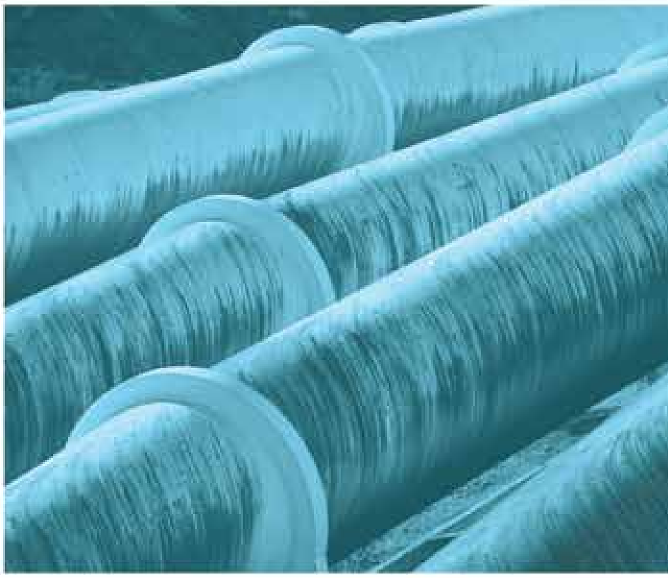
APPENDIX K REVISED AIR QUALITY IMPACT ASSESSMENT


Angus Place Mine Extension Project

Air quality impact assessment

Centennial Angus Place Pty Ltd
October 2019

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Angus Place Mine Extension Project

Air quality impact assessment

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Centennial Angus Place Pty Ltd

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31 October 2019

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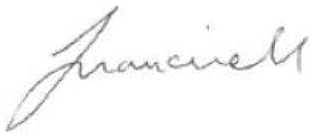
Prepared by



Francine Manansala

Associate - Air Quality

31 October 2019

Approved by

Scott Fishwick

Associate - National Technical Leader, Air Quality

31 October 2019

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

Executive Summary

This air quality impact assessment (AQIA) supports the application for the Angus Place Mine Extension Project (the Project). Angus Place Colliery is an existing underground coal mine producing thermal coal for use predominantly at Mount Piper Power Station (MPPS). The Angus Place Colliery is located 15 kilometres (km) to the north-west of the regional city of Lithgow and 120 km west-north-west of Sydney in New South Wales.

The AQIA documents the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and provides an assessment of predicted impacts relative to criteria.

The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016).

Existing environmental conditions were quantified using data from the Angus Place Automatic Weather Station (AWS). These data were supplemented by data from the Bureau of Meteorology's (BoM) Marrangaroo (Defence) station and the Mt Boyce AWS.

Emissions estimation and dispersion modelling was completed for a single operational scenario corresponding to a maximum coal production rate of 4.5 million tonnes per annum (Mtpa). Emissions of total suspended particulates (TSP), particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) and nitrogen dioxide (NO_2) were estimated and modelled.

The atmospheric dispersion of air pollutant emissions from one construction scenario was also simulated using the CALPUFF model.

The results of the modelling show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) were below the applicable impact assessment criteria at all assessment locations.

The cumulative results showed that compliance with applicable NSW EPA impact assessment criteria was predicted at all assessment locations for all pollutants and averaging periods. A comparison of the background dataset used (Bathurst AQMS) against Project HVAS data showed that the cumulative assessment was highly conservative.

A construction dust assessment was completed to assess the potential of dust impacts on assessment locations. The construction assessment was based on a risk assessment approach as outlined in the Institute of Air Quality Management's (IAQM's) documentation. The assessment found that there would be no human receptors impacted by construction dust. It showed that there was a medium to low potential of dust impacts to ecological receptors in the area. Appropriate mitigation measures have been recommended.

A greenhouse gas (GHG) assessment was also undertaken for the Project. Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Project represent approximately 0.368% of total GHG emissions for NSW and 0.089% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

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1 Introduction

Centennial Angus Place Pty Limited (Centennial Angus Place) operates the Angus Place Colliery, an existing underground coal mine producing thermal coal for use predominantly at the Mount Piper Power Station (MPPS). The Angus Place Colliery is located 15 kilometres (km) to the north-west of the regional city of Lithgow and 120 km west-north-west of Sydney in New South Wales (NSW). Figure 1.1 shows the location of the Project in a regional context.

The existing development consent for the Angus Place Colliery (Project Approval PA_06_0021) will expire in August 2024 and a new consent is required to ensure Angus Place Colliery is operational beyond this date. A new SSD application and supporting Environmental Impact Statement (EIS) was submitted to the NSW Department of Planning and Environment (DPE) (now the Department of Industry, Planning and Environment (DPIE) in April 2014 for the Angus Place Mine Extension Project (SSD 5602).

The exhibition period for the EIS commenced on 12 April 2014 and ended on 26 May 2014. A Response to Submissions (RTS) report was lodged on 1 October 2014 to respond to submissions received during the public exhibition period. A supplementary RTS was lodged with DPE in December 2014. The EIS and associated RTS reports are available on the Department's Major Project website. In response to a prolonged downturn in international coal markets, a decision was made by Centennial Coal in March 2015 to place the Angus Place Colliery into care and maintenance following the completion of secondary extraction within Longwall 900W. At this time, the assessment of the Angus Place Mine Extension Project was placed on hold.

Centennial Angus Place now propose to prepare and submit an Amended Project Report to DPIE to highlight the proposed changes to the Angus Place Mine Extension Project since the submission of the EIS and to enable to the DPIE to recommence their assessment and determination of the project. Centennial Angus Place is seeking approval to extend its mining operations, using longwall mining techniques to the east of its existing workings. This will include an increase to the maximum extraction limit of 4.5 million tonnes per annum (Mtpa) of run of mine (ROM) coal. These operations (ie the subject of this study) are hereafter referred to as 'the Project'.

This air quality impact assessment (AQIA) has been prepared by EMM Consulting Pty Limited (EMM) on behalf of Centennial Angus Place, to assess potential air quality impacts associated with the Project on the surrounding environment. The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016), referred to herein as 'the Approved Methods for Modelling'.

In 2014, SLR Consulting prepared an AQIA for the original Angus Place Mine Extension Project, which sought approval for a maximum of 4 Mtpa of ROM coal (SLR 2014). This AQIA draws on data from that assessment, where appropriate.

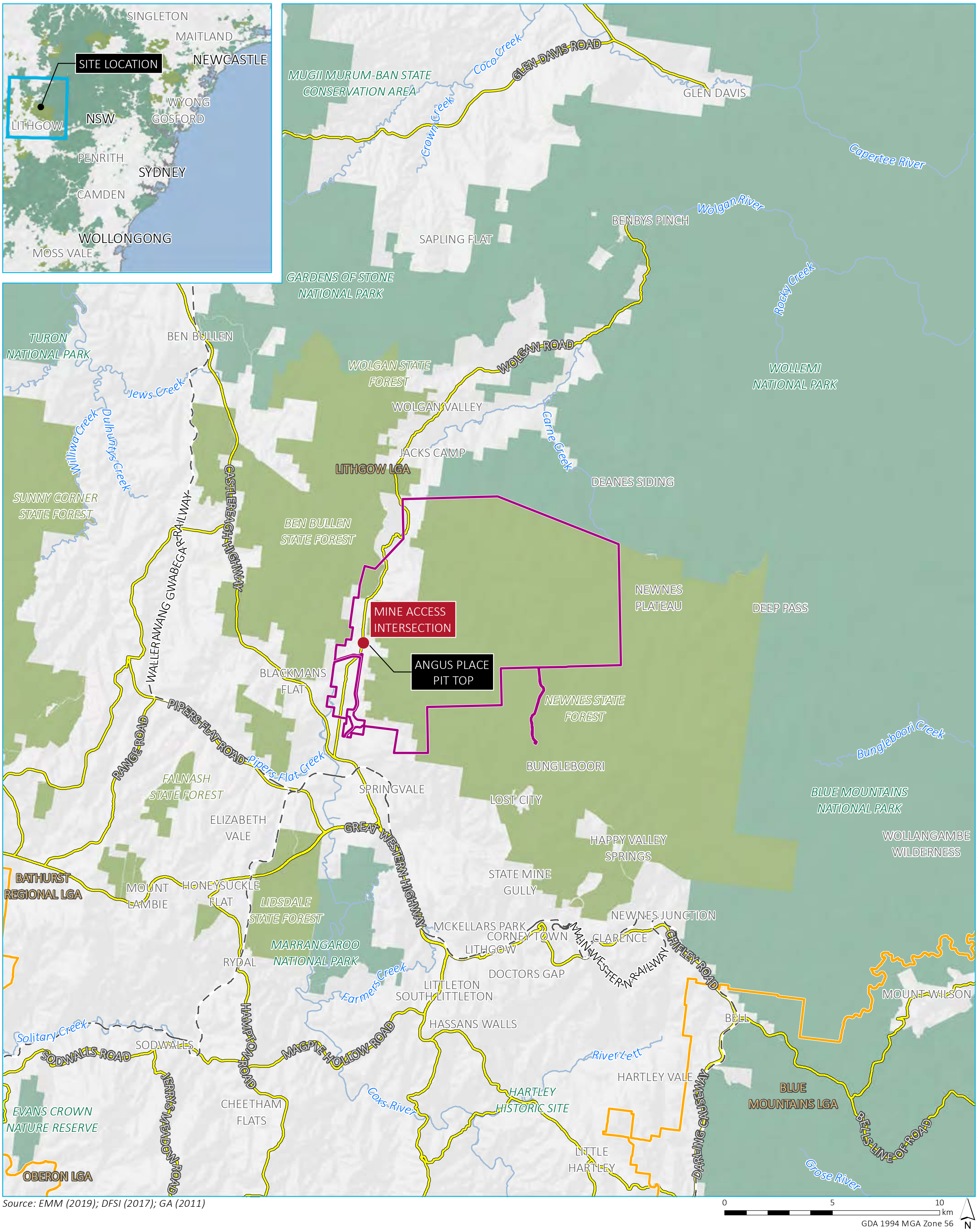
1.1 Purpose of this report

This AQIA documents the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and assessment of predicted impacts relative to criteria.

This AQIA consists of the following sections:

- a description of the local setting and surrounds of the Project;
- the pollutants which are relevant to the assessment, and the applicable impact assessment criteria;
- a description of the existing environment, specifically:

  - the meteorology and climate; and
  - the existing air quality environment;
- a detailed air pollutant emissions inventory for the Project;
- atmospheric dispersion modelling for the quantified emissions, including an analysis of Project-only and cumulative impacts accounting for baseline air quality;
- an overview of mitigation measures and air quality monitoring requirements;
- a semi-quantitative construction phase assessment; and
- a greenhouse gas (GHG) assessment.



Source: EMM (2019); DFSI (2017); GA (2011)

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KEY

- Project application area
- Mine access intersection
- Rail line
- Main road
- Watercourse/drainage line
- NPWS reserve
- State forest
- Local government area

Project location in a regional context

Angus Place Mine Extension Project
Air quality impact assessment
Figure 1.1

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1.2 Assessment guidelines and requirements

This AQIA has been prepared in accordance with the Director General's Environmental Assessment Requirements (EARs) issued 6 November 2012, as well as relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

The EARs related to air quality must be addressed in the AQIA. Table 1.1 lists the matters relevant to this assessment and where they are addressed in this report.

Table 1.1 Air quality related Director General's Environmental Assessment Requirements

Requirement	Section addressed
The EIS must address the following specific issues: **Air Quality** – including a quantitative assessment of potential:	-
- construction and operational impacts, with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10} emissions and dust generation from coal transport;	Chapter 7
- reasonable and feasible mitigation measures to minimise dust emissions, including evidence that there are no such other available measures; and	Section 6.4
- monitoring and management measures, in particular real-time air quality monitoring.	Section 5.3 and Section 6.4

2 Project and site description

2.1 Project overview

The key components of the Project are as follows and the general layout is shown in Figure 2.1.

- extend the life of the mine to 31 December 2053;
- increase in Project Application Area from 10,460 ha to 10,551 ha;
- increase in full time equivalent (FTE) personnel from 300 to 450;
- increase extraction up to 4.5 Mtpa of ROM coal from the Lithgow Seam underlying the Project Application Area;
- continued development of new roadways to enable access to the proposed 1,000 panel longwall mining area;
- extraction of existing approved longwall 910;
- development and extraction of 15 longwalls (LW1001-1015) with void widths of 360 m;
- development of underground roadway connections between the Angus Place Colliery underground mine workings and the Springvale Mine underground mine workings;
- transfer up to 4 Mtpa of ROM coal to the Angus Place Colliery pit top for processing and handling before being transported off-site in accordance with the Western Coal Services Project development consent (SSD-5579);
- transfer up to 4.5 Mtpa of ROM coal by underground conveyor to the Springvale Mine pit top via proposed new underground connection roadways for handling and processing in accordance with the Springvale Mine Extension Project development consent (SSD-5594);
- enlargement of the ROM coal stockpile at the Angus Place Colliery pit top from 90,000 t to 110,000 t capacity;
- construction and operation of the approved but not yet constructed 4.5 m shaft at the Angus Place Colliery ventilation facility (APC-VS2) on the Newnes Plateau;
- construction and operation of one additional downcast shaft and mine services boreholes within the proposed Angus Place Colliery Ventilation Facility (APC-VS3) on the Newnes Plateau to support mining in the 1,000 panel area;
- construction and operation of additional dewatering facilities and associated infrastructure on the Newnes Plateau to support mining in the 1,000 panel area to facilitate the transfer of mine water into the Springvale Delta Water Transfer Scheme (SDWTS);
- transfer of mine inflows from the existing and proposed workings at Angus Place Colliery to the Springvale Water Treatment Project (SSD-7972) for treatment and beneficial reuse at MPPS;

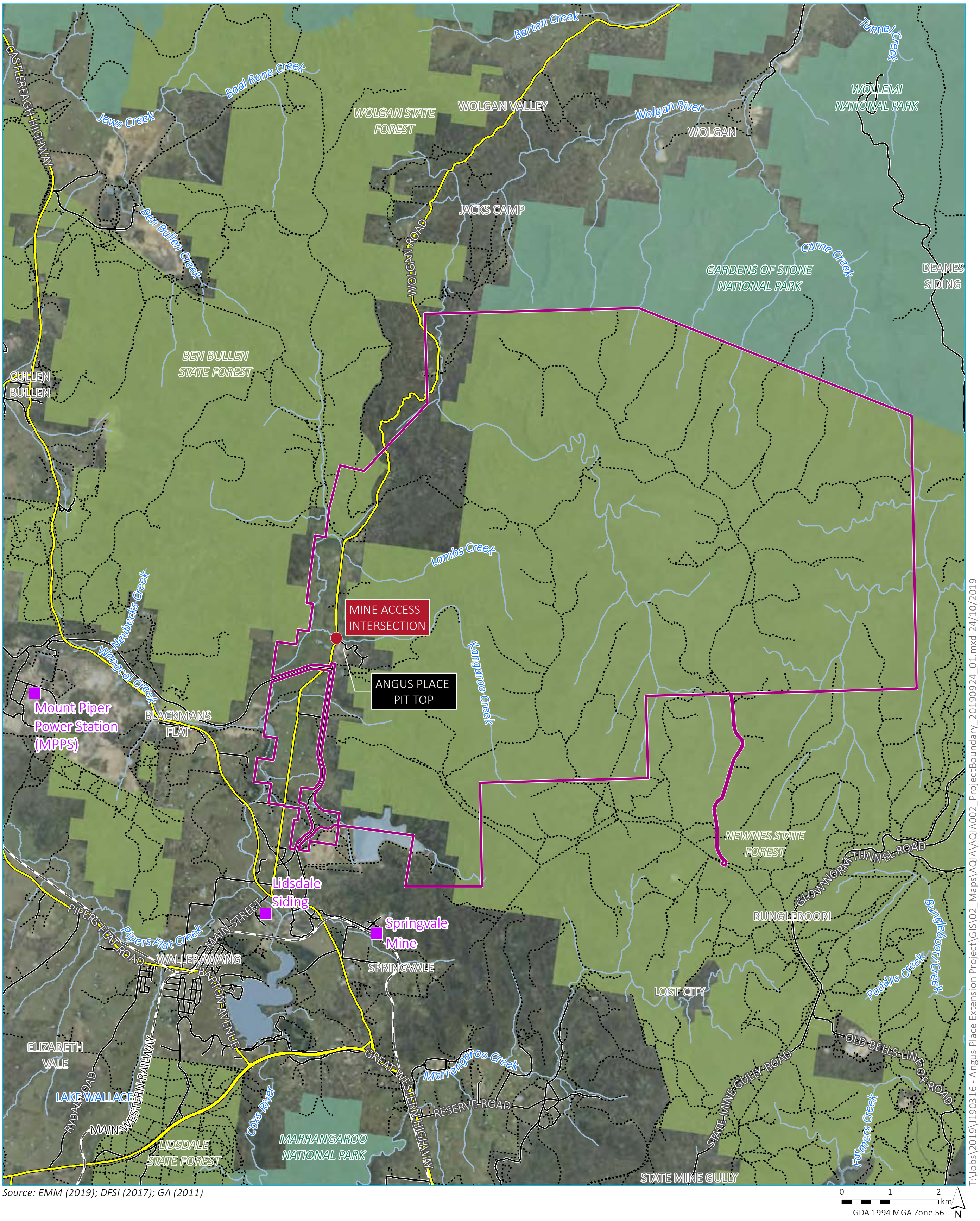
- operation of the Angus Place Colliery 930 Bore and associated infrastructure for raw mine water transfer from the SDWTS to the underground mining area; and

- connection to the Lithgow City Council main sewer line prior to the commencement of longwall extraction (subject to a separate development application through Lithgow City Council).

2.2 Site and surrounding area

The Angus Place Colliery is located approximately 15 km to the north-west of Lithgow and 120 km west-north-west of Sydney, NSW. The Angus Place Colliery is an underground longwall mine, accessed via the Angus Place pit top, and supporting surface infrastructure within the pit top area and on Newnes Plateau within the Newnes State Forest.

The area surrounding the Angus Place Colliery is characterised by flat terrain directly adjacent to the Newnes State Forest which increases in elevation moving east. Elevation in the study area ranges from approximately 925 m AHD to 1,180 m AHD. A three-dimensional representation of the local topography is presented in Figure 2.2.



Source: EMM (2019); DFSI (2017); GA (2011)

KEY

- Study area
- Mine access intersection
- Local Features
- Waterbody
- NPWS reserve
- State forest
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Local context

Angus Place Mine Extension Project
Air quality impact assessment
Figure 2.1

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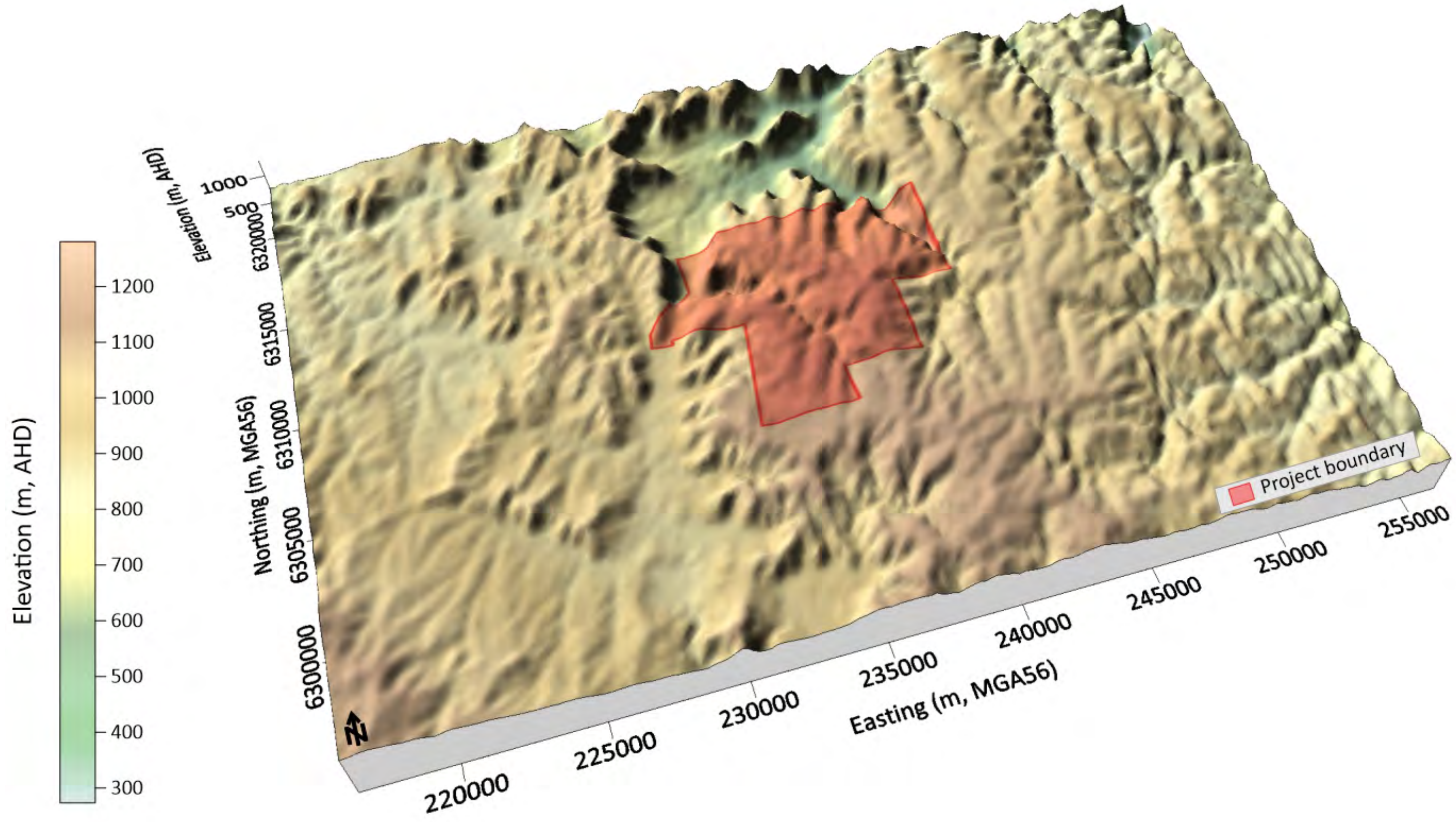


Figure 2.2 **3-dimensional topography surrounding the Project**

Source: NASA Shuttle Radar Topography Mission data

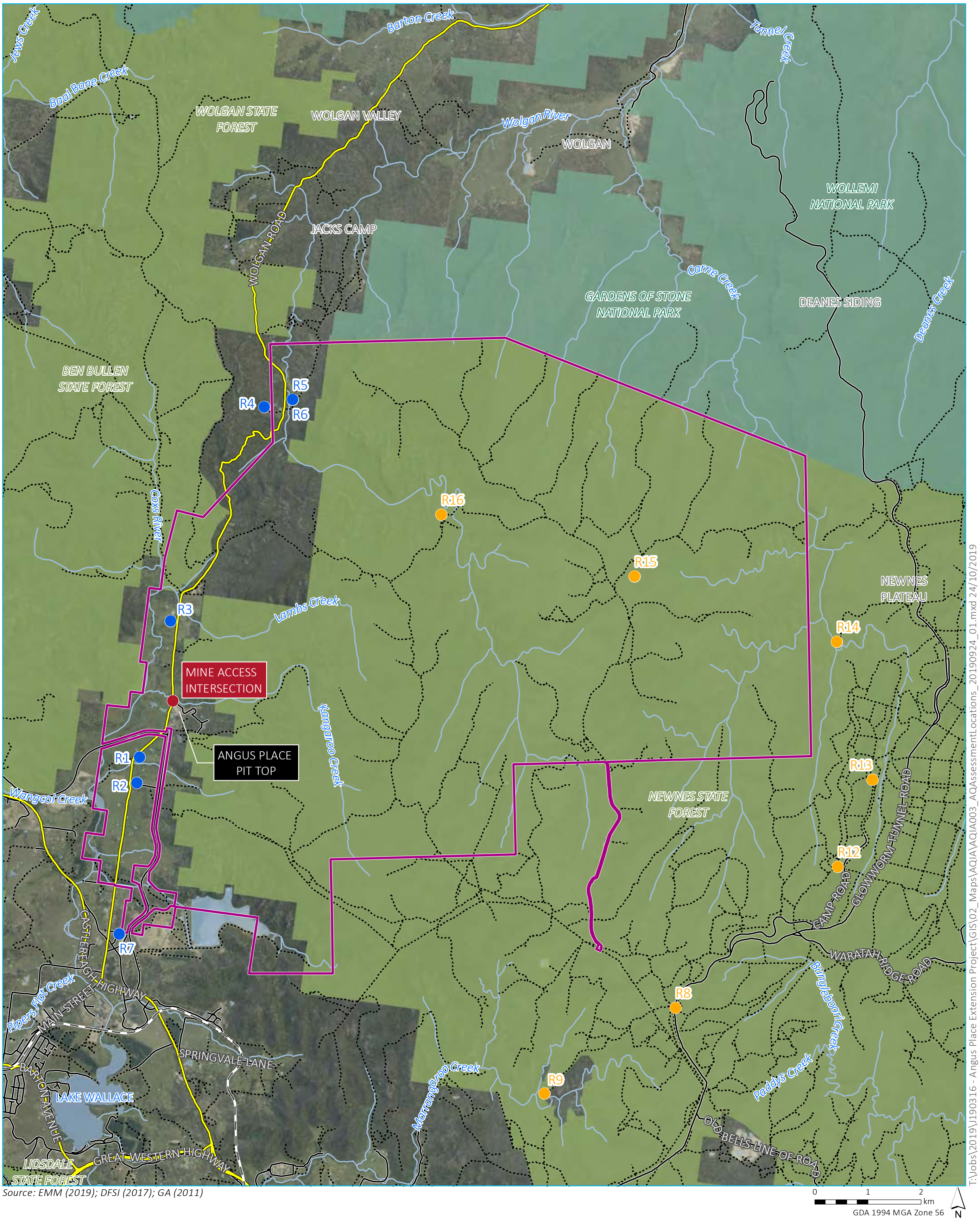
2.3 Assessment locations

The area surrounding the Project includes a number of private residential properties with the closest located approximately 1 km south-west of the Angus Place Colliery pit top area. The Project is also located directly adjacent to the Newnes State Forest which is used for camping and other recreational activities.

