Appendix H

Air Quality and Greenhouse Gas Assessment

WINCHESTER SOUTH PROJECT

Environmental Impact Statement

WHITEHAVEN COAL

Resource Strategies

Contents Page

Winchester South Project - Air Quality and Greenhouse Gas Assessment

Prepared for:

Whitehaven WS Pty Ltd

May 2021

Final

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Ground Floor, 16 Marie Street | PO Box 2217
Milton, Brisbane, Queensland, 4064, Australia

www.katestone.com.au
admin@katestone.com.au
Ph +61 7 3369 3699
Fax +61 7 3369 1966

Contents Page

Document Control

Deliverable #:	D18127-25
Title:	Winchester South Project - Air Quality and Greenhouse Gas Assessment
Version:	1.0 (Final)
Client:	Whitehaven WS Pty Ltd
Document reference:	D18127-25 Air Quality and Greenhouse Gas Assessment of the Winchester South Project v1.0.docx
Prepared by:	Andrew Vernon and Daniel Gallagher
Reviewed by:	Simon Welchman and Natalie Shaw
Approved by:	

Disclaimer

Copyright

Contents

Tables

Figures

Contour Plates

Glossary

Term	Definition
µg/m^3	micrograms per cubic metre
µm	microns/micrometres
°C	degrees Celsius
%	percent
GJ/kL	gigajoules per kilolitre
GJ/t	gigajoules per tonne
ha	hectares
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/m^2/day	milligrams per square metre per day
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
Nomenclature	**Definition**
CH$_4$	methane
CO	carbon monoxide
CO$_2$	carbon dioxide
NOx	oxides of nitrogen
N$_2$O	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
BMA	Billiton Mitsubishi Alliance
BoM	Bureau of Meteorology
CHPP	coal handling and preparation plant

Term	Definition
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
MJ/kWh	megajoules per kilowatt hour
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NPI	National Pollutant Inventory database
ROM	run-of-mine
TAPM	The Air Pollution Model
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 30 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 mining operation stages are based on an indicative mine schedule described in Section 2.5.4 of the Environmental Impact Statement for the Project.

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 proposed proactive dust management system.
- Predicted cumulative concentrations of PM_{10} were found to be elevated at the one closest sensitive receptor and ***comply*** with the relevant air quality objectives at all other sensitive receptors. To 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.

$PM_{2.5}$

- 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 Air EPP 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.

The greenhouse gas (GHG) assessment of the Project found the following:

- Maximum annual Scope 1 and Scope 2 GHG emissions associated with the Project are estimated to be approximately 749,000 tonnes of carbon dioxide equivalent (t CO_2-e) (Year 16).
- Average annual Scope 1 and Scope 2 GHG emissions over the life of the Project are estimated to be approximately 556,000 t CO_2-e.

Compared to National and State GHG inventory levels, the estimated maximum annual GHG emissions from the Project would account for approximately 0.14 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 30 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.

Katestone Environmental Pty Ltd (Katestone) was commissioned by Whitehaven WS to complete an Air Quality and Greenhouse Gas Assessment of the Project for inclusion in the EIS, 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, 2017a).

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* 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 similar 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 EIS.
- 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.

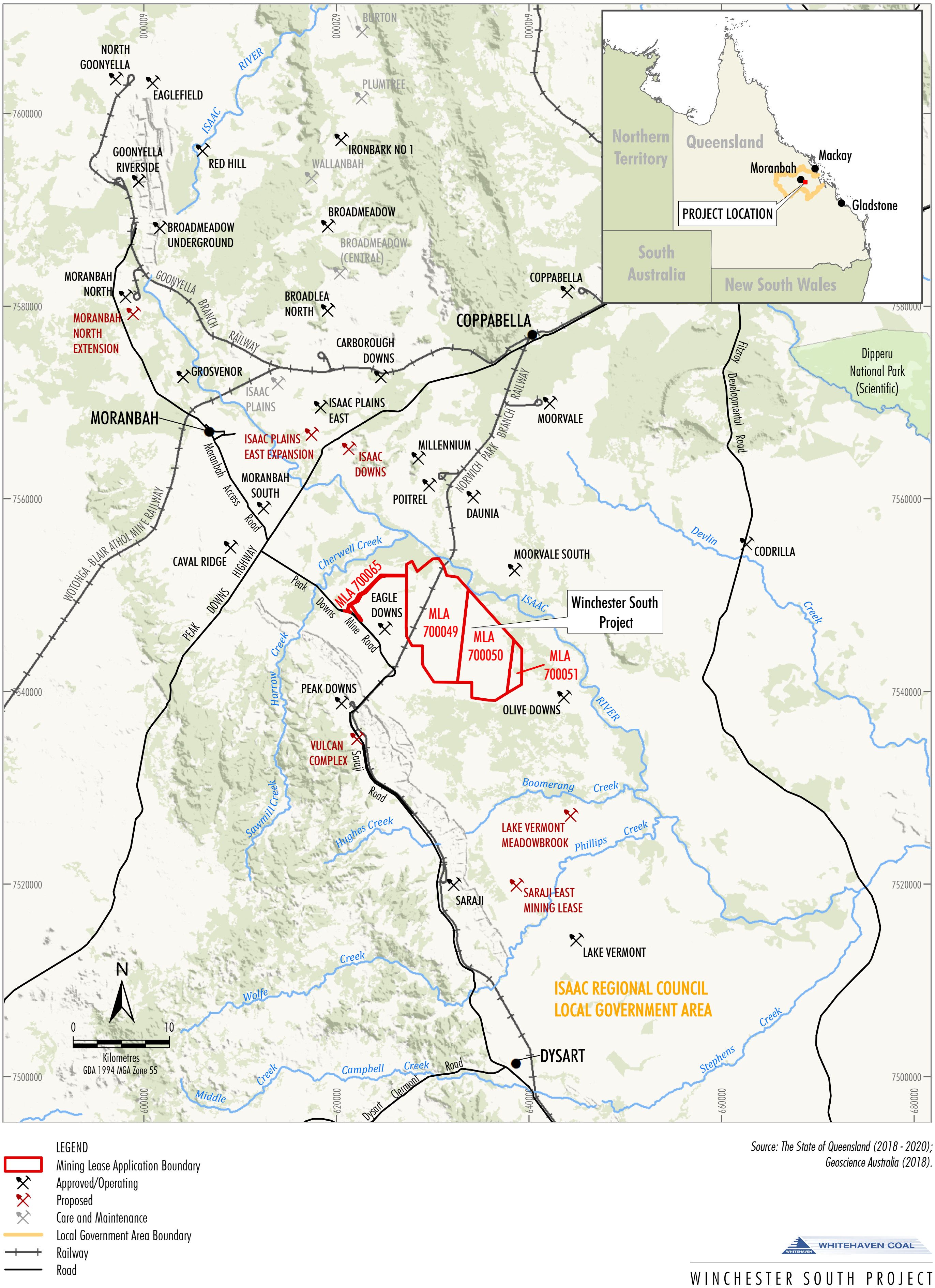
The main activities associated with the Project include:

- 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 30 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. The extent of the Project open cut mining area, waste rock emplacements and infrastructure areas (i.e. the Project disturbance footprint [Project area]) is approximately 7,130 hectares (ha).

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.



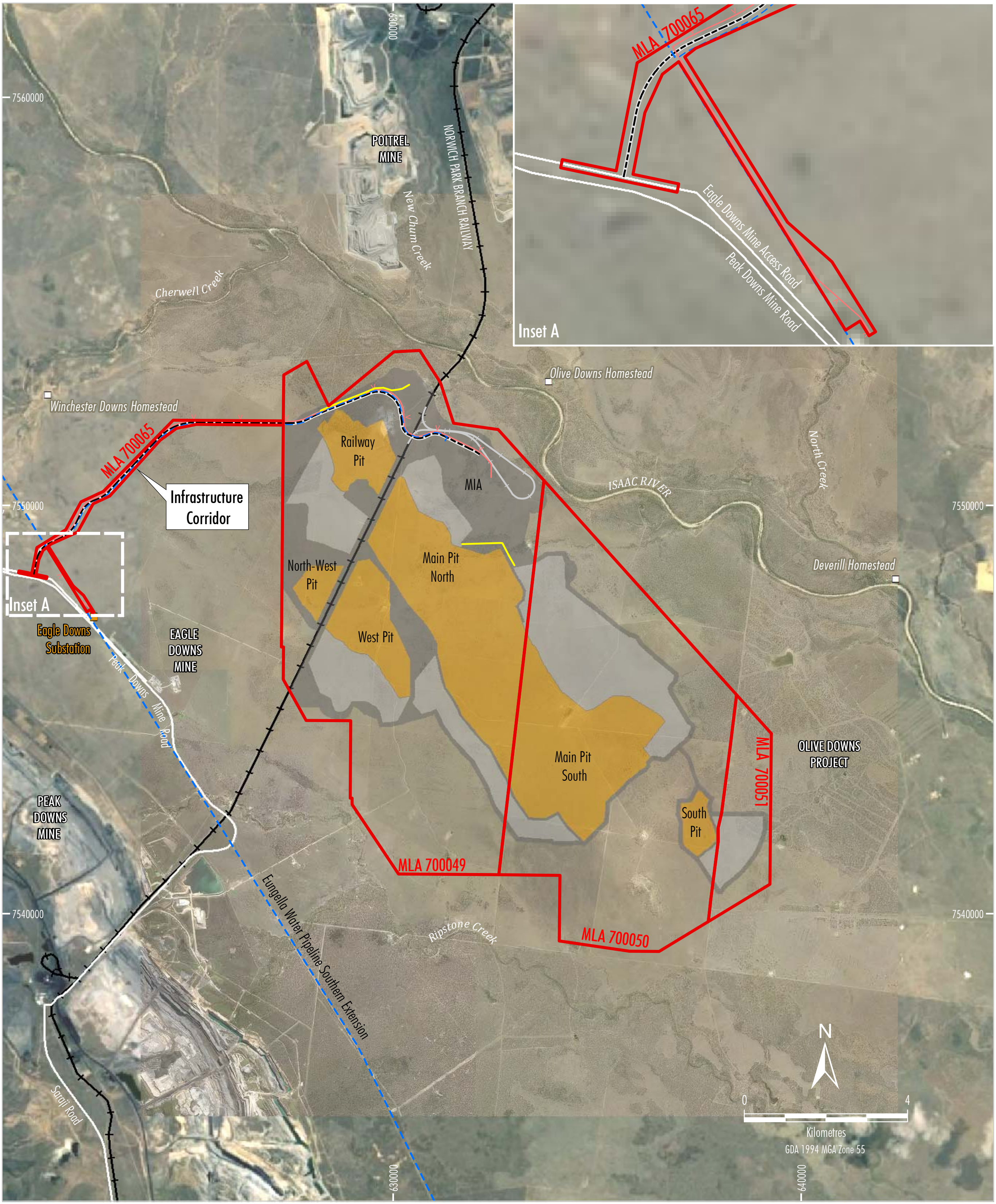
Source: The State of Queensland (2018 - 2020); Geoscience Australia (2018).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Project Location

Figure 1



WHC-18-62_EIS_AppH_202A

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* (2017a). 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 north 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 removal of the largest quantities of waste rock and ROM coal, 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 late mine impacts during 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 (Year 30) 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	Run-of-mine	Product coal	Waste rock
Year 5	15	9	154
Year 9	15	10	179
Year 19	14.1*	9	209
Year 27	5	3	123

* The air quality model conservatively assumes the maximum proposed extraction rate of ROM coal (17 Mtpa).

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 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 Environmental Protection (Air) Policy* (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 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, 2017b), 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* (2017b), not an air quality objective from the Air EPP.
µg/m³ = micrograms per cubic metre.

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.

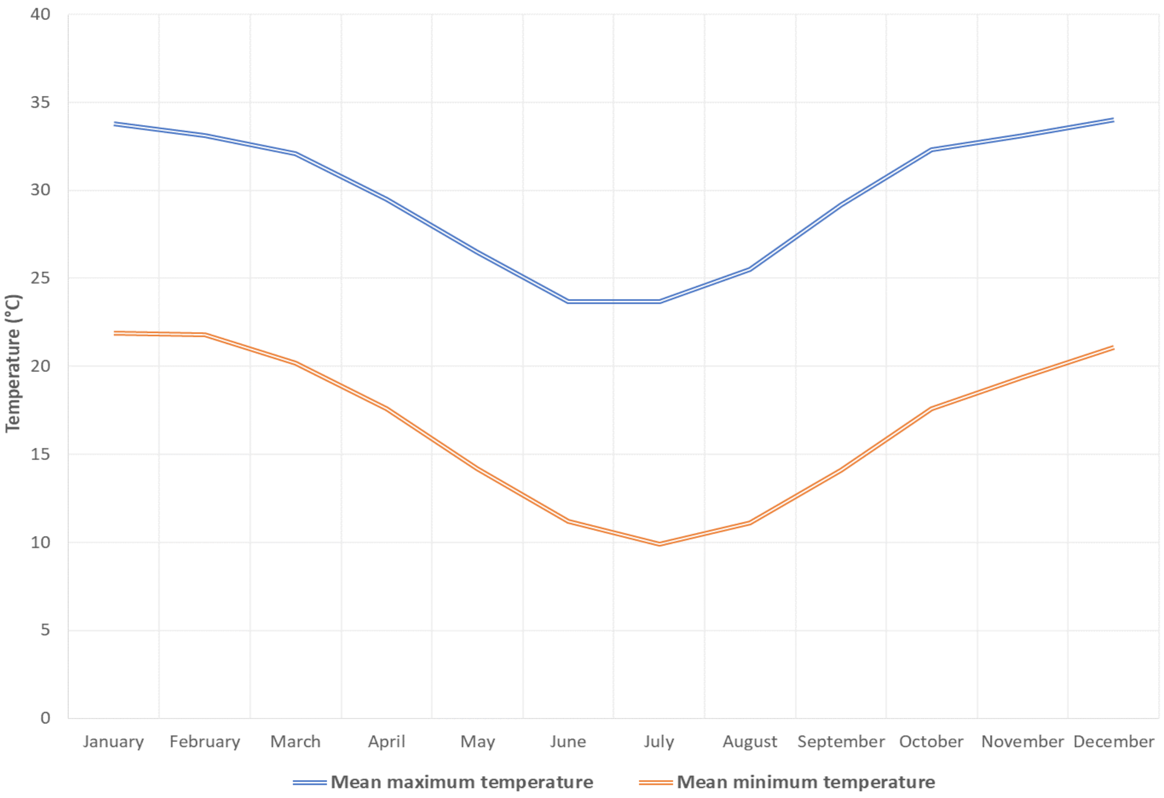


Figure 3 Monthly mean temperature (°C) measured at Moranbah Water Treatment Plant (1986-2012)

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.

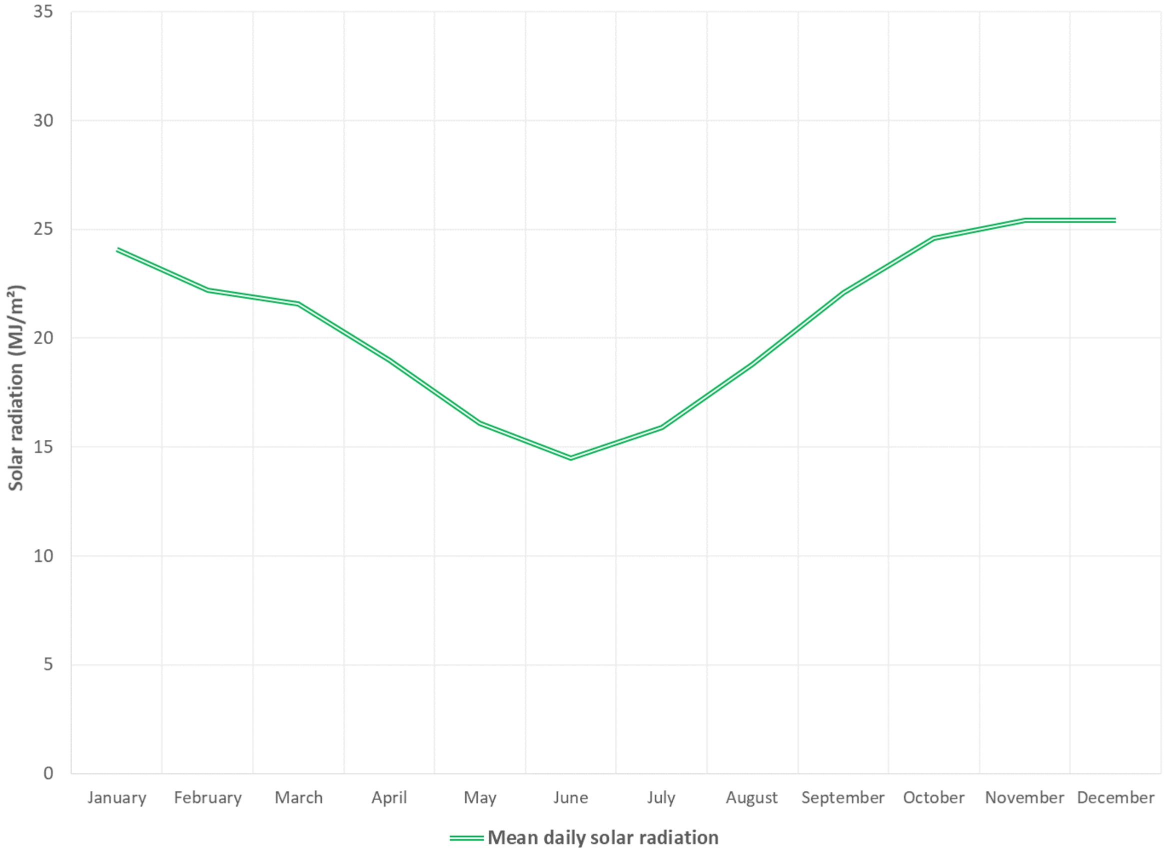


Figure 4 **Mean daily solar radiation (MJ/m²) by month at Moranbah Water Treatment Plant (1986-2012)**

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.

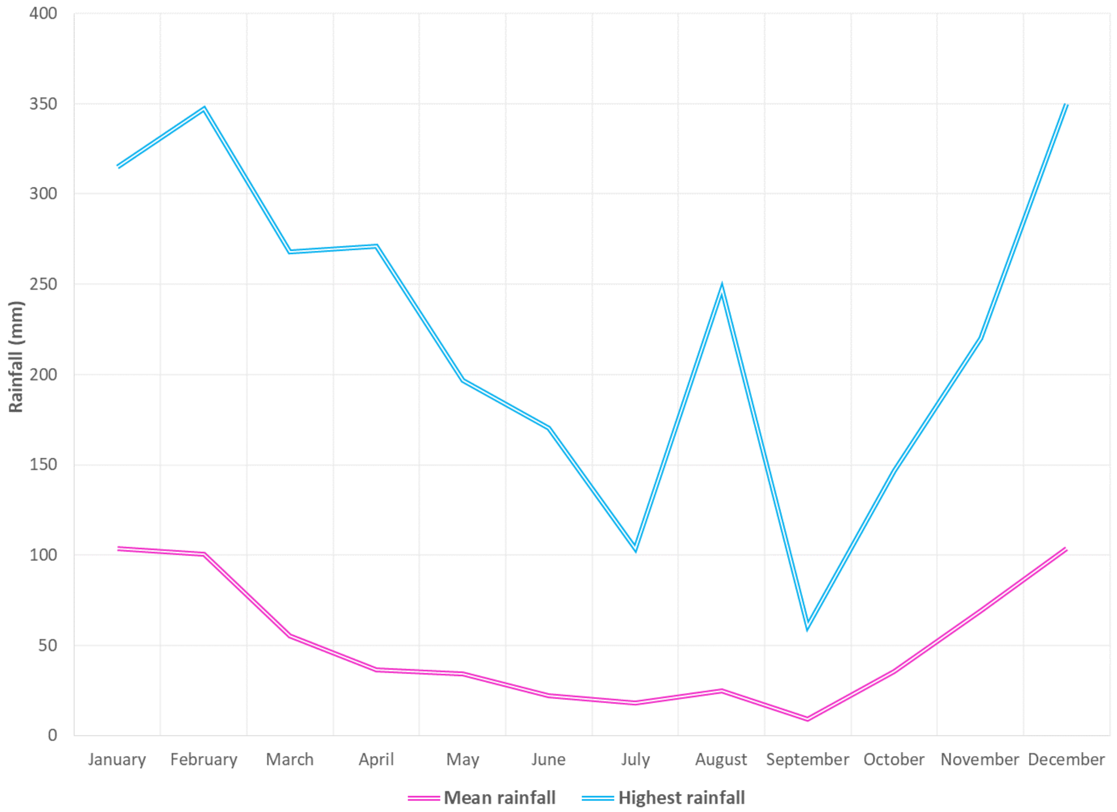


Figure 5 **Range of total monthly rainfall measured at Moranbah Water Treatment Plant (1986-2012)**

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.

