect', which refers to the natural process that warms the Earth's surface. GHG in the atmosphere absorb the solar radiation released by the Earth's surface and then radiate some heat back towards the ground, increasing the surface temperature. Human activity, especially burning fossil fuels and deforestation, is increasing the concentration of GHG in the atmosphere and hence increasing the absorption of outgoing heat energy. Even a small increase in long-term average surface temperatures has numerous direct and indirect consequences for climate.

Australia is a signatory to United Nations Framework Convention on Climate Change (UNFCCC), the associated Kyoto Protocol signalling its commitment to reducing GHG emissions at a national level. Under the Paris Agreement, the most recent progression of the UNFCCC, Australia has set a target to reduce emissions by 26 -28% below 2005 levels by 2030. At the UNFCCC Conference of the Parties in 2021, Australia attended with a new additional target of net zero emissions by 2050.

The main GHG associated with the Project is carbon dioxide (CO_2), with smaller contributions from methane (CH_4) and nitrous oxide (N_2O). These gases vary in effect and longevity in the atmosphere, however a parameter referred to as the Global Warming Potential (GWP) allows each gas to be described in terms of CO_2 (the most prevalent GHG). Thus, a given quantity of CH_4 or N_2O can be expressed in terms of carbon dioxide equivalents (CO_2-e). A unit of one tonne of CO_2-e is the basic unit used in carbon accounting. In simple terms, the GHG emissions associated with the Project can be expressed as the sum of the emission rate of each GHG multiplied by its associated GWP (denoted in squares). For example:

$$\text{tonnes } \mathbf{CO_2\text{-}e} = \text{tonnes } \mathbf{CO_2} \times \boxed{1} + \text{tonnes } \mathbf{CH_4} \times \boxed{28} + \text{tonnes } \mathbf{N_2O} \times \boxed{265}$$

While few, if any, individual Projects would make a noticeable change to the Earth's climate, the summation of human activities increasing the concentrations of GHG in the atmosphere does. Climate change is an environmental concern at a global level. Governments and the global scientific community have established conventions for accounting for GHG emissions to enable the transparent and verifiable assessment of GHG emissions among all global jurisdictions. This assessment employs these established conventions so that the relative impact of the Project can be assessed and understood.

8.2 Regulatory Framework for Greenhouse Gas Emissions

8.2.1 National policy

Australia will seek to meet its emissions targets through the Government's Direct Action Plan. The Emissions Reduction Fund (ERF) is a central component of the Direct Action policies, and comprises emission reduction credits, a fund to purchase emission reductions, and a Safeguard Mechanism.

The Safeguard Mechanism has been put in place to ensure that emission reductions purchased by the Government through the ERF are not offset by significant increases in emissions by large emitters elsewhere in the economy. The Safeguard Mechanism commenced on 1 July 2016 and requires Australia's largest emitters to keep net emissions within baseline levels. It applies to around 140 large businesses that have facilities with direct emissions (Scope 1 emissions) of more than 100,000 tonnes of carbon dioxide equivalent (t CO_2-e) a year and is expected to cover approximately half of Australia's emissions.

Direct emissions associated with the Project are anticipated to exceed 100,000 t CO_2-e for all years with the exception of the first year of operation and decommissioning / final rehabilitation. As a result, the Project will be subject to the requirements of the Safeguard Mechanism.

8.2.2 National Greenhouse and Energy Reporting (NGER)

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) established a national framework for corporations to report GHG emissions and energy consumption.

The *National Greenhouse and Energy Reporting Regulations 2008* recognises Scope 1 and Scope 2 emissions as follows:

- Scope 1 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.
- Scope 2 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

A third category of GHG emissions, namely Scope 3 emissions, are defined as indirect GHG emissions other than Scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business. Some examples are production and manufacture of purchased materials, transportation of products, use of sold products and services, and flying on a commercial airline by a person from another business. Due to the potential for double-counting of GHG emissions, Scope 3 emissions are not included in NGER reporting. Despite this, potential Scope 3 emissions have been considered as part of this assessment.

NGER registration and reporting are mandatory for corporations that have energy production, energy use or GHG emissions that exceed specified thresholds. GHG emission thresholds include Scope 1 and Scope 2 emissions. NGER reporting thresholds are summarised in Table 19.

Table 19 NGER annual reporting thresholds – greenhouse gas emissions and energy use

Threshold level	Threshold type	
	GHG (kt CO_2-e)	Energy production and/or consumption (TJ)
Facility	25	100
Corporate	50	200

Note:
kt CO_2-e = kilotonnes of carbon dioxide equivalent. TJ = terajoules.

Whitehaven has existing reporting obligations in relation to the NGER Scheme and will have ongoing reporting obligations under the NGER Scheme for GHG emissions and energy use and production associated with the Project.

8.3 Existing NGER Data

GHG emissions associated with the Project will contribute to State and National GHG inventories. A summary of Queensland's and Australia's most recently published GHG emissions inventories are provided in Table 20 (Commonwealth of Australia, 2022).

Table 20 Annual GHG emissions for Australia and Queensland – 2019

Category	Australia	Queensland	
	Emissions (Mt CO_2-e)	Emissions (Mt CO_2-e)	Contribution to national emissions
Inventory total*	554.4	148.2	27%

Table notes:
* National and State GHG emissions excluding Land Use and Land Use Change.
Mt CO_2-e = million tonnes of carbon dioxide equivalent.

8.4 GHG Assessment Methodology

8.4.1 Overview

Pollutants of importance to climate change, associated with the Project, include CO_2, CH_4 and N_2O. This study will assess the emissions of GHGs from the Project during construction and operation based on activity data representative of the proposed activities and the methods described in the following resources:

- The National Greenhouse Accounts, August 2019 (Commonwealth Department of the Environment and Energy, 2019)
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008*
- The Greenhouse Gas Protocol.

Scope 1, 2 and 3 GHG emissions will be estimated on an annual basis for the Project. This will include potential emissions from:

Scope 1 GHG emissions:

- Diesel combustion:
  - heavy machinery and equipment
  - haulage vehicles.
- Fugitive emissions of methane from mining of coal deposits – also referred to as waste mine gas.
- Explosives use.
- Land (vegetation) clearing.

Scope 2 GHG Emissions:

- Electricity usage:
  - conveyors
  - coal processing plant
  - amenities.

Scope 3 GHG Emissions:

- Transport of coal:
  - rail transport to coal terminal
  - shipping to international customers.
- Use of coal:
  - thermal application.
- Electricity distribution losses.
- Diesel extraction and processing.

Table 21 provides a summary of the energy content and emissions factors for emissions sources associated with the Project.

Table 21 Summary of energy content and emissions factors

Emission source	Energy content	Units	Emission factor			Units
			Scope 1	Scope 2	Scope 3	
Diesel	38.6	GJ/kL	70.4		3.6	kg CO_2-e/GJ [1]
Fugitive methane	37.7 x 10^{-3}	GJ/t	0.006 to 0.031			t CO_2-e/tROM [1,2]
Explosives (Ammonium Nitrate Fuel Oil - ANFO)	2.4	GJ/t	0.17			t CO_2-e/tANFO [3]
Electricity (Carbon Neutral)	3.6	MJ/kWh	0.0	0.0	0.0	kg CO_2-e/kWh [4]
Coking coal	30	GJ/t			92.03	kg CO_2-e/GJ [1]
Thermal coal	22 – 24	GJ/t			90.24	kg CO_2-e/GJ [1]
Land clearing			141			t CO_2-e/ha [5]
Shipping – bulk carrier					0.00354	kg CO_2-e/ tonne.km [6]

Table notes:
[1]*National Greenhouse and Energy Reporting (Measurement) Determination 2008*, as amended in July 2021, and *National Greenhouse Accounts Factors* (Department of Industry, Science, Energy and Resources [DISER], 2021),
[2]Fugitive methane emissions have been estimated based on a geological sampling program (Whitehaven WS, 2022) .
[3]*National Greenhouse Accounts (NGA) Factors* (Department of Climate Change, 2008).
[4]Whitehaven WS have committed to the purchase of carbon neutral electricity.
[5]Full Carbon Accounting Model (FullCAM) (DISER, 2020), based on 100% conversion factor of carbon to CO_2.
[6]*UK Government GHG Conversion Factors for Company Reporting* (Department for Environment, Food and Rural Affairs, 2022).
GJ/kL = gigajoules per kilolitre, kg CO_2-e/GJ = kilograms of carbon dioxide equivalent per gigajoule, GJ/t = gigajoules per tonne, t CO_2-e/tROM = tonnes of carbon dioxide equivalent per tonne of ROM coal, t CO_2-e/tANFO = tonnes of carbon dioxide equivalent per tonne of ANFO, MJ/kWh = megajoules per kilowatt hour, kg CO_2-e/kWh = kilograms of carbon dioxide equivalent per kilowatt hour, t CO_2-e/ha = tonnes of carbon dioxide equivalent per hectare and kg CO_2-e/t.km = kilograms of carbon dioxide equivalent per tonne per kilometre.

GHG emissions associated with land clearing are not covered by the NGER scheme. Furthermore, as mining operations progress, spent pits and waste emplacement landforms will be progressively rehabilitated with the aim of offsetting any previous GHG emissions from land clearing. Notwithstanding, GHG emissions have conservatively been estimated.

8.4.2 Coal distribution and use

It is intended that coal produced by the Project will be transported by rail to the DBCT (or Abbot Point Coal Terminal or Gladstone coal ports) and subsequently to customers located in Japan, South Korea, India and Vietnam. The Port of Pohang in South Korea has been used as a base, to provide a conservative estimate of the shipping distance associated with product coal.

A summary of key parameters used in the quantification of potential Scope 3 emissions associated with coal transportation is provided in Table 22.

Table 22 Coal transportation – Scope 3 GHG Parameters

Parameter	Estimated quantity	Units
Rail transport distance	200	km
Diesel rate for rail transport	100	tonne.km/L
Shipping distance	8,500	km

The Project would produce a mix of products, including metallurgical coal for the steel industry and thermal coal.

8.5 Emissions

8.5.1 Scopes 1 and 2

GHG emissions associated with the Project have been considered and estimated on an annual basis for the life of the Project. In relation to Scope 2 emissions, Whitehaven WS has committed to purchasing carbon neutral electricity for the Project, eliminating these emissions for the Project. A summary of estimated Scope 1 emissions associated with mining operations, expressed as t CO_2-e per annum is presented. Conservative estimates of annual GHG emissions are summarised in Table 23. The Project would be carried out in three phases:

- Construction: Years 1 to 3
- Operations: Years 2 to 29
- Decommissioning (including final rehabilitation): Years 30 to 31.

Average annual GHG emissions associated with the Project have been estimated to be:

- 498,605 t CO_2-e excluding GHG emissions associated with land clearing
- 531,275t CO_2-e including GHG emissions associated with land clearing

Maximum annual GHG emissions associated with the Project occur in Year 6. Emissions in Year 6 have been estimated to be:

- 642,427 t CO_2-e excluding GHG emissions associated with land clearing
- 675,097 t CO_2-e including GHG emissions associated with land clearing

GHG emissions from the Project would contribute to Australia's and Queensland's annual GHG emissions inventories. A summary of the impact of the maximum estimated annual (Scope 1) GHG emissions from the Project at a State and National scale is provided in Table 24.

Table 23 Summary of estimated annual Scope 1 GHG emissions (t CO_2-e) and energy use (GJ) for the Project

Project Year	Energy	Scope 1				TOTAL	
		Diesel (mining)	Fugitive gas	Blasting	Land Clearing	Including land clearing	Excluding land clearing
	GJ	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
1	-	-	-	-			
2	272,466	17,414	20,771	605	32,670	71,460	38,791
3	1,285,340	82,453	97,255	2,532	32,670	214,910	182,240
4	3,477,292	225,212	275,204	4,557	32,670	537,644	504,974
5	4,040,861	261,212	312,605	5,830	32,670	612,316	579,647
6	**4,490,527**	**290,816**	**345,705**	**5,906**	32,670	675,097	**642,427**
7	4,122,608	266,436	315,029	6,012	32,670	620,147	587,477
8	4,559,803	296,040	339,836	5,210	32,670	673,756	641,087
9	4,168,178	269,919	314,752	5,505	32,670	622,845	590,175
10	4,064,178	262,937	303,282	5,631	32,670	604,521	571,851
11	4,407,000	285,592	330,167	5,599	32,670	654,027	621,358
12	4,307,490	278,626	324,265	6,024	32,670	641,586	608,916
13	4,255,142	275,143	316,931	6,054	32,670	630,798	598,129
14	4,255,775	275,143	307,730	6,099	32,670	621,642	588,972
15	4,570,857	296,040	332,842	5,989	32,670	667,541	634,871
16	4,570,948	296,040	322,644	5,995	32,670	657,349	624,679
17	4,254,933	275,143	303,672	6,039	32,670	617,524	584,854
18	4,097,140	264,695	290,195	6,077	32,670	593,636	560,967
19	4,123,641	266,436	292,940	6,085	32,670	598,130	565,461
20	4,123,593	266,436	297,308	6,081	32,670	602,495	569,825
21	4,570,764	296,040	332,325	5,982	32,670	667,017	634,347
22	4,472,944	290,816	323,695	4,668	32,670	651,849	619,180

Project Year	Energy	Scope 1				TOTAL	
		Diesel (mining)	Fugitive gas	Blasting	Land Clearing	Including land clearing	Excluding land clearing
	GJ	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
23	4,238,206	275,729	312,217	4,237	32,670	624,852	592,183
24	3,727,992	242,031	277,549	4,266	32,670	556,515	523,845
25	4,543,225	296,040	334,224	4,043	32,670	666,977	634,308
26	3,956,934	257,271	304,601	4,125	32,670	598,667	565,998
27	2,706,470	174,690	204,949	4,186	32,670	416,495	383,825
28	2,344,745	150,836	179,268	4,166	32,670	366,940	334,271
29	2,504,959	161,459	190,510	4,114	32,670	388,752	356,082
30	238,459	15,737	-	-	32,670	48,407	15,737
31	179,111	1,689	-	-	32,670	34,358	1,689
TOTAL	106,931,582	6,914,078	7,902,469	141,617	980,091	15,938,255	14,958,164
Average	3,564,386	230,469	263,416	4,721	32,670	531,275	498,605

Table 24 **Comparison of estimated annual GHG emissions (t CO_2-e) for the Project to State and National emissions**

Category	Project[1]	Australia[2]		Queensland[2]	
	Emissions (Mt CO_2-e)	Emissions (Mt CO_2-e)	Project %	Emissions (Mt CO_2-e)	Project %
Inventory total	0.64	554.4	0.12	148.2	0.43

Table note:
[1]Estimated maximum annual GHG emissions excluding GHG emissions associated with land clearing
[2]GHG emissions excluding Land Use and Land Use Change 2019 (Commonwealth of Australia, 2022)

8.5.2 Scope 3

Estimated annual Scope 3 emissions for the Project are summarised in Table 25. A summary of the maximum estimated annual (Scope 3) GHG emissions from the Project at a global scale (compared to 2019 levels) is also provided in Table 25.

