Burrah Park SSDA

Air quality impact assessment

Prepared for Richmond Bridge Burrah Park 2 Pty Ltd as trustee for Burrah Park Prop Trust 1, UniSuper Limited as Trustee for UniSuper and UniSuper Management Pty Limited, ISPT Pty Limited as trustee for The Industry Superannuation Property Trust No. 1 & HB&B Property Pty Ltd

October 2024

Burrah Park SSDA

Air quality impact assessment

Richmond Bridge Burrah Park 2 Pty Ltd as trustee for Burrah Park Prop Trust 1, UniSuper Limited as Trustee for UniSuper and UniSuper Management Pty Limited, ISPT Pty Limited as trustee for The Industry Superannuation Property Trust No. 1 & HB&B Property Pty Ltd

E240316 RP1

October 2024

Version	Date	Prepared by	Approved by	Comments
V1	8 July 2024	A Gilbert	S Fishwick	Draft for review
V2	14 August 2024	A Gilbert	S Fishwick	
V3	3 October 2024	A Gilbert	S Fishwick	Final

Approved by

Scott Fishwick
National Technical Lead – Air Quality and Climate
3 October 2024

Ground floor 20 Chandos Street
St Leonards NSW 2065
ABN: 28 141 736 558

This report has been prepared in accordance with the brief provided by Richmond Bridge Burrah Park 2 Pty Ltd as trustee for Burrah Park Prop Trust 1, UniSuper Limited as Trustee for UniSuper and UniSuper Management Pty Limited, ISPT Pty Limited as trustee for The Industry Superannuation Property Trust No. 1 & HB&B Property Pty Ltd and, in its preparation, EMM has relied upon the information collected at the times and under the conditions specified in this report. All findings, conclusions or recommendations contained in this report are based on those aforementioned circumstances. The contents of this report are private and confidential. This report is only for Richmond Bridge Burrah Park 2 Pty Ltd as trustee for Burrah Park Prop Trust 1, UniSuper Limited as Trustee for UniSuper and UniSuper Management Pty Limited, ISPT Pty Limited as trustee for The Industry Superannuation Property Trust No. 1 & HB&B Property Pty Ltd's use in accordance with its agreement with EMM and is not to be relied on by or made available to any other party without EMM's prior written consent. Except as permitted by the Copyright Act 1968 (Cth) and only to the extent incapable of exclusion, any other use (including use or reproduction of this report for resale or other commercial purposes) is prohibited without EMM's prior written consent. Except where expressly agreed to by EMM in writing, and to the extent permitted by law, EMM will have no liability (and assumes no duty of care) to any person in relation to this document, other than to Richmond Bridge Burrah Park 2 Pty Ltd as trustee for Burrah Park Prop Trust 1, UniSuper Limited as Trustee for UniSuper and UniSuper Management Pty Limited, ISPT Pty Limited as trustee for The Industry Superannuation Property Trust No. 1 & HB&B Property Pty Ltd (and subject to the terms of EMM's agreement with Richmond Bridge Burrah Park 2 Pty Ltd as trustee for Burrah Park Prop Trust 1, UniSuper Limited as Trustee for UniSuper and UniSuper Management Pty Limited, ISPT Pty Limited as trustee for The Industry Superannuation Property Trust No. 1 & HB&B Property Pty Ltd).

© EMM Consulting Pty Ltd, Ground Floor Suite 01, 20 Chandos Street, St Leonards NSW 2065. 2024.
ABN: 28 141 736 558

Executive summary

HB&B Property Pty Ltd (HBB) on behalf of Richmond Bridge Burrah Park 2 Pty Ltd, UniSuper Limited (UniSuper) and ISPT Pty Limited (ISPT) are proposing the development of an industrial warehouse and logistics estate known as Burrah Park, located at 1953–2109 Elizabeth Drive, Badgerys Creek NSW (the site). HBB are seeking approval for the Burrah Park concept plan including future development lots and building footprints. As a part of this approval, consent is being sort for the Stage 1 works which will include bulk earthworks across the site and construction of various infrastructure and amenities, and includes the construction of three warehouse buildings (the project).

EMM Consulting Pty Limited (EMM) have been engaged by HBB to undertake an air quality impact assessment (AQIA) for the project. This AQIA has been conducted in accordance with NSW Environment Protection Authority (EPA) guidance, the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2022).

Meteorological modelling was conducted for the 2021 calendar year influenced by observations from the Bureau of Meteorology (BoM) Badgerys Creek automatic weather station (AWS). Background air pollutant concentrations were derived from the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) air quality monitoring stations at Bringelly.

Emissions estimation and dispersion modelling was completed for a single 'worse case' scenario representative of Stage 1 and Stage 2 construction activities for the project, which was considered to have the largest potential for air quality impacts on the basis of total material extraction and filling, and the overlapping timeline between Stage 1 and Stage 2. Emissions of total suspended particulates (TSP), particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}) and particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$), were estimated and modelled. The atmospheric dispersion of air pollutant emissions was simulated using the AERMOD dispersion model.

The results of the modelling show that 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.

Cumulative impacts were assessed by combining the adopted background concentrations with the predicted incremental concentrations from the project. Cumulative results indicated that air pollution concentrations associated with emissions from the project would be in compliance with the NSW EPA impact assessment criteria at all surrounding assessment locations for all pollutants and averaging periods.

A range of dust mitigation measures are proposed for the project. These include the use of water carts on unpaved roads and scraper/dozer routes, watering at crushing and screening plant and limiting the total area of each stage being actively exposed at one time. These measures have been taken into account in the emissions estimation and dispersion modelling.

In addition to the measures accounted for in the dispersion modelling a CEMP will be implemented which includes measures to manage dust.

A greenhouse gas (GHG) assessment of the proposed earthworks phase was also completed. Annual average GHG emissions (Scope 1) generated by project earthworks and construction represent 0.01% of total GHG emissions for NSW and 0.003% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2022. The calculated yearly scope 1 and 2 emissions from the earthworks and construction for the project are lower than the NGER Scheme facility reporting threshold.

TABLE OF CONTENTS

Appendices

Tables

Figures

1 Introduction

1.1 Project overview

HB&B Property Pty Ltd (HBB) on behalf of Richmond Bridge Burrah Park 2 Pty Ltd, UniSuper Limited (UniSuper) and ISPT Pty Limited (ISPT) are proposing the development of an industrial warehouse and logistics estate known as Burrah Park, located at 1953–2109 Elizabeth Drive, Badgerys Creek NSW (the site) within the City of Penrith local government area (LGA). The site is bound by the M12 motorway to the north and east, the Sydney Metro line to the east and the Western Sydney Airport (WSA) to the south.

HBB are seeking approval for the Burrah Park concept plan including future development lots and building footprints. As a part of this approval, consent is being sought for a concept plan including future development lots and building footprints. The development also seeks consent for the Stage 1 works which will include bulk earthworks across the site and construction of various infrastructure and amenities, and includes the construction of three warehouse buildings (the project).

The project footprint, as shown in Figure 1.1, covers an area of approximately 172 hectares (ha). The site has previously been used for agricultural purposes and is largely cleared of vegetation. The master plan for Burrah Park proposes the site to be a mixed use commercial and industrial premises, including warehousing lots with associated office spaces hardstands and loading docks.

The site's location immediately north of the WSA will provide a gateway access between the two locations and will enable industries required to support the operations of the WSA.

HBB has engaged EMM Consulting Pty Limited (EMM) to prepare this air quality impact assessment (AQIA) to meet the requirements of the Secretary Environmental Assessment Requirements (SEARs) for the State Significant Development Application (SSDA) (SSD-70316465), issued by the Department of Planning, Housing and Infrastructure (DPHI) on 22 May 2024.

The SEARs identify air quality matters needed to be addressed as a part of the Environmental Impact Assessment (EIS). The individual requirements relevant to the AQIA and where they are addressed in this report is provided in Table 1.1.

Table 1.1 Air quality related SEARs

Requirement	Section addressed
Air quality and odour – including:	
• a quantitative assessment of the potential air quality, dust and odour impacts of the development (construction and operation) on surrounding landowners, businesses and sensitive receptors, in accordance with relevant Environment Protection Authority (EPA) guidelines, including details of proposed mitigation, management and monitoring measures, such as staging of earthworks.	This report

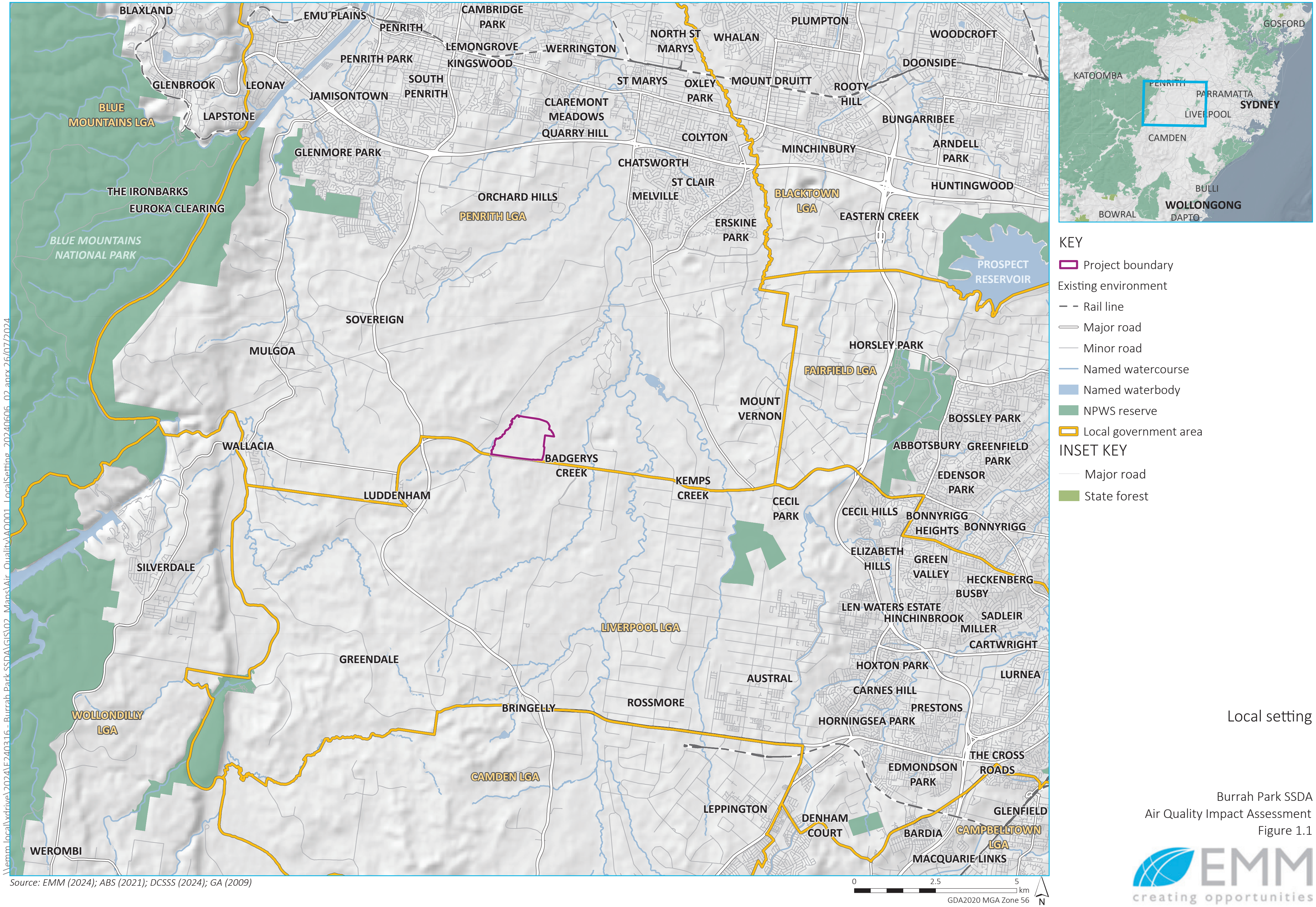
It is noted that the SEARs require an assessment of odour for the project. There are no significant odour emission sources associated with the project and, therefore, no further consideration of odour emissions or impacts is presented in this report.

1.1.1 Agency engagement

DPHI invited government agencies, including Penrith City Council, to recommend matters to be addressed in the assessment for the project. Comments made by agencies related to the assessment of air quality impacts and where they are addressed in this report are listed in Table 1.2.

Table 1.2 Agency comments on SEARs

Requirement		Section addressed
Penrith City Council	An Air Quality Impact Assessment is required to be submitted as a part of an application to demonstrate that the proposed development, construction and operations, will not have any impact on the health of nearby sensitive receptors or the environment. The report is to be prepared by an appropriately qualified consultant.	This report



\\emm.local\vdrive\2024\E240316 - Burrah Park SSDA\GIS\02_Maps\Air_Quality\AQ001_LocalSetting_20240606_02.aprx 26/07/2024

Source: EMM (2024); ABS (2021); DCSSS (2024); GA (2009)

Local setting

Burrah Park SSDA
Air Quality Impact Assessment
Figure 1.1

EMM
creating opportunities

1.2 Details of construction

The construction footprint (or maximum extent of works) for the project, as presented in Figure 1.1, covers an area of approximately 172 ha.

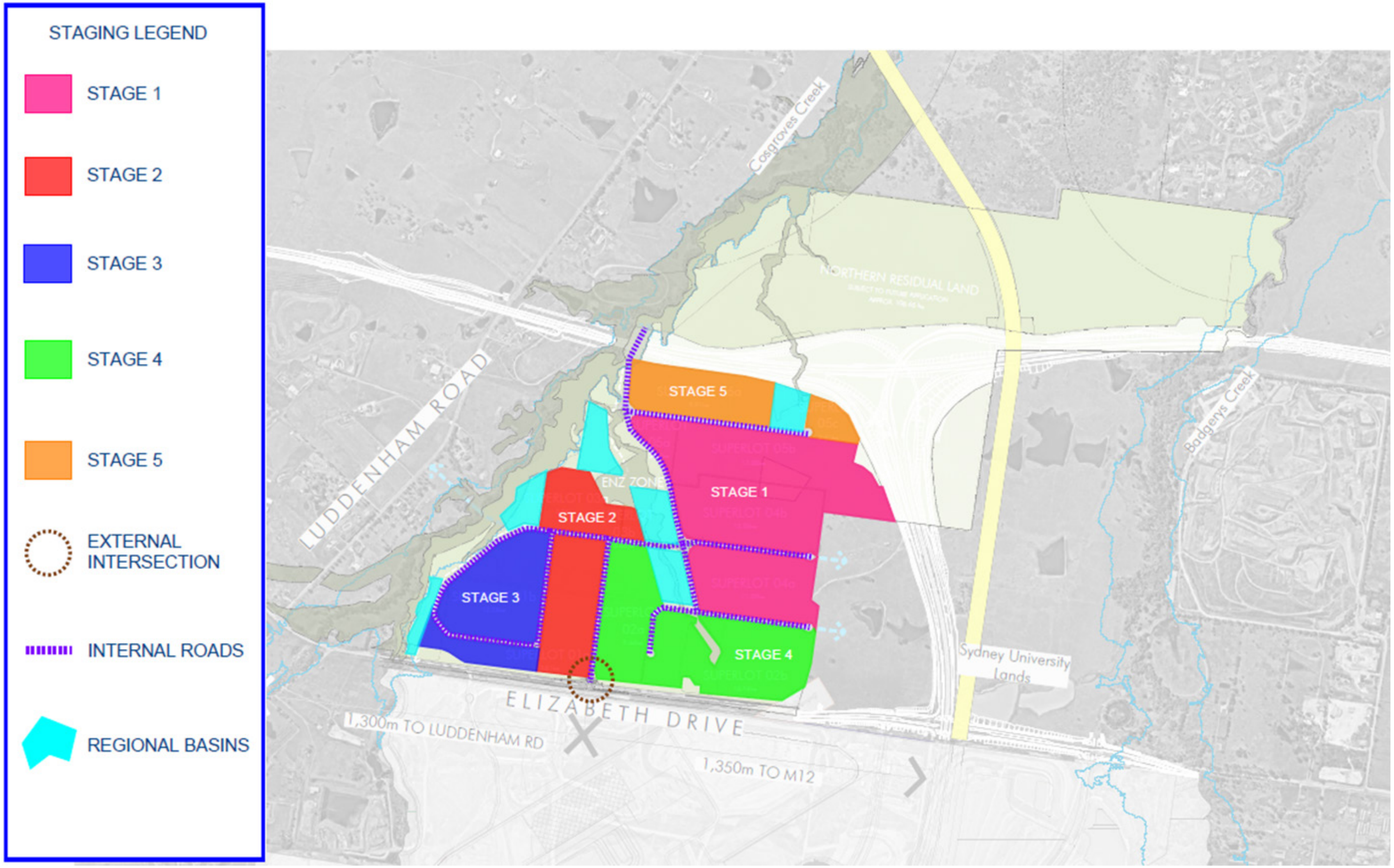
The project will be broken up over five different stages across the site, as shown in Figure 1.2, with the bulk earthworks and construction to include the following site preparation activities:

- demolition and removal of existing structures and vegetation
- heritage salvage works (if appliable)
- bulk earthworks including cut and fill, benching, battering and retaining walls
- dam de-watering and de-commissioning
- construction of roads, access infrastructure, including a signalised intersection with Elizabeth Drive
- stormwater infrastructure including basins and water sensitive urban design elements.

The development phase of the project will include the following activities:

- construction and fit out of 3 warehouse buildings and ancillary office space
- stormwater management, fencing and landscaping
- internal road network, active transport network, public domain and open space
- subdivision
- estate and on lot signage
- total approximate gross floor area (GFA) 85,864 square metres (m^2):
  - Warehouse 1.1 – 26,860 m^2 GFA
  - Warehouse 1.2 – 31,443 m^2 GFA
  - Warehouse 3.1 – 27,561 m^2 GFA.

While additional warehouses and office spaces are proposed to be developed under the Burrah Park master plan, each instance of the individual warehouses, excluding the three proposed as a part of the project, will be assessed under separate approvals and do not form part of the project.



Source: Nettletontribe

Figure 1.2 Construction staging concept plan

1.3 Assessment approach and requirements

This AQIA report has been conducted in accordance with the guidelines specified by the NSW Environmental Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA 2022), hereafter 'the Approved Methods for Modelling'.