The nearest representative air quality sensitive locations to the Project have been identified for the purpose of assessing potential air quality impacts. Details are provided in Table 2.1 and their locations are shown in Figure 2.3 They are referred to in this report as assessment locations.

Table 2.1 Air quality assessment locations

Figure ID	Description	Assessment location type	Easting	Northing
R1	WR1 (Sharpe)	Residential	229408	6305100
R2	WR2 (Mason)	Residential	229351	6304614
R3	WR3	Residential	229990	6307652
R4	WR4	Residential	231748	6311673
R5	WR5	Residential	232286	6311814
R6	L1	Residential	232286	6311814
R7	L2	Residential	229028	6301777
R8	NF1	Recreation	239483	6300390
R9	NF2	Recreation	237015	6298782
R10	NF3	Recreation	243358	6295836
R11	NF4	Recreation	245299	6297921
R12	NF5	Recreation	242528	6303041
R13	NF6	Recreation	243182	6304671
R14	NF7	Recreation	242516	6307266
R15	NF8	Recreation	238709	6308496
R16	NF9	Recreation	235079	6309656



Source: EMM (2019); DFSI (2017); GA (2011)

Air quality assessment locations

Angus Place Mine Extension Project
Air quality impact assessment
Figure 2.3

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3 Pollutants and assessment criteria

3.1 Potential air pollutants

This assessment includes consideration of potential impacts from both construction and operational emissions for the Project.

Operational phase emissions will principally consist of particulate matter emissions from the conveying and transfer of ROM coal, coal sizing, bulldozer on coal stockpiles and wind erosion of the ROM coal stockpile.

The Project will include some minor construction activities which have the potential to generate dust emissions. Construction phase emissions will principally consist of particulate matter emissions related to the construction of bore pumps and a downcast ventilation shaft.

A detailed description of the emission sources associated with the Project is presented in Section 6. The main air pollutants emitted by the Project will be:

- Particulate matter, specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$).
- Gaseous pollutants, specifically:
  - oxides of nitrogen (NO_x)[1], including nitrogen dioxide (NO_2);
  - sulphur dioxide (SO_2);
  - carbon monoxide (CO); and
  - volatile organic compounds (VOCs).

Of the above listed pollutants, this assessment will focus on emissions and impacts from particulate matter (TSP, PM_{10} and $PM_{2.5}$) only. Impact assessment criteria applicable to particulate matter is presented in the following sections as defined in the Approved Methods for Modelling (EPA 2016). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

The Project is anticipated to generate emissions of gaseous pollutants, including NO_x/NO_2, CO, SO_2 and VOCs from fuel combustion and explosives detonation. Surface emissions from diesel fuel combustion at the Project are expected to be low considering the small pit top area, limited surface-based equipment and the use of conveyors on-site. The majority of diesel combustion and explosive emissions are generated underground and will be released from the ventilation shaft (accounted for in the calculated ventilation shaft emissions).

1 By convention, NOx = nitrous oxide (NO) + NO_2.

3.2 Applicable air quality assessment criteria

3.2.1 Particulate matter

The NSW EPA's impact assessment criteria for particulate matter, as documented in Section 7 of the Approved Methods for Modelling, are presented in Table 3.1. The assessment criteria for PM_{10} and $PM_{2.5}$ are consistent with the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (Department of the Environment 2016).

TSP, which relates to airborne particles less than around 45 µm in diameter (US EPA 1999), is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts (NSW EPA 2013). Particles less than 10 µm and 2.5 µm in diameter, a subset of TSP, are fine enough to enter the human respiratory system and can lead to adverse human health impacts. The NSW EPA impact assessment criteria for PM_{10} and $PM_{2.5}$ are therefore used to assess the potential impacts on human health of particulate matter concentrations.

The Approved Methods for Modelling classifies TSP, PM_{10}, $PM_{2.5}$ and dust deposition as criteria pollutants. Assessment criteria for criteria pollutants are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100^{th} percentile (ie the highest) dispersion modelling prediction in the case of 24-hour impacts. Both the incremental (Project impacts only) and cumulative (Project impacts plus background) impacts need to be presented, the latter requiring consideration of existing ambient background concentrations for the criteria pollutants assessed.

For dust deposition, the NSW EPA (2016) specifies criteria for the Project increment and cumulative dust deposition levels. Dust deposition impacts are derived from TSP emission rates and particle deposition calculations in the dispersion modelling process.

Table 3.1 Impact assessment criteria for particulate matter

PM metric	Averaging period	Impact assessment criterion
TSP	Annual	90 µg/m^3
PM_{10}	24 hours	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
Dust deposition	Annual	2 g/m^2/month (Project increment only)
		4 g/m^2/month cumulative)

Notes: µg/m^3: micrograms per cubic metre; g/m^2/month: gram per square metre per month.
Source: EPA 2016.

4 Meteorology and climate

4.1 Introduction

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

Analysis of meteorology for the local area is presented based on the Angus Place automatic weather station (AWS), located approximately 250 m west of the pit top. Data from this station is available between July 2015 to August 2019. Centennial Angus Place operates a second station at the vent shaft facility approximately 7 km east of the pit top. As this station only started operating in March 2019, data from this site has not been analysed further in this assessment.

Data from the Angus Place AWS has been supplemented with data from the closest Bureau of Meteorology (BoM) monitoring stations as follows:

- Marrangaroo (Defence), approximately 9.5 km south-east of the pit top; and
- Mt Boyce AWS, approximately 32 km south-east of the pit top.

The Mt Boyce AWS was primarily included to obtain cloud content and height data as required for modelling. The locations of the meteorological stations used in the assessment are shown in Figure 4.1.

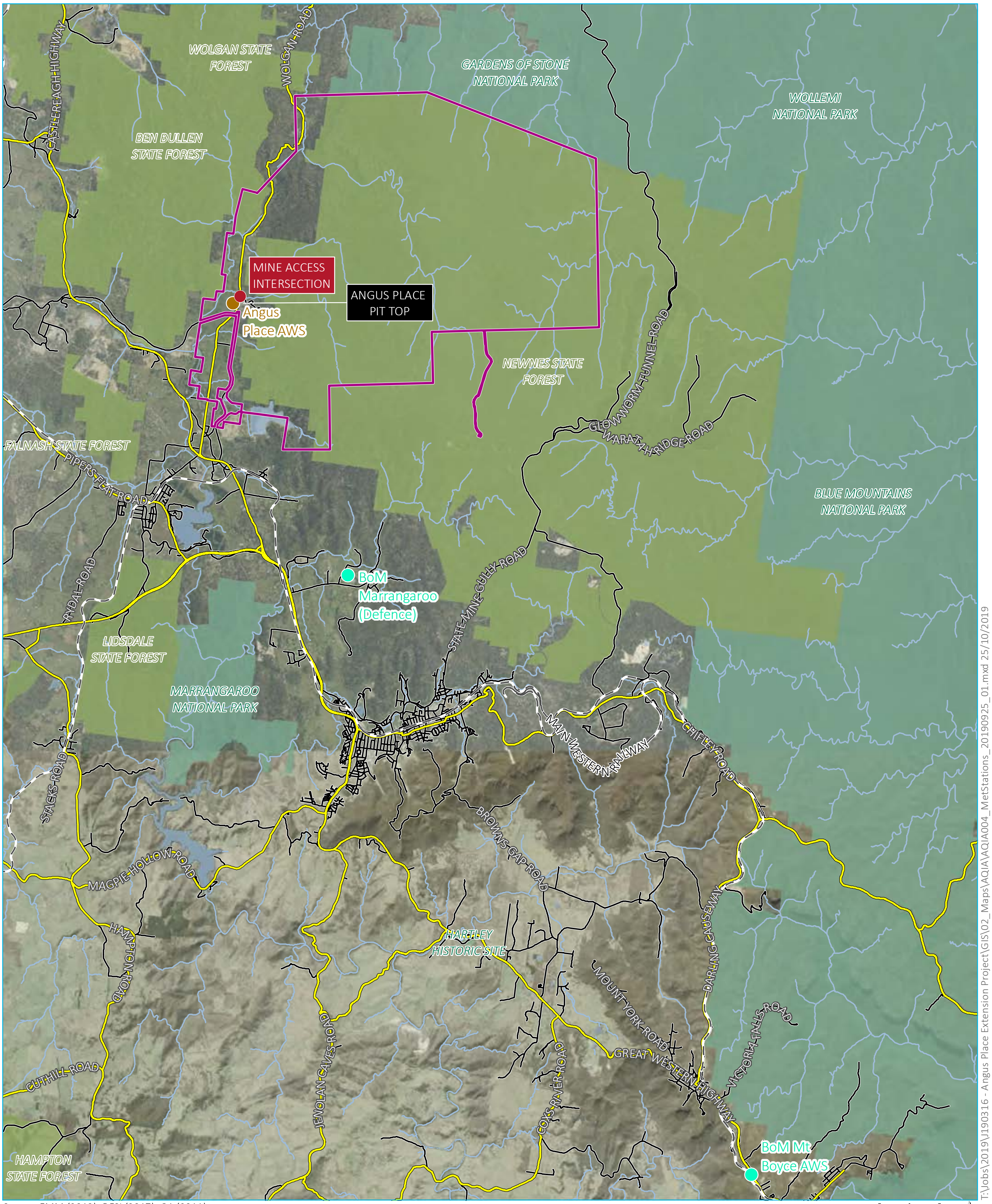
4.2 Selection of a representative year

Meteorological data recorded by the Angus Place AWS for the period between 2015 and 2019 were analysed and details are presented in Appendix A. It is noted that the 2015 dataset begins in July and the 2019 dataset ends in August.

The analysis demonstrated a similarity across years in the most important parameters for pollutant dispersion, such as wind speed and wind direction. The winds recorded by the Angus Place AWS across all five years were predominately north-easterly and south-westerly winds. Annual average wind speeds ranged between 2.4 m/s and 2.8 m/s. The annual average frequency of calm conditions (wind speeds less than 0.5 m/s) ranged between 2.2% and 2.4%.

The inter-annual profiles for air temperature and relative humidity were also comparable between 2015 and 2018. The 2018 dataset showed slightly higher temperature and lower relative humidity, which are indicative of the strong drought conditions occurring during the year.

The 2018 calendar year was adopted as the 12-month modelling period for the purpose of this AQIA. Details relating to the selection of meteorological year and the representativeness of the dataset are provided in Appendix A.



Source: EMM (2019); DFSI (2017); GA (2011)

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GDA 1994 MGA Zone 56
N

KEY

- Study area
- Mine access intersection
- Angus Place meteorological station
- BoM meteorological station
- Waterbody
- NPWS reserve
- State forest
- Rail line
- Main road
- Local road
- Watercourse/drainage line

Location of meteorological stations surrounding the project

Angus Place Mine Extension Project
Air quality impact assessment
Figure 4.1

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4.3 Prevailing winds

Meteorological data located in the vicinity of the Project were analysed. This included the Angus Place AWS and BoM stations at Marrangaroo (Defence) and Mount Boyce.

Meteorological data recorded by the Angus Place AWS for the period between 2014 and 2018 were analysed. Details relating to the selection of meteorological year and the representativeness of the dataset are provided in Section 4.2 and Appendix A.

The 2018 calendar year was deemed representative of meteorological conditions surrounding the Project and therefore was adopted as the 12-month modelling period for the purpose of this AQIA.

An annual wind rose for the Angus Place AWS for 2018 is shown in Figure 4.2. Similar to the inter-annual wind roses presented in Appendix A, the recorded wind patterns for 2018 were dominated by north-easterlies and a smaller proportion of south-westerlies. The annual average wind speed for 2018 was 2.7 m/s and the percentage of annual calm conditions (wind speeds less than 0.5 m/s) was 2.2%.

Seasonal and diurnal wind roses for the Angus Place AWS 2018 are provided in Appendix A.

The seasonal variation in wind speed at the Angus Place AWS was minor, with the mean ranging from 2.5 m/s in autumn to 3.1 m/s in winter. The annual percentage of calm conditions was 1% in spring and summer and 3.3% in autumn and winter. The annual pattern observed in Figure 4.2 is seen in every season; however, south-westerlies are more pronounced in winter.

Variation in wind patterns was more pronounced on a diurnal basis. South-westerlies were prominent during daytime hours where north-easterlies were prominent during night-time hours. The average wind speed during the day was 3.3 m/s compared to 2.1 m/s at night-time. The percentage of calms during the day was 1.7% compared to 2.7% at night.

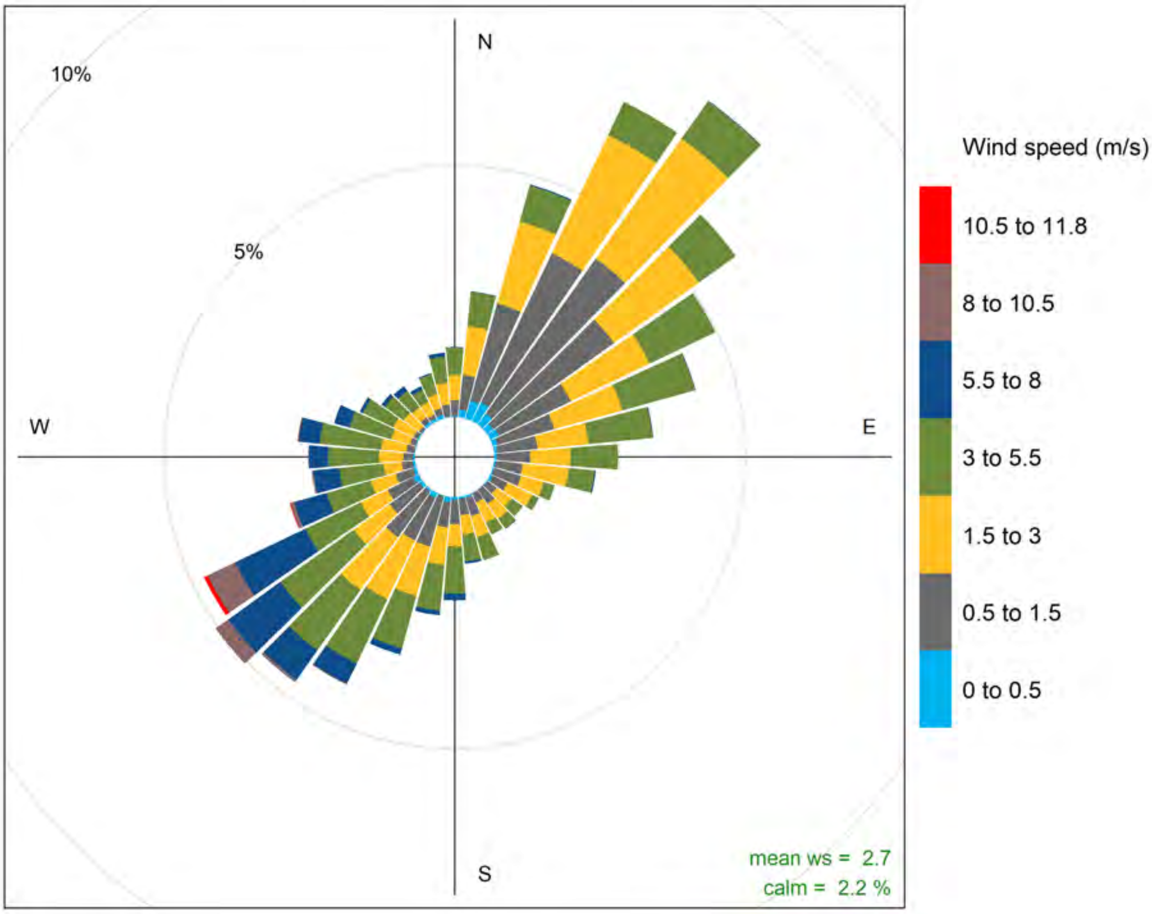


Figure 4.2 Recorded wind speed and direction – Angus Place AWS – 2018

4.4 Meteorological modelling

4.4.1 Overview

Atmospheric dispersion modelling for this assessment has been completed using TAPM and the CALMET/CALPUFF model suite.

Section 4.1 of the Approved Methods for Modelling specifies that meteorological data representative of a site can be used in the absence of suitable on-site observations. The data should cover a period of at least one year with a percentage completeness of at least 90%. Data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

Hourly average meteorological data from the Angus Place AWS was used as observations in the TAPM and CALMET modelling. These data were supplemented with data from the BoM Marrangaroo (Defence) station and the BoM Mount Boyce AWS.

Further details of the TAPM and CALMET meteorological modelling is presented in Appendix B.

4.4.2 CALMET predicted winds

As stated, hourly observations from the Angus Place AWS were used as input to the CALMET meteorological modelling completed. Hourly meteorological predictions were extracted at the pit top to compare with the measured data at the Angus Place AWS and verify the performance of CALMET in predicting local meteorological conditions. It is noted that there was not an appropriate meteorological station to leave out of the modelling for evaluation purposes. Verification was completed to confirm that the predicted winds at the pit top appeared reasonable and reflected local terrain features. Adopted CALMET settings, such as the RMAX and R1 factors are further explained in Appendix B.1.

An annual wind rose created from the CALMET data extract at the pit top is presented in Figure 4.3.

The annual wind rose created from the CALMET data is very similar in pattern to the wind rose created from the observations as shown in Figure 4.2. The annual average wind speed for both datasets is 2.7 m/s. The annual percentage of calms is 2.2% in the observed data and 3.5% from the CALMET extracted data.

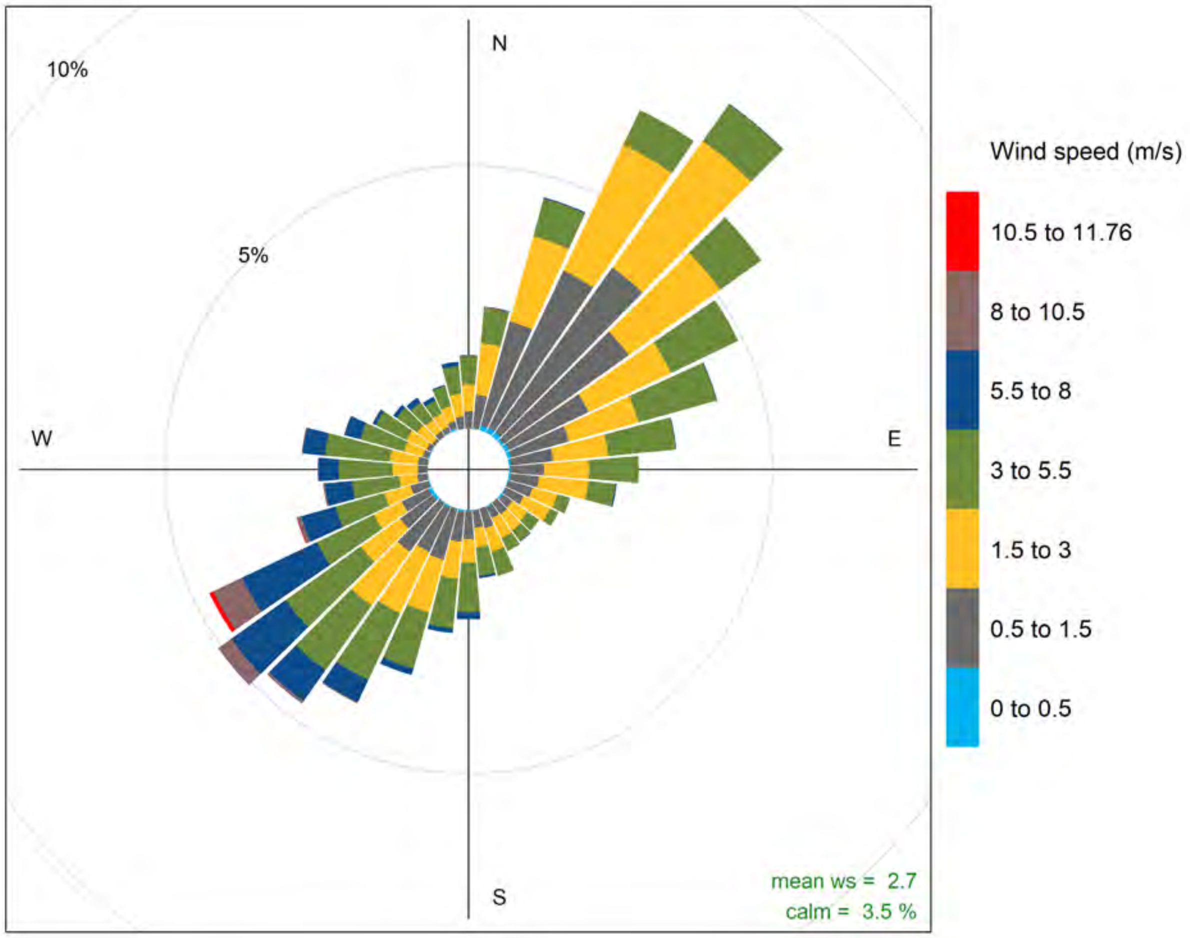


Figure 4.3 CALMET-predicted wind speed and direction – Angus Place – 2018

4.4.3 Atmospheric stability and mixing depth

Atmospheric stability refers to the degree of turbulence or mixing that occurs within the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (ie the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically, about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4.3 illustrates the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by CALMET, extracted at the Angus Place AWS. The diurnal profile shows that atmospheric instability increases during the daylight hours as the sun generated convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for effective atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

Mixing depth refers to the height of the atmosphere above ground level within which the dispersion of air pollution can be dispersed. The mixing depth of the atmosphere is influenced by mechanical (associated with wind speed) and thermal (associated with solar radiation) turbulence. Similar to the Monin-Obukhov length analysis above, higher daytime wind speeds and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases, so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for the atmospheric dispersion of pollutants.