Table 25 **Summary of estimated annual Scope 3 GHG emissions in t CO_2-e**

Year	Diesel	Rail transport of coal	Shipping of coal	End use of product coal (thermal)	End use of product coal (coking)	Total	% of 2019 Global Emissions[1]
	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	%
2	890	3,006	15,831	462,318	809,277	1,291,322	0.00
3	4,216	16,904	89,033	1,713,219	5,756,066	7,579,438	0.01
4	11,517	43,415	228,672	7,046,360	11,091,996	18,421,959	0.04
5	13,357	53,323	280,857	7,440,367	15,312,266	23,100,169	0.04
6	14,871	58,220	306,649	8,688,816	15,902,422	24,970,978	0.05
7	13,625	52,314	275,544	7,881,375	14,186,351	22,409,209	0.04
8	15,138	59,093	311,249	7,861,605	17,381,128	25,628,214	0.05
9	13,803	54,004	284,444	6,293,885	17,102,343	23,748,478	0.05
10	13,446	54,637	287,777	5,747,254	18,301,229	24,404,343	0.05
11	14,604	57,648	303,637	6,415,266	18,720,509	25,511,665	0.05
12	14,248	54,115	285,032	6,993,033	16,281,617	23,628,046	0.05
13	14,070	53,345	280,976	7,020,396	15,861,770	23,230,557	0.05
14	14,070	53,580	282,213	6,709,615	16,376,576	23,436,054	0.05
15	15,138	56,118	295,581	8,279,518	15,522,360	24,168,716	0.05
16	15,138	55,115	290,295	7,902,134	15,542,614	23,805,297	0.05
17	14,070	51,483	271,166	7,713,143	14,098,612	22,148,474	0.04
18	13,536	50,854	267,854	7,268,125	14,492,166	22,092,535	0.04
19	13,625	50,520	266,094	7,269,258	14,296,631	21,896,127	0.04
20	13,625	51,996	273,872	6,505,145	15,887,008	22,731,646	0.04
21	15,138	56,056	295,254	7,204,658	16,781,899	24,353,006	0.05
22	14,871	53,487	281,721	7,435,018	15,253,881	23,038,978	0.04
23	14,100	49,975	263,223	7,966,124	12,963,732	21,257,154	0.04

Year	Diesel	Rail transport of coal	Shipping of coal	End use of product coal (thermal)	End use of product coal (coking)	Total	% of 2019 Global Emissions[1]
	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	%
24	12,377	41,501	218,589	7,464,330	9,347,741	17,084,537	0.03
25	15,138	53,890	283,846	8,714,502	13,639,351	22,706,729	0.04
26	13,156	43,314	228,137	9,089,431	7,816,873	17,190,912	0.03
27	8,933	31,214	164,407	5,953,625	6,555,045	12,713,224	0.02
28	7,713	27,823	146,545	5,251,727	5,995,293	11,429,101	0.02
29	8,256	31,242	164,557	5,756,263	7,085,468	13,045,788	0.03
30	805	-	-	-	-	805	0.00
31	86	-	-	-	-	86	0.00
TOTAL**	353,561	1,318,189	6,943,059	190,046,510	368,362,227	567,023,546	-
Average	11,785	43,940	231,435	6,334,884	12,278,741	18,900,785	0.04

Table note:
[1] UNEP (2021), estimated 2019 Global Emissions = 51.5 GtCO2-e (excl land-use change)
*Production and distribution related emissions
**Totals may not add exactly due to rounding.
Scope 3 emissions associated with the transmission and distribution of electricity are abated through the purchase of carbon neutral electricity.

8.6 Regulatory Obligations – NGER and the Safeguard Mechanism

As detailed in Table 23, the estimated annual Scope 1 GHG emissions of the Project, excluding land clearing, range from 1.7– 642 kilotonnes of carbon dioxide equivalent per year (kt CO_2-e/y).

Based on the NGER Reporting thresholds detailed in Table 19, Whitehaven WS would have ongoing reporting obligations associated with the Project including annual assessment of GHG emissions as set out by the NGER Act and the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*.

In all years of operation, with the exception of Year 2, estimated Scope 1 emissions exceed the reporting threshold of 100 kt CO_2-e/y. Under the current Safeguard Mechanism, facilities with Scope 1 emissions of more than 100 kt CO_2-e/y are required to keep their emissions within baseline levels. This Safeguard Mechanism would apply to the Project. The Project would report against the baseline on an annual basis and if it exceeds its baseline level, it generally would be required to surrender Australian Carbon Credit Units, equivalent to the exceedance, to the Clean Energy Regulator.

8.7 GHG Mitigation and Management

Whitehaven WS has committed to the purchase of certified carbon neutral electricity for the Project. This mitigation measure would eliminate Scope 2 emissions associated with the Project, as well as Scope 3 emissions associated with the transmission and distribution of electricity.

In addition to this, Whitehaven WS intends to implement the following initiatives where appropriate to help mitigate, reduce, control or manage GHG emissions from the Project:

- regular maintenance of plant and equipment to minimise fuel consumption and associated emissions, including training staff on continuous improvement strategies regarding efficient use of plant and equipment
- regular assessment, review and evaluation of GHG reduction opportunities
- procurement policies that require the selection of energy efficient equipment and vehicles

- monitoring and maintenance of equipment in accordance with manufacturer recommendations
- optimisation of diesel consumption through logistics analysis and planning (e.g. review of the mine plan to optimise haul lengths, dump locations, and road gradients).

9. CONCLUSIONS

This air quality and greenhouse gas assessment was conducted for inclusion in the Additional Information and to meet the Project's ToR. The assessment has been prepared in accordance with regulatory guidelines.

An air quality assessment has investigated the potential for the Project to affect air quality in the region. Four scenarios (Years 5, 9, 19, and 27) have been considered that represent various stages of the Project life and potential worst-case impacts. The assessment has used meteorological and dispersion models to assess the potential effect of emissions of particulate matter on concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rate on the surrounding region due to the Project.

Estimated air quality concentrations due to operations of the Project in isolation, and with the inclusion of background levels of dust, were predicted at identified sensitive receptors and on a grid of evenly spaced receptors covering the region. Predicted ground-level concentrations and deposition rates were compared with the relevant air quality objectives and guidelines.

Overall, the outcomes of this air quality assessment (including consideration of the refined the mine plan) are very similar to those in the Draft EIS.

The air quality assessment of the Project found the following:

TSP

- Predicted concentrations of TSP ***comply*** with the relevant air quality objective at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.

PM_{10}

- Predicted 24-hour average and annual concentrations of PM_{10} due to the Project in isolation ***comply*** with the relevant air quality objectives at all sensitive receptors, in all modelled Project scenarios, with the application of the proactive dust management system.
- Predicted cumulative concentrations of PM_{10} were found to be elevated at the closest sensitive receptor and comply with the relevant air quality objectives at all other sensitive receptors, with the application of the proposed proactive dust management system.
- To further address the risk of elevated cumulative concentrations of PM_{10}, Project dust emissions will be managed using a proactive dust management system whereby background dust levels in the region will be monitored and mine operations will be altered when background levels are elevated, such as during bushfires, dust storms and regional dust events.
- South32's Eagle Downs mine assets assets are workplaces and, therefore, any potential exposure should be considered as a workplace exposure matter.

$PM_{2.5}$

- Predicted 24-hour average and annual concentrations of $PM_{2.5}$ due to the Project ***comply*** with the relevant air quality objective at all sensitive receptors, in all modelled Project scenarios, in isolation and cumulatively.

Dust Deposition

- Predicted dust deposition rates due to the Project ***comply*** with the guideline at all sensitive receptors, for all modelled Project scenarios, in isolation and cumulatively.

Greenhouse Gases

The GHG assessment of the Project found the following:

Average annual GHG emissions associated with the Project have been estimated to be:

- 498,605 t CO_2-e excluding GHG emissions associated with land clearing
- 531,275 t CO_2-e including GHG emissions associated with land clearing.

Maximum annual GHG emissions associated with the Project occur in Year 6. Emissions in Year 6 have been estimated to be

- 642,427 t CO_2-e excluding GHG emissions associated with land clearing
- 675,097 t CO_2-e including GHG emissions associated with land clearing.

Compared to National and State GHG inventory levels, the estimated maximum annual GHG emissions from the Project would account for approximately 0.12% and 0.43%, respectively.

10. REFERENCES

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APPENDIX A AIR QUALITY CONTOUR PLATES

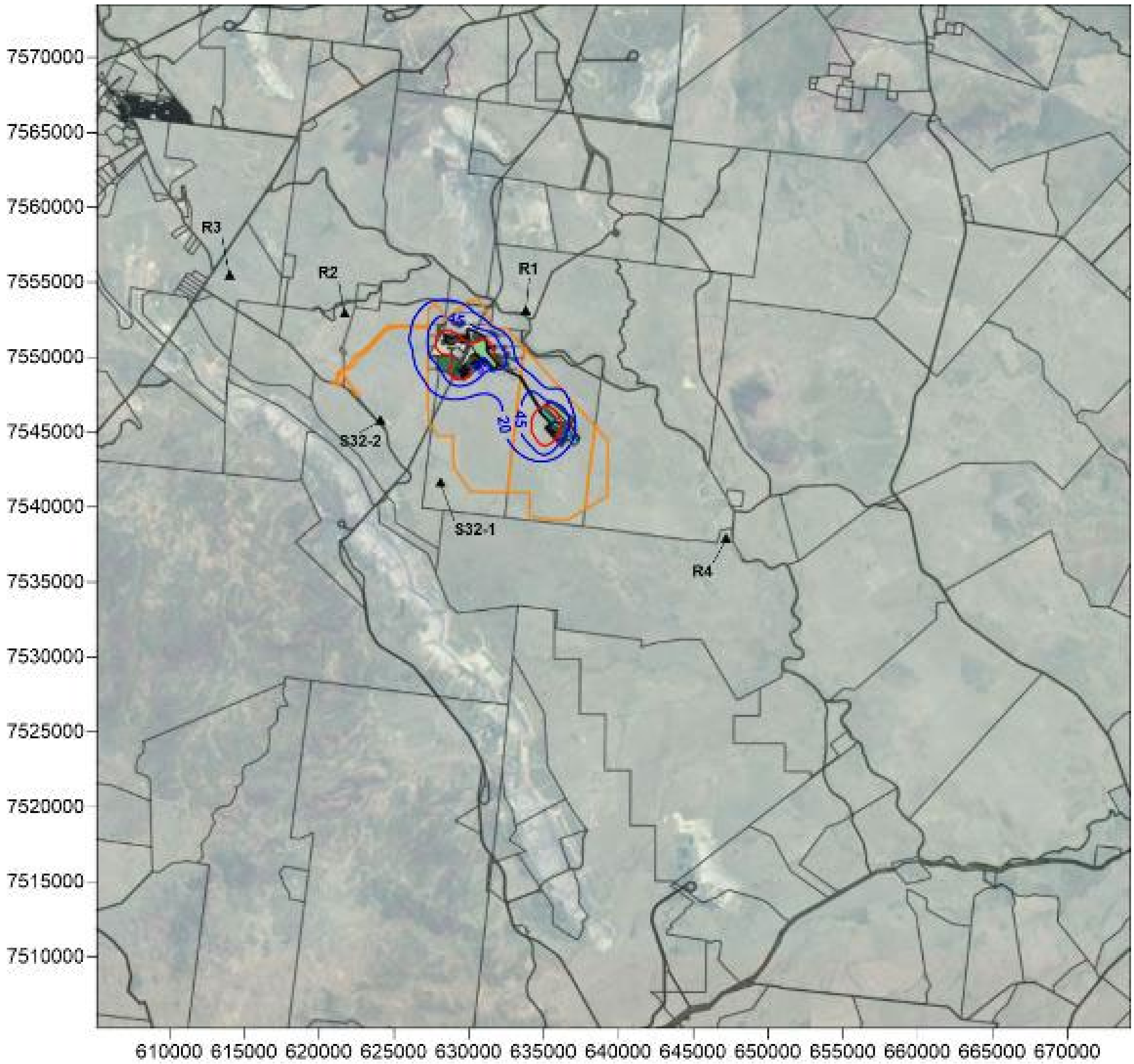

Plate 1	**Year 5 predicted annual average ground level concentration of TSP**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 90 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

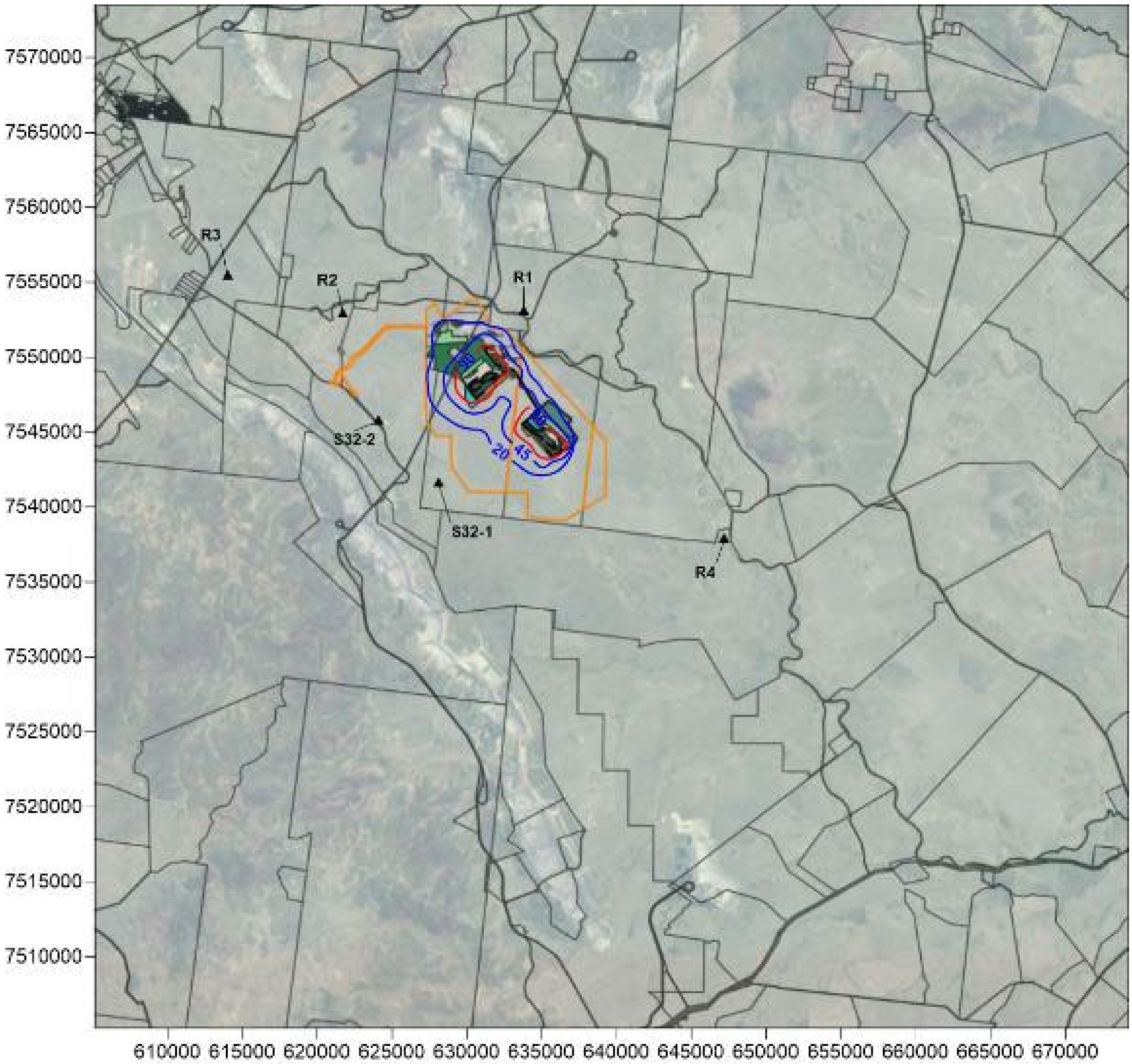

Plate 2	**Year 9 predicted annual average ground level concentration of TSP**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 90 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