This report comprises:

- a description of the local setting and surrounding of the area
- relevant pollutants for assessment and applicable impact assessment criteria
- a description of the existing environment, specifically:
  - meteorology and climate
  - existing air quality environment
- a detailed air pollution emissions inventory
- results of atmospheric dispersion modelling conducted for the project, including analysis of project-only and cumulative impacts accounting for background air quality
- an overview of best practice construction dust mitigation measures
- a detailed greenhouse gas (GHG) emissions inventory for the earthworks of the project.

2 Site setting and sensitive receptors

2.1 Site and surrounding area

The site is currently zoned as ENT Enterprise and is located within the Northern Gate Way section of the Western Sydney Aerotropolis precinct. Land classifications in the surrounding area include ENZ Environment and Recreation, AGB Agribusiness and SP2 Infrastructure (Western Sydney International). The nearest residential zone is an area of C4 Environmental Living within the Twin Creeks Estate, approximately 1.5 km north-east of the site.

2.2 Assessment locations

A selection of representative residential, industrial and commercial properties surrounding the site have been chosen as assessment locations for this modelling study. The assessment locations are presented in Table 2.1 and shown in Figure 2.1.

These locations are used as points for detailed model analysis of air quality impacts from construction activities. Compliance with applicable assessment criteria at these representative assessment locations would indicate the criteria will be met at other more distant locations.

Table 2.1 Assessment locations

Location ID	Classification	Coordinates (MGA, 56)	
		Easting (m)	Northing (m)
R1	Residential	289126	6250062
R2	Residential	288919	6249717
R3	Residential	288848	6249628
R4	Residential	288730	6249581
R5	Commercial (Hubertus Country Club)	288681	6249412
R6	Residential	288964	6250414
R7	Residential	289065	6250410
R8	Commercial (Sydney Society of Model Engineers)	289217	6250581
R9	Residential	289010	6250611
R10	Residential	289015	6250914
R11	Residential	289129	6250948
R12	Residential	289418	6251046
R13	Commercial (Luddenham Raceway)	288963	6251124
R14	Residential	289300	6251608
R15	Residential	289900	6251575
R16	Residential (Green Vale lodge)	289992	6251636
R17	Residential	289962	6251712
R18	Residential	290009	6251746

Table 2.1 Assessment locations

Location ID	Classification	Coordinates (MGA, 56)	
		Easting (m)	Northing (m)
R19	Residential	290262	6251891
R20	Residential	290309	6251982
R21	Residential	290332	6252048
R22	Residential	290709	6252288
R23	Residential	292195	6251833
R24	Residential	292217	6251797
R25	Residential	292283	6251787
R26	Industrial (Cleanaway Kemps Creek Resource Recovery Park)	292444	6250906
R27	Residential	292431	6249608
R28	Residential	292742	6249449
R29	Residential	292707	6249372
R30	Residential	292651	6249329
R31	Residential	292749	6249264

Source: EMM (2024); DCSSS (2024); MetroMap (2024)

0 250 500 m
GDA2020 MGA Zone 56
N

KEY

- Project boundary
- Sensitive receptor

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

Receptor locations

Burrah Park SSDA
Air Quality Impact Assessment
Figure 2.1

EMM
creating opportunities

3 Pollutants and assessment criteria

3.1 Potential air pollutants

The project has the potential to generate emissions of various pollutants to the ambient atmosphere. Emissions sources will comprise a mixture of fugitive sources (material handling from excavating and filling activities and the movement of mobile plant equipment) and mobile combustion sources (diesel combustion by construction machinery and trucks).

The main air pollutants include:

- particulate matter, specifically
  - total suspended particulate matter (TSP)
  - particulate matter less than 10 micrometres in aerodynamic diameter (PM_{10})
  - particulate matter less than 2.5 micrometres in aerodynamic diameter ($PM_{2.5}$)
- oxides of nitrogen (NO_X)[1], including nitrogen dioxide (NO_2)
- sulfur dioxide (SO_2)
- carbon monoxide (CO)
- volatile organic compounds (VOCs).

Of the above listed pollutants, particulate matter (TSP, PM_{10} and $PM_{2.5}$) are anticipated to be the key pollutants with regards to both magnitude of emissions generated by the project and the associated compliance with impact assessment criteria at surrounding assessment locations. This assessment, therefore, focuses on the quantification of particulate matter emissions and impacts (fugitive releases and diesel combustion related particulate matter).

Emissions and impacts from other pollutants associated with diesel combustion (NO_X, SO_2, CO and VOCs) are expected to be minor and have not been addressed further in this assessment.

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 Environmental Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (Department of the Environment 2021).

TSP, which relates to air borne particulates less than 50 micrometres (µm) in diameter, is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of building and surfaces) rather than health impacts (NSW EPA 2013). Particles less than 10 µm and 2.5 µm in diameter 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 impact to human health from particulate matter concentrations.

[1] By convention NO_X = nitrous oxide (NO) + NO_2

The Approved Methods for Modelling classifies TSP, PM_{10}, $PM_{2.5}$ and dust deposition as 'criteria pollutants'. The impact assessment criteria for criteria pollutants are applied at the nearest existing or likely future off-site sensitive receptors[2], and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction for the relevant averaging. Both the incremental (project only) and cumulative (project + background) impacts need to be presented, with the latter requiring consideration of the existing ambient background concentrations.

For dust deposition, the NSW EPA (2022) specify the criteria for project-only increment and cumulative dust deposition levels. Dust deposition impacts are derived from TSP emission rates and particle deposition calculates in the dispersion modelling process.

Table 3.1 Impact assessment criteria for primary pollutants

PM metric	Averaging period	Assessment criteria
TSP	Annual	90 µg/m^3
PM_{10}	24 hour	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hour	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)

Note: µg/m^3: micrograms per cubic meter; g/m^2/month: gram per square meter per month.

[2] NSW EPA (2022) defines a sensitive receptor as a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.

4 Meteorology and climate

4.1 Monitoring data resources

There are no meteorological measurements taken at the site. In reviewing the meteorological environment of the local area, the following publicly available data sources were analysed:

- Bureau of Meteorology (BoM) Automatic weather station (AWS) at Badgerys Creek (station 067108), located approximately 2.9 km south of the site. One-hour average measurements of wind speed, wind direction, standard deviation of wind direction, temperature, relative humidity and station-level barometric pressure were sourced from this AWS.

- BoM Bankstown Airport AWS (station 066137) located approximately 23.4 km east of the site. One-hour average measurements of cloud observations were sourced from this AWS.

The meteorological data recorded by the BoM Badgerys Creek AWS were analysed for the five-year period between 2019 and 2023 (see Appendix A). The analysis demonstrated a similarity across years in the most important parameters for pollutant dispersion, such as wind speed and wind direction winds. The annual average recorded wind speed ranged from 2.4 metres per second (m/s) to 2.5 m/s, while the frequency of calm conditions (wind speeds less than 0.5 m/s) ranged from 7.8% to 11.8% of the time.

The inter-annual profiles for air temperature and relative humidity were also generally comparable between 2019 and 2023 (Appendix A). The 2019 and 2023 datasets showed higher daytime temperatures and lower relative humidity, which are indicative of the strong drought conditions experienced in 2019 and the coinciding onset of wetter La Niña conditions in the years between 2020 and 2022.

4.2 Meteorological modelling

Atmospheric dispersion modelling for this assessment has been completed using the AMS[3]/USEPA[4] regulatory model (AERMOD) (model version v23132, further discussed in Section 7). The meteorological inputs for AERMOD were generated using the AERMET meteorological processor (model version v23132), using local surface observations from the BoM Badgerys Creek AWS and upper air profiles generated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) TAPM meteorological modelling module.

Further details of the TAPM meteorological modelling and AERMET data processing completed to prepare the inputs for AERMOD are documented in Appendix A.

On the basis of similarities in inter-annual trends with wind speed and direction for the years between 2019 and 2023, the 2021 calendar year was adopted as the 12-month modelling period for the purpose of this AQIA and is considered suitably representative of meteorological conditions recorded at the BoM Badgerys Creek AWS.

It is noted that 2022 was affected by the La Niña phenomenon which resulted in significantly higher than average rainfall across the region. In addition, while 2023 was the most recent year with complete data, the meteorological dataset was below the threshold required for dispersion modelling, as set out in the Approved Methods for Modelling. The assessment period was also chosen with regard to the background air quality which is discussed in Section 5.3.

[3] AMS – American Meteorological Society

[4] USEPA – United States Environmental Protection Agency

4.3 Prevailing winds

The annual wind rose showing the wind speed direction from BoM Badgerys Creek AWS in 2021 is presented in Figure 4.1.

The wind rose shows a prevailing wind alignment from the north-east and the south to south-west. The annual average recorded wind speed was 2.4 m/s, while the frequency of calm conditions was 7.9%. Calm winds are typically associated with stable atmospheric conditions (see Section 4.4 for additional discussion) which have lower potential for the dispersion of air pollutant emissions.

Seasonal wind roses from the BoM Badgerys Creek AWS 2021 dataset are shown in Figure 4.2. The mean wind speed ranges from 2.1 m/s in autumn and 2.6 m/s in spring. The frequency of calm conditions ranges from 6.7% in spring to 8.8% in winter. The autumn and winter months show prevailing south-westerly winds, while winds from the north-east through to the south-east are more dominant in the summer months.

Diurnal wind roses from the BoM Badgerys Creek AWS 2021 dataset are shown in Figure 4.3. The wind direction patterns during the night hours are dominant from the south-west, while a notable north-east and south-west is experienced during the day. Wind speeds are higher during the daylight hours, with an average wind speed of 2.6 m/s compared to 2.1 m/s at night-time, while the percentage of calms is higher at night (9.3% versus 6.6% during the day).

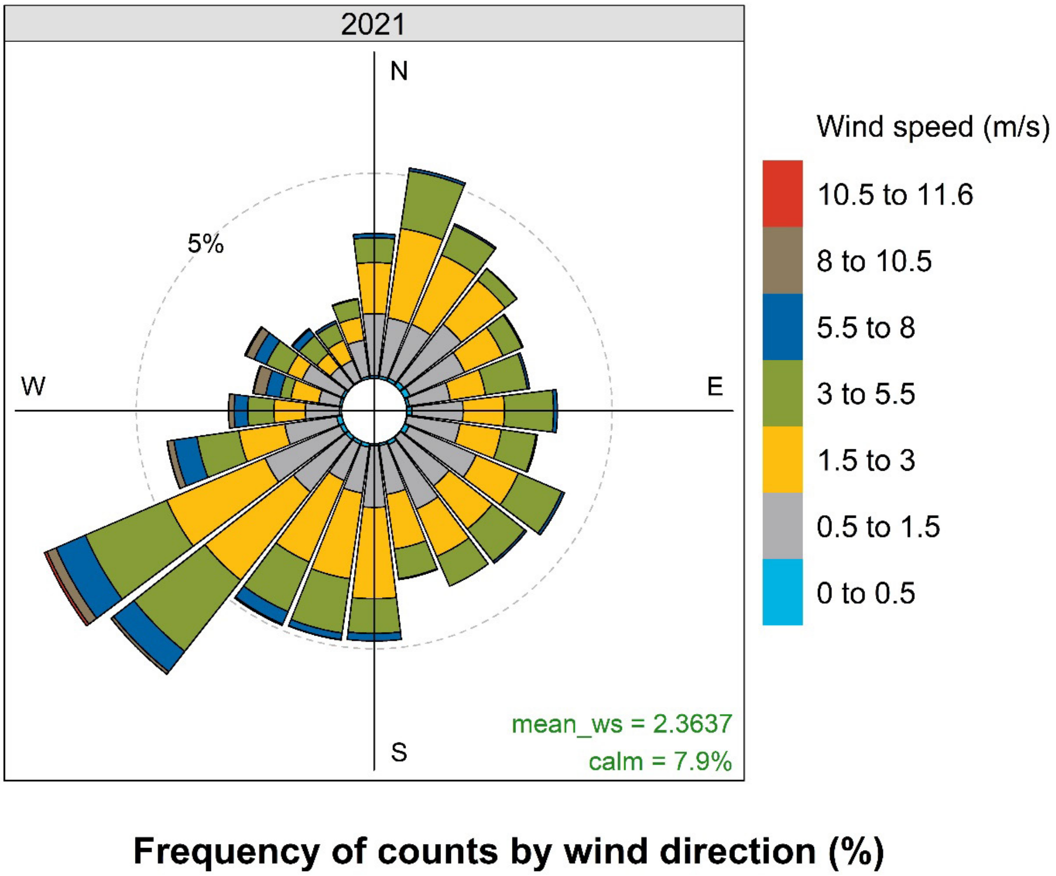


Figure 4.1 Annual wind speed and direction – Badgerys Creek AWS – 2021

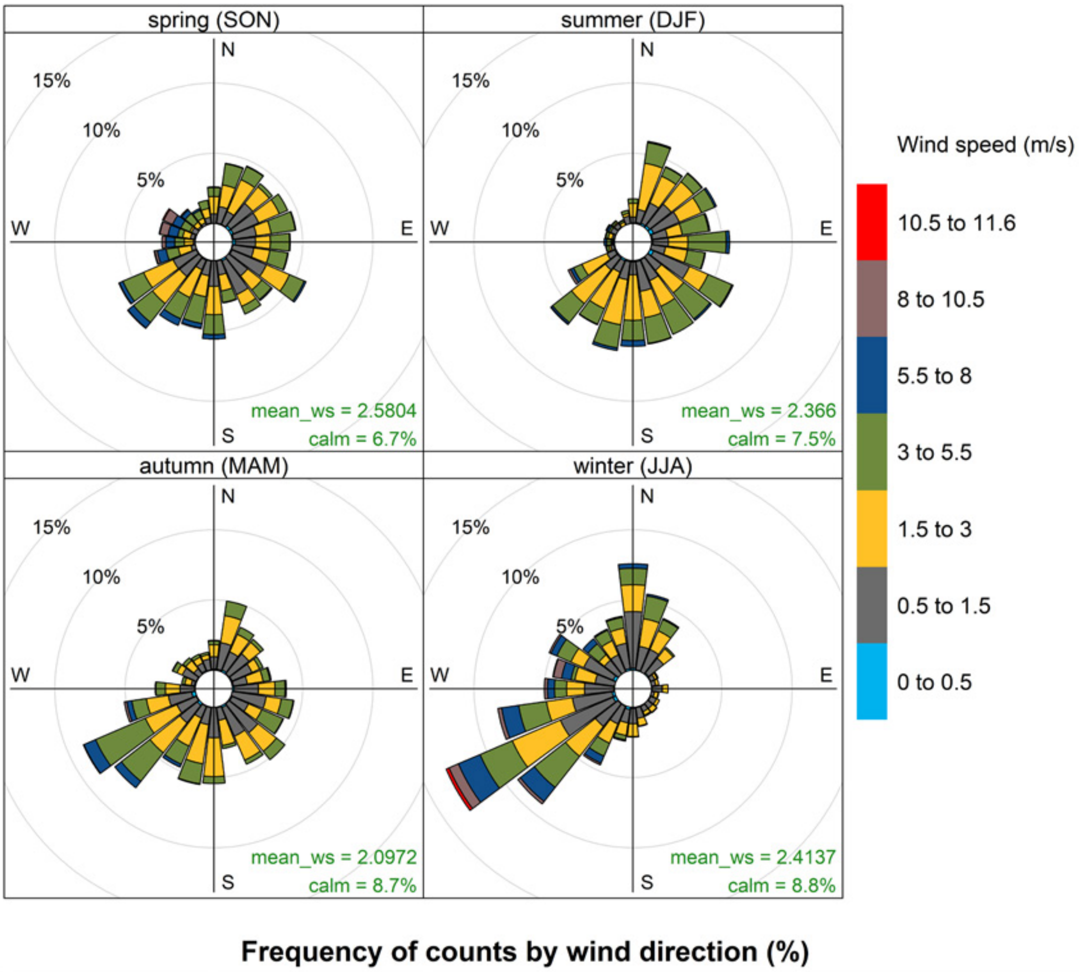


Figure 4.2 Seasonal wind speed and direction – BoM Badgerys Creek – 2019 to 2023

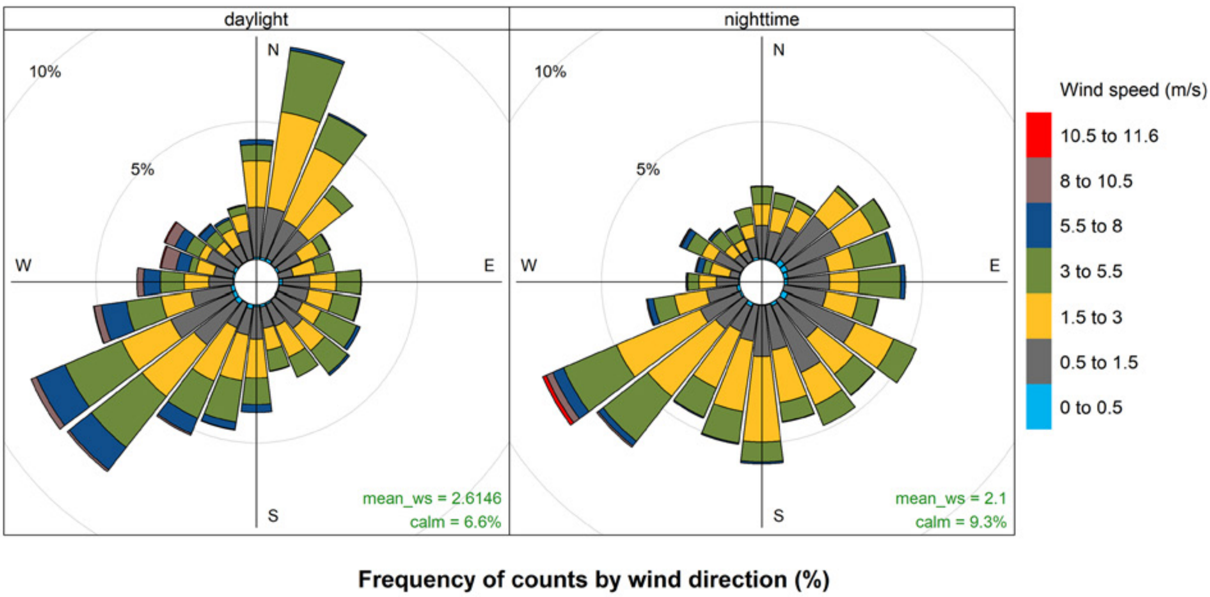


Figure 4.3 Diurnal wind speed and direction – BoM Badgerys Creek -2019 to 2023

4.4 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 (i.e. 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 4.4 illustrates the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by AERMET based on observation data collected from the BoM Badgerys Creek AWS in 2021.