Figure 4.5 presents the hourly-varying atmospheric boundary layer depths generated by CALMET. Greater boundary layer depths occur during the daytime hours, peaking in the mid to late afternoon.

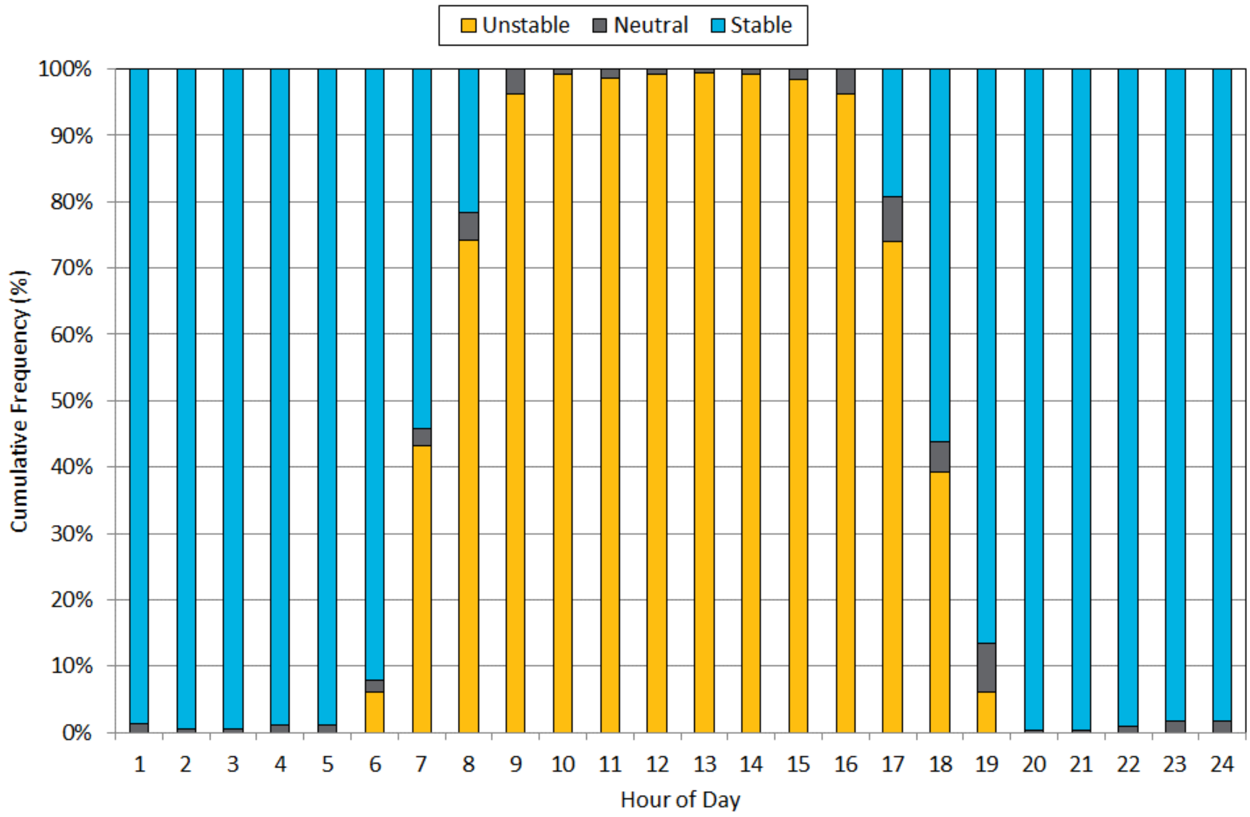


Figure 4.4 CALMET-calculated diurnal variation in atmospheric stability – Angus Place AWS 2018

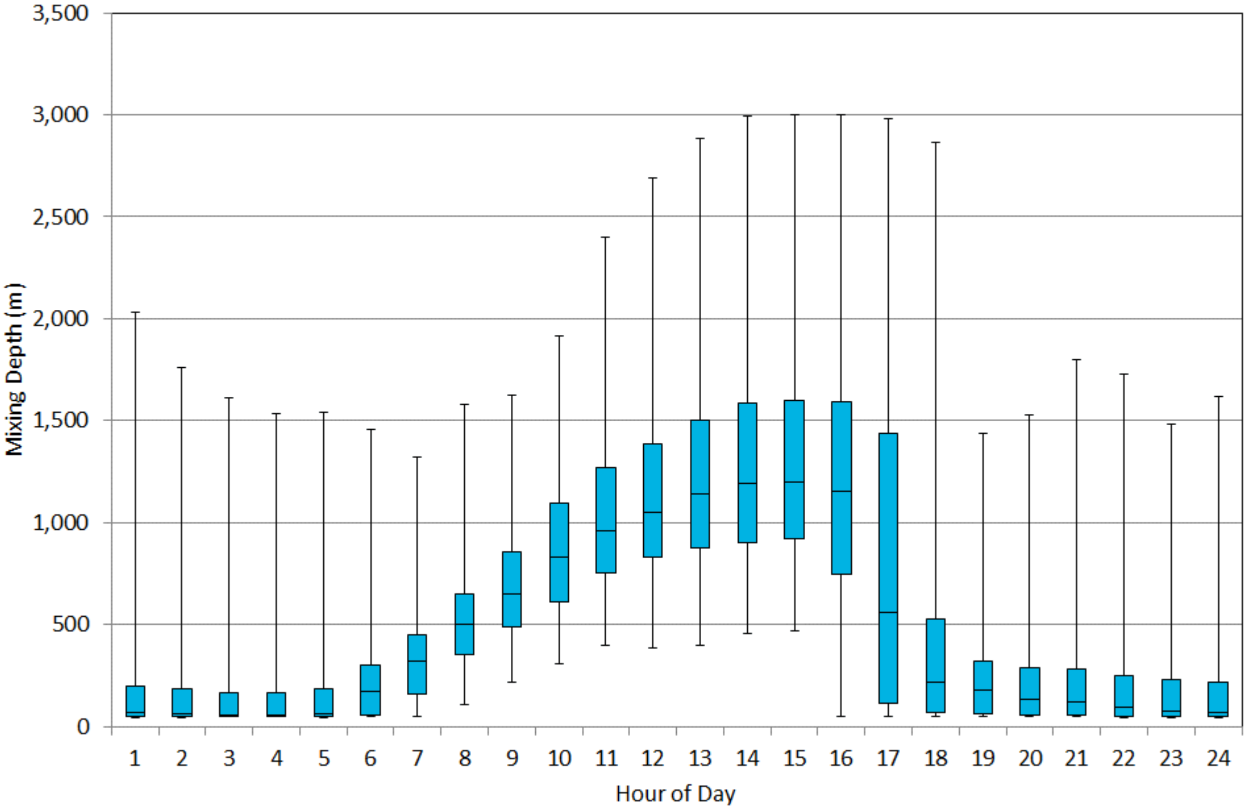


Figure 4.5 CALMET-calculated diurnal variation in atmospheric mixing depth – Angus Place AWS 2018

5 Baseline air quality

5.1 Introduction

The local air quality environment is expected to be influenced by existing activities in the area including local industrial activity such as the MPPS, Lidsdale Siding and Springvale Mine. As stated in Chapter 1, Angus Place Colliery was placed into care and maintenance in 2015. Therefore, the existing background levels presented herein are not influenced by mining operations at Angus Place Colliery.

In addition, the local airshed will also be influenced by:

- wind generated dust from exposed areas;
- dust entrainment and tailpipe emissions from vehicle movements along unsealed and sealed roads;
- seasonal emissions from household wood heaters;
- episodic emissions from bushfires; and
- long-range transport of fine particles into the region.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. It is considered that all of the above emission sources are accounted for in the monitoring data analysed in the following sections of this report.

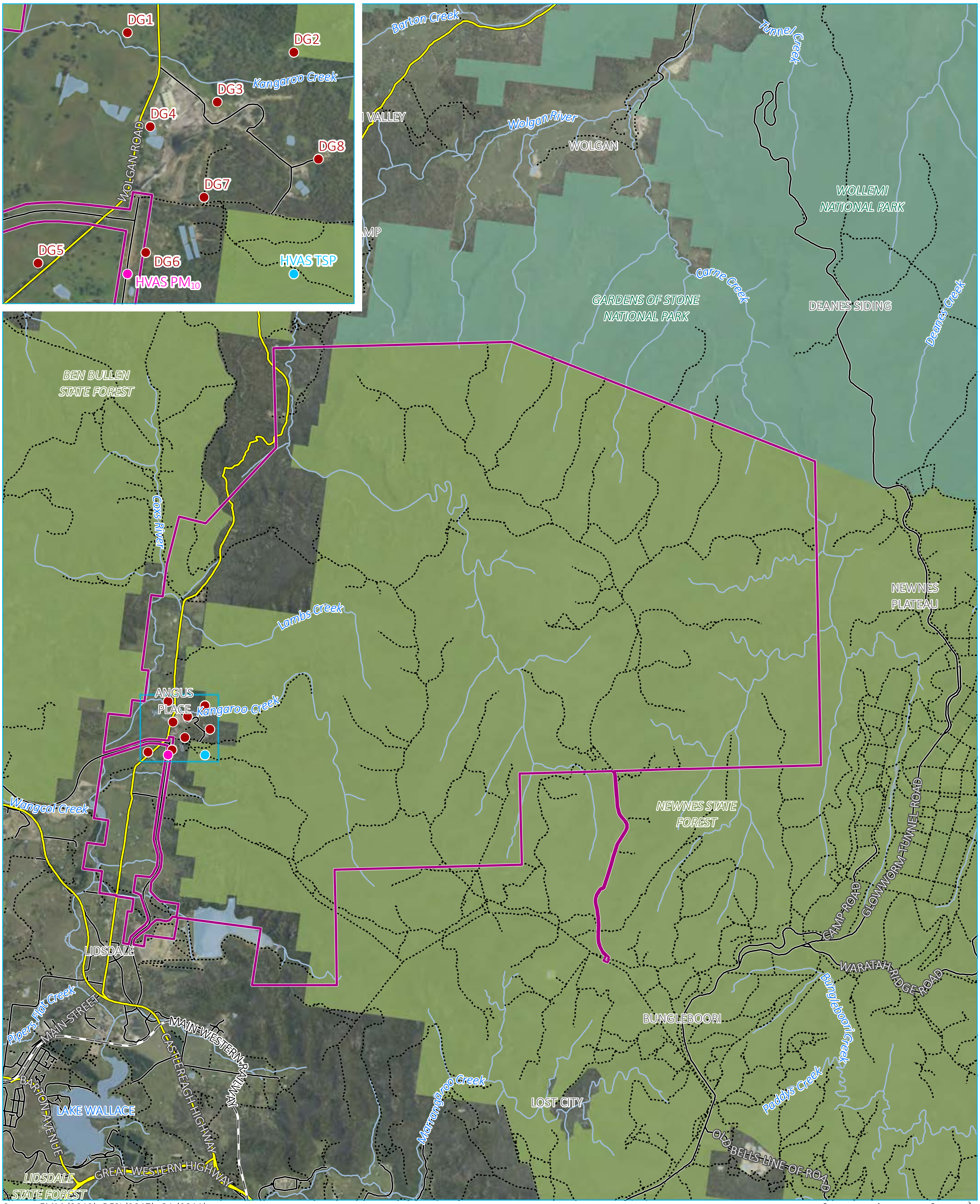
5.2 Air quality monitoring data resources

Centennial Angus Place has commissioned an air quality monitoring network for the Project. The network consists of the following monitoring equipment:

- two high-volume air samplers (HVAS) for the recording of PM_{10} and TSP concentrations on a one-in-six day run cycle;
- eight dust deposition gauges for recording monthly dust deposition rates; and
- two meteorological stations recording weather conditions, including wind speed and direction, temperature, solar radiation, rainfall and atmospheric pressure.

The locations of the Project-specific monitoring equipment are shown in Figure 5.1.

Hourly average concentrations of PM_{10} and $PM_{2.5}$ for the period 2014-2018 were also obtained from the DPIE's air quality monitoring station at Bathurst (hereafter Bathurst AQMS), located approximately 50 km west of the Project.



Source: EMM (2019); DFSI (2017); GA (2011)

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KEY

- Study area
- Dust deposition gauges
- HVAS PM_{10}
- HVAS TSP
- Waterbody
- NPWS reserve
- State forest
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Location of air quality monitoring network

Angus Place Mine Extension Project
Air quality impact assessment
Figure 5.1

EMM
creating opportunities

5.3 Background air quality

5.3.1 PM_{10}

i Angus Place HVAS monitoring data

As stated above, 24-hour average PM_{10} concentrations are recorded at the existing HVAS on a one-in-six day run cycle. A summary of key statistics for the five years of analysed data from the HVAS is presented in Table 5.1. A single exceedance of the NSW EPA 24-hour average criterion of 50 µg/m³ was recorded in 2017 which was the result of a grass fire on Wolgan Road located approximately 100 m from the HVAS (Centennial Coal 2017).

Table 5.1 Statistics for PM_{10} concentrations – Angus Place HVAS – 2014–2018

Monitoring year	PM_{10} concentration (µg/m³)		
	Maximum 24-hour average	Annual average	Days > 50 µg/m³
2014	16.0	5.7	0
2015	17.0	5.3	0
2016	20.0	6.6	0
2017	101.0	9.3	1
2018	24.0	7.8	0

ii Bathurst AQMS

Although PM_{10} concentrations are monitored at Angus Place, the data are measured on a one-in-six day run cycle and therefore cannot be used alone in a contemporaneous cumulative analysis for the Project. To supplement the data from the Angus Place HVAS, reference is made to the Bathurst AQMS, the closest publicly available continuous monitoring station for PM_{10} and $PM_{2.5}$. A summary of key statistics for the five years of analysed data from the Bathurst AQMS is presented in Table 5.3. Two exceedances of the NSW EPA 24-hour average criterion of 50 µg/m³ were recorded in 2015 and eight were recorded in 2018.

Table 5.2 Statistics for PM_{10} concentrations –Bathurst AQMS – 2014–2018

Monitoring year	PM_{10} concentration (µg/m³)		
	Maximum 24-hour average	Annual average	Days > 50 µg/m³
2014	42.8	14.4	0
2015	94.6	13.3	2
2016	34.1	12.4	0
2017	49.9	13.7	0
2018	274.1	18.8	8

A time series of recorded 24-hour average PM_{10} concentrations at the Bathurst AQMS for the period between 2014 and 2018 is presented in Figure 5.2. The recorded 24-hour average PM_{10} concentrations fluctuated throughout the period. Concentrations at Bathurst are typically below the NSW EPA assessment criterion of 50 µg/m³ although a number of days above the criterion were recorded in 2018. The annual average and 24-hour average PM_{10} concentrations for 2018 at Bathurst are significantly higher than the previous five years of monitoring data. The higher concentrations in 2018 are attributed to intensive drought and smoke from bushfires and hazard reduction burns (NSW OEH 2019).

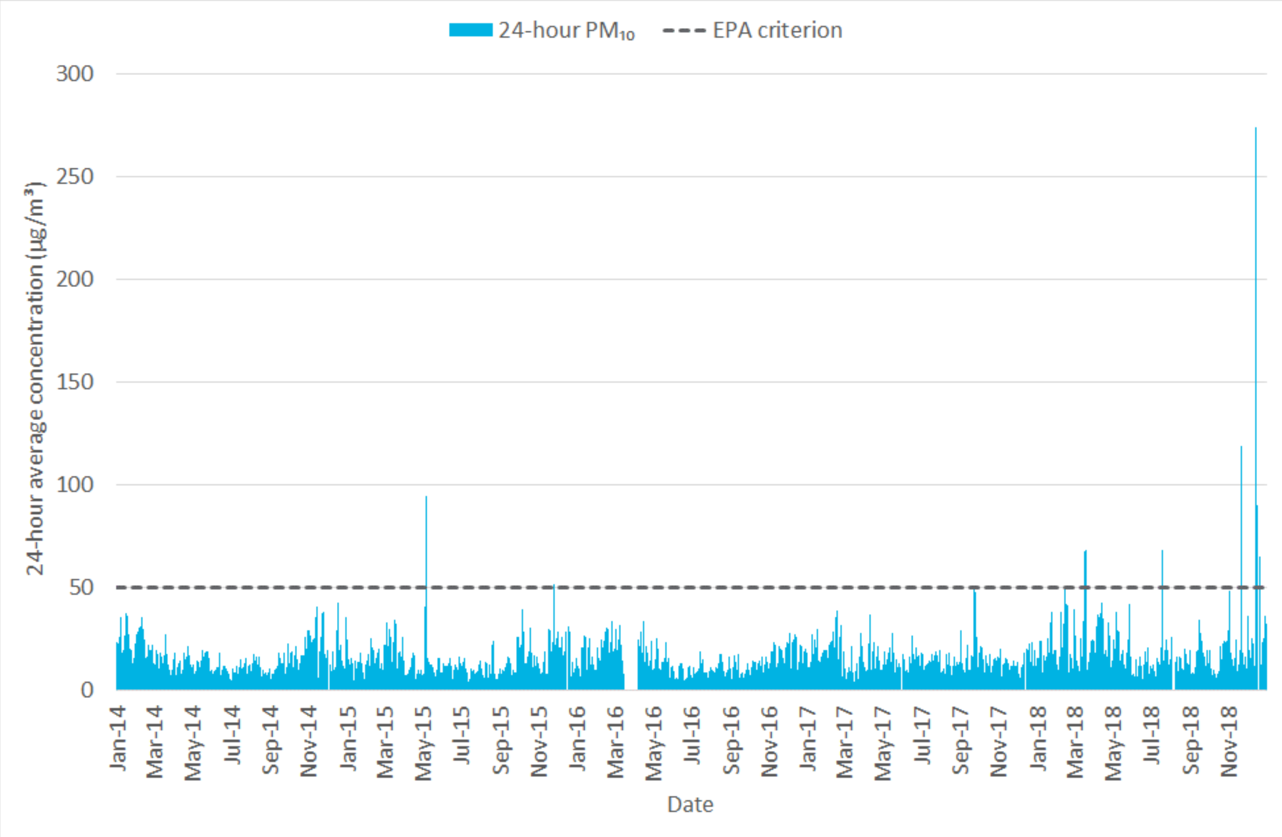


Figure 5.2 Time series of 24-hour average PM_{10} concentrations – Bathurst AQMS – 2014–2018

It is acknowledged that land use and dust-generating activities surrounding the Project differ to those at the Bathurst monitoring station. The dominant dust source in the vicinity of the Project is mining, whereas the dominant dust sources in Bathurst are residential activities such as wood heaters and fuel combustion from vehicles. To compare the Angus Place HVAS and Bathurst datasets, coincident 24-hour average PM_{10} concentrations recorded at the two locations were extracted for the period 2014-2018. The coincident concentrations at the two sites are presented in Figure 5.3.

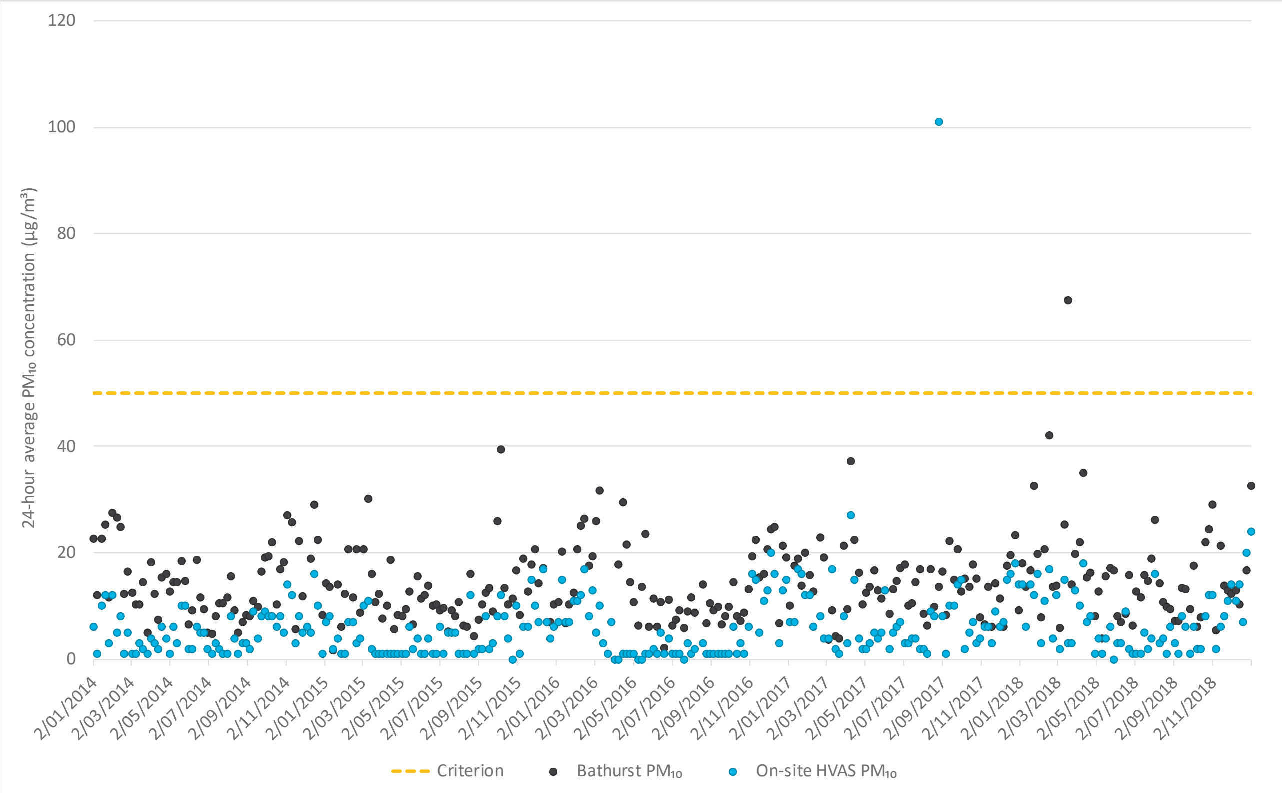


Figure 5.3 Coincident 24-hour average PM_{10} concentrations – Angus Place HVAS and Bathurst AQMS – 2014–2018

Note: only dates with co-incident 24-hour average PM_{10} concentrations at both the Project HVAS and Bathurst AQMS are shown.