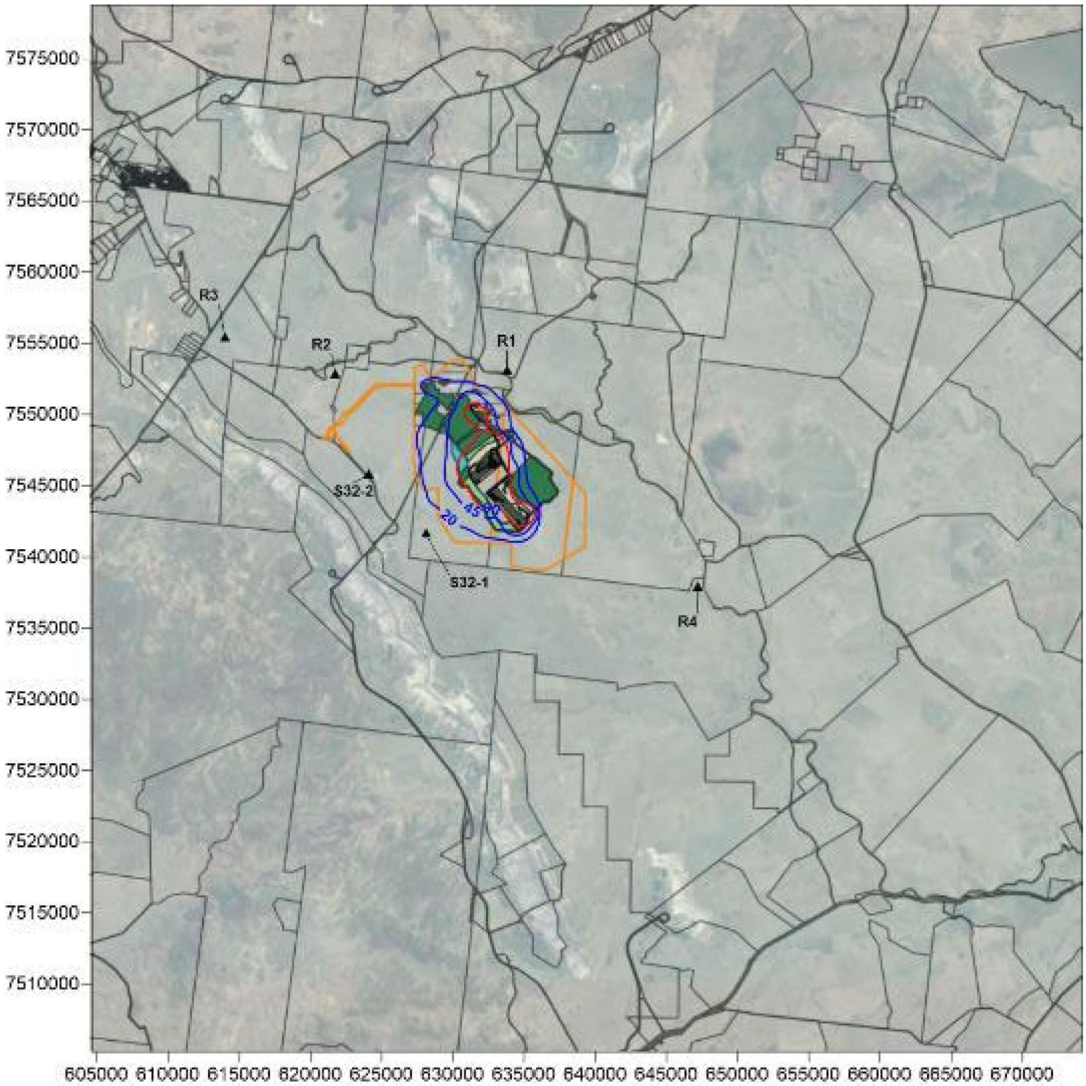

Plate 3 **Year 19 predicted annual average ground level concentration of TSP**

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 90 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

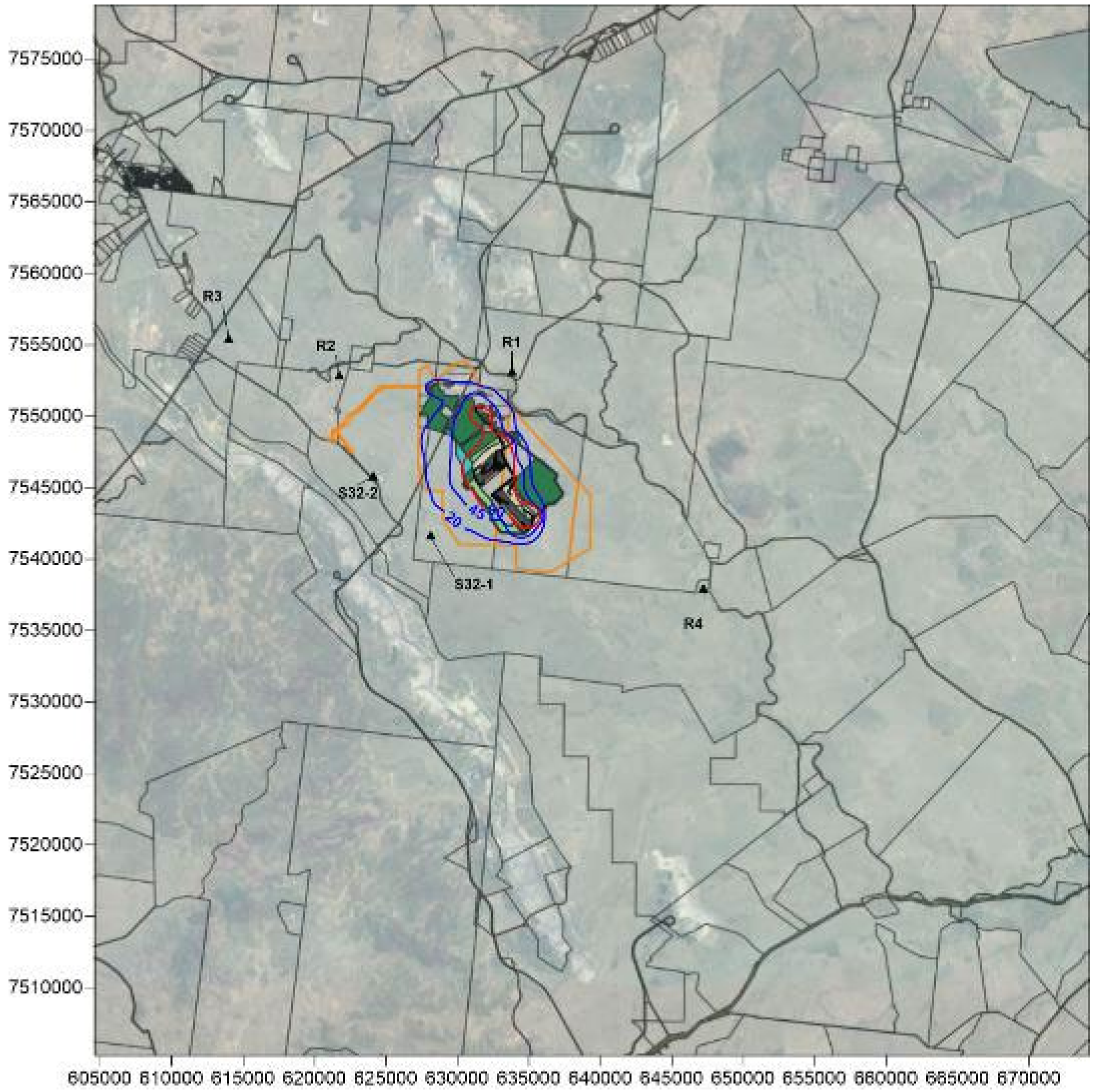

Plate 4	**Year 27 predicted annual average ground level concentration of TSP**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 90 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

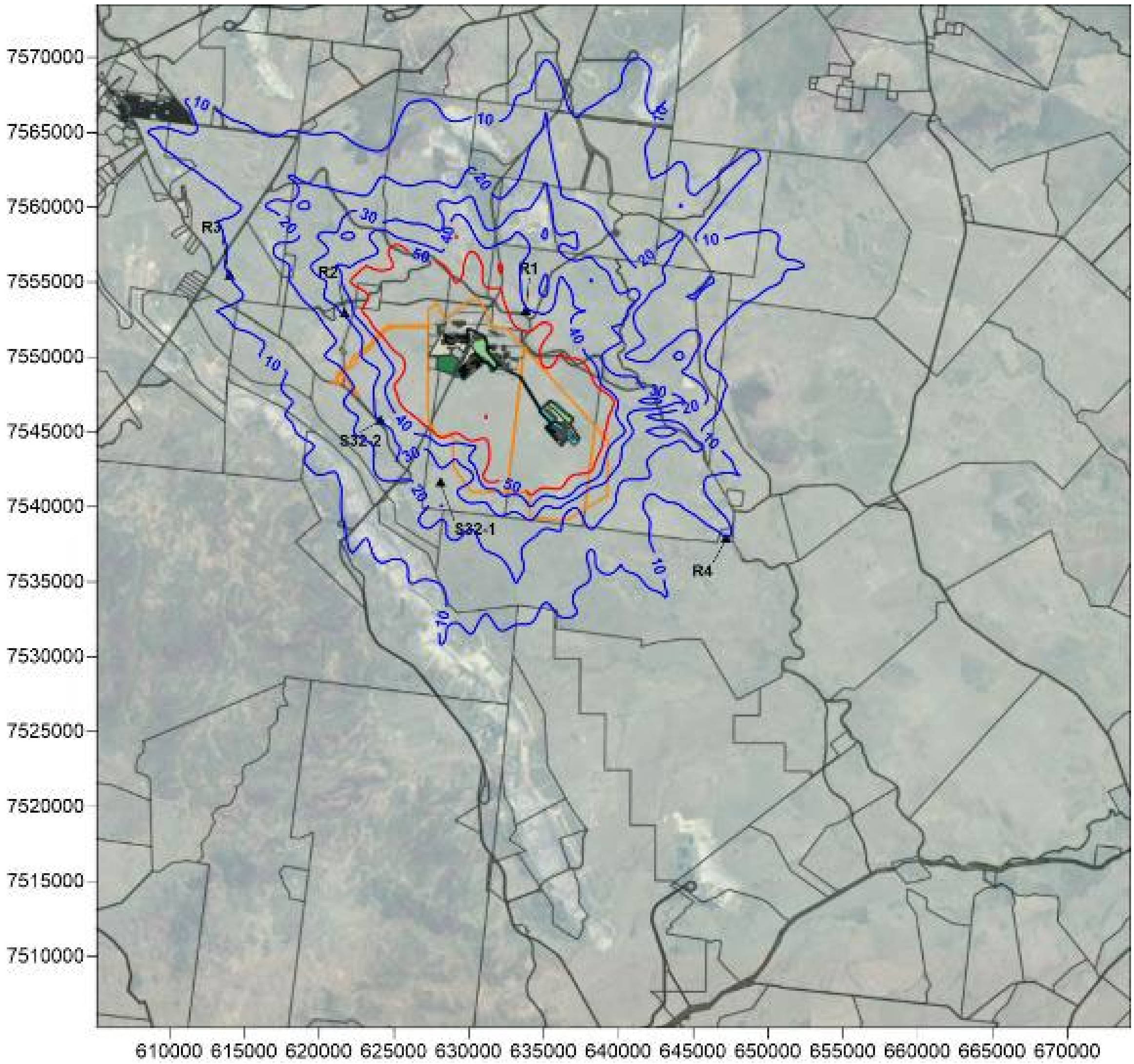

Plate 5	**Year 5 predicted maximum 24-hour ground level concentration of PM_{10}**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: 24-hour maximum	**Objective:** 50 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

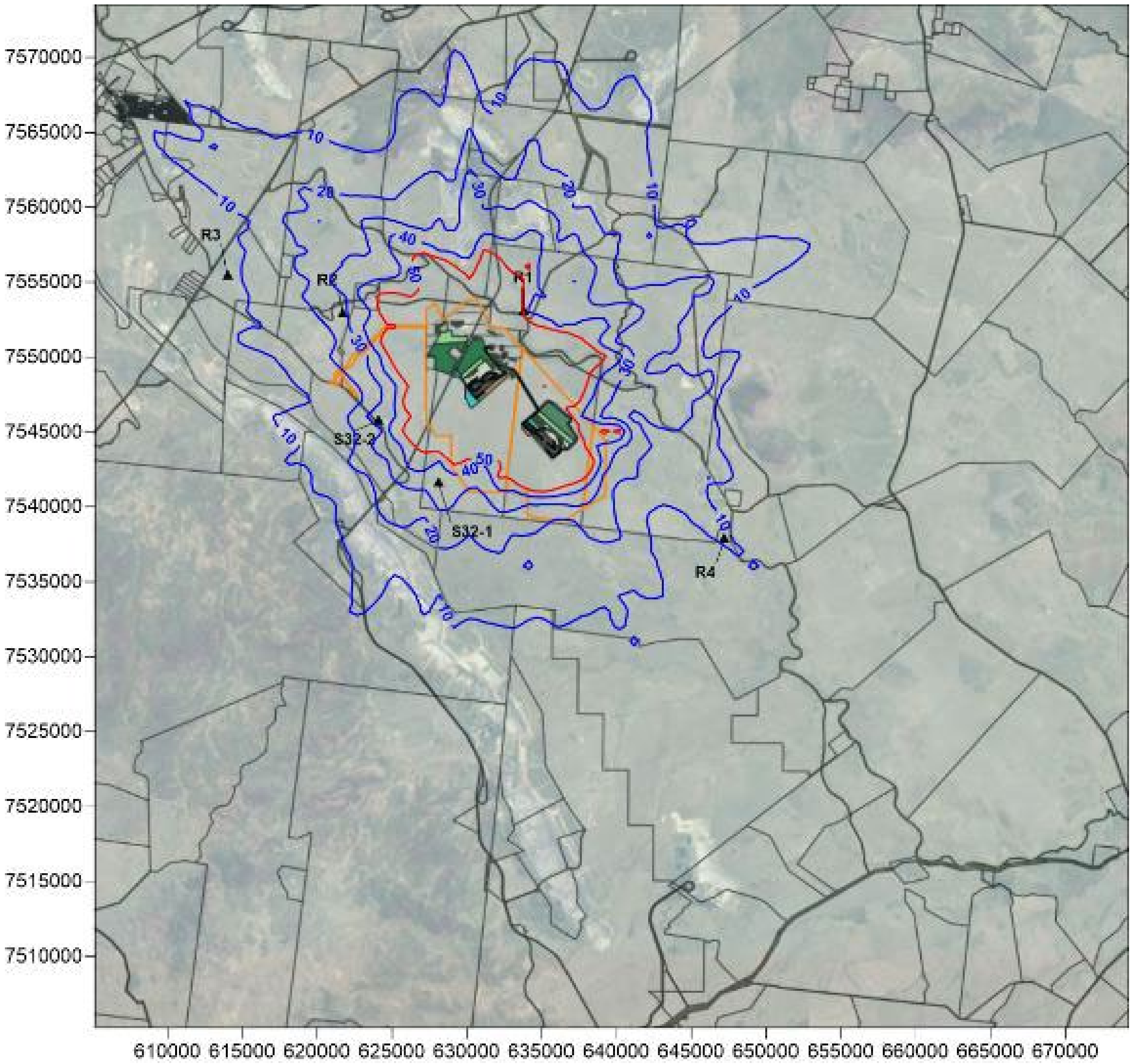

Plate 6	**Year 9 predicted maximum 24-hour ground level concentration of PM_{10}**

Location:	**Averaging period:**	**Data source:**	**Units:**
Winchester South Project, Moranbah, QLD	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
24-hour maximum	50 µg/m³ (red contour)	Daniel Gallagher	April 2022