The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

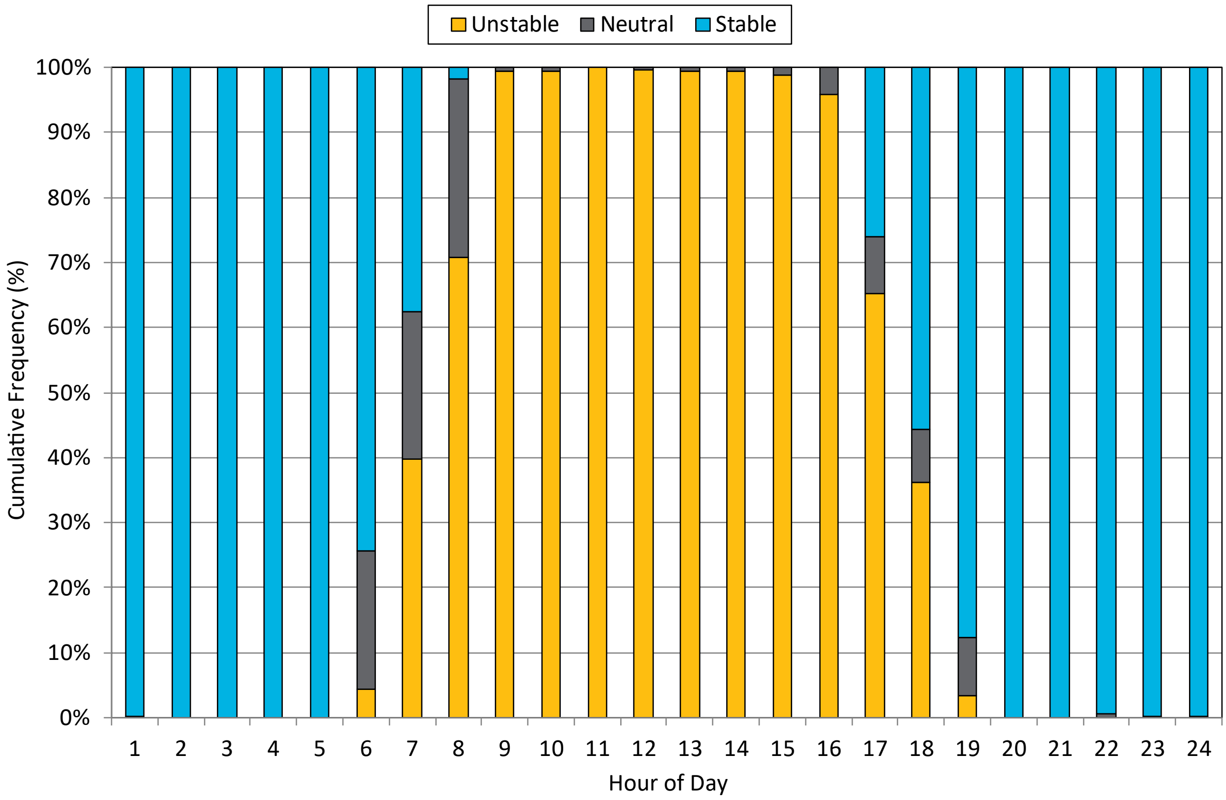
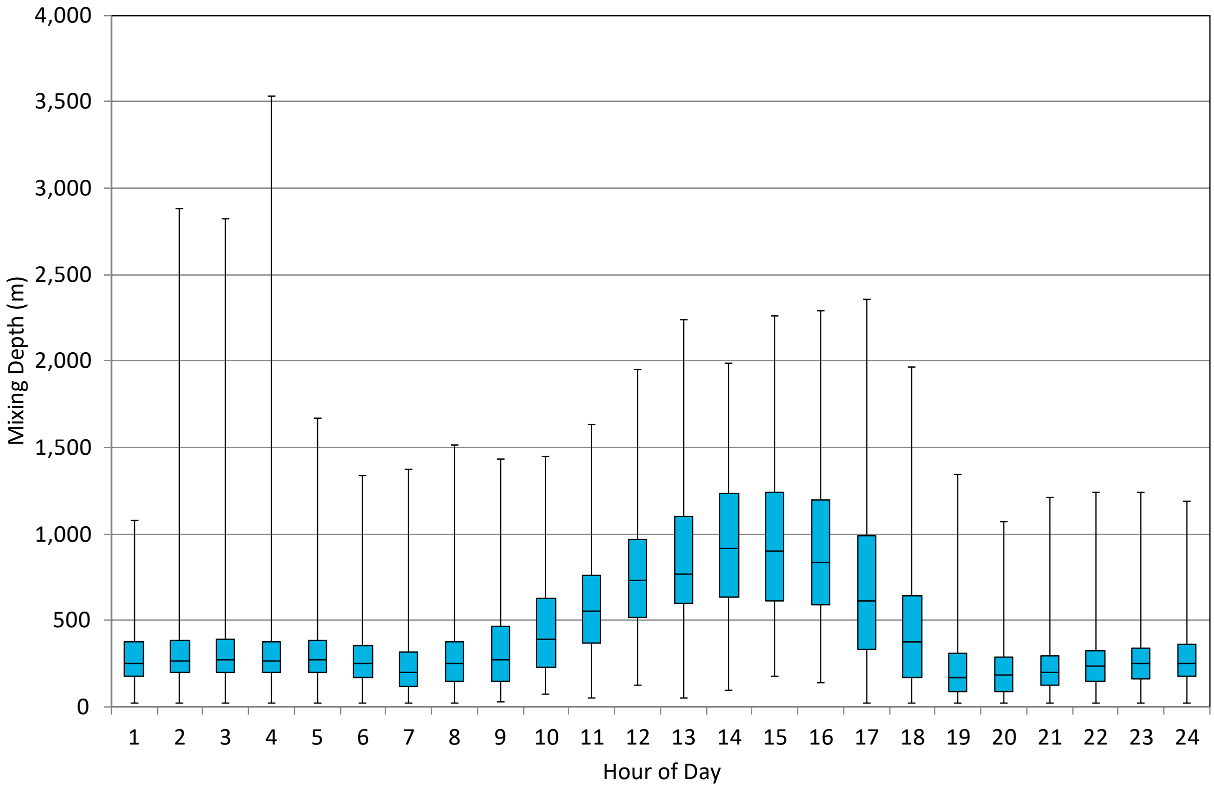


Figure 4.4 AERMET-generated diurnal variation in atmospheric stability – BoM Badgerys Creek AWS - 2021

Hourly-varying atmospheric boundary layer depths were calculated by AERMET and refers to the height of the atmosphere above ground level within which the dispersion of air pollution occurs. The variation in boundary layer depth by hour of the day is illustrated in Figure 4.5. The profile presented Figure 4.5 shows that greater boundary layer depths are experienced during the daytime hours between mid-morning and late afternoon. Higher day-time wind velocities 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 atmospheric dispersion of pollutants.



Note: blue bars indicate the interquartile range (IQR), or middle 50% of the data, while the whiskers indicate highest and lowest values.

Figure 4.5 **AERMET-generated diurnal variation in atmospheric boundary layer depth – BoM Badgerys Creel AWS - 2021**

5 Background air quality

5.1 Existing sources of emissions

The site is located in Western Sydney and is largely surrounded by rural residential properties. The site is also bounded by the construction of the WSA and adjoining M12 West (also under construction). Existing neighbouring sources include the Luddenham Quarry, approximately 0.5 km south-west of the site and the Cleanaway Kemps Creek Resource Recovery Park, approximately 1.1 km east of the site.

The construction of the WSA commenced with the bulk earthworks in March 2020 and reached practical completion in March 2023[5]. Construction of the WSA is scheduled for completion in 2026.

Construction of the M12 West began in August 2022, with 98% of bulk earthworks completed as of February 2024 and is scheduled to be operational by mid-2026[6].

Other sources that contribute to particulate matter concentrations in the vicinity of the site include:

- dust entrainment and tyre break wear due to vehicle movements along public roads
- petrol and diesel emissions from vehicle movements along public roads
- seasonal emissions from household woodfire heaters
- wind generated dust from exposed areas within the surrounding region.

Other remote sources which contribute episodically to suspend particulate in the region include dust storms and bushfires.

5.2 Air quality monitoring data resources

There are no air quality measurements available for the site. The NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) maintains air quality monitoring stations (AQMS) at Bringelly approximately 5.7 km south-east of the site. Data was also collated from the NSW DCCEEW AQMS location at St Marys (located approximately 7.7 km north-east of the site)

Throughout the collated data period, there were a number of missing data points for both PM_{10} and $PM_{2.5}$ at the Bringelly AQMS. To complete the gaps in the Bringelly AQMS dataset for 2019 to 2023, missing data points were substituted with the corresponding measurements at the nearby St Marys AQMS location (approximately 13.6 km south of the Bringelly AQMS).

5.3 Baseline air quality environment

5.3.1 PM_{10}

A timeseries of 24-hour average PM_{10} concentrations recorded at the Bringelly AQMS between 2019 and 2023 is presented in Figure 5.1. Recorded 24-hour average PM_{10} concentrations fluctuate throughout the presented period. Recorded 24-hour average PM_{10} concentrations throughout the period are typically below the applicable NSW EPA impact assessment criterion of 50 µg/m^3; however, a higher frequency of elevated concentrations occurred between 2019 and early 2020 relative to the later years of the data period.

5 https://westernsydney.com.au/construction/whos-helping-us-build-wsi

6 https://www.transport.nsw.gov.au/system/files/media/documents/2024/m12-231127-community-update-web.pdf

Key statistics for the five years of data from the Bringelly AQMS dataset are presented in Table 5.1.

The 2021 calendar year PM_{10} dataset from the Bringelly AQMS has been adopted to represent background conditions consistent with the adopted meteorological year.

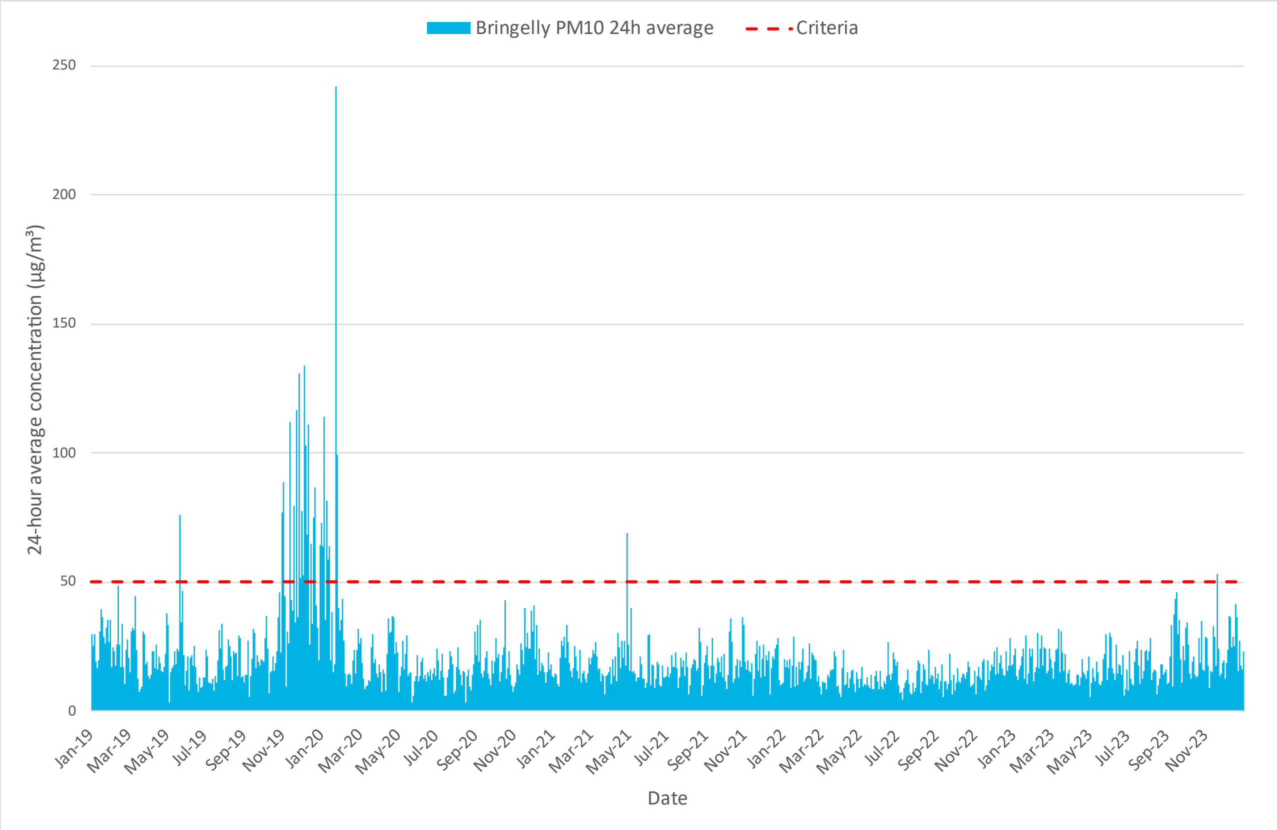


Figure 5.1 Time series of 24-hour average PM_{10} concentrations – Bringelly AQMS dataset – 2019 to 2023

Table 5.1 Statistics for PM_{10} concentrations – Bringelly AQMS dataset – 2019 to 2023

Year	Maximum	99th percentile	75th percentile	Median	Average	Days > 50 µg/m³
	24-hour average PM_{10} concentration (µg/m³)					
2019	134.0	111.4	27.5	18.7	23.7	26
2020	241.8	71.3	21.5	14.6	18.3	11
2021	69.0	34.4	19.5	14.2	15.4	1
2022	28.7	25.4	15.2	11.4	12.1	0
2023	53.2	38.8	20.3	14.5	16.3	1

Exceedance of the 24-hour average criterion occurred in four of the five years studied between 2019 and 2023, ranging from no days in 2022 and 2023 to 26 days for 2019. There was an increasing trend in the magnitude of recorded concentrations from 2019 through to early 2020, coinciding with the Black Summer bushfires between October 2019 and February 2020.

The recorded PM_{10} concentrations decrease during 2020 relative to 2019, associated with the onset of La Niña conditions (i.e. increasing rainfall and reduction in drought conditions). Annual average PM_{10} concentrations are below the applicable criterion of 25 µg/m³ for all years.

5.3.2 $PM_{2.5}$

A time series of recorded 24-hour average $PM_{2.5}$ concentrations from the Bringelly AQMS recorded between 2019 and 2023 is presented in Figure 5.2. Similar to PM_{10} concentrations, the recorded 24-hour average $PM_{2.5}$ concentrations fluctuate throughout the presented period. Recorded 24-hour average $PM_{2.5}$ concentrations were generally below the NSW EPA impact assessment criterion of 25 µg/m³.

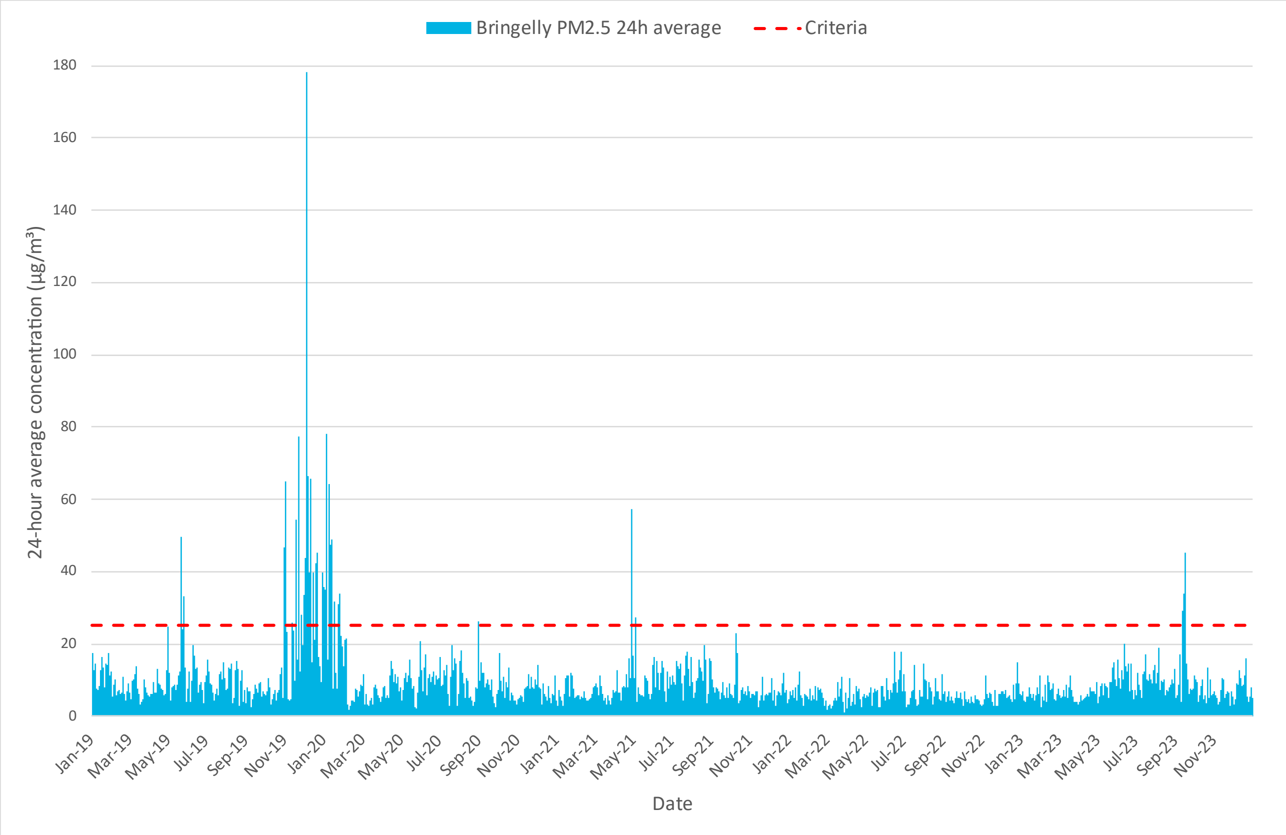


Figure 5.2 Time series of 24-hour average $PM_{2.5}$ concentrations – Bringelly AQMS dataset – 2019 to 2023

Key statistics for the five years of data from the Bringelly AQMS dataset are presented in Table 5.2.

Consistent with PM_{10}, the 2021 calendar year $PM_{2.5}$ dataset from the Bringelly AQMS has been adopted to represent background conditions.