The following points are noted from the comparison:

- there was a similar inter-annual fluctuation in PM_{10} concentrations over the five years at the two sites;
- the Bathurst station recorded higher average PM_{10} concentrations than the Angus Place HVAS for all years of monitoring; and
- on average, the Angus Place HVAS recorded concentrations that were approximately 40% of the concentrations recorded at Bathurst.

Two main factors are considered to contribute to the higher concentrations recorded at Bathurst:

- There were a larger number of data points in the Bathurst dataset (continuous measurements) relative to the Angus Place HVAS (one-in-six days). Regional-scale events such as dust storms or bushfires can result in elevated concentrations for several days, and these could have been missed by the HVAS monitoring method.
- The Bathurst site features a higher density of urban development and associated emission sources (motor vehicles, domestic heating, etc) than the area around surrounding the Project. In particular, the elevated concentrations during the autumn and winter months were likely attributable to wood heater emissions.

The Bathurst dataset is therefore considered a conservatively high continuous record of 24-hour average PM_{10} concentrations that better meets the data completeness requirements for a Level 2 AQIA. However, as reported in Table 5.3, there were eight days in 2018 when the PM_{10} concentrations were already above 50 µg/m³.

Consistent with the approach in the Approved Methods for Modelling for dealing with elevated background, these days are not reported for cumulative assessment. There are also three additional days where the concentrations recorded at Bathurst were elevated due to dust storms, as follows:

- On 14/02/2018 a concentration of 49.2 µg/m³ was recorded at Bathurst. The NSW Government Dust Watch Report for February 2018 indicates that widespread dust storms occurred on 10 and 11 February (NSW OEH 2018a).
- On 19/07/2018 a concentration of 49.7 µg/m³ was recorded at Bathurst. The NSW Government Dust Watch Report for July 2018 indicates that significant dust storm on 17 July originated in the South Australian and Victoria Mallee and travelled east, eventually affecting air quality in the Greater Sydney Metropolitan Area (NSW OEH 2018b).
- On 2/11/2018 a concentration of 48.7 µg/m³ was recorded at Bathurst. The NSW Government Dust Watch Report for November 2018 indicates that major dust events occurred on 2 November and 21 November (NSW OEH 2018c).

The background concentrations at Bathurst on these days appear to be influenced by regional dust storms and are not necessarily representative of background concentrations at Angus Place Colliery. To illustrate this, the Angus Place HVAS data periods between these elevated events is compared to the Bathurst data. Although there are no co-incident measurements for the actual days, it is useful to look at the pattern of concentrations for the period between the two datasets. As shown in Figure 5.4, Figure 5.5 and Figure 5.6, the Angus Place HVAS concentrations are between 30% and 40% of the total Bathurst concentrations for periods between these exceptional events.

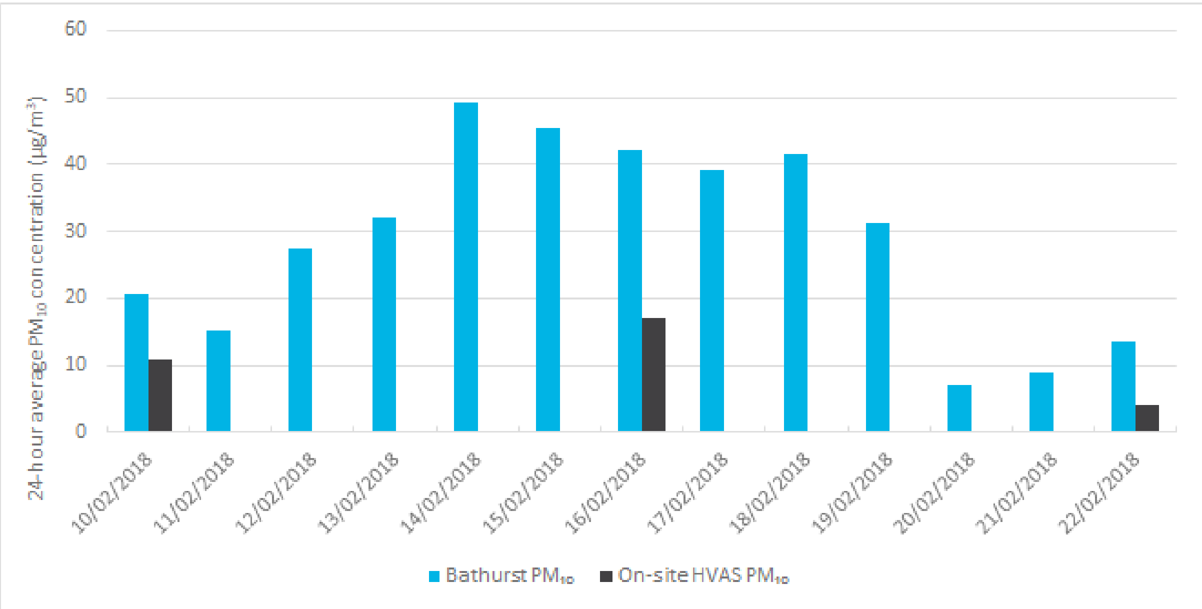


Figure 5.4 24-hour average PM_{10} concentrations – Angus Place HVAS and Bathurst AQMS – 10 February 2018 to 22 February 2018

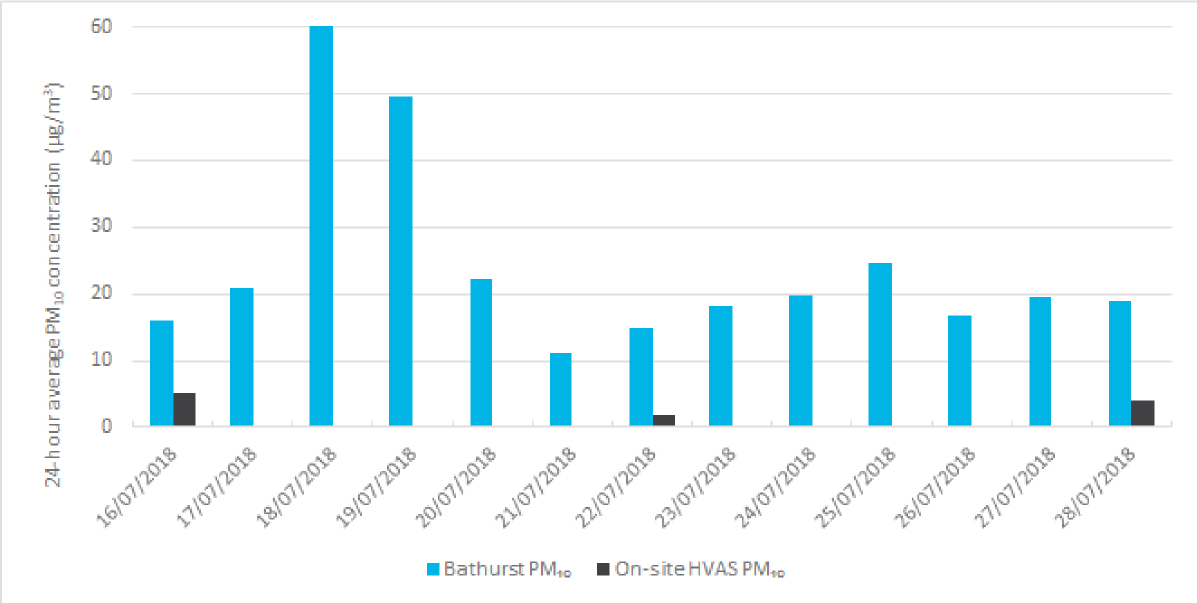


Figure 5.5 24-hour average PM_{10} concentrations – Angus Place HVAS and Bathurst AQMS – 16 July 2018 to 28 July 2018

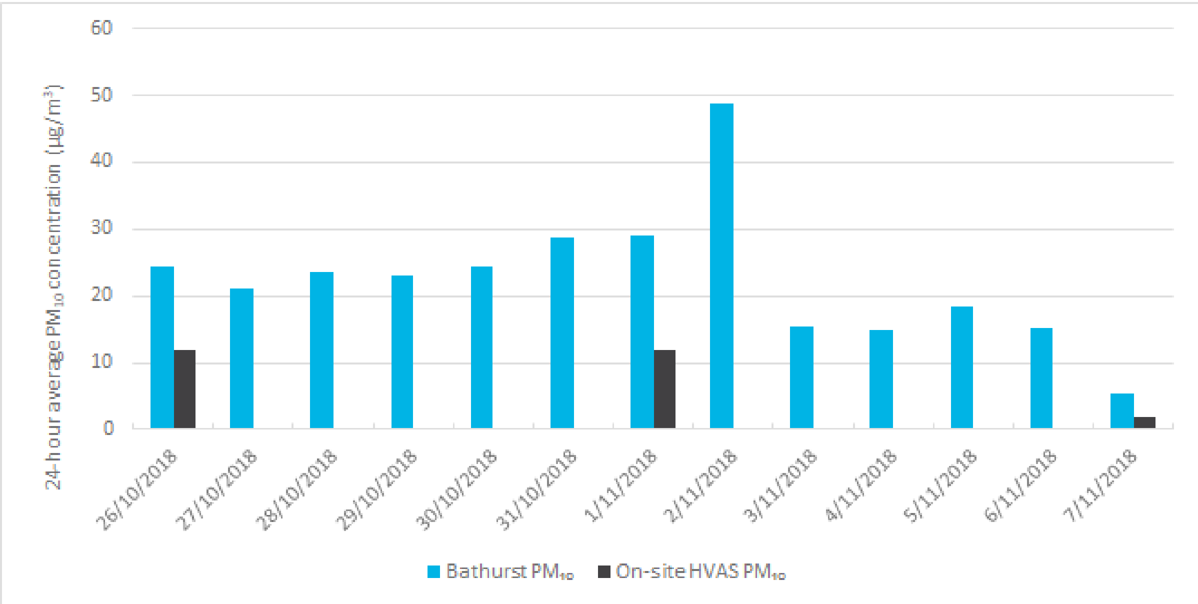


Figure 5.6 24-hour average PM_{10} concentrations – Angus Place HVAS and Bathurst AQMS – 26 October 2018 to 7 November 2018

5.3.2 $PM_{2.5}$

No monitoring of $PM_{2.5}$ is conducted by the existing air quality monitoring network at Angus Place Colliery. To provide an analysis of background $PM_{2.5}$ concentrations in the absence of these measurements, $PM_{2.5}$ concentrations recorded by the Bathurst station were reviewed. The Bathurst station commenced measurement of $PM_{2.5}$ concentrations in April 2016.

Key statistics for the analysed $PM_{2.5}$ monitoring data from the Bathurst station are presented in Table 5.3. As was the case for PM_{10}, the presented statistics for 2018 are higher than the 2016 (partial year) and 2017 datasets. Consistent with PM_{10}, the 2018 calendar year $PM_{2.5}$ dataset from the Bathurst station has been adopted to represent background conditions for the assessment.

Table 5.3 Statistics for $PM_{2.5}$ concentrations –Bathurst – 2016–2018

Monitoring year	$PM_{2.5}$ concentration (µg/m³)		
	Maximum 24-hour average	Annual average	Days > 25 µg/m³
2016	15.0	3.8	0
2017	17.5	6.1	0
2018	40.5	7.0	2

Note: Monitoring of $PM_{2.5}$ at the Bathurst AQMS commenced in April 2016.

A time series of the recorded 24-hour average $PM_{2.5}$ concentrations at Bathurst is presented in Figure 5.7. Like the PM_{10} concentrations, the recorded 24-hour average $PM_{2.5}$ concentrations fluctuated throughout the presented period. The recorded $PM_{2.5}$ concentrations were generally below the NSW EPA assessment criterion of 25 µg/m³, although two exceedances were recorded in 2018. Consistent with the approach in the Approved Methods for Modelling for dealing with elevated background, these days are not reported for cumulative assessment.

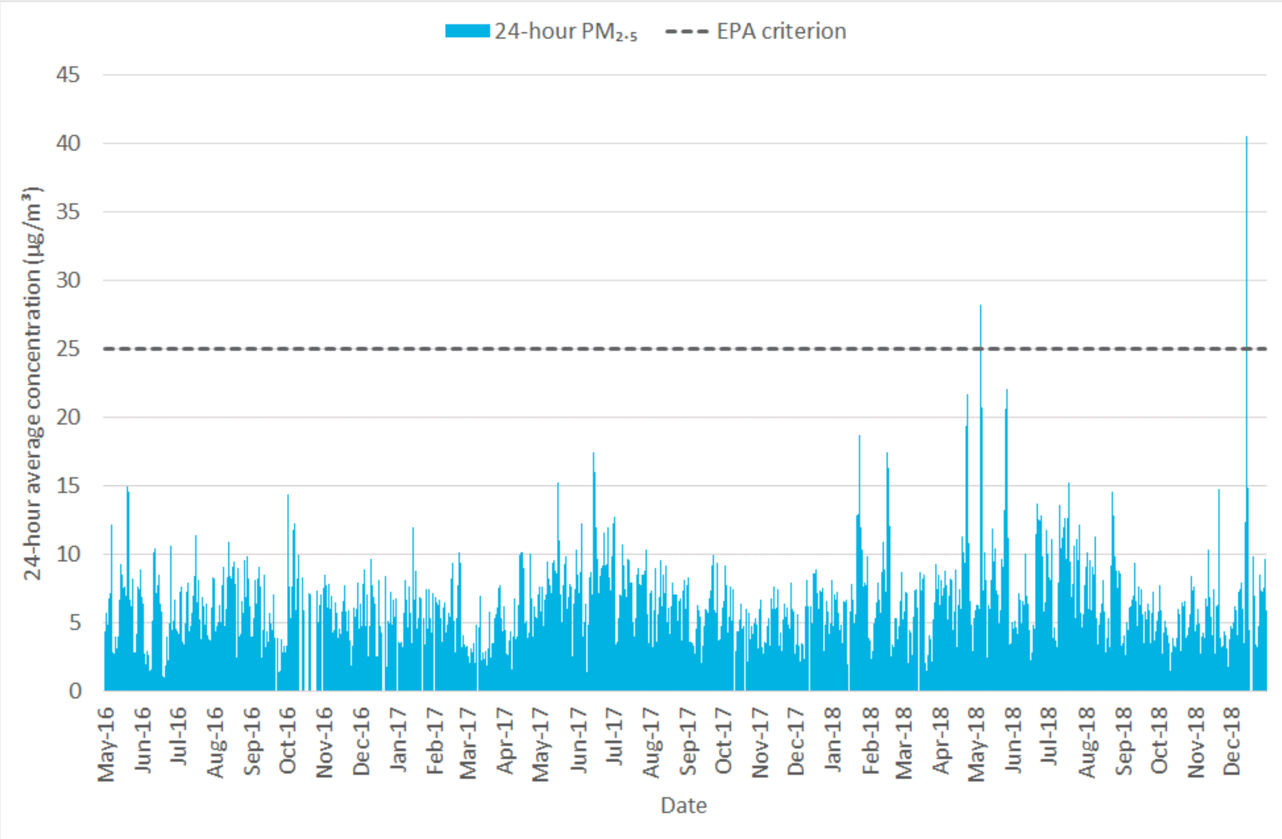


Figure 5.7 Time series of 24-hour average $PM_{2.5}$ concentrations – Bathurst AQMS – 2016 to 2018

Note: Monitoring of $PM_{2.5}$ at the Bathurst AQMS commenced in April 2016.

5.3.3 TSP

TSP concentrations are recorded at Angus Place by HVAS on a one-in-six day run cycle. A summary of key statistics for the five years of analysed data from the Angus Place HVAS is presented in Table 5.4. As with the PM_{10} concentrations shown in Section 5.3.1, Table 5.4 shows that measured TSP concentrations were higher in 2017 and 2018 compared with previous years. Again, this is likely to be due to drought conditions across the state in these years.

Although TSP concentrations are measured at Angus Place, to maintain consistency with the adopted background for PM_{10}, TSP concentrations are derived from the Bathurst PM_{10} data, based on the ratio of PM_{10}/TSP from the Angus Place HVAS measurements (see Table 5.4). Similar to typically values for rural areas, the Angus Place PM_{10}/TSP ratio ranges from 0.4 to 0.5. Applying a PM_{10}/TSP ratio of 0.4 to the annual average PM_{10} concentration for 2018 (of 18.8 µg/m³), results in a conservatively high TSP background concentration of 47.1 µg/m³.

Table 5.4 Statistics for TSP concentrations – Angus Place HVAS – 2014–2018

Monitoring year	TSP concentration (µg/m³)	
	Annual average	PM_{10}/TSP ratio
2014	12.1	0.4
2015	11.0	0.4
2016	13.0	0.4
2017	17.8	0.5
2018	16.6	0.4

5.3.4 Dust deposition

Centennial Angus Place operates a network of eight dust deposition gauges in the vicinity of the Angus Place pit top. Recorded dust deposition rates since January 2014 were provided by Centennial Angus Place and have been analysed to determine existing dust deposition levels. Dust deposition results from the four monitoring locations for the previous five years were processed, with the results presented in Table 5.5. For all years of monitoring, the impact assessment criterion was not exceeded at any monitoring location. The highest annual average dust deposition level recorded for the 2018 period was 1.5 g/m^2/month at depositional dust gauge DG1 (refer to Figure 2.3). This value has been adopted as background for this assessment.

Table 5.5 Annual dust deposition results – Angus Place monitoring network

Monitoring year	Annual average dust deposition levels (g/m²/month)							
	DG1	DG2	DG3	DG4	DG5	DG6	DG7	DG8
2014	0.9	1.3	1.7	1.5	3.1	0.8	1.1	0.5
2015	0.3	1.1	3.4	1.0	0.3	0.5	1.6	0.4
2016	0.2	1.3	0.3	0.5	0.2	1.6	0.3	0.4
2017	1.8	0.6	0.6	0.7	0.2	0.7	0.4	0.5
2018	1.5	1.0	1.1	1.1	0.9	1.0	1.2	1.2
Criterion	**4**							

5.4 Assumed background concentrations

As described above, the Bathurst 2018 dataset is considered a conservatively high background for cumulative assessment of PM. For dust deposition, the dust deposition levels recorded in the vicinity of the Angus Place Colliery pit top will be used as a background for cumulative assessment. In summary, the following background values will be adopted for cumulative assessment:

- 24-hour PM_{10} concentration – daily varying;
- annual average PM_{10} concentration – 18.8 µg/m³;
- 24-hour $PM_{2.5}$ concentration – daily varying;

- annual average $PM_{2.5}$ concentration – 7.0 µg/m³;
- annual average TSP concentration – 47.1 µg/m³; and
- annual average dust deposition – 1.5 g/m²/month.

6 Emissions inventory

6.1 Sources of emissions

Sources of atmospheric emissions associated with the Project include the following:

- conveyor transfer from underground portal;
- conveyor transfer to ROM stockpile;
- bulldozers working on ROM stockpile;
- wind erosion from ROM stockpile;
- conveyor transfer to the coal handling plant (CHP);
- coal sizing;
- conveyor transfer to load-out bin;
- loading coal to trucks; and
- upcast ventilation shafts.

These activities are accounted for in the assessment scenario for the Project.

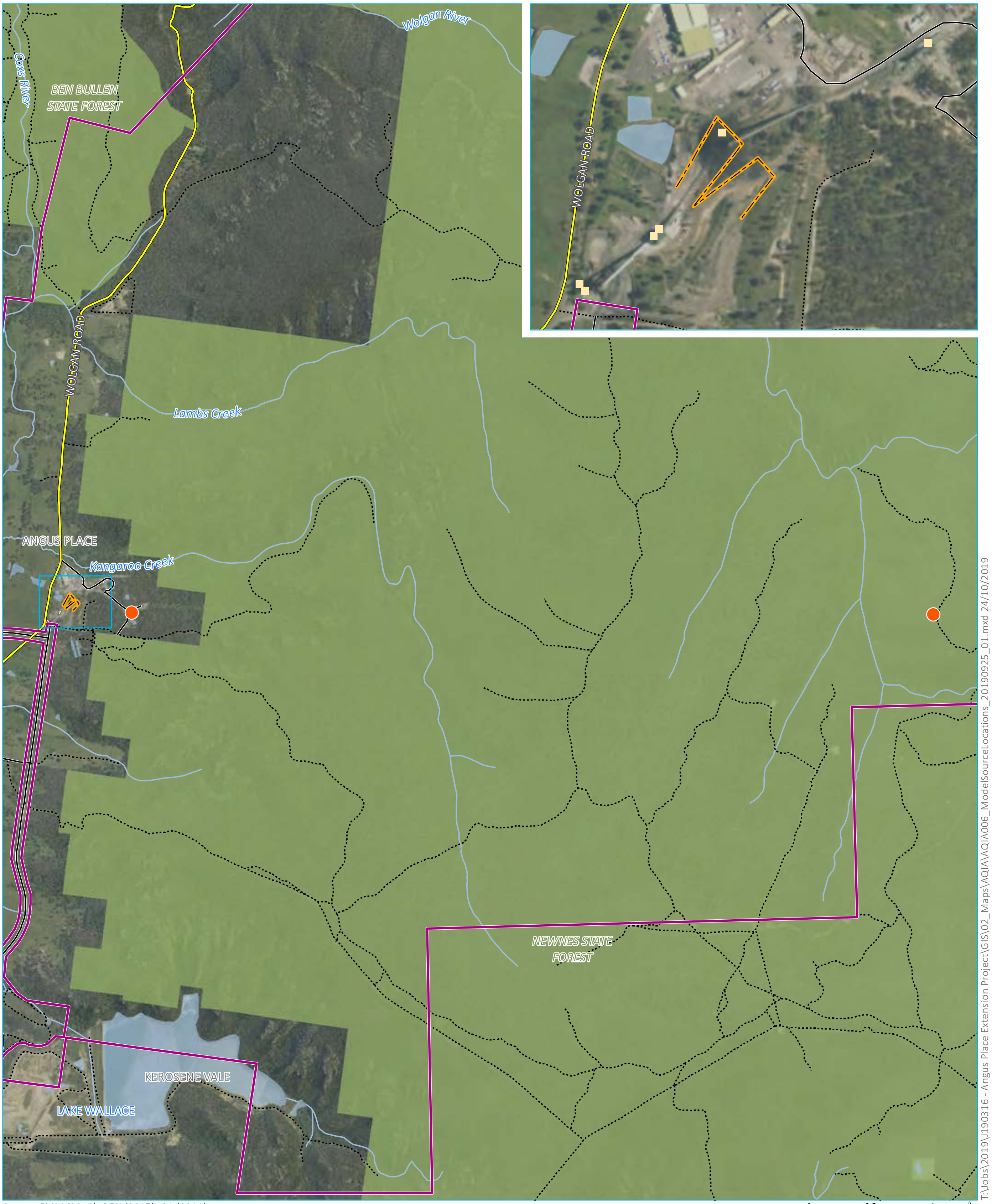
6.2 Emissions scenario

In order to quantify peak air pollution emissions and associated impacts in the surrounding environment from the Project's operations, a worst-case emissions scenario has been configured. The worst-case emissions scenario corresponds to the maximum production (4.5 Mtpa).