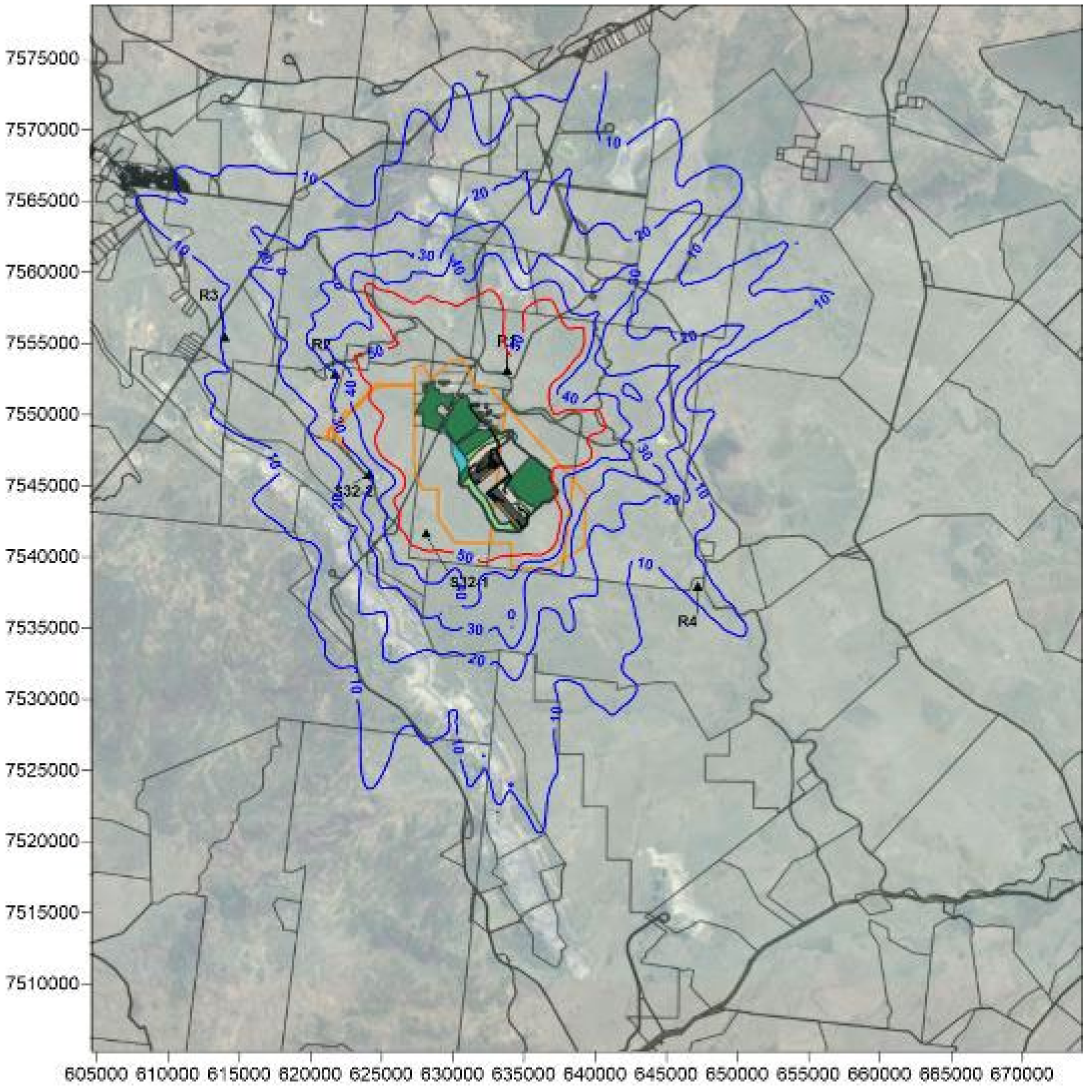

Plate 7	**Year 19 predicted maximum 24-hour ground level concentration of PM_{10}**

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: 24-hour maximum	**Objective:** 50 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

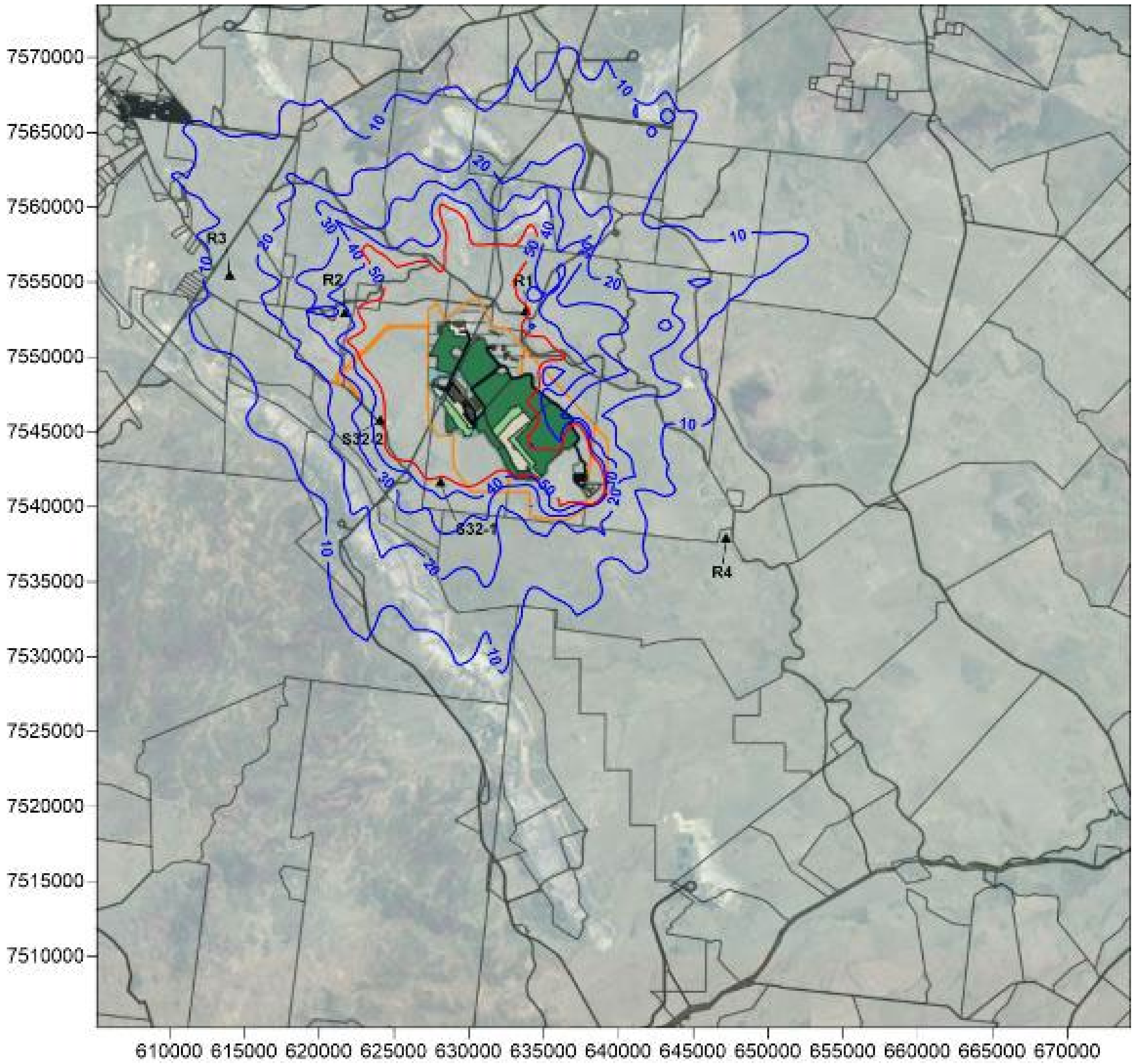

Plate 8	**Year 27 predicted maximum 24-hour ground level concentration of PM_{10}**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m^3
Type: 24-hour maximum	**Objective:** 50 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

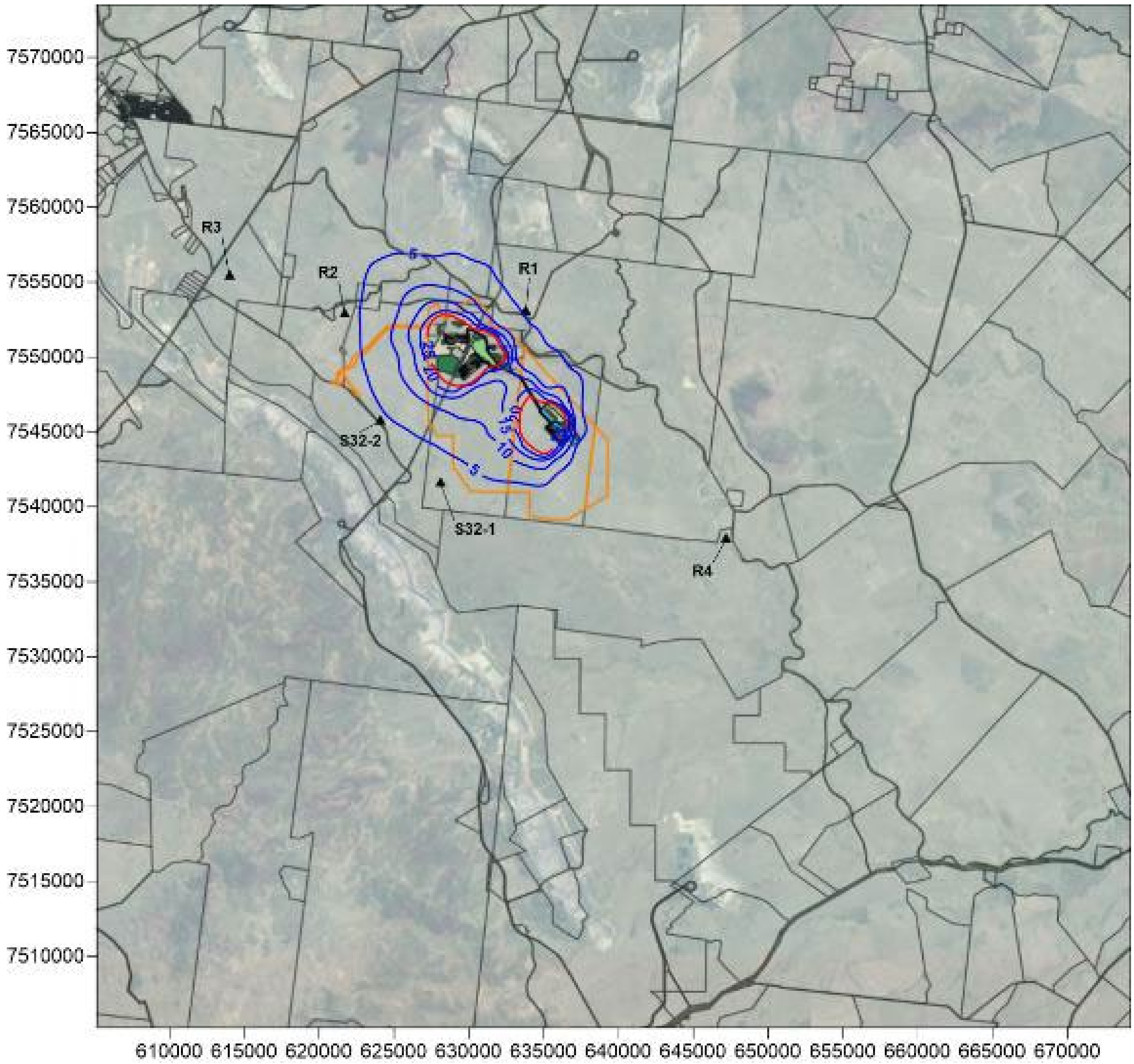

Plate 9 Year 5 predicted annual average ground level concentration of PM_{10}

Location:	Averaging period:	Data source:	Units:
Winchester South Project, Moranbah, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average	25 µg/m³ (red contour)	Daniel Gallagher	April 2022

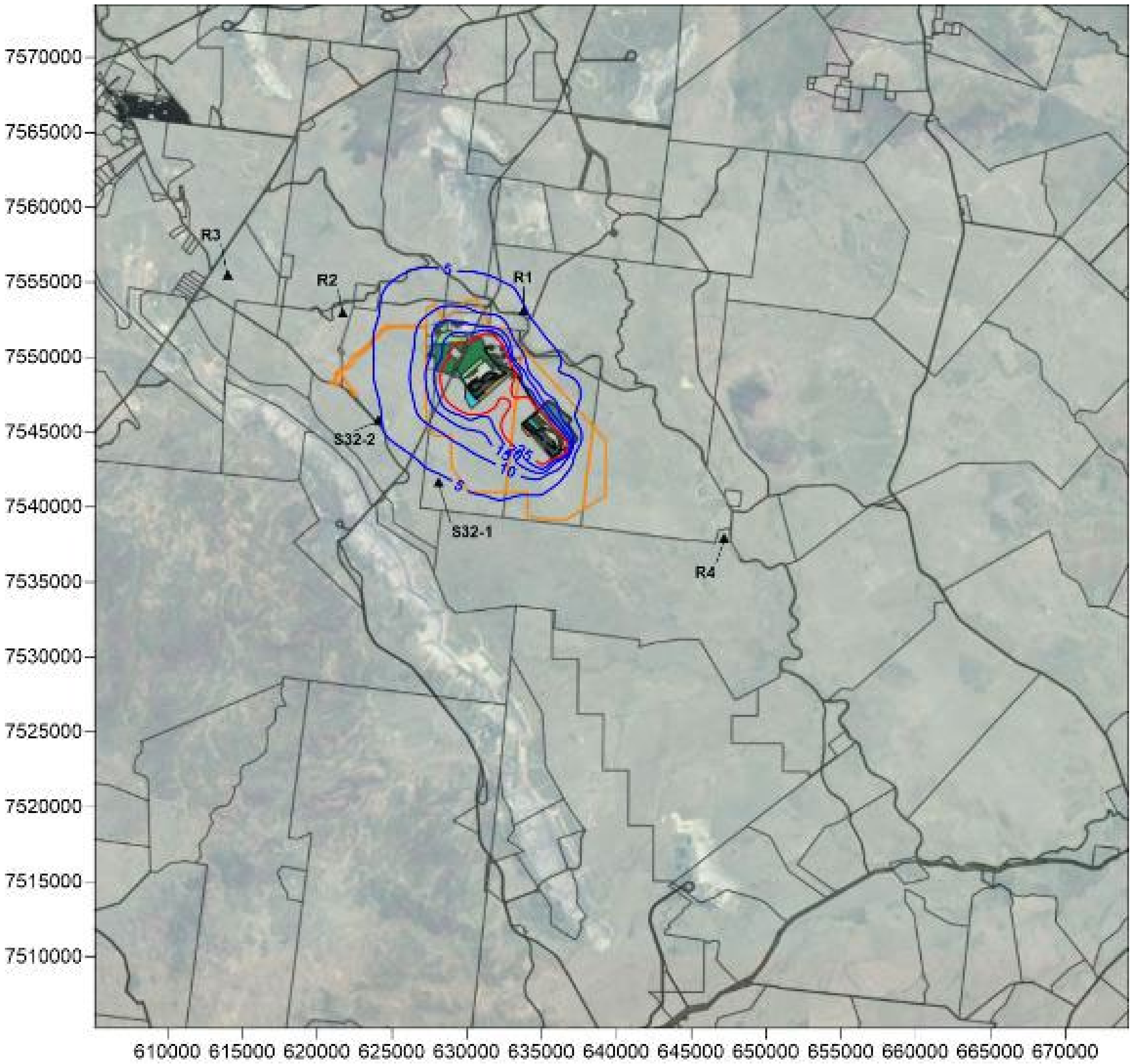

Plate 10	**Year 9 predicted annual average ground level concentration of PM_{10}**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 25 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