Table 5.2 Statistics for $PM_{2.5}$ concentrations – Bringelly AQMS dataset – 2019 to 2023

Year	Maximum	99th percentile	75th percentile	Median	Average	Days > 25 µg/m³
	24-hour average $PM_{2.5}$ concentration (µg/m³)					
2019	178.0	65.9	11.8	7.5	11.2	27
2020	78.1	39.3	10.0	6.7	8.4	12
2021	57.4	20.8	8.8	6.1	7.2	3
2022	17.8	14.3	6.4	4.6	5.1	0
2023	45.4	19.4	8.5	5.9	7.0	3

Across the five years of analysed data, 2019 and 2020 feature a notably higher occurrence of elevated concentrations and 2022 feature a high occurrence of lower concentrations. The remaining two years of data are reasonably comparable.

Multiple NSW EPA criterion exceedances were experienced for all years (ranging from 0 days in 2022 to 27 days in 2019). Exceedances were associated with regional scale events such as dust storms, hazard reduction burns and during 2019 and 2020, extensive bushfire events across NSW. Annual average $PM_{2.5}$ concentrations were below the applicable criterion of 8 µg/m³ for all years excluding 2019 and 2020.

Recorded exceedances of $PM_{2.5}$ in 2023 were largely attributed to hazard reduction burns and low wind conditions impacting the region.

5.3.3 TSP

There are no measurements of TSP available for the site. The typical ratio between ambient annual average PM_{10} and TSP concentrations is 0.4. In the absence of locally source TSP monitoring data, a PM_{10} to TSP ratio of 0.4 has been adopted. When applied to the annual average PM_{10} concentration for the for 2021 of 15.0 µg/m³ from the Bringelly AQMS dataset, the annual average TSP background concentration for 2021 is 38.4 µg/m³.

5.3.4 Dust deposition

There are no measurements of dust deposition available at the site. This assessment therefore focuses on the incremental contribution from site emissions only. This approach is suitable for assessment against the NSW EPA incremental criterion of 2.0 g/m²/month, expressed as an annual average.

5.3.5 Adopted background summary

In summary, the following background values were adopted for cumulative assessment:

- 24-hour PM_{10} concentration – daily varying 2021 dataset with one day above impact assessment criteria (existing exceedance)
- annual average PM_{10} concentration – 15.0 µg/m³
- 24-hour $PM_{2.5}$ concentration – daily varying 2021 dataset with three days above impact assessment criteria (existing exceedances)
- annual average $PM_{2.5}$ concentration – 7.2 µg/m³
- annual average TSP concentration – 38.4 µg/m³.

6 Emissions inventory

6.1 Sources of construction emissions

Sources of atmospheric emissions associated with the project include:

- transportation (hauling) of topsoil and overburden along unpaved internal roads
- removal, handling and dumping of topsoil and overburden
- material processing (crushing and screening)
- wind erosion from stockpiles and exposed surfaces
- diesel fuel combustion by plant machinery, equipment and trucks.

Fugitive dust sources associated with the operation of the proposed development were quantified through the application of National Pollution Inventory (NPI) emission estimation techniques and United States Environmental Protection Agency (US-EPA) AP-42 emission factor equations. Particulate matter emissions were quantified for various particle size fractions, with the TSP fraction being estimated to provide an indication of dust deposition rates. Coarse particles (PM_{10}) and fine particle ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the US-EPA AP-42).

6.2 Emissions scenario

The earthworks phase of the project will have the highest potential for particulate matter emission generation and associated offsite impacts, therefore, emissions from these activities have been quantified and are the focus of this report. Other activities such as the construction of amenities and warehouses are assumed to have lower emissions potential than the earthworks and have not been quantified further.

The total proposed earthworks for the project across the earthwork stages 1 to 5 are presented in Table 6.1. In converting cubic metres (m^3) into tonnes (t) a density factor of 2.02 t/m^3 for clay and overburden was applied[7].

Table 6.1 Proposed earthwork material extraction and filling by stage

Activity	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
	Proposed earthwork quantities (m^3)				
Extraction	815,726	153,472	119,242	425,944	105,392
Filling	461,225	227,671	364,589	328,278	288,397
	Proposed earthwork quantities (t)				
Extraction	1,647,767	310,013	240,869	860,407	212,892
Filling	931,675	459,895	736,470	663,122	582,562

7 https://www.cat.com/en_US/articles/ci-articles/earthwork-volumes-reference-tables.html

To assess the potential impacts associated with the project, a single 'worst case' emissions scenario was configured taking projected earthworks volumes and the indicative earthworks schedule into account. On the basis of overlapping works, the peak 12-month period of earthworks occurs in Stage 1 and Stage 2 occurring concurrently. Therefore, combined earthworks from Stage 1 and Stage 2 were adopted as the worst case emissions scenario. The adopted annual totals for extraction and filling as part of the earthworks are as follows:

- Stage 1 extraction rate of 1,647,767 t and filling rate of 931,675 t
- Stage 2 extraction rate of 310,013 t and filling rate of 459,895 t.

Construction works are proposed to occur Monday to Friday from 7:00 am to 8:00 pm and Saturday from 8:00 am to 5:00 pm. For dispersion modelling purposes, activities were modelled for 13 hours of the day between 7:00 am and 8:00 pm.

6.3 Emissions reduction factors

A range of particulate matter emissions mitigation measures have been integrated into the project. Based on information provided by HBB, the following emissions reduction factors were applied to account for controls at the project site:

- use of water carts on unpaved haul roads –75% reduction for water application (NPI 2012)
- use of watering on travel routes during topsoil removal – 50% reduction for soils kept most (naturally or artificially) (NPI 2012)
- use of water sprays during crushing and screening – 50% reduction for water application (NPI 2012).

In addition to these reduction factors, for wind erosion emission calculations, it was assumed that only 50% of the total stage areas were exposed and actively emitting at any one time.

6.4 Particulate matter emissions

A summary of the calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions rates by source type are presented in Table 6.2, while the significance of key source types by particle size is illustrated in Figure 6.1. Particulate matter control measures, as documented in Section 6.3, are accounted for in these annual emissions totals. The data shows that truck haulage on unpaved surfaces and dozer/grader activities are the key contributing sources to total construction emissions.

Further details regarding emissions estimation factors and assumptions are provided in Appendix B.

Table 6.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Stage 1 – Material transportation			
Excavated material haulage to fill area	86,016.3	24,576.7	2,457.7
Stage 1 - Earthworks			
Scrapers stripping topsoil	1,865.4	469.6	71.1
Excavator at cut area	2,157.4	1,020.4	154.5

Table 6.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Crushing sandstone & oversized	667.3	296.6	20.0
Topsoil screening	804.0	276.6	18.7
Loading material to trucks in cut area	2,157.4	1,020.4	154.5
Unloading at fill area	1,219.8	576.9	87.4
Dozer/grader at fill area	48,624.5	11,750.4	5,105.6
Excavator at fill area	1,219.8	576.9	87.4
Stage 2 – Material transportation			
Excavated material haulage to fill area	16,183.3	4,623.9	462.4
Excavated material haulage from stage 1 to stage 2 fill area	7,824.1	2,235.5	223.6
Stage 2 - Earthworks			
Scrapers stripping topsoil	758.3	190.9	28.9
Excavator at cut area	405.9	192.0	29.1
Crushing sandstone & oversized	125.6	55.8	3.8
Topsoil screening	326.8	112.4	7.6
Loading material to trucks in cut area	405.9	192.0	29.1
Unloading at fill area	602.1	284.8	43.1
Dozer/grader at fill area	48,625	6,312	5,106
Excavator at fill area	602.1	284.8	43.1
Wind erosion			
Stage 1 area wind erosion	6,374.0	3,187.0	956.1
Stage 2 area wind erosion	2,597.5	1,298.7	389.6
Other			
Diesel combustion – Stage 1	894.0	894.0	819.5
Diesel combustion – Stage 2	894.0	894.0	819.5
Total	**231,350.0**	**61,322.1**	**17,117.7**

*Totals may not add up exactly due to rounding

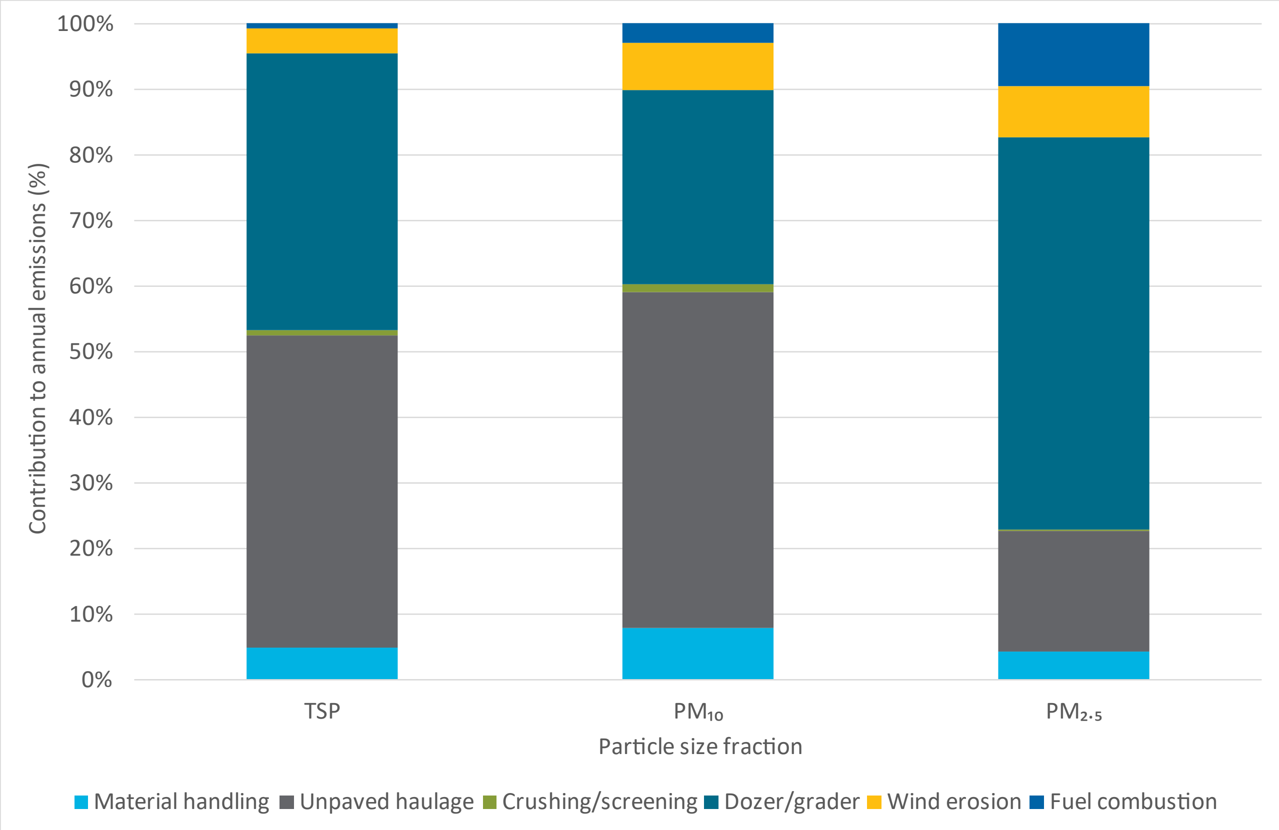


Figure 6.1 Contribution to annual emissions by source type and particle size

6.5 Operational emissions

As mentioned previously, in addition to the earthworks and construction activities for the project, the establishment of three warehousing buildings and ancillary offices are also proposed as a part of the project.

Currently, the proposed operational use for each of the warehouses is not yet known; however, the typical use of a warehouse within a mixed commercial and industrial park can range from activities such as manufacturing, storage and distribution, retail and data centres.

Potential sources and pollutant types from operational activities may include but are not limited to the following:

- wheel-generated particulate matter emissions from the movement of trucks, forklifts and light vehicles from operations associated with the warehouse
- fuel combustion and associated pollutants (particulate matter and NO_x) from vehicles and mobile plant machinery such as trucks, forklifts and light vehicles
- fuel combustion and associated pollutants (particulate matter and NO_x) from backup diesel generators
- gas combustion (such as natural gas or LPG) and associated pollutants (particulate matter, NO_x, CO, SO_2, VOCs) from boilers and other heating systems
- particulate matter emissions generated through material handling and stockpiling activities inside and outside of warehouse buildings.

Factors such as the size of the facility, the type and intensity of operations and the efficiency of equipment used can greatly influence the impact from operational emissions.

In general, pollutant emissions from operational activities can be effectively managed through implementing measures to ensure offsite impacts are low. For example, impacts from activities such as material handling and stockpiling can be effectively managed by restricting these activities to an enclosed building/warehouse, or opting to implement systems that are powered through mains electricity rather than through fuel combustion (e.g. electric forklifts).

Depending on the proposed use, each warehouse may be subject to further assessment.

7 Air dispersion modelling

7.1 Dispersion model selection and configuration

The atmospheric dispersion modelling completed for this assessment used the AERMOD dispersion model (version v23132). AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

In addition to the 31 individual assessment locations (documented in Section 2.2), air pollutant concentrations were predicted over a multi-tier grid domain of 8 km by 8 km with spacing ranging from 500 m to 100 m decreasing with proximity to the site (totalling 1,549 receptor points).

Simulations were undertaken for the 12-month period of January to December 2021 using the AERMET-generated meteorological domain file (see Chapter 4 for description of input meteorology).

7.2 Incremental (project-only) results

Predicted incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates from the project are presented in Table 7.1 for each of the assessment locations.

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

Isopleth plots, illustrating spatial variations in project-related incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust depositions rates are provided in Appendix C. Isopleth plots of the maximum 24-hour average concentrations presented in Appendix C do not represent the dispersion pattern on any individual day, but rather illustrate the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2021 modelling period.

Table 7.1 Incremental (project-only) concentration and deposition results

Assessment location ID	Predicted incremental concentrations (µg/m³) or dust deposition rates (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	2.4	11.8	1.3	3.8	0.5	0.2
R2	1.5	13.6	0.9	6.7	0.3	0.1
R3	1.3	12.0	0.7	5.7	0.3	0.1
R4	1.1	10.9	0.7	5.6	0.2	0.1
R5	0.9	10.3	0.5	4.0	0.2	0.1
R6	2.4	9.9	1.2	4.2	0.5	0.2
R7	2.8	10.6	1.4	5.1	0.6	0.2
R8	3.6	13.4	1.7	6.3	0.7	0.3

Table 7.1 Incremental (project-only) concentration and deposition results

Assessment location ID	Predicted incremental concentrations (µg/m³) or dust deposition rates (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**
R9	2.5	10.0	1.2	5.1	0.5	0.2
R10	1.9	5.7	0.8	2.6	0.3	0.2
R11	2.2	8.7	0.9	4.2	0.3	0.2
R12	3.5	13.2	1.6	5.9	0.6	0.3
R13	1.7	9.8	0.8	3.9	0.3	0.1
R14	1.5	6.4	0.7	3.1	0.2	0.1
R15	2.0	9.4	1.1	3.2	0.4	0.2
R16	1.9	8.5	1.0	2.8	0.3	0.1
R17	1.7	8.2	0.9	2.8	0.3	0.1
R18	1.6	7.2	0.9	2.4	0.3	0.1
R19	1.4	9.1	0.8	2.6	0.2	0.1
R20	1.2	10.3	0.7	2.9	0.2	0.1
R21	1.1	10.4	0.6	3.0	0.2	0.1
R22	0.9	9.7	0.5	2.9	0.2	0.1
R23	1.3	19.7	0.9	5.9	0.3	0.1
R24	1.4	21.4	0.9	6.4	0.3	0.1
R25	1.3	22.4	0.9	6.7	0.3	0.1
R26	1.0	10.1	0.7	3.0	0.2	0.1
R27	0.8	9.3	0.5	2.8	0.2	0.1
R28	0.6	7.1	0.4	2.5	0.1	0.1
R29	0.6	6.2	0.4	1.9	0.1	0.1
R30	0.6	6.3	0.4	1.9	0.1	0.1
R31	0.5	6.0	0.4	1.8	0.1	0.1

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

7.3 Cumulative (project + background) results

Predicted cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations for each of the assessment locations presented in Table 7.2. Cumulative impacts at each of the assessment locations surrounding the site have been assessed in the following ways:

- For 24-hour average concentrations – each daily varying predicted 24-hour concentration for PM_{10} and $PM_{2.5}$ from the project have been combined with the corresponding concentrations from the adopted assessment period background concentration datasets (Section 5.3).
- For annual average concentrations – the predicted annual concentrations from the project have been paired with the corresponding background annual average concentrations (Section 5.3).

As detailed in Section 5.3, there is one existing exceedance of the 24-hour average PM_{10} criterion and three existing exceedances of the 24-hour $PM_{2.5}$ criterion in the Bringelly AQMS background dataset. For cumulative impact assessment purposes, these are classed as existing exceedances.

Section 5.1.3 of the Approved Methods for Modelling states that in the event of existing ambient air pollutant concentration in exceedance of applicable impact assessment the criteria, the assessment must:

> ...demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.

To demonstrate that no additional exceedances of the applicable criteria will occur as a result of emissions from the project, the 2nd highest cumulative PM_{10} concentrations and 4th highest $PM_{2.5}$ concentrations at each assessment location are reported in Table 7.2. Data has not been removed from the analysis but simply, the next highest result not affected by background above the criterion is shown in this section.