6.3 Emissions estimates

Fugitive dust sources associated with the operations of the Project were quantified through the application of US-EPA AP-42 emission factor equations. Particulate matter emissions were quantified for the three size fractions identified in Section 3, with the TSP fraction also used to provide an indication of dust deposition rates. Emission rates for coarse particles (PM_{10}) and fine particles ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available in the literature (principally the US-EPA AP-42).

A detailed description of the assumptions and emission factors adopted in the development of the emissions inventory are provided in Appendix C. The modelled source locations are shown in Figure 6.1.



Source: EMM (2019); DFSI (2017); GA (2011)

KEY

- Study area
- Point source
- Line-volume source
- Volume source
- Waterbody
- State forest
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Model source locations

Angus Place Mine Extension Project
Air quality impact assessment
Figure 6.1

creating opportunities

6.3.1 Emissions summary

As stated, annual emissions from the Project were estimated for a single operational scenario corresponding to a maximum coal production rate of 4.5 Mtpa.

A graphical summary of the contribution to annual dust emissions by source type is provided in Figure 6.2. Calculated annual emissions by emissions source is presented in Table 6.1. Particulate matter control measures, as documented in Section 6.4, are accounted for in these emission totals.

From the data presented in Figure 6.2 and Table 6.1, the most significant source of particulate matter emissions from the operation of the Project is associated with dozer operations at the ROM stockpile.

Further details regarding emission estimation factors and assumptions are provided in Appendix C.

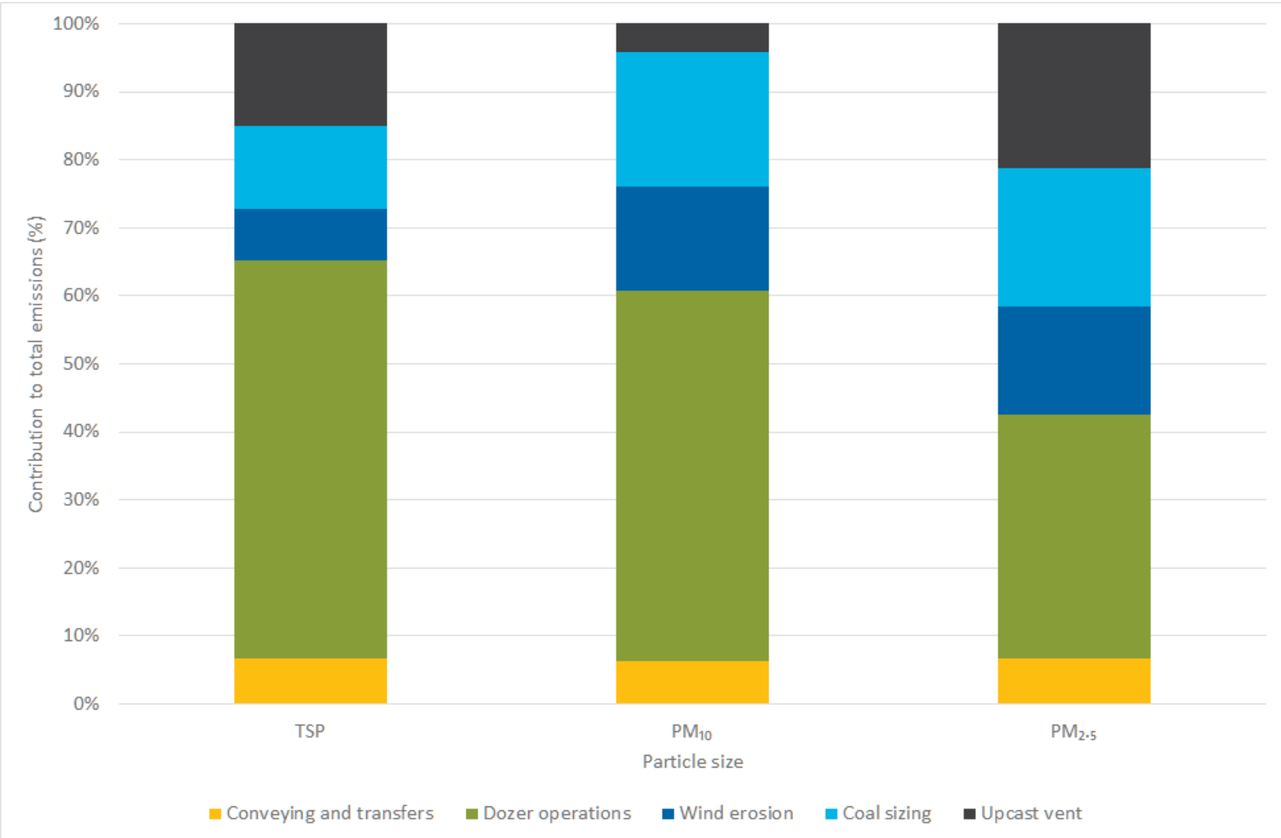


Figure 6.2 Contribution to annual emissions by emissions source type and particle size

Table 6.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions –4.5 Mtpa operational scenario

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Conveyor transfer point from portal	229	53	8
Conveyor transfer to ROM stockpile	229	53	8
Dozer on ROM stockpile	32,323	7,399	711
Wind erosion from ROM stockpile	4,158	2,079	312
Conveyor transfer to CHP	229	53	8
Coal sizing	6,750	2,700	405
Conveyor transfer to load out bin	1,528	351	53
Loading coal to trucks	1,528	351	53
Upcast vent fan (APC-VS1)	4,183	279	209
Upcast vent fan (APC-VS2)	4,183	279	209
Total	**55,340**	**13,594**	**1,976**

Note: Emission totals incorporate particulate matter management measures (refer Section 6.4).

6.4 Management measures

In order to manage particulate matter emissions from the operational phase, a range of mitigation measures and management practices are required.

Proposed dust management measures include the following:

- enclosures at conveyor transfer points;
- water sprays at conveyor transfer points;
- enclosure of coal sizer; and
- watering at coal sizer.

To account for these emission management methods, the following particulate matter emission reduction factors have been applied in the emissions totals presented in Table 6.1:

- conveyor transfer points - 70% reduction for enclosure and 50% watering of materials (NPI 2012); and
- coal sizer - 70% reduction for enclosure and 50% watering of materials (NPI 2012).

7 Air dispersion modelling

7.1 Dispersion model selection and configuration

Dispersion modelling for this assessment uses the CALPUFF modelling system, which is commonly used in NSW for applications where non-steady state conditions may occur (ie complex terrain or coastal locations) or when calm wind conditions are important (ie for odour assessment). In the absence of available upper air measurements, CALMET (the meteorological pre-processor for CALPUFF) can be run using prognostic upper air data (as a three-dimensional '3D.dat' file). Gridded upper air data were derived using The Air Pollution Model (TAPM), which is then used in CALMET to derive an initial wind field (known as the Step 1 wind field). CALMET then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and has been adopted for this assessment. TAPM and CALMET model settings are described in Appendix B and selected in accordance with recommendations in EPA (2016) and TRC (2011). Surface observations are included in the modelling (referred to as data assimilation) and are discussed and described in Section 4.

In addition to the 16 individual assessment locations (documented in Section 2.3), air pollutant concentrations were predicted over a 20 km by 20 km domain with 500 m resolution.

Specific activities (listed in Table 9.3) were represented by line-volume, volume and point sources which were located according to the layout of the existing Angus Place Colliery pit top. The modelled source locations are shown in Figure 6.1. Simulations were undertaken for the 12-month period of 2018.

7.2 Incremental (Project-only) results

Predicted incremental TSP, PM_{10}, $PM_{2.5}$, and dust deposition levels from the Project operational phase are presented in Table 7.1 for each of the assessment locations.

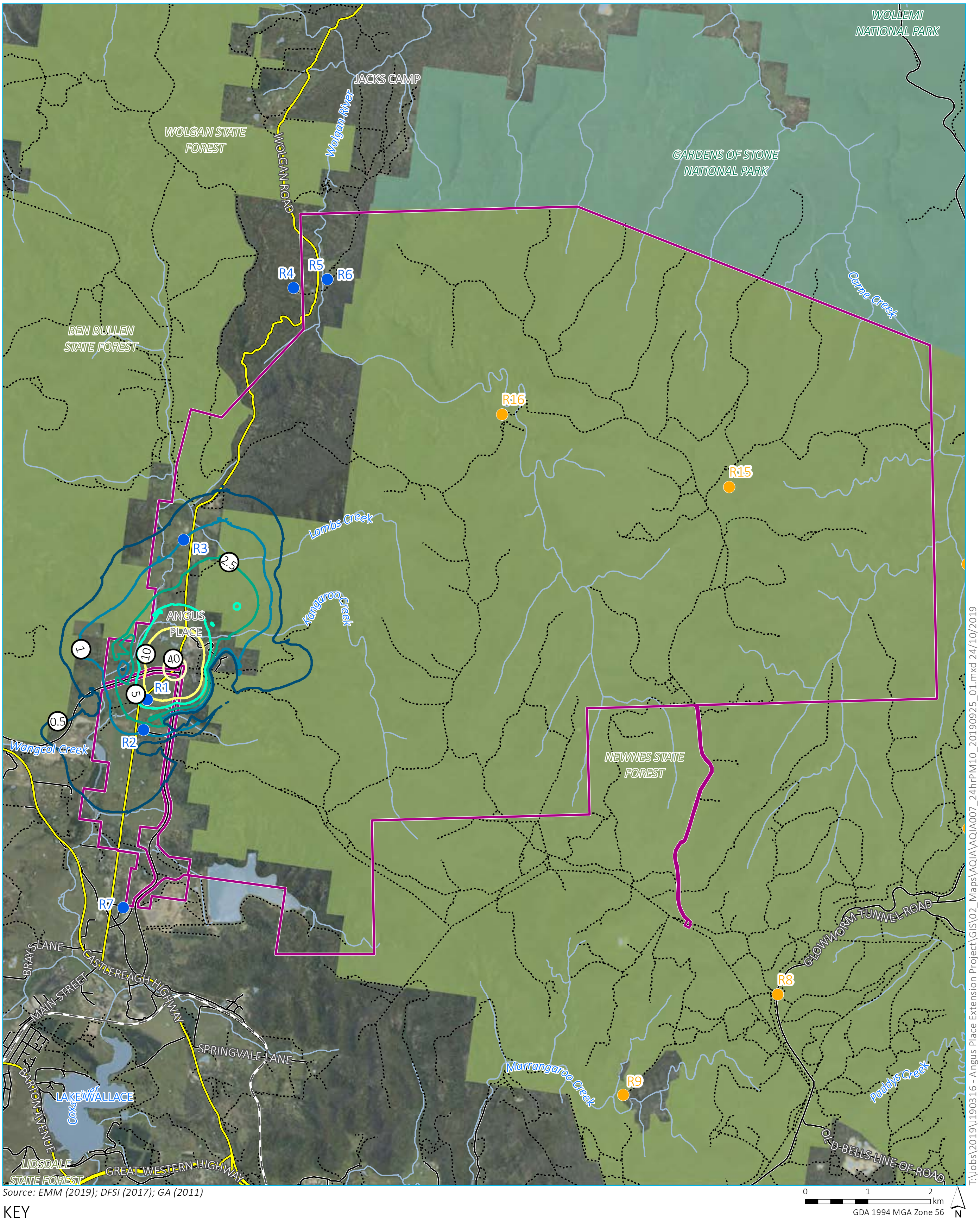
The predicted concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criterion at all assessment locations. Except for dust deposition, the assessment criteria listed are applicable to cumulative concentrations. Analysis of cumulative impact compliance is presented in Section 7.3.

Contour plots, illustrating spatial variations in Project-related incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates are provided in Figure 7.1 to Figure 7.6 below. Isopleth plots of the maximum 24-hour average concentrations presented do not represent the dispersion pattern on any day, but rather, the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2018 modelling period.

Table 7.1 Incremental (Project operational phase only) concentration and deposition results

Assessment location ID	Predicted incremental concentration (µg/m³) and deposition rate (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
R1	3.0	8.2	2.6	1.9	0.6	0.1
R2	0.3	1.3	0.2	0.2	<0.1	<0.1
R3	0.1	1.0	0.1	0.2	<0.1	<0.1
R4	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
R5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R6	<0.1	0.3	<0.1	0.1	<0.1	<0.1
R7	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
R8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background). Criteria is provided for comparison purposes only.



Source: EMM (2019); DFSI (2017); GA (2011)

KEY

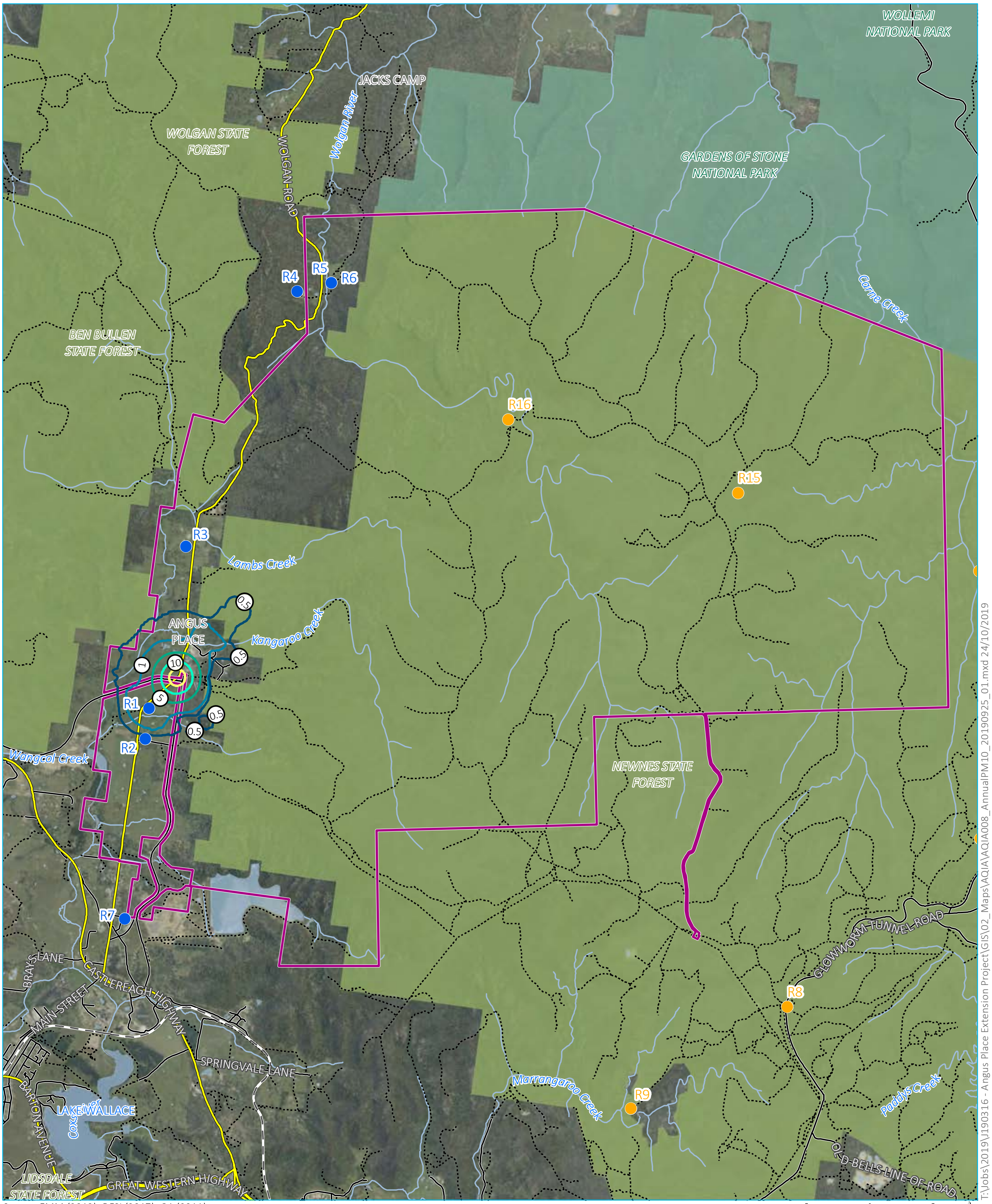
- Study area
- Recreation receptor
- Residential receptor
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

PM_{10} concentration (µg/m^3)

- 0.5
- 1
- 2.5
- 5
- 10
- 40

Maximum predicted 24-hour average PM_{10} concentrations – project only

Angus Place Mine Extension Project
Air quality impact assessment
Figure 7.1



Source: EMM (2019); DFSI (2017); GA (2011)

KEY

- Study area
- Recreation receptor
- Residential receptor

PM_{10} concentration (μg/m^3)

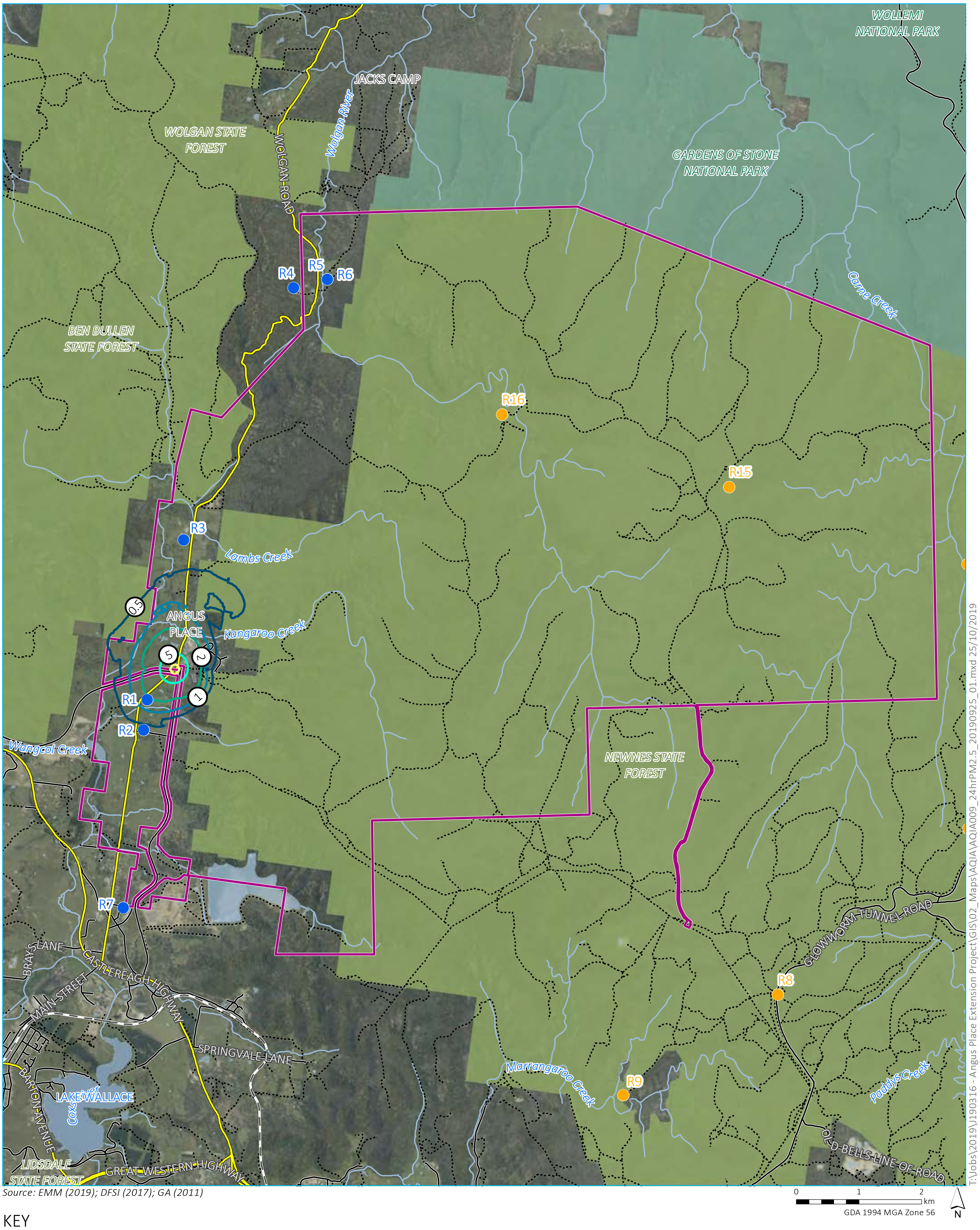
- 0.5
- 1
- 5
- 10
- 15

- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

Predicted annual average PM_{10} concentrations – project only

Angus Place Mine Extension Project
Air quality impact assessment
Figure 7.2

EMM creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

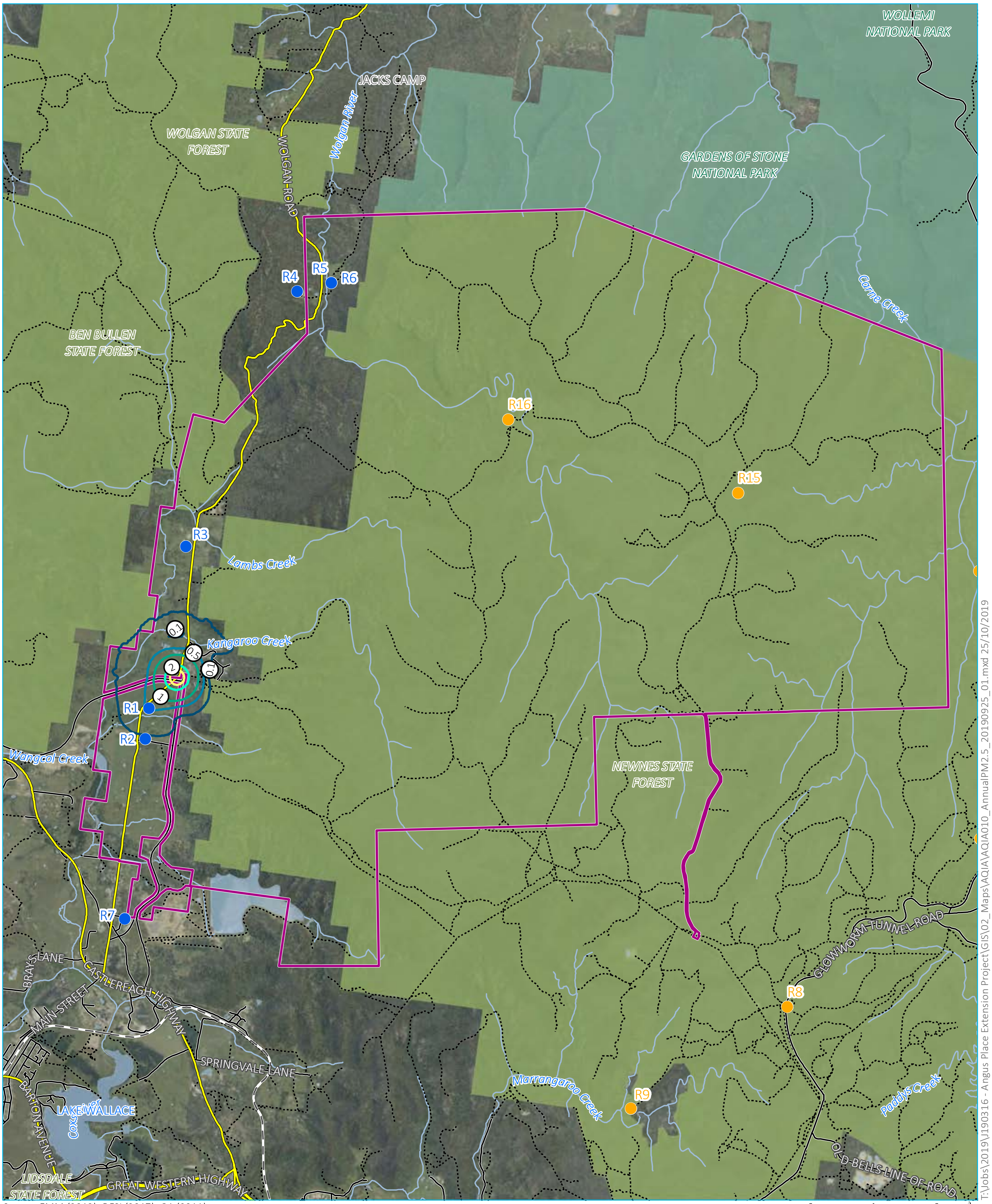
KEY

- Study area
- Recreation receptor
- Residential receptor
- $PM_{2.5}$ concentration (µg/m^3)
  - 0.5
  - 1
  - 2
  - 5
  - 7
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