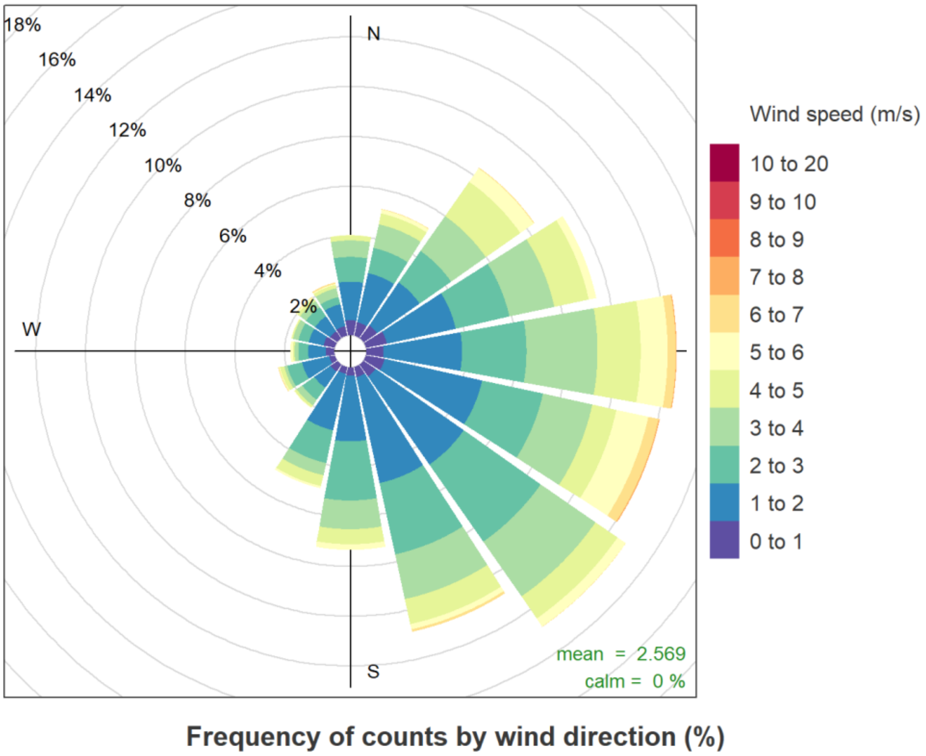


Figure 6 Annual wind rose for the Project site (extracted from CALMET) – 2015

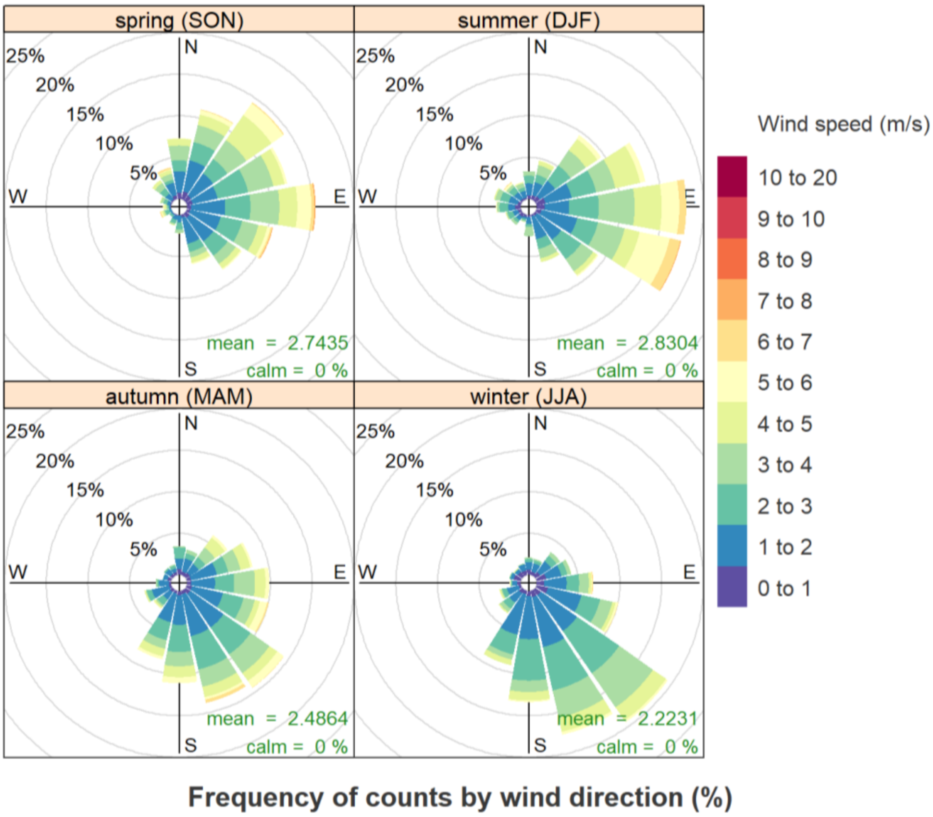


Figure 7 Seasonal wind roses for the Project site (extracted from CALMET) – 2015

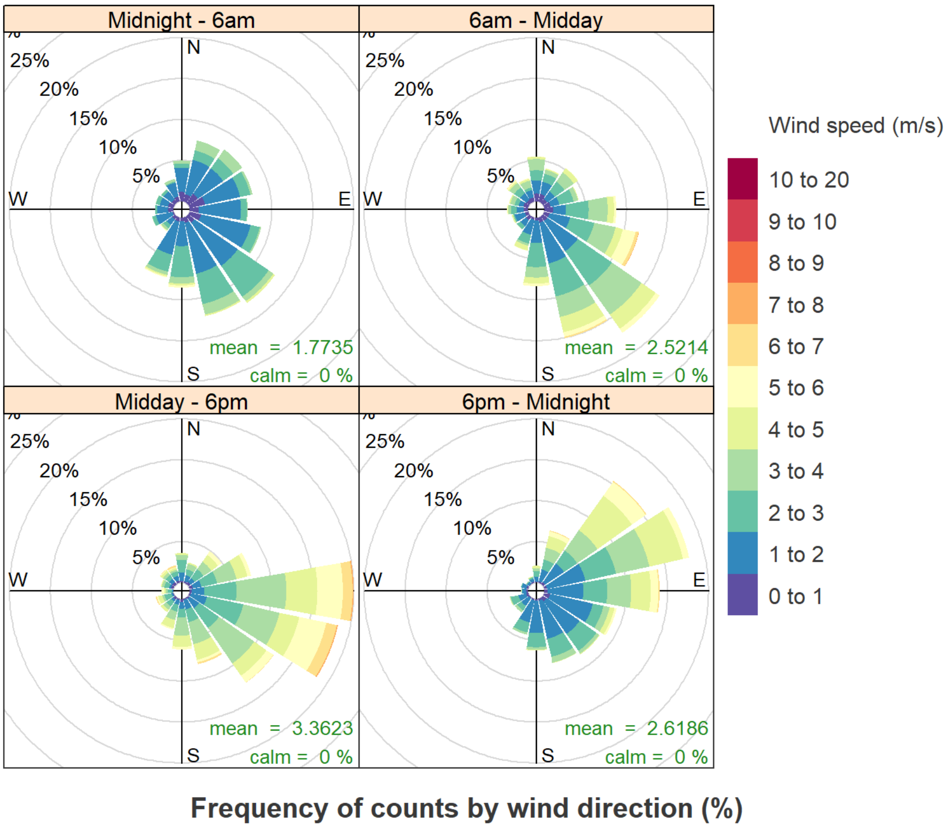


Figure 8 Diurnal wind roses for the Project site (extracted from CALMET) – 2015

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.

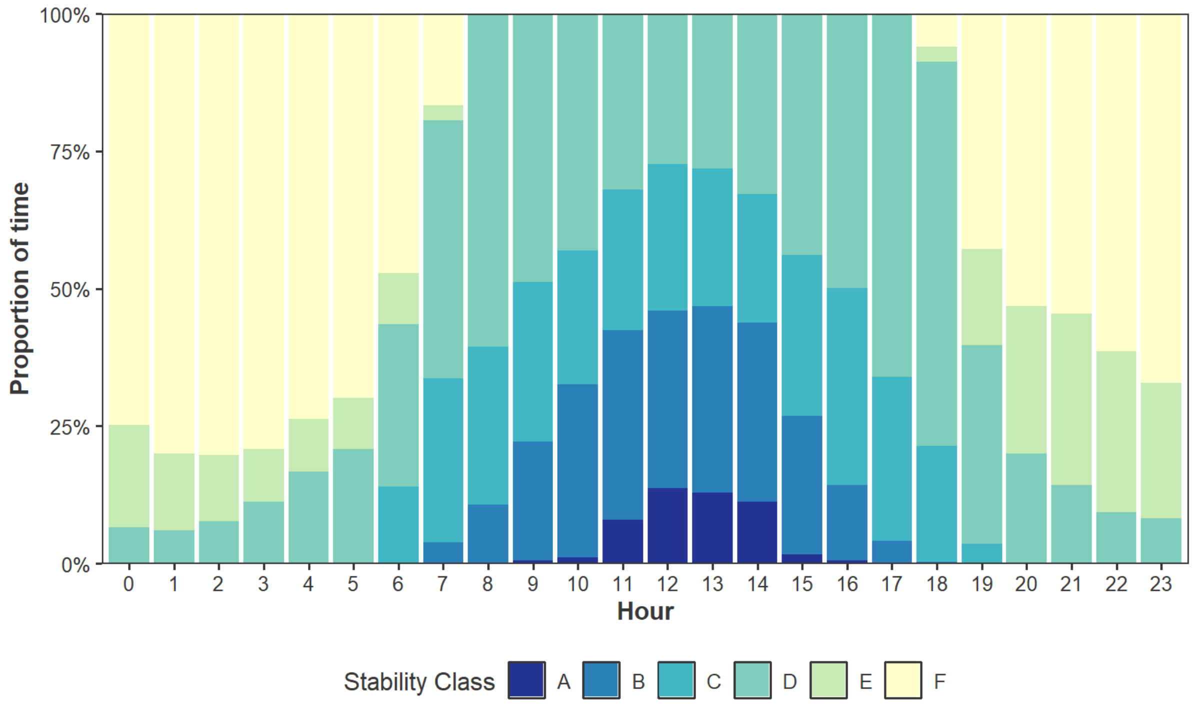


Figure 9 Stability class frequency for the Project site (extracted from CALMET) – 2015

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, increases to a peak at 3 pm to 6 pm before descending rapidly after 6 pm.

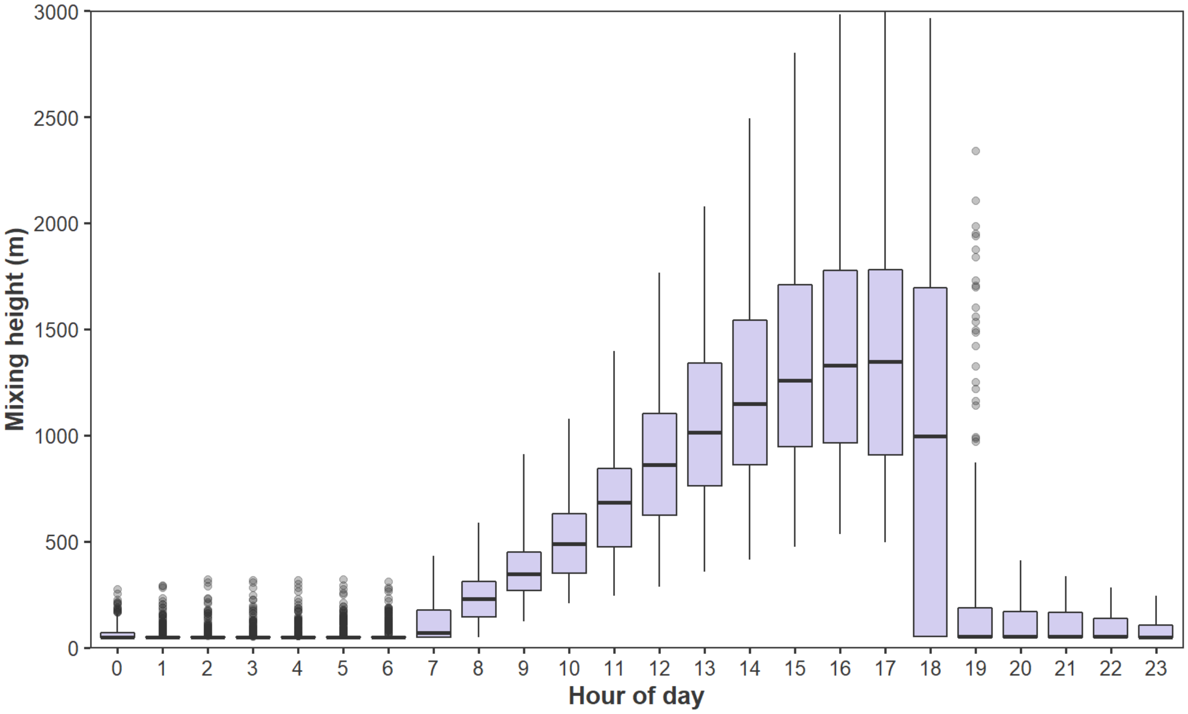


Figure 10 Diurnal variation in mixing height at the Project site (extracted from CALMET) – 2015

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 Sensitive Receptors

Sensitive receptors in the vicinity of the Project have been identified. These are shown in Table 3 and Figure 11.

Table 3 Nearest sensitive 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

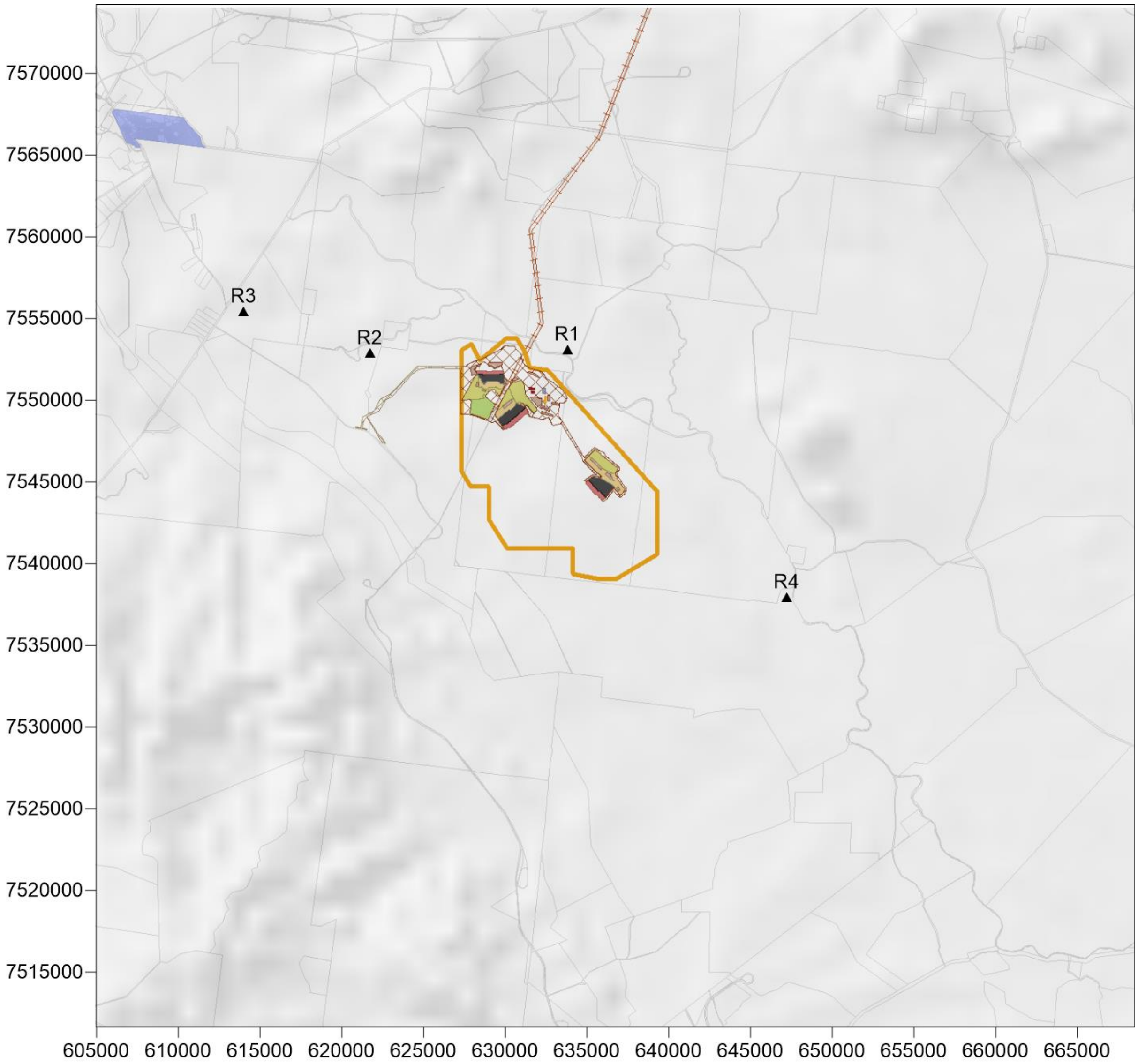


Figure 11 Map of sensitive receptors

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 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

The Isaac Regional Council Local Government Area is home to 22 currently operating coal mines, quarries, and gas production fields. 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 National Pollutant Inventory (NPI) database (NPI, 2020) for 2018/19 from identified industries in the Project region.

Table 4 Dust emissions reported to NPI for 2018/2019

Facility Name	Main Activities	Approximate Distance and Direction from the Project Boundary	PM_{10} (tonnes/year)	$PM_{2.5}$ (tonnes/year)
Poitrel Coal Mine	Coal Mining	300 m north	1,900	69
Daunia Mine	Coal Mining	2.5 km north	2,200	78
Peak Downs Mine	Coal Mining	3.5 km south-west	13,000	180
Saraji Mine	Coal Mining	7.5 km south	7,000	160
Caval Ridge Mine	Coal Mining	7.5 km west	6,900	100
Millennium Coal Mine	Coal Mining	8 km north	1,800	23
Carborough Downs Coal Mine	Coal Mining	13 km north	1,300	5.3
Moorvale Coal Mine	Coal Mining	14 km north	4,700	69
Lake Vermont	Coal Mining	15.5 km south-east	8,100	670
Isaac Plains Coal Mine	Coal Mining	16 km north-west	2,200	48
Grosvenor	Coal Mining	17 km north-west	890	20
Norwich Park Mine	Coal Mining	18.5 km south	1,400	2.3
Moranbah Power Station	Electricity production (coal seam gas)	30 km north-west	0.025	0.025
Dyno Noble Moranbah	Gun cotton manufacturing	30 km north-west	9.2	9.1
Moranbah Operations	Oil and gas extraction	30 km north-west	9.2	0.49
Moranbah North	Coal Mining	31 km north-west	1,900	23
Coppabella Coal Mine	Coal Mining	33 km north	6,800	79
South Walker Creek Mine	Coal Mining	38 km north-east	2,900	46

Source: NPI (2020).

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 in Moranbah (approximately 30 km north-west). Relevant PM_{10} statistics from data measured from 2011 to 2019 at DES's Moranbah site are presented in Table 5 (Queensland Data, 2019).

The Moranbah PM_{10} data shows the following:

- The Moranbah monitoring station has recorded 104 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³ (Air EPP objective) over the nine 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 metres 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.
    - 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.

Table 5 **Concentrations of PM_{10} at Moranbah monitoring station from 2011 to 2019**

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
Objective	50	-	-	25

Source: Queensland Data (2020).

5.5.2.2 TSP and $PM_{2.5}$

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%.

DES only commenced monitoring of $PM_{2.5}$ at Moranbah in October 2019 and so a complete dataset is not yet available for use in this assessment. Other publicly available information on ambient air quality monitoring in Moranbah is limited, however, available data, including the Moranbah South Project Air Quality Assessment (Katestone, 2015) and Caval Ridge EIS (BHP Billiton Mitsubishi Alliance [BMA], 2010), provides information on available ambient air quality monitoring of $PM_{2.5}$ that can be used to represent background in this assessment.

BMA conducted monitoring of $PM_{2.5}$ at the corner of Jackson Avenue and Clements Street, Moranbah, using a Hi-volume air sampler in accordance with the Australian Standards for measurements of $PM_{2.5}$. Nine months of monitoring data are publicly available from this site from 1 January 2012 to 31 September 2012.

These data have been used to represent background levels of $PM_{2.5}$ in the Project region, namely:

- $PM_{2.5}$
  - 4.3 µg/m³ - 24-hour average (70th percentile)
  - 3.6 µg/m³ - Annual average.

5.5.2.3 Dust deposition rate

Dust deposition monitoring is not undertaken by Whitehaven or DES in the region. However, as detailed in the Moranbah South Project Air Quality Assessment (Katestone, 2015), Anglo American has conducted dust deposition monitoring at its Golf Course deposition monitoring station every month from April 2009 to October 2012. The maximum rolling annual average from this site is 71 mg/m²/day.

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 6.

Table 6 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	4.3 µg/m^3
	Annual	3.6 µg/m^3
Dust deposition	Annual average	71 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 7.

Table 7 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 considered to be 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; 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 8 and a detailed breakdown is provided in Table 9.