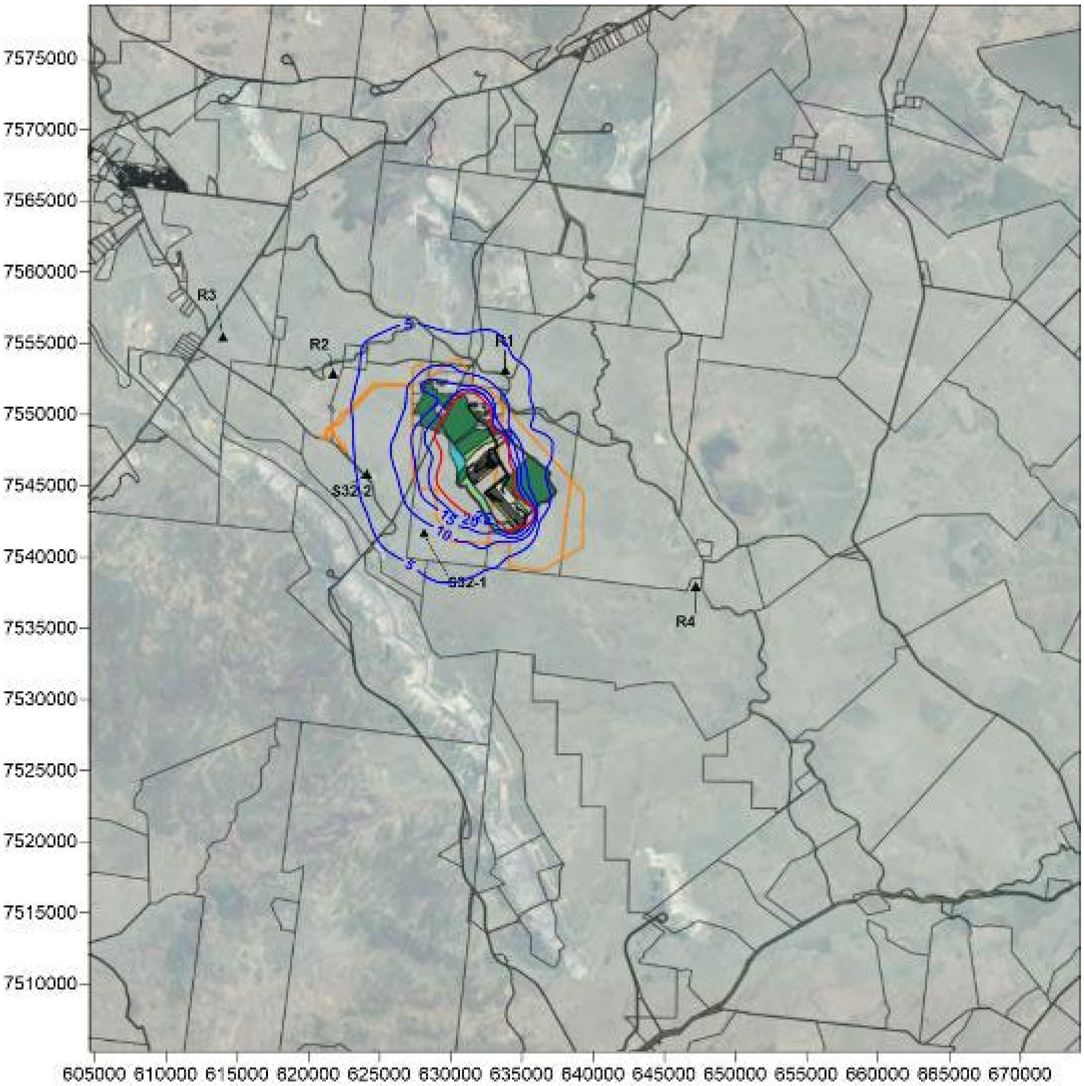

Plate 11	**Year 19 predicted annual average ground level concentration of PM_{10}**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 25 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

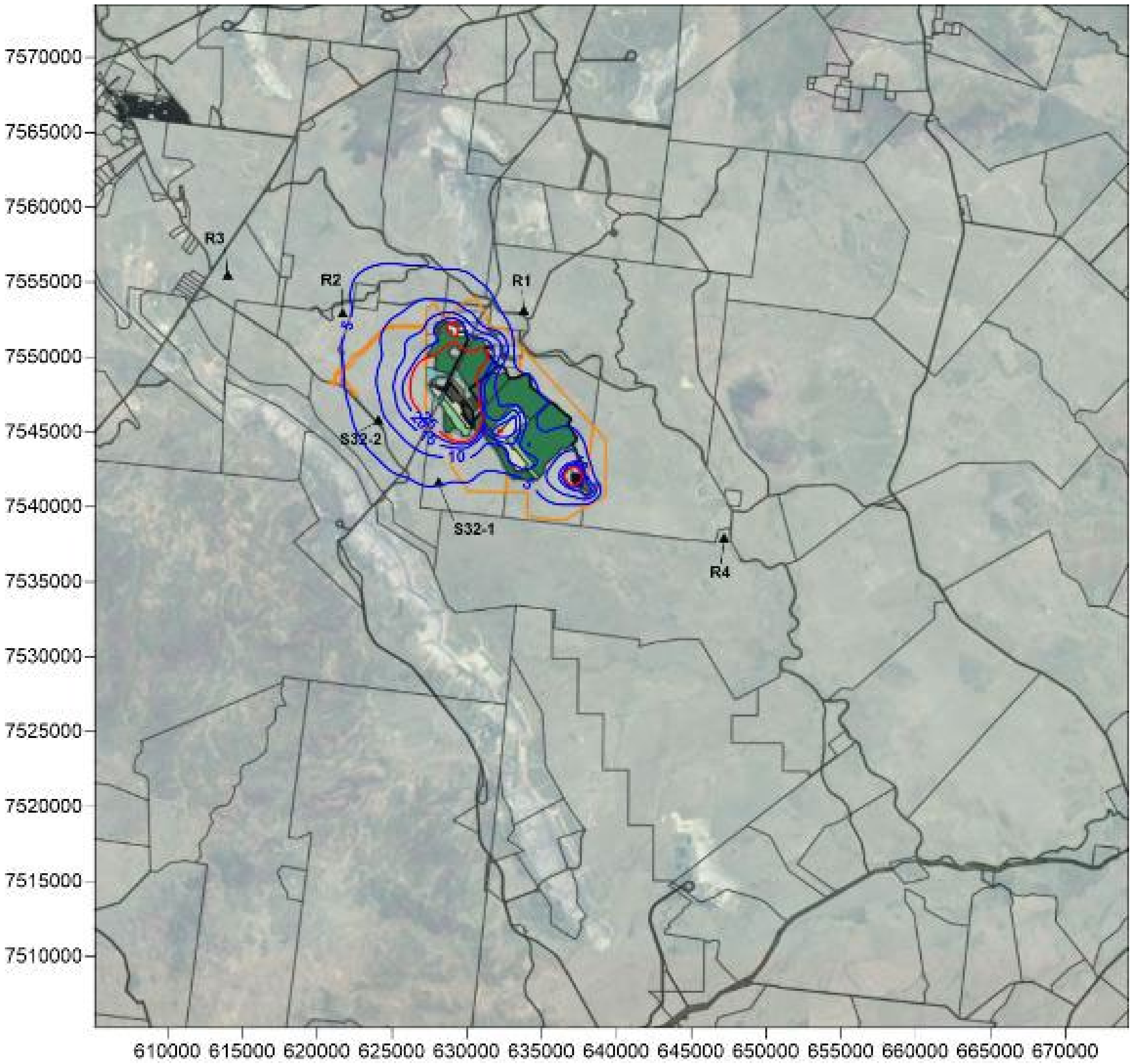

Plate 12	**Year 27 predicted annual average ground level concentration of PM_{10}**

Location:	**Averaging period:**	**Data source:**	**Units:**
Winchester South Project, Moranbah, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average	25 µg/m³ (red contour)	Daniel Gallagher	April 2022

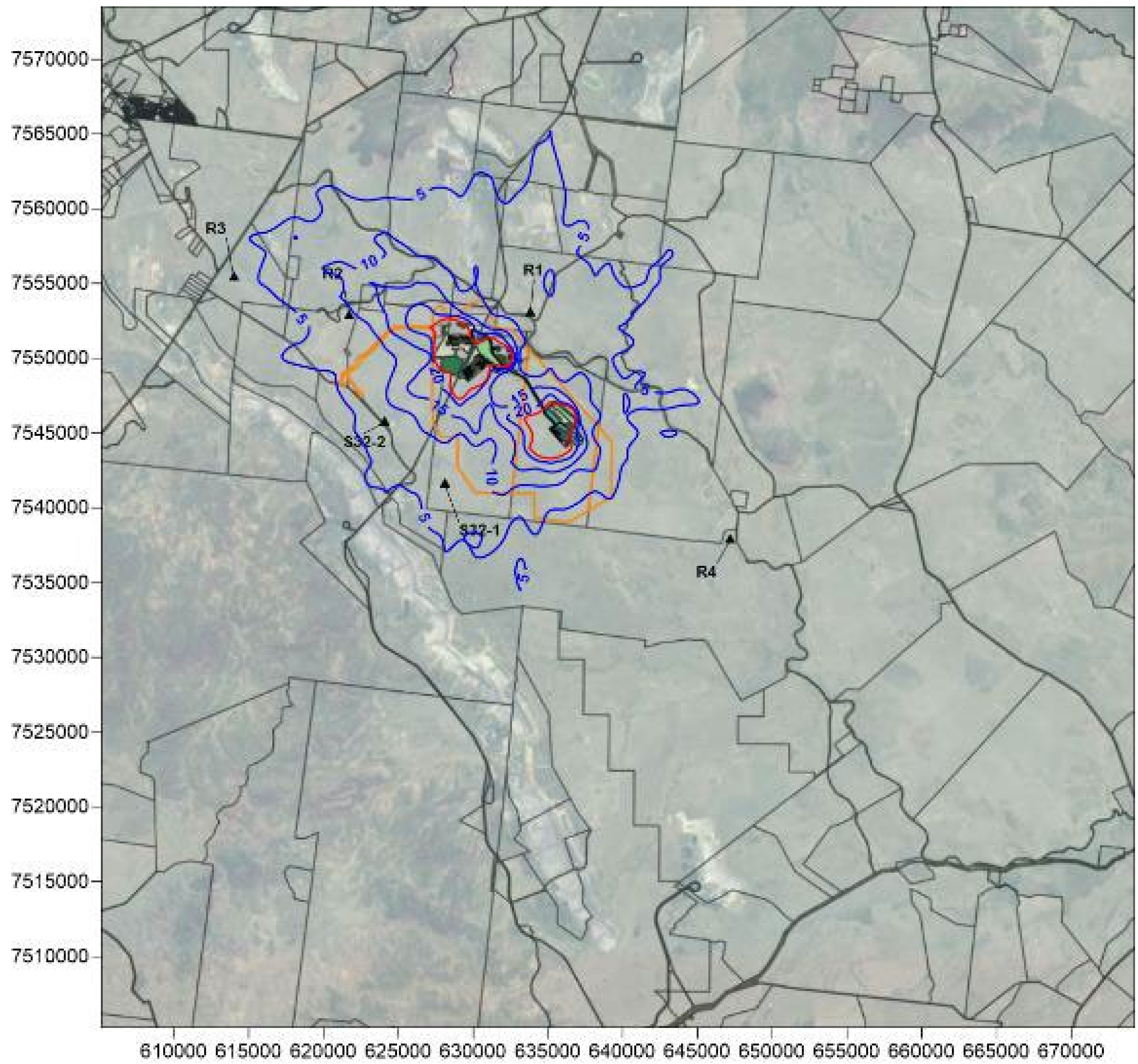

Plate 13 **Year 5 predicted maximum 24-hour ground level concentration of $PM_{2.5}$**

Location:	Averaging period:	Data source:	Units:
Winchester South Project, Moranbah, QLD	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
24-hour maximum	25 µg/m³ (red contour)	Daniel Gallagher	April 2022

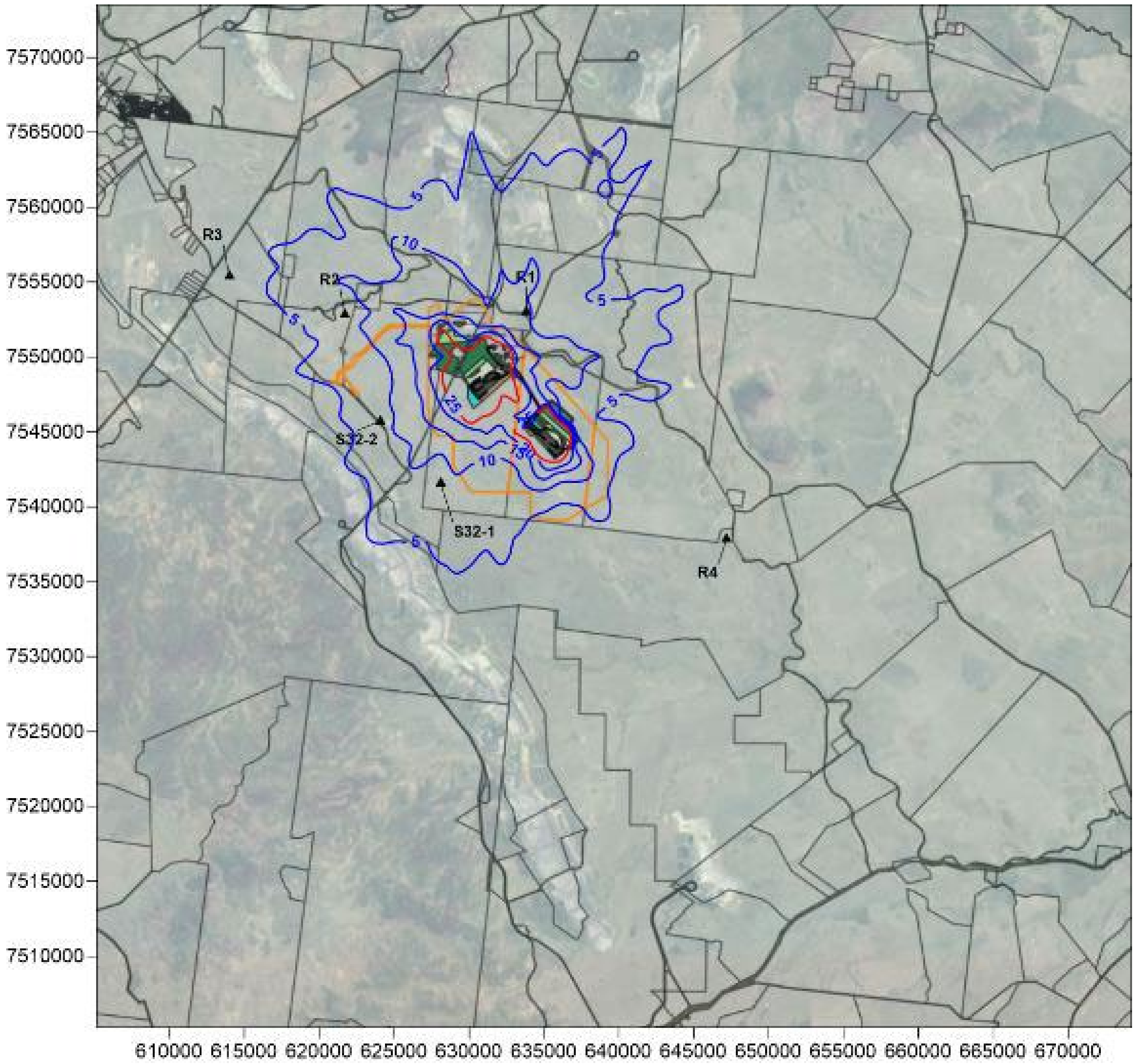

Plate 14	**Year 9 predicted maximum 24-hour ground level concentration of $PM_{2.5}$**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: 24-hour maximum	**Objective:** 25 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