The predicted cumulative 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 + background) concentrations

Assessment location ID	Predicted cumulative concentrations (µg/m^3)				
	TSP	PM_{10}		$PM_{2.5}$	
	Annual	2nd highest 24-hour	Annual	4th highest 24-hour	Annual
Criterion	**90**	**50**	**25**	**25**	**8**
R1	40.8	41.1	16.6	23.3	7.7
R2	40.0	40.7	16.2	23.3	7.5
R3	39.7	40.6	16.1	23.3	7.5
R4	39.6	40.5	16.0	23.3	7.4
R5	39.4	40.4	15.9	23.3	7.4
R6	40.8	41.0	16.5	23.4	7.7
R7	41.2	41.1	16.7	23.5	7.8
R8	42.1	41.5	17.0	24.0	7.9
R9	40.9	41.0	16.5	23.8	7.7

Table 7.2 Cumulative (project + background) concentrations

Assessment location ID	Predicted cumulative concentrations ($\mu g/m^3$)				
	TSP	PM_{10}		$PM_{2.5}$	
	Annual	2nd highest 24-hour	Annual	4th highest 24-hour	Annual
Criterion	**90**	**50**	**25**	**25**	**8**
R10	40.4	40.6	16.1	23.9	7.5
R11	40.7	40.7	16.2	23.4	7.5
R12	42.0	41.4	16.9	23.1	7.8
R13	40.2	40.7	16.1	23.1	7.5
R14	40.0	40.5	16.0	22.8	7.4
R15	40.5	41.2	16.4	22.9	7.6
R16	40.3	41.1	16.3	22.9	7.5
R17	40.1	41.0	16.2	22.9	7.5
R18	40.1	40.9	16.2	22.9	7.5
R19	39.8	40.8	16.1	22.9	7.4
R20	39.7	40.7	16.0	22.9	7.4
R21	39.6	40.7	15.9	22.9	7.4
R22	39.3	40.5	15.8	22.9	7.4
R23	39.8	40.3	16.2	22.8	7.5
R24	39.8	40.3	16.2	22.8	7.5
R25	39.8	40.3	16.2	22.8	7.5
R26	39.5	40.3	16.0	22.9	7.4
R27	39.2	40.3	15.8	22.9	7.4
R28	39.1	40.2	15.7	22.9	7.3
R29	39.0	40.2	15.7	22.9	7.3
R30	39.0	40.3	15.7	22.9	7.3
R31	39.0	40.2	15.7	22.8	7.3

Note: due to the occurrence of one existing exceedance of the 24-hour average PM_{10} criterion and three existing exceedances of the 24-hour average $PM_{2.5}$ criterion in the Bringelly AQMS background dataset, the 2nd highest cumulative PM_{10} concentrations and 4th highest cumulative $PM_{2.5}$ concentrations at each assessment location are presented.

Predicted cumulative annual average TSP, PM_{10} and $PM_{2.5}$ concentrations by assessment location associated with the project are presented in Figure 7.1, Figure 7.2 and Figure 7.3.

As shown in Figure 7.1, Figure 7.2 and Figure 7.3, compliance with the applicable impact assessment criterion is predicted for annual average TSP, PM_{10} and $PM_{2.5}$ concentrations.

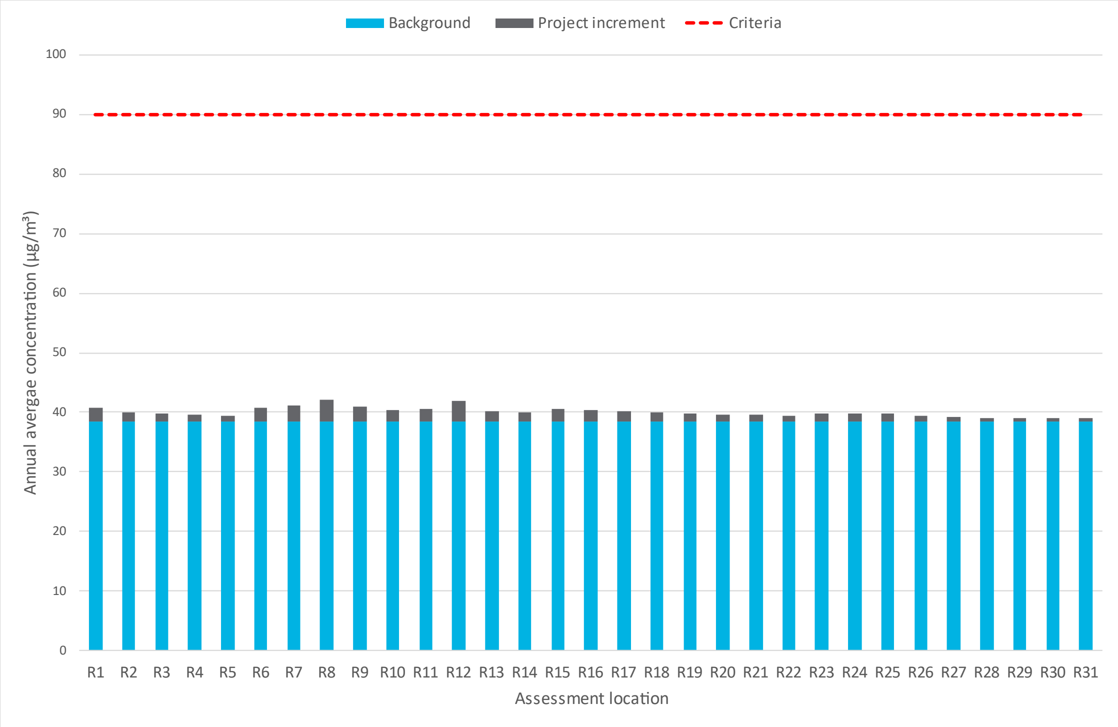


Figure 7.1 Predicted cumulative annual average TSP concentrations

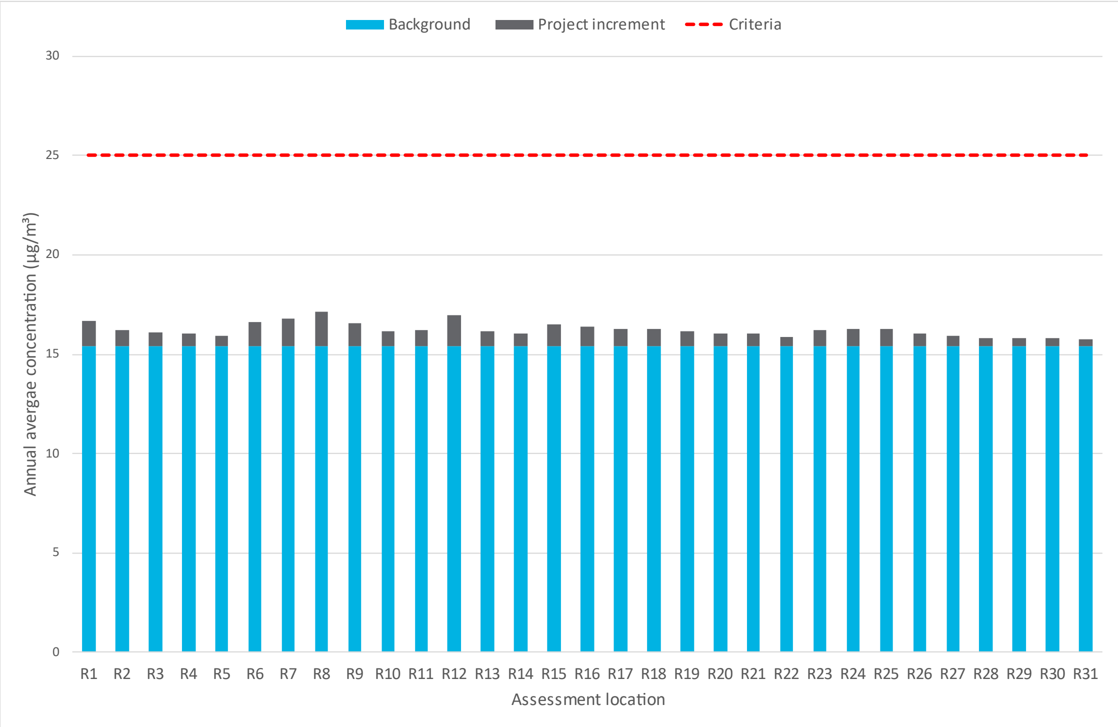


Figure 7.2 Predicted cumulative annual average PM_{10} concentrations

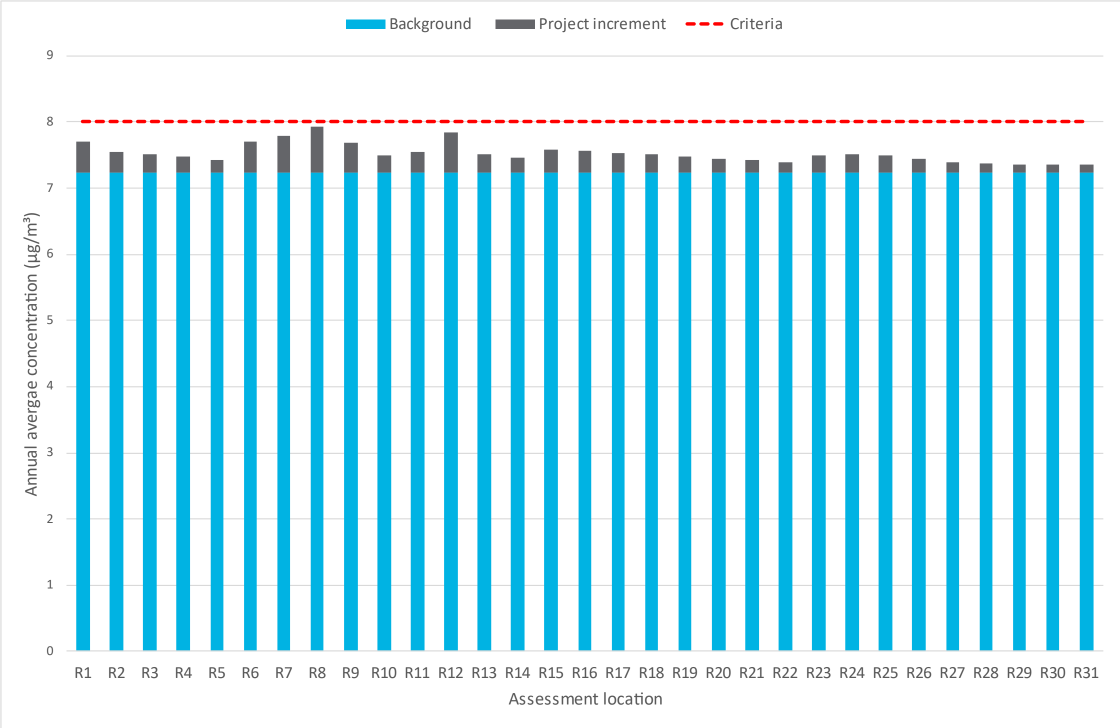


Figure 7.3 Predicted cumulative annual average $PM_{2.5}$ concentrations

7.4 Management and mitigation

A range of mitigation measures will be implemented during the earthworks and construction phases of the project. Mitigation measures were incorporated into the emissions calculation and dispersion modelling wherever an appropriate emission control factor (or reduction factor) was available, and are discussed in more detail in Section 6.3, these include:

- application of water carts to unpaved haul routes and scraper/dozer travel routes
- use of water sprays at mobile material crushing and screening plant
- minimisation of exposed areas for wind erosion generation (limit of 50% of stage area assumed conservatively).

The project would be constructed according to conventional methods and would be guided by a Construction Environment Management Plant (CEMP) to effectively manage off-site environmental impacts. The CEMP may include (but will not be limited to) the recommended mitigation measures listed below. These measures are routinely employed as 'good-practice' at construction sites.

The following general mitigation measures are recommended:

- prior to commencement of construction and earthwork activities, develop appropriate communications to notify the potentially impacted residences of the project (duration, types of work, etc.), relevant contact details for environmental complaint reporting
- a complaints logbook should be maintained through the construction and earthworks phase which should include any complaints related to dust; where a dust complaint is received, the response actions should be detailed in the logbook

- record any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation in the logbook
- carry out daily site inspections, including local meteorological forecast, record inspection results in a logbook
- modify working practices by limited activity during periods of adverse weather (hot, dry and windy conditions) and when dust is seen leaving the site
- erect shade cloth barriers around potentially dusty activities such as excavation and material stockpiles or at the site boundary where practicable
- keep site barries clean using wet methods
- ensure proper maintenance of all equipment engines
- avoid leaving engines running at idle where possible
- vegetation clearing to be staged where possible to minimise the area and time that surfaces are exposed
- minimise drop heights from loading and handling equipment
- ensure vehicle loads entering and leaving the site are covered to prevent escape of materials during transport
- implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable)
- used water-assisted dust sweeper(s), to remove, as necessary, any material tracked out of the site onto public roads.

8 Greenhouse gas assessment

8.1 Introduction

The estimation of GHG emissions from the earthworks and construction for the project was based on the Commonwealth Government's Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2023) National Greenhouse Accounts Factors (NGAF) workbook and the Greenhouse Gas Assessment Workbook for Road Projects (TAAG 2013).

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* (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). The National Greenhouse and Energy Reporting (NGER) scheme is a single national framework for reporting information about greenhouse gas emissions, energy production and energy consumption.

Facilities or corporations must report under the NGERs scheme if they emit GHG emissions or produce/ consume energy at or above the following thresholds:

- greater than 25 kilotones (kt) GHG emissions (as CO_2-e) or produced/consumed greater than 100 terajoules (TJ) of energy (facility level)

- greater than 125 kt of GHG emissions (as CO_2-e) or produced/consumed greater than 500 TJ of energy (corporate level).

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 the project and as a result of the projects' activities. Indirect emissions are generated as a consequence of the projects activities but are physically produced by the activities of another organisation (DCCEEW 2023). 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 a project. 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 and projects, for example, in benchmarking the GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported.

8.2 Emission sources

The GHG emission sources included in this assessment are listed in Table 8.1, representing the most significant sources associated with the earthworks for the project.

Table 8.1 Scope 1, 2 and 3 GHG emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from diesel combustion by onsite mobile plant equipment	-	Indirect emissions from extraction, production and transport of diesel
Direct emissions from vegetation clearing (loss of carbon sink)	-	-

8.3 Excluded emission sources

The primary focus of this GHG assessment is emissions from the proposed earthworks and construction at the site. The following emissions have been excluded from the calculations:

- embodied carbon (Scope 3) associated with the production and transportation of construction materials such as asphalt, concrete and steel
- fuel combustion emissions (Scope 3) associated with the travel of employees to and from the site
- operational emissions from the proposed warehouses.

8.4 Activity data

8.4.1 Diesel consumption

An anticipated daily diesel fuel consumption rate of 5,000 litres per day for earthworks was provided by HBB. An annual consumption rate of fuel was calculated based on the timing of each stage of works and the number of operational days per year by earthworks stage.

Diesel fuel consumption associated with the construction of concrete hardstand areas and asphalt roads were estimated using the relevant default quantity factors listed in TAAG 2013, presented in Table 8.2. The quantity factors were combined with the total proposed area for the three warehouses included in the project (conservatively assumed at total land area of 14.6 ha) and the internal road networks within the concept master plan (conservatively assumed at total of 30.1 ha).

The adopted activity data for the emissions estimates is presented in Table 8.3.

Table 8.2 Default quantity factors for diesel consumption during construction (TAAG 2013)

Construction activity	Diesel (kL/unit)	Unit
Full depth asphalt	0.00907	m^2
Reinforced concrete	0.00144	m^2

Table 8.3 Indicative annual diesel activity data

Period	Diesel consumption per activity (kL)		
	Earthworks	Construction	Total
Year 1	3,600	910	4,510
Year 2	1,800	1,120	2,920
Year 3	450	910	1,360
Project lifetime (3 years)	**5,850**	**2,940**	**8,790**

8.4.2 Vegetation clearing

Table 8.4 presents the amount of land and land types estimated to be cleared for the project. Vegetation would be cleared progressively over the 5 stages of earthworks, with a majority of vegetation removal occurring in the stage 1 and stage 4 areas. The area and types of vegetation to be cleared were analysed based on geospatial information and previous land use information. The land area of clearing by vegetation type are presented in Table 8.4.

Table 8.4 Vegetation clearing calculation inputs

Period	Vegetation class (TAAG 2013)	Vegetation type	Emission factor (t CO_2-e/ha)	Amount cleared (ha)
Year 1	I	Grasslands	110	54.5
Year 2				57.2
Year 3				13.0
Total vegetation clearing (3 years)				**124.7**

8.5 Emission estimates

The estimated yearly and project lifetime GHG emissions for each emission source, are presented in Table 8.5. Details of the GHG emissions calculations are provided in Appendix D.

The significance of GHG emissions generated by the earthworks and construction for the project relative to State and National GHG is made by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2022[8]) for NSW (110,997 kt CO_2-e) and Australia (432,621 kt CO_2-e).

Annual average GHG emissions (Scope 1) generated by the earthworks and construction for the project represent 0.01% of total GHG emissions for NSW and 0.003% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2022 (DCCEEW 2024). The calculated annual scope 1 and 2 emissions from the earthworks and construction for the project are lower than the NGER Scheme facility reporting threshold of 25,000 tpa CO_2-e.

Table 8.5 Estimated yearly and project lifetime GHG emissions (all scopes)

Year	Annual GHG emissions (t CO_2-e/year) by scope						
	Scope 1			Scope 2	Scope 3		Total
	Diesel - earth works	Diesel - const ruction	Vegetation clearing	-	Diesel - earth works	Diesel - constr uction	
Year 1	9,755	2,465	5,998	-	2,404	607	21,229
Year 2	4,877	3,036	6,289	-	1,202	748	16,152
Year 3	1,219	2,465	1,430	-	301	607	6,022
Annual average	5,284	2,655	4,572		1,302	654	14,468
TOTAL (All years)	**15,852**	**7,966**	**13,717**	**0**	**3,907**	**1,963**	**43,404**

[8] http://ageis.climatechange.gov.au

8.6 Mitigation

GHG emissions from the earthworks for the project are principally associated with diesel consumption by plant equipment and vehicles.

The following management practices to minimise emissions from the combustion of diesel consumption for the duration of earthworks for the project are suggested:

- minimise haul distances as far as practicable to reduce diesel consumption
- regular review of extraction practices to minimise double handling of materials and ensure that haulage is undertaken using the most efficient routes
- consider the use of alternative fuels (e.g. low sulphur) where economically and practically feasible
- minimise idling of diesel equipment wherever feasible
- routinely service all equipment to maintain manufacturers' emission specifications to ensure that operational efficiency
- perform pre-start inspections at each shift on mobile plant and vehicles
- track fuel usage.

9 Conclusion

This AQIA presents a quantitative modelling assessment of potential air quality impacts for the construction and bulk earthworks that form part of the project.

Background concentrations were adopted from data recorded during the 2021 calendar year from the NSW DCCEEW Bringelly AQMS sites. Meteorological modelling was completed using AERMET, with observations incorporated primarily from the BoM Badgerys Creek AWS.

Emissions of TSP, PM_{10} and $PM_{2.5}$ associated with the project were quantified using publicly available emission estimation techniques. Atmospheric dispersion modelling of air pollution emissions was undertaken using the AERMOD dispersion model. The results of the dispersion modelling highlighted the following:

- 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 the adopted background concentrations with the predicted incremental concentrations from the project. Cumulative results indicated that air pollution concentration associated with emissions from the project would be in compliance with the impact assessment criteria at all assessment locations for all pollutants and averaging periods.