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 8 **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	4,345	1,500	202	4,915	1,648	218	6,616	2,196	287	5,808	2,271	326
Activity Contribution (tonnes)												
Pit Activities	485	199	41	455	197	41	510	220	46	363	123	33
CHPP	189	89	14	189	90	14	191	90	14	181	86	13
Hauling	2,758	705	71	3,333	846	85	4,529	1,140	115	2,420	615	62
Wind Erosion	913	506	77	938	515	78	1,387	746	113	2,844	1,447	217
Activity Contribution (% of total)												
Pit Activities	11%	13%	20%	9%	12%	19%	8%	10%	16%	6%	5%	10%
CHPP	4%	6%	7%	4%	5%	6%	3%	4%	5%	3%	4%	4%
Hauling	63%	47%	35%	68%	51%	39%	68%	52%	40%	42%	27%	19%
Wind Erosion	21%	34%	38%	19%	31%	36%	21%	34%	39%	49%	64%	67%
Note: Totals may not add exactly due to rounding. t/year = tonnes per year												

Table 9 **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	17	9	1	15	8	0.5	18	9	0.5	11	6	0.3
Blasting	71	37	2	83	43	2	88	46	3	104	38	7
Bulldozing – waste rock	29	10	6	47	15	10	47	15	10	29	10	6
Bulldozing – ROM	89	39	4	44	19	2	44	19	2	44	19	2
Excavator – ROM removal	2	2	0.3	2	2	0.3	3	2	0.4	1	1	0.1
Excavator waste rock removal	41	37	6	48	43	7	55	50	8	15	13	2
Truck dumping (waste rock)	82	39	6	95	45	7	111	52	8	30	14	2
Truck dumping (reject coal)	2	1.1	0.2	3	2	0.2	3	2	0.2	1.1	0.5	0.08
Dozer on waste rock	70	12	7	70	12	7	70	12	7	35	6	4
Dozer on rehabilitation	35	6	4	23	4	2	70	12	7	70	12	7
Dozer on topsoil	47	8	5	23	4	2	-			19	4	2
CHPP												
Screens	Enclosed source											
Crushers Primary												
Crushers Secondary												
Crushers Tertiary												
Transfers (ROM)	3	1	0.2	3	1	0.2	3	2	0.2	1	0.4	0.1
Truck dumping	5	2	0.3	5	2	0.3	5	3	0.4	2	1	0.1
Load ROM to CHPP	2	1	0.2	2	1	0.2	3	1	0.2	1	0.4	0.1
Dozer reclaim	2	1	0.1	2	1	0.1	2	1	0.1	1	0.2	0.04
Transfers (Product)	Enclosed source											
Train loading from surge bin	1	0.5	0.1	1	0.5	0.1	1	0.5	0.1	1	0.5	0.1
Train load-out conveyor	176	83	13	176	83	13	176	83	13	176	83	13

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}	$PM_{2.5}$
Transfer to rejects bin	0.2	0.1	0.01	0.2	0.1	0.01	0.2	0.1	0.01	0.1	0.03	0.004
Hauling												
Waste rock hauling	1,468	361	36	1,833	450	45	2,790	686	69	1,480	357	36
ROM hauling	751	185	18	961	236	24	1,200	295	29	401	99	10
Grader waste rock hauls	346	102	11	343	102	11	367	109	11	416	123	13
Grader ROM hauls	192	57	6	195	58	6	171	51	5	122	36	4
Wind Erosion												
Initial rehabilitation	216	108	16	76	38	6	97	49	7	168	84	13
Active emplacements	211	105	16	342	171	26	548	274	41	937	469	70
Active pit	111	105	17	102	97	15	117	111	18	56	53	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	59	9	133	67	10	115	57	9	91	46	7
Exposed areas	139	70	10	162	81	12	353	177	26	1,550	775	116
Soil stripping	112	56	8	117	58	9	151	75	11	34	17	3

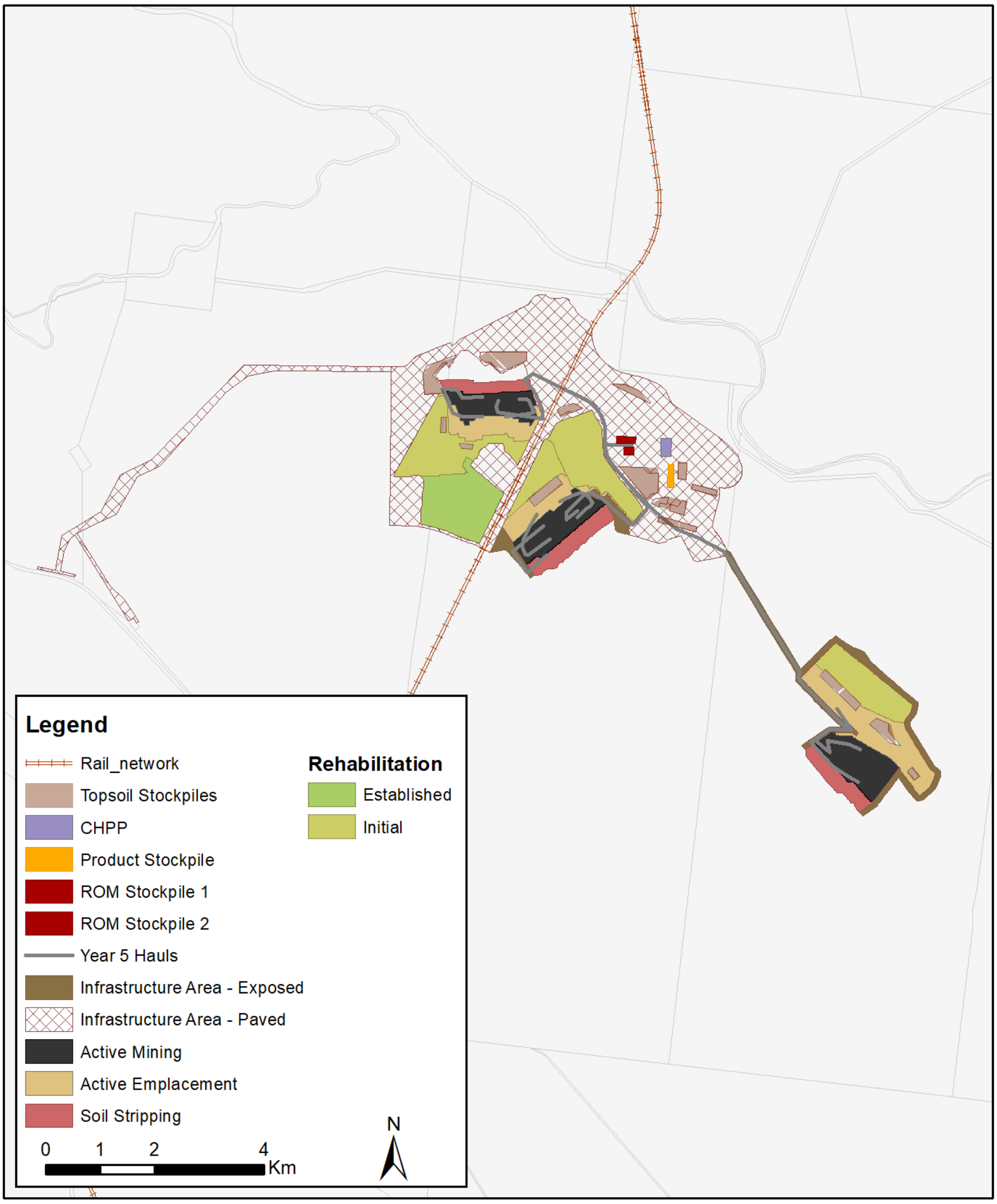


Figure 12 Year 5 – Dust emission source areas

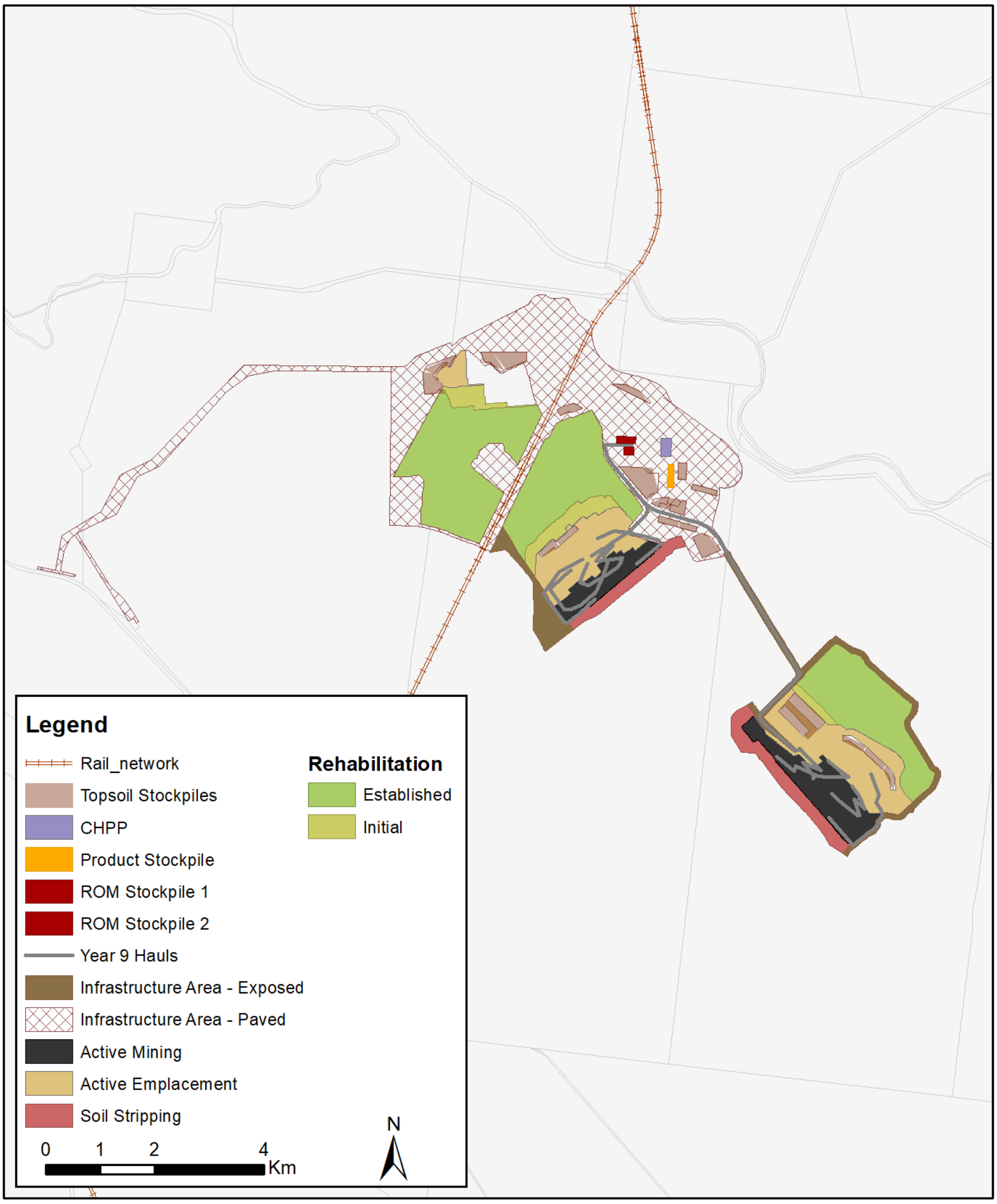


Figure 13 Year 9 – Dust emission source areas

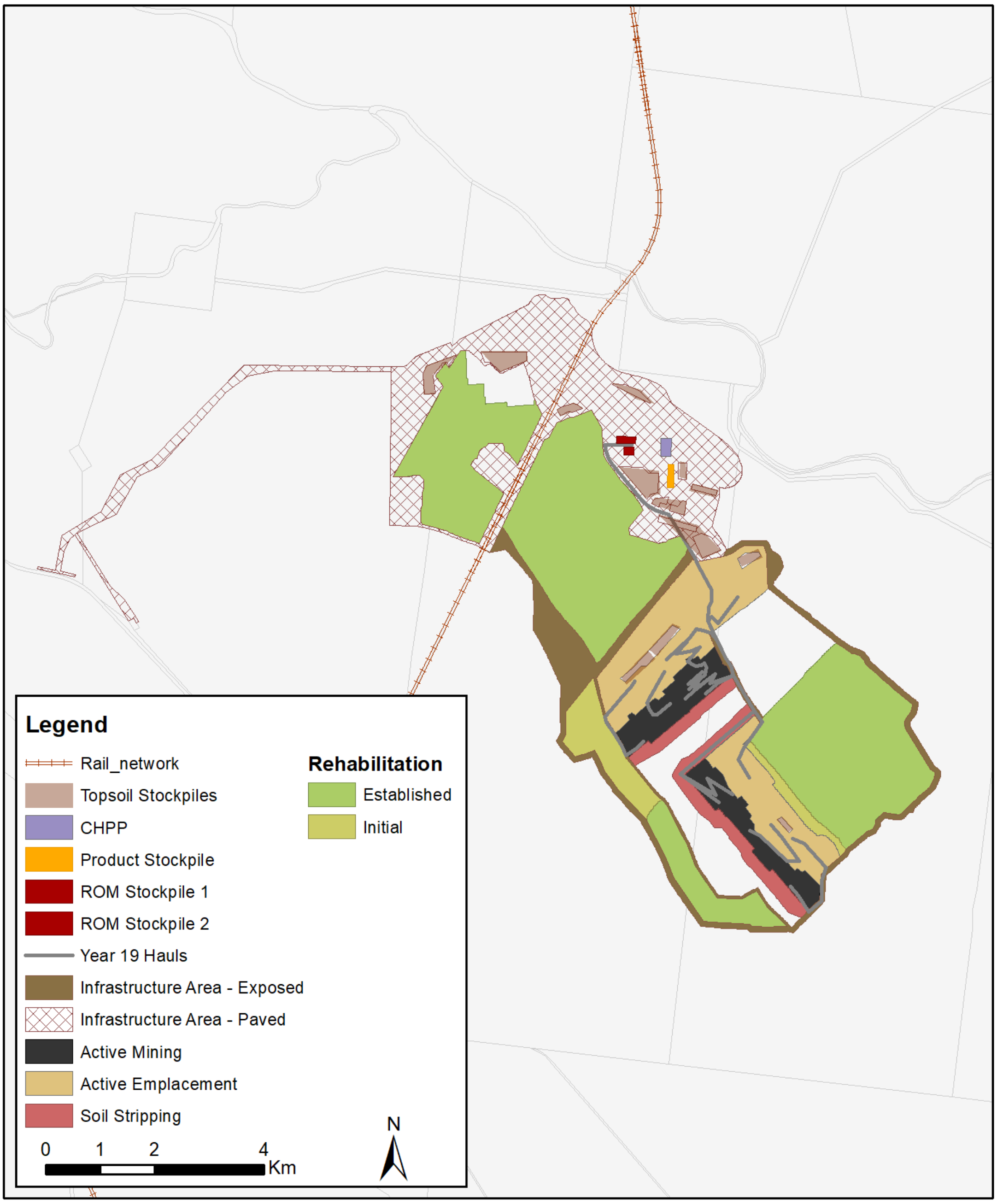


Figure 14 Year 19 – Dust emission source areas

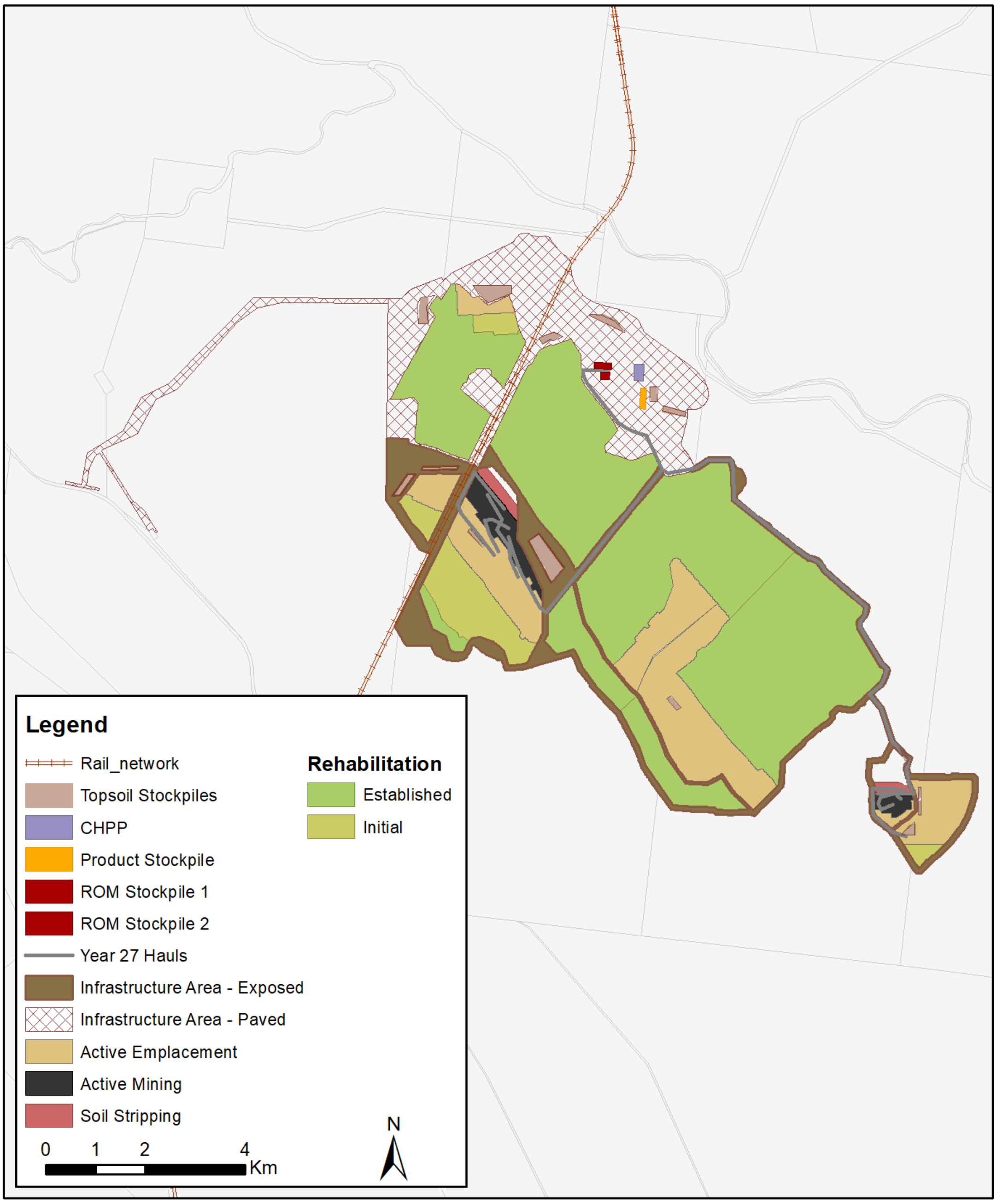


Figure 15 Year 27 – Dust emission source areas

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 10 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.

Table 10 Predicted annual average ground-level concentrations of TSP (µg/m^3)

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	6.2	50.4	7.7	51.9	11.2	55.4	3.9	48.1
R2	4.5	48.7	3.4	47.6	4.3	48.5	3.0	47.2
R3	1.3	45.5	1.1	45.3	1.6	45.8	1.0	45.2
R4	0.2	44.4	0.3	44.5	0.4	44.6	0.2	44.4
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 11 and Table 12, 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 average 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 mitigation measures that are discussed in Section 6.2 and include the following:
    - Application of chemical suppressant on hauls for 29 nights in Year 9.
    - Application of chemical suppressant on hauls for 51 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} across all assessment years. R1 is located 1.4 km from the Project.
- The cumulative assessment results for all other receptors demonstrate compliance with the 24-hour average and annual average air quality objectives.
- For R2, 6.5 km from the Project, the predicted 24-hour average and annual average concentrations of PM_{10} require application of proactive mitigation measures to ensure compliance. This includes the following:
    - The predicted 24-hour average concentrations at R2 for Year 5, 9 and 19 include the application of chemical suppressant on hauls for 3, 1 and 1 nights, respectively.
    - The annual average concentrations at R2 for Year 5 and 19 include the application of chemical suppressant on hauls for 100 nights and 55 nights, respectively.
- 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 11 Predicted maximum 24-hour average ground-level concentrations of PM_{10} ($\mu g/m^3$)

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	42.5	**69.6**	38.3[A]	**65.5[A]**	47.9[B]	**75.1[B]**	35.8	**63.0**
R2	26.1	46.1[C]	27.0	48.5[D]	30.5	49.8[E]	15.8	43.0
R3	9.0	36.2	8.02	35.2	10.52	37.7	7.56	34.8
R4	8.0	35.2	11.4	38.6	13.13	40.3	5.68	32.9
Objective	**50**							

Table note:
[A] Predicted concentration accounts for the application of chemical suppressant on hauls for 29 nights
[B] Predicted concentration accounts for the application of chemical suppressant on hauls for 51 nights
[C] Predicted concentration accounts for the application of chemical suppressant on hauls for 3 nights
[D] Predicted concentration accounts for the application of chemical suppressant on hauls for 1 night
[E] Predicted concentration accounts for the application of chemical suppressant on hauls for 1 night

Table 12 **Predicted annual average ground-level concentrations of PM_{10} (µg/m^3)**

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**	5.6	**27.7**	7.6	**29.7**	3.0	**25.1**
R2	2.8^{A}	24.9^{A}	2.8	24.9	2.8^{B}	24.9^{B}	2.4	24.5
R3	1.1	23.2	0.9	23.0	1.3	23.4	0.8	22.9
R4	0.2	22.3	0.3	22.4	0.3	22.4	0.2	22.3
Objective	**25**							

Table note:
^{A} Predicted concentration accounts for the application of chemical suppressant on hauls at night, required on 100 nights
^{B} Predicted concentration accounts for the application of chemical suppressant on hauls at night, required on 55 nights

7.3 $PM_{2.5}$

Table 13 and Table 14 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.

Table 13 **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	8.6	12.9	14.6	18.9	11.9	16.2	6.6	10.9
R2	8.1	12.4	8.6	12.9	8.2	12.5	4.9	9.2
R3	3.8	8.1	3.6	7.9	3.9	8.2	3.0	7.3
R4	1.8	6.1	2.5	6.8	2.9	7.2	1.3	5.6
Objective	**25**							

Table 14 **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	0.8	4.4	0.9	4.5	1.2	4.8	0.6	4.2
R2	1.0	4.6	0.8	4.4	0.9	4.5	0.6	4.2
R3	0.4	4.0	0.3	3.9	0.4	4.0	0.3	3.9
R4	0.0	3.6	0.1	3.7	0.1	3.7	0.05	3.6
Objective	**8**							

7.4 Dust Deposition

Table 15 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.

Table 15 Predicted maximum monthly dust deposition rates (mg/m^2/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	85.1	7.1	78.1	24.4	95.4	7.1	78.1
R2	11.3	82.3	6.6	77.6	6.7	77.7	6.6	77.6
R3	3.6	74.6	3.9	74.9	3.3	74.3	3.9	74.9
R4	0.5	71.5	0.4	71.4	0.7	71.7	0.4	71.4
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 (DSITIA, 2013 and 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 (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 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.

Lastly, 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.

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 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 complies with all of the objectives 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.