Maximum predicted 24-hour average $PM_{2.5}$ concentration – project only

Angus Place Mine Extension Project
Air quality impact assessment
Figure 7.3

EMM
creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

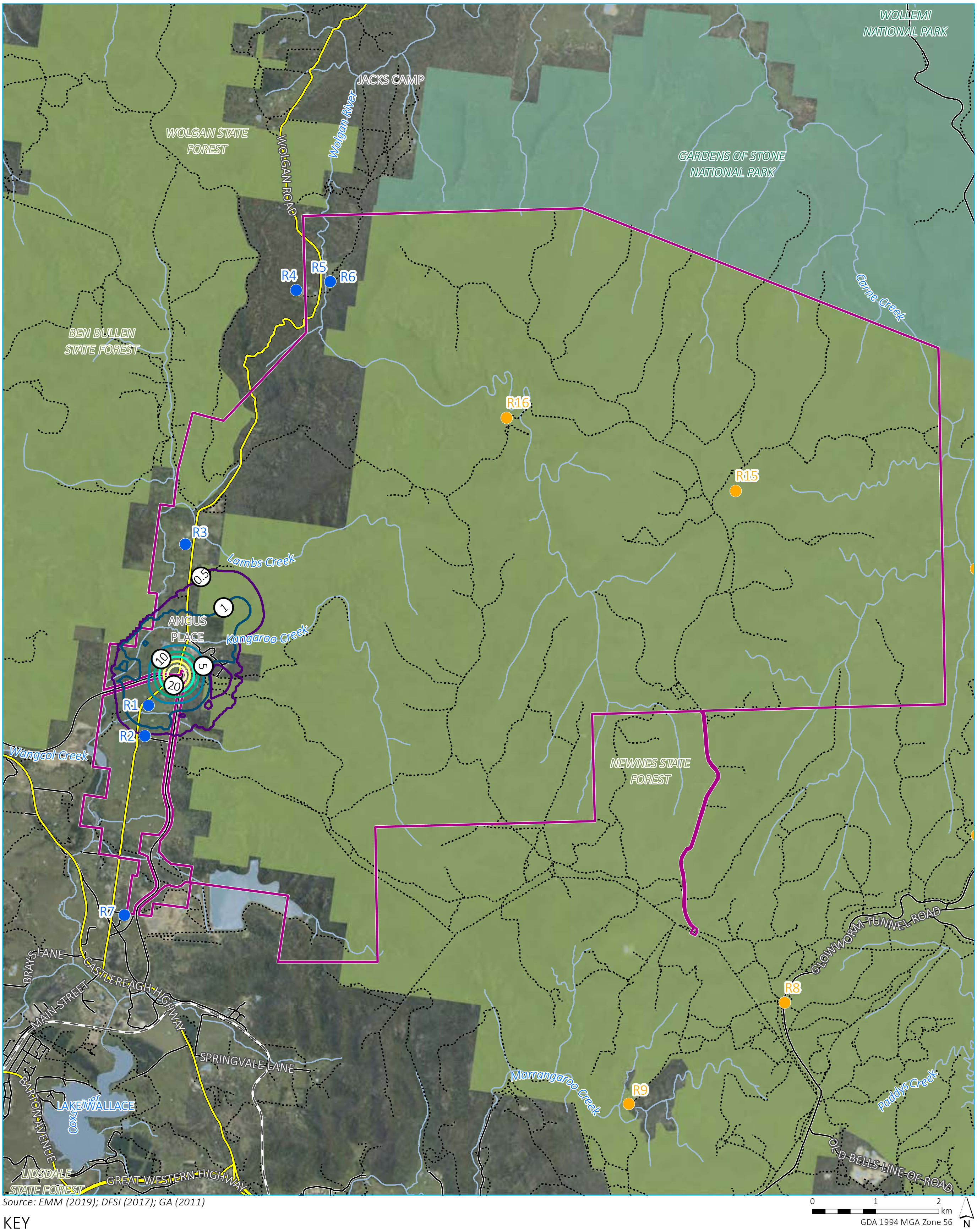
KEY

- Study area
- Recreation receptor
- Residential receptor
- $PM_{2.5}$ concentration (µg/m^3)
  - 0.1
  - 0.5
  - 1
  - 2
  - 2.5
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

Predicted annual average $PM_{2.5}$ concentrations – project only

Angus Place Mine Extension Project
Air quality impact assessment
Figure 7.4

EMM creating opportunities



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Source: EMM (2019); DFSI (2017); GA (2011)

KEY

- Study area
- Recreation receptor
- Residential receptor

TSP concentration (µg/m³)

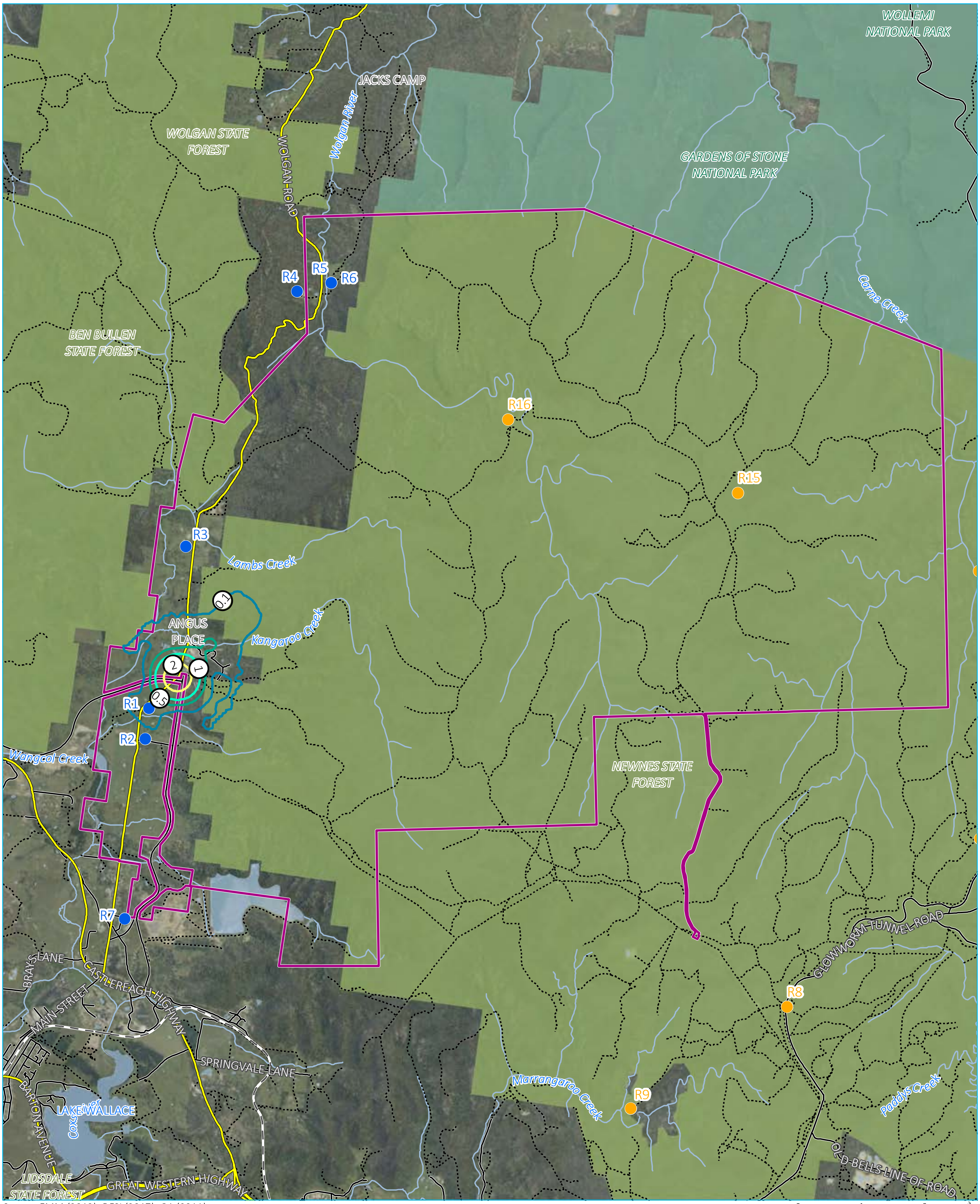
- 0.5
- 1
- 5
- 10
- 15
- 20
- 25

- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

Predicted annual average TSP concentrations – project only

Angus Place Mine Extension Project
Air quality impact assessment
Figure 7.5

EMM creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 1 2 km

GDA 1994 MGA Zone 56

N

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KEY

- Study area
- Recreation receptor
- Residential receptor

Dust deposition level (µg/m²/month)

- 0.1
- 0.5
- 1
- 2

- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

Predicted annual average dust deposition levels - project only

Angus Place Mine Extension Project
Air quality impact assessment
Figure 7.6

EMM
creating opportunities

7.3 Cumulative (Project plus background) results

Cumulative concentrations (ie Project plus background) were derived following the contemporaneous assessment approach. For each pollutant and averaging period, the coincident model prediction and corresponding background value were paired together to derive a cumulative concentration at each receptor location. For example, in the case of 24-hour average PM_{10}, at each assessment location the background concentration on 1 January 2018 was paired with the model prediction on 1 January 2018 and repeated for the entire modelling period. It is noted that due to regional dust storms causing exceptional events and days above the criterion, the 12th highest cumulative concentration is presented for PM_{10} and the 3rd highest cumulative concentration is presented for $PM_{2.5}$.

A summary of the predicted cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations associated with Project activities are presented in Table 7.2. The cumulative results show the predicted concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criteria at all assessment locations.

Table 7.2 Cumulative (Project plus background) concentration and deposition results

Assessment location ID	Predicted cumulative concentration (µg/m³) and deposition rate (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum[1]	Annual	24-hour maximum[2]	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
R1	50.1	47.4	21.5	23.3	7.6	1.6
R2	47.4	45.7	19.1	22.2	7.0	1.5
R3	47.2	45.7	18.9	22.1	7.0	1.5
R4	47.1	45.5	18.8	22.1	7.0	1.5
R5	47.1	45.5	18.8	22.1	7.0	1.5
R6	47.1	45.5	18.9	22.1	7.0	1.5
R7	47.1	45.5	18.8	22.1	7.0	1.5
R8	47.1	45.5	18.8	22.1	7.0	1.5
R9	47.1	45.5	18.8	22.1	7.0	1.5
R10	47.1	45.5	18.8	22.1	7.0	1.5
R11	47.1	45.5	18.8	22.1	7.0	1.5
R12	47.1	45.5	18.8	22.1	7.0	1.5
R13	47.1	45.5	18.8	22.1	7.0	1.5
R14	47.1	45.5	18.8	22.1	7.0	1.5
R15	47.1	45.5	18.8	22.1	7.0	1.5
R16	47.1	45.5	18.8	22.1	7.0	1.5

Note:[1] Due to 11 exceedances and exceptional events in the background dataset, the 12th highest cumulative PM_{10} concentration is presented.
[2] Due to 2 exceedances and exceptional events in the background dataset, the 3rd highest cumulative $PM_{2.5}$ concentration is presented.

8 Construction dust assessment

8.1 Introduction

The Project will include some minor construction activities which have the potential to generate dust emissions. The two main construction activities will be:

- The construction of several bore pumps in the Project Application Area, which will likely include the following:
  - installation of power supply;
  - clearing of vegetation;
  - pipe laying;
  - installation of joints and pits;
  - road restoration;
  - drilling of holes; and
  - concrete slab laying.
- The construction of a downcast shaft ventilation shaft, which will likely include the following:
  - vegetation clearing;
  - construction of ponds;
  - concrete laying;
  - drilling; and
  - site rehabilitation.

8.2 Assessment overview

The construction dust assessment follows the *Guidance on the Assessment of Dust from Demolition and Construction* published by the Institute of Air Quality Management in the United Kingdom (IAQM) (IAQM 2014).

In the IAQM assessment procedure, activities at construction sites are divided into four types:

- demolition, which is any activity that involves the removal of existing structures;
- earthworks, which covers the processes of soil stripping, ground levelling, excavation and landscaping and primarily involves excavating material, haulage, tipping and stockpiling;
- construction, which is any activity that involves the provision of new structures, modification or refurbishment; and

- track-out, which involves the transport of dust and dirt by vehicles from the construction site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network.

The assessment methodology considers three separate dust impacts:

- annoyance due to dust soiling;
- the risk of health effects due to an increase in exposure to PM_{10}; and
- harm to ecological receptors.

The procedure for assessing risk is shown in Figure 8.1. Professional judgement is required in some cases, and where justification cannot be given a precautionary approach is adopted. The assessment is used to define appropriate mitigation measures to ensure that there will be no significant residual effects.

The key steps in the procedure are as follows:

- Step 1 – a screening requirement for a detailed assessment based on the proximity of surrounding receptors;
- Step 2 – an assessment of the risk of dust impacts and the sensitivity of surrounding receptors;
- Step 3 – a determination of site-specific mitigation;
- Step 4 – consideration of residual effects and significance; and
- Step 5 – an assessment report (this document).

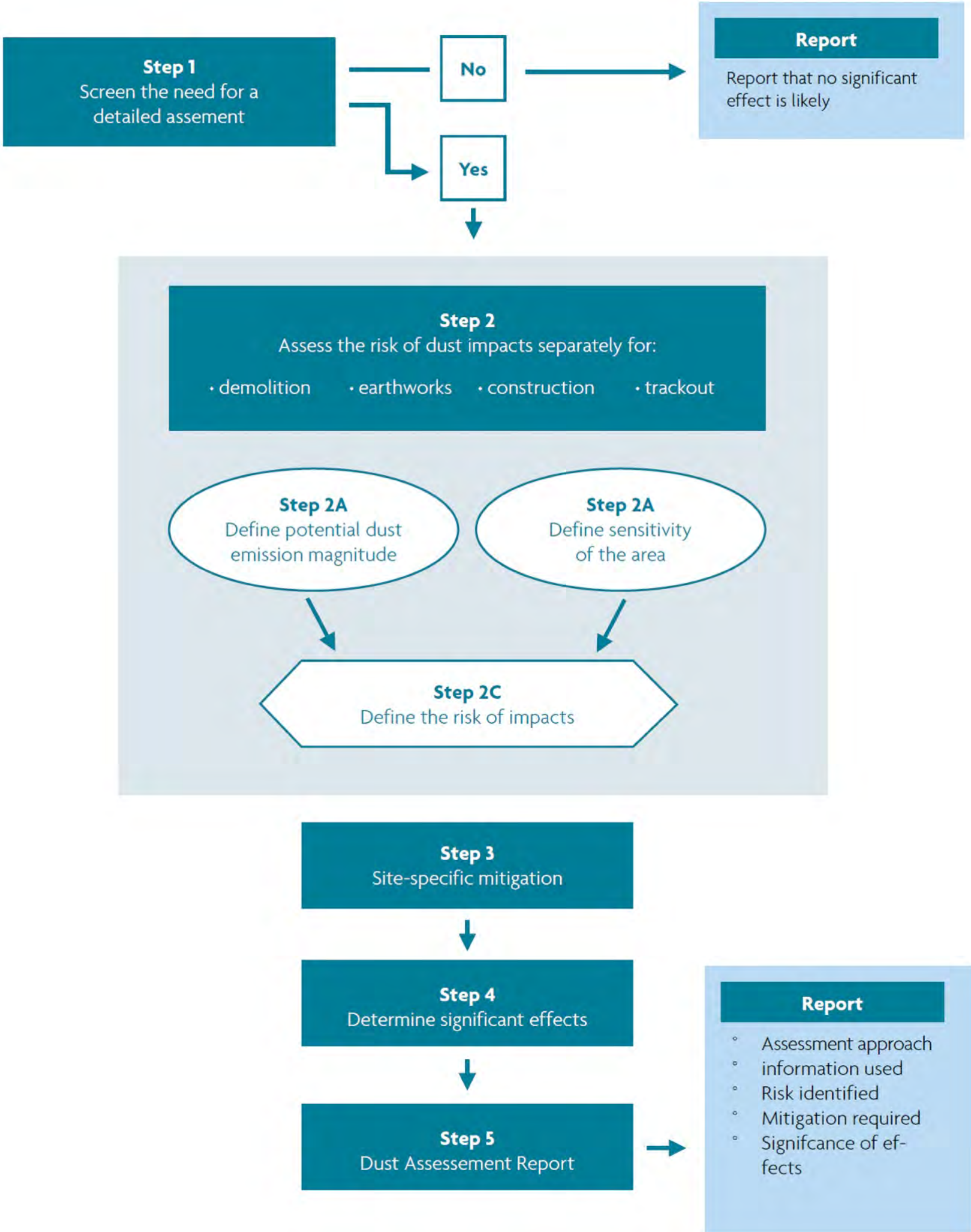

Figure 8.1 Procedure for the assessment of construction dust (IAQM 2014)

8.3 Step 1 - Screening

The IAQM guidance specifies that if a human receptor[2] is located within 350 m of the site boundary, an ecological receptor[3] is located within 50 m of the site boundary, or a human/ecological receptor is within 50 m of a route used by construction vehicles up to 500 m from a site entrance, then a detailed construction dust assessment should be undertaken.

The results of Step 1 are summarised in Table 8.1. As there are likely to be ecological receptors within 50 m of the site boundary, the proposed construction activities trigger the requirement for detailed assessments of dust impacts.

Table 8.1 Results of Step 1

Human receptors		Ecological receptors		Detailed assessment required
Within 350 m of the site boundary	Within 50 m of the route used by construction vehicles	Within 50 m of the site boundary	Within 50 m of route used by construction vehicles	
No	No	Likely	Likely	Yes, for ecological receptors only.

8.4 Step 2 – Assessment of risk of dust impacts

The IAQM guidance dictates that the risk category for dust impacts from construction activities should be allocated based on the following:

- the scale and nature of works (Step 2A); and
- the sensitivity of the area to dust impacts (Step 2B).

These factors are then combined to determine the risk of impacts from the construction activities (Step 2C). The risk rating process is addressed in the following sections.

8.4.1 Step 2A – Scale and nature of works

The scale and nature of demolition, earthworks, construction and track-out were determined. The IAQM guidance prescribes a range of criteria that classify the magnitude of each activity as either large, medium or small (Table D.1). The proposed activities were reviewed in order to allocate a potential dust emission magnitude in accordance with the guidance, and the findings are summarised below.

i Demolition

It is anticipated that there will be no demolition required as part of the Project's construction activities.

[2] A 'human receptor', refers to any location where a person or property may experience the adverse effects of airborne dust or dust soiling, or exposure to PM_{10} over a time period relevant to air quality standards and goals. In terms of annoyance effects, this will most commonly relate to dwellings, but may also refer to other premises such as museums, galleries, vehicle showrooms, food manufacturers, electronics manufacturers, amenity areas and horticultural operations.

[3] An 'ecological receptor' refers to any sensitive habitat affected by dust soiling. This includes the direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g. on foraging habitats).

ii Earthworks

Based on data provided by Centennial Angus Place, the construction activities related to the downcast ventilation shaft fall into the 'medium' earthworks category (between 2,500 m^2 and 10,000 m^2 of earth moved) and construction activities related to the bore pumps fall into the small category (<2,500 m^2 soil moved). For conservatism, construction activities have been placed into the 'medium' category.

a Construction

The construction of the ventilation shaft and bore bumps fall into the 'small category' (total building volume <25,000 m^3).

iii Track-out

Based on data provided by Centennial Angus Place, the construction activities related to the downcast ventilation shaft fall into the 'medium' earthworks category (10-50 heavy duty vehicle (>3.5t) outward movements in any one day) and the bore pump construction activities fall into the small category (<10 heavy duty vehicle (>3.5t) outward movements in any one day). For conservatism, construction activities have been placed into the 'medium' category.

iv Summary of dust emission potential

The dust emission magnitude ratings are summarised in Table 8.2.

Table 8.2 Summary of dust emission magnitude

Activity	Potential dust emission magnitude
Demolition	Not applicable
Earthworks	Medium
Construction	Small
Track-out	Medium

8.4.2 Step 2B – Sensitivity of area

The Step 1 analysis found that there were no human receptors affected by construction activities. Therefore, the following steps focus on impacts to ecological receptors.

Step 2B requires a selection of 'small', 'medium' and 'large' when determining ecological receptor sensitivity to each of the four activities (ie demolition, earthworks, construction and track-out). A distance from source is then specified (<20 m or between 20 m and 50 m).

The exact nature of ecological receptors, their locations and sensitivity to dust impacts is currently unknown; however, as the construction works are to occur in discreet areas within the Newnes State Forest, it has been assumed that receptor sensitivity will be 'medium' for earthworks, construction and track-out and that all receptors are located within <20 m of construction activities. The summary of sensitivity to ecological impacts is provided in Table 8.3.

Table 8.3 Summary of sensitivity to ecological impacts

Activity	Sensitivity of area to ecological impacts
Demolition	Not applicable
Earthworks	Medium
Construction	Medium
Track-out	Medium

8.4.3 Step 2C – Definition of risk of impacts

To determine the risk of impacts with no mitigation applied, the IAQM guidance requires that the dust magnitude rating is combined with the sensitivity of the local area for each of the four activity categories (ie demolition, earthworks, construction and track-out). Using the lookup tables in the guidance (see Table D.1) risk ratings for each type of activity were allocated and are presented in Table 8.4. For all activities (other than demolition), the risk rating for ecological receptor impacts was determined to be medium risk for earthworks and low risk for construction and track-out.