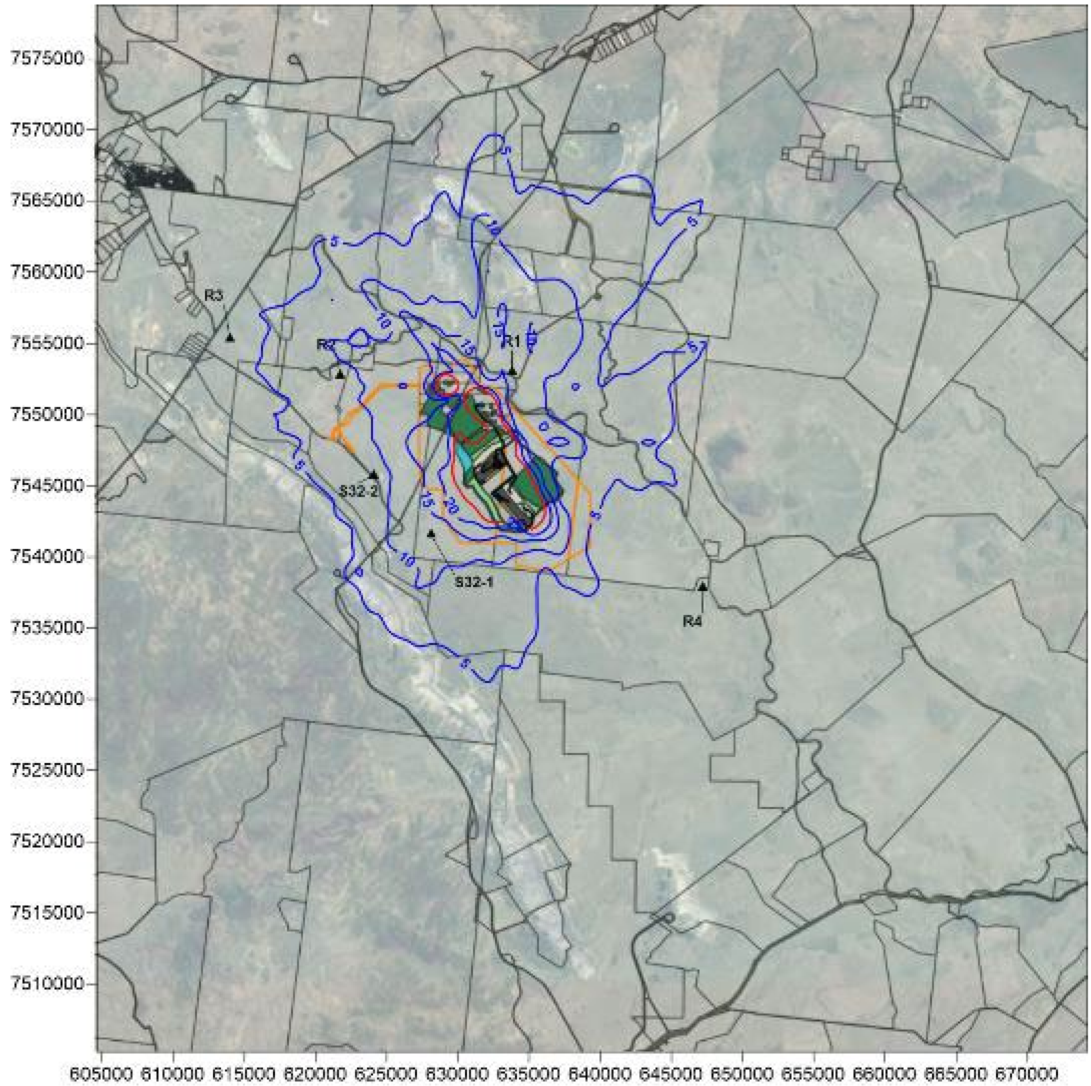

Plate 15 Year 19 predicted maximum 24-hour ground level concentration of $PM_{2.5}$

Location:	**Averaging period:**	**Data source:**	**Units:**
Winchester South Project, Moranbah, QLD	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
24-hour maximum	25 µg/m³ (red contour)	Daniel Gallagher	April 2022

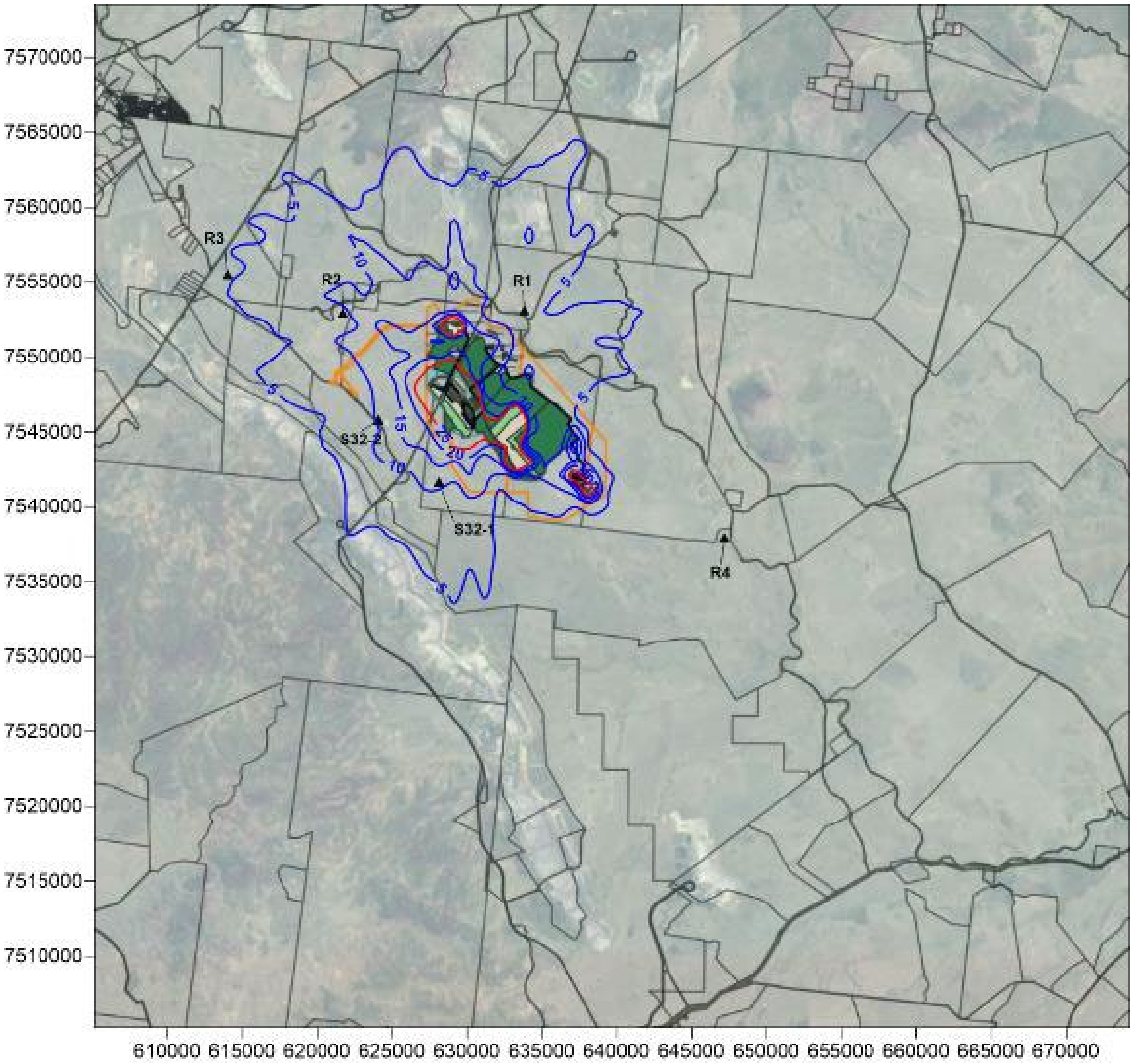

Plate 16	**Year 27 predicted maximum 24-hour ground level concentration of $PM_{2.5}$**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: 24-hour maximum	**Objective:** 25 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

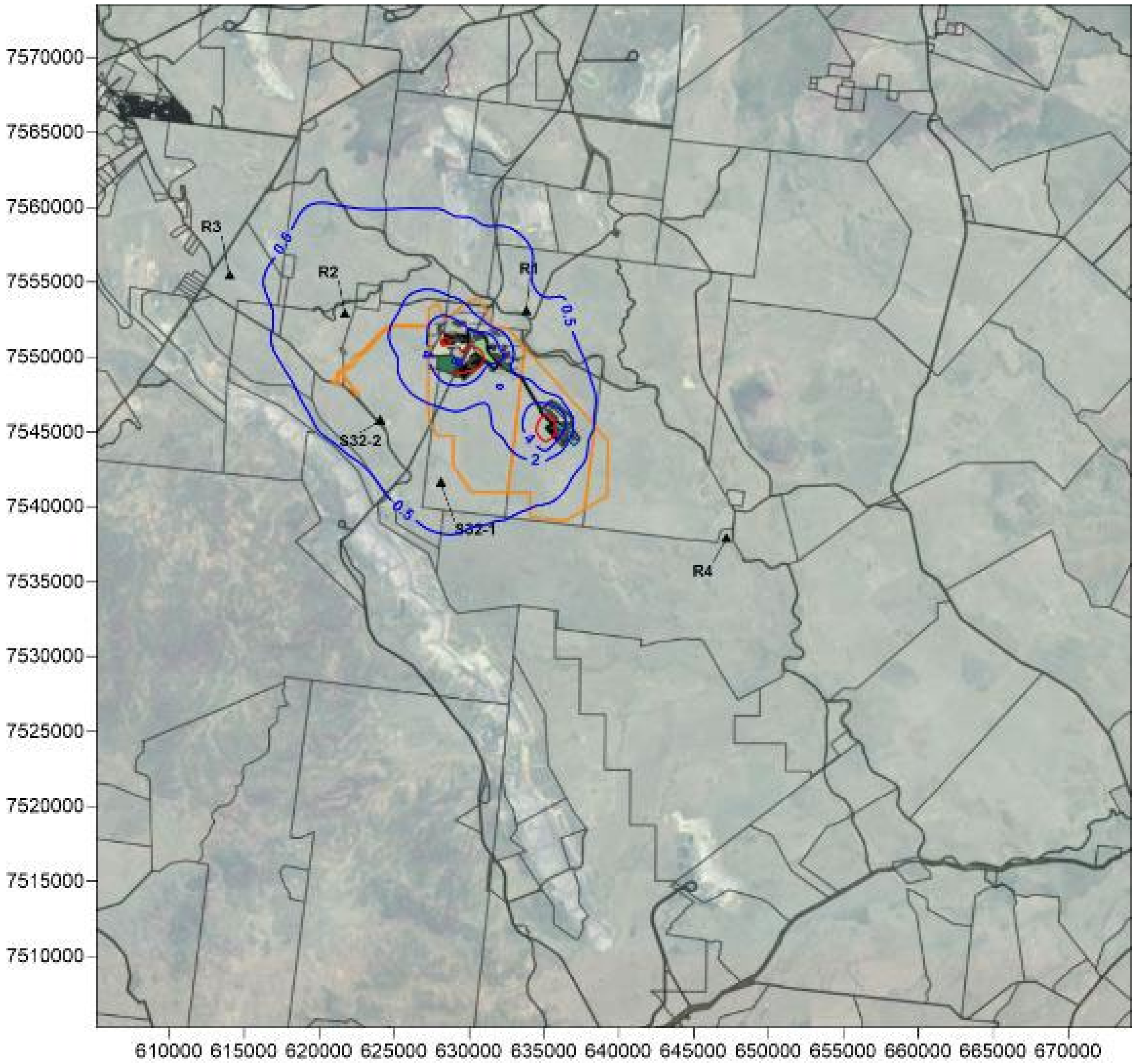

Plate 17	Year 5 predicted annual average ground level concentration of $PM_{2.5}$		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 8 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

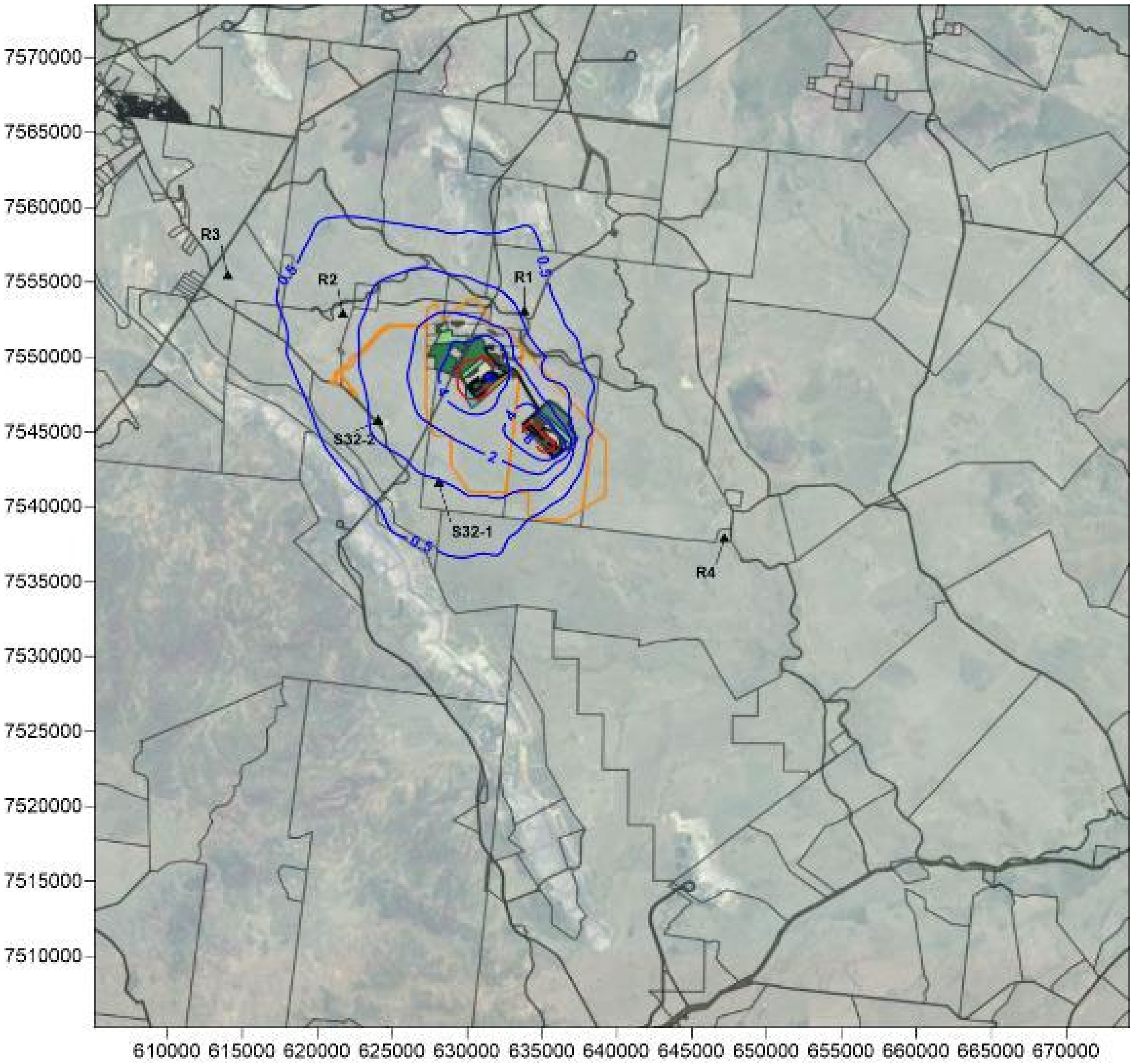

Plate 18	Year 9 predicted annual average ground level concentration of $PM_{2.5}$		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Annual average	**Objective:** 8 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