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 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, building on the 2020 target of reducing emissions by 5% below 2000 levels.

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:

$$\text{tonnes } \mathbf{CO_2\text{-}e} = \text{tonnes } \mathbf{CO_2} \text{ x } \boxed{\mathbf{1}} + \text{tonnes } \mathbf{CH_4} \text{ x } \boxed{\mathbf{25}} + \text{tonnes } \mathbf{N_2O} \text{ x } \boxed{\mathbf{310}}$$

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 (2023). 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 16.

Table 16 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 17 (Commonwealth of Australia, 2020).

Table 17 Annual GHG emissions for Australia and Queensland – 2018

Category	Australia	Queensland	
	Emissions (Mt CO_2-e)	Emissions (Mt CO_2-e)	Contribution to national emissions
Inventory total*	536.5	171.7	32%
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.

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

Table 18 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 (Qld – open cut)	37.7 x 10^{-3}	GJ/t	0.023			t CO_2-e/tROM [1]
Explosives (Ammonium Nitrate Fuel Oil - ANFO)	2.4	GJ/t	0.17			t CO_2-e/tANFO [2]
Electricity (Queensland)	3.6	MJ/kWh		0.81	0.12	kg CO_2-e/kWh [1]
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]
Shipping – bulk carrier					0.00354	kg CO_2-e/ tonne.km [3]

Table notes:
[1]*National Greenhouse and Energy Reporting (Measurement) Determination 2008*, as amended in July 2020, and *National Greenhouse Accounts Factors* (Department of Environment and Energy, 2019),
[2]*National Greenhouse Accounts (NGA) Factors* (Department of Climate Change, 2008),
[3]*UK Government GHG Conversion Factors for Company Reporting* (Department for Environment, Food and Rural Affairs, 2020).
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 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. Additionally, GHG emissions originating from land clearing are not expected to be significant compared to the annual Scope 1 and Scope 2 GHG emissions associated with the Project, with GHG emissions from land clearing estimated to account for approximately 1% of the overall annual GHG emissions of the Project.

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 19.

Table 19 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. A summary of estimated Scope 1 and Scope 2 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 20. The Project would be carried out in three phases:

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

Average annual GHG emissions associated with the Project have been estimated to be 556,000 t CO_2-e.

Maximum annual GHG emissions associated with the Project occur in Year 16. Emissions in Year 16 have been estimated to be 749,000 t CO_2-e.

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 (Scopes 1 and 2) GHG emissions from the Project at a State and National scale is provided in Table 21.

Table 20 **Summary of estimated annual Scope 1 and Scope 2 GHG emissions (t CO_2-e) and energy use (GJ) for the Project**

Project Year	Energy	Scope 1				Scope 2	TOTAL
		Diesel (mining)	Fugitive gas	Blasting	Total	Electricity	Scope 1 + Scope 2
	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	264,000	16,700	23,000	657	40,400	3,960	44,300
3	1,310,000	83,500	115,000	2,400	201,000	19,800	221,000
4	3,510,000	226,000	311,000	4,680	541,000	53,400	594,000
5	3,890,000	251,000	345,000	4,790	600,000	59,400	660,000
6	4,320,000	279,000	384,000	4,740	668,000	66,100	734,000
7	3,970,000	256,000	352,000	4,820	612,000	60,600	673,000
8	4,410,000	284,000	391,000	5,160	680,000	67,300	747,000
9	4,010,000	257,000	354,000	5,640	617,000	61,000	678,000
10	4,160,000	267,000	368,000	5,620	641,000	63,300	704,000
11	4,260,000	274,000	377,000	5,590	657,000	64,900	722,000
12	4,110,000	264,000	363,000	5,630	633,000	62,600	696,000
13	3,930,000	252,000	347,000	5,660	605,000	59,800	665,000
14	4,010,000	257,000	354,000	5,670	617,000	61,000	678,000
15	4,430,000	284,000	391,000	6,450	681,000	67,300	749,000
16	4,430,000	284,000	391,000	6,460	681,000	67,300	749,000
17	3,970,000	254,000	350,000	6,530	610,000	60,200	670,000
18	3,820,000	244,000	336,000	6,570	586,000	57,800	644,000
19	3,690,000	236,000	324,000	6,570	566,000	55,800	622,000
20	3,620,000	232,000	320,000	5,700	558,000	55,000	613,000
21	4,030,000	259,000	357,000	5,620	621,000	61,400	682,000
22	3,550,000	227,000	313,000	5,650	546,000	53,800	600,000

Project Year	Energy	Scope 1				Scope 2	TOTAL
		Diesel (mining)	Fugitive gas	Blasting	Total	Electricity	Scope 1 + Scope 2
	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	3,980,000	256,000	352,000	5,480	613,000	60,600	674,000
24	3,180,000	204,000	281,000	4,750	489,000	48,300	537,000
25	2,340,000	149,000	205,000	5,000	358,000	35,200	394,000
26	2,060,000	130,000	179,000	4,830	315,000	30,900	345,000
27	1,300,000	81,900	113,000	3,880	198,000	19,400	218,000
28	855,000	53,500	73,600	2,750	130,000	12,700	142,000
29	664,000	41,800	57,500	1,900	101,000	9,900	111,000
TOTAL	**92,000,000**	**5,900,000**	**8,130,000**	**139,000**	**14,200,000**	**1,400,000**	15,600,000
Average	3,290,000	211,000	290,00	4,970	506,000	50,000	556,000
Note: values presented to three significant figures.							

Table 21 **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	0.75	536.5	0.14	171.7	0.43

Notes: [1]Estimated maximum annual GHG emissions [2]State and Territory Greenhouse Gas Inventories 2017 (Commonwealth of Australia, 2020), GHG emissions excluding Land Use and Land Use Change.

8.5.2 Scope 3

Estimated annual Scope 3 emissions for the Project are summarised in Table 22. 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 22.

Table 22 **Summary of estimated annual Scope 3 GHG emissions in t CO_2-e**

Year	Diesel + Electricity*	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	1,441	3,428	18,054	625,346	773,052	1,421,321	0.0039
3	7,204	18,852	99,297	3,002,297	5,135,274	8,262,924	0.0225
4	19,452	47,416	249,747	8,516,145	10,905,555	19,738,315	0.0538
5	21,613	51,986	273,819	9,352,531	12,092,742	21,792,692	0.0594
6	24,062	56,557	297,891	10,600,998	12,755,358	23,734,866	0.0647
7	22,045	52,558	276,828	9,084,056	12,893,403	22,328,889	0.0608
8	24,495	57,128	300,900	9,524,679	14,246,244	24,153,446	0.0658
9	22,189	55,985	294,882	7,953,146	15,958,002	24,284,205	0.0662
10	23,054	55,414	291,873	8,688,077	14,881,251	23,939,669	0.0652
11	23,630	58,842	309,927	8,736,979	16,427,355	25,556,733	0.0696
12	22,766	57,699	303,909	8,201,170	16,510,182	25,095,725	0.0684
13	21,757	52,558	276,828	8,184,487	13,970,154	22,505,783	0.0613
14	22,189	54,843	288,864	8,369,941	15,046,905	23,782,742	0.0648
15	24,495	59,984	315,945	9,360,791	15,985,611	25,746,826	0.0702
16	24,495	59,413	312,936	9,753,607	15,350,604	25,501,055	0.0695
17	21,901	52,558	276,828	8,581,465	13,666,455	22,599,207	0.0616
18	21,037	51,415	270,810	8,349,405	13,362,756	22,055,423	0.0601
19	20,316	48,559	255,765	7,875,252	12,727,749	20,927,641	0.0570
20	20,028	49,130	258,774	7,601,857	13,445,583	21,375,372	0.0582
21	22,333	53,700	282,846	8,408,176	14,384,289	23,151,345	0.0631
22	19,596	47,416	249,747	7,616,546	12,451,659	20,384,964	0.0555
23	22,045	54,272	285,855	9,472,061	13,141,884	22,976,117	0.0626
24	17,578	42,846	225,675	7,494,349	10,436,202	18,216,650	0.0496

Year	Diesel + Electricity*	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	%
25	12,824	31,992	168,504	5,470,916	7,951,392	13,635,628	0.0372
26	11,239	27,421	144,432	5,111,176	6,184,416	11,478,684	0.0313
27	7,060	16,567	87,261	3,394,742	3,478,734	6,984,365	0.0190
28	4,611	13,711	72,216	2,664,629	3,092,208	5,847,374	0.0159
29	3,602	10,283	54,162	2,548,402	1,684,149	4,300,598	0.0117
TOTAL	**509,056**	**1,242,534**	**6,544,575**	**204,543,228**	**318,939,168**	**531,778,561**	-
Average	18,181	44,376	233,735	7,305,115	11,390,685	18,992,091	0.0517

Notes: [1] United Nations Framework Convention on Climate Change (2020)
*Production and distribution related emissions
Note: Totals may not add exactly due to rounding.

8.6 Regulatory Obligations – NGER and the Safeguard Mechanism

As detailed in Table 20, the estimated annual GHG emissions of the Project range from:

- Scope 1: 40 – 681 kilotonnes of carbon dioxide equivalent per year (kt CO_2-e/y)
- Scope 2: 4 – 67 kt CO_2-e/y
- Total: 44 – 749 kt CO_2-e/y.

Based on the NGER Reporting thresholds detailed in Table 16, 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 1, 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; however, the exact implications of this would need to be reviewed on an annual basis in communication with the Clean Energy Regulator.

8.7 GHG Mitigation and Management

Whitehaven WS would develop a plan to abate carbon dioxide emissions which would include 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).

Whitehaven WS considered the potential use of carbon capture and sequestration of GHG emissions; however, it has been determined that these measures are not viable at this stage.

9. CONCLUSIONS

This air quality and greenhouse gas assessment was conducted for inclusion in the EIS 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 levels 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.

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 proposed proactive dust management system.
- Predicted cumulative concentrations of PM_{10} were found to be elevated at the one closest sensitive receptor and ***comply*** with the relevant air quality objectives at all other sensitive receptors. To 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.

$PM_{2.5}$

- 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.

The GHG assessment of the Project found the following:

- Maximum annual Scope 1 and Scope 2 GHG emissions associated with the Project are estimated to be approximately 749,000 t CO_2-e (Year 16).
- Average annual Scope 1 and Scope 2 GHG emissions over the life of Project are estimated to be approximately 556,000 t CO_2-e.

Compared to National and State GHG inventory levels, the estimated maximum annual GHG emissions from the Project would account for approximately 0.14% and 0.43%, respectively.

10. REFERENCES

ACARP Project C22027, 2015. *Development of Australia-specific PM_{10} Emission Factors for Coal Mines*. Prepared for the Australian Coal Association Research Program by Pacific Environment Operations Pty Ltd.

Aurizon, 2020. *Coal Dust Management Plan*.

BHP Billiton Mitsubishi Alliance, 2010. *Caval Ridge Mine Project Environmental Impact Statement*. Available at: https://www.statedevelopment.qld.gov.au/assessments-and-approvals/caval-ridge-mine-eis-documents.html.

Commonwealth of Australia, 2020. *State and Territory Greenhouse Gas Inventories 2018*. May 2020. Available online at: https://www.industry.gov.au/data-and-publications/national-greenhouse-gas-inventory-report-2018f

Department for Environment, Food and Rural Affairs, 2020. *UK Government GHG Conversion Factors for Company Reporting*. July 2020.

Department of Climate Change, 2008. *National Greenhouse Accounts (NGA) Factors*. January 2008.

Department of Environment and Science, 2013. *Guideline – Model water conditions for coal mines in the Fitzroy basin*.

Department of Environment and Science, 2017a. *Application requirements for activities with impacts to air.* Version 4.03, October 2019.

Department of Environment and Science, 2017b. *Guideline – Model mining conditions.* Version 6.02, March 2017.

Department of Science, Information Technology and Innovation, 2016. *Western – Metropolitan Rail System Phase 2 Coal Dust Monitoring Program, Phase 2 monitoring report: February 2014 to December 2015*. Prepared for the Queensland Resources Council.

Department of Science, Information Technology, Innovation and the Arts, 2013. *Western – Metropolitan Rail Systems Coal Dust Monitoring Program*. Prepared for the Queensland Resources Council.

Department of the Environment and Energy, 2019. *National Greenhouse Accounts Factors*. August 2019.

Environmental Risk Sciences (2019) *Maxwell Project Human Health Risk Assessment*.

Katestone Environmental, 2008a. *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains*. Report for Queensland Rail Limited.

Katestone Environmental, 2008b. *Moura Link – Aldoga Rail Project, Air Quality Assessment*. Report for Connell Hatch.

Katestone Environmental Pty Ltd, 2015. *Air Quality Impact Assessment for the Moranbah South Project*. Report prepared for Hansen Bailey.

Katestone Environmental Pty Ltd, 2018. *Air Quality and Greenhouse Gas Assessment of the Olive Downs Coking Coal Project.*

National Pollutant Inventory, 2012. *Emission Estimation Technique Manual for Mining*. Version 3.1.

National Pollutant Inventory, 2020. *National Pollutant Inventory 2018/19 Database*. Available online at: https://www.npi.gov.au/npi-data (accessed September 2020).

Queensland Data, 2020. *Ambient air quality monitoring dataset from Moranbah Station 2012-2019*. Available for downland at Queensland Data (https://data.qld.gov.au/) (accessed January 2020).

Queensland Government, 1994. *Environmental Protection Act*.

Queensland Government, 2019. *Environmental Protection (Air) Policy 2019.*

United Nations Framework Convention on Climate Change, 2020. *Transformational Action Needed for Paris Agreement Targets - United in Science Report*.

United States Environmental Protection Agency, 1998. *Western surface coal mining, AP42 Chapter 11.9*. United States Environmental Protection Agency Office of Air Quality Planning and Standards.

United States Environmental Protection Agency, 2006. *Industrial wind erosion, AP4.2 Chapter 13.2.5*. United States Environmental Protection Agency Office of Air Quality Planning and Standards.

APPENDIX A AIR QUALITY CONTOUR PLATES

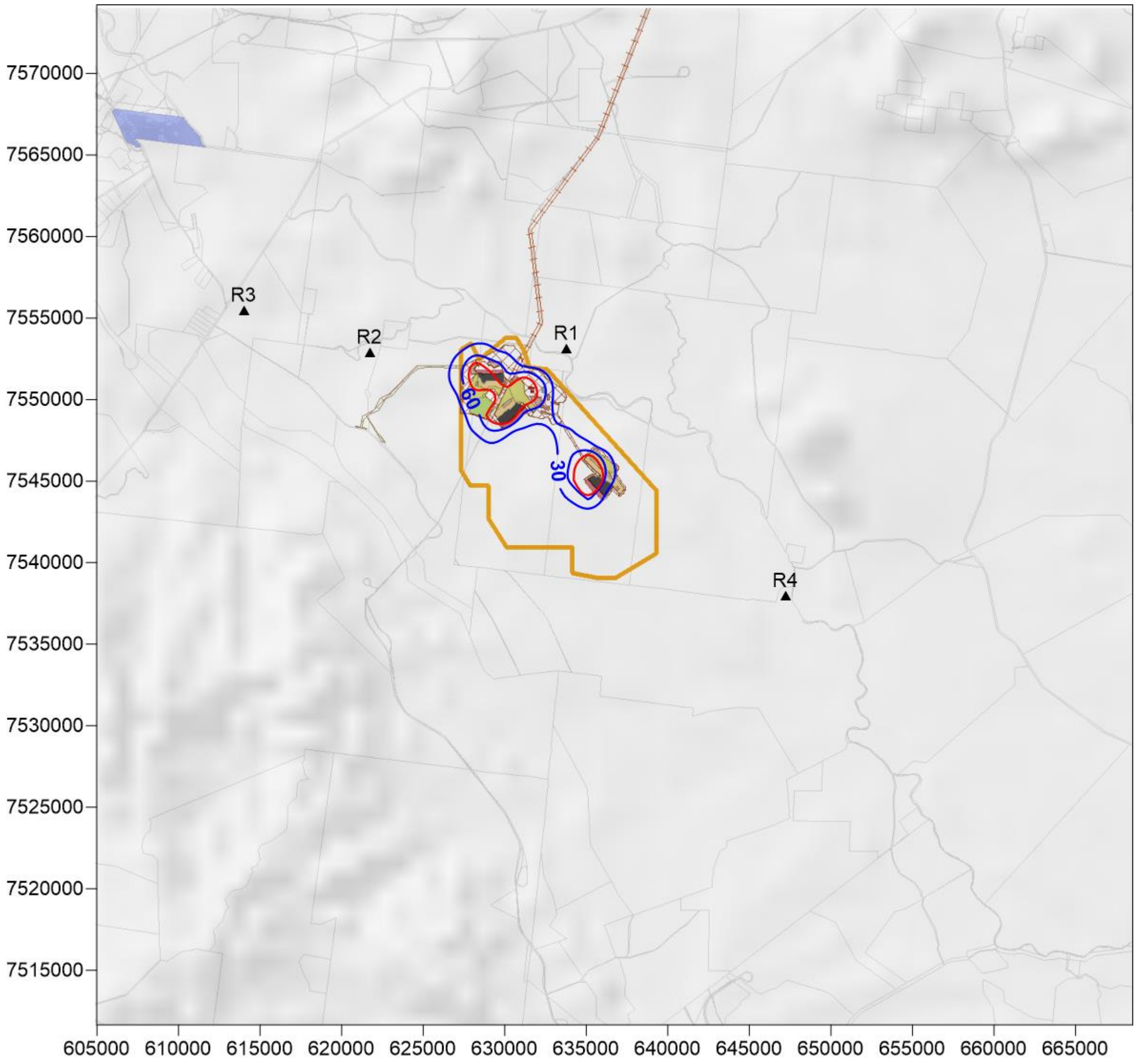


Plate 1 Year 5 predicted annual average ground level concentration of TSP

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Annual average	**Objective:** 90 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