Table 8.4 Summary of risk assessment

Activity	Step 2A: Potential for dust emissions	Step 2B: Sensitivity of area	Step 2C: Risk of dust impacts
Demolition	N/A	Negligible	Negligible
Earthworks	Medium risk	Medium risk	Medium risk
Construction	Low risk	Medium risk	Low risk
Track-out	Medium risk	Medium risk	Low risk

N/A = not applicable

8.5 Step 3 – Mitigation and significance of risk

The dust impact risk allocation in Section 8.4.3 relates to unmitigated construction dust emissions. Step 3 involves determining mitigation measures for each of the four potential activities in Step 2 to further reduce the residual risk for impacts to the surrounding area. This is based on the risk of dust impacts identified in Step 2C. Recommended mitigation measures are listed below and are routinely employed as 'good practice' on construction sites:

- carry out regular site inspections to monitor compliance with the existing Air Quality and Greenhouse Gas Management Plan (Centennial Coal 2018), record inspection results, and make an inspection log available to the local authority when asked;
- increase the frequency of site inspections by the person accountable for air quality and dust issues on-site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions;
- keep site fencing, barriers and scaffolding clean using wet methods;
- remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on-site (if they are being re-used on-site cover as described below);

- cover, seed or fence stockpiles to prevent wind whipping;
- ensure all vehicles switch off engines when stationary - no idling vehicles;
- ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate;
- minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate; and
- ensure equipment is readily available on-site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

8.5.1 Significance of risks

Once the appropriate dust mitigation measures have been identified in Step 3, the next step in the IAQM procedure is to determine whether there are residual significant effects arising from the construction phase of a proposed development. For almost all construction activities, the aim should be to prevent significant effects on receptors through effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant' (IAQM, 2014).

As identified in Section 8.4.3, a medium risk rating was determined for risk of dust impacts on ecological receptors due to earthworks activities. The assessment returned a low risk rating for dust impacts from construction and track-out activities. With the successful implementation of the recommended dust mitigation measures listed in Section 8.5, the risk of impacts to ecological receptors will be further reduced.

Given the type and low intensity of construction activities, overall construction dust is unlikely to represent a serious ongoing problem. Any effects will be temporary and relatively short-lived and will only arise during dry weather with the wind blowing towards an ecological receptor, at a time when dust is being generated and mitigation measures are not being fully effective. The likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be 'not significant'.

9 Greenhouse gas assessment

9.1 Introduction

The estimation of GHG emissions for the Project was based on the DoEE National Greenhouse Accounts Factors (NGAF) workbook (DoEE 2018). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoEE 2018). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (Bhatia et al 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels and purchased electricity, making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

9.2 Emission sources

The GHG emission sources included in this assessment are listed in Table 9.1 and represent the most significant sources associated with the Project.

GHG emissions from the Project have been estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and Scope 1, 2 and 3 emission factors for diesel, fugitive emissions, electricity use, SF_6 combustion, oil and grease use, waste disposal and product coal combustion in NSW.

Table 9.1 Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel).	Indirect emissions associated with the consumption of purchased electricity.	Indirect upstream emissions from the extraction, production and transport of diesel.
Fugitive emissions of coal seam methane (CH_4) and CO_2 from the ventilation shafts.	-	Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.
Direct emissions from the use of sulphur hexafluoride (SF_6).	-	Indirect upstream emissions from the extraction, production and transport of oil and grease.
Direct emissions from the use of oils and greases.	-	Indirect upstream emissions from product coal combustion.
-	-	Indirect emissions associated with solid waste disposal in the landfill.
-	-	Indirect upstream emissions from fuel for employee travel.

9.3 Activity data

Estimates of annual diesel and electricity consumption associated with the Project have been provided by Centennial Angus Place. All other activity data has been scaled from previously reported activity data (SLR 2014) pro-rata based on the increase in ROM coal production. The adopted activity data (fuel and electricity) for the emission estimates is presented in Table 9.2.

Table 9.2 Annual activity data

Activity data/use	Quantity
Annual ROM production (t)	4,500,000
Electricity (kWh)	48,000,000
Diesel used on-site (L)	800,000
Diesel used for employee travel (L)	880
Fugitive emissions from ventilation shaft (M m^3)	15,492
Solid waste to landfill (t)	575
SF_6 (kg)	25.019
Petroleum based oils and greases (L)	224,047

9.4 Emission estimates

The following emission factors and input data have been used to estimate GHG emissions from the Project:

- diesel consumption on-site (Scope 1) – diesel oil factor from Table 3 of the NGAF workbook (2018);

- oil and grease consumption (Scope 1) – petroleum-based greases factor from Table 3 of the NGAF workbook (2018);
- SF_6 (Scope 1) – Global Warming Potential taken from Table 27 of the NGAF workbook (2018) and leakage rate for SF_6 taken from Table 25 of the NGAF workbook (2018);
- fugitive emissions (Scope 1) – 15,492 M m^3 at 0.09% CO_2 and 0.015% CH_4 and adjusted for standard temperature using a ventilation exhaust temperature of 290 K;
- electricity consumption (Scope 2) – NSW Scope 2 emission factor from Table 5 of the NGAF workbook (2018);
- diesel consumption on-site (Scope 3) – diesel oil factor from Table 40 of the NGAF workbook (2018);
- oil and grease consumption (Scope 3) – petroleum-based greases factor from Table 40 of the NGAF workbook (2018);
- product coal combustion (Scope 3) – bituminous coal energy content taken from Table 1 of the NGAF workbook (2018) and emission factor from Table 37 of the NGAF workbook (2018);
- waste disposal to landfill (Scope 3) – CO_2-e conversion factor taken from Table 42 of the NGAF workbook (2018); and
- diesel used for employee travel (Scope 3) – diesel oil factor taken from Table 4 of the NGAF workbook (2018) and emission factor from Table 40 of the NGAF workbook (2018).

The estimated annual GHG emissions for each emission source are presented in Table 9.3.

The significance of Project emissions relative to State and National GHG emissions has been made by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2017[4]) for NSW (128,870 kt CO_2-e) and Australia (530,841 kt CO_2-e).

Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Project's operations represent approximately 0.368% of total GHG emissions for NSW and 0.089% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017. The contribution of the Project to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions.

4 http://ageis.climatechange.gov.au/

Table 9.3 Estimated annual GHG emissions during operations

Activity/fuel	Scope 1 (t CO_2-e/year)	Scope 2 (t CO_2-e/year)	Scope 3 (t CO_2-e/year)	Total
Diesel combustion	2,168	-	111	2,279
Fugitive emissions	62,698	-	-	62,698
SF_6 combustion	5	-	-	5
Oil and grease consumption	30	-	31	62
Electricity consumption	-	39,360	4,800	44,160
Product coal combustion	-	-	364,500	364,500
Waste disposal	-	-	690	690
Employee travel	-	-	122	122
Total	**64,901**	**39,360**	**370,255**	**474,516**

10 Conclusions

Dispersion modelling has been completed for a single operational scenario corresponding to a maximum coal production rate of 4.5 Mtpa. Atmospheric dispersion modelling was completed using the CALPUFF model system. Hourly meteorological observations from 2018, collected at the existing Angus Place AWS as well as the BoM Marrangaroo and BoM Mount Boyce AWS, were used as inputs into the dispersion model.

The results of the modelling show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) are below the applicable impact assessment criteria at all assessment locations.

Cumulative impacts were assessed by combining modelled Project impacts with recorded ambient background levels. The cumulative results showed that compliance with applicable NSW EPA impact assessment criteria is predicted at all assessment locations for all pollutants and averaging periods. A comparison of the background dataset used (Bathurst AQMS) against Angus Place HVAS data showed that the cumulative assessment was highly conservative.

In order to control particulate matter emissions during the operation of the Project, dust mitigation measures are required. These measures include:

- enclosures at conveyor transfer points;
- water sprays at conveyor transfer points;
- enclosure of coal sizer; and
- watering at coal sizer.

These measures have been taken into account in the emissions estimation and modelling of the operational scenario.

A GHG assessment was also undertaken for the Project. Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Project represent approximately 0.368% of total GHG emissions for NSW and 0.089% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

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Abbreviations

AHD	Australian height datum
Approved Methods for Modelling	*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
AWS	automatic weather station
BoM	Bureau of Meteorology
CHP	coal handling plant
CO_2-e	carbon dioxide equivalent
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoEE	Department of the Environment and Energy
DPIE	Department of Planning, Industry and Environment
EPA	Environment Protection Authority
EPL	environment protection licence
GHG	greenhouse gas
kW	kilowatt
Mtpa	million tonnes per annum
MPPS	Mount Piper Power Station
NGAF	National Greenhouse Accounts Factors
NO_x	oxides of nitrogen
NPI	National Pollution Inventory
O_3	ozone
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
TAPM	The Air Pollution Model
US-EPA	United States Environmental Protection Agency

Appendix A

Meteorological processing

A.1 Meteorological monitoring datasets

As discussed in Section 4, meteorological datasets were collated from the following monitoring stations:

- Angus Place AWS;
- BoM Marrangaroo (Defence) station; and
- BoM Mt Boyce AWS.

The Angus Place AWS is the primary resource for meteorological data in this assessment and data from this station is available for the period July 2015 to March 2019. These data are supplemented by the BoM Marrangaroo and My Boyce stations.

Data from the Angus Place AWS has been analysed for the period between July 2015 to 2018. Data availability and analysis of inter-annual trends for this period is presented in the following sections.

A.1.1 Data availability

A summary of data availability for the Angus Place AWS dataset for the period between July 2015 and March 2019 is provided in Figure A.1. The following points are noted:

- data completeness is close to 100% for all parameters for all full data years between 2016 and 2018. Therefore, these three years meet the minimum 90% data completeness requirements for all parameters specified with Section 4.1 of the Approved Methods for Modelling (EPA 2016); and
- being the most recent and available year of data, 2018 was chosen for assessment. It was also deemed representative of meteorological conditions at this location over the period of data analysed. This is further analysed below.

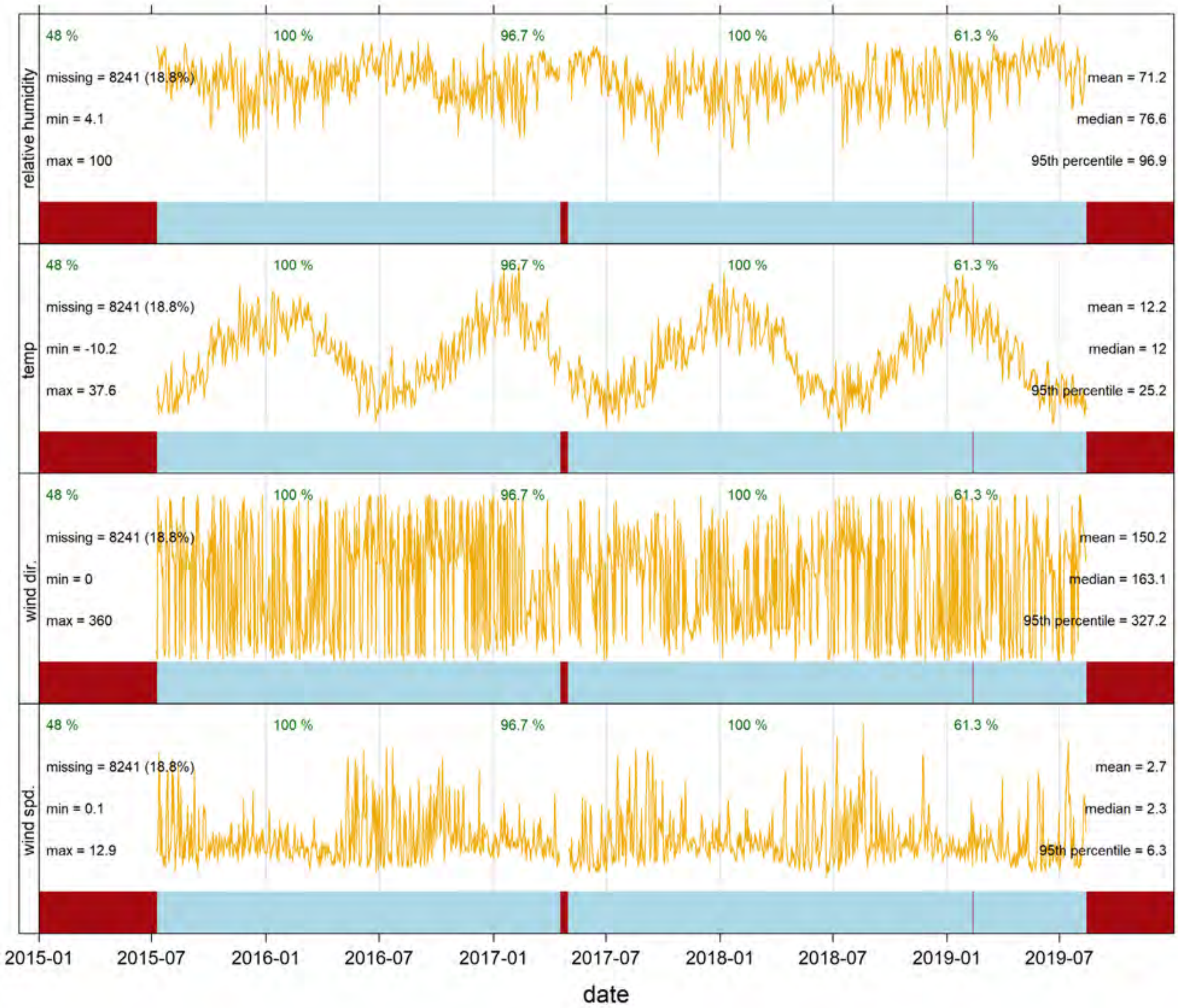


Figure A.1 Data completeness analysis plot – Angus Place AWS – July 2015 to 2018

A.1.2 Selection of a representative year

While 2018 was the most recent and complete year of monitoring data from the available meteorological datasets, in order to determine the most representative year of data for modelling, an analysis of inter-annual trends was conducted.

Inter-annual wind roses for the Angus Place AWS is presented in Figure A.2 below.

The wind roses for the Angus Place AWS show that the general wind directions were similar for all years. Winds were predominately from the north-east and south-west. Annual average wind speeds ranged between 2.4 m/s and 2.8 m/s. The annual average frequency of calm conditions (wind speeds less than 0.5 m/s) ranged between 2.2% and 2.4%.

The inter-annual profiles for wind speed, air temperature and relative humidity were also comparable between 2015 and 2018. The 2018 dataset showed slightly higher temperature and lower relative humidity, which are indicative of the strong drought conditions during the year.

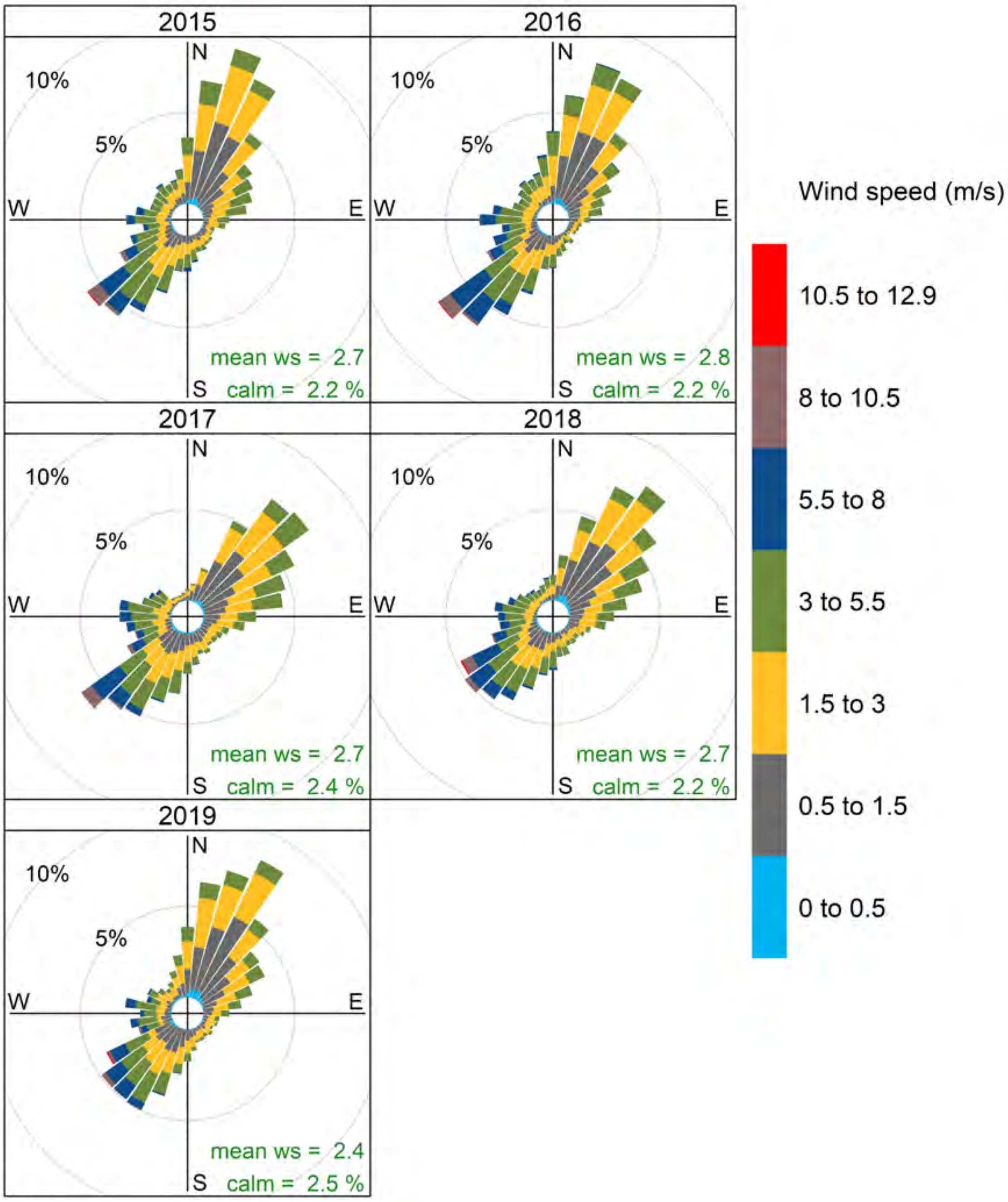


Figure A.2 Inter-annual comparison of recorded wind speed and direction – Angus Place AWS – July 2015 to August 2019

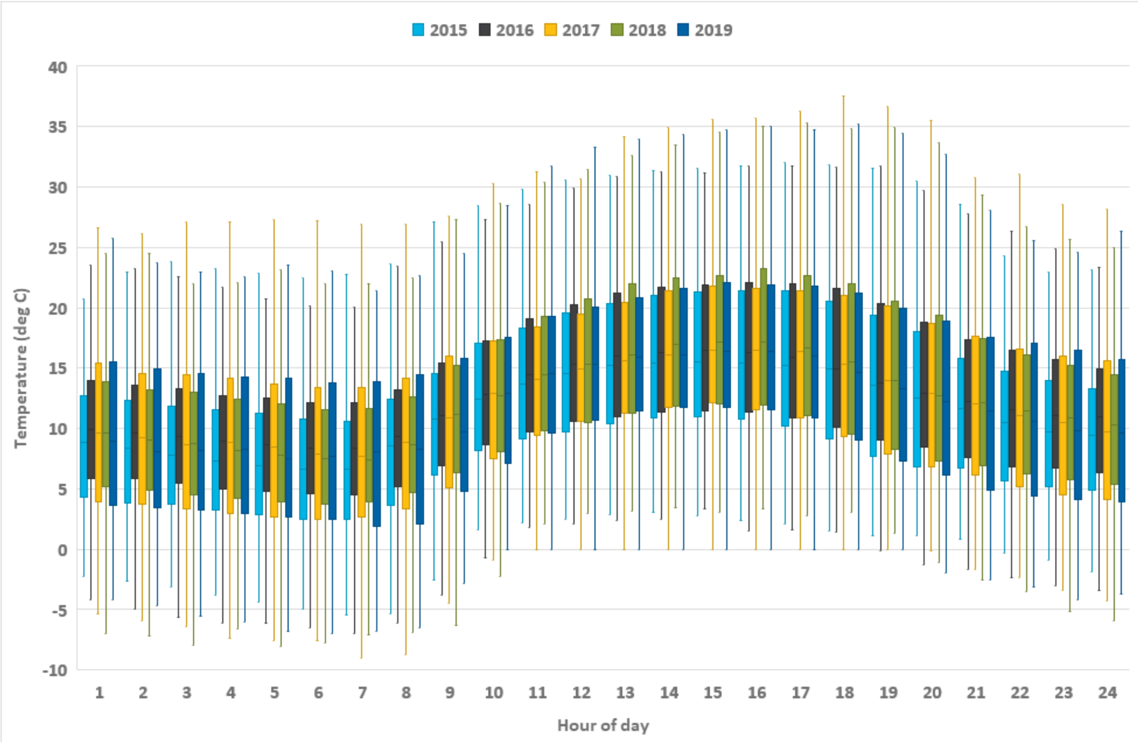


Figure A.3 Inter-annual variability in diurnal wind speed – Angus Place AWS – 2014 to 2018

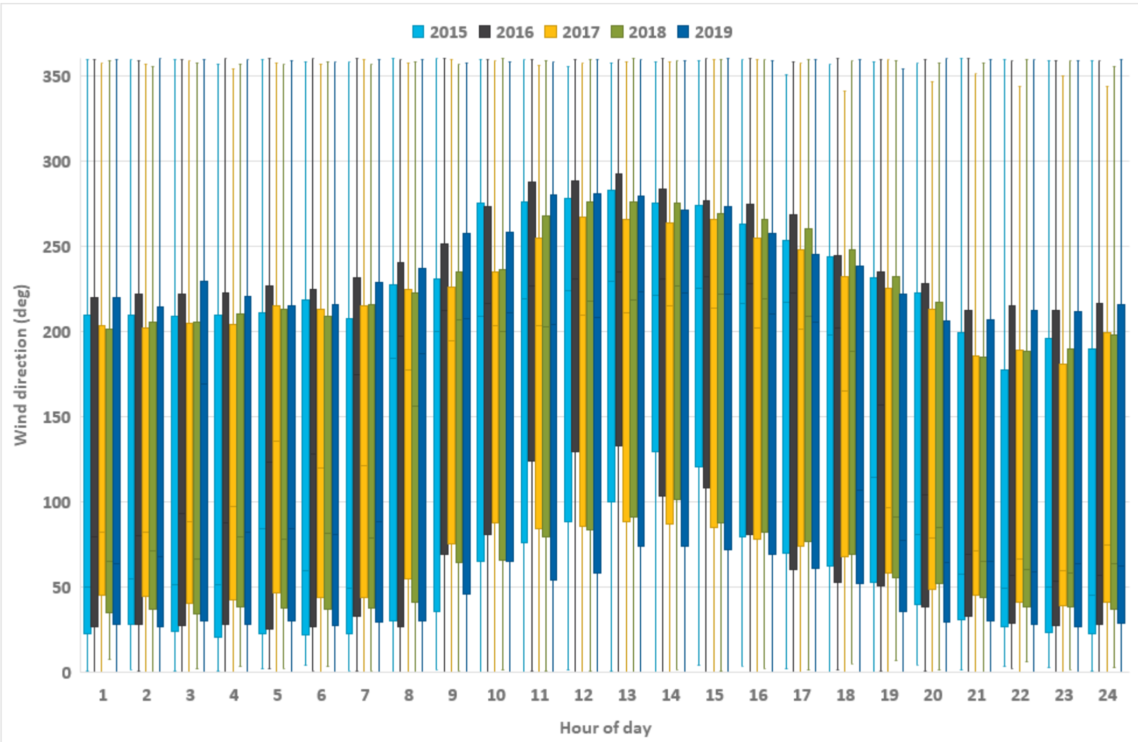


Figure A.4 Inter-annual variability in diurnal wind direction – Angus Place AWS – 2014 to 2018