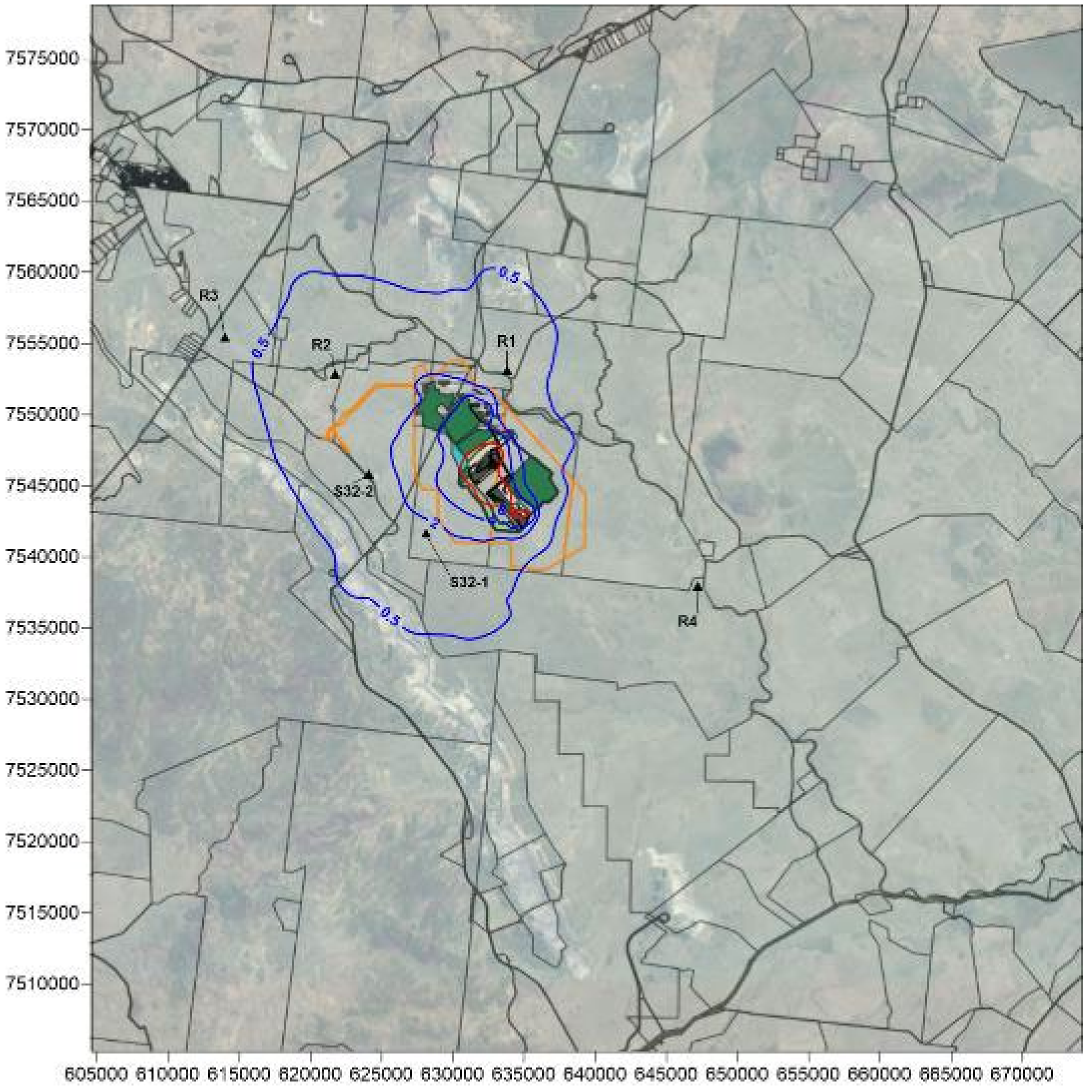

Plate 19	**Year 19 predicted annual average ground level concentration of $PM_{2.5}$**

Location:	**Averaging period:**	**Data source:**	**Units:**
Winchester South Project, Moranbah, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average	8 µg/m³ (red contour)	Daniel Gallagher	April 2022

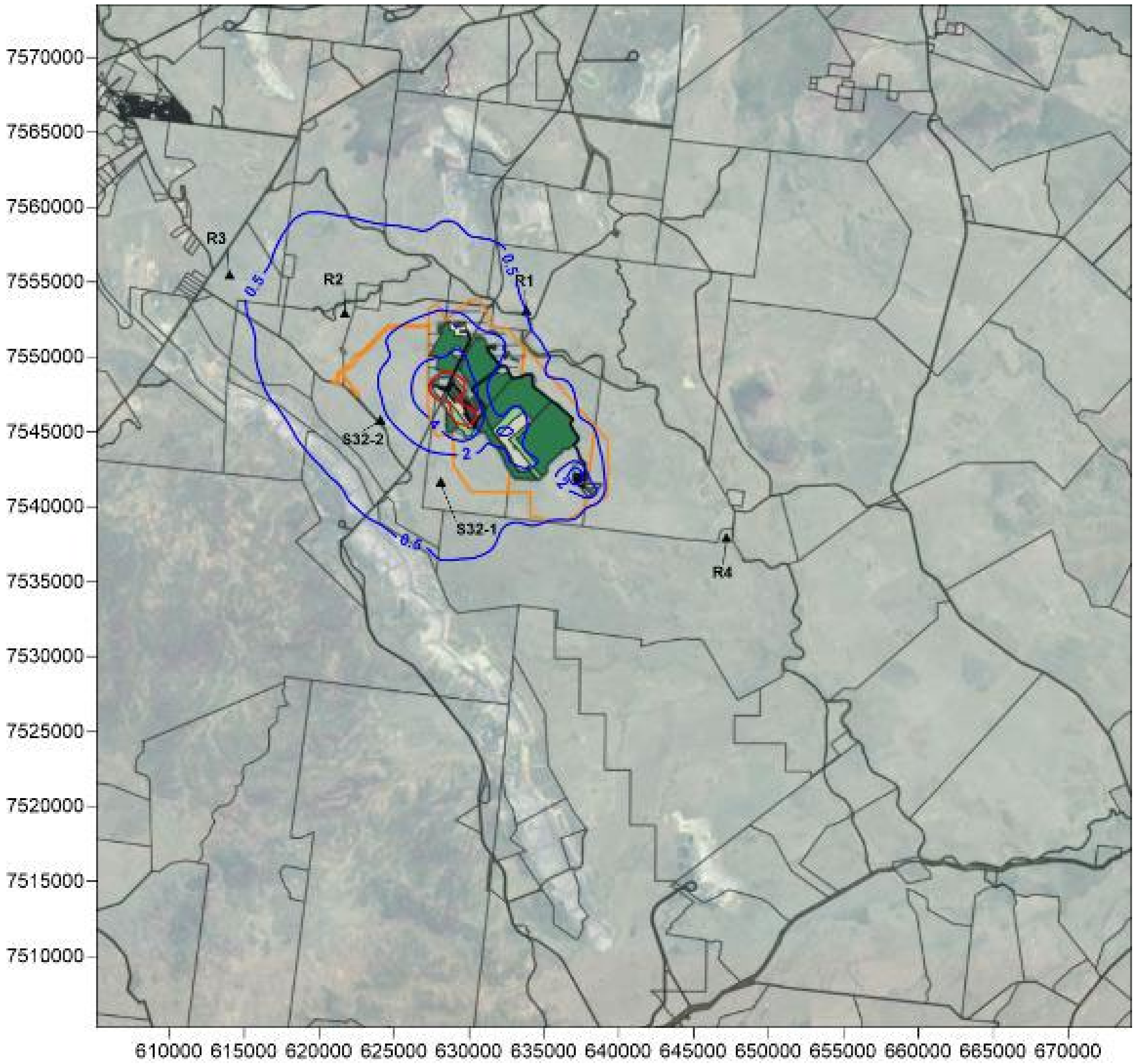

Plate 20 **Year 27 predicted annual average ground level concentration of $PM_{2.5}$**

Location:	Averaging period:	Data source:	Units:
Winchester South Project, Moranbah, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average	8 µg/m³ (red contour)	Daniel Gallagher	April 2022

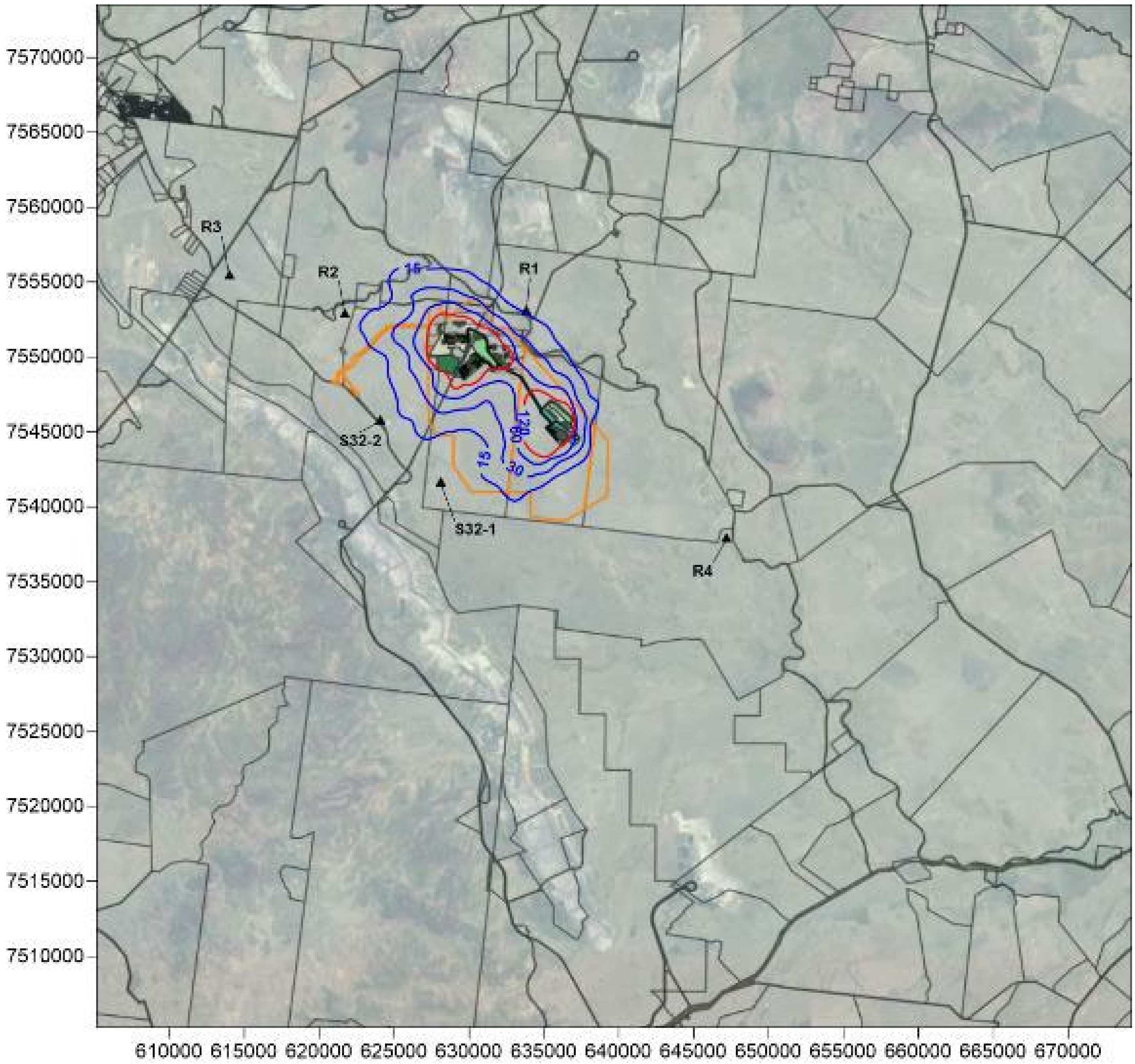

Plate 21	Year 5 predicted maximum monthly dust deposition		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** µg/m³
Type: Monthly maximum	**Objective:** 120 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

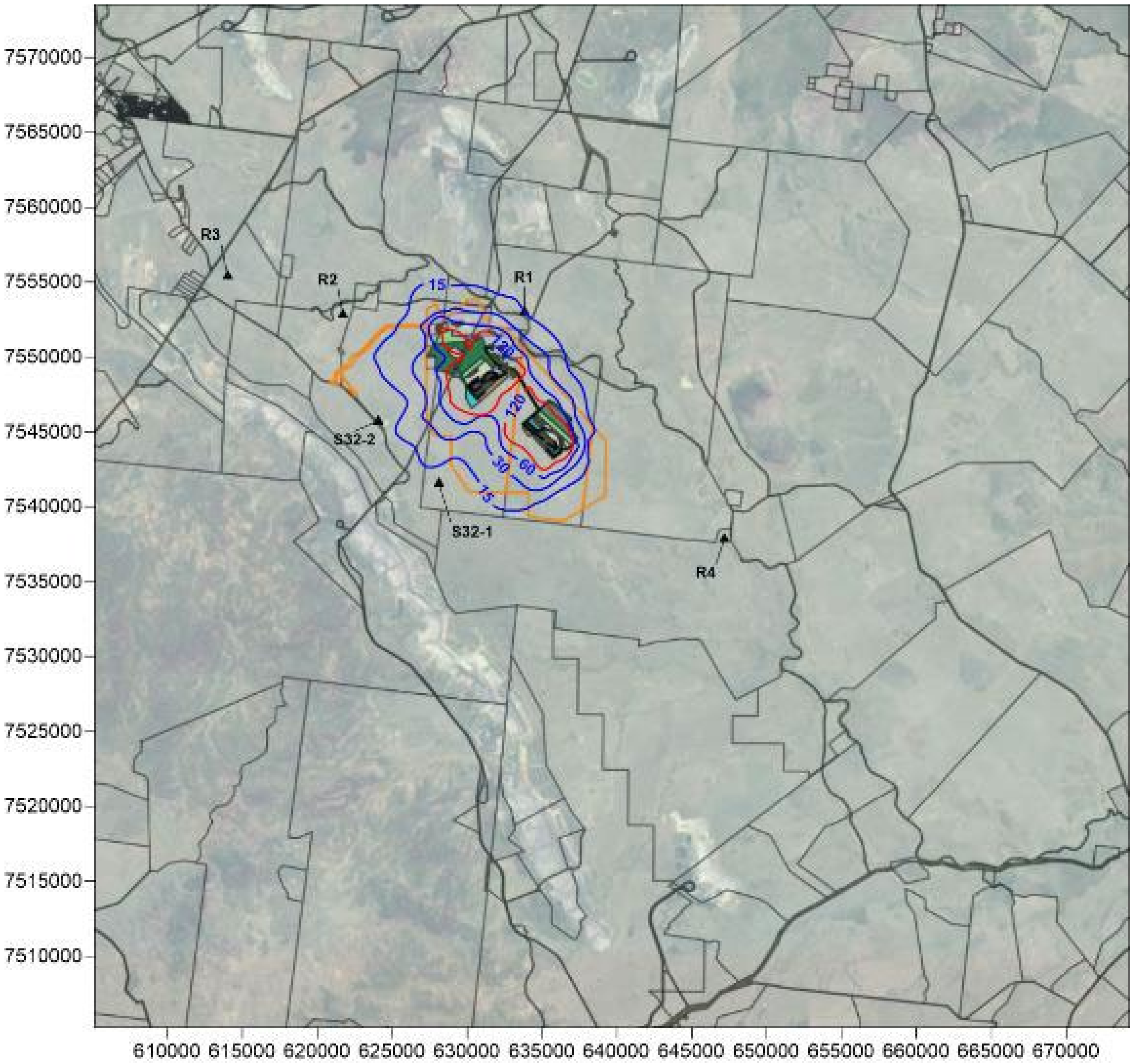

Plate 22	**Year 9 predicted maximum monthly dust deposition**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** µg/m³
Type: Monthly maximum	**Objective:** 120 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