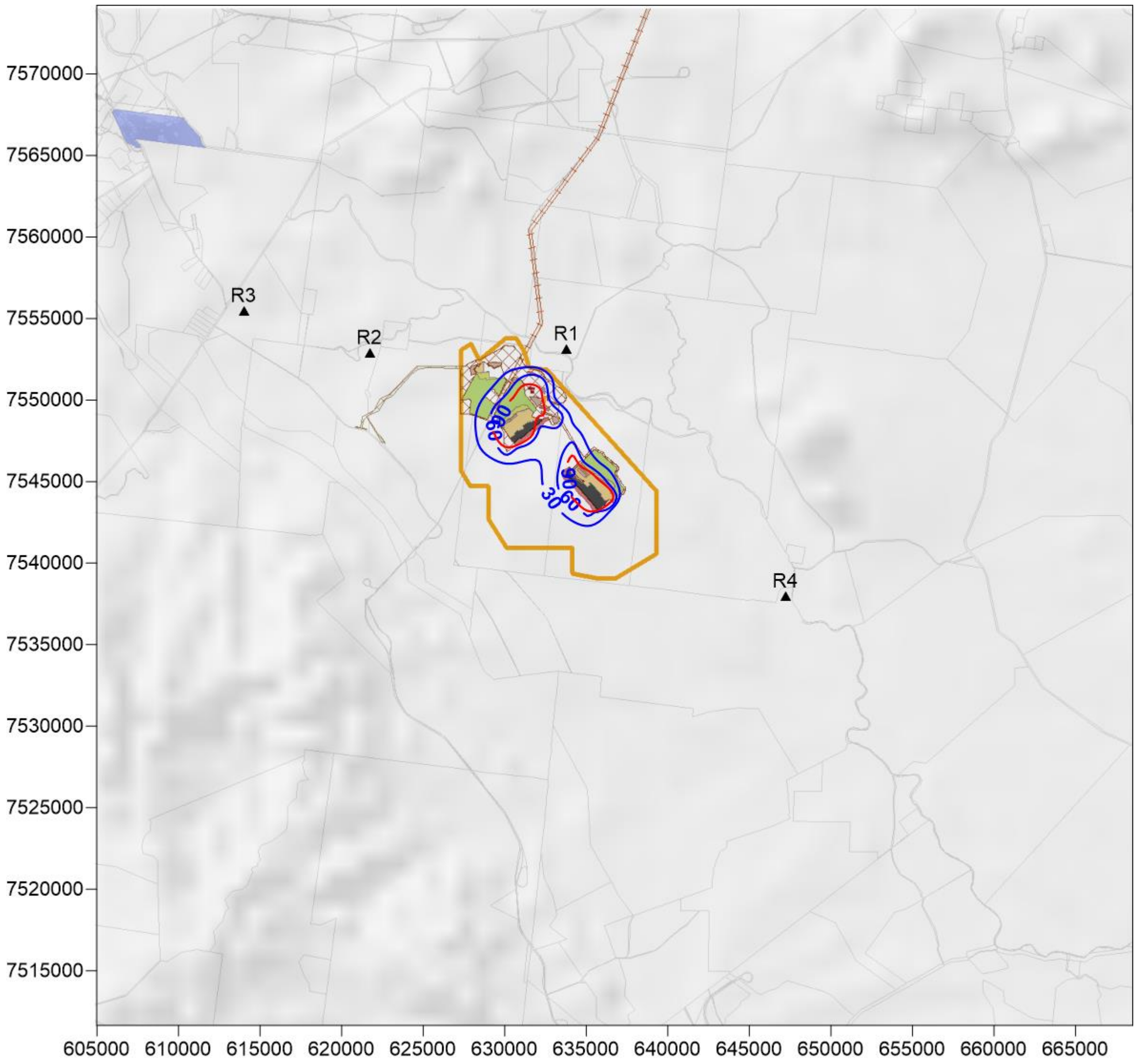


Plate 2 Year 9 predicted annual average ground level concentration of TSP

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:** August 2020

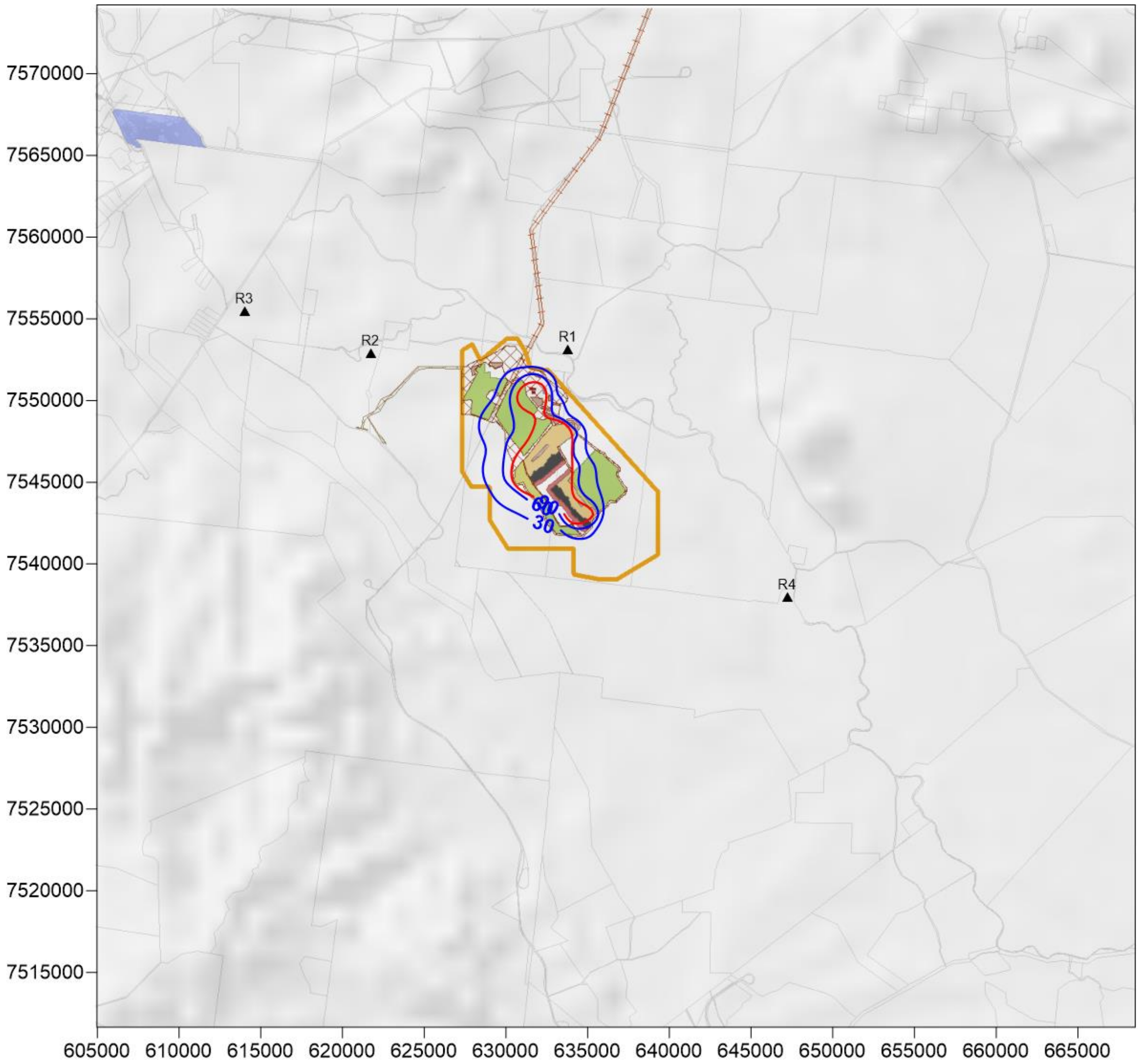


Plate 3 Year 19 predicted annual average ground level concentration of TSP

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Annual average	**Objective:** 90 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

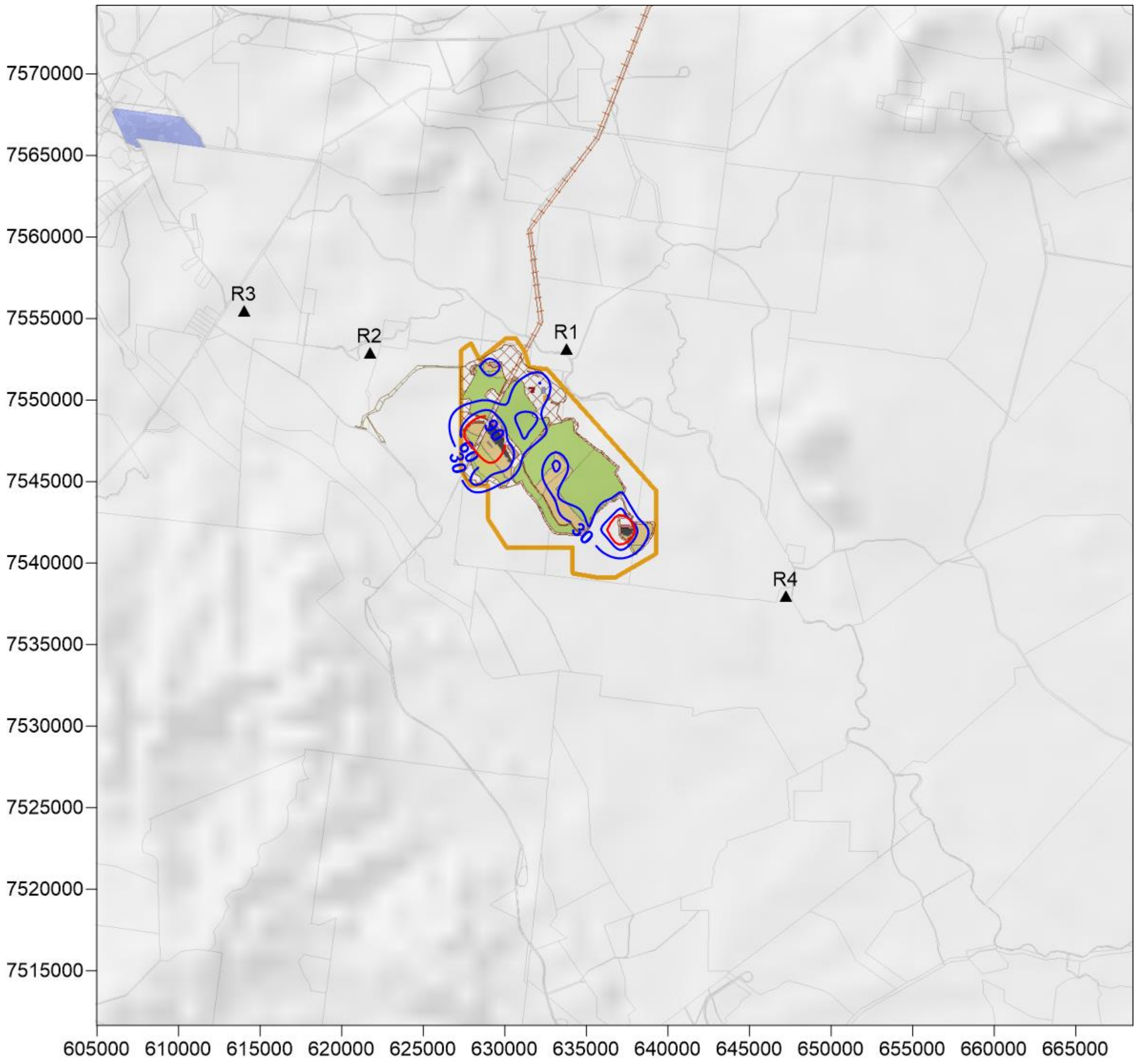


Plate 4 **Year 27 predicted annual average ground level concentration of TSP**

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Annual average	**Objective:** 90 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

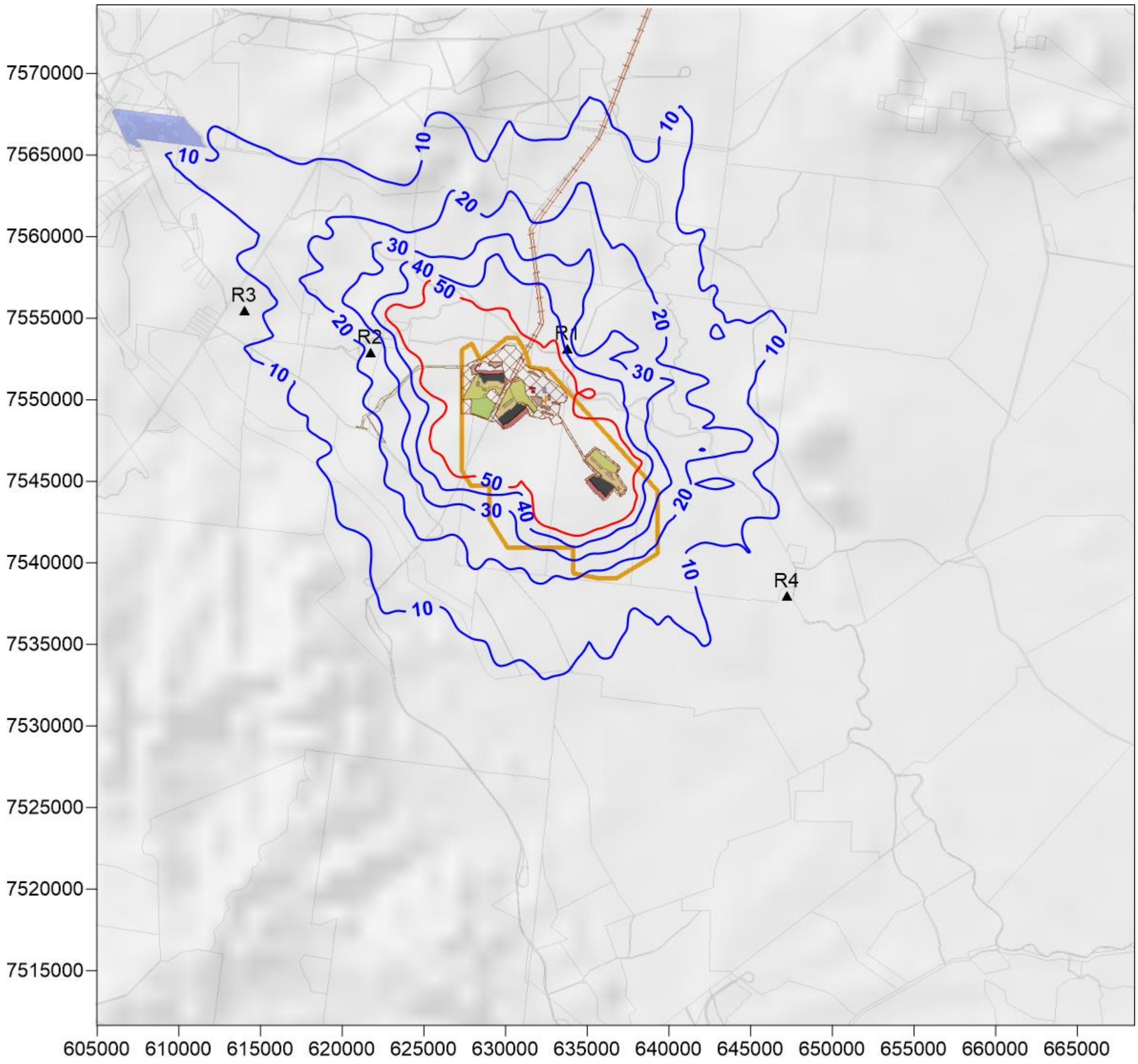


Plate 5	Year 5 predicted maximum 24-hour ground level concentration of PM_{10}		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m^3
Type: 24-hour maximum	**Objective:** 50 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

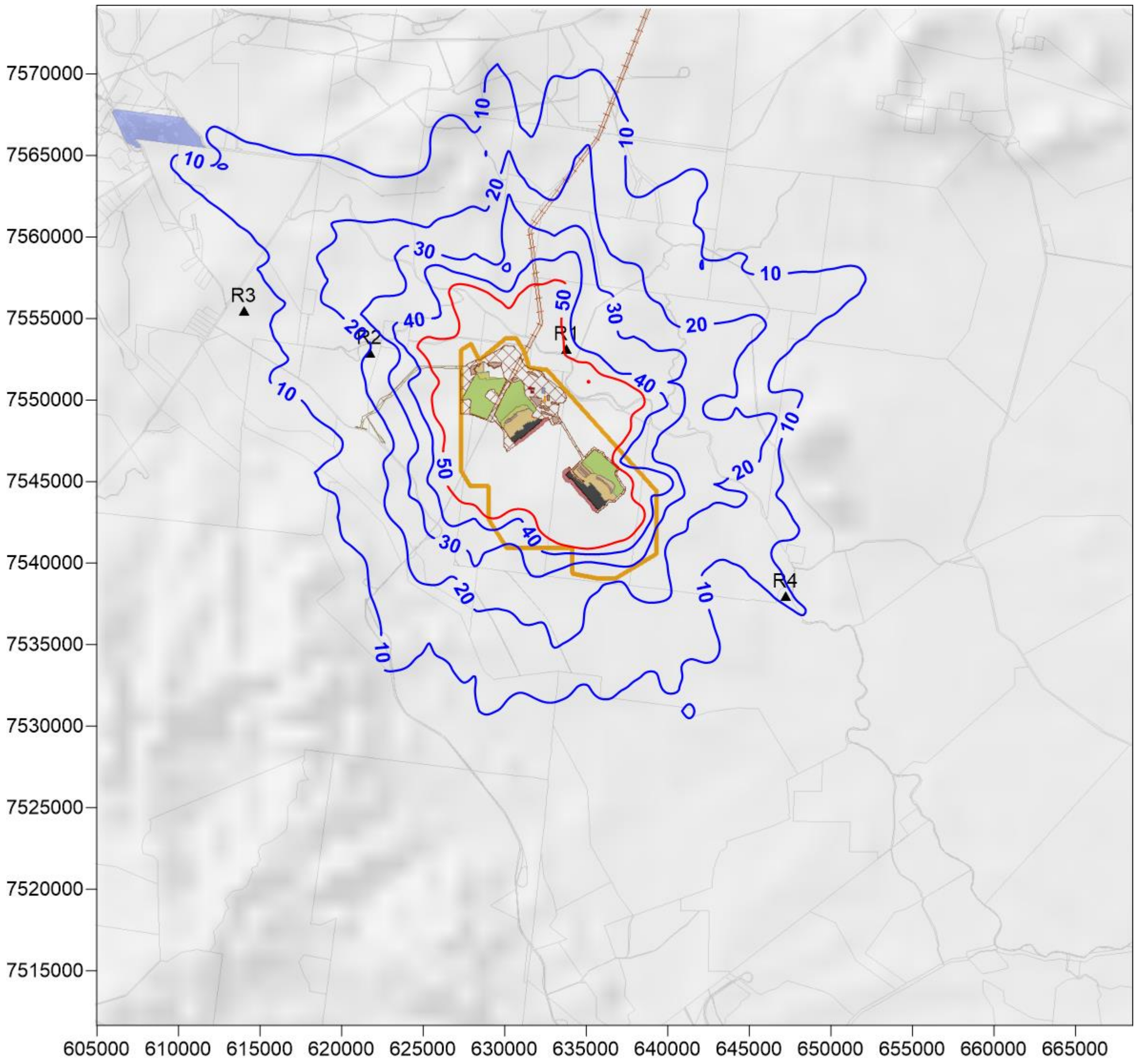


Plate 6 Year 9 predicted maximum 24-hour ground level concentration of PM_{10}

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:** August 2020

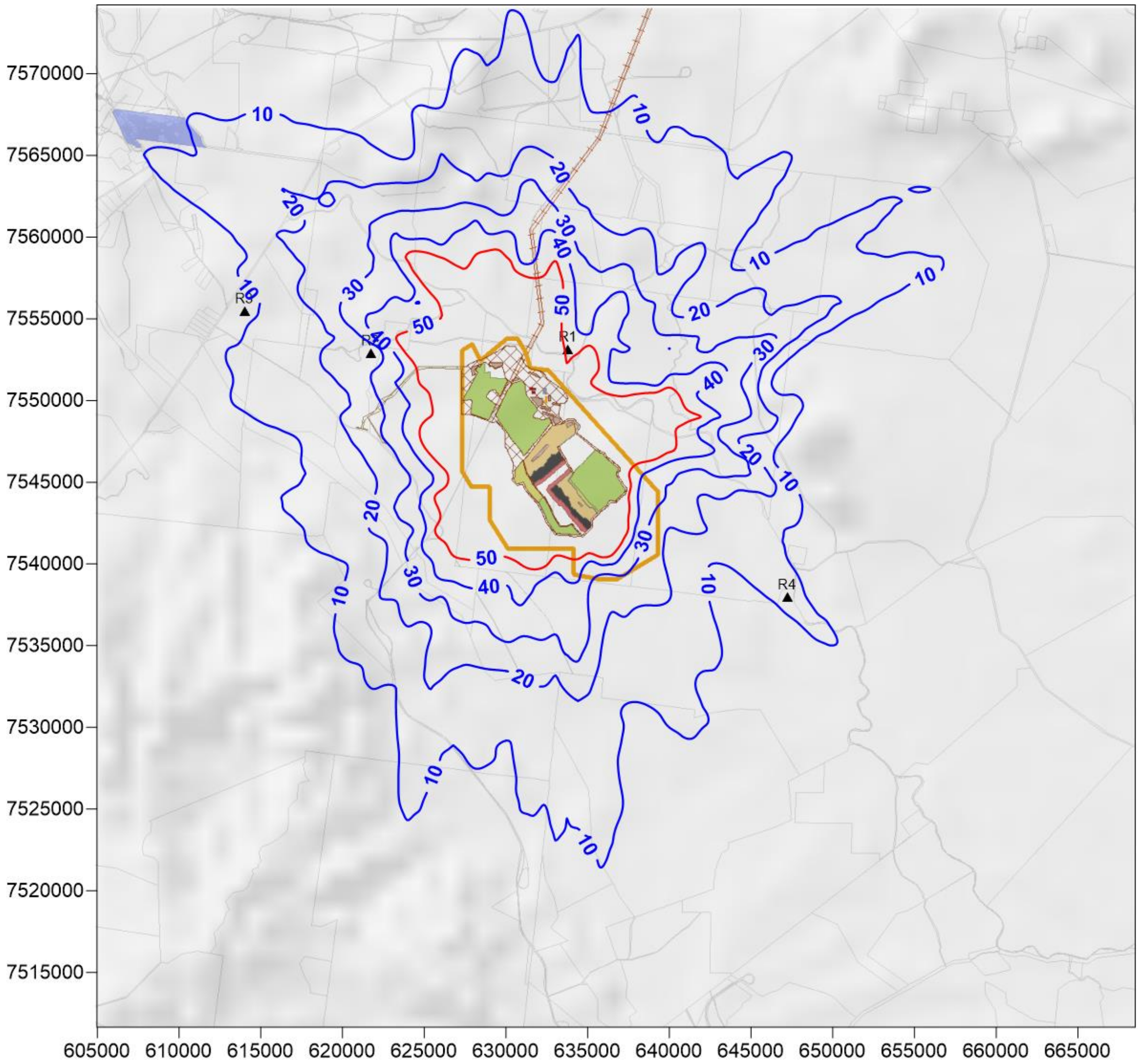


Plate 7	**Year 19 predicted maximum 24-hour ground level concentration of PM_{10}**

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m^3
Type: 24-hour maximum	**Objective:** 50 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

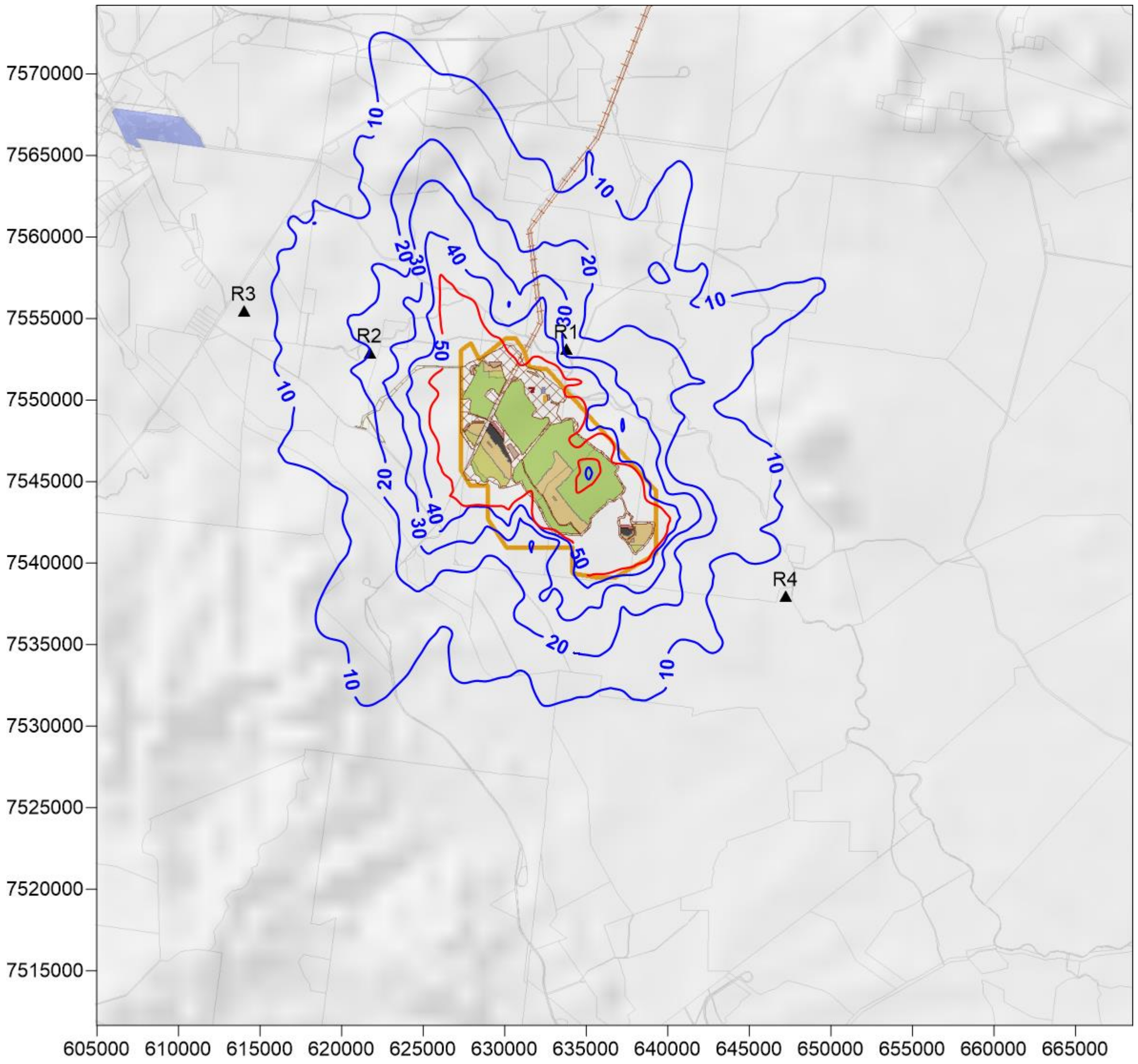


Plate 8 Year 27 predicted maximum 24-hour ground level concentration of PM$_{10}$