- Background annual average $PM_{2.5}$ concentrations from the NSW DCCEEW Bringelly AQMS 2021 dataset are already close to the impact assessment criterion with a minor incremental concentration from earthwork activities.

A range of dust mitigation measures are proposed for the project. These include the use of water carts on unpaved roads and scraper/dozer routes, watering at crushing and screening plant and limiting the total area of each stage being actively exposed at one time. These measures have been taken into account in the emissions estimation and dispersion modelling.

In addition to the measures accounted for in the dispersion modelling a CEMP will be implemented which includes measures to manage dust.

A GHG assessment of the proposed earthworks phase was also completed. Annual average GHG emissions (Scope 1) generated by project earthworks represent 0.01% of total GHG emissions for NSW and 0.003% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2022. The calculated annual scope 1 and 2 emissions from the earthworks and construction for the project are lower than the NGER Scheme facility reporting threshold.

References

Bhatia, P, Cummis, C, Brown, A, Rich, D, Draucker, L & Lahd, H 2010, Greenhouse Gas Protocol. *Corporate Value Chain (Scope 3) Accounting and Reporting Standard*. Supplement to the GHG Protocol Corporate Accounting and Reporting Standard, World Resources Institute & World Business Council for Sustainable Development.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) 2024, *Australia's National Greenhouse Accounts, emissions by state and territory,* website: https://ageis.climatechange.gov.au/, 2024.

DCCEEW 2023, *National Greenhouse Accounts Factors*, Commonwealth Department of Climate Change, Energy, the Environment and Water.

Department of Climate Change, Energy, the Environment and Water (NSW) (NSW DCCEEW) 2024, Climate and Atmospheric Research Branch, air quality monitoring data from Bringelly and St Marys air quality monitoring stations.

Department of the Environment 2016, *National Environment Protection (Ambient Air Quality) Measure*.

Department of the Environment and Energy (DoE) 2014, *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines.*

Infrastructure NSW 2024, *Embodied Carbon Measurement for Infrastructure Technical Guidance*.

National Pollution Inventory (NPI) 2008, *Emission Estimation Technique Manual for Combustion Engines.*

NPI 2012, *Emission Estimation Technique Manual for Mining.*

NSW EPA 2013, *Air Emissions in My Community web tool Substance information*.

NSW EPA 2022, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. New South Wales Environment Protection Authority, Sydney.

Transport Authorities Greenhouse Group (TAAG) 2013, *Greenhouse gas assessment workbook for road projects*, prepared by the Transport Authorities Greenhouse Group, February 2013.

US-EPA 1998, AP-42 Chapter 11.9.9 – Western surface coal mining.

US-EPA 2004, AP-42 Chapter 11.19.2 – Crushed Stone Processing and Pulverized Mineral Processing

US-EPA 2006b, AP-42 Chapter 13.2.4 – Aggregate Handling and Storage Piles.

US-EPA 2006, AP-42 Chapter 13.2.2 – Unpaved Roads.

US-EPA 2016, Nonroad Compression-Ignition Engines: Exhaust Emission Standards (EPA-420-B-16-022, March 2016).

Abbreviations

AAQNEPM	Ambient Air Quality National Environment Protection Measure
AQIA	Air quality impact assessment
AQMS	air quality monitoring station
AWS	Automatic weather station
BoM	Bureau of Meteorology
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DoE	Commonwealth Department of the Environment
DPHI	NSW Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
GHG	greenhouse gas
GJ	gigajoule
ha	hectares
km	kilometres
LGA	local government area
EPA	NSW Environment Protection Authority
NGERs	National Greenhouse and Energy Reporting
NO_x	oxides of nitrogen
NPI	National Pollution Inventory
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
POEO	Protection of the Environment Operations
SEARs	Secretary's Environmental Assessment Requirements
SO_2	sulphur dioxide
SSD	State Significant Development
TAPM	The Air Pollution Model
tpa	tonnes per annum
TSP	Total suspected particulates

VKT	Vehicle Kilometres Travelled
VOC	Volatile organic compounds
WSA	Western Sydney Airport

Appendix A
Meteorological analysis

creating opportunities

A.1 Meteorological data analysis for the Badgerys Creek AWS – 2019 to 2023

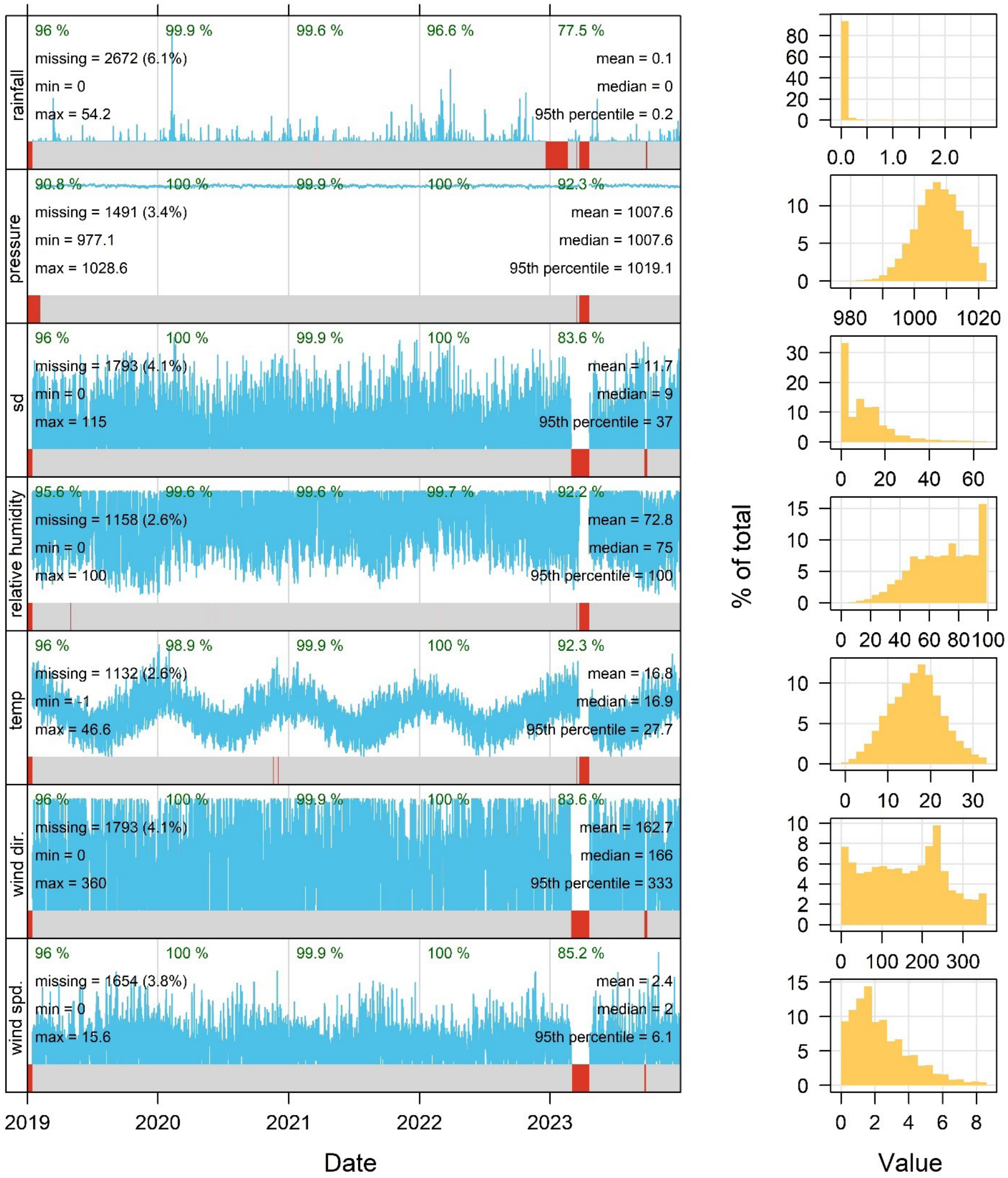


Figure A.1 Data completeness analysis plot – BoM Badgerys Creek AWS – 2019 to 2023

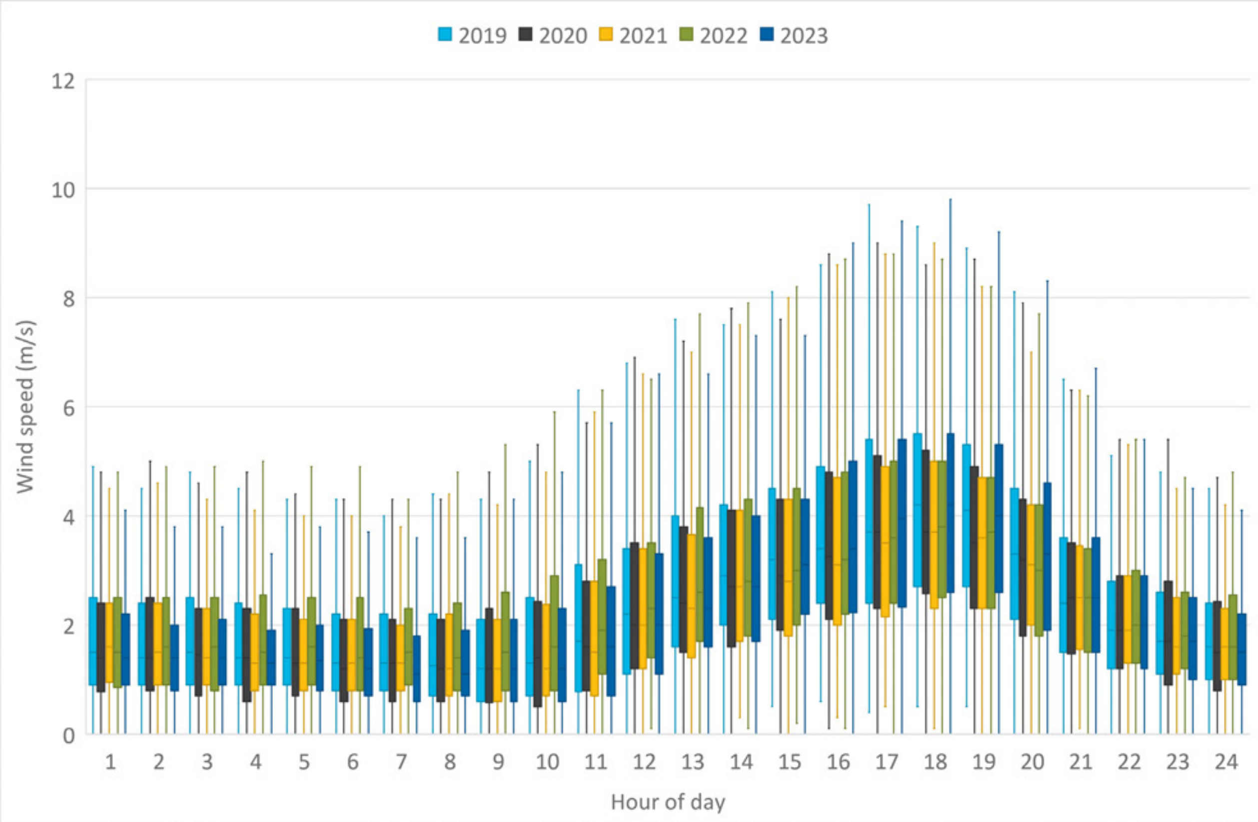


Figure A.2 Inter-annual variability in diurnal wind speed – Badgerys Creek– 2019 to 2023

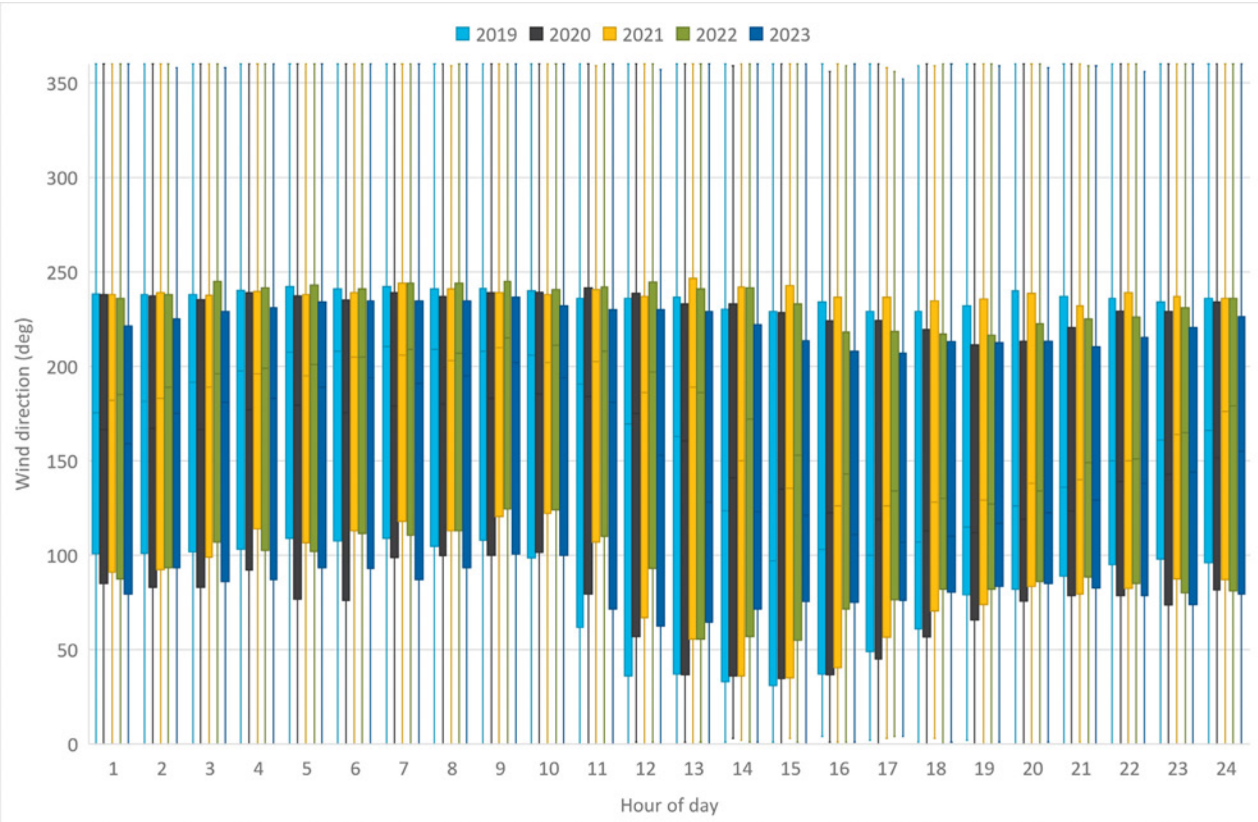


Figure A.3 Inter-annual variability in diurnal wind direction – Badgerys Creek– 2019 to 2023

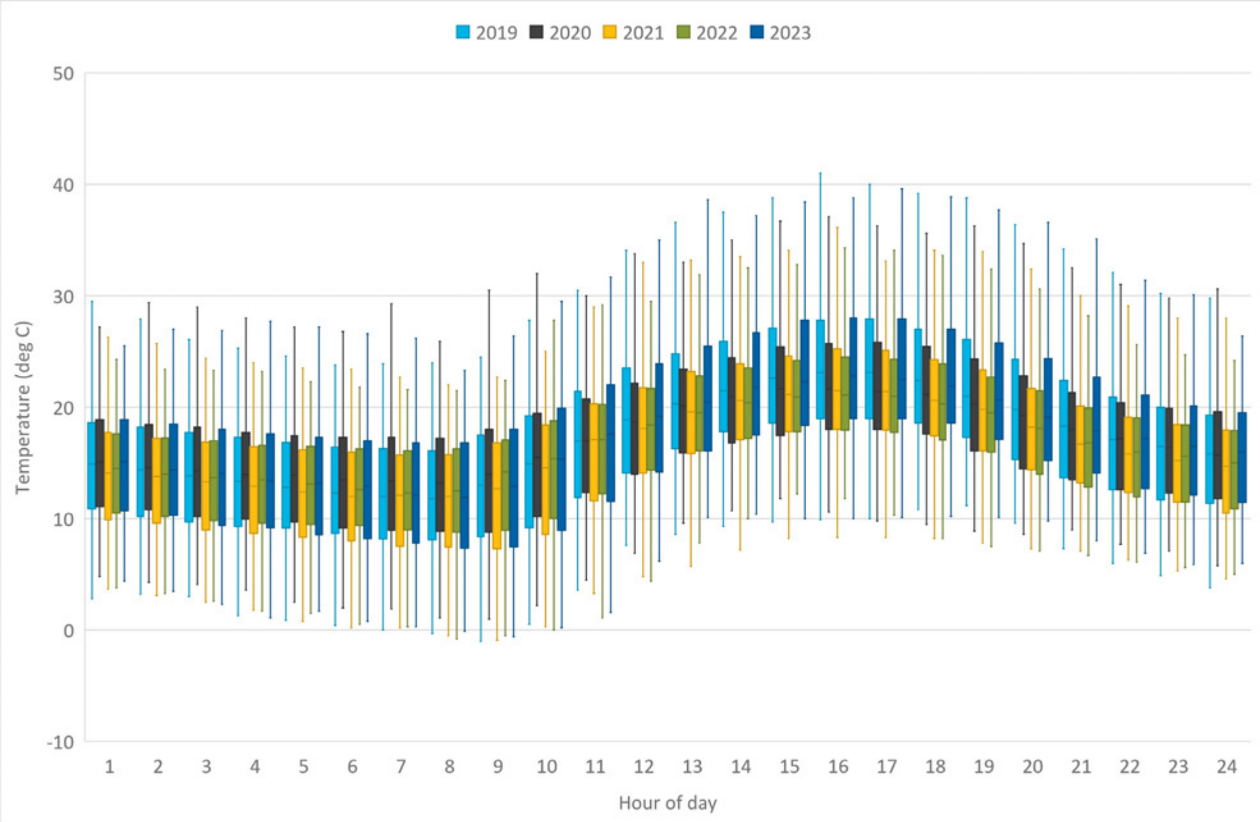


Figure A.4 Inter-annual variability in diurnal air temperature – Badgerys Creek– 2019 to 2023