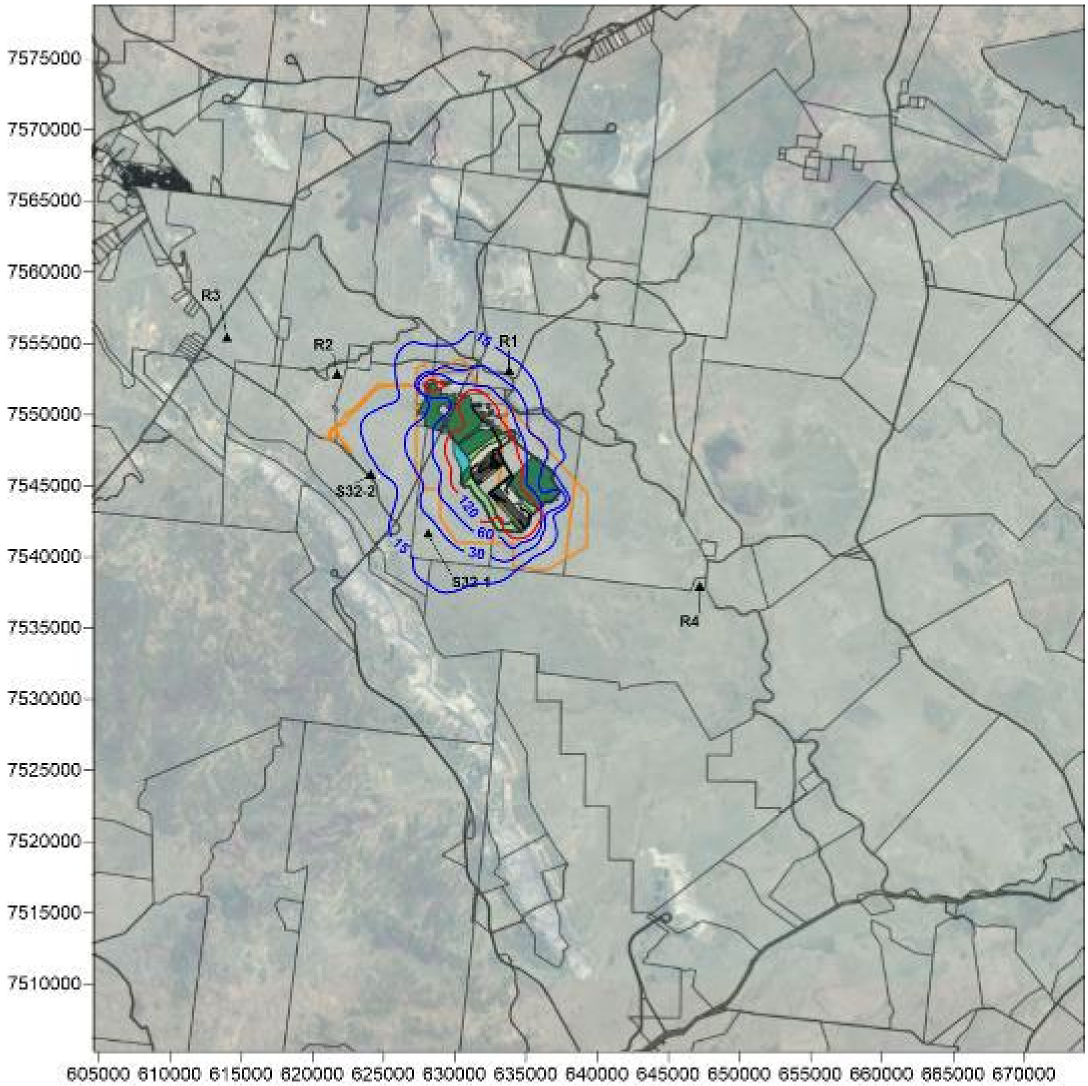

Plate 23 **Year 19 predicted maximum monthly dust deposition**

Location:	Averaging period:	Data source:	Units:
Winchester South Project, Moranbah, QLD	Monthly	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Monthly maximum	120 µg/m³ (red contour)	Daniel Gallagher	April 2022

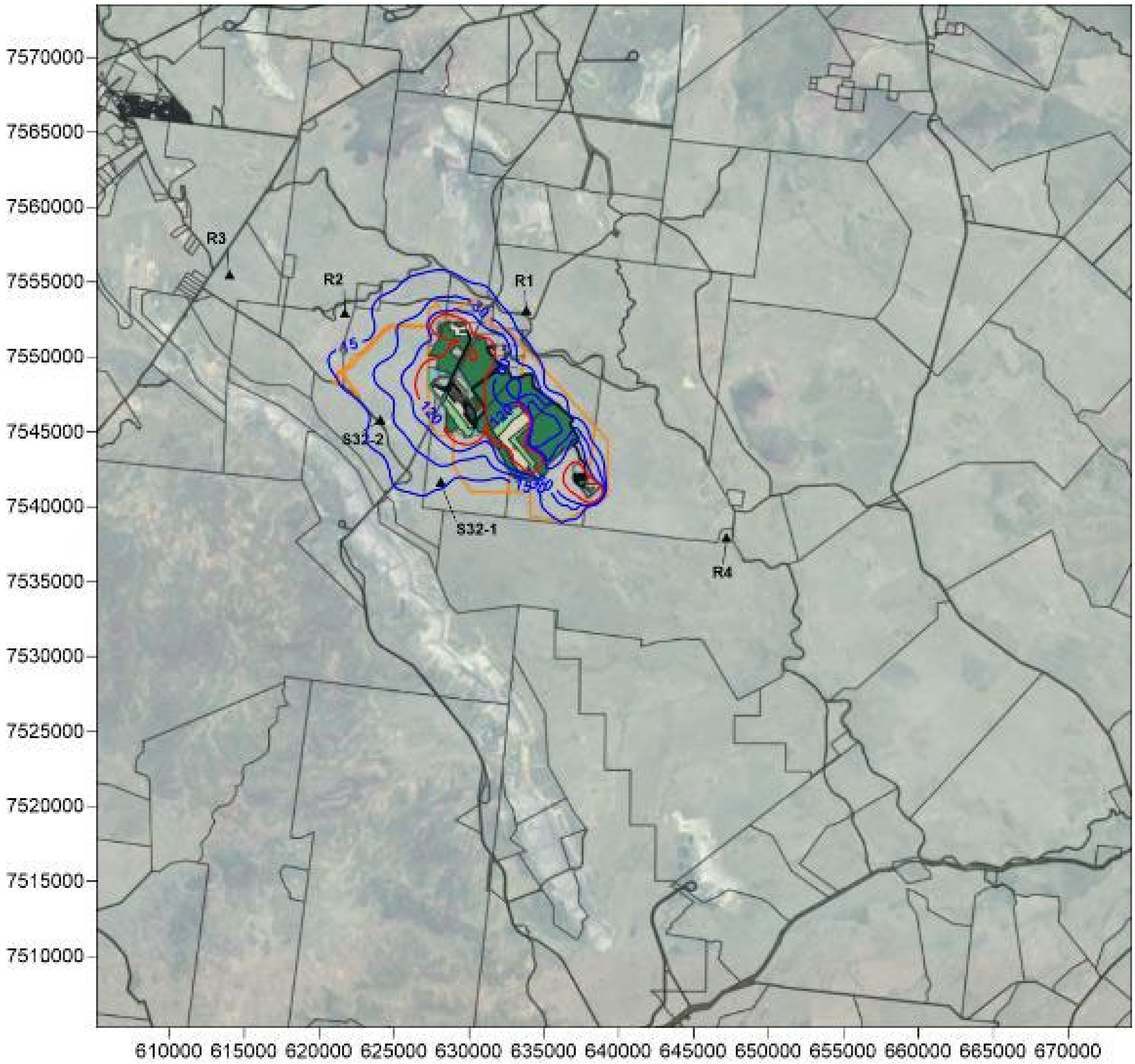

Plate 24	**Year 27 predicted maximum monthly dust deposition**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** µg/m³
Type: Monthly maximum	**Objective:** 120 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** April 2022

APPENDIX B ACTIVITY DATA

Operational parameters and activity data for the Project, used as input for the emissions calculations, are provided in Table B1.

Table B1 Summary of activity data used in emissions calculations

Activity	Values Year 5	Values Year 9	Values Year 19	Values Year 27	Units	Information source
Operations						
Days per year	365	365	365	365	days/year	Whitehaven
Standard hours of operation	24	24	24	24	hours/day	
Blasting hours	12	12	12	12	hours/day	
Hours on rehabilitation	12	12	12	12	hours/day	
Throughput						
Total ROM coal	15	15.5	17	10	million tonnes	Whitehaven
Total product coal	9.3	9.5	9.6	5.5	million tonnes	
Waste rock - truck and shovel	185	175	194	133	million tonnes	
Drilling and blasting						
Blasting frequency (average)	140	198	219	120	blasts/year	Whitehaven
Holes drilled per blast (average)	215.3	215.3	215.3	215.3	holes/blast	
Blast area (average)	6,000	6,000	6,000	6,000	m^2	
Mine areas						
Active pit area	186	284	344	128	ha	Geographic information
ROM stockpile	6.75	6.75	6.75	6.75	ha	Whitehaven
Product stockpile	7.48	7.48	7.48	7.48	ha	
Topsoil/waste rock dump area	469	428	527	779	ha	Geographic information

Activity	Values Year 5	Values Year 9	Values Year 19	Values Year 27	Units	Information source
Rehabilitating area (initial)	193	285	418	442	ha	
Rehabilitated area (established)	144	761	1,913	3,183	ha	
Soil strip area	89	149	136	78	ha	
Exposed area	248	250	442	665	ha	
Transport						
Waste rock haulage to dump	2,117,473	2,220,429	3,235,268	2,768,324	VKT/year	Geographic information
ROM coal haulage to CHPP	886,547	1,044,106	1,554,394	998,248	VKT/year	
Bulldozing						
Number of dozers in operation	26	23	25	21	#	Whitehaven
Total hours of operation per vehicle per year	5,341	5,341	5,341	5,341	hr.op/year/vehicle	
Grading						
Number of graders in operation	6	6	6	5	#	Whitehaven
Grading speed (3,500 hrs/yr)	11.4	11.4	11.4	11.4	km/h	AP42, Table 11.9-3, mean grader speed.
Total grader travel	360,878	360,878	360,878	360,878	VKT/year	Calculation
Conveying						
Length of conveyor	3.9	3.9	3.9	3.9	km	Whitehaven
Material characteristics						
ROM coal moisture content	6	6	6	6	%	Whitehaven
ROM coal silt content	2.4	2.4	2.4	2.4	%	ACARP C22027
Waste rock moisture content	4.1	4.1	4.1	4.1	%	ACARP C22027
Waste rock silt content	4.0	4.0	4.0	4.0	%	AP42 Table 11.9-3

Activity	Values Year 5	Values Year 9	Values Year 19	Values Year 27	Units	Information source
Waste rock density	2.2	2.2	2.2	2.2	%	Whitehaven
Waste rock haul road silt content	4.0	4.0	4.0	4.0	%	ACARP C22027
ROM haul road silt content	4.0	4.0	4.0	4.0	%	
Product moisture content	9	9	9	9	%	Whitehaven
Meteorology						
Mean on-site wind speed	2.6				m/s	TAPM/CALMET modelling
Note: m^2 = square metres, ha = hectares, VKT/year = vehicle kilometres travelled per year, hr.op/year/vehicle = hours of operation per year per vehicle, km/h = kilometres per hour, km = kilometres, % = percent, hrs/yr = hours per year, ACARP = Australian Coal Association Research Program, m/s = metres per second.						

APPENDIX C METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

C1 TAPM METEOROLOGY

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.5, was developed by the CSIRO and has been validated by the CSIRO, Katestone and others for many locations in Australia, in south-east Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone has used the TAPM model throughout Australia and it has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM requires synoptic meteorological information for the region surrounding the Project. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 metres to five km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM resolves local terrain and land use features that may influence local meteorology and generates a meteorological dataset that is representative of site-specific geographic conditions. A year of synoptic data must be selected as input for TAPM. The selection of this year should be such that the year is representative of typical meteorological conditions (and therefore is not necessarily the most recent year of available data) and whether monitoring data is available for the time period to validate the output dataset. In addition, Katestone's experience elsewhere in Central Queensland suggests that variability of dispersion meteorological conditions from year to year are unlikely to change the outcome of the air quality assessment.

TAPM was configured as follows:

- 1 January 2015 to 31 December 2015 modelled.
- 30 x 30 grid point domain with an outer grid of 30 km and nesting grids of 10 km, and 3 km.
- Grid centred at latitude -22°14’ and longitude 148°22.5’.
- Geoscience Australia 9-second digital elevation model terrain data.
- 25 vertical grid levels.
- No observational data assimilated.
- Advanced options set to default.

C2 CALMET METEOROLOGICAL MODELLING

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple sites within the modelling domain, it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.5) was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 3 km grid. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

Key features of CALMET used to generate the site-specific meteorology are as follows:

- modelling period from 1 January to 31 December 2015
- 70 x 65 grid point domain with 1.0 km resolution, nested within the TAPM inner domain
- twelve vertical levels at heights of 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600 and 4600 metres
- prognostic wind fields generated by TAPM input as MM5/3D.DAT at surface and upper air for "initial guess" field (no-observations mode)
- gridded cloud cover from prognostic relative humidity at all levels
- no extrapolation of surface winds observations
- all other wind field options set as default
- terrain radius of influence set at 5 km
- mixing height parameters all set as default
- 3D Relative humidity and temperature from prognostic data
- no data assimilation.

All other options and factors were set to default.

C3 CALPUFF DISPERSION MODELLING

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF considers the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 70 by 65 grids at 1.0 km spacing, equivalent to the domain defined in CALMET, with a nesting factor of 1.
- 365 days modelled (1 January 2015 to 31 December 2015).
- Gridded 3D hourly-varying meteorological conditions generated by CALMET.
- Partial plume path adjustment for terrain modelled.
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables.

All other options set to default.

C3.1 Source configuration

Emissions were modelled in CALPUFF using area sources with a constant, diurnal or hourly-varying (wind erosion) profile. Source characteristics for the modelled activity classes are presented in Table C1.

Table C1 CALPUFF area source characteristics

Emission source	Effective height (m)	Initial vertical dispersion coefficient (σz)
Material extraction	8.0	2.0
Dumping and bulldozing	10.0	2.5
Haulage	10.0	2.5
Rehabilitation activities	4.0	1.0
Wind erosion	1.0	0.25