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:** August 2020

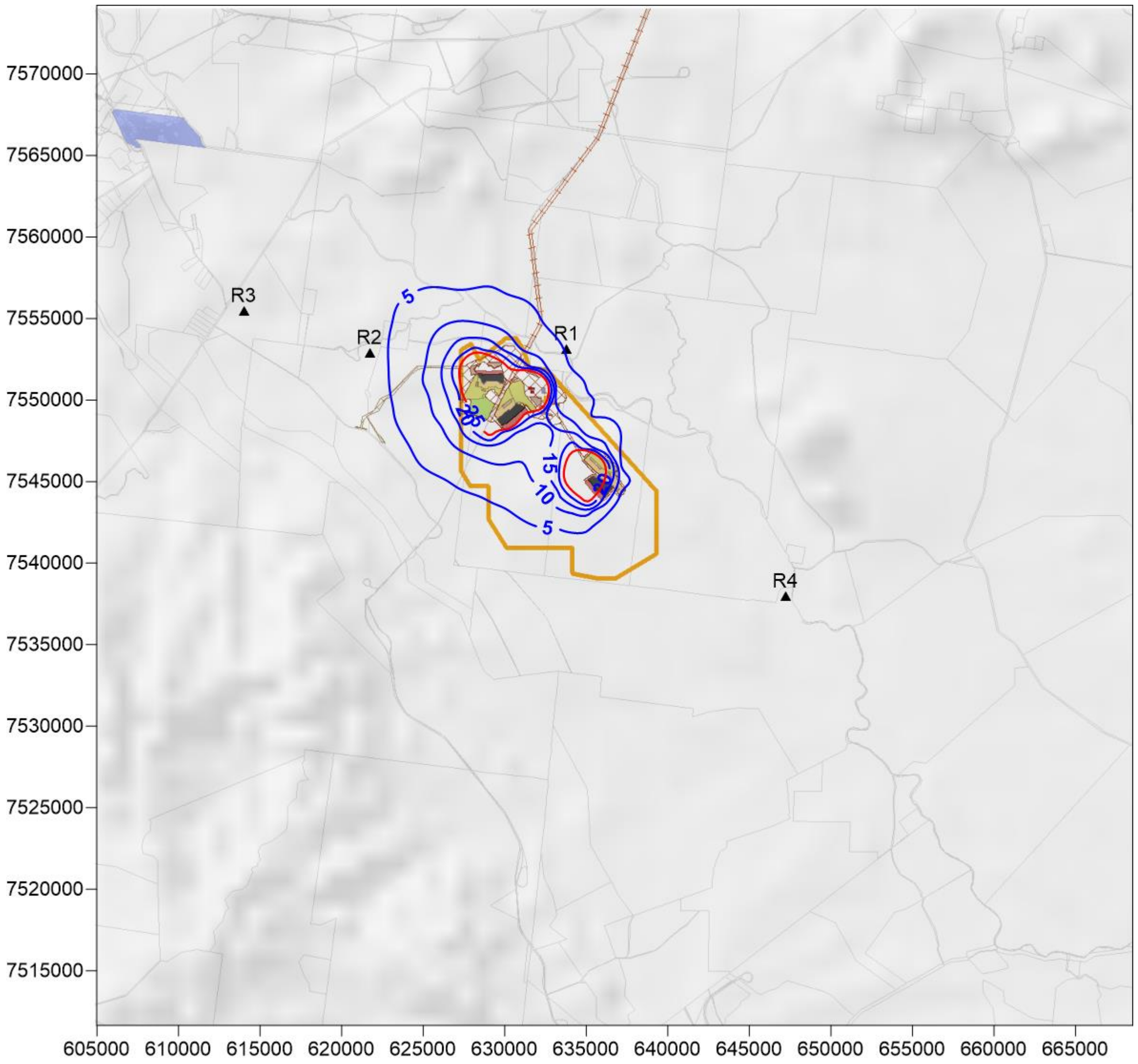


Plate 9 Year 5 predicted annual average ground level concentration of PM_{10}

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:** August 2020

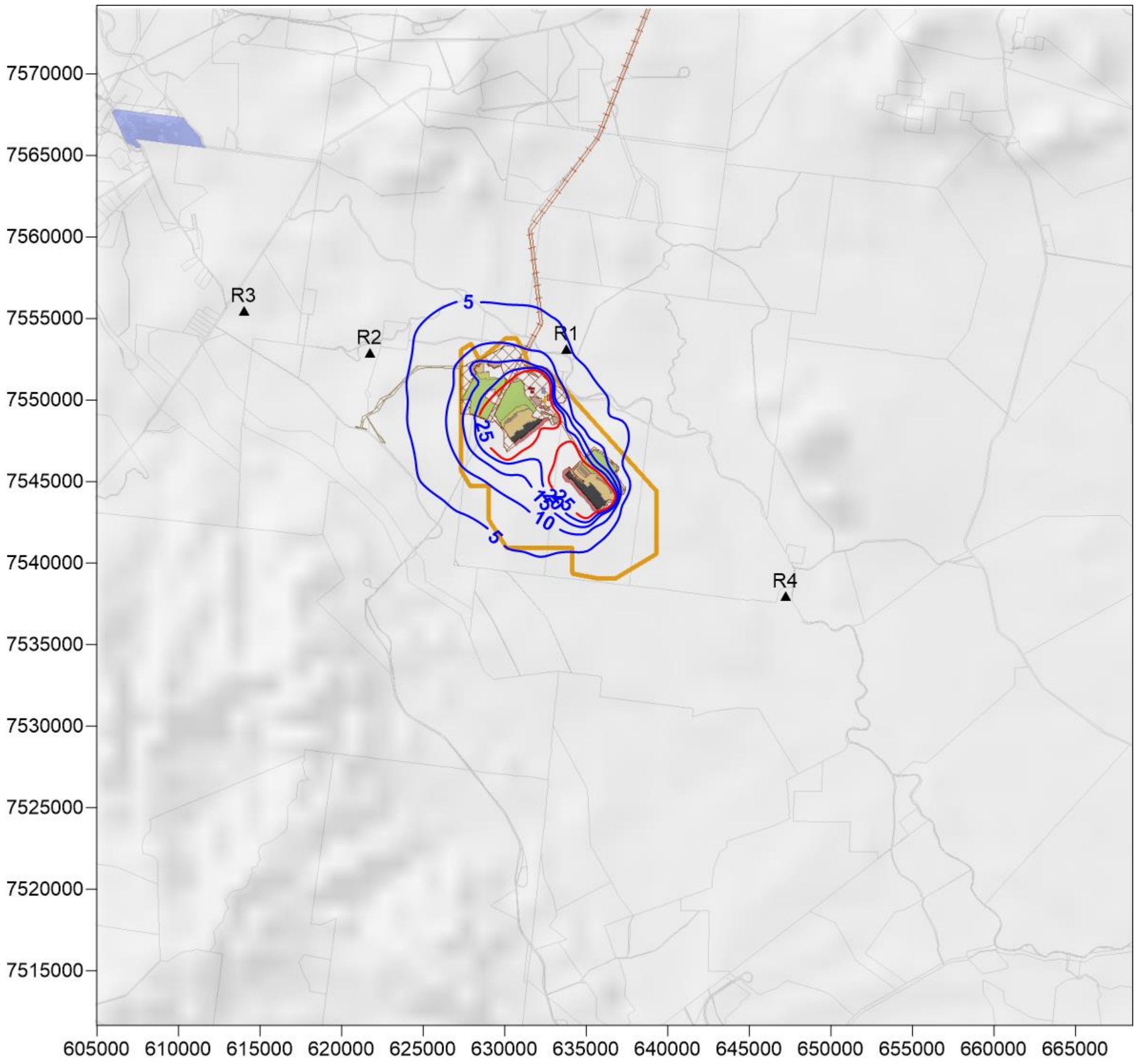


Plate 10 Year 9 predicted annual average ground level concentration of PM_{10}

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	August 2020

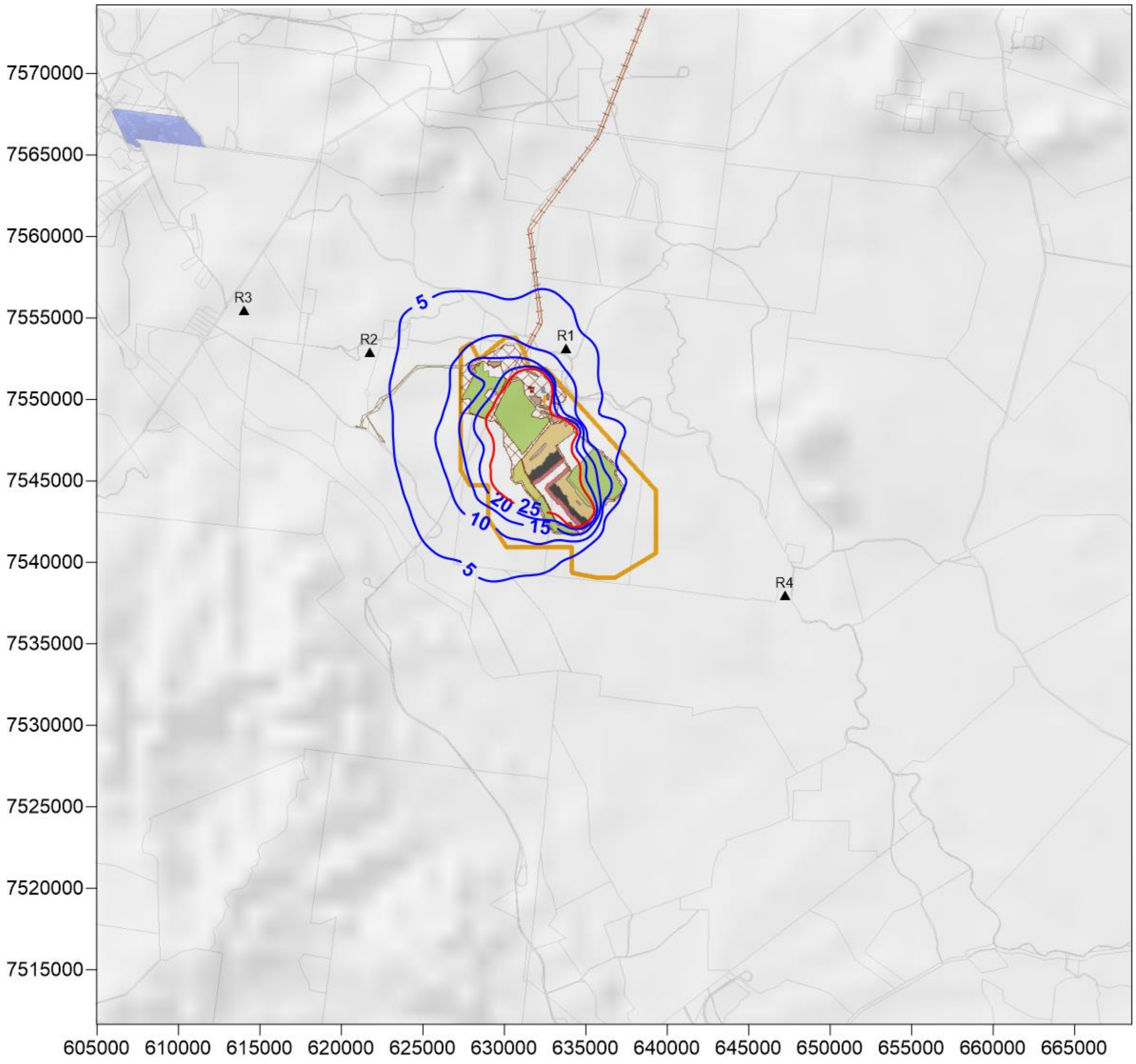


Plate 11	Year 19 predicted annual average ground level concentration of PM_{10}		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average	**Objective:** 25 µg/m³ (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

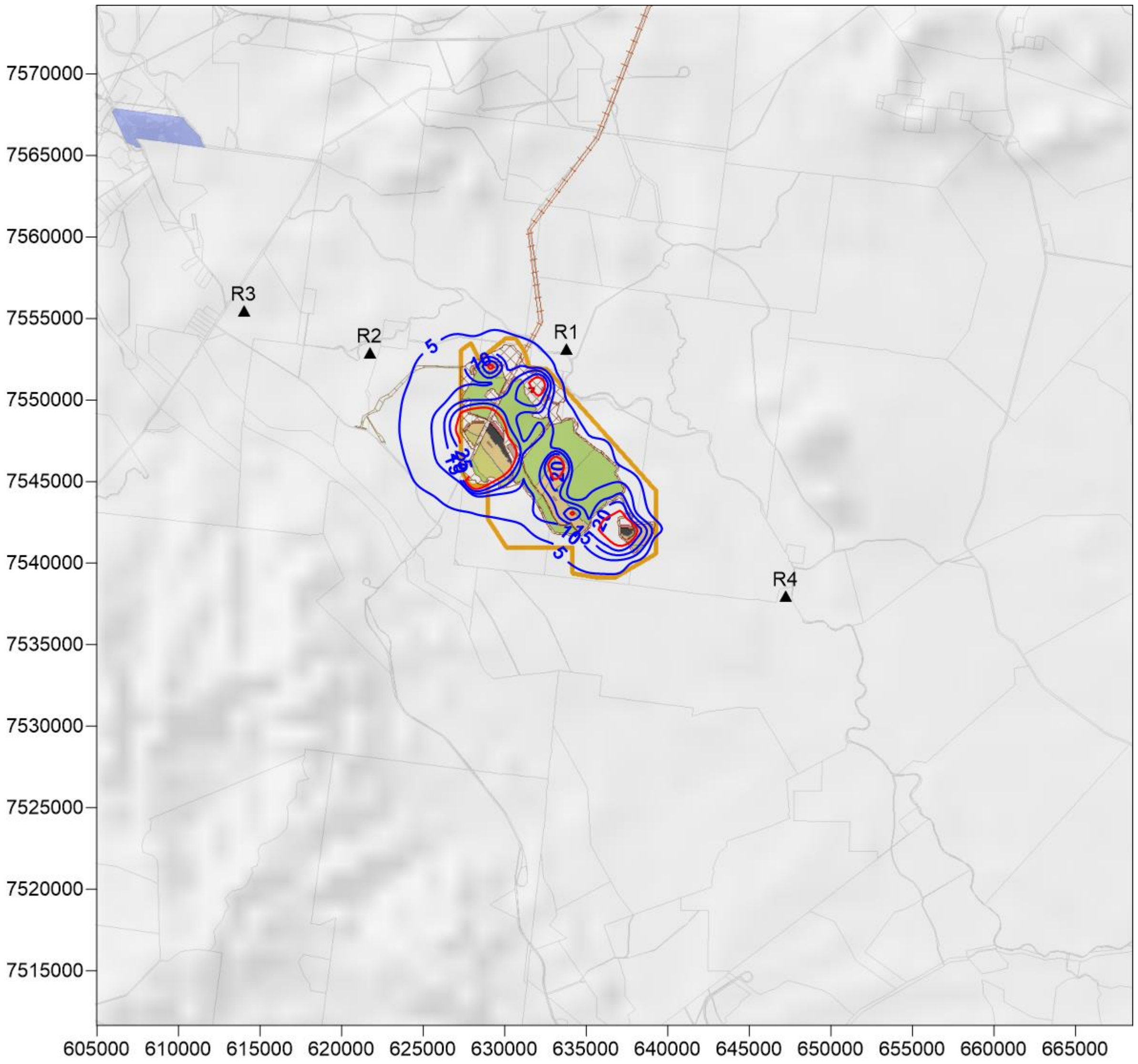


Plate 12 Year 27 predicted annual average ground level concentration of PM_{10}

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:** August 2020

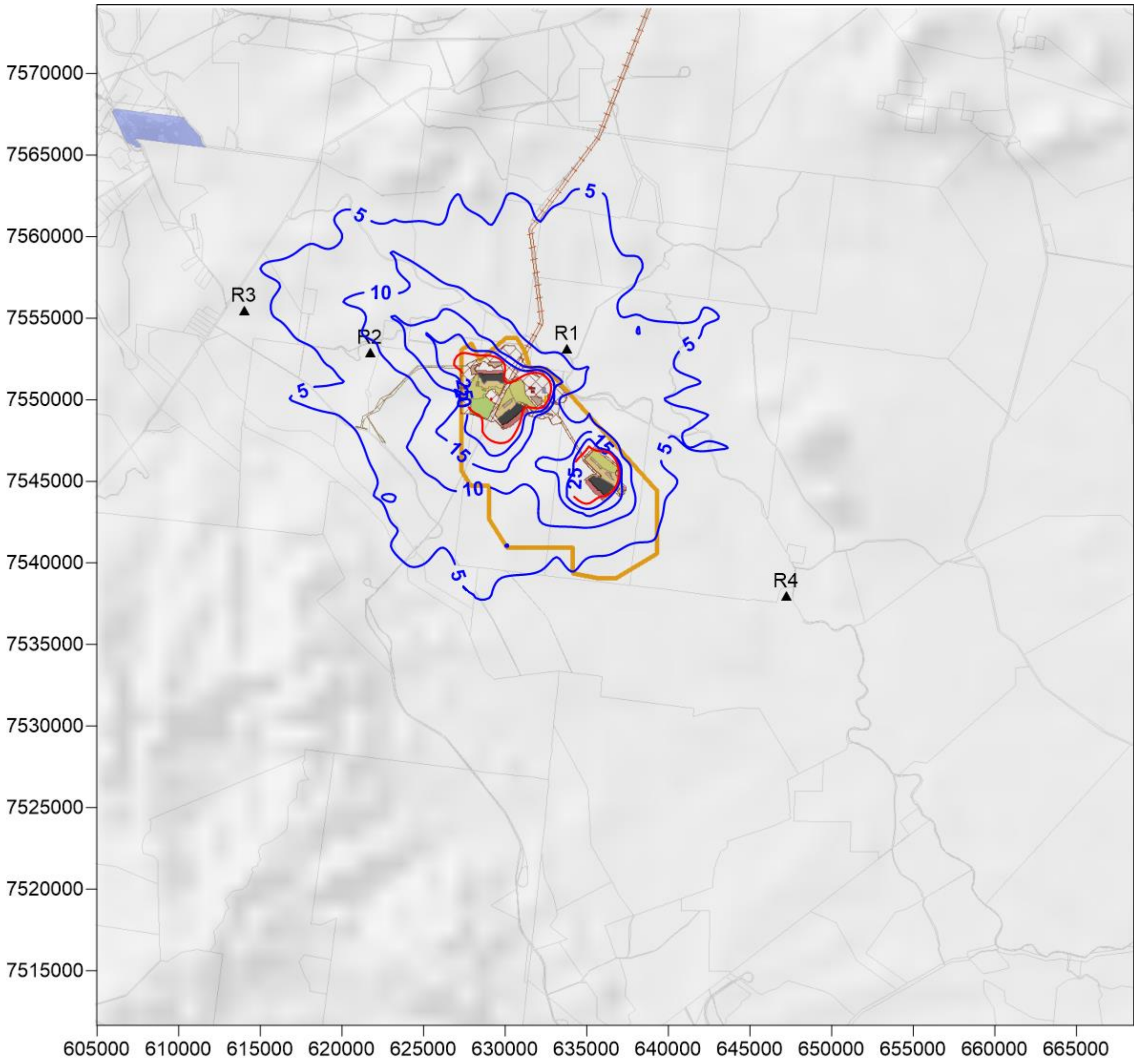


Plate 13 Year 5 predicted maximum 24-hour ground level concentration of $PM_{2.5}$