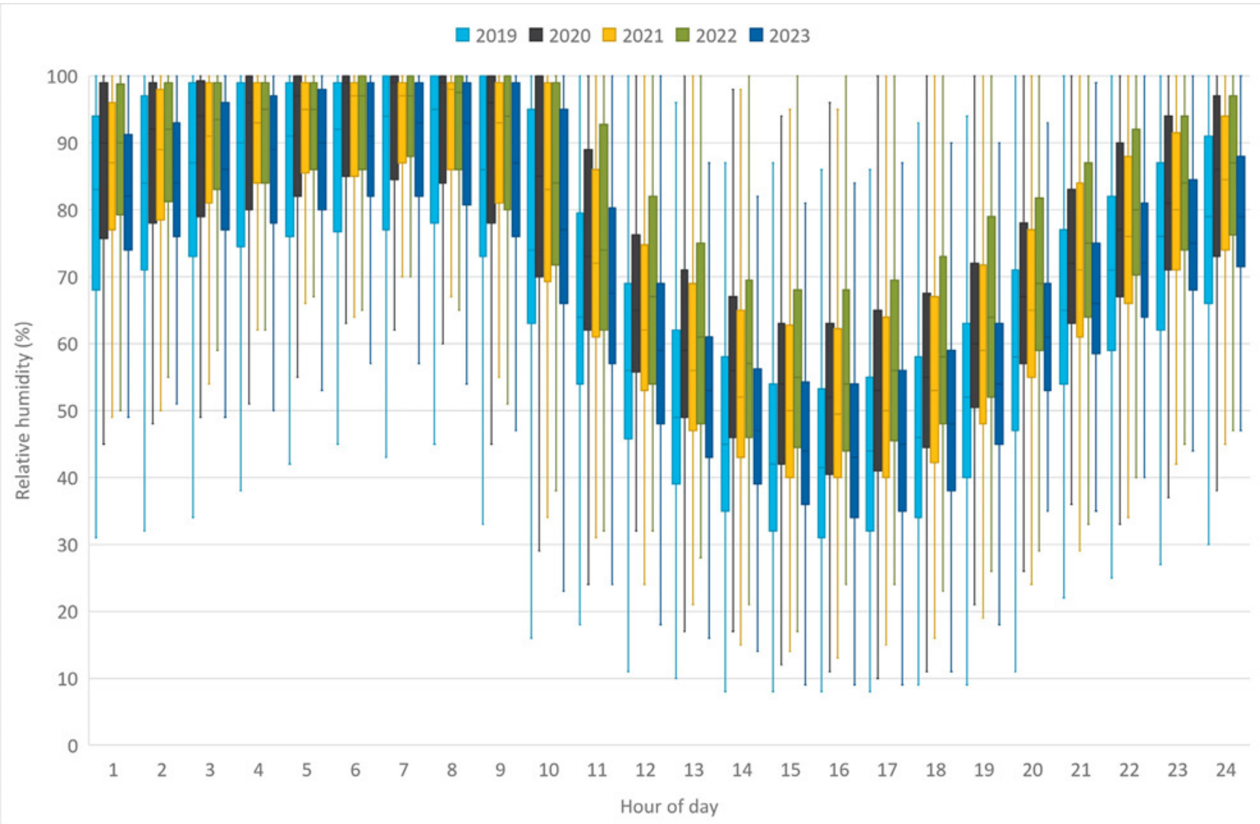


Figure A.5 Inter-annual variability in diurnal relative humidity – Badgerys Creek– 2019 to 2023

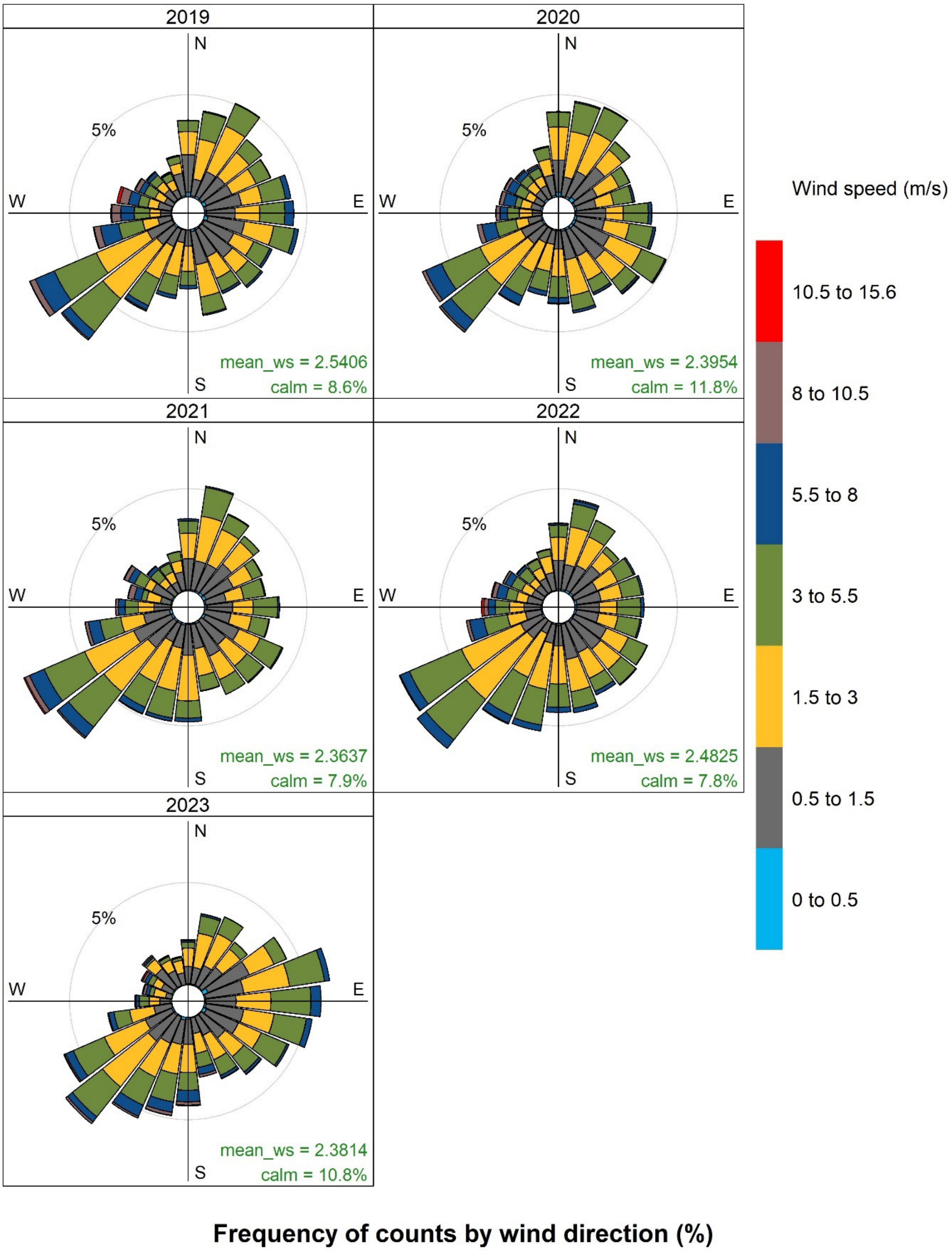


Figure A.6 **Inter-annual comparison of recorded wind speed and direction – Badgerys Creek AWS – 2019 to 2023**

A.2 Meteorological modelling

A.2.1 TAPM modelling

The CSIRO prognostic meteorological model TAPM was used to generate the required upper air prognostic dataset required for AERMET modelling.

TAPM was configured and run as:

- TAPM version 4.0.4
- 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, 3 km, 1 km and 0.3 km. Each grid domain features 25 x 25 horizontal grid points and 25 vertical levels
- TAPM default databases for land use, synoptic analyses and sea surface temperature
- TAPM defaults for advanced meteorological inputs
- surface meteorological data from the BoM Badgerys Creek AWS location were incorporated into the modelling
- two 'spin-up' days allowed at the beginning and end of the run.

A.2.2 AERMET meteorological processing

The meteorological inputs for AERMOD were generated using the AERMET meteorological processor. The following sections provide an overview of meteorological processing completed for this assessment.

A.2.3 Surface characteristics

Prior to processing meteorological data, the surface characteristics of the area surrounding the adopted monitoring station require parameterisation. The following surface parameters are required by AERMET:

- surface roughness length
- albedo
- Bowen ratio.

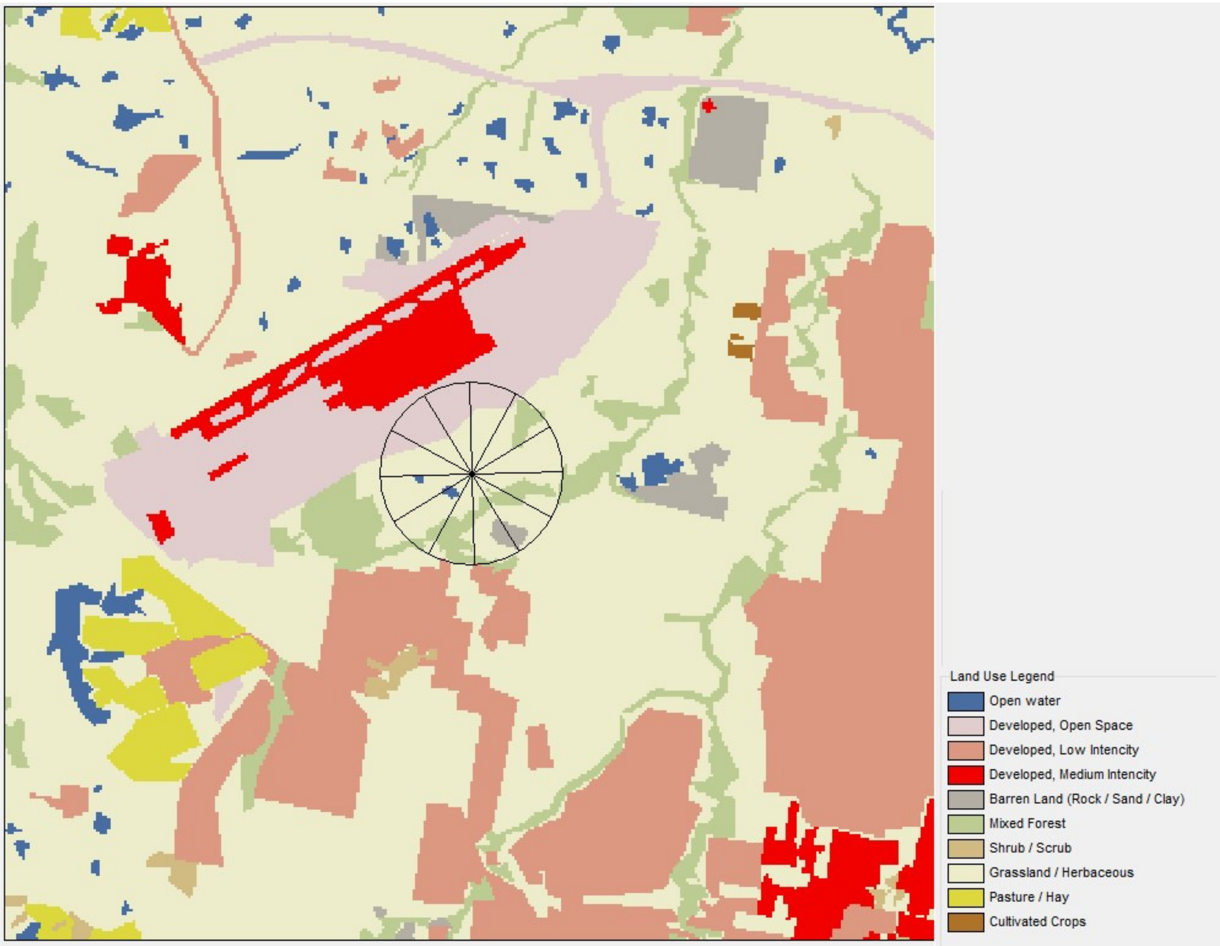
As detailed by USEPA (2013), the surface roughness length is related to the height of obstacles to the wind flow (e.g. vegetation, built environment) and is, in principle, the height at which the mean horizontal wind speed is zero based on a logarithmic profile. The surface roughness length influences the surface shear stress and is an important factor in determining the magnitude of mechanical turbulence and the stability of the boundary layer. The albedo is the fraction of total incident solar radiation reflected by the surface back to space without absorption. The daytime Bowen ratio, an indicator of surface moisture, is the ratio of sensible heat flux to latent heat flux and is used for determining planetary boundary layer parameters for convective conditions driven by the surface sensible heat flux.

The land cover of the 10 km by 10 km area surrounding the site was mapped (see Figure A.7). Using the AERSURFACE tool and following the associated guidance of USEPA (2013), surface roughness was determined for 12 (30 degree) sectors grouped by similar land use types within a 1 km radius around the on-site meteorological station, while the Bowen ratio and albedo were determined for the total area. Monthly-varying values for surface roughness, Bowen ratio and albedo were allocated to each sector based on the values prescribed by USEPA (2013).

Surface moisture characteristics for the 2021 modelling period was determined by comparing the period rainfall total to the previous 30-year rainfall records from the following BoM long term rainfall stations:

- Badgerys Creek AWS (067108)
- Bringelly (Maryland) (067015)
- Orchard Hills Treatment Works (067084).

Annual rainfall modelling was 1,064 mm, which places the 12-month period wetter than average with the 70th percentile rainfall totals for the previous 30 years. A 'wet' surface moisture classification was allocated. It is noted that the rainfall records are not incorporated into dispersion model predictions (i.e. no wet deposition is modelled).



Note: Marked in figure are the 1 km radius for surface roughness (12 sectors defined) and 10 km x 10 km for albedo/Bowen ratio (total image shown)

Figure A.7 Land use map for AERSURFACE processing

Table A.1 Monthly surface roughness length values by sector

Month	Surface roughness length (m) by sector (degrees)											
	0-30	30-60	60-90	90-120	120-150	150-180	180-210	210-240	240-270	270-300	300-330	330-0
Jan	0.223	0.179	0.145	0.175	0.168	0.056	0.181	0.185	0.202	0.136	0.084	0.271
Feb	0.223	0.179	0.145	0.175	0.168	0.056	0.181	0.185	0.202	0.136	0.084	0.271
Mar	0.223	0.179	0.145	0.175	0.168	0.056	0.181	0.185	0.202	0.136	0.084	0.271
Apr	0.223	0.179	0.145	0.175	0.168	0.056	0.181	0.185	0.202	0.136	0.084	0.271
May	0.223	0.179	0.145	0.175	0.168	0.056	0.181	0.185	0.202	0.136	0.084	0.271
Jun	0.119	0.060	0.032	0.057	0.049	0.016	0.145	0.134	0.163	0.076	0.023	0.219
Jul	0.119	0.060	0.032	0.057	0.049	0.016	0.145	0.134	0.163	0.076	0.023	0.219
Aug	0.119	0.060	0.032	0.057	0.049	0.016	0.145	0.134	0.163	0.076	0.023	0.219
Sep	0.185	0.129	0.092	0.125	0.116	0.039	0.169	0.167	0.190	0.114	0.057	0.254
Oct	0.185	0.129	0.092	0.125	0.116	0.039	0.169	0.167	0.190	0.114	0.057	0.254
Nov	0.185	0.129	0.092	0.125	0.116	0.039	0.169	0.167	0.190	0.114	0.057	0.254
Dec	0.223	0.179	0.145	0.175	0.168	0.056	0.181	0.185	0.202	0.136	0.084	0.271

Table A.2 Monthly Bowen ratio and albedo values (all sectors)

Month	Monthly value (all sectors)	
	Bowen ratio	Albedo
January	1.03	0.18
February	1.03	0.18
March	1.13	0.18
April	1.13	0.18
May	1.13	0.18
June	1.13	0.18
July	1.13	0.18
August	1.13	0.18
September	0.98	0.18
October	0.98	0.18
November	0.98	0.18
December	1.03	0.18

A.2.4 Meteorological inputs

Monitoring data from the Badgerys Creek AWS were combined with TAPM meteorological modelling outputs for input to AERMET. The following parameters were input as on-site data to AERMET:

- wind speed and directions – Badgerys Creek AWS
- temperature (heights of 10 m and 50 m) – Badgerys Creek AWS (10 m) and TAPM (50 m)
- relative humidity – Badgerys Creek AWS
- station level pressure – Badgerys Creek AWS
- cloud cover – Bankstown Airport AWS (in absence of measurements at Badgerys Creek)
- solar insolation – TAPM
- mixing depth – TAPM.

The period of meteorological data input to AERMET was 1 January 2021 to 31 December 2021.

A.2.5 Upper air profile

Due to the absence of necessary local upper air meteorological measurements, the hourly profile generated by TAPM at the on-site meteorological station location was adopted. Using the temperature difference between levels, the TAPM-generated vertical temperature profile for each hour was adjusted relative to the hourly surface (10 m) temperature observations from the Badgerys Creek AWS.

Appendix B

Emissions inventory background

EMM
creating opportunities

B.1 Introduction

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

- NPI Emissions Estimation Technique Manual for Combustion Engines (NPI 2008)
- NPI Emission Estimation Technique Manual for Mining (NPI 2012)
- US-EPA AP-42 Chapter 11.9, Table 11.9-4 – Wind erosion of exposed areas (US-EPA 1998)
- US-EPA AP-42 Chapter 11.9, Table 11.19.2-1 – Tertiary crushing (controlled) (US-EPA 2004)
- US-EPA AP-42 Chapter 11.9, Table 11.19.2-1 – Screening (controlled) (US-EPA 2004)
- US-EPA AP-42 Chapter 13.2.2 – Unpaved roads (US-EPA 2006a)
- US-EPA AP-42 Chapter 13.2.4 – Aggregate handling and storage piles (US-EPA 2006b).

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

B.2 Emissions inventory assumptions

Material parameters adopted within the emissions inventory are presented in Table B.1.

Table B.1 Assumed material parameters

Material / site area	Parameter	Value	Source
Topsoil & overburden / cut and fill	Moisture content (%)	2	Default silt content for material, NPI 2012
	Silt content (%)	10	Default moisture content for material, NPI 2012
Material haulage	Silt content (%)	8.5	Default moisture content for construction sites – Material storage area AP42 13.2.2

B.3 Material haulage assumptions

Assumptions adopted for material haulage for the project are presented in Table B.2.