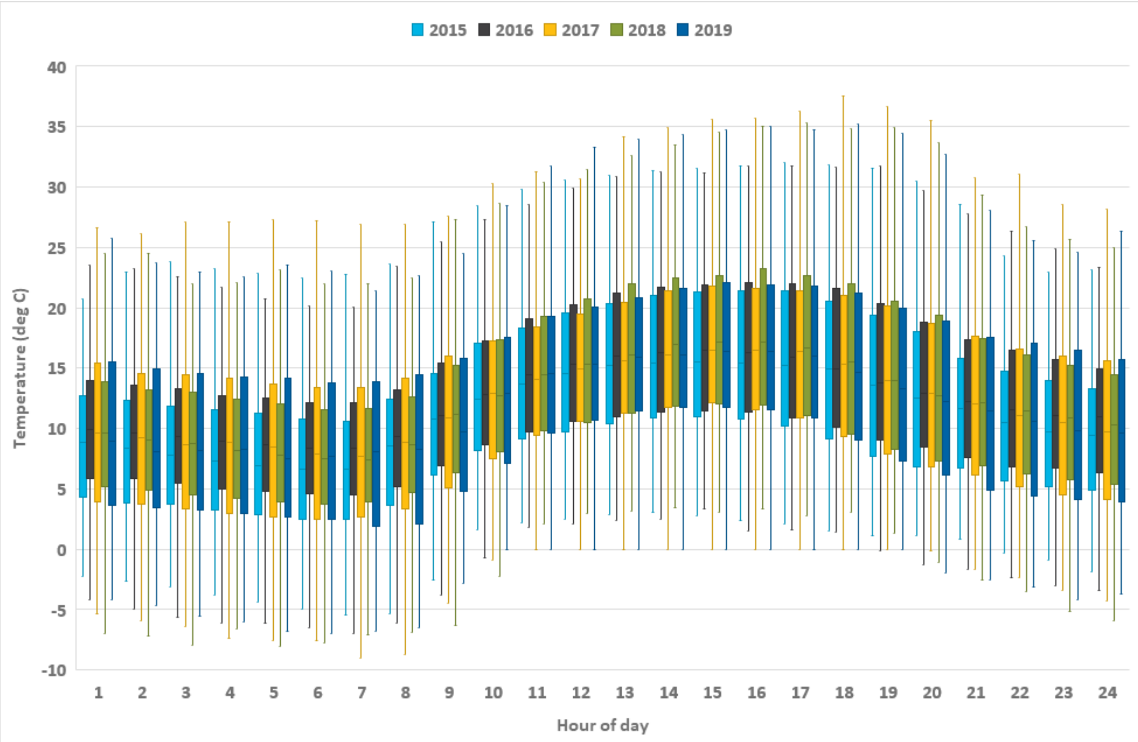


Figure A.5 Inter-annual variability in diurnal air temperature – Angus Place AWS – 2014 to 2018

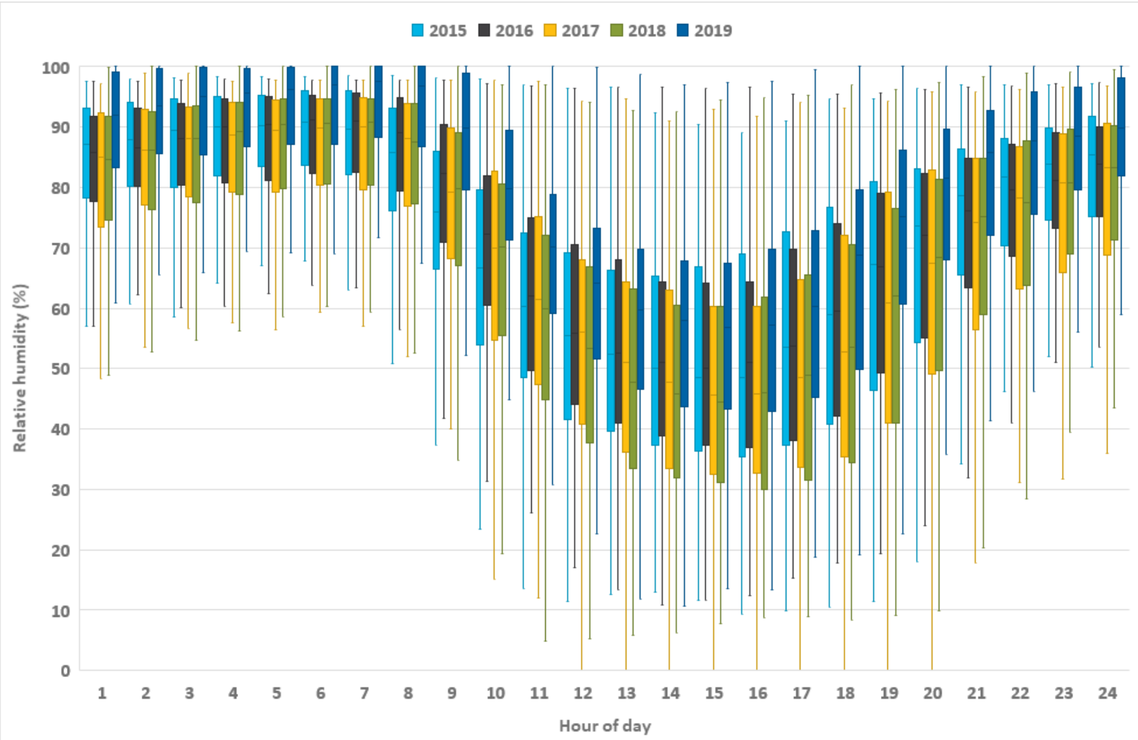


Figure A.6 Inter-annual variability in diurnal relative humidity – Angus Place AWS – 2014 to 2018

A.1.3 Seasonal and diurnal wind roses for Angus Place AWS

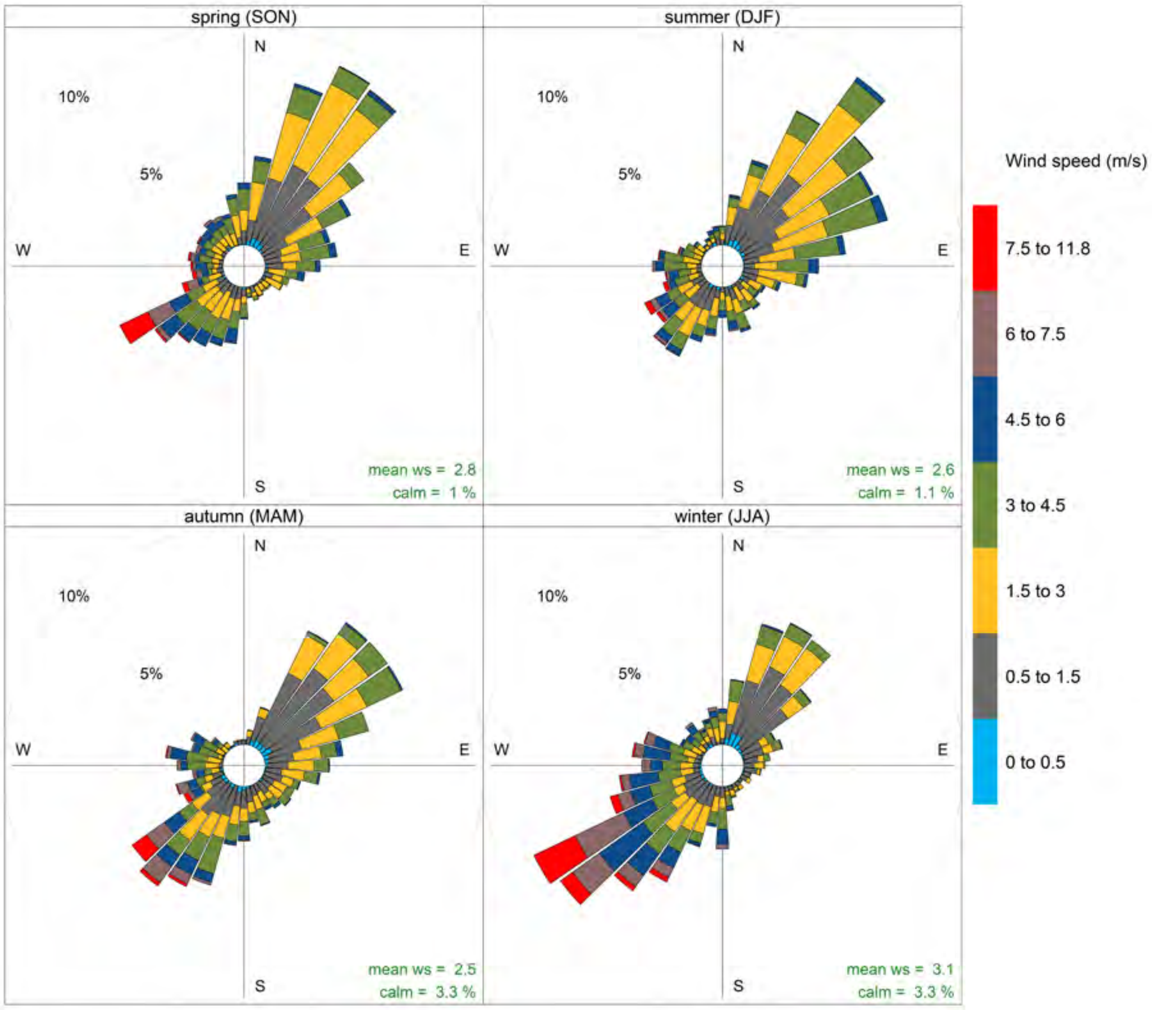


Figure A.7 Seasonal wind speed and direction – Angus Place AWS – 2018

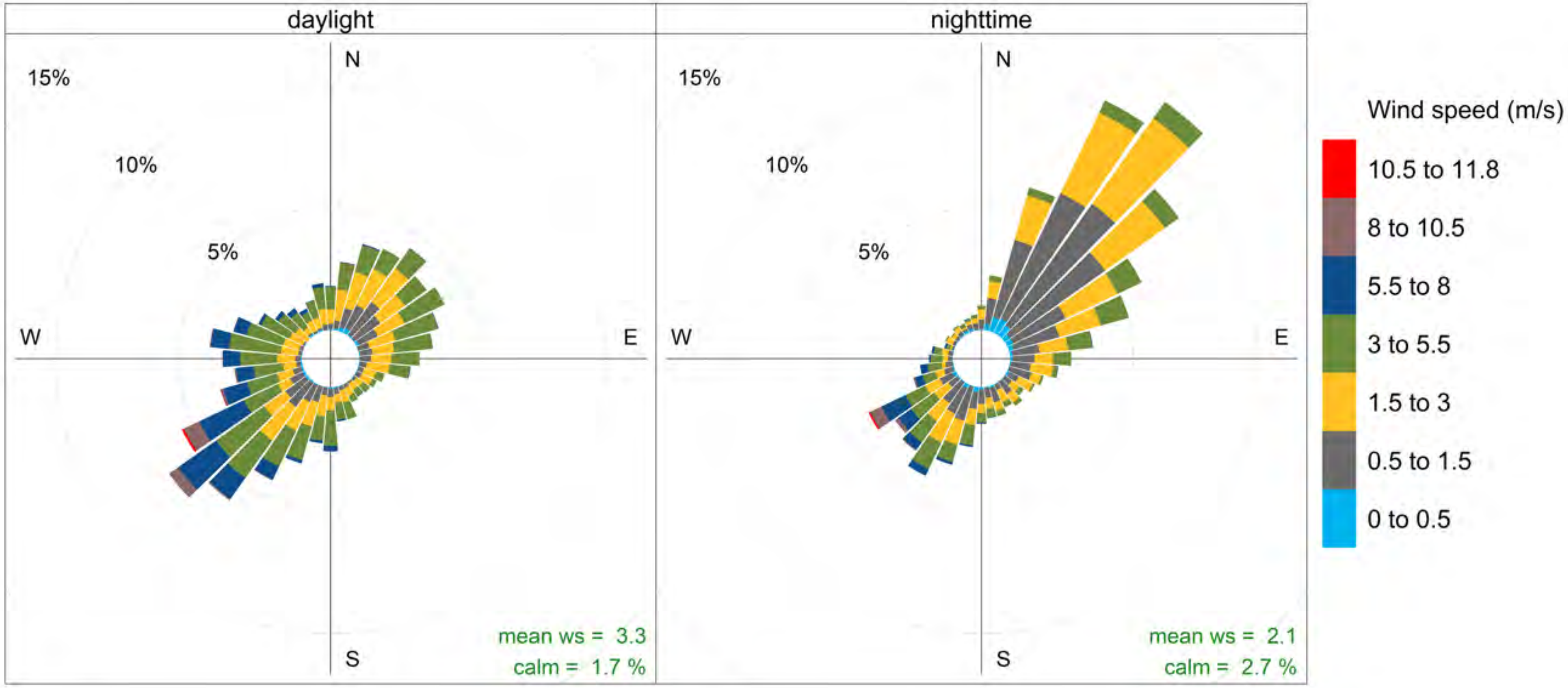


Figure A.8 Diurnal wind speed and direction – Angus Place AWS – 2018

Appendix B

Meteorological modelling

B.1 TAPM modelling

To supplement the meteorological monitoring datasets adopted for this assessment, the Commonwealth Scientific and Industry Research Organisation (CSIRO) prognostic meteorological model The Air Pollution Model (TAPM) was used to generate required parameters that are not routinely measured, specifically mixing height and vertical wind/temperature profile.

TAPM was configured and run in accordance with the Section 4.5 of the Approved Methods for Modelling as follows:

- TAPM version 4.0.5;
- inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data);
- grid domains with cell resolutions of 30 km, 10 km and 3 km. Each grid domain features 25 x 25 horizontal grid points and 35 vertical levels;
- TAPM default databases for land use, synoptic analyses and sea surface temperature; and
- TAPM defaults for advanced meteorological inputs.

A surface observations file was included in TAPM with meteorological data from Angus Place AWS the BoM Marrangaroo (Defence) station and the BoM Mt Boyce AWS.

B.2 CALMET

The CALMET/CALPUFF model suite was chosen for this study. CALMET was used to produce 3-dimensional meteorological fields for use in the CALPUFF model.

In the absence of upper air measurements, CALMET can be run using prognostic upper air data (as a three-dimensional '3D.dat' file), which is used to derive an initial wind field (known as the Step 1 wind field in the CALMET model). The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and is adopted for this assessment. TAPM was used to generate gridded upper air data for each hour of the model run period, for input into CALMET.

A CALMET grid of 40 km by 50 km was run with a resolution of 200 m. Surface meteorological data from the Angus Place AWS and the two BoM stations were incorporated in the modelling. Cloud content and height data were taken from the BoM Mt Boyce AWS.

The observations at Angus Place AWS provided the dominant influence on the derived wind field and the resultant dispersion meteorology within the model. The distance at which the observation influences the model (radius of influence) is determined by the CALMET setting 'RMAX'. The relative importance of the observation in the model (relative weighting of the Step 1 wind field and the observation) is determined by the CALMET setting 'R1'.

An RMAX of 2 km and R1 of 2.5 km was assigned in the model to reflect the local scale topographical influence seen in the observational data.

The detailed CALMET model options used are presented in Table B.1. These were selected in accordance with recommendations in the Approved Methods for Modelling and in TRC (2011). Surface observations were included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind fields.

Table B.1 CALMET model options used

Flag	Descriptor	Default	Value used
IEXTRP	Extrapolate surface wind observations to upper layers	Similarity theory	Similarity theory
BIAS (NZ)	Relative weighting given to vertically extrapolated surface observations versus upper air data	No default	-1, -0.989, -0.971, -0.937, -0.868, -0.731, -0.479, -0.089, 0.427, 1.0
TERRAD	Radius of influence of terrain	No default (typically 5-15 km)	3
RMAX1 and RMAX2	Maximum radius of influence over land observations in layer 1 and aloft	No default	2, 2
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind field are weighted equally	No default	2.5, 2.5

Appendix C

Emissions inventory background

C.1 Introduction

Particulate matter emissions from the Project were quantified through the application of accepted published emission estimation factors, collated from a combination of United States Environmental Protection Agency (US-EPA) AP-42 Air Pollutant Emission Factors and NPI emission estimation manuals, including the following:

- US-EPA AP-42 Chapter 11.9 – Western surface coal mining (US-EPA 1998);
- US-EPA AP-42 Chapter 11.24 – Metallic minerals processing (US-EPA 1982);
- US-EPA AP-42 Chapter 13.2.4 – Aggregate handling and storage piles (US-EPA 2006a);
- US-EPA AP-42 Chapter 13.2.4 – Industrial wind erosion (US-EPA 2006b);

Particulate releases were quantified for TSP, PM_{10} and $PM_{2.5}$ as documented in subsequent sections.

C.2 Sources of particulate matter emissions

Sources of particulate matter emissions associated with the Project include:

- conveyor transfer from portal;
- conveyor transfer to ROM stockpile;
- bulldozers working on ROM stockpile;
- wind erosion from ROM stockpile;
- conveyor transfer to the CHP;
- coal sizing;
- conveyor transfer to load-out bin;
- loading coal to trucks; and
- upcast ventilation shafts.

C.3 Particulate matter emissions inventory

The emissions inventory developed for the operations at the Project is presented in Table C.1.

Table C.1 Emissions inventory

Source name	TSP emissions (kg/year)	PM_{10} emissions (kg/year)	$PM_{2.5}$ emissions (kg/year)	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Unit	Parameter 1	Unit	Parameter 2	Unit	Reduction factor	Assumptions	Emission factor source
Conveyor transfer point from portal	229	53	8	4,500,000	t/y	0.0003	0.0001	0.00001	kg/t	2.73	Average wind speed (m/s)	10	Moisture content (%)	0.85	Enclosure,water sprays at transfer points	USEPA AP-42 13.2.4
Conveyor transfer to ROM stockpile	229	53	8	4,500,000	t/y	0.0003	0.0001	0.00001	kg/t	2.73	Average wind speed (m/s)	10	Moisture content (%)	0.85	Enclosure,water sprays at transfer points	USEPA AP-42 13.2.4
Dozer on ROM stockpile	32,323	7,399	711	2,626	h/y	12.3	2.8	0.3	kg/h	5	Silt content (%)	10	Moisture content (%)			USEPA AP-42 11.9.2
Wind erosion from ROM stockpile	4,158	2,079	312	1.61	Area (ha)	2,583	1,291	194	kg/ha/y							USEPA AP-42 13.2.5
Conveyor transfer to CHP	229	53	8	4,500,000	t/y	0.0003	0.0001	0.00001	kg/t	2.73	Average wind speed (m/s)	10	Moisture content (%)	0.85	Enclosure,water sprays at transfer points	USEPA AP-42 13.2.4
Coal sizing	6,750	2,700	405	4,500,000	t/y	0.0100	0.0040	0.00060	kg/t					0.85	Enclosure, water sprays at coal sizer	USEPA AP-42 11.24
Conveyor transfer to load out bin	1,528	351	53	4,500,000	t/y	0.0003	0.0001	0.00001	kg/t	2.73	Average wind speed (m/s)	10	Moisture content (%)			USEPA AP-42 13.2.4
Loading coal to trucks	1,528	351	53	4,500,000	t/y	0.0003	0.0001	0.00001	kg/t	2.73	Average wind speed (m/s)	10	Moisture content (%)			USEPA AP-42 13.2.4
Upcast vent fan (APC-VS1)	4,183	279	209													
Upcast vent fan (APC-VS2)	4,183	279	209													
Total	**55,340**	**13,594**	**1,976**													

C.4 Project-related input data used for particulate matter emission estimates

The material property inputs used in the emission estimates are summarised in Table C.2.

Table C.2 Material property inputs for emission estimation

Material properties	Value	Source of information
Coal silt content (%)	5	SLR 2014
Coal moisture (%)	10	SLR 2014

Appendix D

IAQM criteria

The assessment criteria in the IAQM guidance are summarised in the following tables.

Table D.1 Site categories (scale of works)

Type of activity	Site category definitions		
	Large	**Medium**	**Small**
Demolition	Building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level.	Building volume 20,000–50,000m^3, potentially dusty construction material, demolition activities 10-20 m above ground level.	Building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding, timber), demolition activities <10 m above ground and during wetter months.
Earthworks	Site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth-moving vehicles active at any one time, formation of bunds>8 m in height, total material moved >100,000 tonnes.	Site area 2,500-10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4-8 m in height, total material moved 20,000-100,000 tonnes.	Site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <20,000 tonnes, earthworks during wetter months.
Construction	Total building volume >100,000 m^3, piling, on site concrete batching; sandblasting	Building volume 25,000-100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching.	Total building volume <25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).
Track-out	>50 HDV (>3.5t) OUTWARD movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.	10-50 HDV (>3.5t) OUTWARD movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50–100 m.	<10 HDV (>3.5t) OUTWARD movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.

Table D.2 Sensitivity of area to dust soiling impacts

Receptor sensitivity	Number of receptors	Distance from source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

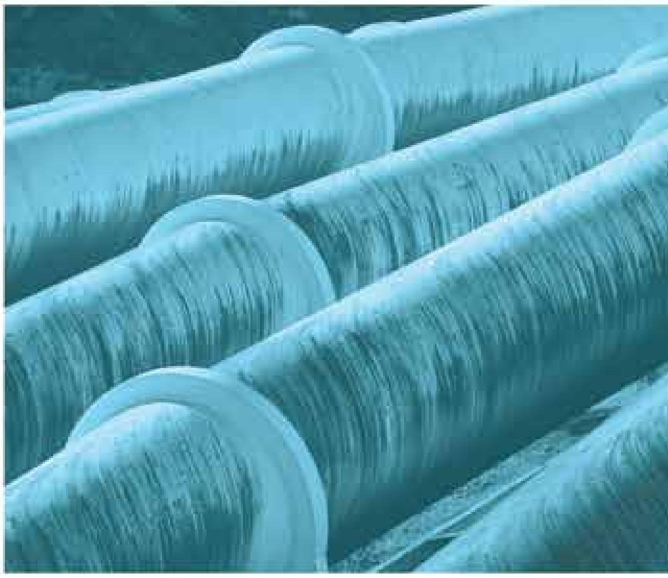
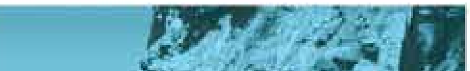
Table D.3 Sensitivity of area to human health impacts

Receptor sensitivity	Annual mean PM_{10} concentration	Number of receptors	Distance from the source (m)				
			<20	<50	<100	<200	<350
High	>20 µg/m³	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	17.5 - 20 µg/m³	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	15 – 17.5 µg/m³	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<15 µg/m³	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>20 µg/m³	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	17.5 - 20 µg/m³	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	15 – 17.5 µg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<15 µg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table D.4 Sensitivity of area to ecological impacts

Receptor sensitivity	Distance from source (m)	
	<20	20-50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

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