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:** August 2020

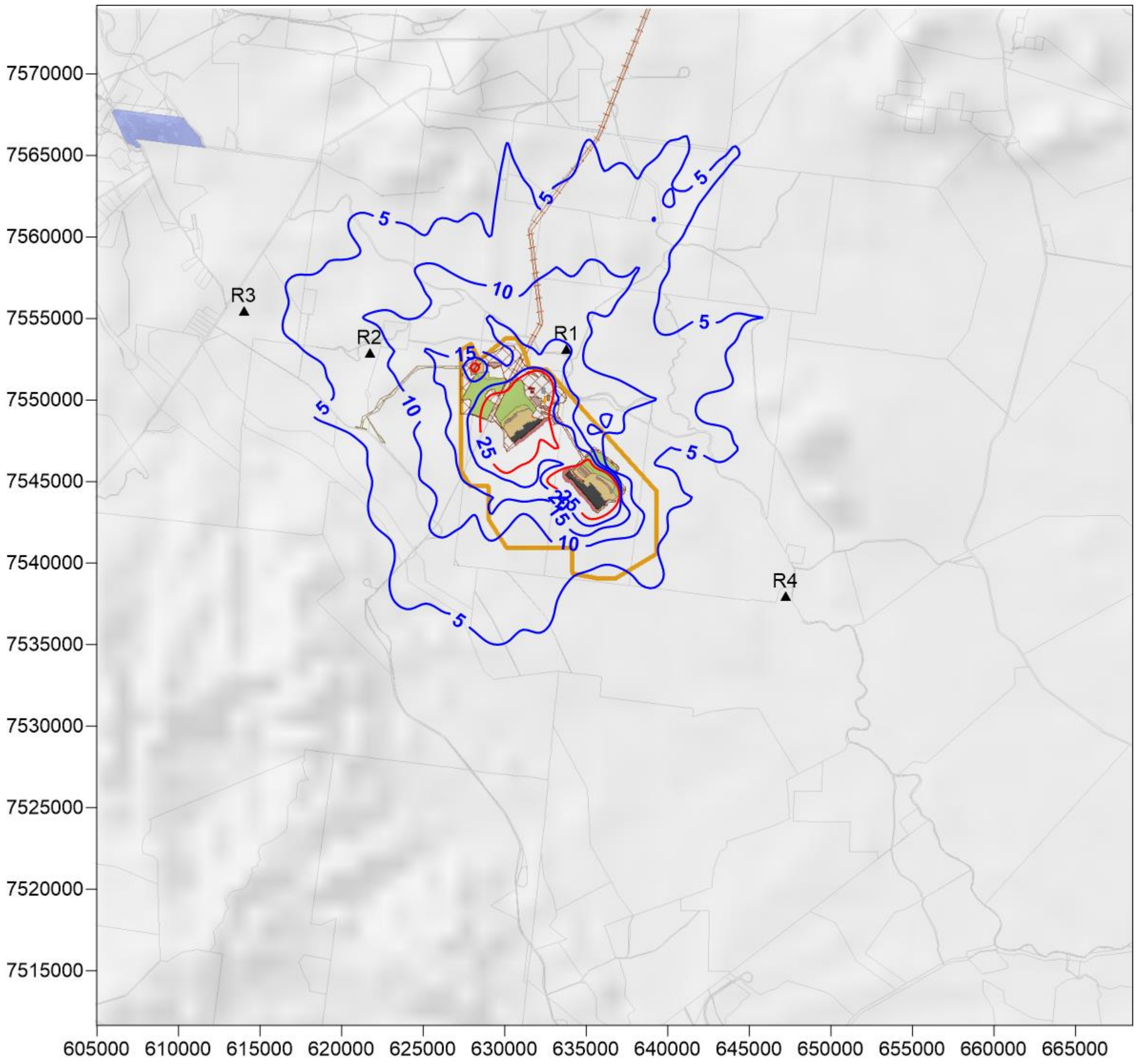


Plate 14 Year 9 predicted maximum 24-hour ground level concentration of $PM_{2.5}$

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:** August 2020

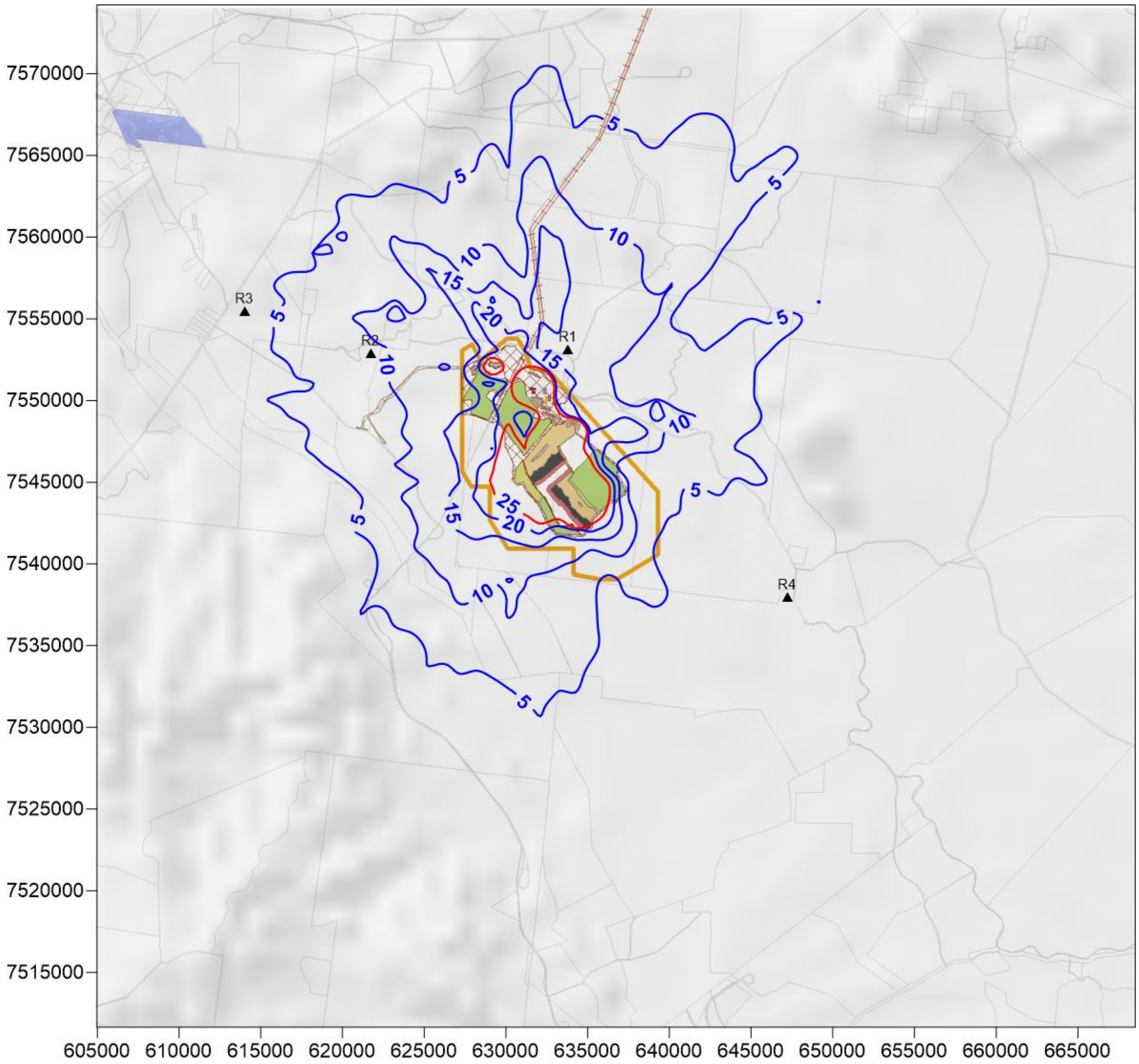


Plate 15 Year 19 predicted maximum 24-hour ground level concentration of $PM_{2.5}$

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m^3
Type: 24-hour maximum	**Objective:** 25 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

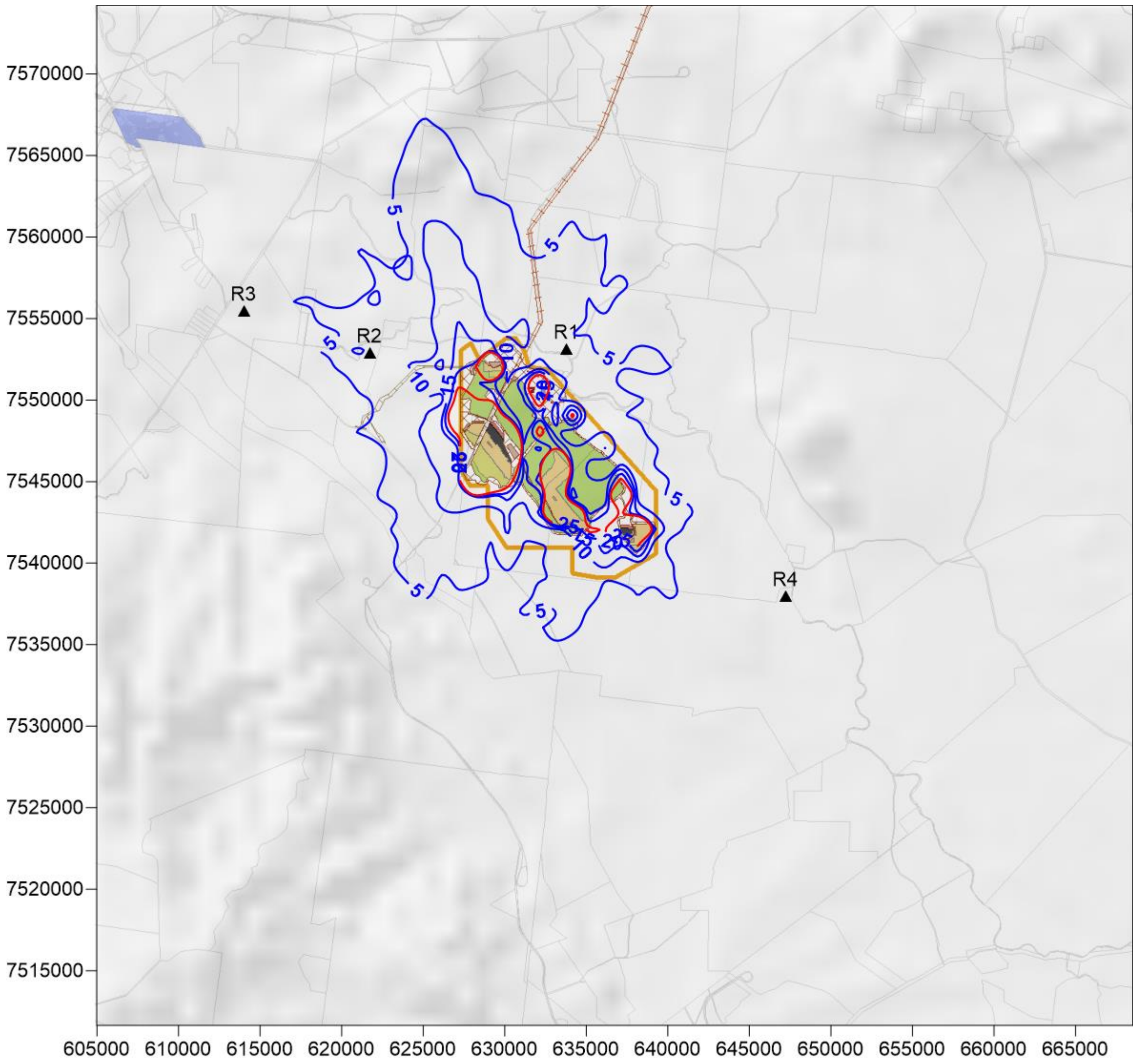


Plate 16 Year 27 predicted maximum 24-hour ground level concentration of $PM_{2.5}$

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m^3
Type: 24-hour maximum	**Objective:** 25 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

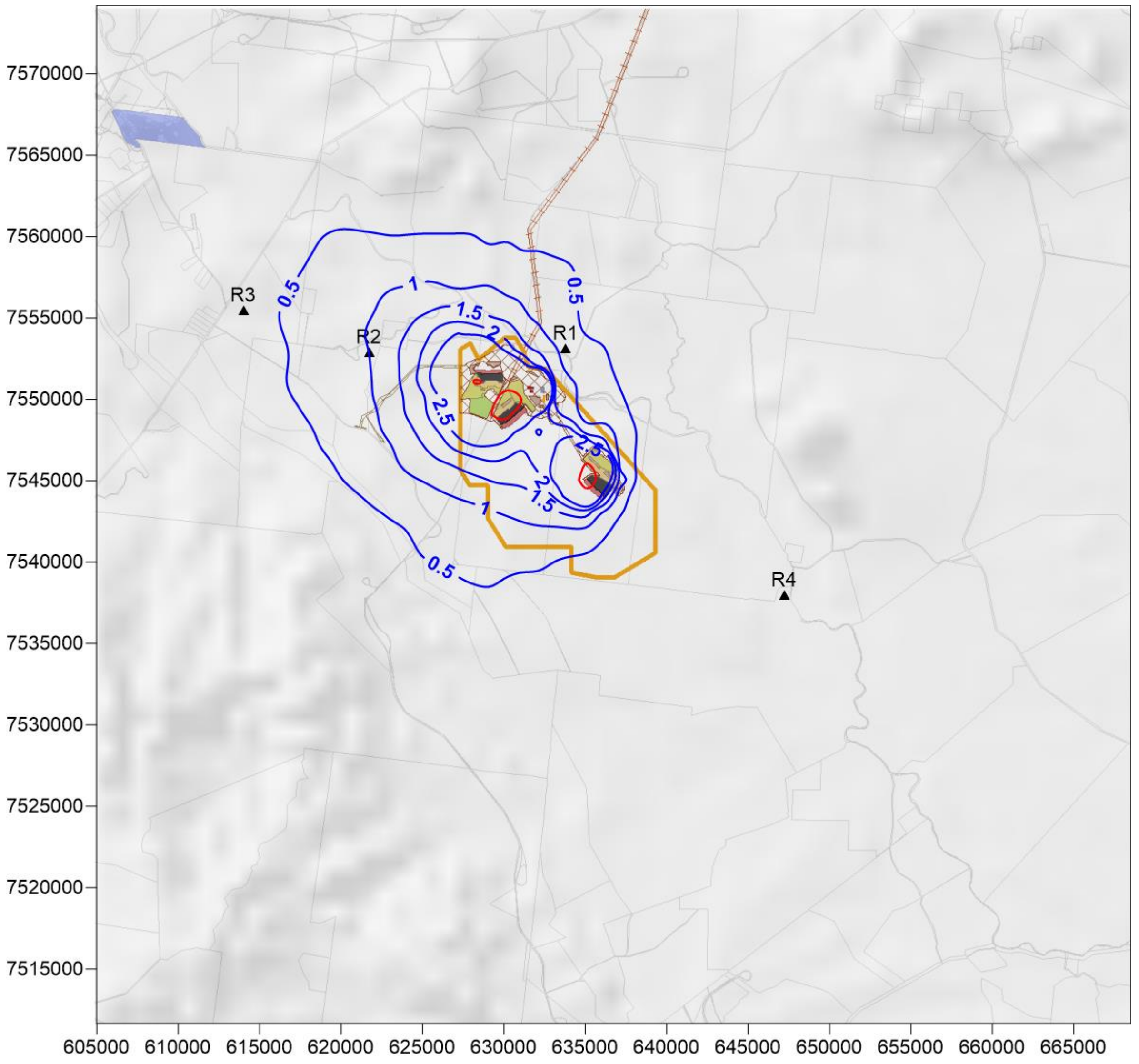


Plate 17 **Year 5 predicted annual average ground level concentration of $PM_{2.5}$**

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Annual average	**Objective:** 8 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

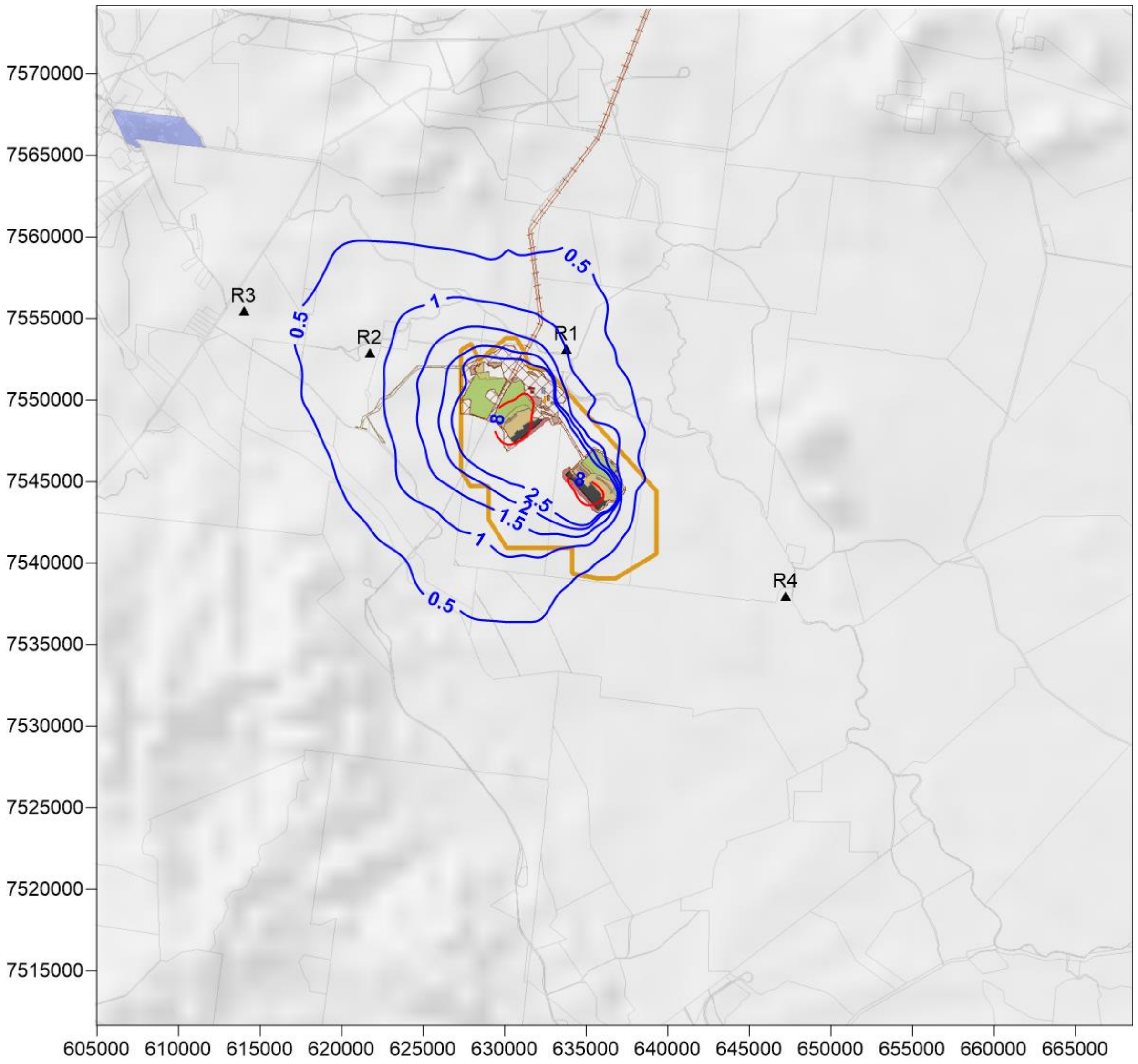


Plate 18 Year 9 predicted annual average ground level concentration of $PM_{2.5}$

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:** August 2020

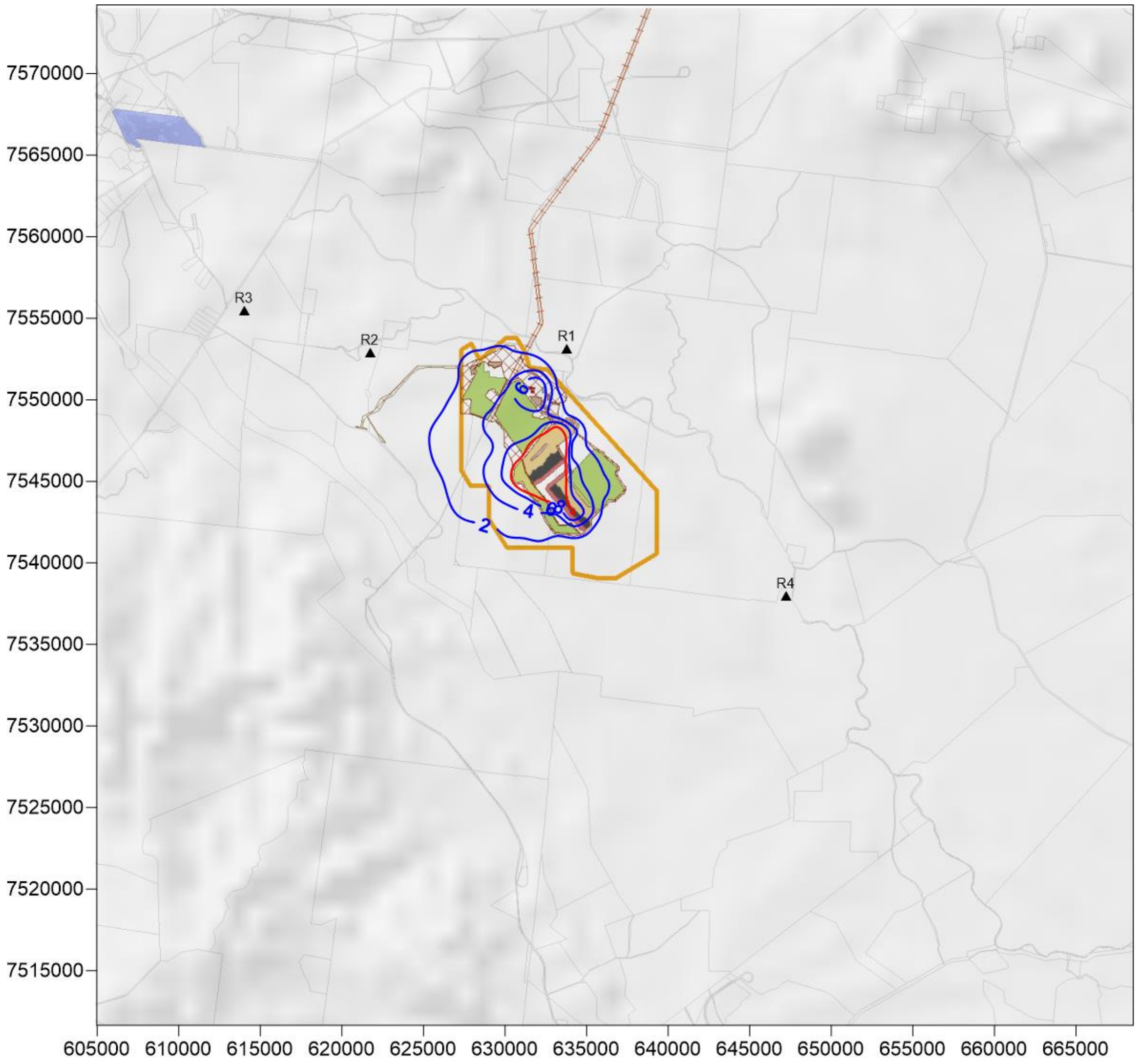


Plate 19	**Year 19 predicted annual average ground level concentration of $PM_{2.5}$**		
Location: Winchester South Project, Moranbah, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Annual average	**Objective:** 8 µg/m^3 (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