Table B.2 Haulage calculations

Haulage source	Distance (km)	Truck capacity (t)	Truck weight empty (t)	Truck weight full (t)	Truck weight average (t)	Loads per year	VKT per year (km)
Cut material – stage 1	0.8	30.2	32.8	63.0	47.9	54,516.7	87,226.7
Fill material – stage 1 to stage 2	0.8	30.2	32.8	63.0	47.9	4,958.9	7,934.2
Cut material – stage 2	0.8	30.2	32.8	63.0	47.9	10,256.9	16,411.0

Note: VKT = Vehicle kilometres travelled

B.4 Onsite diesel combustion emissions

Emissions generated by onsite plant and equipment diesel consumption was quantified through the following assumptions:

- project operations with annual diesel consumption rate for quarrying of 5,000 L per year per stage and annual diesel consumption rate for construction works of 1,490,000 L per year per each stage
- the corresponding USEPA (USEPA 2016) Tier 2 emissions standards for PM of 0.2 g/kWh was selected
- the g/kWh emission standard was converted to g per litre of diesel by applying a scaling factor of 3, as per the notes for Table 35 in *NPI Emissions Estimation Technique Manual for Combustion Engines* (NPI 2018)
- the PM emission standard is assumed to correspond to PM_{10} with $PM_{2.5}$ emissions derived from the relationship between PM_{10} and $PM_{2.5}$ emission factors presented in Table 35 in NPI 2008 (91.7%).

B.5 Emissions inventory table

A summary of the emissions inventory for the project is presented in Table B.3.

Table B.3 Emissions inventory

Source name	Source type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Reduction factor	Emission control
Excavated material haulage to fill area	Unpaved haulage	86,016.3	24,576.7	2,457.7	87,227	VKT/year	3.94	1.13	0.11	kg/VKT	8.5	% silt content	1.6	Return haul distance (km)	54,517	Loads/year	48	Average weight (t)	75%	Water cart
Scrapers stripping topsoil	Material handling	1,865.4	469.6	71.1	128,645	t/y	0.029	0.007	0.001	kg/t									50%	Watering of travel routes
Excavator at cut area	Material handling	2,157.4	1,020.4	154.5	1,647,767	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Crushing sandstone & oversized	Crushing/ screening	667.3	296.6	20.0	494,330	t/y	0.00270	0.00120	0.00008	kg/t									50%	Water sprays
Topsoil screening	Crushing/ screening	804.0	276.6	18.7	128,645	t/y	0.0125	0.0043	0.00029	kg/t									50%	Water sprays
Loading material to trucks in cut area	Material handling	2,157.4	1,020.4	154.5	1,647,767	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Unloading at fill area	Material handling	1,219.8	576.9	87.4	931,675	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Dozer/grader at fill area	Dozer/grader	48,624.5	11,750.4	5,105.6	5,811	h/y	16.735	4.044	1.757	kg/h	10.0	Silt content (%)	2	Moisture content (%)					50%	Watering of travel routes
Excavator at fill area	Material handling	1,219.8	576.9	87.4	931,675	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Excavated material haulage to fill area	Unpaved haulage	16,183.3	4,623.9	462.4	16,411	VKT/year	3.94	1.13	0.11	kg/VKT	8.5	% silt content	1.6	Return haul distance (km)	10,257	Loads/year	48	Average weight (t)	75%	Water cart
Stage 1 excavated material haulage to Stage 2 fill area	Unpaved haulage	7,824.1	2,235.5	223.6	7,934	VKT/year	3.94	1.13	0.11	kg/VKT	8.5	% silt content	1.6	Return haul distance (km)	4,959	Loads/year	48	Average weight (t)	75%	Water cart
Scrapers stripping topsoil	Material handling	758.3	190.9	28.9	52,296	t/y	0.029	0.007	0.001	kg/t									50%	Watering of travel routes
Excavator at cut area	Material handling	405.9	192.0	29.1	310,013	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						

Table B.3 Emissions inventory

Source name	Source type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Reduction factor	Emission control
Crushing sandstone & oversized	Crushing/ screening	125.6	55.8	3.8	93,004	t/y	0.00270	0.00120	0.00008	kg/t									50%	Water sprays
Topsoil screening	Crushing/ screening	326.8	112.4	7.6	52,296	t/y	0.0125	0.0043	0.00029	kg/t									50%	Water sprays
Loading material to trucks in cut area	Material handling	405.9	192.0	29.1	310,013	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Unloading at fill area	Material handling	602.1	284.8	43.1	459,895	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Dozer/grader at fill area	Dozer/grader	48,625	6,312	5,106	5,811	h/y	16.735	2.172	1.757	kg/h	10.0	Silt content (%)	2	Moisture content (%)					50%	Watering of travel routes
Excavator at fill area	Material handling	602.1	284.8	43.1	459,895	t/y	0.0013	0.0006	0.00009	kg/t	2.4	Average wind speed (m/s)	2	Moisture content (%)						
Stage 1 area wind erosion	Wind erosion	6,374.0	3,187.0	956.1	23.5	Area (ha)	0.400	0.200	0.060	kg/ha/hour	677	Hours >5.4 m/s								
Stage 2 area wind erosion	Wind erosion	2,597.5	1,298.7	389.6	9.6	Area (ha)	0.400	0.200	0.060	kg/ha/hour	677	Hours >5.4 m/s								
Diesel combustion - Stage 1	Fuel combustion	894.0	894.0	819.5																
Diesel combustion - Stage 2	Fuel combustion	894.0	894.0	819.5																

Appendix C
Incremental (project-only) isopleth plots

creating opportunities

KEY

- Project boundary
- Sensitive receptor

Annual average TSP concentrations (µg/m³)

- 2
- 5
- 10
- 50
- 80

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

Source: EMM (2024); DCSSS (2024); MetroMap (2024)

Predicted annual average TSP concentrations (µg/m³) - project only

Burrah Park SSDA
Air Quality Impact Assessment
Figure C.1

creating opportunities

\\emm.local\xdrive\2024\E240316 - Burrah Park SSDA\GIS\02_Maps\Air_Quality\AQ003_TSPconcentrations_20240708_03.aprx 26/07/2024

Source: EMM (2024); DCSSS (2024); MetroMap (2024)

0 0.5 1 km
GDA2020 MGA Zone 56
N

KEY

Project boundary

Sensitive receptor

24-hour average PM_{10} concentrations (μg/m³)

5

10

20

50

Existing environment

Major road

Minor road

Vehicular track

Named watercourse

Named waterbody

Predicted maximum 24-hour average PM_{10} concentrations (μg/m³) - project only

Burrah Park SSDA
Air Quality Impact Assessment
Figure C.2

EMM
creating opportunities

Source: EMM (2024); DCSSS (2024); MetroMap (2024)

Predicted annual average PM_{10} concentrations (µg/m³) - project only

Burrah Park SSDA
Air Quality Impact Assessment
Figure C.3

EMM creating opportunities

\\emm.local\sydrive\2024\E240316 - Burrah Park SSDA\GIS\02_Maps\Air_Quality\AQ005_AnnualPM10Concentrations_20240708_03.aprx 26/07/2024

Source: EMM (2024); DCSSS (2024); MetroMap (2024)

0 0.5 1 km

GDA2020 MGA Zone 56

N

KEY

Project boundary

Sensitive receptor

24-hour average $PM_{2.5}$ concentrations (µg/m³)

3

5

10

Existing environment

Major road

Minor road

Vehicular track

Named watercourse

Named waterbody

Predicted maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³) - project only

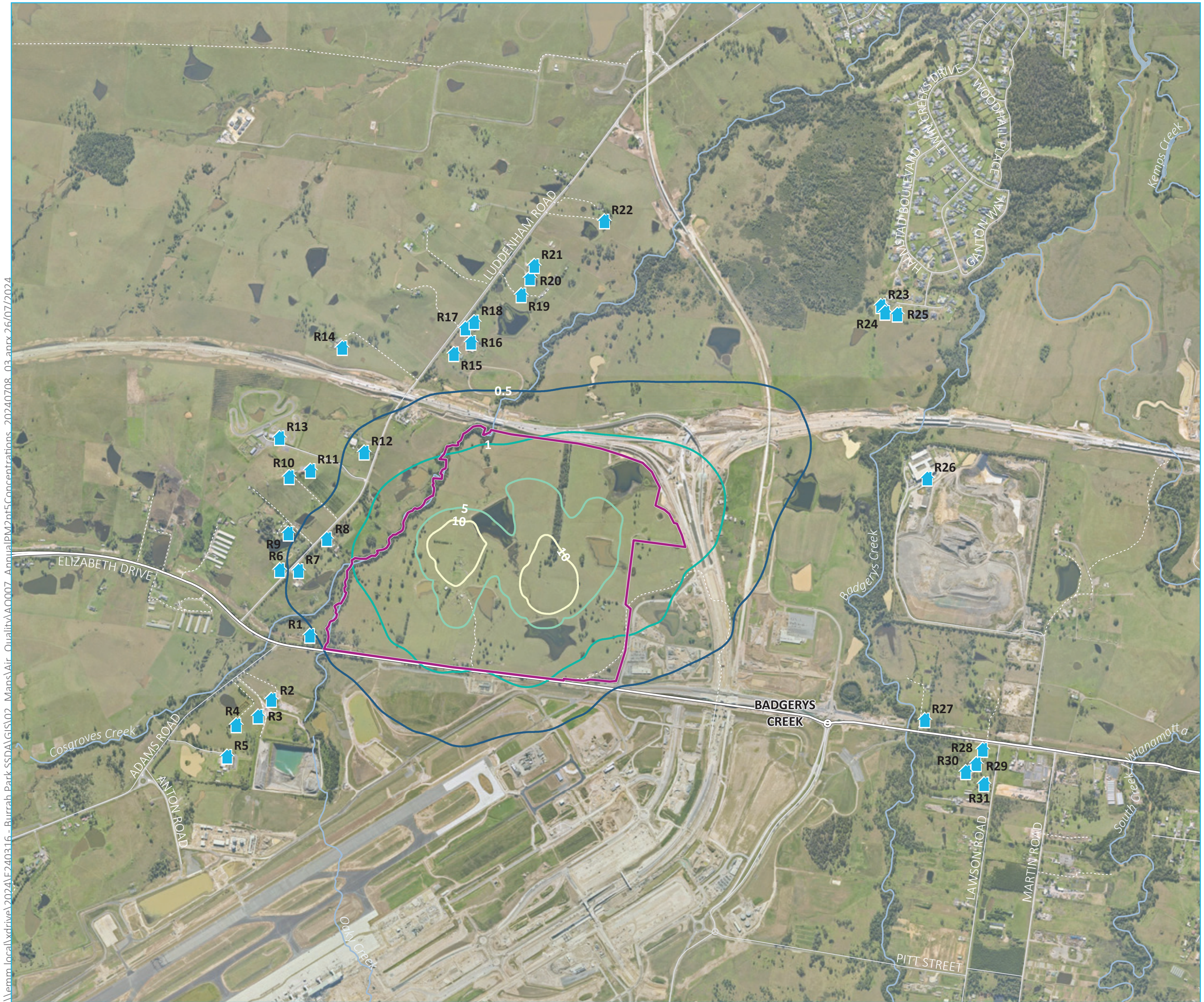
Burrah Park SSDA

Air Quality Impact Assessment

Figure C.4

EMM creating opportunities

\\emm.local\vdrive\2024\E240316 - Burrah Park SSDA\GIS\02_Maps\Air_Quality\AQ006_PM2pt524hrConcentrations_20240708_02.aprx 25/07/2024



KEY

- Project boundary
- Sensitive receptor

Annual average $PM_{2.5}$ concentrations (μg/m³)

- 0.5
- 1
- 5
- 10

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

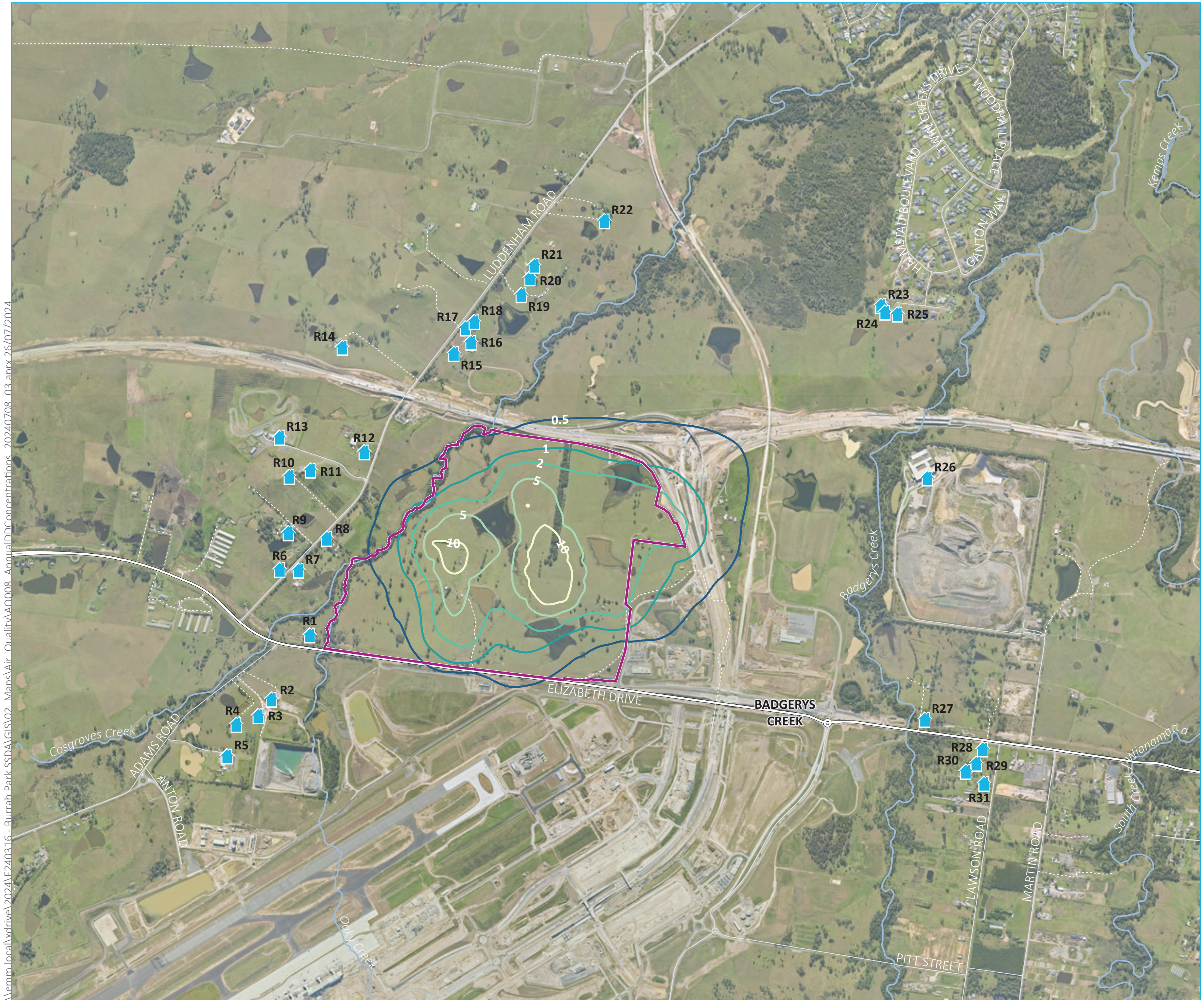
Source: EMM (2024); DCSSS (2024); MetroMap (2024)

\\emm.local\xdrive\2024\E240316 - Burrah Park SSDA\GIS\02_Maps\Air_Quality\AQ007_AnnualPM2pt5Concentrations_20240708_03.aprx 26/07/2024

Predicted annual average $PM_{2.5}$ concentrations (μg/m³) - project only

Burrah Park SSDA
Air Quality Impact Assessment
Figure C.5

EMM creating opportunities



Source: EMM (2024); DCSSS (2024); MetroMap (2024)

0 0.5 1 km
GDA2020 MGA Zone 56

KEY

- Project boundary
- Sensitive receptor

Annual average dust deposition levels (g/m²/month)

- 0.5
- 1
- 2
- 5
- 10

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

Predicted annual average dust deposition levels (g/m²/month) -project only

Burrah Park SSDA
Air Quality Impact Assessment
Figure C.6

EMM
creating opportunities

Appendix D
GHG emissions detail

EMM
creating opportunities

D.1 Diesel (onsite plant and equipment)

GHG emissions from diesel consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from diesel combustion	(t CO_2-e)
Q_i	=	Quantity of fuel	(kL)
EC_i	=	Energy content of fuel	(GJ/kL)[9]
EF_{ijoxec}	=	Emission factor (scope 1) for diesel consumption	(kg CO_2-e/GJ)[10]

GHG emission factors and energy content for diesel were source from the NGAF (DCCEEW 2023). These are presented in Table D.1.

The estimated GHG emissions from the on-site diesel consumption are presented in Table D.2.

Table D.1 GHG emission factors – diesel combustion (stationary)

Fuel type	Energy content (Gj/kL)	Scope 1 emission Factors (kg CO_2-e/GJ)		
		CO_2	CH_4	N_2O
Diesel	38.6	69.9	0.1	0.2

Table D.2 Estimate CO_2-e (tonnes) for annual project diesel consumption – earthworks and construction

Period	Diesel use (kL/annum)		Emissions (t CO_2-e)
	Earthworks	Construction	
Year 1	3,600	910	12,220
Year 2	1,800	1,120	7,913
Year 3	450	910	3,684
Project lifetime	**5,850**	**2,940**	**23,818**

9 GJ = gigajoules

10 kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

D.2 Vegetation clearing

GHG emissions from carbon sink loss due to vegetation clearing were estimated using the methodology set out in Appendix E of TAAG 2013. The main steps in the methodology included the following:

1. Determine of the types and areas of vegetation to be cleared over the course of the project.
2. Link the vegetation type to a vegetation class as given in Table 1 of TAAG 2013.
3. Use the maps given in Attachment A of TAAG 2013 to determine the 'maximum potential biomass class' based on the project's location.
4. Use the vegetation type and maximum potential biomass class to look up the CO_2-e emission factor for each vegetation class.
5. Multiply the area of vegetation cleared with the emission factor for each vegetation class and combine to estimate the total GHG emissions.

The emissions input data and estimated GHG emissions from land clearing are presented in Table D.3.

Table D.3 Emissions input data and estimated CO2-e (tonnes) for vegetation clearing

Period	Vegetation class	Vegetation type	Amount cleared (ha)	Maximum potential biomass class	TAAG Workbook Table 2 emission factors (t CO_2-e/ha)	Annual Scope 1 (t CO_2-e)
Year 1	I	Grasslands	54.5	4	110	5,998
Year 2			57.1			6,289
Year 3			13.0			1,430
TOTAL						**13,717**

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Level 2 Suite 2.04
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8 454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9 109 St Georges Terrace
Perth WA 6000

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au