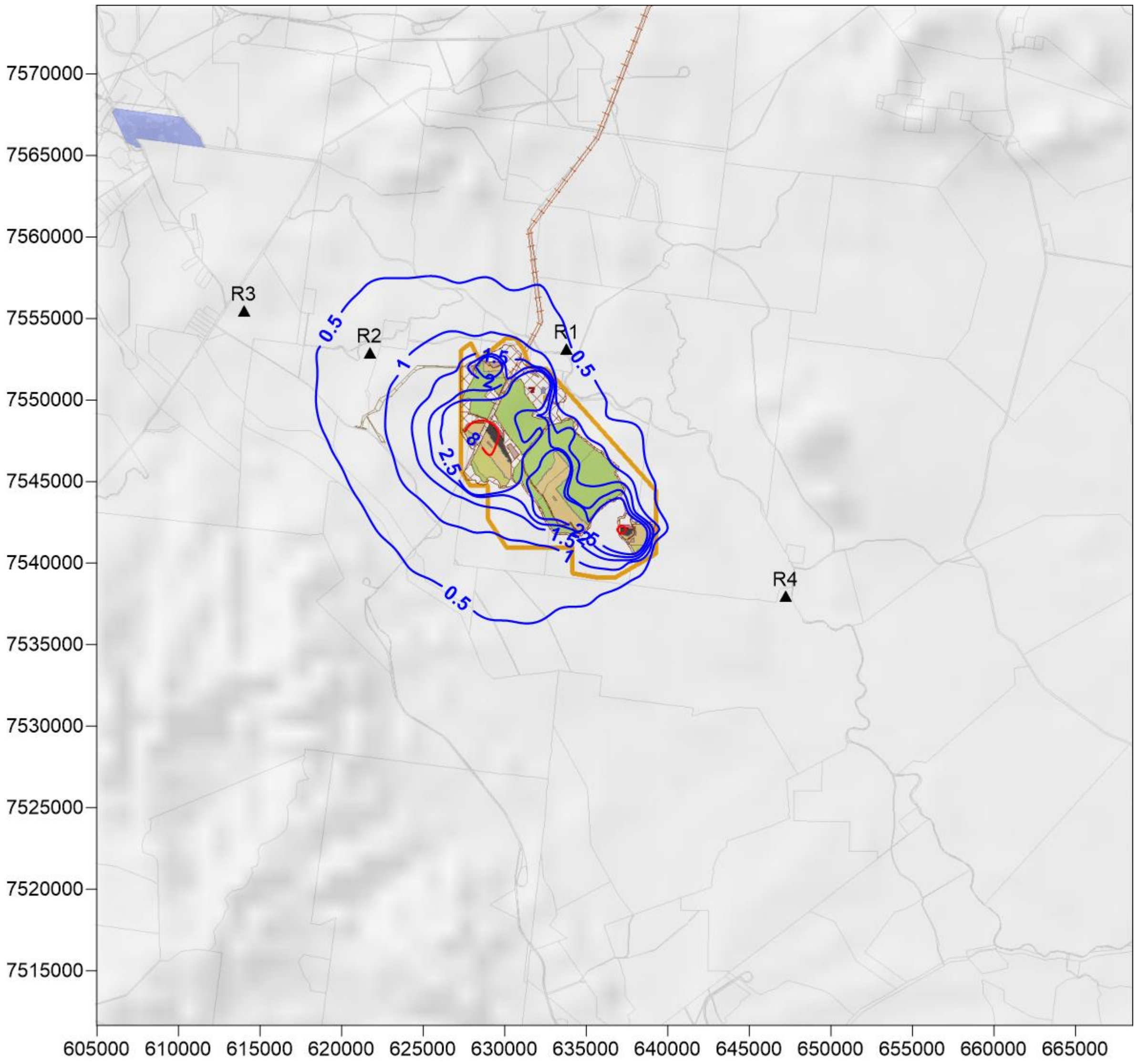


Plate 20 Year 27 predicted annual average ground level concentration of PM$_{2.5}$

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:** August 2020

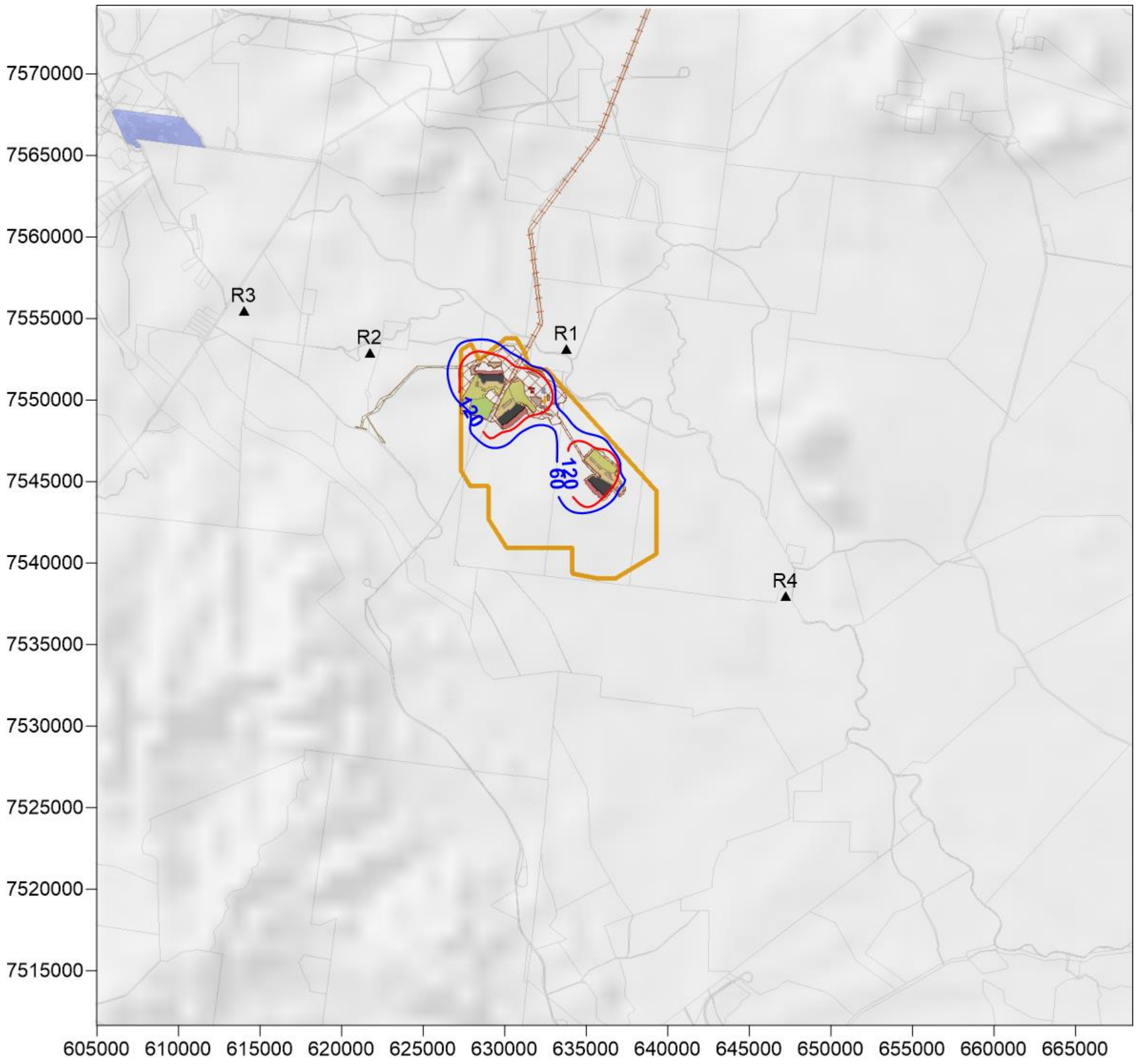


Plate 21 **Year 5 predicted maximum monthly dust deposition**

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:** August 2020

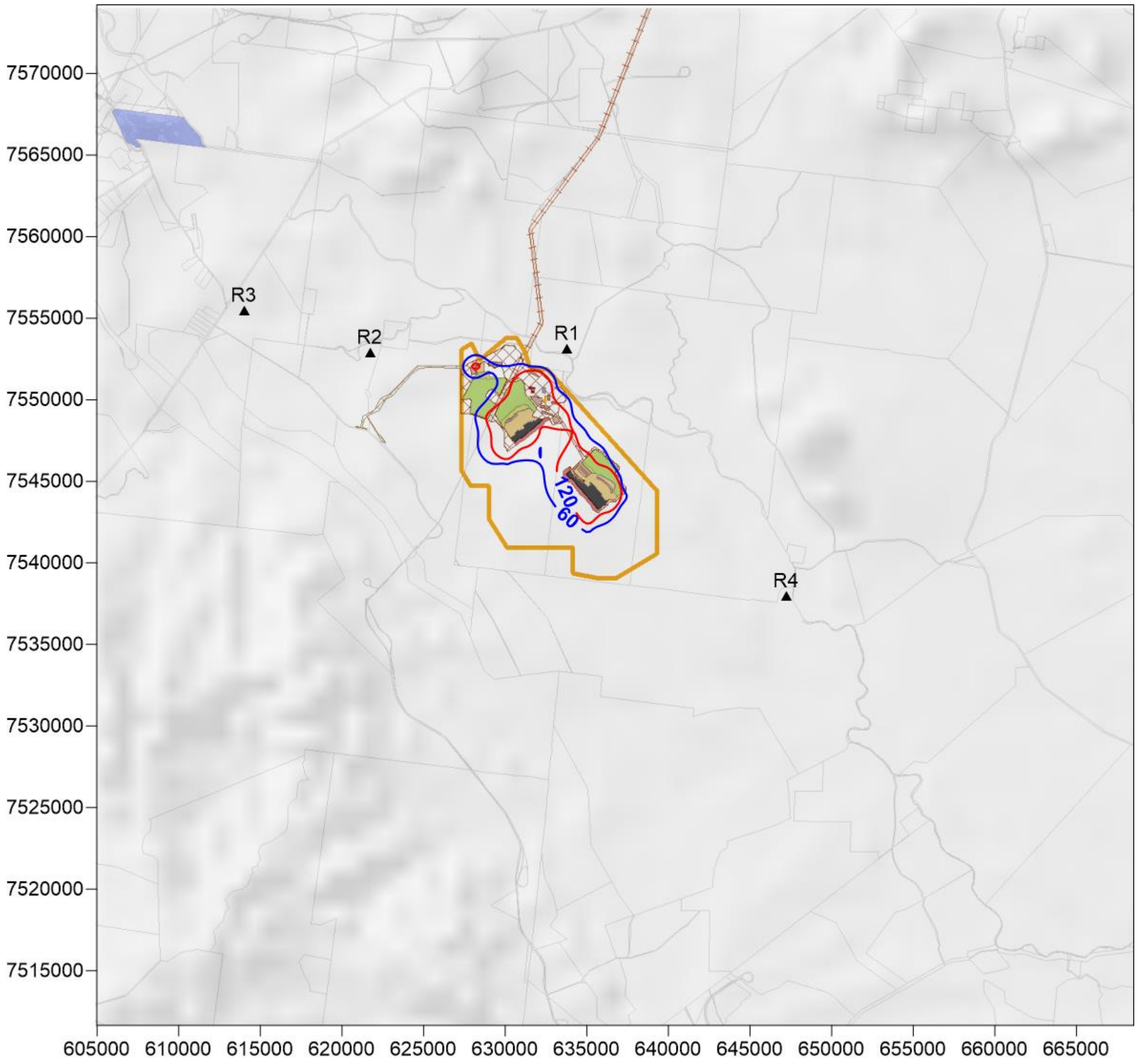


Plate 22 Year 9 predicted maximum monthly dust deposition

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:** August 2020

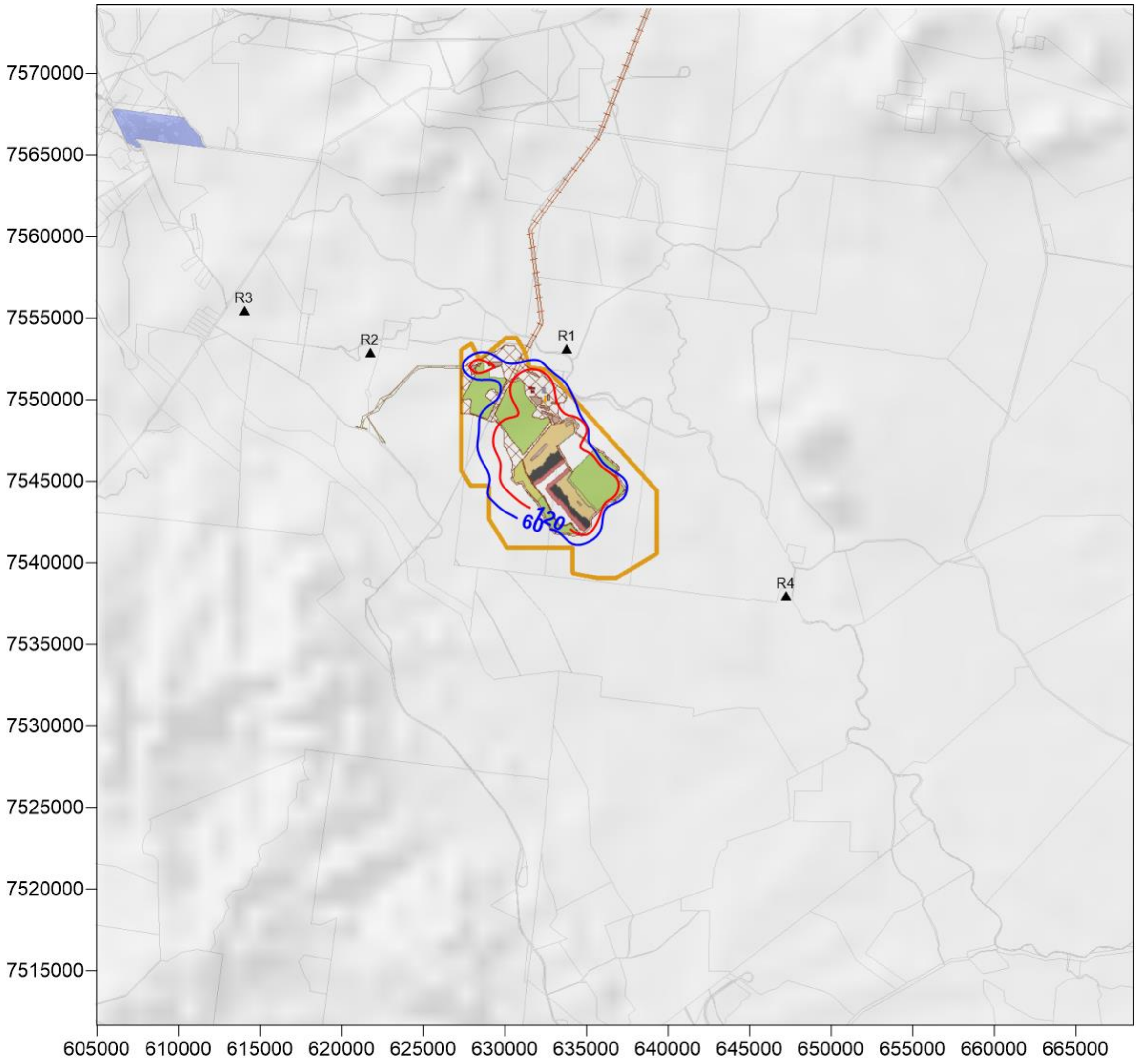


Plate 23 Year 19 predicted maximum monthly dust deposition

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:** August 2020

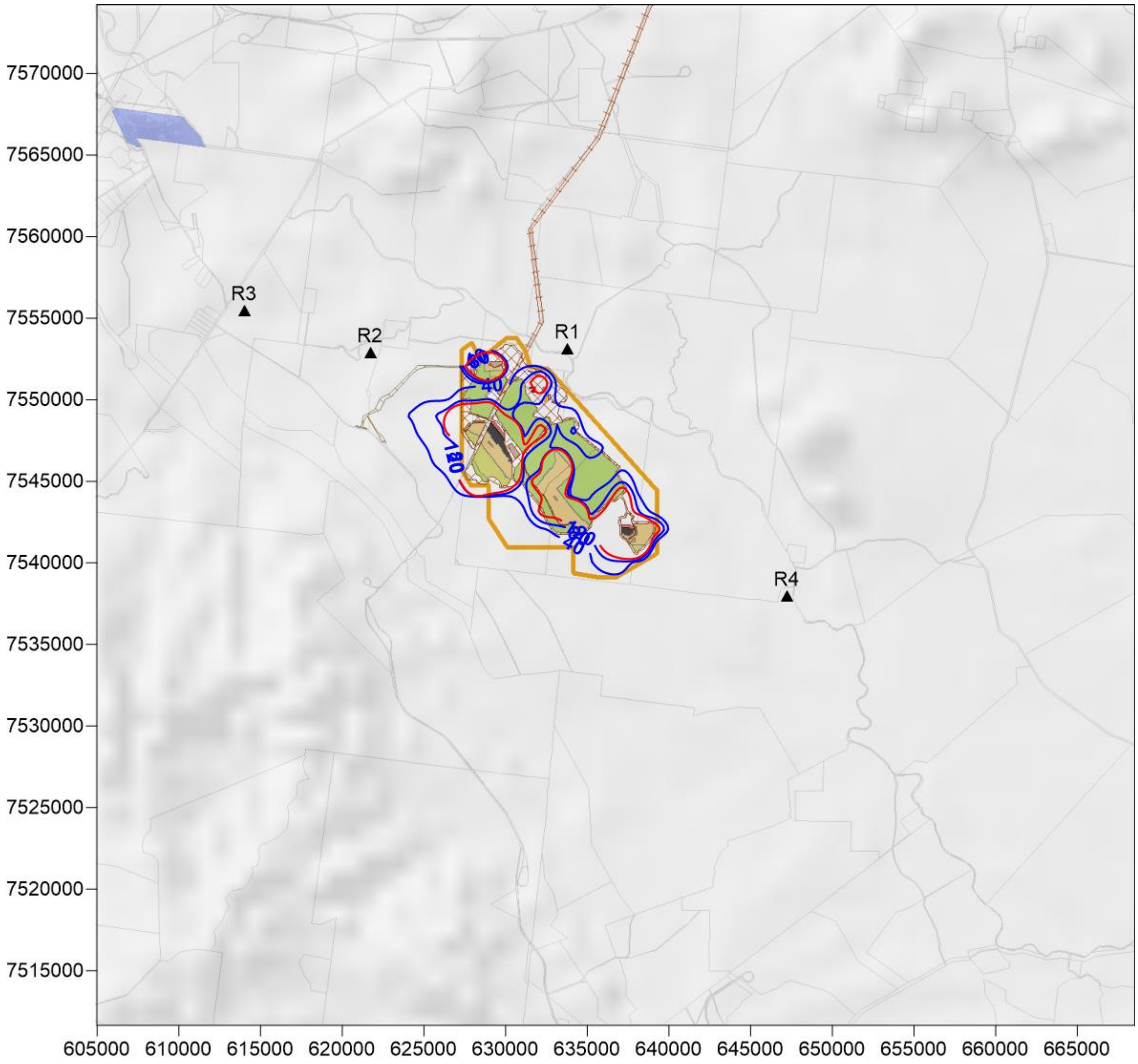


Plate 24 **Year 27 predicted maximum monthly dust deposition**

Location: Winchester South Project, Moranbah, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** µg/m^{3}
Type: Monthly maximum	**Objective:** 120 µg/m^{3} (red contour)	**Prepared by:** Daniel Gallagher	**Date:** August 2020

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	17	5	million tonnes	Whitehaven
Total product coal	9	10	10	3	million tonnes	
Waste rock - truck and shovel	154	179	209	123	million tonnes	
Drilling and blasting						
Blasting frequency (average)	116	203	236	139	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	260	240	275	132	ha	Geographic information
ROM stockpile	7	7	7	7	ha	Whitehaven
Product stockpile	7	7	7	7	ha	
Topsoil/waste rock dump area	388	559	780	1,210	ha	Geographic information

Activity	Values Year 5	Values Year 9	Values Year 19	Values Year 27	Units	Information source
Rehabilitating area	423	148	190	329	ha	
Rehabilitated area	147	934	2,080	3,406	ha	
Soil strip area	132	137	178	41	ha	
Exposed area	164	191	416	1,824	ha	
Transport						
Waste rock haulage to dump	1,691,038	2,111,670	3,214,199	1,705,112	VKT/year	Geographic information
ROM coal haulage to CHPP	939,917	1,202,526	1,501,856	502,077	VKT/year	
Bulldozing						
Number of dozers in operation	19	19	19	16	#	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	6	#	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
Waste rock density	2.2	2.2	2.2	2.2	%	Whitehaven

Activity	Values Year 5	Values Year 9	Values Year 19	Values Year 27	Units	Information source
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 (σ_Z)
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